Conselho das Finanças Públicas

MOST PROBABLE OR MORE PRUDENT? ANALYZING CFP'S MACROECONOMIC PROJECTIONS, 2015-2019

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April 2022

Occasional Paper n.º
02/2022

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Most probable or more prudent? Analysing CFP's macroeconomic projections, 2015-2019

Nuno Gonçalves*

Conselho das Finanças Públicas

Abstract

The CFP macroeconomic projections provide an independent contribute for the public debate on economic developments and fiscal policy in Portugal. They are an important input for the endorsement of macroeconomic forecasts underlying budgetary programming documents. According to the Law, these must be based on the most likely macro scenario or on a more prudent scenario. Naturally, the CFP projections are also following the same principles, and so it is crucial to assess whether they are the "most probable" or "more prudent". This paper makes a first study of CFP macroeconomic projections regarding forecasting performance and its optimality properties. In general, the results suggest that CFP projections are prudent and fulfil most optimality conditions, proving to be a reliable contribute to policy debate. The findings also show that CFP projection errors are also in line with those of other institutions that develop scenarios under the no policy change assumption.

JEL classification: C53, E37, E60, E66.

Keywords: Macroeconomic forecasts; forecast performance and evaluation; Portugal.

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The opinions here expressed are solely of the author, and not those of the Portuguese Public Finance Council. The author would like to thank Carlos Marinheiro, Miguel St. Aubyn and Nazaré da Costa Cabral for helpful comments and suggestions and Tiago Martins for provided outstanding assistance. All remaining errors and omissions are my own.

Contents

1 Introduction

The Portuguese Public Finance Council (CFP), under the responsibilities entrusted by its Statutes, produces since 2015 macro-fiscal scenarios under the no policy change assumption.[1] Twice a year, usually in March and September, the five-year projections are presented in the publication *Economic and Fiscal Outlook*, previously named as *Public Finance: Position and Constraints*.

The EU legislation requires national medium-term fiscal plans and draft budgets to be based on independent macroeconomic forecasts, which are defined as "macroeconomic forecasts produced or endorsed by independent bodies".[2] In Portugal, CFP is the independent body that has the responsibility to endorse such macroeconomic forecasts.[3] In this context, CFP's projections assist,[4] above all, the endorsement of the macroeconomic scenarios presented by the Ministry of Finance in the budgetary programming documents (*i.e.*, the Stability Programme and the State Budget), whilst also fostering, from an independent and transparent technical point of view, the public discussion on current developments and the expected medium-term outlook for the Portuguese economy and public finances. Such macroeconomic projections allow CFP to: express views on eventual macroeconomic imbalances; elaborate an assessment of the prevailing risks; anchor budgetary projections; and, have a benchmark for reflection on the sustainability of public finances.

The quality of CFP forecasts assumes paramount importance, in particular considering their role in the endorsement process and to avoid any large optimistic deviation in official budgetary projections (Jonung and Larch, 2006; Marinheiro, 2011). Official forecasts are now subject to a set of legal restrictions, at both the national and at the European level. In particular "The budgetary projections underlying the budgetary programming documents (…) must be based on the most probable macroeconomic scenario or on a more prudent scenario", according to the principles set out in Article 8 of the Budgetary Framework Law (Law No. 151/2015 of 11 September), in the Stability and Growth Pact[5] and in the Council Directive 2011/85/EU.[6] Naturally, the CFP projections are also following the same principles. This paper assesses the quality of CFP macroeconomic projections over the period 2015-2019.

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[1] The assumption of no policy change implies that the scenario considers the effects of policy measures already implemented/legislated or sufficiently specified by the government.

[2] Regulation (EU) No 473/2013 of the European Parliament and Council, of May 21st 2013, Article 2(1)(b), Article 4(4) and Article 6(3)(f).

[3] Article 8 of the Budgetary Framework Law (Law No. 151/2015 of 11 September).

[4] Together with the projections for the Portuguese economy prepared by Banco de Portugal, the International Monetary Fund, the European Commission and the Organisation for Economic Cooperation and Development. See the Memorandum of Understanding signed between the CFP and the Ministry of Finance.

[5] Article 3 (2a) of Council Regulation (EC) No 1466/97 of 7 July 1997.

[6] Article 4 of the Council Directive 2011/85/EU of 8 November 2011, on requirements for budgetary frameworks of the Member States, states that: "Member States shall ensure that fiscal planning is based on realistic macroeconomic and budgetary forecasts using the most up-to-date information. Budgetary planning shall be based on the most likely macrofiscal scenario or on a more prudent scenario."

It should be noted that any forecast exercise – by any institution – is subject to uncertainty. Projecting the exact state of the economy requires, for instance, a complete and reliable knowledge of the economy fundamentals and transmission channels, the absence of random shocks, symmetrical and perfect information, and the inexistence of statistical series revisions. Although incomplete by nature, the projection exercise of future economic developments should be as defined and consistent as possible, considering all available information at the time it is elaborated. It should reflect a knowledge of the economy and a technical and independent perspective, rather than a political will or ideology.

The study provides a quantitative analysis of the deviations of CFP's macroeconomic projections. The performance of three macroeconomic reference indicators – real Gross Domestic Product (GDP) growth, inflation measured by the Harmonised Index of Consumer Prices (HICP) and the current account as a percentage of GDP – and of a set of fiscal determinants - nominal private consumption growth, nominal GDP growth, unemployment rate (as a percentage of the labour force), employment and the rate of change of total compensation of employees - is assessed. To this end, statistics typically used in this type of analysis are calculated, namely the mean error, the mean absolute error and the root mean square error. The quality of the deviations is tested according to the properties of "optimal projections" – unbiased, serially uncorrelated, efficient and with the variance of the deviations not increasing as the projection horizon decreases. Using the same methodology, and to complete the analysis, the deviations of the CFP macroeconomic projections are compared to those of other institutions that produce macroeconomic scenarios for Portugal under a no policy change assumption and for the same period: Banco de Portugal (BdP), European Commission (EC), International Monetary Fund (IMF) and Organisation for Economic Co-operation and Development (OECD).

In general, the results show that CFP macroeconomic projections are prudent. Optimal properties are satisfied for most variables, except strong efficiency which holds only for current year projections for real GDP growth, unemployment rate and compensations growth. Comparing with other institutions the CFP forecasts perform satisfactorily, are qualitatively similar and have the same statistical accuracy for a 5% confidence level (Diebold-Mariano test), despite the CFP being the first institution to present its projections each year (in March, and September), while other institutions usually publish later on the year (the IMF in April and October, the EC in May and November, the OECD in May and November, and the BdP in March and December).

