

**STUDY COMMISSIONED
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**Evaluation of economic forecasts
for Austria**

An update for the years 2005 to 2020

Philip Schuster

Vienna, December 2021

Evaluation of Economic Forecasts for Austria – An update for the years 2005 to 2020

Philip Schuster*

Study commissioned by the Austrian Fiscal Advisory Council**

December 2021

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TABLE OF CONTENTS

EXECUTIVE SUMMARY	2
1. INTRODUCTION.....	3
2. RESULTS.....	5
REFERENCES	16
APPENDIX A: METHODS OF FORECAST EVALUATION	17
APPENDIX B: ADDITIONAL TABLES AND FIGURES	19

LIST OF TABLES

Table 1: Overview of forecasting dates of different institutions.....	3
Table 2: Overview of forecasted variables and definitions used.....	4
Table 3: Summary of forecast errors of all institutions.....	8
Table 4: Persistency in forecast errors as measured by the autocorrelation coefficient.....	13
Table 5: Number of episodes with at least 8 consecutive biased forecasts in the same direction ...	14
Table 6: Summary of Ministry of Finance forecasts of general government budget balance (in % of GDP) for t and t+1	19
Table 7: Summary of forecast errors (vs. current realisation) of all institutions.....	21
Table 8: Summary of forecast errors of all institutions (using June instead of March and December instead of September forecasts for WIFO and IHS).....	23
Table 9: Summary of forecast errors of all institutions (without 2020)	25

LIST OF FIGURES

Figure 1: Standardised and non-standardised forecast errors.....	6
Figure 2: Forecasts and data realisations for the years 2005 to 2020	7
Figure 3: Forecast errors over forecasting horizon	11
Figure 4: Standardised and non-standardised forecast errors (using June instead of March and December instead of September forecasts for WIFO and IHS)	20
Figure 5: Standardised and non-standardised forecast errors (without 2020)	20
Figure 6: Forecast errors over forecasting horizon (without 2020)	27

EXECUTIVE SUMMARY

English summary:

This study evaluates the macroeconomic forecasts by the Austrian Institute of Economic Research (WIFO) that serve as input for the official government budget forecasts prepared by the Austrian Federal Ministry of Finance (MOF), as well as MOF's forecasts for the years 2005 to 2020. We benchmark WIFO's and MOF's forecasts against other institutions' forecasts. The study is an update of Schuster (2018) and confirms the following key findings: First, forecasts by different institutions are much more correlated with each other than with actual outcomes. Second, forecasts tend to underestimate upswings and downturns. Third, in general, GDP forecasts are less biased than the forecasts of GDP subcomponents. Private consumption, imports and export tend to be overestimated, while public consumption tends to be underestimated. Fourth, a ranking of institutions by forecasting performance in general is not robust to changes in the evaluation setting. WIFO's forecasts of investment, compensation of employees and unemployment robustly have above-average precision, while WIFO's precision of imports and exports forecasts robustly falls short of WIFO's peers' forecasts, but, in general, the differences between institutions' forecasts are quite small. The COVID-19 pandemic led to a general deterioration in forecasting precision, in particular in institutions' forecasts with early publication dates in the spring of 2020. MOF's overall government budget forecasting performance – until 2019 the most precise of all evaluated institutions' forecasts – suffered the most due to a smaller number of total observations, which implies a higher relative weight for the forecast errors for the year 2020. If we use a tolerance level of one standard deviation, neither WIFO nor MOF produced a single episode (8 consecutive forecasts or more) of same-signed significantly biased forecasts, i.e. no systematic bias in the sense of Council Directive 2011/85/EU was detected.

Deutsche Zusammenfassung:

Die vorliegende Studie evaluiert die Makroprognosen des Österreichischen Instituts für Wirtschaftsforschung (WIFO), die als Grundlage für die offiziellen Budgetprognosen des Bundesministeriums für Finanzen (BMF) dienen, sowie die diesbezüglichen Budgetprognosen des BMF für die Jahre 2005 bis 2020. Die Evaluierung erfolgt durch einen Vergleich mit den Prognosen anderer Institutionen. Die Studie ist eine Aktualisierung von Schuster (2018) und bestätigt die folgenden Erkenntnisse: Erstens, Prognosen unterschiedlicher Institutionen sind stärker untereinander korreliert als mit den realisierten Daten. Zweitens, Auf- und Abschwünge werden tendenziell unterschätzt. Drittens, Prognosen des BIP sind im Allgemeinen weniger verzerrt als jene der Subkomponenten. Tendenziell werden privater Konsum, Importe und Exporte überschätzt, während die Entwicklung des öffentlichen Konsums unterschätzt wird. Viertens, eine allgemeine Reihung der Institutionen nach Prognosegüte ist nicht robust gegenüber Änderungen in der Ausgestaltung der Evaluierung. Die WIFO-Prognosen für Investitionen, Arbeitnehmerentgelte und Arbeitslosigkeit sind robust überdurchschnittlich präzise, während die Prognosen für Importe und Exporte robust unterdurchschnittlich präzise sind. Allerdings sind die Unterschiede zwischen den Institutionen im Allgemeinen sehr klein. Die COVID-19-Pandemie führte zu einer allgemeinen Verschlechterung der Prognosegüte, wobei dies im Besonderen für Institutionen zutrifft, die früh im Frühling 2020 ihre Prognosen veröffentlichten. Die BMF-Budgetprognose – bis 2019 die präziseste Prognose aller untersuchten Institutionen – litt aufgrund der geringeren Gesamtanzahl an Beobachtungen, die ein höheres relatives Gewicht der Fehler für 2020 bedeutet, am meisten. Dennoch konnte unter Anwendung einer Toleranzschwelle von einer Standardabweichung weder für das WIFO noch für das BMF eine Episode von zumindest acht aufeinanderfolgenden, gleichgerichteten signifikanten Prognosefehlern – und folglich keine systematische Verzerrung im Sinne der Richtlinie 2011/85/EU – identifiziert werden.

1. INTRODUCTION

This study provides an ex-post evaluation of macroeconomic forecasts for Austria in line with Council Directive 2011/85/EU, which calls for regular independent assessments of Member States' forecasts. The analysis is an update of Schuster (2018) to extend the analysed time horizon by three additional years to 2005 to 2020. As there have been no methodological changes, data and forecast evaluation methods are only sketched briefly. Interested readers are referred to Schuster (2018) for more details and background information. Similar exercises for Austria have been done by Baumgartner (2002a,b), Ragacs and Schneider (2007) and Fortin et. al (2020).

The Austrian Federal Ministry of Finance (henceforth MOF) uses the macroeconomic forecast prepared by an independent institution – the Austrian Institute of Economic Research (henceforth WIFO) – as input when preparing its budget plans. Given its aim, this study focuses on the macroeconomic forecasting performance of WIFO forecasts and on the quality of MOF's government budget balance forecasts. Their forecasts for Austria are benchmarked against the forecasts by other institutions, namely the European Commission (EC), the Institute for Advanced Studies, Vienna (IHS), the International Monetary Fund (IMF), the Organisation for Economic Co-operation and Development (OECD) and the Austrian central bank (Oesterreichische Nationalbank, OeNB). As different forecasting schedules hinder the interinstitutional comparability of forecasting performance, the study groups the forecasts by the different institutions in such a way that the available information sets are as similar as possible. This way the relative strengths and weaknesses of the WIFO and MOF forecasts can be best identified.

MOF typically uses WIFO's March forecast to prepare the Stability Programme (StabPro)¹ and the October forecast as input for compiling the Draft Budgetary Plan (DBP). Therefore, we consider only spring and autumn forecasts. Table 1 lists all institutions covered and the publication times of their spring and autumn forecasts. According to the chosen grouping, WIFO and IHS are always the first to present their macroeconomic forecasts within a term, followed by the IMF, the EC, and the OECD, while the OeNB's forecasts are the last ones to be published within a term.²

Table 1: Overview of forecasting dates of different institutions

Institution	Acronym	forecasts published per year	forecasts per year considered	spring forecast		autumn forecast	
				month of publication	last available quarter before cut-off	month of publication	last available quarter before cut-off
Austrian Institute of Economic Research	WIFO	4	2	March	Q4/t-1	October	Q2/t
Institute for Advanced Studies	IHS	4	2	March	Q4/t-1	October	Q2/t
Austrian Federal Ministry of Finance (budget forecast only)	MOF	2	2	April	Q4/t-1	October	Q2/t
International Monetary Fund	IMF	2	2	April	Q4/t-1	October	Q2/t
European Commission	EC	4 ^{*)}	2	May	Q4/t-1	October	Q2/t
Organisation for Economic Co-operation and Development	OECD	2	2	May	Q4/t-1	November	Q2/t
Oesterreichische Nationalbank	OeNB	2	2	June	Q1/t	December	Q3/t

Source: own compilation based on (latest) individual forecast material. 'quarter' refers to regular (i.e. non-flash) quarterly national accounts data.

Note: *) The winter and summer forecasts of the EC are currently limited to presenting updated estimates for GDP growth and inflation.

Table 2 provides an overview of the 13 chosen variables that are benchmarked across forecasting institutions. Next to the usually benchmarked indicators (i.e. real GDP and its components by the expenditure approach, inflation, unemployment rate, etc.), this list includes additional variables that are particularly

¹ In spring of 2020 MOF published the StabPro unusually early (mid of March) due to the delayed budgeting process in fall 2019 because of the formation of a new government. They published an official technical update of the StabPro around the usual publication date (end of April), which was classified as MOF spring forecast 2020 in our exercise.

² The disadvantage this grouping for WIFO and IHS in comparison to OeNB is assessed in the robustness check section.

relevant as inputs for fiscal forecasts (nominal GDP, employment, compensation of employees, gross operating surplus).

Table 2: Overview of forecasted variables and definitions used

Variable	Measure	Institutions						
		EC	IHS	IMF	MOF	OeNB	OECD	WIFO
GDP, real	annual growth rate	NSA	NSA	NSA	x	SCA	SCA	NSA
private consumption, real	annual growth rate	NSA	NSA	x	x	SCA	SCA	NSA
public consumption, real	annual growth rate	NSA	NSA	x	x	SCA	SCA	NSA
investment, real	annual growth rate	NSA, GFCF	NSA, GCF	x	x	SCA, GFCF	SCA, GFCF	NSA, GFCF
exports (goods and services), real	annual growth rate	NSA	NSA	NSA ³⁾	x	SCA	SCA	NSA
imports (goods and services), real	annual growth rate	NSA	NSA	NSA ³⁾	x	SCA	SCA	NSA
GDP, nominal	annual growth rate	NSA	NSA	NSA	x	SCA	SCA	NSA
compensation of employees	annual growth rate	NSA ¹⁾	NSA	x	x	SCA	x	NSA
gross operating surplus (and mixed income)	annual growth rate	NSA ²⁾	NSA	x	x	SCA	x	NSA
inflation	annual growth rate	HICP	CPI	HICP	x	HICP	HICP	HICP
employment	annual growth rate	LNN	HV	LFSE ⁴⁾	x	LEN	LFSE ⁶⁾	HV
unemployment rate	annual level (in % of LF)	LFSU	LFSU	LFSU	x	LFSU	LFSU ⁶⁾	LFSU
(general) government budget balance	annual level (in % of GDP)	NSA	NSA	NSA	NSA ⁵⁾	NSA	NSA	NSA

Source: own compilation based on individual forecast material.

Notes: x: not available, LF: labour force, SCA: seasonally and calendar adjusted (for OeNB only trend-cycle without irregular component), NSA: not seasonally or calendar adjusted, GFCF: gross fixed capital formation, GCF: gross capital formation, HICP: harmonized index of consumer prices, CPI: (national) consumer price index, LFSU: Labour Force Survey; as % of labour force, HV: Main Association of Austrian Social Security Institutions ("Hauptverband"), employees only, LEN: national accounts (domestic concept), employees only, LNN: national accounts (domestic concept), total employment, LFSE: Labour Force Survey (resident concept), 15+, total employment. 1) only since spring 2006 (spring 2007 missing), 2) only since spring 2011, 3) only since autumn 2011, 4) only since autumn 2007, 5) for publication dates see table in appendix, 6) only since spring 2010.

The observation period runs from 2005 to 2020, which allows for a sufficiently complete and consistent data set. The evaluation is restricted to current year (t) and year ahead (t+1) forecasts. By default, forecast errors are computed by using first available realisations as reference data. The initial realisations as published by the Austrian statistical agency, Statistics Austria (STAT), are typically available after the first quarter of the following year.

The study confirms the following main findings of Schuster (2018): First, forecasts by different institutions are more correlated with each other than with actual outcomes. Second, forecasts are smoother than outcomes, i.e. upswings and downturns tend to be underestimated. Also, without taking 2020 into account, the other key findings of Schuster (2018) are still valid: GDP estimates (real and nominal) are unbiased, while the same is not necessarily true for its components. Private consumption and investment growth tends to be overestimated, while the growth of public consumption and net exports tends to be underestimated. For GDP components by the income approach, it was found that compensation of employees was underestimated, while gross operating surplus was overestimated. Last, and probably partly related to the general underestimation of employment and compensation of employees, it was found that the budget deficit was significantly overestimated by all institutions.

Taking 2020 into account has sizable consequences for the average forecast errors, even when averaged over a period of 15 years, due to the sheer size of the unpredicted economic shock following the COVID-19 pandemic. The forecasting performance of all institutions was affected. The average overestimation of the yearly real GDP growth rate increases from 0.09 to 0.35 just by including 2020. Likewise, the average root mean squared error (RMSE) increases from 1.14 to 1.84. The tendency that private consumption is overestimated increases if 2020 is included. On the other hand, the significant underestimation of compensation of employees and the government budget balance vanishes once the year 2020 is included in the analysis. These changes are much less pronounced when looking at the median bias (MDB) and the root median squared error (RMDSE).

The interpretation of forecast errors including 2020 requires some additional qualifying comments. First, while all institutions' forecasting performance suffered – and the study's focus is more on relative than absolute forecast errors – this is still more the case for some institutions than for others. In particular,

the information disadvantage of WIFO and (to a slightly larger extent³) IHS, who were the first to publish in the spring 2020 forecasting term, was much more severe than in normal times, which is reflected in a larger increase in overall current year forecast errors, e.g. for real GDP. Second, due to the grave uncertainty some institutions only published a reduced forecast in spring 2020 in terms of forecasting horizon and/or set of variables. Again, this was particularly the case with WIFO and IHS. Due to the methodological set-up, this tends to improve their average forecasting performance in relative terms for the omitted variables.⁴ Third, the inclusion of 2020 renders the bias (calculated by using the arithmetic mean) less informative. For example, the fact that the government budget balance is now found to be not significantly biased anymore is not the result of an improvement in the quality of the forecasts but solely due to two unrelated errors cancelling each other out. This calls for a stronger emphasis on the median bias (MDB) in the interpretation. These issues must be kept in mind, which is why the robustness check excluding 2020 is not just presented in the robustness check section but is already contrasted with the default setting in the main results section whenever necessary.

In terms of error persistence, it is found that autocorrelation of forecast errors is hardly an issue (except for public consumption). In comparison with other institutions' forecasts, same-signed bias is not more pronounced in WIFO and MOF forecasts. With a tolerance level of one standard deviation neither WIFO nor MOF produced a single episode of same-signed biased forecasts.

The next section reports the main results in greater detail. Forecast errors are checked in terms of bias, precision, and persistency. In addition, the robustness of the results is reported. Detailed information from the robustness checks (tables and figures) are presented in the appendix.

2. RESULTS

Forecast errors by variable and institution

The observation period 2005–2020 was characterised by the following business cycle pattern. Growth of real GDP was strong until 2008, before the economy was hit by the ramifications of the global financial crisis, which in 2009 led to a drop in real GDP which then was the biggest since the Second World War. After a swift recovery in the following two years, economic growth remained weak before gaining momentum until the COVID-19 pandemic resulted in an unprecedented economic contraction in 2020, which dwarfed the downturn due to the financial crisis. Figure 2 plots the development of the 13 selected economic indicators based on first and revised data versus the averaged forecasts. As the projections by WIFO (all variables but government budget balance) and MOF (government budget balance only) are at the core of this study, their forecasts are always plotted against the unweighted averages over provided by all institutions. The main observations that can be made from Figure 2 are that forecasts are more correlated amongst themselves than compared to actual outcomes and that upswings and downturns tend to be underestimated. These findings and their causes are discussed in more detail in Schuster (2018).

Figure 1 shows the forecast error measures (pooled over all forecasts per institution) for all variables provided by WIFO (and MOF for government budget balance) and all institutions combined. The forecasts of almost all variables are biased in the same direction and to a comparable magnitude when comparing

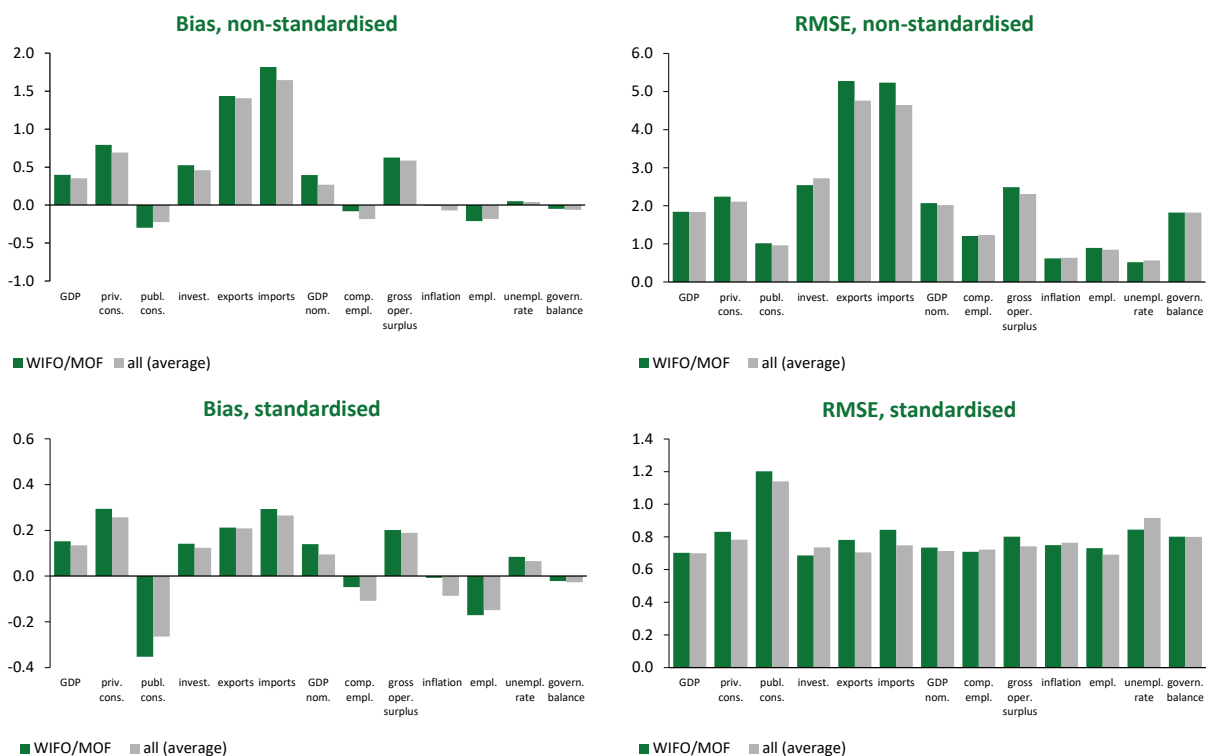
³ While the regular March forecast by IHS was classified as spring forecast, WIFO prepared an additional, updated forecast mid of April, which served as basis for the official technical update of the Stability Programme by MOF. We classified the updated April forecast by WIFO as their spring forecast.

