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Fiscal Performance under Inflation and Inflation Surprises: Evidence from Fiscal Reaction Functions for the Euro Area*

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Abstract

This paper estimates fiscal reaction functions to examine the importance of inflation and inflation surprises for fiscal outcomes in the euro area countries, covering the first 12 countries to join the euro area. The effect of HICP inflation on the primary fiscal balance in per cent of GDP is positive, and statistically and economically significant. The positive effect stems from both the revenue side, particularly direct taxes and indirect taxes, and the expenditure side, particularly primary current expenditures. The effects of HICP inflation on the primary balance and other fiscal outcomes appear in large part to stem from inflation surprises, which are errors in the inflation forecasts available for preparing budgets. The positive effect on the primary fiscal balance does not exhibit noticeable non-linearities.

Keywords: Public finances; Fiscal outcome; Inflation; Inflation surprises

JEL Codes: H6, H62, H68, E31

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1 Introduction

Public finances are at the centre of economic policymaking. Large deficits may push debt onto unsustainable trajectories and jeopardise financial and economic stability in both the short and long terms. The issue of fiscal sustainability in the euro area economies has featured prominently in both academic and policy debates, and this makes it crucial to identify the factors that drive such fiscal outcomes as the primary balance and its various components. One such factor may be the rate of inflation, whose impact on fiscal outcomes has largely been ignored in the empirical literature so far. The rate of inflation has varied across euro area countries since the introduction of the euro, and while the medium-term inflation target of the euro area is two per cent per year, the rate of inflation has exceeded or fallen below that target at times, and has even been negative in some cases.

Our study is the first to investigate systematically the importance of inflation and inflation surprises for fiscal outcomes in the euro area countries using the fiscal reaction function. The fiscal reaction function, introduced as a concept by Bohn (1998), has largely been used to examine the relationship between public debt and the primary balance. There may be several reasons for including inflation measures in fiscal reaction functions. One is that the effect of the inflation rate is of interest because inflation rising or falling can mask underlying fiscal performance and complicate assessments of the fiscal stance. Another is that incorporating the rate of inflation makes it possible to identify potential omitted biases of the effect of the output gap that may arise from the correlation between the rate of inflation and the business cycle stance, as suggested by the Phillips curve relationship.

The paper estimates fiscal reaction functions using annual data from 1999 to 2021 for a sample of the 12 euro area countries (EA12), comprising the 11 founding members of the euro area and Greece, which joined the euro area in 2001.[1] These countries have shared a common monetary policy since the inception of the euro, and they have relatively similar levels of economic development and comparable tax systems. Moreover, their fiscal policies have been run under a common institutional framework, the Stability and Growth Pact. This means the EA12 constitutes a relatively homogeneous group of countries.[2]

We use annual data as it is commonplace in the literature on fiscal reaction functions and it lets us compare our results with previous findings. Furthermore, inflation forecasts are available from the European Commission but only at an annual frequency and we use those forecasts to compute inflation surprises when we investigate how inflation surprises impact fiscal outcomes. We regress measures of fiscal performance, expressed as a percentage of GDP, on HICP inflation or measures of inflation surprises, while controlling for

[1] By starting the sample in 1999 we exclude the period in the 1990s when many EU countries pursued contractionary fiscal policies to satisfy the fiscal criterion of the Maastricht Treaty. By dropping the most recent year 2022, which saw very high inflation rates in most euro area countries, we avoid the results being unduly affected by the outlying year. After the very high inflation in 2022, the effect of inflation on fiscal performance received substantial attention in monitoring and policy evaluation in the spring of 2023; see for instance IMF (2023) and Caló et al. (2023)

[2] Earlier studies have demonstrated some heterogeneity across various country groups in Europe, particularly between the countries in Western Europe and the EU countries in Central and Eastern Europe (Staehr 2008, Baldi and Staehr 2016).

the lagged dependent variable, debt stocks, and the output gap. We use System GMM to account for the Nickell bias and possible endogeneity of the output gap and the inflation rate. For reference we also use fixed effect estimations.

The paper finds that an increase of 1 percentage point in the HICP inflation rate leads to an improvement of around 0.7 percentage point in the primary balance. The positive effect of inflation on the primary balance is attributed to both the revenue side and the expenditure side. A higher rate of HICP inflation results in an increase in the ratio of direct and indirect tax to GDP while having no discernible effect on social security contributions. On the expenditure side, a higher HICP inflation rate is associated with a fall in primary current expenditure in per cent of GDP, but not with any fall in capital expenditure, a result which might be seen as surprising. The study also finds that the effects of inflation result from the inflation being in large part unexpected which is consistent with the expected inflation rate being used for budget planning and execution.