The next section describes how the data is compiled, how the statistics used in the study are produced and presents the optimal forecast properties to be tested. Section 3 carries out the analysis of the deviations by projection horizon and tests the optimal properties of the forecasts. Section 4 presents a comparison of the projection deviations with those of other benchmark institutions. Finally, section 5 concludes.

2 Methodological framework

The methodological framework used in this study follows the common international practice in the data timing conventions, in the statistics computed to assess forecasting performance and in the analysis of optimal forecast properties. At the institutional level, a non-exhaustive list of the literature that conducted similar analysis includes Timmermann (2007) and IMF IEO (2014) for the IMF, Pain *et al.* (2014) and Turner (2016) for the OECD, Fioramanti *et al.* (2016) and Chabin *et al.* (2020) for the European Commission, Kontogeorgos and Lambrias (2019) for the European Central Bank, BoE-IEO (2015) for the Bank of England, and OBR (2019) for the Office for Budget Responsability.

2.1 Dataset and timing-conventions

The dataset used contains the CFP's macroeconomic projections over the period 2015 2019. The analysis focus on three reference macroeconomic variables: real GDP growth, inflation (measured by the HICP) and current account balance (as percentage of GDP); and a set of fiscal determinants: nominal private consumption growth, nominal GDP growth, unemployment rate (as percentage of labour force), employment growth and the growth of total compensations in the economy.

For each reference period, four sets of short-term forecasts are used to assess performance, as the CFP publishes twice a year (both in March and September) vintages for current- and next-year projections. For instance, four projections of real GDP growth relative to the year 2019 are reported, namely the March and September 2018 year-ahead projections and the March and September 2019 current-year projections. The forecast error is defined as follows:

$$e^{i}_{t,t} = y^{i}_{t,t} - y_t, \text{ for the current year}$$
$$e^{i}_{t+1,t} = y^{i}_{t+1,t} - y_{t+1}, \text{ for the year-ahead,}$$

where $y^{i}_{t,t}$ and $y^{i}_{t+1,t}$ are the forecasts made at time t in vintage i, $i \in$ {March, September}, for period t and $t+1$ respectively; y_t and y_{t+1} are the realizations of that variable for period t and $t+1$ respectively. With this notation, positive deviations refer to an overestimation, whilst negative deviations show an underestimation of the outturns.

Given the target variables are subject to eventual revisions by the statistical authorities, and following the above-mentioned literature, in particular Timmermann (2007), the first-available data in the March vintage of year $t+1$ is used to measure the outcome of the projected variable in period t, whilst year-ahead forecasts for period $t+1$ are compared to the realized values for year $\underline{t}+1$ reported in the September vintage of year $t+2$. A complementary exercise is made using the deviations ($e^{i,f}_{.,t}$) obtained with the final data (y^{f}_{t}) from national accounts (except for inflation and for unemployment rate), defined as

$$e^{i,f}_{t,t} = y^{i}_{t,t} - y^{f}_{t} \text{ , for the current year}$$
$$e^{i,f}_{t+1,t} = y^{i}_{t+1,t} - y^{f}_{t} \text{ , for the year-ahead.}$$

The CFP's medium-term forecasts performance (three to five years horizon, $t+2 : t+4$) is set out of the scope of the analysis for two main reasons: the limited number of observations does not allow to take any robust conclusions – for instance, there is only one observation for the $t+4$ forecast (the year 2019); and, these projections are based on the no policy change assumption, so the values do not necessarily represent forecasts of the future state of the economy, but rather, an extension of economic dynamics, constrained by initial economic conditions and the set of policy measures in force. For transparency purposes Table A1 in Appendix presents the summary statistics for the CFP's medium-term macroeconomic projections published to date.

2.2 Performance measures

The performance of CFP's macroeconomic projections is assessed through the summary statistics described below, both for the current- and next-year forecasts (τ).

The average forecast error over period T is given by the mean error (ME) and indicates possible bias in the projections, as positive errors can offset negative errors and vice-versa. It is represented as

$$ME = \frac{1}{T}\sum_{t=1}^{T} e_{\tau,t} \ , \ \tau \in \{t, t+1\} .$$

The mean absolute error (MAE) is computed as the average of the absolute value of the forecast errors over period T. All the errors are equally weighted in the average. Algebraically,

$$MAE = \frac{1}{T}\sum_{t=1}^{T} \left|e_{\tau,t}\right| \ , \ \tau \in \{t, t+1\} .$$

The root mean squared error (RMSE) is the square root of the average of squared forecast errors over period T, where errors are weighted relatively to their size. It is given by

$$RMSE = \sqrt{\frac{1}{T}\sum_{t=1}^{T} e_{\tau,t}^2} \ , \ \tau \in \{t, t+1\} .$$

Additionally, the normalized root mean squared error (NRMSE) is calculated, to help compare the forecast performance across different variables – as more volatile variables are likely to induce less accurate forecasts. The normalization of the square root of the average of squared forecast errors over period T is made using the standard deviation of the variable (σ) – see Table A2 in appendix:

$$NRMSE = \sqrt{\frac{1}{T}\sum_{t=1}^{T} \left(\frac{e_{\tau,t}}{\sigma}\right)^2} \ , \ \tau \in \{t, t+1\} .$$

2.3 Optimal forecasts properties

To assess the quality of the CFP macroeconomic forecasts this paper tests a set of statistical properties that optimal forecasts should have. Following, among others, Timmermann (2007), Kontogeorgos and Lambrias (2019), and Chabin *et al.* (2020), the forecasts are tested for: unbiasedness, error persistence (serial correlation), quantitative accuracy, efficiency, and non-increasing variance of errors as forecast horizon decreases. Forecasts are optimal when they minimize a given loss function, commonly set in the literature (*e.g.*, Timmermann, 2007) as a quadratic loss function, *i.e.* Mean Squared Error (MSE) loss, $L(e) = \alpha e^2$, where e is the forecast error. Under the assumed squared loss function, optimal forecasts satisfy the properties of unbiasedness, weak efficiency and variance is a non-decreasing function of the forecast horizon (Kontogeorgos and Lambrias, 2019).