⁴ WIFO published forecasts for real and nominal GDP, real private consumption, inflation, employment, unemployment, and the government budget balance. IHS restricted its forecast to real GDP, inflation, employment, and the government budget balance and omitted a next year forecast altogether. The latter will probably improve their average t+1-forecast errors, once 2021 is included in the evaluation period.

WIFO (and MOF) forecasts with the other institutions’ forecasts. The largest bias is observed for imports and exports. However, when normalising by the standard deviation (“standardised errors”), we find the largest bias for public consumption. WIFO has marginally higher RMSE compared to the average of the other institutions for most of the variables. However, this is mainly due to WIFO (and IHS) being most affected due to their publishing at the earliest date within a publication term (see robustness section).

Table 3 provides a more detailed overview of the forecast errors reported for all individual institutions, and additionally split by forecast for t and t+1. In particular, the table contains the bias including the results of the corresponding t-test, the median bias (MDB), the root mean squared error (RMSE) and the root median squared error (RMDSE) for all institutions and the naïve forecast that always uses the last available realisation as predictor. The forecasting performance of the different institutions cannot be ranked in general but only for individual indicators. For instance, WIFO had comparatively small errors when predicting inflation, unemployment, investment and compensation of employees and comparatively large errors when forecasting imports and exports. The general government budget balance is the only variable that is directly forecasted by MOF. All forecasts are significantly negatively biased for the current year, meaning that the budget deficit was systematically overestimated by all institutions. The same is true for forecasts for the next year if 2020 is neglected. The unexpected COVID-19-related expansion of the budget deficit in 2020 implies a sizable underestimation of the budget balance of all institutions that cancels out the fundamental overestimation for t+1 once 2020 is included in the analysis. Interestingly, MOF has the most precise forecast (in terms of RMSE) until 2019 (Figure 5). Once 2020 is included, MOF’s forecast performance suffers the most. However, this is not due to MOF’s forecasts for 2020 being comparably more off than the forecasts of the other institutions but related to the fact that in the overall time span 2005 to 2020 there are fewer observations for MOF, which gives the errors done when forecasting the budget balance 2020 a relative higher weight.⁵

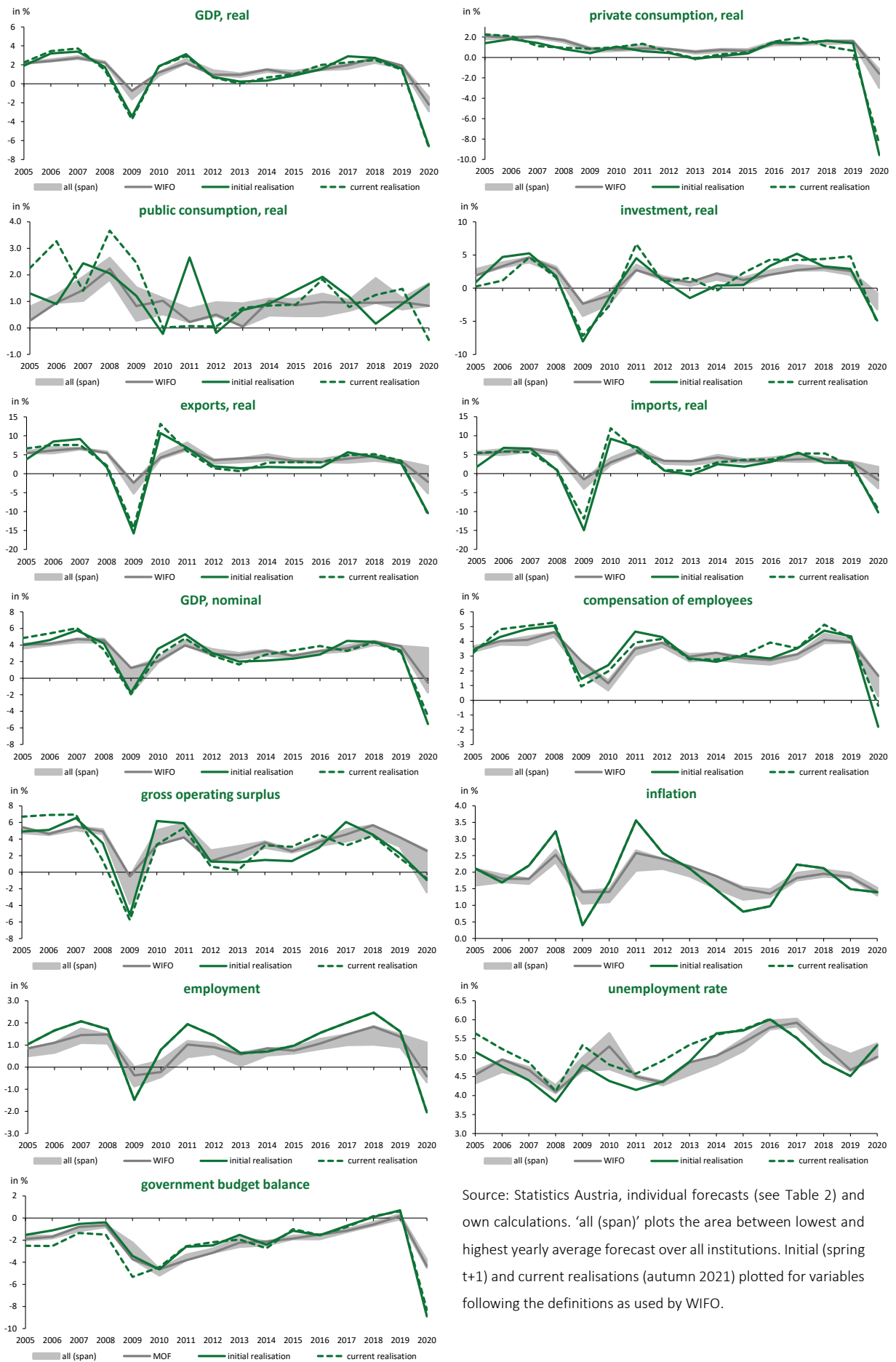
Figure 1: Standardised and non-standardised forecast errors



Source: own calculations. For all variables, the WIFO forecast errors are plotted except for government budget balance (MOF).

⁵ This highlights the difficulty of comparing forecast errors between institutions with different number of observations.
6

Figure 2: Forecasts and data realisations for the years 2005 to 2020



Source: Statistics Austria, individual forecasts (see Table 2) and own calculations. 'all (span)' plots the area between lowest and highest yearly average forecast over all institutions. Initial (spring t+1) and current realisations (autumn 2021) plotted for variables following the definitions as used by WIFO.

Table 3: Summary of forecast errors of all institutions

GDP, real	Total					t					t+1				
	N	Bias [p-value]	MDB	RMSE	RMDSE	N	Bias [p-value]	MDB	RMSE	RMDSE	N	Bias [p-value]	MDB	RMSE	RMDSE
EC	64	0.32 [0.16]	-0.05	1.82	0.51	32	-0.06 [0.46]	-0.08	0.48	0.22	32	0.71 [0.11]	0.39	2.53	1.09
IHS	64	0.45 [0.06*]	0.02	1.94	0.60	32	0.11 [0.52]	-0.06	0.93	0.20	32	0.79 [0.08*]	0.44	2.58	1.11
IMF	64	0.33 [0.16]	0.07	1.88	0.61	32	-0.06 [0.54]	0.01	0.53	0.30	32	0.72 [0.12]	0.50	2.61	1.19
OeNB	64	0.32 [0.14]	0.00	1.75	0.47	32	-0.05 [0.44]	-0.03	0.38	0.11	32	0.70 [0.11]	0.41	2.45	0.99
OECD	64	0.29 [0.19]	-0.00	1.78	0.44	32	-0.10 [0.22]	-0.06	0.44	0.11	32	0.69 [0.12]	0.30	2.47	1.01
WIFO	64	0.40 [0.08*]	0.09	1.84	0.58	32	0.08 [0.40]	0.06	0.55	0.25	32	0.71 [0.11]	0.37	2.54	0.91
Naive	64	0.51 [0.21]	-0.09	3.27	1.23	32	0.54 [0.31]	0.00	2.94	1.20	32	0.48 [0.45]	-0.36	3.56	1.26
Average		0.35	0.02	1.84	0.53		-0.01	-0.03	0.55	0.20		0.72	0.40	2.53	1.05
private consumption, real	Total					t					t+1				
EC	64	0.68 [0.01***]	0.20	2.13	0.30	32	0.35 [0.04**]	0.17	0.98	0.20	32	1.01 [0.04**]	0.55	2.85	0.58
IHS	63	0.70 [0.01***]	0.35	2.08	0.40	31	0.33 [0.01***]	0.26	0.70	0.28	32	1.06 [0.03**]	0.48	2.83	0.62
OeNB	64	0.61 [0.01**]	0.26	2.02	0.37	32	0.23 [0.08*]	0.12	0.75	0.19	32	0.99 [0.04**]	0.46	2.76	0.51
OECD	64	0.67 [0.01***]	0.29	2.08	0.37	32	0.27 [0.03**]	0.11	0.73	0.20	32	1.07 [0.03**]	0.45	2.85	0.53
WIFO	64	0.79 [0.00***]	0.29	2.24	0.36	32	0.50 [0.03**]	0.15	1.32	0.20	32	1.08 [0.03**]	0.49	2.88	0.58
Naive	64	0.69 [0.05*]	0.04	2.83	0.39	32	0.69 [0.16]	0.13	2.78	0.39	32	0.69 [0.18]	-0.06	2.87	0.43
Average		0.69	0.28	2.11	0.36		0.34	0.16	0.90	0.22		1.04	0.49	2.83	0.56
public consumption, real	Total					t					t+1				
EC	64	-0.06 [0.60]	-0.01	0.91	0.70	32	0.10 [0.53]	0.03	0.87	0.63	32	-0.22 [0.20]	-0.19	0.95	0.74
IHS	63	-0.42 [0.00***]	-0.42	1.05	0.72	31	-0.23 [0.16]	-0.33	0.92	0.64	32	-0.60 [0.00***]	-0.67	1.16	0.87
OeNB	64	-0.07 [0.48]	-0.06	0.81	0.49	32	-0.10 [0.48]	-0.18	0.75	0.48	32	-0.05 [0.76]	0.16	0.87	0.55
OECD	64	-0.27 [0.04**]	-0.18	1.03	0.59	32	-0.07 [0.63]	-0.07	0.77	0.40	32	-0.47 [0.03**]	-0.55	1.24	0.74
WIFO	63	-0.30 [0.02**]	-0.27	1.02	0.69	31	-0.12 [0.42]	-0.21	0.83	0.62	32	-0.47 [0.02**]	-0.36	1.17	0.79
Naive	64	-0.03 [0.83]	-0.17	1.25	0.86	32	-0.03 [0.91]	-0.17	1.27	0.76	32	-0.04 [0.86]	-0.32	1.23	1.12
Average		-0.22	-0.19	0.96	0.64		-0.08	-0.15	0.83	0.56		-0.36	-0.32	1.08	0.74
investment, real	Total					t					t+1				
EC	64	0.32 [0.32]	-0.00	2.57	1.38	32	-0.32 [0.24]	-0.03	1.49	0.58	32	0.96 [0.10]	0.53	3.31	1.83
IHS	63	0.63 [0.20]	-0.02	3.82	1.60	31	0.11 [0.79]	-0.02	2.29	1.20	32	1.13 [0.20]	0.13	4.87	2.83
OeNB	64	0.38 [0.20]	0.11	2.37	1.40	32	-0.19 [0.42]	0.11	1.29	0.67	32	0.94 [0.08*]	0.24	3.10	2.07
OECD	64	0.44 [0.13]	-0.04	2.31	1.23	32	-0.40 [0.04*]	-0.08	1.37	1.02	32	1.29 [0.01**]	0.63	2.96	1.56
WIFO	63	0.52 [0.10]	0.09	2.54	1.40	31	0.07 [0.76]	0.02	1.28	0.52	32	0.96 [0.10]	0.99	3.34	1.88
Naive	64	0.59 [0.37]	0.24	5.13	2.94	32	0.54 [0.49]	0.15	4.39	2.90	32	0.63 [0.55]	0.45	5.77	3.08
Average		0.46	0.03	2.72	1.40		-0.14	-0.00	1.54	0.80		1.06	0.50	3.51	2.04
exports, real	Total					t					t+1				
EC	64	1.12 [0.08*]	0.47	5.11	2.00	32	-0.02 [0.96]	0.12	2.21	1.10	32	2.26 [0.06*]	1.87	6.88	2.82
IHS	63	1.57 [0.02**]	1.09	5.31	2.30	31	0.48 [0.30]	0.81	2.50	1.32	32	2.63 [0.03**]	2.28	7.04	3.04
IMF	34	1.33 [0.03**]	0.93	3.63	1.30	17	0.10 [0.74]	0.54	1.25	0.93	17	2.56 [0.03**]	2.92	4.98	3.02
OeNB	64	1.44 [0.01***]	0.61	4.51	1.51	32	0.49 [0.17]	0.38	2.00	0.91	32	2.39 [0.02**]	1.54	6.06	2.37
OECD	64	1.55 [0.01***]	0.77	4.71	1.44	32	0.11 [0.72]	0.29	1.71	0.91	32	2.98 [0.01***]	1.87	6.44	2.54
WIFO	63	1.43 [0.03**]	0.97	5.28	1.96	31	0.54 [0.27]	0.37	2.66	1.16	32	2.30 [0.06*]	1.71	6.93	2.95
Naive	64	1.16 [0.34]	0.34	9.67	4.02	32	1.21 [0.46]	0.91	9.16	3.96	32	1.10 [0.55]	0.16	10.15	4.72
Average		1.41	0.80	4.76	1.75		0.28	0.42	2.06	1.05		2.52	2.03	6.39	2.79
imports, real	Total					t					t+1				
EC	64	1.41 [0.02**]	0.50	5.02	1.60	32	0.28 [0.53]	0.19	2.48	0.97	32	2.55 [0.03**]	0.97	6.66	2.91
IHS	63	1.86 [0.00***]	0.80	5.17	2.13	31	0.82 [0.08*]	0.50	2.64	1.48	32	2.87 [0.01**]	2.05	6.77	3.13
IMF	34	1.52 [0.01**]	0.74	3.65	1.59	17	0.07 [0.84]	0.18	1.38	0.58	17	2.97 [0.01***]	2.60	4.98	3.08
OeNB	64	1.48 [0.00***]	0.76	4.27	1.24	32	0.41 [0.27]	0.29	2.08	0.82	32	2.54 [0.01***]	1.16	5.67	2.13
OECD	64	1.77 [0.00***]	0.76	4.51	1.69	32	0.32 [0.39]	0.30	2.02	1.11	32	3.23 [0.00***]	2.01	6.04	2.32
WIFO	63	1.82 [0.00***]	0.90	5.23	1.88	31	0.89 [0.10]	0.45	3.03	1.00	32	2.71 [0.02**]	1.31	6.71	2.91
Naive	64	1.06 [0.35]	0.45	8.90	3.27	32	1.05 [0.49]	0.88	8.47	2.75	32	1.07 [0.53]	0.03	9.32	4.28
Average		1.64	0.74	4.64	1.69		0.46	0.32	2.27	0.99		2.81	1.68	6.14	2.75
GDP, nominal	Total					t					t+1				
EC	64	0.23 [0.38]	-0.05	2.02	0.63	32	-0.12 [0.32]	-0.11	0.70	0.39	32	0.57 [0.25]	0.07	2.77	1.17
IHS	63	0.30 [0.24]	0.11	2.06	0.54	31	-0.09 [0.36]	0.08	0.56	0.36	32	0.69 [0.17]	0.30	2.83	1.21
IMF	62	0.30 [0.27]	-0.09	2.11	0.65	30	-0.10 [0.42]	-0.11	0.68	0.41	32	0.68 [0.19]	0.26	2.86	1.15
OeNB	64	0.28 [0.27]	0.03	1.98	0.62	32	-0.10 [0.38]	-0.04	0.64	0.30	32	0.65 [0.18]	0.28	2.73	1.00
OECD	64	0.11 [0.65]	-0.05	1.85	0.58	32	-0.19 [0.04**]	-0.07	0.54	0.28	32	0.41 [0.38]	0.02	2.56	1.09
WIFO	64	0.39 [0.13]	0.27	2.07	0.70	32	0.12 [0.35]	0.28	0.74	0.53	32	0.66 [0.19]	0.22	2.84	1.06
Naive	64	0.57 [0.19]	-0.10	3.49	1.17	32	0.59 [0.30]	-0.10	3.16	1.11	32	0.55 [0.42]	0.03	3.80	1.23
Average		0.27	0.04	2.02	0.62		-0.08	0.01	0.64	0.38		0.61	0.19	2.77	1.11