The rest of the paper is organised as follows. Section 2 discusses some literature of relevance to the study. Section 3 presents the data and the modelling approach. Section 4 provides the baseline estimations for the primary fiscal balance and its components. Section 5 examines how various measures of inflation surprises affect the fiscal outcomes. Section 6 presents the results of various extensions and sensitivity analyses. Finally, Section 7 summarises the main results of the paper.

2 Related literature

Conceptual issues

The relationship between inflation and fiscal outcomes such as the budget balance or its components is complex. It runs through a multitude of channels, either directly between the variables or through other variables in the economy, and the causality can go in both directions (Bańkowski et al. 2023).

Studies on the relationship between inflation and fiscal outcomes have often been conducted against a backdrop of very high inflation. This backdrop includes outbreaks of hyperinflation in which money issuance provided a link between the budget balance and inflation (Bresciani-Turroni 2013, Cagan 1956). Arguably the most celebrated theoretical contributions in the area are the Olivera-Tanzi and Patinkin effects, which are also applicable at lower levels of inflation.

The Olivera-Tanzi effect posits that episodes of high inflation erode real tax revenues if there is a long time gap between the generation of the tax obligation and the actual payment of it (Tanzi 1977). Unexpected inflation and a lack of indexing of taxes and tax obligations could aggravate the negative effects of inflation on real revenues. Unexpected inflation may however also result in increased real revenues, for instance if there is bracket-creep and the brackets of the tax system are not adjusted in line with inflation, an outcome

that Afonso and Jalles (2019) labelled the reverse Olivera-Tanzi effect.

The Patinkin effect posits that high inflation leads to lower real government expenditure. Government expenditure is usually planned or programmed in nominal terms, so high inflation or unanticipated high inflation hollows out the real value of the expenditure (Patinkin 1993, Cardoso 1998). Cardoso (1998) stresses that the Patinkin effect implies that disinflation often requires substantial fiscal consolidation to compensate for the loss in real revenues.

Inflation and fiscal outcomes are linked in other ways besides through budgeting and budget execution. Inflation can also be raised by choice by policymakers who want to achieve certain fiscal outcomes such as reducing the debt-to-GDP ratio (Adam and Billi 2008, Aizenman and Marion 2011, Leeper and Zhou 2021). The direction of causality may alternatively go from fiscal outcomes to inflation, for instance if fiscal outcomes affect the macroeconomic stance, including the rate of inflation. Overall macroeconomic developments may equally affect both inflation and fiscal outcomes, so that the variables become interconnected.

Studies of inflation and fiscal outcomes

The many channels implies that it is not possible to provide clear hypotheses in advance how inflation will affect fiscal outcomes and their various components. The relationship between inflation and fiscal outcomes is an empirical issue, but it has received limited attention in the empirical literature that focuses on developed economies.[3]) Studies for developed economies have used a range of methodologies.

Large-scale macroeconomic models have been used in various policy studies. The ECB Economic Bulletin presents the results of simulations where a macroeconomic model is used to analyse how an inflation surprise affects the budget balance and its various revenue and spending components in the euro area (Bańkowski et al. 2023). The baseline scenario finds that the surprise has a very small effect on the budget balance in the first year and moderate negative effects in the following years, and that this is driven in part by higher spending on social benefits and interest payments.

Other studies using large-scale macroeconomic models include de Cos et al. (2016), who consider how various factors impact fiscal variables in Spain using a quarterly macro-econometric model. Attinasi et al. (2016) simulate the effects of an inflation shock on the budget balance and various subcomponents using the fiscal forecast models of the national central banks of Germany, France, Italy, Austria and Greece. A positive inflation shock of one percentage point improves the primary budget balance in all five countries, but the effect is relatively small in the first year, ranging from 0.05 to 0.27 percentage point of GDP, and it is typically even smaller in the following year.[4]

Dynamic stochastic general equilibrium (DSGE) models may be used to analyse the effect of inflation on

[3]The issue has arguably received more attention for emerging market economies with very high and varying inflation, a backdrop shared by many Latin American countries (Edwards and Tabellini 1991, Cardoso 1998, Pittaluga et al. 2021

[4]Prammer et al. (2015) use the same model for Austria as the one used in Attinasi et al. (2016) but provide more details on the dynamics of the various revenue and spending components.

fiscal variables. Krause and Moyen (2016) calibrate their model using US data and consider the effect when central banks change their inflation targets, which effectively causes an inflation shock to the economy. In the forward-looking universe of the DSGE model, a temporary increase in the inflation target has relatively modest effects on the dynamics of public debt, while a permanent increase has larger effects.