The test for **unbiasedness** requires the forecast errors to be close to zero on average over the sample, which means that there should not be any systematic over- or under-prediction of a variable. To test for unbiasedness the forecast errors for period t and $t + 1$ are regressed using heteroscedasticity and autocorrelation consistent (HAC) standard errors on a constant, as follows:

$$e_t = \alpha + \varepsilon_t \tag{1}$$

$$e_{t+1} = \alpha + \varepsilon_{t+1} \tag{2}$$

where ε stands for an independently and identically distributed error term. Unbiasedness requires that the coefficient α should not be statistically different from zero. In other words, using a simple t-student test, the null hypothesis of the absence of a bias ($\alpha = 0$) should not be rejected at the 5% significance level.

Serial correlation in forecast errors may arise in the presence of systematic mistakes or due to the compensation of past mistakes by subsequent errors of the opposite sign. Following Chabin *et al.* (2020) this paper employs a Ljung-Box test (Ljung and Box, 1978) for testing the null hypothesis of absence of autocorrelation (**uncorrelated errors**) in forecast errors up to two lags.

Following Chabin *et al.* (2020), it is tested whether the CFP's forecasts are **quantitatively accurate**, *i.e.* if the published forecasts systematically beat *naïve* forecasts – defined as keeping the variable in question at the latest known actual value. The difference between the two forecasts is statistically assessed using the Diebold-Mariano test (Diebold and Mariano, 1995). The null hypothesis of both forecasts being equally accurate is tested against the alternative hypothesis that the CFP's forecast is more accurate.

To test the forecasts for efficiency, consider the following regressions:

$$y_t = \alpha + \beta y_{t,t} + \varepsilon_t \,, \tag{3}$$

$$y_{t+1} = \alpha + \beta y_{t+1,t} + \varepsilon_{t+1} \,. \tag{4}$$

A forecast is considered (strongly) **efficient** if it jointly holds that the intercept is zero and the slope coefficient is not different from unity ($\alpha = 0, \beta = 1$) (Chabin *et al.*, 2020) – implying unbiasedness and uncorrelated errors. The null hypothesis is tested using a F test. When unbiasedness and uncorrelated errors hypothesis hold separately, a forecast can be considered as weakly efficient.

A final property than an optimal forecast should have, is that the **variance of the forecast error should decline as more information becomes available**. As there is more available information about the outcome in the current year or the year-ahead in September than in March of the same year (Timmermann, 2007) it is expected that forecast errors will have a greater variance in March than in September:

$$Var\left(e_{t,t}^{Sep}\right) \leq Var\left(e_{t,t}^{Mar}\right), \quad (5)$$

$$Var\left(e_{t+1,t}^{Sep}\right) \leq Var\left(e_{t+1,t}^{Mar}\right). \quad (6)$$

The tests are performed using linear regressions and the results should be read with caution given the small size of the sample, even though all of CFP's forecast exercises for the period 2015-2019 are used in this study. The test-statistics used in the analysis are valid asymptotically and, although t-tests or small-sample adjustments are used where possible, one cannot be sure about the properties at short samples. A robustness analysis of the results achieved is expected in a future update of this paper.

3 The CFP's macroeconomic projection errors

3.1 Forecasting performance 2015-2019

This section discusses the performance of macroeconomic forecasts for the selected variables using the summary statistics previously presented. Table 1 shows the global results for the period 2015-2019. The detailed results for March and September vintages are presented in Table A3 and Table A4, respectively, in Appendix.

For the selected variables, NRMSE – the RMSE statistic corrected for the volatility of the series – shows that on average the current-year forecasts are more accurate for nominal private consumption, GDP growth and current account. Correcting for the volatility of the underlying data, the year-ahead forecasts are shown to be more accurate for the current account, nominal private consumption and nominal GDP. The NRMSE of the year-ahead forecasts are higher than the current- year forecasts, as expected.

Table 1 – CFP macroeconomic projection errors, 2015-2019

	Current year				Year-ahead			
	ME	*MAE*	*RMSE*	*NRMSE*	*ME*	*MAE*	*RMSE*	*NRMSE*
Real GDP	-0.13	0.29	0.39	0.17	-0.33	0.65	0.74	0.33
Inflation	0.15	0.26	0.39	0.29	0.44	0.73	0.82	0.62
Current account	0.03	0.61	0.77	0.17	0.05	0.41	0.51	0.11
Fiscal determinants:								
Nominal GDP	-0.23	0.55	0.65	0.20	-0.39	0.74	0.89	0.27
Private consumption	-0.07	0.26	0.29	0.09	0.09	0.68	0.83	0.25
Unemployment rate	0.29	0.51	0.62	0.18	1.17	1.31	1.57	0.45
Employment	-0.36	0.52	0.80	0.41	-0.94	1.14	1.41	0.72
Total compensations	-0.39	1.15	1.31	0.34	-1.82	1.82	2.06	0.54

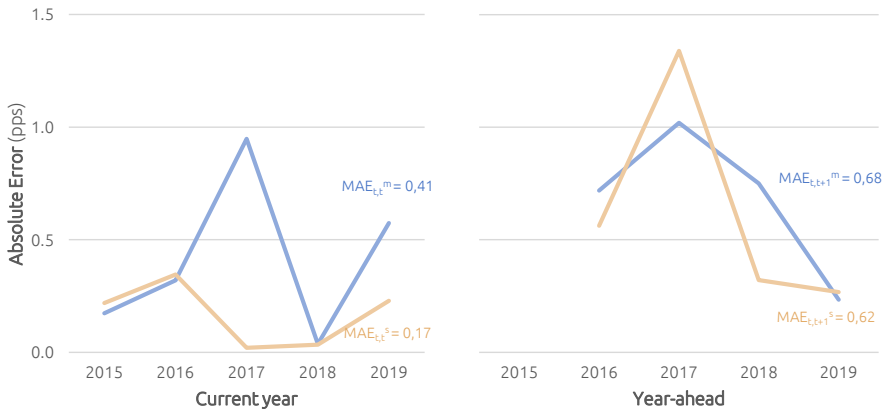
Notes: results in percentage points; full sample.

Real GDP growth

The mean of the current-year forecast error (ME) for the real GDP growth rate is negative but close to zero (Table 1), evidencing a possible small bias across time to underestimation of growth in the years 2015-2019.[7] The forecast errors are larger for the year-ahead than for the current year, as much less information is available at the time of forecasting. The deviations from observed GDP growth were particularly high in 2017 as the forecasts (current year and year-ahead) did not accurately anticipate the strength of growth in that year. This outlier is clearly apparent in Figure 1.