Table 3 (cont'd): Summary of forecast errors of all institutions

compensation of employees	Total					t					t+1				
	N	Bias [p-value]	MDB	RMSE	RMDSE	N	Bias [p-value]	MDB	RMSE	RMDSE	N	Bias [p-value]	MDB	RMSE	RMDSE
EC	56	-0.27 [0.12]	-0.37	1.29	0.49	29	-0.30 [0.01***]	-0.26	0.61	0.39	27	-0.24 [0.48]	-0.62	1.75	0.98
IHS	63	-0.22 [0.18]	-0.40	1.28	0.53	31	-0.29 [0.00***]	-0.23	0.57	0.34	32	-0.15 [0.62]	-0.53	1.71	0.69
OeNB	64	-0.17 [0.25]	-0.18	1.15	0.36	32	-0.18 [0.01**]	-0.10	0.42	0.18	32	-0.15 [0.59]	-0.37	1.57	0.75
WIFO	63	-0.08 [0.60]	-0.13	1.21	0.46	31	-0.02 [0.85]	-0.08	0.44	0.27	32	-0.15 [0.62]	-0.53	1.64	0.78
Naive	64	0.25 [0.37]	-0.37	2.19	0.92	32	0.30 [0.39]	-0.28	1.98	0.62	32	0.20 [0.65]	-0.17	2.38	1.56
Average		-0.18	-0.27	1.23	0.46		-0.20	-0.17	0.51	0.30		-0.17	-0.51	1.67	0.80
gross operating surplus	Total					t					t+1				
N	Bias [p-value]	MDB	RMSE	RMDSE	N	Bias [p-value]	MDB	RMSE	RMDSE	N	Bias [p-value]	MDB	RMSE	RMDSE	
EC	38	0.97 [0.00***]	0.89	1.88	1.11	20	0.44 [0.11]	0.70	1.24	0.83	18	1.55 [0.00***]	1.84	2.40	1.84
IHS	63	0.62 [0.04**]	0.37	2.41	1.20	31	0.14 [0.47]	-0.07	1.03	0.62	32	1.08 [0.06*]	1.07	3.22	1.97
OeNB	64	0.13 [0.67]	-0.13	2.46	1.17	32	-0.64 [0.09]	-0.15	2.14	0.62	32	0.90 [0.06]	0.77	2.74	1.77
WIFO	63	0.63 [0.04**]	0.66	2.49	1.59	31	0.28 [0.31]	0.64	1.53	1.25	32	0.96 [0.08*]	0.91	3.15	1.98
Naive	64	0.46 [0.42]	0.11	4.53	1.62	32	0.42 [0.57]	0.20	4.08	1.57	32	0.49 [0.58]	-0.17	4.95	2.22
Average		0.59	0.45	2.31	1.27		0.06	0.28	1.48	0.83		1.12	1.15	2.88	1.89
inflation	Total					t					t+1				
N	Bias [p-value]	MDB	RMSE	RMDSE	N	Bias [p-value]	MDB	RMSE	RMDSE	N	Bias [p-value]	MDB	RMSE	RMDSE	
EC	64	-0.08 [0.31]	-0.01	0.62	0.31	32	-0.06 [0.14]	0.01	0.22	0.11	32	-0.10 [0.51]	-0.29	0.85	0.53
IHS	64	0.00 [0.98]	-0.02	0.66	0.29	32	-0.04 [0.48]	-0.04	0.28	0.18	32	0.03 [0.85]	-0.00	0.89	0.53
IMF	64	-0.13 [0.13]	-0.19	0.70	0.39	32	-0.15 [0.04**]	-0.10	0.42	0.27	32	-0.12 [0.46]	-0.27	0.90	0.57
OeNB	64	-0.08 [0.28]	-0.02	0.57	0.22	32	-0.04 [0.21]	-0.01	0.18	0.07	32	-0.11 [0.42]	-0.13	0.78	0.52
OECD	64	-0.13 [0.10]	-0.09	0.64	0.21	32	-0.07 [0.06*]	-0.08	0.22	0.11	32	-0.19 [0.23]	-0.21	0.87	0.61
WIFO	64	-0.01 [0.94]	0.00	0.62	0.30	32	-0.01 [0.78]	0.02	0.28	0.20	32	0.00 [0.99]	-0.06	0.83	0.50
Naive	64	0.03 [0.85]	0.19	1.22	0.85	32	0.04 [0.85]	0.10	1.08	0.64	32	0.02 [0.92]	0.38	1.35	1.13
Average		-0.07	-0.05	0.63	0.29		-0.06	-0.03	0.27	0.16		-0.08	-0.16	0.85	0.54
employment	Total					t					t+1				
N	Bias [p-value]	MDB	RMSE	RMDSE	N	Bias [p-value]	MDB	RMSE	RMDSE	N	Bias [p-value]	MDB	RMSE	RMDSE	
EC	64	-0.28 [0.00***]	-0.28	0.78	0.40	32	-0.34 [0.00***]	-0.26	0.53	0.27	32	-0.21 [0.23]	-0.35	0.97	0.69
IHS	64	-0.21 [0.06*]	-0.24	0.88	0.45	32	-0.16 [0.04**]	-0.11	0.44	0.18	32	-0.25 [0.22]	-0.59	1.17	0.82
IMF	50	-0.14 [0.26]	-0.13	0.84	0.45	25	-0.23 [0.09*]	-0.17	0.68	0.49	25	-0.04 [0.82]	-0.07	0.98	0.41
OeNB	64	-0.33 [0.01***]	-0.40	1.01	0.43	32	-0.27 [0.00***]	-0.20	0.47	0.32	32	-0.38 [0.11]	-0.59	1.35	0.91
OECD	41	0.06 [0.58]	0.07	0.68	0.39	21	-0.06 [0.59]	0.07	0.54	0.37	20	0.19 [0.30]	0.17	0.81	0.45
WIFO	64	-0.21 [0.06*]	-0.22	0.90	0.35	32	-0.12 [0.04**]	-0.09	0.35	0.16	32	-0.30 [0.17]	-0.64	1.22	0.82
Naive	64	0.20 [0.34]	-0.29	1.69	0.74	32	0.24 [0.38]	-0.18	1.55	0.51	32	0.16 [0.62]	-0.48	1.82	0.95
Average		-0.18	-0.20	0.85	0.41		-0.20	-0.13	0.50	0.30		-0.17	-0.34	1.08	0.68
unemployment rate	Total					t					t+1				
N	Bias [p-value]	MDB	RMSE	RMDSE	N	Bias [p-value]	MDB	RMSE	RMDSE	N	Bias [p-value]	MDB	RMSE	RMDSE	
EC	64	0.09 [0.31]	0.08	0.67	0.36	32	0.11 [0.15]	0.08	0.42	0.18	32	0.06 [0.68]	0.07	0.85	0.61
IHS	63	0.05 [0.48]	0.07	0.59	0.38	31	0.06 [0.36]	0.08	0.37	0.13	32	0.05 [0.74]	-0.07	0.75	0.54
IMF	64	0.04 [0.64]	0.03	0.61	0.40	32	0.09 [0.22]	0.09	0.40	0.29	32	-0.02 [0.90]	-0.17	0.77	0.57
OeNB	64	0.05 [0.42]	0.04	0.53	0.31	32	0.06 [0.35]	0.03	0.36	0.10	32	0.05 [0.70]	0.09	0.65	0.50
OECD	42	-0.04 [0.60]	0.05	0.47	0.23	22	0.04 [0.48]	0.08	0.29	0.19	20	-0.13 [0.35]	-0.06	0.61	0.38
WIFO	64	0.05 [0.43]	0.04	0.52	0.35	32	0.05 [0.38]	0.07	0.31	0.14	32	0.06 [0.65]	-0.01	0.67	0.52
Naive	64	-0.06 [0.47]	-0.15	0.64	0.54	32	-0.05 [0.59]	0.08	0.53	0.46	32	-0.07 [0.62]	-0.32	0.73	0.70
Average		0.04	0.05	0.57	0.34		0.07	0.07	0.36	0.17		0.01	-0.03	0.72	0.52
government budget balance	Total					t					t+1				
N	Bias [p-value]	MDB	RMSE	RMDSE	N	Bias [p-value]	MDB	RMSE	RMDSE	N	Bias [p-value]	MDB	RMSE	RMDSE	
EC	64	-0.09 [0.68]	-0.54	1.84	0.63	32	-0.34 [0.01***]	-0.40	0.75	0.49	32	0.15 [0.73]	-0.63	2.49	0.69
IHS	64	0.01 [0.98]	-0.42	1.89	0.56	32	-0.37 [0.03**]	-0.42	0.99	0.43	32	0.38 [0.39]	-0.38	2.48	0.66
IMF	64	-0.07 [0.74]	-0.41	1.73	0.58	32	-0.41 [0.00***]	-0.46	0.65	0.54	32	0.27 [0.53]	-0.37	2.36	0.72
MOF	54	-0.05 [0.85]	-0.40	1.82	0.51	32	-0.40 [0.00***]	-0.40	0.56	0.40	22	0.46 [0.45]	-0.44	2.78	0.65
OeNB	64	0.00 [0.99]	-0.30	1.76	0.40	32	-0.28 [0.00***]	-0.21	0.42	0.22	32	0.28 [0.52]	-0.46	2.46	0.58
OECD	64	-0.16 [0.49]	-0.51	1.81	0.62	32	-0.44 [0.00***]	-0.45	0.69	0.48	32	0.12 [0.78]	-0.59	2.47	0.75
WIFO	64	-0.07 [0.77]	-0.48	1.88	0.57	32	-0.43 [0.00***]	-0.44	0.78	0.48	32	0.29 [0.52]	-0.56	2.54	0.76
Naive	64	0.42 [0.22]	-0.42	2.71	0.85	32	0.47 [0.32]	-0.27	2.65	0.82	32	0.36 [0.47]	-0.59	2.75	0.92
Average		-0.06	-0.44	1.82	0.55		-0.38	-0.40	0.69	0.44		0.28	-0.49	2.51	0.69

Source: own calculations. 'N' is the number of forecasts, '*/**/***' means rejection of the null hypothesis of unbiased forecast at 10%/5%/1%-significance level. For definition of error measures 'MDB', 'RMSE' and 'RMDSE' see appendix. 'Average' is an unweighted over all institutions (excluding the naive forecast). Red and green indicate the best and the worst forecast.

Forecast error persistency

Looking at forecast error persistence reveals insights about whether forecast errors get smaller within the forecasting horizon, whether forecasters learn from previous mistakes or whether longer episodes of same-signed forecast errors occur. Figure 3 plots the evolution of bias, MDB and RMSE from the spring forecast for $t+1$ to the autumn forecast for t for WIFO (MOF for government budget balance) in contrast to all forecasts combined.⁶ For most variables, the improvement of the forecast over the forecasting horizon is clearly visible; bias, MDB and RMSE tend towards zero. The previous result (Schuster, 2018) according to which in contrast to most of the other variables, the bias of the government budget balance is hardly improving over the forecasting horizon is still valid if the year 2020 is excluded (Figure 6) or when looking at the MDB (Figure 3). Once included, this is overshadowed by the large forecast errors made in 2019 for the budget balance of 2020, switching the bias of the year-ahead forecast from negative to positive.

Table 4 reports the autocorrelation of forecast errors for all variables and institutions. The analysis is done for four subsets (spring for t , spring for $t+1$, autumn for t and autumn for $t+1$). A lag of 1 therefore implies that the forecast error of, e.g., a spring forecast for the year it was published is always compared with the previous year's spring forecast for the previous year. Public consumption seems to be the only variable where WIFO's (as well as other institutions') forecasts are plagued by autocorrelation, i.e. they are negatively correlated with their first lags. This means that there is a systematic pattern in the size of the public consumption forecast errors that alternates depending on whether the year is even or odd, i.e. a big bias is compensated by a comparatively small one next year and vice versa.

Complementary to the presented persistency analyses, Table 5 reports the results of a more heuristic approach that was calculated separately for current- and next-year forecasts to address the requirements of Council Directive 2011/85/EU, Article 4, Paragraph 6: *"If the evaluation detects a significant bias affecting macroeconomic forecasts over a period of at least 4 consecutive years, [...]"*. As done in Schuster (2018), the table simply shows the count of episodes that consist of at least 8 consecutive same-signed biased forecasts, e.g. overestimating a variable at least 8 times in a row counts as one episode. With biannual forecasts, this corresponds to 4 consecutive years. To take the qualification of a "significant" bias into account, the number of bias episodes for three different tolerance levels are reported: zero, half the standard deviation of the realisation ($\sigma/2$) and a full standard deviation of the realisation (σ). In comparison with the other institutions, same-signed biased forecasts are not more pronounced in WIFO (and MOF) forecasts. With a tolerance level of one standard deviation, neither WIFO nor MOF produced a single episode of same-signed biased forecasts.

⁶ Figure 6 shows the same information except that 2020 was excluded from the analysis. See section on robustness results.

Figure 3: Forecast errors over forecasting horizon

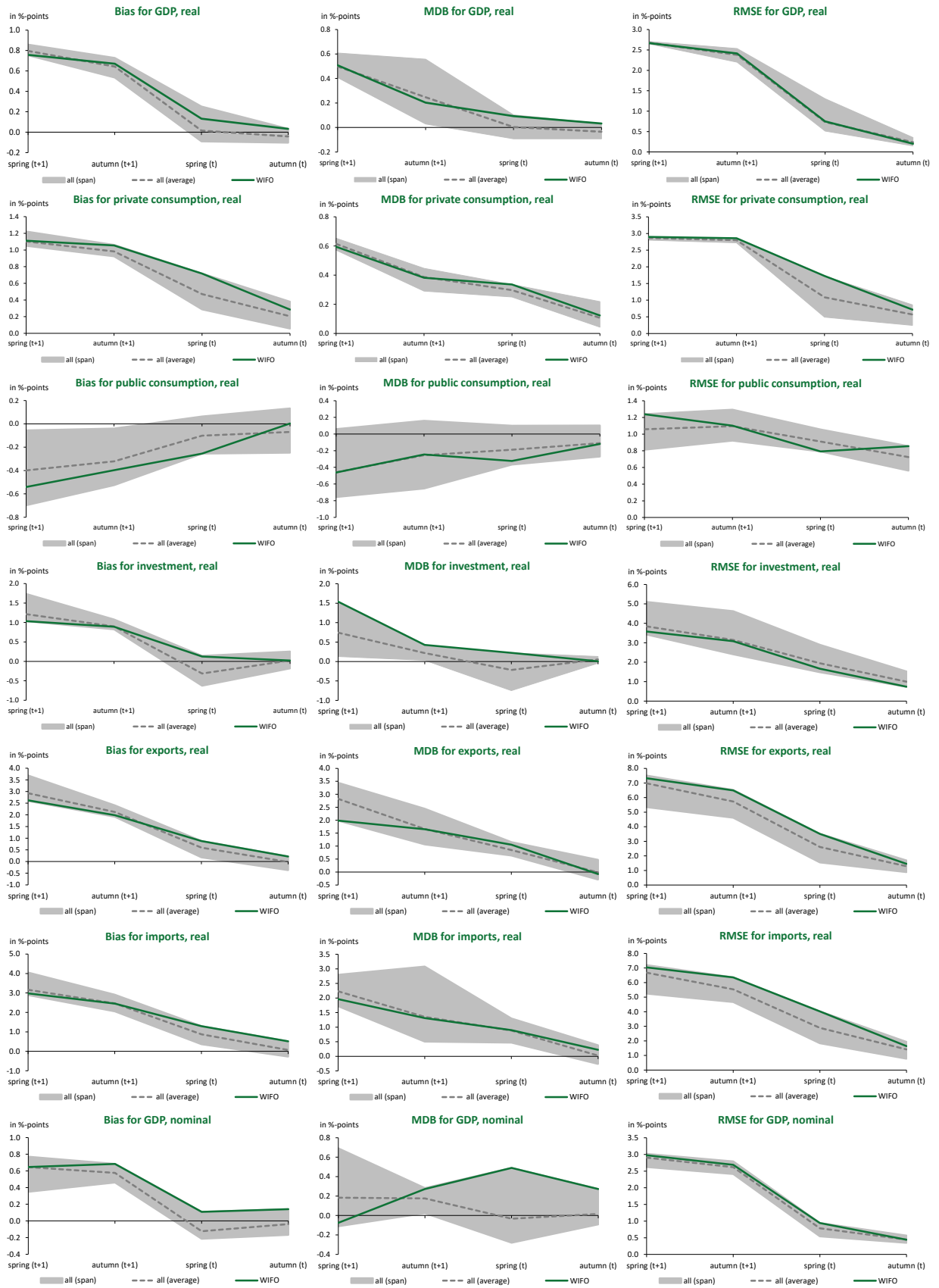
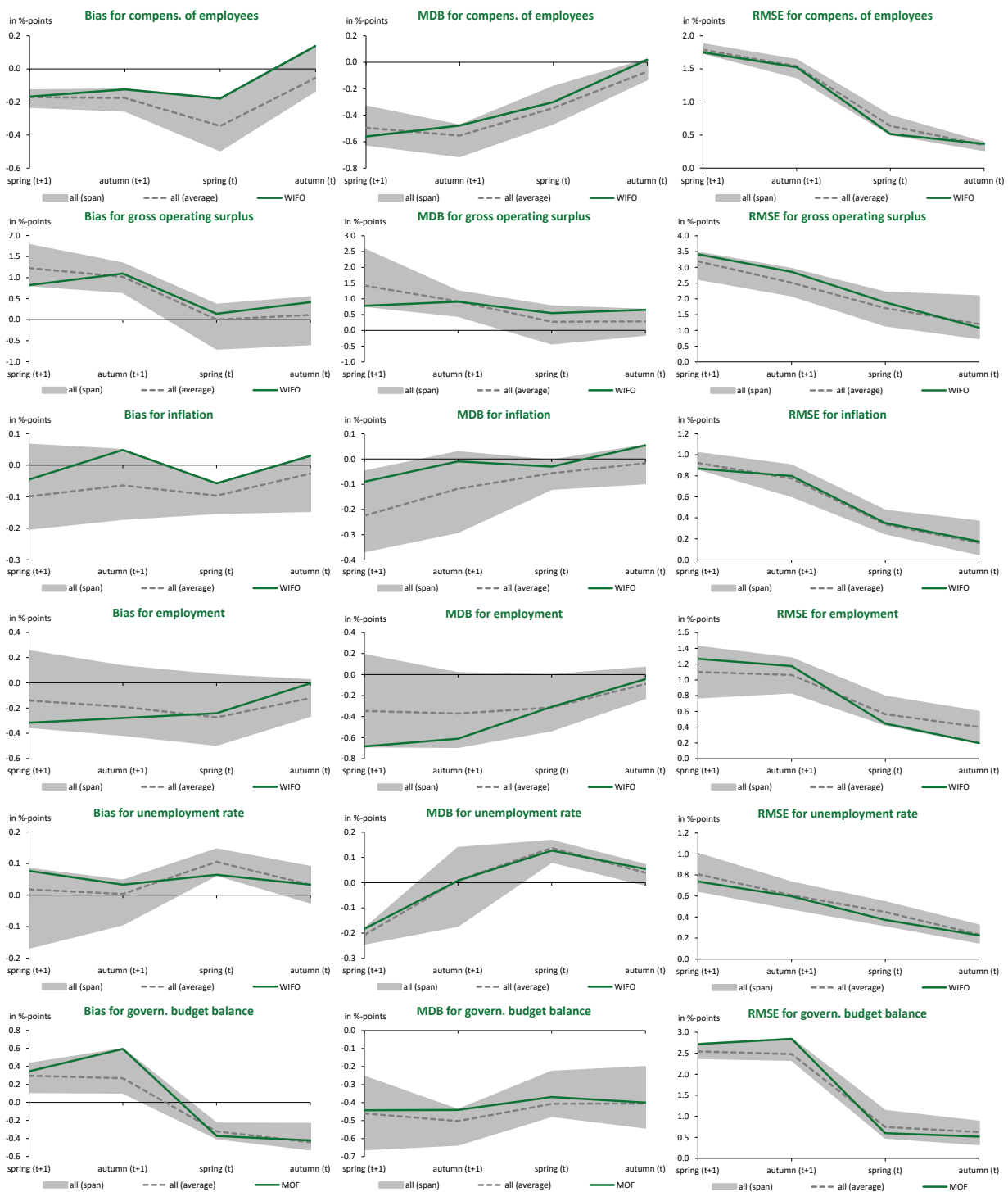


Figure 3 (cont'd): Forecast errors over forecasting horizon



Source: Own calculations. 'all (span)' plots the area between lowest and highest error measure over all institutions, 'all (average)' is an unweighted average of the error measures over all institutions.