Vector Autoregressive (VAR) models often use variables like GDP growth, interest rates, or the rate of inflation, or those that indicate fiscal outcomes. If an inflation shock can be identified, it becomes easy to obtain the impulse response functions for the fiscal variables. Only a few studies report such impulse response functions though.[5] A notable example is Cherif and Hasanov (2018), who construct a structural VAR model for the USA that computes feedback from the debt stock using accounting identities. An inflation shock has little effect in the very short term but causes the debt ratio to rise after a few quarters in response to lower growth and higher interest rates.[6]

The Local Projection methodology is used by Fukunaga et al. (2022) to derive the responses of various macroeconomic variables to an inflation shock that has been identified, and these responses are then used to derive the path of public debt. This assumes however that the inflation shock does not in itself change the primary fiscal balance. The study uses quarterly data for various developed countries and finds that a positive inflation shock reduces the debt-to-GDP ratio, but the effect is not very large, perhaps because of the assumption that there is no direct effect on the primary fiscal balance. IMF (2023) also uses local projections to estimate the dynamic effects of inflation shocks on fiscal variables in a very broad sample of 85 countries. It reports that primary balances improve in the near term as nominal expenditures are sticky.

Fiscal Reaction functions

This paper uses fiscal reaction functions to examine how inflation and inflation surprises affect fiscal outcomes in a panel of EU countries. The estimation of fiscal reaction functions harks back to Bohn (1998), who regresses the primary balance relative to GDP in the USA on the stock of public debt to GDP and measures of temporary spending and the cyclical stance. The coefficient of the debt stock is positive and around 0.04, suggesting that there is substantial feedback from the debt stock to the budget balance. Bohn (1998) interpreted this as indicating that the fiscal stance had been sustainable in the USA in the period considered (see also Bohn 2007). Subsequent studies have used specifications of the fiscal reaction function that incorporate persistence, asymmetries, time-varying effects, political-economy variables and other features (Nguyen et al. 2017, Cassou et al. 2017, Aldama and Creel 2019).

European data have been used in a number of fiscal reaction studies. These are often panel data studies because the time samples available are typically relatively short, though some country-specific studies have also been published (Berti et al. 2016, Afonso et al. 2021, Gootjes and de Haan 2022).

[5] See Fukunaga et al. (2022) for the results of some additional studies.
[6] Hasko (2007) reaches similar conclusions using VAR models estimated on data from a number of European countries.

Most studies use realised variables, and the estimated reaction functions may then be labelled as ex post relationship. Some studies start from the point that the primary fiscal balance and other fiscal variables come partly out of fiscal budgeting processes that use forecasts of various variables and of the execution of the budget, which takes place in real time. Studies that use forecast values or real-time values of the variables include Hughes Hallett et al. (2012), Cimadomo (2012) and Golinelli and Momigliano (2009). One key advantage of doing this is that it is possible to distinguish between intended and unexpected fiscal outcomes (Cimadomo 2016).

So that specific issues can be analysed, additional regressors have been included. The hypothesis of fiscal fatigue has been examined in studies that include quadratic or higher powers of the debt stock (Ghosh et al. 2013, Checherita-Westphal and Žďárek 2017, Everaert and Jansen 2018), and the consequences of various institutional and governance structures in Europe have been examined in several studies.[7] Other studies have included the interest rate or interest payments as an additional regressor and find that these feed into the primary fiscal balance (Ciżkowicz et al. 2015, Tkačevs and Vilerts 2019).

We have found only one study that uses fiscal reaction functions to investigate the effects of inflation – or actually deflation – on fiscal outcomes. Afonso and Jalles (2019) consider a panel of 12 countries during what the authors label the golden age of globalisation from 1870 to 1914. The fiscal reaction function does not include the debt stock as a regressor, but uses the lagged dependent variable, the rate of economic growth, the real effective interest rate, and one of two possible proxies for deflation. The panel data estimations generally show that the effect of each of the deflation measures on the primary balance is negative, suggesting that deflation causes the fiscal stance to deteriorate. The effect is typically negative for revenues and positive for primary expenditure, the estimated coefficients for these variables are often statically insignificant.