[7] Specific tests for unbiasedness and other optimal properties of forecasts are carried out in section 3.2.

Figure 1 – Real GDP growth, absolute error



Source: CFP macroeconomic projections and own calculations. *Notes*: MAE – mean absolute error; m – March vintage exercises; s – September vintage exercises.

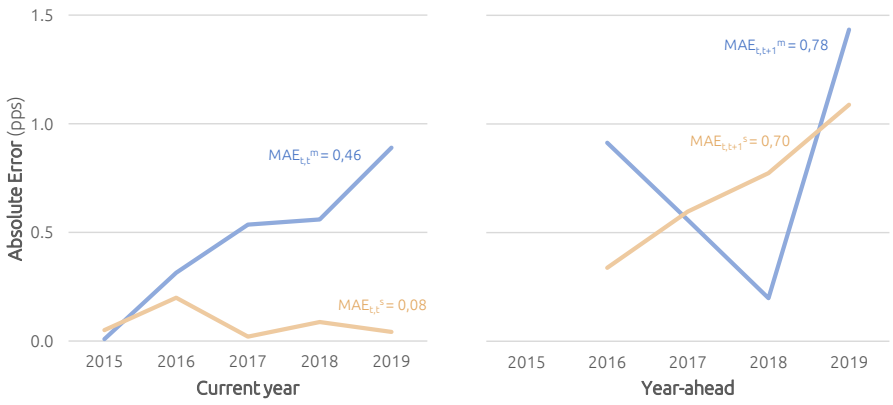
Regarding forecast revisions, the March exercise forecast errors are, as expected, significantly reduced in the September exercise, as a result from the incorporation of additional information (Figure 1 and Table A3 and Table A4).

Inflation

For inflation, measured as the annual rate of change in the HICP, the mean of the current-year forecast errors is positive, suggesting a propensity for inflation overestimation in the period 2015-2019.

The year-ahead inflation projection errors are higher than those for real GDP growth, despite the former being less volatile (Table A2), resulting into a higher NRMSE (Table 1) and evidencing that further refinements are needed in year-ahead inflation projections.

Figure 2 – Inflation, absolute error



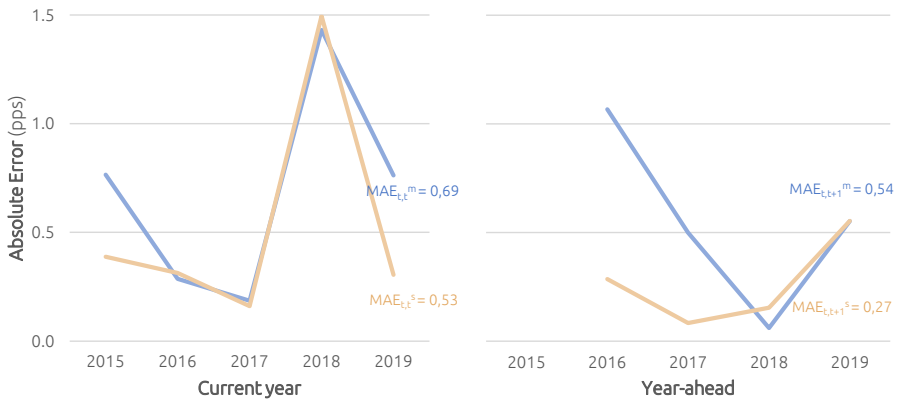
Source: CFP macroeconomic projections and own calculations. *Notes*: MAE – mean absolute error; m – March vintage exercises; s – September vintage exercises.

The forecast errors in September vintages are lower than in March exercises both for current year and year-ahead forecasts (Figure 2).

Current account

The current account balance, measured as a ratio of nominal GDP, is the variable under study with the highest volatility (Table A2). The mean forecast error (ME), both for current-year and the year-ahead, are approximately zero, which contrasts with a considerable MAE, illustrating the volatility in the forecasts.

Figure 3 – Current account (% GDP), absolute error



Source: CFP macroeconomic projections and own calculations. *Notes*: MAE – mean absolute error; m – March vintage exercises; s – September vintage exercises.

The results show that both the MAE and RMSE of current-year forecasts are higher than those of the year-ahead forecasts, which suggests the necessity to improve the precision of current year forecasts (Figure 3 and Table 1).

Fiscal determinants

The statistics for the fiscal determinants, reported in Table 1, show possible evidence of a recurrent prudent posture in forecasting current- and next-year figures. The ME has negative signal (underestimation) for most variables but the unemployment rate, which is positive (overestimation). The current-year MAE ranges from 0.26 p.p. for nominal private consumption growth to 1.15 p.p. for total compensations growth. The year-ahead figures report a similar conclusion regarding accuracy. As expected, the forecast errors are larger than those for current year projections.

Table A3 and Table A4, in Appendix, show that for most of the fiscal determinants under study, the forecast errors in September exercises are lower than in March, due to the incorporation of additional information.

Deviations relative to final data

Target variables can be subject to data revisions by the statistical authority, leading to differences in the forecasting performance depending on whether one uses the first estimate or the final data. The main results of this paper are obtained using first estimates of data, as in real-time, for the CFP work, those estimates are the relevant ones. Nonetheless, this complementary exercise may be useful to assess the impact of data revision in CFP's macroeconomic forecasting performance. The results are presented in Table 2.

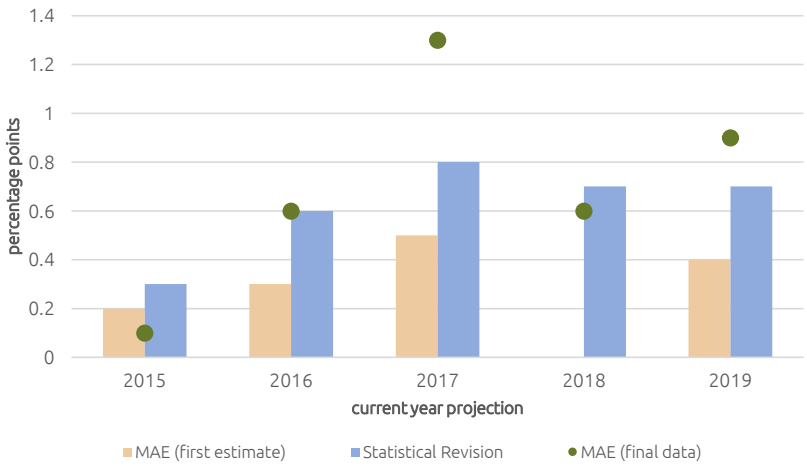
Table 2 – CFP forecasting performance relative to final data, 2015-2019