Table 4: Persistency in forecast errors as measured by the autocorrelation coefficient

GDP, real	AC (spring, t)		AC (spring, t+1)		AC (autumn, t)		AC (autumn, t+1)		compensation of employees	AC (spring, t)		AC (spring, t+1)		AC (autumn, t)		AC (autumn, t+1)	
	N	1 Lag	N	1 Lag	N	1 Lag	N	1 Lag		N	1 Lag	N	1 Lag	N	1 Lag	N	1 Lag
EC	16	0.08	16	0.02	16	-0.16	16	0.06	EC	14	0.24	13	0.02	15	-0.10	14	-0.02
IHS	16	0.03	16	0.01	16	0.02	16	0.02	IHS	15	0.31	16	-0.04	16	0.04	16	-0.07
IMF	16	0.18	16	0.01	16	0.11	16	0.05	OeNB	16	-0.12	16	-0.07	16	-0.14	16	-0.00
OeNB	16	-0.24	16	0.00	16	-0.23	16	0.03	WIFO	15	0.02	16	-0.01	16	-0.24	16	-0.07
OECD	16	-0.05	16	-0.00	16	-0.07	16	0.05	Naive	16	0.03	16	0.06	16	0.03	16	0.06
WIFO	16	0.02	16	0.04	16	-0.12	16	0.03									
Naive	16	-0.03	16	0.12	16	-0.03	16	0.12									
private consumption, real	AC (spring, t)		AC (spring, t+1)		AC (autumn, t)		AC (autumn, t+1)		gross operating surplus	AC (spring, t)		AC (spring, t+1)		AC (autumn, t)		AC (autumn, t+1)	
EC	N	1 Lag	N	1 Lag	N	1 Lag	N	1 Lag		N	1 Lag	N	1 Lag	N	1 Lag	N	1 Lag
EC	16	0.01	16	-0.02	16	0.03	16	-0.00	EC	10	0.23	9	0.44	10	-0.41	9	0.33
IHS	15	0.45*	16	-0.04	16	-0.02	16	-0.03	IHS	15	0.13	16	-0.00	16	-0.00	16	0.06
OeNB	16	0.08	16	-0.01	16	-0.05	16	0.03	OeNB	16	-0.07	16	-0.12	16	0.06	16	-0.05
OECD	16	0.09	16	-0.01	16	0.01	16	0.01	WIFO	15	0.11	16	0.00	16	0.13	16	0.01
WIFO	16	-0.00	16	-0.01	16	-0.01	16	-0.00	Naive	16	-0.26	16	0.02	16	-0.26	16	0.02
Naive	16	0.02	16	0.02	16	0.02	16	0.02									
public consumption, real	AC (spring, t)		AC (spring, t+1)		AC (autumn, t)		AC (autumn, t+1)		inflation	AC (spring, t)		AC (spring, t+1)		AC (autumn, t)		AC (autumn, t+1)	
EC	N	1 Lag	N	1 Lag	N	1 Lag	N	1 Lag		N	1 Lag	N	1 Lag	N	1 Lag	N	1 Lag
EC	16	-0.50**	16	-0.20	16	-0.53**	16	-0.35	EC	16	0.11	16	0.03	16	-0.09	16	-0.08
IHS	15	-0.44*	16	-0.44*	16	-0.37	16	-0.48**	IHS	16	0.21	16	-0.12	16	0.08	16	-0.09
OeNB	16	-0.39*	16	-0.04	16	-0.21	16	-0.26	IMF	16	0.16	16	0.02	16	0.16	16	-0.01
OECD	16	-0.33	16	-0.00	16	-0.35	16	-0.30	OeNB	16	-0.04	16	-0.04	16	0.07	16	0.03
WIFO	15	-0.39*	16	-0.55**	16	-0.65***	16	-0.45**	OECD	16	-0.14	16	0.08	16	0.03	16	0.27
Naive	16	-0.53**	16	-0.06	16	-0.53**	16	-0.06	WIFO	16	0.23	16	-0.09	16	0.05	16	-0.06
									Naive	16	-0.24	16	0.03	16	-0.24	16	0.03
investment, real	AC (spring, t)		AC (spring, t+1)		AC (autumn, t)		AC (autumn, t+1)		employment	AC (spring, t)		AC (spring, t+1)		AC (autumn, t)		AC (autumn, t+1)	
EC	N	1 Lag	N	1 Lag	N	1 Lag	N	1 Lag		N	1 Lag	N	1 Lag	N	1 Lag	N	1 Lag
EC	16	0.06	16	0.16	16	-0.08	16	0.11	EC	16	0.46**	16	-0.05	16	-0.07	16	0.06
IHS	15	0.16	16	-0.03	16	0.26	16	0.01	IHS	16	0.12	16	-0.03	16	-0.11	16	-0.07
OeNB	16	0.02	16	0.07	16	0.04	16	0.20	IMF	12	-0.31	12	0.11	13	-0.15	13	-0.05
OECD	16	0.06	16	0.07	16	-0.17	16	0.07	OeNB	16	-0.05	16	-0.10	16	0.24	16	-0.05
WIFO	15	0.25	16	0.15	16	-0.05	16	0.18	OECD	10	-0.28	10	0.05	11	-0.37	10	0.13
Naive	16	-0.04	16	0.17	16	-0.04	16	0.17	WIFO	16	-0.01	16	-0.06	16	-0.14	16	-0.05
									Naive	16	-0.06	16	0.14	16	-0.06	16	0.14
exports, real	AC (spring, t)		AC (spring, t+1)		AC (autumn, t)		AC (autumn, t+1)		unemployment rate	AC (spring, t)		AC (spring, t+1)		AC (autumn, t)		AC (autumn, t+1)	
EC	N	1 Lag	N	1 Lag	N	1 Lag	N	1 Lag		N	1 Lag	N	1 Lag	N	1 Lag	N	1 Lag
EC	16	-0.16	16	-0.15	16	0.08	16	-0.15	EC	16	0.21	16	0.28	16	-0.43*	16	-0.06
IHS	15	-0.16	16	-0.12	16	0.03	16	-0.14	IHS	15	0.39**	16	0.38*	16	-0.04	16	0.07
IMF	8	0.16	8	0.07	9	-0.34	9	0.03	IMF	16	0.51**	16	0.41*	16	0.25	16	0.09
OeNB	16	-0.27	16	-0.19	16	0.14	16	-0.18	OeNB	16	0.13	16	0.24	16	-0.09	16	-0.03
OECD	16	-0.29	16	-0.21	16	-0.27	16	-0.19	OECD	11	0.11	10	0.22	11	-0.05	10	0.27
WIFO	15	-0.21	16	-0.16	16	-0.01	16	-0.15	WIFO	16	0.01	16	0.18	16	-0.26	16	-0.05
Naive	16	-0.32	16	-0.00	16	-0.32	16	-0.00	Naive	16	-0.01	16	0.39*	16	-0.01	16	0.39*
imports, real	AC (spring, t)		AC (spring, t+1)		AC (autumn, t)		AC (autumn, t+1)		government budget balance	AC (spring, t)		AC (spring, t+1)		AC (autumn, t)		AC (autumn, t+1)	
EC	N	1 Lag	N	1 Lag	N	1 Lag	N	1 Lag		N	1 Lag	N	1 Lag	N	1 Lag	N	1 Lag
EC	16	-0.04	16	-0.13	16	-0.03	16	-0.13	EC	16	-0.12	16	-0.04	16	-0.23	16	-0.05
IHS	15	-0.01	16	-0.12	16	-0.15	16	-0.11	IHS	16	0.03	16	-0.08	16	-0.07	16	-0.05
IMF	8	0.29	8	0.04	9	-0.12	9	-0.10	IMF	16	-0.09	16	-0.07	16	-0.20	16	-0.06
OeNB	16	-0.30	16	-0.14	16	-0.16	16	-0.09	MOF	16	-0.08	12	-0.03	16	-0.18	10	-0.05
OECD	16	-0.24	16	-0.17	16	-0.15	16	-0.14	OeNB	16	-0.39*	16	-0.04	16	-0.37	16	-0.04
WIFO	15	-0.16	16	-0.15	16	0.12	16	-0.12	OECD	16	-0.11	16	-0.04	16	-0.02	16	-0.00
Naive	16	-0.32	16	0.00	16	-0.32	16	0.00	WIFO	16	0.09	16	-0.02	16	-0.13	16	-0.03
									Naive	16	-0.05	16	0.03	16	-0.05	16	0.03
GDP, nominal	AC (spring, t)		AC (spring, t+1)		AC (autumn, t)		AC (autumn, t+1)		Source: own calculations. 'N' is the number of forecasts, AC the autocorrelation coefficient. **/**/** means rejection of the null hypothesis of no serial correlation (Ljung-Box-test) at 10%/5%/1%-significance level.								
EC	N	1 Lag	N	1 Lag	N	1 Lag	N	1 Lag									
EC	16	0.11	16	0.01	16	-0.03	16	0.06									
IHS	15	0.01	16	-0.00	16	-0.05	16	-0.01									
IMF	15	0.26	16	0.02	15	-0.34	16	0.01									
OeNB	16	-0.31	16	-0.04	16	-0.00	16	0.04									
OECD	16	0.14	16	0.20	16	-0.02	16	0.07									
WIFO	16	-0.05	16	0.01	16	0.20	16	0.02									
Naive	16	-0.04	16	0.09	16	-0.04	16	0.09									

Robustness checks

This section concludes with a brief discussion of the robustness of the above results. The corresponding figures and tables are presented in the appendix. Table 7 summarizes the forecast errors when final instead of first releases are used as reference data. The difference in comparison with Table 3 is related to the ex-post revisions in the data. This is most prominently the case for the unemployment rate (with a strong ex-post upward revision) and the general government budget balance (with a strong ex-post downward revision). Given the nature of the revision (methodological changes), it seems unlikely that they were foreseen by the forecasters (see Schuster, 2018, for a discussion).

The second robustness check addresses the problem of comparability resulting from different publishing schedules. Based on the clustering used, WIFO and IHS always publish their forecasts at the earliest point in time within a forecasting term. June (rather than March) forecasts and always the December (rather than the September) forecasts for WIFO and IHS were used as robustness checks so that both institutions become the last ones to forecast within a forecasting term. The results are reported in Table 8 and Figure 4. Comparing Figure 1 and Figure 4 reveals that while in the default setting, WIFO has slightly larger forecasting errors than its peers for the majority of variables, this result is reversed in the robustness check setting. An exception are imports and exports which, are still forecasted slightly more imprecisely in comparison to the average of the other institutes.

In the last robustness check, the year 2020 was dropped from the observation period to isolate the overall forecast errors from the COVID-19 pandemic. As mentioned before, while hardly affecting the relative forecasting performance of the institutions, this has a sizable effect on average forecast errors. Not surprisingly, RMSE decrease for virtually all variables and institutions, e.g. for real GDP growth from 1.84 to 1.14 on average. The bias is also uniformly shifted downward, e.g. from 0.35 to 0.09 for real GDP growth. Whether 2020 is included in the analysis has consequences for the overall assessment of whether a variable is over- or underestimated on average. For example, neglecting 2020 implies that all institutions significantly underestimated the government budget balance; a result that disappears once 2020 is included. Note that the median bias (MBD) and the root median squared error (RMDSE) are much less affected by the inclusion of 2020.

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APPENDIX A: METHODS OF FORECAST EVALUATION

The **forecast error** of a variable x at time t is defined as the difference between the forecasted values (x_t^f) and realisation (x_t^r)

$$d(x_t) = x_t^f - x_t^r,$$

such that $d(x_t) > 0$ implies an **overestimation**. Note that both the forecasted values as well as the realisations can be measured at different points in time. The forecast of x_t is done at some earlier point in time s , with $s \leq t$, and the realisation can be measured at some future point in time $u > t$. The forecast error is therefore computed based on the choice of three points in time (t, s, u) . For the sake of simplicity, this is not reflected in the mathematical notation used, while it is made clear when results are presented.

Taking the average over the forecast errors (mean error) of a variable x over a number of forecasts (N) gives the **bias** of these forecasts:

$$Bias(x) = \frac{1}{N} \sum_{i=1}^N d(x_i).$$

If $Bias(x) > (<)0$ then x was **overestimated (underestimated) on average**. Using the median instead of the arithmetic mean gives the **Median Bias(x) (MDB)**, which is less sensitive to outliers. To evaluate the fit or **precision** of a forecast, the study uses the usual measures. The **mean absolute error (MAE)** is computed as the sum over all forecast errors without allowing overestimations and underestimations to cancel each other out. The **root mean squared error (RMSE)** is interpreted similarly, but in combination with a quadratic instead of a linear weight it punishes large forecast errors more severely than the MAE.

$$MAE(x) = \frac{1}{N} \sum_{i=1}^N |d(x_i)|.$$

$$RMSE(x) = \sqrt{\frac{1}{N} \sum_{i=1}^N d(x_i)^2}.$$

Alternatively, when using the median instead of the arithmetic mean of the squared errors before taking the square root gives the **root median squared error (RMDSE)**. The MAE, RMSE and RMDSE can be used to rank the forecasts of variable x by different institutions by precision. The lower the MAE (or the RMSE, or the RMDSE), the more precise the forecast. To compare the relative precision (or bias) of forecasts **across variables**, the error measures should be normalized to capture the fact that some variables are more difficult to forecast simply because they are more volatile. This is typically done by dividing the error measures by the standard deviation of the realization (x^r) which is denoted as $\sigma(x^r)$, e.g. the **standardised RMSE** is equal to $RMSE(x)/\sigma(x^r)$. Another way of normalised comparison is to look at how much more precise a given forecast is than a naïve forecast.⁷ A naïve forecast in this context is defined as a forecast using the last available realisation as the new forecast, i.e. $x_t^f = x_{t-h}^r$, with $h = 1$ for forecasting next year, $h = 2$ for forecasting the year after next, etc. This is conceptualised by **Theil's U-statistic** (Theil, 1966), which is given as

⁷ A more demanding reference forecast would be to use ARIMA or VAR time-series models (see Holden, 1995).

$$TU(x) = RMSE(x) / \sqrt{\frac{1}{N} \sum_{i=1}^N (x_{t-h}^r - x_t^r)^2},$$

i.e. the quotient of the RMSE of the forecast to be benchmarked and the RMSE of the naïve forecast. If $TU(x) < 1$ then the forecast produced a better fit than the naïve forecast. Good forecasts are characterised by a Theil's U-statistic that is clearly smaller than one. To enhance comparison, this study reports forecast errors of the naïve forecast also for the other error measures mentioned.⁸

Testing⁹ for unbiasedness is done by estimating the following equation following Holden and Peel (1990)

$$d(x_t) = \alpha + \varepsilon_t,$$

with null hypothesis: $\alpha = 0$, using a standard t-test.¹⁰ If the null hypothesis is rejected, the forecast is

considered to be significantly biased.¹¹ In addition, forecast errors should be **non-persistent**. This means that a **forecast error should not feed into the next forecasts**. This is tested by using a Ljung and Box (1978) test that exploits the autocorrelation structure of the forecast errors. A positive autocorrelation coefficient using one lag indicates that an overestimation is likely to be followed by another overestimation in the next forecast, and vice versa. In contrast, a negative autocorrelation coefficient indicates that an overestimation is likely to be "compensated" by an underestimation in the next forecast, and vice versa. As there is no new realisation between the spring and the autumn forecast that a forecaster could use, one can expect these forecast errors to be correlated. Therefore, non-persistence was only tested within each of the following four data partitions: spring for t, spring for t+1, autumn for t and autumn for t+1. The null hypothesis of no serial correlation is tested using the Q-test statistic

$$Q_k(x) = N(N + 2) \sum_{j=1}^k (AC_j(d(x)))^2 / (N - j),$$

where AC_j is the autocorrelation coefficient of the forecast errors, i.e. the correlation of the forecast errors with their j th lag. Q_k follows a χ^2 distribution with k degrees of freedom. The smaller Q_k the less the forecast errors are serially correlated (for chosen k). Because of the already small sample size only the results for first lags, i.e. $k = 1$, are presented in this study.

⁸ Note that the naïve forecast is by construction asymptotically unbiased, i.e. the bias tends to 0 as $N \rightarrow \infty$, if the forecasted variable is stationary, which is the case for growth rates. To illustrate this, assume (without loss of generality of the argument) that only one forecast was carried out for the current year and abstract from ex-post revisions of realised data. In this case the bias of the naïve forecast ($x_t^f = x_{t-1}^r$) from period T to $T + N - 1$ is $(x_{T+N-1}^r - x_{T-1}^r)/N$, which decreases as N increases. Hence, a low bias of the naïve forecast should not come as a surprise and if bias was the only relevant evaluation metric then the naïve forecast would be a good forecast.

⁹ Other common tests that were not considered in this study test for efficiency (Holden and Peel, 1990), directional accuracy (Pesaran and Timmermann, 1992), bilateral superiority in terms of precision (Diebold and Mariano, 1995), etc.

¹⁰ Note that the t-statistic ($Tstat$) can be expressed as a formula of our error measures: $Tstat = \frac{Bias}{\sqrt{(RMSE^2 - Bias^2)/(N-1)}}$.

¹¹ For the comparison between institutions, it is important to keep in mind that for two forecasts with the same bias, the bias of the more imprecise forecast is less likely to significantly deviate from 0.