Some studies that estimate fiscal reaction functions include the inflation rate as a control variable; see for instance Staehr (2008), Ghosh et al. (2013), Mauro et al. (2015), Berti et al. (2016), Bökemeier and Stoian (2018) and Everaert and Jansen (2018). There is however typically little or no discussion of the results for the inflation variable in these studies, and moreover, the estimated coefficients are often statistically insignificant and quite sensitive to the choice of sample and specification.

Summary

To summarise, the effect of inflation on fiscal outcomes has only been investigated in a relatively small number of studies that use large-scale macroeconomic models, DSGE models, Vector Autoregressive models or Local Projection. The conclusion is generally that the effects on the fiscal balance or the primary fiscal balance are relatively small in the short term and may be negative. The study by Afonso and Jalles (2019)

[7] Weichenrieder and Zimmer (2014) examine whether membership of the euro area alters the reaction function and conclude that membership reduces the feedback from the debt stock to the fiscal balance. De Jong and Gilbert (2020) find a substantial improvement in the fiscal balance for EU countries that are subject to the Excessive Deficit Procedure.

using fiscal reaction functions suggests that the effect of inflation could be positive, but their time sample has no overlap with that of the euro area countries used in this study.

3 Methodology and data

This study employs a standard fiscal reaction function with the lagged dependent variable, and extends it with measures of inflation or inflation surprises. The general form of the equation we estimate is the following:

$$F_{it} = \alpha_1 F_{it-1} + \alpha_2 D_{it-1} + \alpha_3 Y_{it} + \alpha_4 I_{it} + \gamma_i + \epsilon_{it} \tag{1}$$

where the index i = 1, . . . , N stands for the country and t = 1, . . . , T indicates the period. The variable F_{it} is the fiscal policy variable considered, D_{it-1} is the debt ratio, Y_{it} denotes the output gap, I_{it} is the inflation measure, γ_{it} are unobserved time-invariant country effects, and ϵ_{it} denotes the idiosyncratic error term. The coefficients α_1 to α_4 are to be estimated. We include a dummy variable to capture the extraordinary surge in the primary deficit in Ireland in 2010 that resulted from the financial support given to Irish commercial banks.

We estimate fiscal reaction functions where the dependent variable is the primary balance, and also where it is one of the two main components of the primary balance, i.e. revenues and primary expenditures. We also run estimations where the dependent fiscal variable is various components of revenues and expenditures.

The government debt variable is gross debt. The output gap depicts the deviation of output from its potential in per cent, and it is computed by the European Commission and made available in AMECO. The main inflation variable is the rate of HICP inflation, but we also run estimations with two measures of inflation surprises.

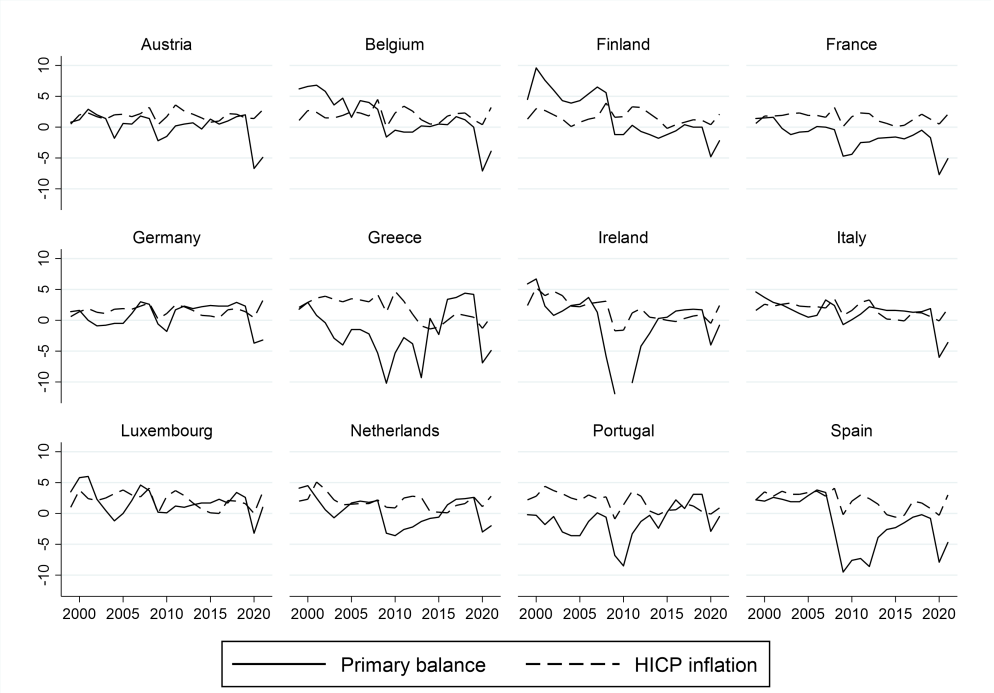
We express the fiscal variables in per cent of GDP. In this we follow virtually all the other studies that estimate fiscal reaction functions, and this means that our results are easily comparable to those in the literature. Another advantage of doing this is that fiscal policy making revolves around fiscal variables expressed in per cent of GDP. The targets for the budget balance, the structural balance and the debt stock are all expressed in per cent of GDP in the fiscal framework of the European Union.