	Current year			Year-ahead		
	ME	*MAE*	*RMSE*	*ME*	*MAE*	*RMSE*
Real GDP	-0.74	0.74	0.88	-0.89	0.97	1.19
Inflation	0.15	0.26	0.39	0.44	0.73	0.82
Current account	-0.21	0.46	0.52	-0.32	0.52	0.72
Fiscal determinants:						
Nominal GDP	-1.00	1.00	1.15	-1.14	1.18	1.44
Private consumption	-0.33	0.51	0.60	-0.24	0.61	0.68
Unemployment rate	-0.01	0.42	0.54	0.91	1.19	1.39
Employment	-0.46	0.65	0.88	-1.00	1.23	1.46
Total compensations	-1.49	1.64	1.91	-2.66	2.67	3.12

Notes: results in percentage points. Final data extracted from Statistics Portugal, annual national accounts, September 2021.

Comparing with the performance statistics computed with first-estimate data (Table 1), results indicate that current year forecasts of current account balance and unemployment rate perform better when using final data. The same happens for the year-ahead forecasts of nominal private consumption growth and unemployment rate. Inflation data (which is not a national accounts' concept) is not revised so the forecasting performance indicators remain unchanged. For the remaining indicators, using final data worsens the forecasting performance.

Figure 4 – Real GDP growth forecast errors (MAE) and statistical revisions



Source: CFP macroeconomic projections, Statistics Portugal GDP vintages (2016-2021) and own calculations. *Notes*: MAE – mean absolute error.

Using real GDP as an example to illustrate how data revisions may impact the forecast assessment, forecast errors computed using final National Accounts data are shown in Figure 4.[8] It shows that forecast errors based on final National Accounts data are higher than errors based on first estimates, with the exception of 2015 where the opposite occurs. In this sample GDP growth has been systematically revised upwards from firstly released official estimate. The revision was particularly strong for 2017: final GDP growth surpassed the initial published estimate by 0.8 p.p.. As a result of such official upward revisions of real GDP growth there is a systematic detachment of CFP forecasts from the final data. Figure 4 also presents the amplitude of real GDP growth revisions. The forecast errors relative to GDP first estimates are lower than the amplitude of data revisions in real GDP growth, for the period under analysis.

3.2 Results on the optimality of CFP macroeconomic forecasts

The following analysis tests the properties of CFP's macroeconomic projections and if they are deemed optimal as described in section 2.3. It is worth re-emphasising the small sample size caveat, as the analysis is conducted on a sample which is not long enough to derive concrete conclusions. In general, although t-tests are used and the test-statistics employed below are valid asymptotically, one cannot be entirely sure about their properties at such short samples. Results are summarized in Table 3.

[8] At the time this paper is being written, 2019 is the last year closed in national accounts.

Table 3 – Forecast optimal properties tests

	Current year				Year-ahead			
	Bias	*Lag1*	*Lag2*	*DM*	*Bias*	*Lag1*	*Lag2*	*DM*
Real GDP	-0.13	0.49	2.70	1.64*	-0.33	1.86	3.85	-1.86
Inflation	0.16	0.34	0.43	2.66**	0.45	3.82*	4.02	-1.01
Current account	0.03	0.49	2.64	-1.29	0.05	0.58	1.08	-1.60
Fiscal determinants:								
Nominal GDP	-0.23	0.03	7.09**	1.61*	-0.39	1.78	4.09	-2.43
Private consumption	-0.07	0.90	3.02	1.17	0.09	2.66	2.91	-0.15
Unemployment rate	0.30	0.09	0.87	4.20***	1.17**	0.22	0.35	0.24
Employment	-0.36	0.00	0.10	1.70*	-0.95*	0.92	1.32	-0.55
Total compensations	-0.39	1.67	1.68	0.15	-1.82***	2.21	3.10	-0.68

Notes: results in percentage points; full sample. *, **, *** indicate the null hypothesis is rejected at 10%, 5% and 1% significance level respectively. The Diebold-Mariano test statistics (DM) used a small-sample bias corrected variance following Harvey, Leybourne, and Newbold (1997); the null hypothesis that both forecasts (*naïve* and CFP) have the same accuracy is tested against the alternative that the CFP forecast is more accurate.

Unbiasedness

Unbiasedness implies that a forecast does not systematically over- or under-estimate a selected variable – *i.e.*, the average projection error should not be significantly different from zero over the sample. Regressing projection errors on a constant through equations (1) and (2), the intercept should not be statistically different from zero ($\alpha = 0$).

Results in Table 3 show that CFP forecasts are unbiased, except for unemployment rate and total compensations growth year-ahead forecasts, statistically significant at the 5% and 1% level, respectively. Employment growth forecasts for the year-ahead reveal a possible negative bias, only significant at a 10% level. For the remaining variables, real and nominal GDP growth indicate a negative but statistically not significant average deviation in current year and year-ahead forecasts. Inflation projections suggest an average overestimation, but the null hypothesis, of absence of a bias, cannot be rejected at the 5% significance level.

Non-correlated errors

The absence of serial correlation in the forecast errors is an optimal property and another requirement for weak efficiency of forecasts. Autocorrelation arises if forecasters repeat the same mistake or compensate past mistakes by subsequent errors of the opposite sign (positive and negative autocorrelation, respectively). Autocorrelation properties of the errors are investigated up to two lags using the Ljung-Box test, where the null hypothesis is the absence of autocorrelation in forecast errors.

Evidence of serial correlation in errors is found for the year-ahead inflation forecasts at one lag (10% significance level). After adding the second lag, the test identifies error persistence for current year nominal GDP growth forecasts, at 5% significance level. For the remaining variables, no evidence of error persistence is found (Table 3).

Quantitative accuracy

To answer if the CFP forecasts are quantitatively more accurate than *naïve* forecasts the Diebold Mariano test was performed. The null hypothesis of the *naïve* forecast being equally accurate as the CFP's forecast, is tested against the alternative that the CFP's forecast is more accurate. The test statistics, in Table 3, suggest that, for current year estimates, at 5% or less significance level, inflation and unemployment rate forecasts are found to be significantly more accurate than *naïve* forecasts (which assumes the previous period observation constant). There is statistical evidence that the CFP current year growth forecasts of real GDP, nominal GDP, and employment outperform the *naïve* forecasts at 10% significance level. The year-ahead CFP's macroeconomic forecasts could not systematically beat the *naïve* forecasts.