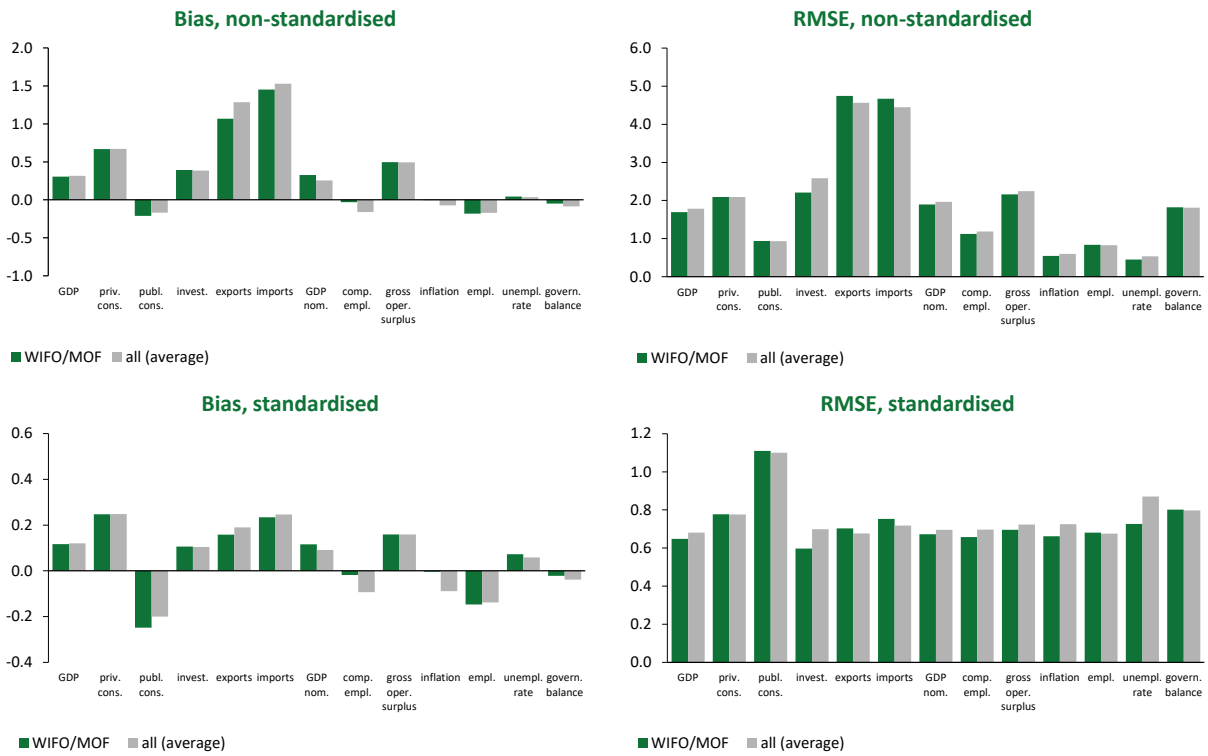
APPENDIX B: ADDITIONAL TABLES AND FIGURES

Table 6: Summary of Ministry of Finance forecasts of general government budget balance (in % of GDP) for t and t+1

publication date classified as year	StabPro 2004		EDP Not. 2005		StabPro 2005		EDP Not. 2006		StabPro 2006		EDP Not. 2007		StabPro 2007		EDP Not. 2008		StabPro 2008		EDP Not. 2009		StabPro 2009		EDP Not. 2010		StabPro 2010		EDP Not. 2011		StabPro 2011		EDP Not. 2012		StabPro 2012		EDP Not. 2013		StabPro 2013				
	Dec. 2004	Mar. 2005	Mar. 2005	Mar. 2006	Mar. 2006	Mar. 2006	Mar. 2007	Mar. 2007	Mar. 2007	Mar. 2007	Mar. 2007	Mar. 2008	Mar. 2008	Mar. 2008	Mar. 2008	Mar. 2008	Mar. 2008	Mar. 2008	Mar. 2008	Mar. 2008	Mar. 2008	Mar. 2008	Mar. 2008	Mar. 2008	Mar. 2008	Mar. 2008	Mar. 2008	Mar. 2008	Mar. 2008	Mar. 2008	Mar. 2008	Mar. 2008	Mar. 2008	Mar. 2008	Mar. 2008	Mar. 2008	Mar. 2008	Mar. 2008	Mar. 2008		
2005	-1.9	-1.9	-1.7	-1.7	-1.7	-1.7	-0.9	-0.7	-0.6	-0.6	-0.7	-3.5	-3.9	-4.7	-4.0	-4.5	-3.9	-3.3	-3.6	-3.0	-2.1	-3.1	-2.3	-1.5																	
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publication date classified as year	Oct. 2013	Apr. 2014	Apr. 2014	Apr. 2015	Apr. 2015	Apr. 2016	Oct. 2016	Apr. 2017	Apr. 2017	Oct. 2017	Mar. 2018	Oct. 2018	Apr. 2019	Apr. 2019	Oct. 2019	Apr. 2020 ²⁾	Apr. 2020 ²⁾	Oct. 2020	Oct. 2020	Mar. 2021	Mar. 2021	Mar. 2021	Mar. 2021	Mar. 2021	Mar. 2021	Mar. 2021	Mar. 2021	Mar. 2021	Mar. 2021	Mar. 2021	Mar. 2021	Mar. 2021	Mar. 2021	Mar. 2021	Mar. 2021	Mar. 2021	Mar. 2021	Mar. 2021	Mar. 2021	Mar. 2021	
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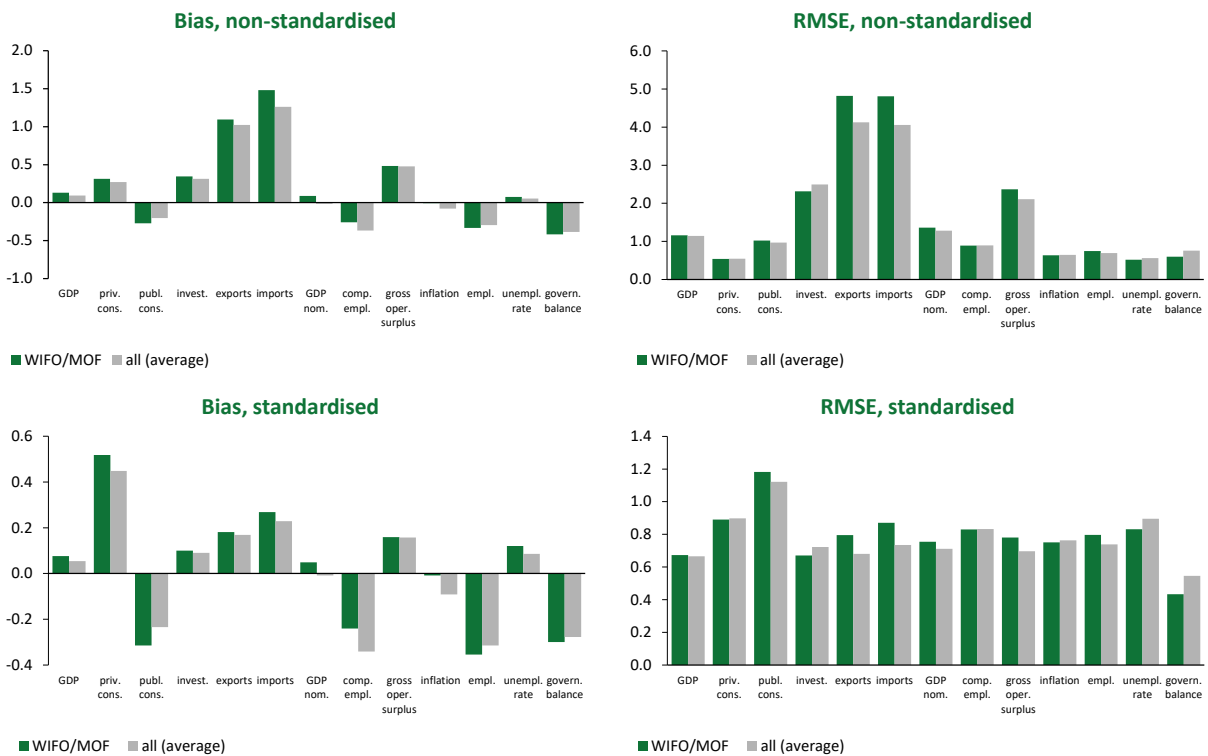
Source: Austrian Federal Ministry of Finance, Stability Programmes (StabPro), Draft Budgetary Plans (DBP), Excessive Deficit Procedure (EDP) notifications since 2004 and Statistics Austria (STAT).
 1) StabPro from January 2010 was classified as spring forecast 2010. 2) Official technical update of StabPro from end of April instead of first version of StabPro from mid of March was classified as spring forecast 2020.

Figure 4: Standardised and non-standardised forecast errors (using June instead of March and December instead of September forecasts for WIFO and IHS)



Source: own calculations. For all variables, the WIFO forecast errors are plotted except for government budget balance (MOF).

Figure 5: Standardised and non-standardised forecast errors (without 2020)



Source: own calculations. For all variables, the WIFO forecast errors are plotted except for government budget balance (MOF).

Table 7: Summary of forecast errors (vs. current realisation) of all institutions

GDP, real	Total					t					t+1				
	N	Bias [p-value]	MDB	RMSE	RMDSE	N	Bias [p-value]	MDB	RMSE	RMDSE	N	Bias [p-value]	MDB	RMSE	RMDSE
EC	64	0.34 [0.14]	0.01	1.87	0.55	32	-0.04 [0.62]	-0.01	0.50	0.38	32	0.73 [0.11]	0.23	2.59	0.99
IHS	64	0.47 [0.06*]	0.06	1.99	0.60	32	0.13 [0.47]	0.01	0.97	0.40	32	0.81 [0.08*]	0.26	2.64	1.07
IMF	64	0.35 [0.15]	0.08	1.92	0.72	32	-0.04 [0.69]	-0.00	0.55	0.39	32	0.73 [0.12]	0.28	2.66	1.07
OeNB	64	0.32 [0.15]	-0.04	1.80	0.50	32	-0.05 [0.49]	-0.14	0.44	0.34	32	0.70 [0.12]	-0.01	2.51	0.87
OECD	64	0.29 [0.20]	-0.10	1.83	0.58	32	-0.10 [0.28]	-0.14	0.50	0.38	32	0.68 [0.13]	-0.03	2.54	0.89
WIFO	64	0.42 [0.08*]	0.13	1.90	0.65	32	0.10 [0.36]	-0.03	0.62	0.38	32	0.73 [0.11]	0.22	2.61	0.96
Naive	64	0.53 [0.21]	-0.34	3.34	1.40	32	0.56 [0.30]	-0.34	3.02	1.09	32	0.50 [0.44]	-0.43	3.64	1.50
Average		0.37	0.02	1.88	0.60		0.00	-0.05	0.60	0.38		0.73	0.16	2.59	0.97
private consumption, real	Total					t					t+1				
EC	64	0.50 [0.04**]	0.15	1.92	0.53	32	0.17 [0.26]	0.02	0.85	0.43	32	0.83 [0.07*]	0.43	2.58	0.60
IHS	63	0.54 [0.02**]	0.28	1.86	0.50	31	0.19 [0.11]	0.11	0.65	0.41	32	0.88 [0.05**]	0.40	2.54	0.60
OeNB	64	0.43 [0.06*]	0.14	1.85	0.45	32	0.06 [0.65]	0.02	0.69	0.40	32	0.81 [0.07*]	0.31	2.53	0.55
OECD	64	0.50 [0.03**]	0.19	1.90	0.46	32	0.10 [0.42]	0.03	0.65	0.32	32	0.90 [0.05**]	0.35	2.60	0.60
WIFO	64	0.61 [0.01**]	0.25	2.02	0.55	32	0.32 [0.11]	0.08	1.15	0.45	32	0.90 [0.05**]	0.43	2.61	0.60
Naive	64	0.51 [0.12]	0.03	2.59	0.58	32	0.51 [0.26]	-0.16	2.53	0.50	32	0.51 [0.29]	0.22	2.64	0.66
Average		0.52	0.20	1.91	0.50		0.17	0.05	0.80	0.40		0.86	0.39	2.57	0.59
public consumption, real	Total					t					t+1				
EC	64	-0.16 [0.28]	-0.03	1.18	0.70	32	0.00 [0.99]	0.11	1.17	0.70	32	-0.32 [0.13]	-0.07	1.18	0.71
IHS	63	-0.55 [0.00***]	-0.46	1.14	0.65	31	-0.40 [0.02**]	-0.38	0.96	0.49	32	-0.70 [0.00***]	-0.58	1.28	0.76
OeNB	64	-0.19 [0.14]	0.12	1.06	0.57	32	-0.22 [0.26]	0.11	1.08	0.61	32	-0.17 [0.36]	0.19	1.04	0.48
OECD	64	-0.39 [0.01***]	-0.32	1.19	0.64	32	-0.19 [0.36]	-0.07	1.15	0.71	32	-0.59 [0.01***]	-0.36	1.24	0.60
WIFO	63	-0.43 [0.00***]	-0.28	1.17	0.78	31	-0.29 [0.12]	-0.18	1.03	0.76	32	-0.57 [0.01***]	-0.37	1.29	0.87
Naive	64	-0.13 [0.39]	-0.24	1.23	0.93	32	-0.13 [0.54]	-0.34	1.15	1.01	32	-0.14 [0.55]	-0.15	1.29	0.81
Average		-0.35	-0.19	1.15	0.67		-0.22	-0.08	1.08	0.65		-0.47	-0.24	1.20	0.68
investment, real	Total					t					t+1				
EC	64	0.12 [0.73]	-0.13	2.77	1.72	32	-0.52 [0.16]	-0.42	2.08	1.18	32	0.76 [0.20]	0.69	3.33	2.11
IHS	63	0.35 [0.45]	0.54	3.60	2.07	31	-0.15 [0.73]	-0.28	2.40	1.77	32	0.83 [0.30]	1.39	4.47	2.36
OeNB	64	-0.08 [0.81]	-0.62	2.56	1.76	32	-0.64 [0.04**]	-0.72	1.78	1.31	32	0.49 [0.39]	-0.04	3.15	2.12
OECD	64	-0.01 [0.97]	-0.45	2.56	1.77	32	-0.86 [0.01**]	-0.71	2.01	1.38	32	0.83 [0.12]	0.23	3.00	1.81
WIFO	63	0.32 [0.37]	0.15	2.75	1.90	31	-0.15 [0.67]	0.09	1.84	1.30	32	0.76 [0.21]	0.32	3.40	2.09
Naive	64	0.39 [0.56]	-0.10	5.22	3.58	32	0.34 [0.66]	-0.31	4.35	2.85	32	0.43 [0.69]	0.99	5.97	3.75
Average		0.14	-0.10	2.85	1.84		-0.46	-0.41	2.02	1.39		0.73	0.51	3.47	2.10
exports, real	Total					t					t+1				
EC	64	0.70 [0.27]	-0.05	5.06	1.39	32	-0.44 [0.29]	-0.37	2.32	0.96	32	1.84 [0.13]	0.55	6.77	2.18
IHS	63	1.14 [0.08*]	0.33	5.17	1.85	31	0.03 [0.94]	0.16	2.46	1.25	32	2.21 [0.07*]	0.85	6.84	2.09
IMF	34	0.98 [0.11]	-0.03	3.59	1.62	17	-0.23 [0.51]	-0.30	1.34	1.04	17	2.19 [0.06*]	1.81	4.90	1.96
OeNB	64	0.81 [0.17]	0.12	4.71	1.30	32	-0.14 [0.74]	-0.07	2.35	1.00	32	1.75 [0.11]	0.46	6.23	1.53
OECD	64	0.91 [0.14]	0.21	4.89	1.05	32	-0.53 [0.22]	0.07	2.41	0.93	32	2.35 [0.04**]	0.74	6.48	1.87
WIFO	63	1.01 [0.13]	0.26	5.21	1.64	31	0.10 [0.85]	-0.19	2.69	1.30	32	1.89 [0.12]	0.27	6.81	2.24
Naive	64	0.74 [0.55]	0.72	9.75	3.64	32	0.80 [0.64]	0.95	9.40	2.83	32	0.69 [0.71]	-1.07	10.09	4.81
Average		0.93	0.14	4.77	1.48		-0.20	-0.12	2.26	1.08		2.04	0.78	6.34	1.98
imports, real	Total					t					t+1				
EC	64	0.60 [0.31]	0.16	4.71	1.53	32	-0.53 [0.25]	-0.19	2.60	1.37	32	1.73 [0.11]	1.00	6.13	2.10
IHS	63	1.05 [0.08*]	0.44	4.72	1.51	31	0.01 [0.99]	0.17	2.45	1.44	32	2.06 [0.06*]	1.20	6.16	2.02
IMF	34	0.86 [0.13]	0.53	3.33	1.67	17	-0.51 [0.17]	-0.22	1.53	0.78	17	2.24 [0.03**]	1.71	4.46	2.04
OeNB	64	0.62 [0.25]	0.46	4.26	1.49	32	-0.44 [0.33]	-0.07	2.54	1.35	32	1.68 [0.08*]	1.00	5.47	1.79
OECD	64	0.92 [0.09*]	0.23	4.36	1.54	32	-0.54 [0.23]	-0.19	2.51	0.86	32	2.38 [0.01**]	1.60	5.63	1.90
WIFO	63	1.00 [0.10*]	0.42	4.83	1.82	31	0.08 [0.88]	0.07	2.90	1.33	32	1.90 [0.08*]	0.99	6.15	2.05
Naive	64	0.25 [0.82]	0.16	8.69	3.50	32	0.24 [0.88]	0.52	8.49	2.76	32	0.25 [0.88]	-1.69	8.89	3.88
Average		0.84	0.37	4.37	1.59		-0.32	-0.07	2.42	1.19		2.00	1.25	5.67	1.99
GDP, nominal	Total					t					t+1				
EC	64	0.14 [0.56]	-0.15	1.94	0.80	32	-0.21 [0.18]	-0.25	0.85	0.69	32	0.49 [0.29]	0.05	2.61	1.10
IHS	63	0.24 [0.34]	-0.19	1.95	0.75	31	-0.15 [0.29]	-0.19	0.77	0.74	32	0.61 [0.20]	-0.21	2.64	0.75
IMF	62	0.25 [0.34]	-0.00	2.01	0.96	30	-0.13 [0.45]	-0.00	0.90	0.89	32	0.59 [0.21]	-0.04	2.66	1.03
OeNB	64	0.14 [0.55]	-0.13	1.89	0.92	32	-0.24 [0.17]	-0.17	0.97	0.78	32	0.52 [0.24]	-0.13	2.49	1.07
OECD	64	-0.03 [0.90]	-0.33	1.78	0.91	32	-0.33 [0.04**]	-0.37	0.91	0.81	32	0.27 [0.52]	-0.13	2.34	1.11
WIFO	64	0.31 [0.21]	-0.04	1.96	0.86	32	0.04 [0.78]	-0.08	0.83	0.55	32	0.58 [0.22]	0.03	2.65	1.00
Naive	64	0.49 [0.25]	-0.63	3.39	1.45	32	0.51 [0.35]	-0.63	3.03	1.41	32	0.47 [0.48]	-0.36	3.72	1.50
Average		0.18	-0.14	1.92	0.87		-0.17	-0.18	0.87	0.74		0.51	-0.07	2.56	1.01