Efficiency

A forecast can be considered (strongly) efficient if the unbiasedness and the absence of serial correlation properties jointly hold. Using equations (3) and (4) from section 2.3, assessing strong efficiency means testing $\alpha = 0$ and $\beta = 1$ jointly, using the F statistic. The test investigates whether the forecasts are statistically indistinguishable from the outcome values. As explained by Chabin *et al.* (2020) in case the hypothesis is rejected the regression coefficients provide an estimate of the scaling factors by which forecasts could have been made more accurate – nonzero intercept values represent an additive factor while the slope coefficient is a multiplicative factor.

Table 4 presents the efficiency analysis for CFP macroeconomic forecasts in the period 2015-2019. Results suggest that current year projections of real GDP growth, unemployment rate and compensations growth are efficient and, at 10% significance level, inflation and employment growth are also efficient. For the year-ahead, only employment growth forecasts are found to be efficient. Forecast strong efficiency hypothesis is rejected for the remaining variables. In any case, for most variables under analysis, the estimated intercept (α) is rather large and positive and the slope different from unity, suggesting that the CFP macroeconomic forecasts may be conservative.

Table 4 – Forecast efficiency tests

	Current year			Year-ahead		
	$\alpha = 0$	$\beta = 1$	$F(\alpha=0, \beta=1)$	$\alpha = 0$	$\beta = 1$	$F(\alpha=0, \beta=1)$
Real GDP	0.55	0.77	2.22	4.45***	-1.20***	227.29***
Inflation	0.12*	0.72*	3.41*	1.62**	-0.53***	13.12***
Current account	0.19	-0.20***	7.90**	0.13*	0.06***	606.73***
Fiscal determinants:						
Nominal GDP	2.98***	0.18***	29.22***	5.17***	-0.42***	227.29***
Private consumption	2.55***	0.26***	32.53***	4.64***	-0.29***	15.14***
Unemployment rate	0.66	0.90*	2.53	1.38	0.73*	5.42**
Employment	0.70*	0.76**	3.45*	2.65*	-0.70	2.78
Total compensations	0.39	1.00	0.64	4.88***	-0.08***	204.37***

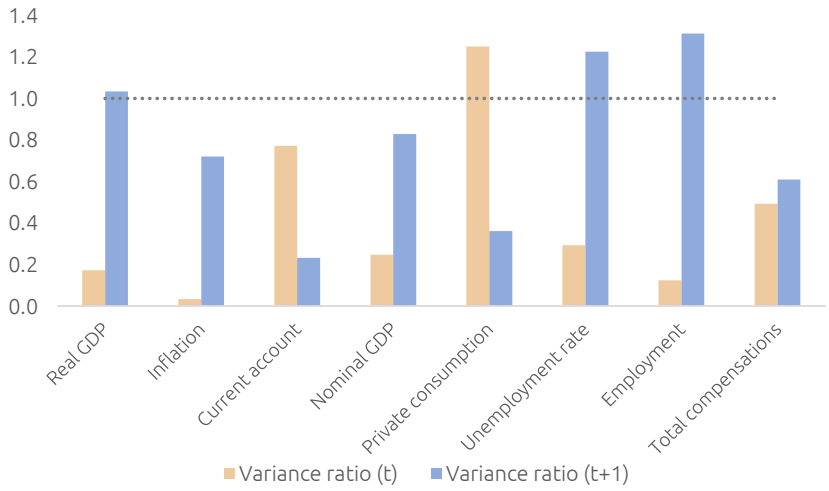
Notes: *, **, *** indicate the null hypothesis is rejected at 10%, 5% and 1% significance level respectively. The results reported are the estimated coefficients from equations (3) and (4) and the F statistic.

Non-increasing variance

To assess if the variance of the forecast error declines as more information becomes available – a final property that an optimal forecast should have – this paper resorts to pattern analysis associated with different projection horizons, given the small size of the sample. Concerning CFP exercises, for this optimal property to be fulfilled, it means that the March current year (year-ahead) forecast errors should have a greater variance than the September current year (year-ahead) forecast errors, as represented in section 2.3, equations (5) and (6).

Based on the results presented in Table A3 and Table A4 in the Appendix, for each variable and forecast horizon the ratio between September vintage variance and March vintage variance was computed. The non-increasing variance property sets, for a given forecast horizon, that $Var(e^{Sep})/Var(e^{Mar}) \leq 1$.

Figure 5 – Forecast errors variance ratio



Source: CFP macroeconomic projections, 2015-2019 and own calculations.

Figure 5 compiles the results and shows evidence that the year-ahead forecasts of real GDP growth, unemployment rate and employment growth fail to meet the non-increasing variance property. The result for real GDP growth year-ahead forecasts, in particular, is penalized by an outlier in 2017, as it can be seen in Figure 1. Regarding current year forecasts, the March exercises errors have, in general, a greater variance than the September ones, except for nominal private consumption growth.

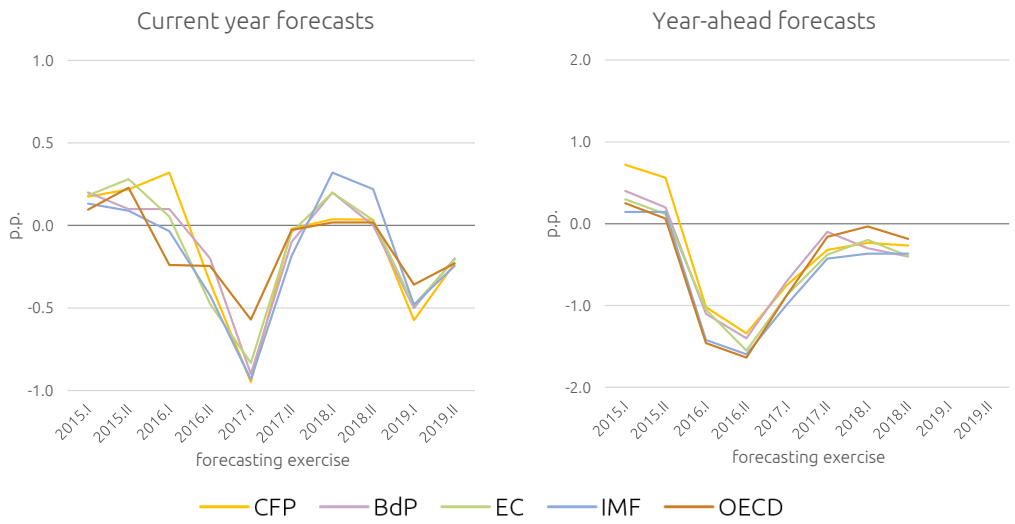
4 Comparative analysis with other institutions

This section compares the accuracy of the CFP macroeconomic forecasts with those of other institutions that elaborate macroeconomic projections for Portugal under a no policy change assumption. For this reason, the forecasts of the Portuguese Ministry of Finance are excluded. The analysis works with the forecasts from BdP, EC, IMF and OECD.