Table 7 (cont'd): Summary of forecast errors (vs. current realisation) of all institutions

compensation of employees	Total					t					t+1				
	N	Bias [p-value]	MDB	RMSE	RMDSE	N	Bias [p-value]	MDB	RMSE	RMDSE	N	Bias [p-value]	MDB	RMSE	RMDSE
EC	56	-0.39 [0.01**]	-0.50	1.18	0.61	29	-0.44 [0.00***]	-0.44	0.68	0.48	27	-0.35 [0.24]	-0.85	1.54	1.33
IHS	63	-0.32 [0.03**]	-0.47	1.17	0.68	31	-0.37 [0.00***]	-0.31	0.60	0.33	32	-0.27 [0.32]	-0.55	1.53	0.97
OeNB	64	-0.34 [0.02**]	-0.33	1.16	0.49	32	-0.35 [0.01**]	-0.16	0.80	0.30	32	-0.32 [0.21]	-0.66	1.43	1.00
WIFO	63	-0.18 [0.20]	-0.31	1.12	0.66	31	-0.09 [0.35]	0.04	0.55	0.34	32	-0.27 [0.31]	-0.78	1.47	1.15
Naive	64	0.13 [0.61]	-0.52	2.03	1.37	32	0.18 [0.57]	-0.44	1.79	0.72	32	0.08 [0.85]	-0.64	2.25	1.70
Average		-0.31	-0.40	1.15	0.61		-0.31	-0.22	0.66	0.36		-0.30	-0.71	1.49	1.11
gross operating surplus	Total					t					t+1				
EC	38	0.98 [0.00***]	1.12	1.92	1.29	20	0.49 [0.12]	0.51	1.38	1.12	18	1.54 [0.00***]	1.31	2.38	1.77
IHS	63	0.74 [0.03**]	0.49	2.68	1.86	31	0.27 [0.39]	0.49	1.69	1.60	32	1.20 [0.04**]	0.47	3.37	2.03
OeNB	64	0.33 [0.36]	0.31	2.83	1.89	32	-0.45 [0.35]	-0.52	2.63	1.63	32	1.10 [0.04]	0.62	3.02	2.14
WIFO	63	0.75 [0.02**]	0.67	2.66	1.61	31	0.41 [0.18]	0.71	1.69	1.39	32	1.08 [0.07*]	0.62	3.34	2.28
Naive	64	0.58 [0.32]	-0.56	4.61	2.48	32	0.54 [0.45]	0.30	4.02	2.04	32	0.61 [0.51]	-1.27	5.14	3.22
Average		0.70	0.65	2.52	1.66		0.18	0.30	1.85	1.44		1.23	0.76	3.03	2.05
inflation	Total					t					t+1				
EC	64	-0.08 [0.31]	-0.01	0.62	0.31	32	-0.06 [0.14]	0.01	0.22	0.11	32	-0.10 [0.51]	-0.29	0.85	0.53
IHS	64	0.00 [0.98]	-0.02	0.66	0.29	32	-0.04 [0.48]	-0.04	0.28	0.18	32	0.03 [0.85]	-0.00	0.89	0.53
IMF	64	-0.13 [0.13]	-0.19	0.70	0.39	32	-0.15 [0.04**]	-0.10	0.42	0.27	32	-0.12 [0.46]	-0.27	0.90	0.57
OeNB	64	-0.08 [0.28]	-0.02	0.57	0.22	32	-0.04 [0.21]	-0.01	0.18	0.07	32	-0.11 [0.42]	-0.13	0.78	0.52
OECD	64	-0.13 [0.10]	-0.09	0.64	0.21	32	-0.07 [0.06*]	-0.08	0.22	0.11	32	-0.19 [0.23]	-0.21	0.87	0.61
WIFO	64	-0.01 [0.94]	0.00	0.62	0.30	32	-0.01 [0.78]	0.02	0.28	0.20	32	0.00 [0.99]	-0.06	0.83	0.50
Naive	64	0.03 [0.85]	0.19	1.22	0.85	32	0.04 [0.85]	0.10	1.08	0.64	32	0.02 [0.92]	0.38	1.35	1.13
Average		-0.07	-0.05	0.63	0.29		-0.06	-0.03	0.27	0.16		-0.08	-0.16	0.85	0.54
employment	Total					t					t+1				
EC	64	-0.42 [0.00***]	-0.57	0.87	0.64	32	-0.49 [0.00***]	-0.33	0.69	0.40	32	-0.35 [0.05*]	-0.59	1.02	0.81
IHS	64	-0.21 [0.06*]	-0.24	0.88	0.45	32	-0.16 [0.04**]	-0.11	0.44	0.18	32	-0.25 [0.22]	-0.59	1.17	0.82
IMF	50	-0.14 [0.26]	-0.13	0.84	0.45	25	-0.23 [0.09*]	-0.17	0.68	0.49	25	-0.04 [0.82]	-0.07	0.98	0.41
OeNB	64	-0.39 [0.00***]	-0.48	0.99	0.52	32	-0.34 [0.00***]	-0.39	0.48	0.42	32	-0.45 [0.05**]	-0.61	1.31	0.90
OECD	41	0.06 [0.58]	0.07	0.68	0.39	21	-0.06 [0.59]	0.07	0.54	0.37	20	0.19 [0.30]	0.17	0.81	0.45
WIFO	64	-0.21 [0.06*]	-0.22	0.90	0.35	32	-0.12 [0.04**]	-0.09	0.35	0.16	32	-0.30 [0.17]	-0.64	1.22	0.82
Naive	64	0.20 [0.34]	-0.29	1.69	0.74	32	0.24 [0.38]	-0.18	1.55	0.51	32	0.16 [0.62]	-0.48	1.82	0.95
Average		-0.22	-0.26	0.86	0.47		-0.23	-0.17	0.53	0.34		-0.20	-0.39	1.09	0.70
unemployment rate	Total					t					t+1				
EC	64	-0.17 [0.05*]	-0.17	0.70	0.42	32	-0.15 [0.07*]	-0.12	0.46	0.29	32	-0.19 [0.22]	-0.33	0.88	0.63
IHS	63	-0.21 [0.01***]	-0.33	0.64	0.52	31	-0.20 [0.01***]	-0.28	0.44	0.33	32	-0.21 [0.13]	-0.45	0.79	0.70
IMF	64	-0.22 [0.01***]	-0.38	0.69	0.58	32	-0.17 [0.05*]	-0.20	0.49	0.45	32	-0.27 [0.07*]	-0.40	0.84	0.83
OeNB	64	-0.20 [0.01***]	-0.28	0.60	0.44	32	-0.20 [0.02**]	-0.22	0.48	0.30	32	-0.21 [0.09*]	-0.30	0.69	0.59
OECD	42	-0.20 [0.01**]	-0.20	0.52	0.38	22	-0.13 [0.10]	-0.10	0.36	0.28	20	-0.27 [0.06*]	-0.42	0.65	0.54
WIFO	64	-0.20 [0.00***]	-0.23	0.58	0.43	32	-0.21 [0.00***]	-0.22	0.40	0.32	32	-0.20 [0.11]	-0.34	0.71	0.56
Naive	64	-0.32 [0.00***]	-0.34	0.76	0.65	32	-0.31 [0.01***]	-0.15	0.67	0.42	32	-0.32 [0.03**]	-0.50	0.84	0.79
Average		-0.20	-0.27	0.62	0.46		-0.17	-0.19	0.44	0.33		-0.23	-0.38	0.76	0.64
government budget balance	Total					t					t+1				
EC	64	0.27 [0.25]	-0.18	1.87	0.74	32	0.02 [0.87]	-0.12	0.79	0.55	32	0.52 [0.25]	-0.47	2.53	0.82
IHS	64	0.37 [0.13]	-0.26	1.96	0.65	32	-0.01 [0.97]	-0.26	1.07	0.60	32	0.75 [0.10*]	-0.21	2.55	0.75
IMF	64	0.29 [0.20]	-0.25	1.81	0.71	32	-0.05 [0.75]	-0.26	0.79	0.64	32	0.63 [0.15]	-0.15	2.43	0.81
MOF	54	0.24 [0.33]	-0.12	1.78	0.64	32	-0.03 [0.82]	-0.08	0.77	0.59	22	0.64 [0.27]	-0.20	2.64	0.82
OeNB	64	0.37 [0.11]	-0.05	1.82	0.59	32	0.08 [0.43]	-0.01	0.59	0.50	32	0.65 [0.15]	-0.17	2.50	0.65
OECD	64	0.21 [0.37]	-0.25	1.83	0.64	32	-0.08 [0.58]	-0.13	0.76	0.53	32	0.49 [0.27]	-0.30	2.47	0.79
WIFO	64	0.30 [0.22]	-0.18	1.94	0.65	32	-0.07 [0.69]	-0.17	0.92	0.62	32	0.66 [0.15]	-0.28	2.58	0.71
Naive	64	0.78 [0.02**]	0.03	2.78	0.99	32	0.84 [0.08*]	0.31	2.74	0.99	32	0.72 [0.15]	-0.25	2.81	1.05
Average		0.29	-0.18	1.86	0.66		-0.02	-0.15	0.81	0.58		0.62	-0.25	2.53	0.76

Source: own calculations. 'N' is the number of forecasts. '***/**' means rejection of the null hypothesis of unbiased forecast at 10%/5%/1%-significance level. For definition of error measures 'MDB', 'RMSE' and 'RMDSE' see appendix. 'Average' is an unweighted over all institutions (excluding the naive forecast). Red and green indicate the best and the worst forecast.

Table 8: Summary of forecast errors of all institutions (using June instead of March and December instead of September forecasts for WIFO and IHS)

GDP, real	Total					t					t+1				
	N	Bias [p-value]	MDB	RMSE	RMDSE	N	Bias [p-value]	MDB	RMSE	RMDSE	N	Bias [p-value]	MDB	RMSE	RMDSE
EC	64	0.32 [0.16]	-0.05	1.82	0.51	32	-0.06 [0.46]	-0.08	0.48	0.22	32	0.71 [0.11]	0.39	2.53	1.09
IHS	64	0.32 [0.15]	0.00	1.77	0.39	32	-0.08 [0.25]	-0.03	0.40	0.15	32	0.73 [0.10*]	0.12	2.47	1.02
IMF	64	0.33 [0.16]	0.07	1.88	0.61	32	-0.06 [0.54]	0.01	0.53	0.30	32	0.72 [0.12]	0.50	2.61	1.19
OeNB	64	0.32 [0.14]	0.00	1.75	0.47	32	-0.05 [0.44]	-0.03	0.38	0.11	32	0.70 [0.11]	0.41	2.45	0.99
OECD	64	0.29 [0.19]	-0.00	1.78	0.44	32	-0.10 [0.22]	-0.06	0.44	0.11	32	0.69 [0.12]	0.30	2.47	1.01
WIFO	64	0.31 [0.15]	0.05	1.70	0.37	32	-0.03 [0.58]	0.00	0.33	0.12	32	0.64 [0.13]	0.22	2.38	0.82
Naive	64	0.51 [0.21]	-0.09	3.27	1.23	32	0.54 [0.31]	0.00	2.94	1.20	32	0.48 [0.45]	-0.36	3.56	1.26
Average		0.32	0.01	1.78	0.46		-0.06	-0.03	0.43	0.17		0.70	0.32	2.49	1.02
private consumption, real	Total					t					t+1				
EC	64	0.68 [0.01***]	0.20	2.13	0.30	32	0.35 [0.04**]	0.17	0.98	0.20	32	1.01 [0.04**]	0.55	2.85	0.58
IHS	64	0.72 [0.01***]	0.29	2.13	0.37	32	0.37 [0.03**]	0.20	0.99	0.23	32	1.07 [0.03**]	0.44	2.84	0.65
OeNB	64	0.61 [0.01**]	0.26	2.02	0.37	32	0.23 [0.08*]	0.12	0.75	0.19	32	0.99 [0.04**]	0.46	2.76	0.51
OECD	64	0.67 [0.01***]	0.29	2.08	0.37	32	0.27 [0.03**]	0.11	0.73	0.20	32	1.07 [0.03**]	0.45	2.85	0.53
WIFO	64	0.67 [0.01***]	0.18	2.09	0.22	32	0.30 [0.03**]	0.10	0.79	0.15	32	1.04 [0.04**]	0.47	2.85	0.57
Naive	64	0.69 [0.05*]	0.04	2.83	0.39	32	0.69 [0.16]	0.13	2.78	0.39	32	0.69 [0.18]	-0.06	2.87	0.43
Average		0.67	0.24	2.09	0.33		0.30	0.14	0.85	0.19		1.04	0.47	2.83	0.57
public consumption, real	Total					t					t+1				
EC	64	-0.06 [0.60]	-0.01	0.91	0.70	32	0.10 [0.53]	0.03	0.87	0.63	32	-0.22 [0.20]	-0.19	0.95	0.74
IHS	64	-0.23 [0.05**]	-0.29	0.96	0.71	32	-0.05 [0.73]	-0.11	0.75	0.44	32	-0.42 [0.03**]	-0.63	1.13	0.92
OeNB	64	-0.07 [0.48]	-0.06	0.81	0.49	32	-0.10 [0.48]	-0.18	0.75	0.48	32	-0.05 [0.76]	0.16	0.87	0.55
OECD	64	-0.27 [0.04**]	-0.18	1.03	0.59	32	-0.07 [0.63]	-0.07	0.77	0.40	32	-0.47 [0.03**]	-0.55	1.24	0.74
WIFO	64	-0.21 [0.07*]	-0.21	0.94	0.66	32	-0.08 [0.54]	-0.15	0.72	0.44	32	-0.34 [0.08*]	-0.24	1.12	0.77
Naive	64	-0.03 [0.83]	-0.17	1.25	0.86	32	-0.03 [0.91]	-0.17	1.27	0.76	32	-0.04 [0.86]	-0.32	1.23	1.12
Average		-0.17	-0.15	0.93	0.63		-0.04	-0.10	0.77	0.48		-0.30	-0.29	1.06	0.74
investment, real	Total					t					t+1				
EC	64	0.32 [0.32]	-0.00	2.57	1.38	32	-0.32 [0.24]	-0.03	1.49	0.58	32	0.96 [0.10]	0.53	3.31	1.83
IHS	64	0.39 [0.37]	0.21	3.46	1.38	32	-0.04 [0.91]	0.31	2.00	1.17	32	0.83 [0.30]	-0.02	4.47	2.35
OeNB	64	0.38 [0.20]	0.11	2.37	1.40	32	-0.19 [0.42]	0.11	1.29	0.67	32	0.94 [0.08*]	0.24	3.10	2.07
OECD	64	0.44 [0.13]	-0.04	2.31	1.23	32	-0.40 [0.10*]	-0.08	1.37	1.02	32	1.29 [0.03**]	0.63	2.96	1.56
WIFO	64	0.39 [0.16]	0.16	2.21	1.00	32	0.07 [0.74]	0.10	1.09	0.59	32	0.72 [0.17]	0.35	2.93	1.84
Naive	64	0.59 [0.37]	0.24	5.13	2.94	32	0.54 [0.49]	0.15	4.39	2.90	32	0.63 [0.55]	0.45	5.77	3.08
Average		0.39	0.09	2.58	1.28		-0.18	0.08	1.45	0.81		0.95	0.35	3.35	1.93
exports, real	Total					t					t+1				
EC	64	1.12 [0.08*]	0.47	5.11	2.00	32	-0.02 [0.96]	0.12	2.21	1.10	32	2.26 [0.06*]	1.87	6.88	2.82
IHS	64	1.19 [0.04**]	0.56	4.69	1.58	32	0.14 [0.67]	0.25	1.79	1.11	32	2.25 [0.04**]	1.45	6.39	3.13
IMF	34	1.33 [0.03**]	0.93	3.63	1.30	17	0.10 [0.74]	0.54	1.25	0.93	17	2.56 [0.03**]	2.92	4.98	3.02
OeNB	64	1.44 [0.01***]	0.61	4.51	1.51	32	0.49 [0.17]	0.38	2.00	0.91	32	2.39 [0.02**]	1.54	6.06	2.37
OECD	64	1.55 [0.01***]	0.77	4.71	1.44	32	0.11 [0.72]	0.29	1.71	0.91	32	2.98 [0.01***]	1.87	6.44	2.54
WIFO	64	1.07 [0.07*]	0.56	4.75	1.46	32	0.04 [0.90]	0.24	1.98	1.04	32	2.09 [0.06*]	1.36	6.41	2.73
Naive	64	1.16 [0.34]	0.34	9.67	4.02	32	1.21 [0.46]	0.91	9.16	3.96	32	1.10 [0.55]	0.16	10.15	4.72
Average		1.28	0.65	4.57	1.55		0.15	0.30	1.82	1.00		2.42	1.83	6.19	2.77
imports, real	Total					t					t+1				
EC	64	1.41 [0.02**]	0.50	5.02	1.60	32	0.28 [0.53]	0.19	2.48	0.97	32	2.55 [0.03**]	0.97	6.66	2.91
IHS	64	1.54 [0.01***]	0.59	4.58	1.88	32	0.58 [0.12]	0.19	2.06	0.69	32	2.51 [0.02**]	1.56	6.14	2.12
IMF	34	1.52 [0.01**]	0.74	3.65	1.59	17	0.07 [0.84]	0.18	1.38	0.58	17	2.97 [0.01***]	2.60	4.98	3.08
OeNB	64	1.48 [0.00***]	0.76	4.27	1.24	32	0.41 [0.27]	0.29	2.08	0.82	32	2.54 [0.01***]	1.16	5.67	2.13
OECD	64	1.77 [0.00***]	0.76	4.51	1.69	32	0.32 [0.39]	0.30	2.02	1.11	32	3.23 [0.00***]	2.01	6.04	2.32
WIFO	64	1.45 [0.01**]	0.61	4.67	1.26	32	0.40 [0.27]	0.43	2.01	0.77	32	2.50 [0.02**]	1.15	6.29	2.50
Naive	64	1.06 [0.35]	0.45	8.90	3.27	32	1.05 [0.49]	0.88	8.47	2.75	32	1.07 [0.53]	0.03	9.32	4.28
Average		1.53	0.66	4.45	1.54		0.34	0.26	2.01	0.82		2.72	1.58	5.96	2.51
GDP, nominal	Total					t					t+1				
EC	64	0.23 [0.38]	-0.05	2.02	0.63	32	-0.12 [0.32]	-0.11	0.70	0.39	32	0.57 [0.25]	0.07	2.77	1.17
IHS	64	0.30 [0.21]	0.06	1.92	0.43	32	-0.06 [0.48]	0.01	0.43	0.22	32	0.66 [0.17]	0.26	2.68	1.09
IMF	62	0.30 [0.27]	-0.09	2.11	0.65	30	-0.10 [0.42]	-0.11	0.68	0.41	32	0.68 [0.19]	0.26	2.86	1.15
OeNB	64	0.28 [0.27]	0.03	1.98	0.62	32	-0.10 [0.38]	-0.04	0.64	0.30	32	0.65 [0.18]	0.28	2.73	1.00
OECD	64	0.11 [0.65]	-0.05	1.85	0.58	32	-0.19 [0.04**]	-0.07	0.54	0.28	32	0.41 [0.38]	0.02	2.56	1.09
WIFO	64	0.33 [0.17]	0.04	1.90	0.49	32	-0.01 [0.88]	0.02	0.47	0.27	32	0.67 [0.16]	0.30	2.64	0.88
Naive	64	0.57 [0.19]	-0.10	3.49	1.17	32	0.59 [0.30]	-0.10	3.16	1.11	32	0.55 [0.42]	0.03	3.80	1.23
Average		0.26	-0.01	1.96	0.57		-0.10	-0.05	0.58	0.31		0.61	0.20	2.71	1.06

Table 8 (cont'd): Summary of forecast errors of all institutions (using June instead of March and December instead of September forecasts for WIFO and IHS)

compensation of employees	Total					t					t+1				
	N	Bias [p-value]	MDB	RMSE	RMDSE	N	Bias [p-value]	MDB	RMSE	RMDSE	N	Bias [p-value]	MDB	RMSE	RMDSE
EC	56	-0.27 [0.12]	-0.37	1.29	0.49	29	-0.30 [0.01***]	-0.26	0.61	0.39	27	-0.24 [0.48]	-0.62	1.75	0.98
IHS	64	-0.17 [0.25]	-0.23	1.19	0.43	32	-0.14 [0.02**]	-0.04	0.37	0.19	32	-0.20 [0.50]	-0.47	1.64	0.74
OeNB	64	-0.17 [0.25]	-0.18	1.15	0.36	32	-0.18 [0.01**]	-0.10	0.42	0.18	32	-0.15 [0.59]	-0.37	1.57	0.75
WIFO	64	-0.03 [0.83]	-0.13	1.12	0.36	32	0.05 [0.39]	0.03	0.31	0.23	32	-0.11 [0.70]	-0.35	1.56	0.63
Naive	64	0.25 [0.37]	-0.37	2.19	0.92	32	0.30 [0.39]	-0.28	1.98	0.62	32	0.20 [0.65]	-0.63	2.38	1.56
Average		-0.16	-0.23	1.19	0.41		-0.14	-0.09	0.43	0.25		-0.18	-0.45	1.63	0.77
gross operating surplus	Total					t					t+1				
EC	38	0.97 [0.00***]	0.89	1.88	1.11	20	0.44 [0.11]	0.70	1.24	0.83	18	1.55 [0.00***]	1.84	2.40	1.84
IHS	64	0.38 [0.23]	0.33	2.48	0.94	32	-0.34 [0.39]	-0.09	2.16	0.61	32	1.09 [0.02**]	1.10	2.77	1.67
OeNB	64	0.13 [0.67]	-0.13	2.46	1.17	32	-0.64 [0.09]	-0.15	2.14	0.62	32	0.90 [0.06]	0.77	2.74	1.77
WIFO	64	0.50 [0.07*]	0.30	2.16	1.41	32	0.07 [0.78]	0.14	1.37	0.73	32	0.92 [0.05*]	1.25	2.73	1.91
Naive	64	0.46 [0.42]	0.11	4.53	1.62	32	0.42 [0.57]	0.20	4.08	1.57	32	0.49 [0.58]	-0.17	4.95	2.22
Average		0.49	0.35	2.24	1.16		-0.11	0.19	1.73	0.70		1.12	1.24	2.66	1.80
inflation	Total					t					t+1				
EC	64	-0.08 [0.31]	-0.01	0.62	0.31	32	-0.06 [0.14]	0.01	0.22	0.11	32	-0.10 [0.51]	-0.29	0.85	0.53
IHS	64	-0.02 [0.79]	0.00	0.53	0.20	32	-0.01 [0.65]	0.00	0.16	0.08	32	-0.02 [0.87]	0.00	0.74	0.46
IMF	64	-0.13 [0.13]	-0.19	0.70	0.39	32	-0.15 [0.04**]	-0.10	0.42	0.27	32	-0.12 [0.46]	-0.27	0.90	0.57
OeNB	64	-0.08 [0.28]	-0.02	0.57	0.22	32	-0.04 [0.21]	-0.01	0.18	0.07	32	-0.11 [0.42]	-0.13	0.78	0.52
OECD	64	-0.13 [0.10]	-0.09	0.64	0.21	32	-0.07 [0.06*]	-0.08	0.22	0.11	32	-0.19 [0.23]	-0.21	0.87	0.61
WIFO	64	0.00 [0.96]	-0.00	0.55	0.22	32	-0.01 [0.72]	-0.01	0.22	0.10	32	0.01 [0.95]	0.09	0.75	0.47
Naive	64	0.03 [0.85]	0.19	1.22	0.85	32	0.04 [0.85]	0.10	1.08	0.64	32	0.02 [0.92]	0.38	1.35	1.13
Average		-0.07	-0.05	0.60	0.26		-0.06	-0.03	0.24	0.12		-0.09	-0.13	0.81	0.53
employment	Total					t					t+1				
EC	64	-0.28 [0.00***]	-0.28	0.78	0.40	32	-0.34 [0.00***]	-0.26	0.53	0.27	32	-0.21 [0.23]	-0.35	0.97	0.69
IHS	64	-0.16 [0.12]	-0.17	0.82	0.26	32	-0.04 [0.34]	-0.04	0.24	0.07	32	-0.28 [0.16]	-0.49	1.14	0.80
IMF	50	-0.14 [0.26]	-0.13	0.84	0.45	25	-0.23 [0.09*]	-0.17	0.68	0.49	25	-0.04 [0.82]	-0.07	0.98	0.41
OeNB	64	-0.33 [0.01***]	-0.40	1.01	0.43	32	-0.27 [0.00***]	-0.20	0.47	0.32	32	-0.38 [0.11]	-0.59	1.35	0.91
OECD	41	0.06 [0.58]	0.07	0.68	0.39	21	-0.06 [0.59]	0.07	0.54	0.37	20	0.19 [0.30]	0.17	0.81	0.45
WIFO	64	-0.18 [0.08*]	-0.14	0.84	0.23	32	-0.05 [0.21]	-0.04	0.24	0.11	32	-0.31 [0.14]	-0.56	1.16	0.82
Naive	64	0.20 [0.34]	-0.29	1.69	0.74	32	0.24 [0.38]	-0.18	1.55	0.51	32	0.16 [0.62]	-0.48	1.82	0.95
Average		-0.17	-0.18	0.83	0.36		-0.17	-0.11	0.45	0.27		-0.17	-0.31	1.07	0.68
unemployment rate	Total					t					t+1				
EC	64	0.09 [0.31]	0.08	0.67	0.36	32	0.11 [0.15]	0.08	0.42	0.18	32	0.06 [0.68]	0.07	0.85	0.61
IHS	64	0.04 [0.56]	0.06	0.49	0.29	32	0.03 [0.51]	0.06	0.28	0.10	32	0.04 [0.73]	0.01	0.64	0.50
IMF	64	0.04 [0.64]	0.03	0.61	0.40	32	0.09 [0.22]	0.09	0.40	0.29	32	-0.02 [0.90]	-0.17	0.77	0.57
OeNB	64	0.05 [0.42]	0.04	0.53	0.31	32	0.06 [0.35]	0.03	0.36	0.10	32	0.05 [0.70]	0.09	0.65	0.50
OECD	42	-0.04 [0.60]	0.05	0.47	0.23	22	0.04 [0.48]	0.08	0.29	0.19	20	-0.13 [0.35]	-0.06	0.61	0.38
WIFO	64	0.04 [0.43]	0.08	0.45	0.23	32	0.03 [0.51]	0.06	0.25	0.10	32	0.06 [0.57]	0.09	0.58	0.44
Naive	64	-0.06 [0.47]	-0.15	0.64	0.54	32	-0.05 [0.59]	0.08	0.53	0.46	32	-0.07 [0.62]	-0.32	0.73	0.70
Average		0.04	0.06	0.54	0.30		0.06	0.07	0.34	0.16		0.01	0.00	0.68	0.50
government budget balance	Total					t					t+1				
EC	64	-0.09 [0.68]	-0.54	1.84	0.63	32	-0.34 [0.01***]	-0.40	0.75	0.49	32	0.15 [0.73]	-0.63	2.49	0.69
IHS	64	-0.07 [0.75]	-0.40	1.80	0.50	32	-0.43 [0.00***]	-0.30	0.69	0.34	32	0.28 [0.53]	-0.52	2.45	0.63
IMF	64	-0.07 [0.74]	-0.41	1.73	0.58	32	-0.41 [0.00***]	-0.46	0.65	0.54	32	0.27 [0.53]	-0.37	2.36	0.72
MOF	54	-0.05 [0.85]	-0.40	1.82	0.51	32	-0.40 [0.00***]	-0.40	0.56	0.40	22	0.46 [0.45]	-0.44	2.78	0.65
OeNB	64	0.00 [0.99]	-0.30	1.76	0.40	32	-0.28 [0.00***]	-0.21	0.42	0.22	32	0.28 [0.52]	-0.46	2.46	0.58
OECD	64	-0.16 [0.49]	-0.51	1.81	0.62	32	-0.44 [0.00***]	-0.45	0.69	0.48	32	0.12 [0.78]	-0.59	2.47	0.75
WIFO	64	-0.17 [0.49]	-0.43	1.92	0.51	32	-0.54 [0.00***]	-0.38	1.11	0.39	32	0.21 [0.65]	-0.50	2.48	0.61
Naive	64	0.42 [0.22]	-0.42	2.71	0.85	32	0.47 [0.32]	-0.27	2.65	0.82	32	0.36 [0.47]	-0.59	2.75	0.92
Average		-0.09	-0.43	1.81	0.54		-0.41	-0.37	0.70	0.41		0.25	-0.50	2.50	0.66

Source: own calculations. 'N' is the number of forecasts. "***" means rejection of the null hypothesis of unbiased forecast at 10%/5%/1%-significance level. For definition of error measures 'MDB', 'RMSE' and 'RMDSE' see appendix. 'Average' is an unweighted over all institutions (excluding the naive forecast). Red and green indicate the best and the worst forecast.

Table 9: Summary of forecast errors of all institutions (without 2020)

GDP, real	Total					t					t+1				
	N	Bias [p-value]	MDB	RMSE	RMDSE	N	Bias [p-value]	MDB	RMSE	RMDSE	N	Bias [p-value]	MDB	RMSE	RMDSE
EC	60	0.06 [0.67]	-0.06	1.16	0.47	30	-0.09 [0.29]	-0.08	0.45	0.21	30	0.22 [0.46]	0.28	1.57	1.03
IHS	60	0.14 [0.39]	-0.03	1.23	0.59	30	-0.03 [0.70]	-0.06	0.48	0.20	30	0.31 [0.32]	0.22	1.68	1.10
IMF	60	0.08 [0.60]	0.07	1.22	0.61	30	-0.05 [0.65]	0.02	0.54	0.30	30	0.21 [0.49]	0.41	1.64	1.06
OeNB	60	0.09 [0.51]	0.00	1.05	0.43	30	-0.03 [0.71]	-0.02	0.37	0.10	30	0.21 [0.44]	0.22	1.44	0.98
OECD	60	0.06 [0.68]	-0.03	1.06	0.37	30	-0.08 [0.28]	-0.06	0.38	0.10	30	0.19 [0.49]	0.19	1.45	0.98
WIFO	60	0.13 [0.38]	0.07	1.16	0.52	30	0.05 [0.61]	0.06	0.50	0.25	30	0.22 [0.46]	0.20	1.56	0.90
Naive	60	-0.04 [0.90]	-0.14	2.50	1.20	30	0.03 [0.94]	-0.10	2.18	1.15	30	-0.11 [0.84]	-0.64	2.78	1.20
Average		0.09	0.00	1.15	0.50		-0.04	-0.02	0.45	0.19		0.22	0.25	1.56	1.01
private consumption, real	Total					t					t+1				
EC	60	0.23 [0.00***]	0.20	0.50	0.28	30	0.14 [0.01***]	0.15	0.29	0.20	30	0.33 [0.00***]	0.37	0.64	0.56
IHS	60	0.32 [0.00***]	0.30	0.61	0.38	30	0.24 [0.00***]	0.23	0.40	0.27	30	0.40 [0.00***]	0.44	0.77	0.53
OeNB	60	0.22 [0.00***]	0.18	0.52	0.36	30	0.11 [0.12]	0.11	0.38	0.18	30	0.34 [0.00***]	0.45	0.63	0.48
OECD	60	0.27 [0.00***]	0.25	0.55	0.37	30	0.13 [0.04**]	0.09	0.35	0.18	30	0.41 [0.00***]	0.40	0.69	0.50
WIFO	60	0.31 [0.00***]	0.22	0.54	0.31	30	0.22 [0.00***]	0.15	0.36	0.17	30	0.41 [0.00***]	0.40	0.67	0.57
Naive	60	-0.01 [0.95]	-0.01	0.57	0.34	30	0.01 [0.94]	0.10	0.47	0.38	30	-0.02 [0.89]	-0.10	0.65	0.30
Average		0.27	0.23	0.54	0.34		0.17	0.14	0.35	0.20		0.38	0.41	0.68	0.54
public consumption, real	Total					t					t+1				
EC	60	-0.07 [0.57]	-0.01	0.92	0.70	30	0.06 [0.72]	-0.01	0.86	0.63	30	-0.19 [0.29]	-0.10	0.97	0.74
IHS	60	-0.40 [0.00***]	-0.39	1.06	0.73	30	-0.22 [0.20]	-0.27	0.93	0.65	30	-0.59 [0.00***]	-0.67	1.18	0.92
OeNB	60	-0.03 [0.75]	0.01	0.82	0.49	30	-0.05 [0.70]	-0.10	0.75	0.47	30	-0.02 [0.92]	0.27	0.89	0.55
OECD	60	-0.24 [0.08*]	-0.14	1.03	0.59	30	-0.06 [0.66]	-0.07	0.78	0.40	30	-0.41 [0.07*]	-0.44	1.23	0.69
WIFO	60	-0.27 [0.04**]	-0.22	1.02	0.69	30	-0.11 [0.49]	-0.19	0.83	0.63	30	-0.44 [0.04**]	-0.25	1.19	0.79
Naive	60	0.04 [0.82]	-0.07	1.25	0.86	30	0.02 [0.94]	-0.10	1.30	0.76	30	0.06 [0.81]	-0.03	1.21	1.11
Average		-0.20	-0.15	0.97	0.64		-0.08	-0.13	0.83	0.56		-0.33	-0.24	1.09	0.74
investment, real	Total					t					t+1				
EC	60	0.23 [0.45]	-0.00	2.31	1.35	30	-0.15 [0.54]	0.06	1.27	0.56	30	0.61 [0.28]	-0.08	3.01	1.80
IHS	60	0.43 [0.37]	-0.08	3.69	1.55	30	0.14 [0.74]	0.12	2.33	1.20	30	0.72 [0.41]	-0.48	4.67	2.68
OeNB	60	0.22 [0.44]	0.08	2.15	1.28	30	-0.16 [0.50]	0.11	1.28	0.66	30	0.59 [0.25]	-0.11	2.76	1.83
OECD	60	0.34 [0.19]	-0.04	2.01	1.13	30	-0.25 [0.27]	-0.07	1.23	0.98	30	0.94 [0.04**]	0.37	2.56	1.51
WIFO	60	0.34 [0.25]	0.05	2.31	1.33	30	0.10 [0.68]	0.05	1.29	0.52	30	0.59 [0.29]	0.43	3.01	1.88
Naive	60	0.09 [0.88]	0.01	4.88	2.90	30	0.06 [0.94]	-0.08	4.07	2.90	30	0.13 [0.90]	0.10	5.58	2.98
Average		0.31	0.00	2.49	1.33		-0.06	0.05	1.48	0.79		0.69	0.03	3.20	1.94
exports, real	Total					t					t+1				
EC	60	0.81 [0.18]	0.47	4.69	1.92	30	0.08 [0.84]	0.17	2.24	1.03	30	1.53 [0.18]	1.71	6.24	2.71
IHS	60	1.21 [0.06*]	1.07	4.91	2.28	30	0.47 [0.32]	0.86	2.54	1.33	30	1.95 [0.10*]	1.90	6.46	2.90
IMF	32	0.65 [0.08*]	0.79	2.11	1.24	17	0.10 [0.74]	0.54	1.25	0.93	15	1.26 [0.08*]	2.44	2.78	2.72
OeNB	60	1.12 [0.03**]	0.61	3.99	1.51	30	0.58 [0.13]	0.44	2.06	0.96	30	1.67 [0.08*]	1.34	5.25	2.22
OECD	60	1.26 [0.02**]	0.77	4.24	1.37	30	0.21 [0.51]	0.30	1.71	0.91	30	2.32 [0.02**]	1.43	5.75	2.34
WIFO	60	1.10 [0.08*]	0.91	4.82	1.83	30	0.62 [0.21]	0.44	2.67	1.16	30	1.57 [0.17]	1.65	6.27	2.82
Naive	60	0.30 [0.80]	0.16	9.31	3.96	30	0.42 [0.80]	0.55	8.83	3.91	30	0.19 [0.92]	0.14	9.77	4.02
Average		1.02	0.77	4.13	1.69		0.34	0.46	2.08	1.05		1.72	1.75	5.46	2.62
imports, real	Total					t					t+1				
EC	60	1.08 [0.07*]	0.47	4.63	1.60	30	0.29 [0.55]	0.19	2.55	1.05	30	1.86 [0.09*]	0.78	6.03	2.87
IHS	60	1.50 [0.01**]	0.59	4.77	1.99	30	0.77 [0.11]	0.49	2.65	1.39	30	2.23 [0.05**]	1.36	6.20	2.64
IMF	32	0.87 [0.03**]	0.62	2.27	1.41	17	0.07 [0.84]	0.18	1.38	0.58	15	1.77 [0.02**]	2.51	2.97	2.60
OeNB	60	1.17 [0.02**]	0.74	3.80	1.24	30	0.44 [0.27]	0.29	2.13	0.79	30	1.89 [0.03**]	1.15	4.93	1.94
OECD	60	1.49 [0.00***]	0.72	4.05	1.59	30	0.34 [0.36]	0.30	1.97	1.04	30	2.63 [0.01***]	1.90	5.38	2.13
WIFO	60	1.48 [0.02**]	0.80	4.81	1.83	30	0.93 [0.10*]	0.58	3.08	1.05	30	2.03 [0.07*]	1.04	6.06	2.76
Naive	60	0.26 [0.82]	0.23	8.56	2.76	30	0.25 [0.87]	0.64	8.07	2.71	30	0.27 [0.87]	-0.20	9.01	3.68
Average		1.26	0.66	4.06	1.61		0.47	0.34	2.29	0.98		2.07	1.46	5.26	2.49
GDP, nominal	Total					t					t+1				
EC	60	-0.08 [0.64]	-0.11	1.31	0.62	30	-0.18 [0.15]	-0.15	0.68	0.39	30	0.02 [0.95]	0.03	1.72	1.13
IHS	60	0.02 [0.91]	0.09	1.37	0.53	30	-0.11 [0.29]	0.00	0.56	0.33	30	0.15 [0.66]	0.27	1.85	1.11
IMF	60	0.00 [0.98]	-0.09	1.34	0.64	30	-0.10 [0.42]	-0.11	0.68	0.41	30	0.11 [0.74]	0.08	1.77	1.02
OeNB	60	0.02 [0.90]	0.03	1.30	0.59	30	-0.08 [0.52]	0.01	0.65	0.27	30	0.12 [0.71]	0.14	1.72	0.94
OECD	60	-0.15 [0.25]	-0.07	1.01	0.57	30	-0.15 [0.09*]	-0.07	0.46	0.28	30	-0.15 [0.54]	-0.09	1.35	0.98
WIFO	60	0.09 [0.62]	0.22	1.36	0.69	30	0.07 [0.61]	0.27	0.71	0.53	30	0.11 [0.74]	0.10	1.79	0.97
Naive	60	-0.02 [0.97]	-0.17	2.67	1.11	30	0.04 [0.93]	-0.10	2.32	1.06	30	-0.07 [0.90]	-0.34	2.98	1.17
Average		-0.02	0.01	1.28	0.61		-0.09	-0.01	0.62	0.37		0.06	0.09	1.70	1.03