The same period is examined (2015-2019) and current year and year-ahead forecast performance is assessed with the same data conventions applied to CFP in section 2.1. Two exercises per institution are collected: March and December issues of BdP's Economic Bulletin; EC's Spring (May) and Autumn (November) economic forecasts; the IMF forecasts come from the April and October issues of World Economic Outlook; whilst the OECD forecasts are extracted from the May and November Economic Outlook publications.

Before analysing the results, one should note that the timing of forecasting exercises may explain differences in performance. For the panel of institutions used in this study, the CFP is usually the first to publish the forecasts, followed by the IMF, then the EC and the OECD, two months later (May and November) and, in the second exercise of the year, BdP publishes in December. This implies the incorporation of more information, such as: an additional quarter of national accounts (for June and December publications); the first release of survey data for the next quarter; the inclusion of policy measures presented by the government and its anticipated impacts.

Figure 6 – Real GDP growth forecast errors by exercise and institution



Sources: 2015-2019 data from CFP March and September *Perspetivas Economicas e Orçamentais*; BdP March and December Economic Bulletins; EC Spring and Autumn economic forecasts; IMF April and October World Economic Outlooks; OECD May and November Economic Outlook; and own calculations.

Figure 6 allows a qualitative comparison of real GDP growth forecast errors by projection exercise. The graphical analysis evidence some common features:

- on average, the direction of forecasts errors is similar;
- the 2017 outlier is common to all institutions and affects their forecasting performance in the period under analysis, as noted in the next point. The official statistical revision for that year (Figure 4) was also particularly high;
- in 2015-2019, real GDP growth forecasts reveal a common small bias to pessimism, both in current and in next-year projections. The average current year forecast error for real GDP growth is -0.13 p.p. for CFP, BdP, EC and OECD, and -0.15 p.p. for the IMF.[9] For the year-ahead forecasts the average error ranges from CFP's -0.33 p.p. and IMF's -0.61 p.p..

Table 5 – RMSE ratio: institutions relative to CFP, 2015-2019

	Current year				Year-ahead			
	BdP	*EC*	*IMF*	*OECD*	*BdP*	*EC*	*IMF*	*OECD*
Real GDP	0.90	0.95	**1.00**	0.67	0.97	**1.04**	**1.18**	**1.14**
Inflation	0.54	0.72	**1.00**	0.59	0.77	0.90	**1.01**	0.89
Current account	-	**1.03**	0.83	0.83	-	**1.16**	**1.20**	**1.10**
Fiscal determinants:								
Nominal GDP	-	0.72	0.92	**1.06**	-	0.91	**1.02**	**1.38**
Private consumption	-	**1.93**	-	**2.69**	-	**1.04**	-	**1.36**
Unemployment rate	0.69	0.77	**1.10**	0.85	0.71	0.80	**1.11**	0.91
Employment	0.90	0.89	**1.11**	**1.04**	0.89	**1.10**	**1.21**	0.97
Total compensations	-	0.69	-	0.57	-	**1.23**	-	0.99

Sources: 2015-2019 data from CFP March and September *Perspetivas Economicas e Orçamentais*; BdP March and December Economic Bulletins; EC Spring and Autumn economic forecasts; IMF April and October World Economic Outlooks; OECD May and November Economic Outlook; and own calculations. | *Notes*: results in percentage points. Bold numbers indicate CFP forecasting performance equal or better than the respective institution.

Table 5 presents the RMSE of other institutions' forecasts relative to CFP's RMSE, for each variable and projection horizon. The performance of CFP and IMF (the first institutions to publish their projections) is similar for current year real GDP growth and inflation forecasts and is outperformed by the remaining institutions. For the current account balance, current year CFP forecasts only perform better than those by the EC. Regarding fiscal determinant variables, CFP nominal private consumption growth projections outperform the remaining institutions both for current year and year-ahead forecasts. The relative performance of CFP forecasts shows some average improvement

[9] Discarding the 2017 outlier from the data leads to current year average forecast errors for real GDP growth between -0.04 p.p. for CFP and -0.08 p.p. for OECD.

in the period-ahead. For instance, CFP year-ahead real GDP growth forecasts outperform EC, IMF, and OECD, whilst being less accurate than BdP's forecasts.

Table 6 – Diebold-Mariano tests, 2015-2019

	Current year forecasts				Year-ahead forecasts			
	BdP	*EC*	*IMF*	*OECD*	*BdP*	*EC*	*IMF*	*OECD*
Real GDP	-2.22	-0.90	-0.58	-1.63	-2.18*	-0.59	1.06	0.45
Inflation	-1.70*	-1.70	0.02	-1.40	-2.36*	-1.03	0.06	-1.12
Current account	-	-0.94	-1.01	-0.66	-	0.82	0.97	-0.61
Fiscal determinants:								
Nominal GDP	-	-1.51	-0.38	0.61	-	-1.33	0.24	2.06*
Private consumption	-	1.66	-	1.85*	-	0.17	-	1.25
Unemployment rate	-1.67	-0.81	0.68	-0.66	-2.36*	-2.28*	1.29	-0.77
Employment	-1.08	-1.66	0.50	0.12	-2.13	0.97	2.17*	-0.68
Total compensations	-	-1.51	-	-0.31	-	0.89	-	0.17

Sources: 2015-2019 data from CFP March and September *Perspetivas Economicas e Orçamentais*; BdP March and December Economic Bulletins; EC Spring and Autumn economic forecasts; IMF April and October World Economic Outlooks; OECD May and November Economic Outlook; and own calculations. | *Notes*: the table reports the Diebold-Mariano test statistics using a small-sample bias corrected variance following Harvey, Leybourne, and Newbold (1997); the null hypothesis that both forecasts (institution and CFP) have the same accuracy is tested against the alternative that the forecasts do not have the same accuracy; *, **, *** indicate the null hypothesis is rejected at 10%, 5% and 1% significance level respectively.