Table 9 (cont'd): Summary of forecast errors of all institutions (without 2020)

compensation of employees	Total					t					t+1				
	N	Bias [p-value]	MDB	RMSE	RMDSE	N	Bias [p-value]	MDB	RMSE	RMDSE	N	Bias [p-value]	MDB	RMSE	RMDSE
EC	52	-0.50 [0.00***]	-0.45	0.93	0.47	27	-0.37 [0.00***]	-0.30	0.60	0.33	25	-0.65 [0.00***]	-0.62	1.19	0.95
IHS	60	-0.40 [0.00***]	-0.42	0.97	0.50	30	-0.32 [0.00***]	-0.26	0.56	0.34	30	-0.49 [0.03**]	-0.54	1.25	0.66
OeNB	60	-0.30 [0.00***]	-0.18	0.79	0.33	30	-0.12 [0.04**]	-0.07	0.32	0.16	30	-0.48 [0.01**]	-0.52	1.07	0.73
WIFO	60	-0.26 [0.02**]	-0.18	0.89	0.44	30	-0.05 [0.49]	-0.09	0.41	0.26	30	-0.47 [0.03**]	-0.56	1.20	0.71
Naive	60	-0.16 [0.45]	-0.46	1.56	0.85	30	-0.08 [0.73]	-0.33	1.29	0.54	30	-0.23 [0.50]	-0.76	1.79	1.44
Average		-0.37	-0.31	0.90	0.43		-0.22	-0.18	0.47	0.27		-0.52	-0.56	1.18	0.76
gross operating surplus	Total					t					t+1				
EC	34	0.77 [0.00***]	0.89	1.62	1.11	18	0.41 [0.18]	0.61	1.28	0.87	16	1.17 [0.01**]	1.54	1.94	1.72
IHS	60	0.47 [0.12]	0.25	2.31	1.16	30	0.08 [0.65]	-0.11	1.00	0.61	30	0.85 [0.14]	0.90	3.11	1.81
OeNB	60	0.19 [0.49]	-0.13	2.15	1.11	30	-0.29 [0.33]	-0.14	1.58	0.55	30	0.67 [0.16]	0.21	2.59	1.68
WIFO	60	0.48 [0.12]	0.65	2.37	1.55	30	0.29 [0.32]	0.65	1.56	1.26	30	0.68 [0.22]	0.55	2.96	1.87
Naive	60	0.20 [0.74]	-0.03	4.54	1.61	30	0.24 [0.76]	0.13	4.13	1.53	30	0.16 [0.86]	-0.18	4.91	1.64
Average		0.48	0.42	2.11	1.23		0.12	0.25	1.35	0.82		0.84	0.80	2.65	1.77
inflation	Total					t					t+1				
EC	60	-0.09 [0.26]	-0.05	0.64	0.31	30	-0.06 [0.18]	0.01	0.22	0.11	30	-0.13 [0.42]	-0.35	0.87	0.54
IHS	60	-0.01 [0.93]	-0.02	0.68	0.30	30	-0.03 [0.56]	-0.01	0.29	0.18	30	0.02 [0.93]	-0.05	0.91	0.57
IMF	60	-0.14 [0.12]	-0.19	0.71	0.38	30	-0.12 [0.10*]	-0.03	0.39	0.27	30	-0.17 [0.33]	-0.32	0.92	0.57
OeNB	60	-0.08 [0.31]	-0.02	0.58	0.22	30	-0.02 [0.46]	-0.01	0.15	0.07	30	-0.13 [0.38]	-0.25	0.80	0.56
OECD	60	-0.14 [0.10*]	-0.09	0.65	0.21	30	-0.06 [0.14]	-0.07	0.20	0.11	30	-0.22 [0.18]	-0.22	0.89	0.62
WIFO	60	-0.01 [0.93]	0.00	0.64	0.30	30	0.00 [0.93]	0.05	0.27	0.20	30	-0.02 [0.91]	-0.14	0.86	0.52
Naive	60	0.00 [0.98]	0.19	1.26	0.94	30	0.03 [0.88]	0.11	1.12	0.65	30	-0.02 [0.93]	0.27	1.38	1.15
Average		-0.08	-0.06	0.65	0.29		-0.05	-0.01	0.25	0.16		-0.11	-0.22	0.88	0.56
employment	Total					t					t+1				
EC	60	-0.37 [0.00***]	-0.30	0.67	0.39	30	-0.36 [0.00***]	-0.26	0.53	0.26	30	-0.38 [0.01***]	-0.44	0.78	0.59
IHS	60	-0.34 [0.00***]	-0.32	0.73	0.41	30	-0.21 [0.00***]	-0.12	0.42	0.17	30	-0.46 [0.01***]	-0.69	0.95	0.79
IMF	48	-0.24 [0.01**]	-0.15	0.70	0.39	25	-0.23 [0.09*]	-0.17	0.68	0.49	23	-0.26 [0.09*]	-0.10	0.73	0.31
OeNB	60	-0.47 [0.00***]	-0.40	0.83	0.41	30	-0.31 [0.00***]	-0.29	0.47	0.32	30	-0.63 [0.00***]	-0.74	1.08	0.86
OECD	38	-0.01 [0.85]	0.07	0.47	0.37	20	0.00 [0.97]	0.07	0.47	0.34	18	-0.03 [0.83]	0.02	0.47	0.38
WIFO	60	-0.33 [0.00***]	-0.24	0.75	0.35	30	-0.15 [0.02**]	-0.12	0.35	0.16	30	-0.52 [0.00***]	-0.71	1.00	0.79
Naive	60	-0.04 [0.82]	-0.35	1.43	0.68	30	0.02 [0.94]	-0.26	1.30	0.50	30	-0.10 [0.72]	-0.62	1.54	0.94
Average		-0.29	-0.22	0.69	0.39		-0.21	-0.15	0.49	0.29		-0.38	-0.44	0.84	0.62
unemployment rate	Total					t					t+1				
EC	60	0.10 [0.24]	0.08	0.68	0.35	30	0.09 [0.23]	0.08	0.43	0.17	30	0.11 [0.48]	0.09	0.86	0.59
IHS	60	0.07 [0.36]	0.08	0.60	0.38	30	0.06 [0.38]	0.08	0.37	0.14	30	0.08 [0.56]	-0.01	0.76	0.62
IMF	60	0.04 [0.63]	0.03	0.63	0.40	30	0.07 [0.33]	0.06	0.41	0.29	30	0.00 [0.98]	-0.07	0.79	0.58
OeNB	60	0.05 [0.41]	0.05	0.50	0.27	30	0.02 [0.73]	0.03	0.26	0.10	30	0.09 [0.46]	0.14	0.65	0.44
OECD	38	-0.02 [0.79]	0.05	0.45	0.20	20	0.01 [0.86]	0.07	0.28	0.15	18	-0.06 [0.70]	0.00	0.58	0.34
WIFO	60	0.08 [0.27]	0.04	0.52	0.35	30	0.04 [0.46]	0.05	0.32	0.16	30	0.11 [0.39]	0.01	0.67	0.51
Naive	60	-0.02 [0.81]	-0.04	0.64	0.54	30	0.00 [0.99]	0.23	0.51	0.42	30	-0.04 [0.78]	-0.27	0.75	0.75
Average		0.05	0.06	0.56	0.32		0.05	0.06	0.34	0.17		0.06	0.03	0.72	0.51
government budget balance	Total					t					t+1				
EC	60	-0.44 [0.00***]	-0.59	0.84	0.60	30	-0.43 [0.00***]	-0.40	0.57	0.44	30	-0.44 [0.02**]	-0.66	1.04	0.67
IHS	60	-0.32 [0.00***]	-0.43	0.79	0.51	30	-0.43 [0.00***]	-0.42	0.53	0.42	30	-0.20 [0.27]	-0.45	0.98	0.62
IMF	60	-0.38 [0.00***]	-0.42	0.80	0.58	30	-0.46 [0.00***]	-0.46	0.56	0.46	30	-0.29 [0.10]	-0.39	0.99	0.71
MOF	50	-0.42 [0.00***]	-0.40	0.60	0.45	30	-0.43 [0.00***]	-0.40	0.54	0.40	20	-0.39 [0.01***]	-0.54	0.68	0.59
OeNB	60	-0.30 [0.00***]	-0.32	0.71	0.40	30	-0.29 [0.00***]	-0.21	0.43	0.22	30	-0.31 [0.06*]	-0.47	0.90	0.54
OECD	60	-0.48 [0.00***]	-0.56	0.78	0.60	30	-0.47 [0.00***]	-0.45	0.58	0.45	30	-0.48 [0.00***]	-0.66	0.94	0.72
WIFO	60	-0.37 [0.00***]	-0.49	0.79	0.52	30	-0.42 [0.00***]	-0.44	0.56	0.47	30	-0.32 [0.07*]	-0.61	0.97	0.71
Naive	60	-0.18 [0.34]	-0.52	1.43	0.84	30	-0.14 [0.53]	-0.40	1.17	0.80	30	-0.22 [0.48]	-0.73	1.64	0.86
Average		-0.38	-0.46	0.76	0.52		-0.42	-0.40	0.54	0.41		-0.35	-0.54	0.93	0.65

Source: own calculations. 'N' is the number of forecasts, "***" means rejection of the null hypothesis of unbiased forecast at 10%/5%/1%-significance level. For definition of error measures 'MDB', 'RMSE' and 'RMDSE' see appendix. 'Average' is an unweighted over all institutions (excluding the naive forecast). Red and green indicate the best and the worst forecast.

Figure 6: Forecast errors over forecasting horizon (without 2020)

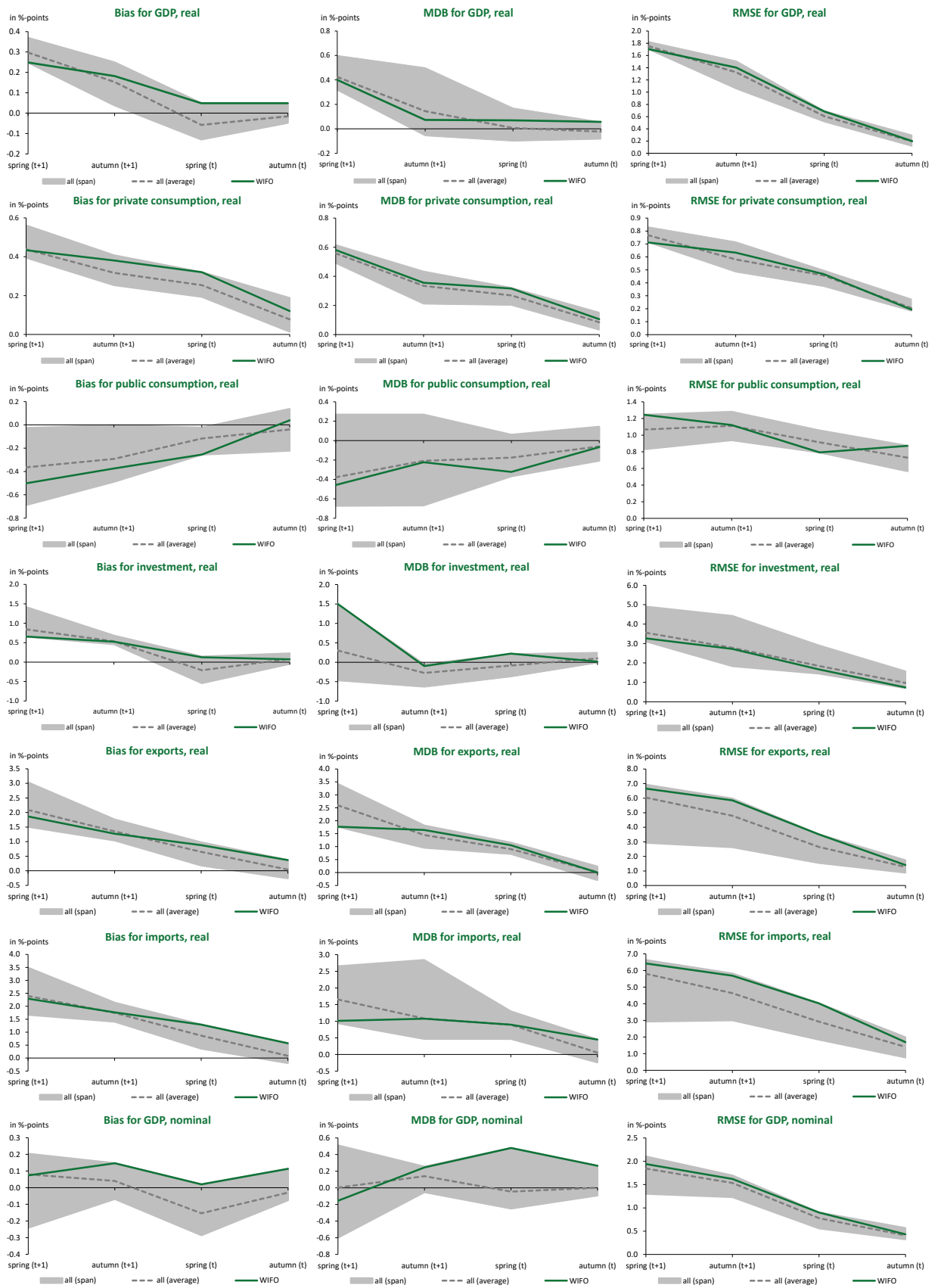
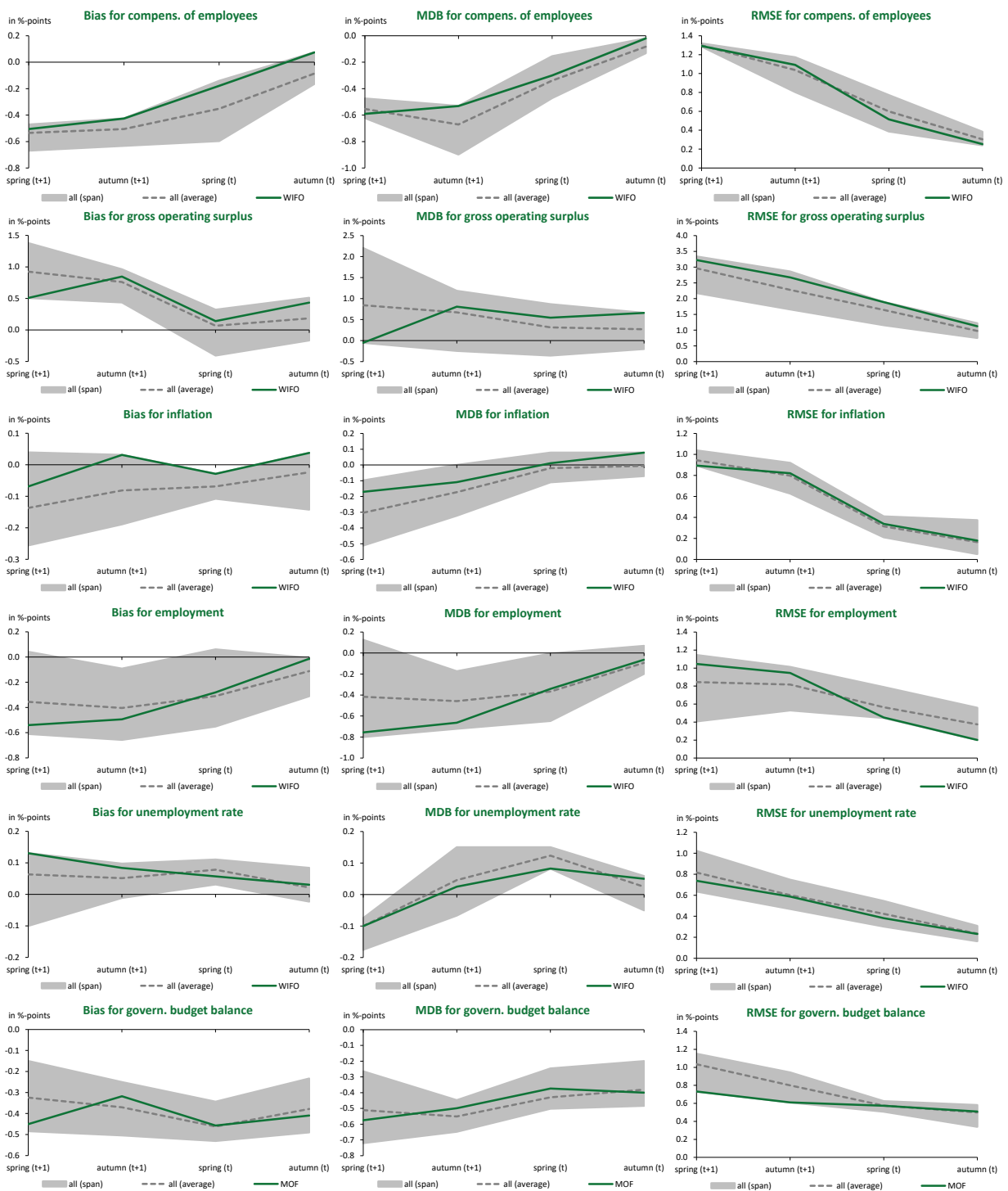


Figure 6 (cont'd): Forecast errors over forecasting horizon (without 2020)



Source: Own calculations. 'all (span)' plots the area between lowest and highest error measure over all institutions, 'all (average)' is an unweighted average of the error measures over all institutions.