To complete the comparison analysis Table 6 presents the Diebold-Mariano test statistics, for the null hypothesis that both forecasts (institution and CFP) have the same accuracy – tested against the alternative that the forecasts do not have the same accuracy. The results show that, for the 5% significance level, the null hypothesis cannot be rejected. Statistically, CFP macroeconomic projections have the same accuracy as the selected institutions' forecasts.

5 Conclusion

The CFP macroeconomic projections provide an independent contribute for the public debate on economic and fiscal policy in Portugal and constitute an important input for the endorsement of budgetary programming documents' macroeconomic forecasts. The budgetary projections underlying these documents must be based on the most probable macroeconomic scenario or on a more prudent one, according to the legal requirements of the Budgetary Framework Law and of the Stability and Growth Pact. Naturally, the CFP projections are also following the same principles, and so it is crucial to assess whether they are the "most probable" or "more prudent".

This paper uses a set of techniques widely used in the applied literature of forecast evaluation to make a first assessment on the performance of CFP macroeconomic forecasts from 2015 to 2019. Statistics such as the mean absolute error and the root mean square error are assessed and the quality of the forecasts is tested according to the properties of optimal projections: unbiasedness, serially uncorrelated errors, efficiency and non-increasing variance of errors as the projection horizon decreases. Due to the small sample size, the results should be read with caution, as one cannot be sure about the statistical properties at short samples.

The analysis shows that, on average, CFP macroeconomic forecasts are found to be fairly prudent (which is not surprising given the legal framework described above) and to follow most of the optimal properties of forecasts: statistically unbiased, weakly efficient, and uncertainty in the forecasts increases with the projection horizon. For real GDP growth in particular, current year projections are found to be strongly efficient, as both unbiasedness and non-correlated errors hypothesis jointly hold.

The quality of CFP forecasts is found to be competitive when compared to that of other institutions that produce macroeconomic scenarios for Portugal under a no policy change assumption (Banco de Portugal, European Commission, International Monetary Fund and Organisation for Economic Co-operation and Development). For the period 2015-2019: the direction of forecasts errors is similar among institutions; forecasting performance is affected by a common outlier in 2017; a common small bias to conservativeness is revealed for real GDP growth forecasts, both in current year and year-ahead projections.

Room for improvement is identified, although additional observations are necessary to take more robust conclusions. Inflation and nominal GDP growth projections appear to be prone to repeat errors. Results also point to an overly conservative year-ahead assessment of labour market variables. CFP's macroeconomic forecasts for the year-ahead could not systematically beat the *naïve* forecasts (keeping the last observed period constant).

This paper offers a first review on CFP's forecasting performance. Further analyses are desirable as more data is gathered, in order to scrutinize the results and to deal with the major caveat of lack of observations. The strengths and weaknesses identified through this study provide a good starting point to improve the macro modelling and forecasting procedure at the CFP.

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Appendix

Table A1 – CFP medium-term projection errors, 2015-2019

	Medium-term			
	ME	*MAE*	*RMSE*	*NRMSE*
Real GDP	-0.50	0.50	0.56	0.25
Inflation	0.18	0.55	0.83	0.62
Current account	-0.51	0.51	0.80	0.18
Fiscal determinants:				
Nominal GDP	-0.93	0.93	1.01	0.31
Private consumption	-0.39	0.56	0.83	0.25
Unemployment rate	3.12	3.12	3.44	0.97
Employment	-1.52	1.52	1.45	0.73
Total compensations	-2.70	2.70	2.94	0.77

Notes: results in percentage points. Medium-term projections refer to the three to five years forecast horizon.

Table A2 – Standard deviation parameters

Variable	*y*	*p*	*ca*	*yn*	*cn*	*u*	*e*	*w*
s.d.	2.28	1.34	4.53	3.25	3.28	3.53	1.98	3.80

Source: Statistics Portugal (1995-2019) and own calculations. *Notes*: *y* – real GDP growth, *p* – inflation, *ca* – current account ratio, *yn* – nominal GDP growth, *cn* – private consumption nominal growth, *u* – unemployment rate, *e* – employment growth, *w* – total compensations growth.

Table A3 – March vintage projection errors, 2015-2019

	Current year				Year-ahead			
	ME	*MAE*	*RMSE*	$Var(e_{t,t}^{Mar})$	*ME*	*MAE*	*RMSE*	$Var(e_{t+1,t}^{Mar})$
Real GDP	-0.20	0.41	0.52	0.29	-0.32	0.68	0.74	0.59
Inflation	0.25	0.46	0.55	0.30	0.50	0.78	0.90	0.75
Current account	0.00	0.69	0.82	0.83	0.01	0.54	0.65	0.56
Fiscal determinants:								
Nominal GDP	-0.29	0.77	0.82	0.73	-0.36	0.83	0.91	0.93
Private consumption	0.01	0.25	0.26	0.08	0.16	0.83	1.01	1.33
Unemployment rate	0.60	0.74	0.83	0.41	1.65	1.65	1.87	1.07
Employment	-0.76	0.80	1.11	0.81	-1.12	1.27	1.48	1.25
Total compensations	-0.68	1.50	1.57	2.50	-1.94	1.94	2.21	1.51

Notes: results in percentage points, March vintage of CFP projection exercises.

Table A4 – September vintage projection errors, 2015-2019

	Current year				Year-ahead			
	ME	*MAE*	*RMSE*	$Var(e_{t,t}^{Sep})$	*ME*	*MAE*	*RMSE*	$Var(e_{t+1,t}^{Sep})$
Real GDP	-0.07	0.17	0.21	0.05	-0.34	0.62	0.76	0.61
Inflation	0.06	0.08	0.10	0.01	0.40	0.70	0.75	0.54
Current account	0.07	0.53	0.72	0.64	0.08	0.27	0.32	0.13
Fiscal determinants:								
Nominal GDP	-0.17	0.34	0.42	0.18	-0.42	0.65	0.87	0.77
Private consumption	-0.16	0.28	0.32	0.10	0.02	0.53	0.60	0.48
Unemployment rate	-0.01	0.29	0.31	0.12	0.70	0.98	1.21	1.31
Employment	0.04	0.26	0.29	0.10	-0.77	1.02	1.35	1.64
Total compensations	-0.11	0.81	1.00	1.23	-1.71	1.71	1.90	0.92

Notes: results in percentage points, September vintage of CFP projection exercises.

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