Using fiscal variables in per cent of GDP entails some complications though, given that the regressors may affect both the nominal fiscal variable in the nominator and the nominal GDP in the denominator. This makes it harder to interpret the results in some cases. Higher HICP inflation may affect the nominal fiscal variable for instance, but it may also affect nominal GDP. This complication is however customary in studies that estimate fiscal reaction functions; it also applies to the output gap for instance, which may affect not only the fiscal outcome variable but also nominal GDP. We return to these issues when we discuss the results in Section 4, Section 5 and Section 6.

We apply the standard panel fixed effects estimator and the System GMM estimator. The standard panel fixed effects estimator has two potential sources of estimation bias, as there may be reverse causality, since the fiscal policy stance may also affect the output gap and the rate of inflation, and the lagged dependent variable may correlate with the fixed effect, which is known as the Nickell (1981) bias.

To address the potential biases, we use the one-step System GMM estimator (Blundell and Bond 1998).[8] This method estimates the fiscal reaction function simultaneously in first differences using lagged levels of the variables as instruments, and in levels using the first differences of the variables as instruments. We compute the first differences as orthogonal differences to minimise the loss of data (Roodman 2009). We apply the System GMM estimator using a collapsed set from the matrix of available instruments. The decision on the maximum length of lags in each regression considers the performance of the Hansen test of over-identifying restrictions and the absence of second order autocorrelation in the first difference errors. We use robust standard errors, adjusted for heteroskedasticity.

Figure 1: Primary budget balance (per cent of GDP), and HICP inflation (per cent)



Source: Eurostat and AMECO databases; see Table A.1 in Appendix A

We employ an annual panel of 12 euro area member states, comprising Germany, France, Italy, Spain, Portugal, Greece, Ireland, Austria, Finland, the Netherlands, Belgium and Luxembourg. The estimations cover the period 1999-2021. The data are mostly taken from Eurostat and the AMECO database provided by the European Commission. in Table A.1 in Appendix A gives an overview of the variables used in our

[8] We favour the System GMM estimator in this study since the data appear to have a high degree of persistence and the GMM difference estimator "behaves" less well in such a case.

analysis and their sources, while Table A.2 presents the corresponding descriptive statistics.

Figure 1 shows two of the key variables for each of the 12 countries in our sample, the primary budget balance in per cent of GDP and the rate of HICP inflation in per cent.[9] There are noticeable differences across the 12 countries, particularly for the primary budget balance. The primary budget balance in a lot of the countries deteriorated substantially in the aftermath of the global financial crisis and during the Covid-19 pandemic.

4 Inflation and fiscal outcomes

Baseline estimations

The results of our baseline estimations are presented in Table 1. The table contains the results for both the fixed effect estimator (FE) and the System GMM estimator. For all System GMM estimations the diagnostic test results confirm the validity of the instruments used and the absence of second-order serial correlation in disturbances.

Table 1: Baseline estimation results

Variable	FE (1) Primary balance	FE (2) Total revenue	FE (3) Primary expenditure	System GMM (4) Primary balance	System GMM (5) Total revenue	System GMM (6) Primary expenditure
Lagged dependent	0.540***	0.880***	0.624***	0.565***	1.001***	0.802***
	(0.056)	(0.063)	(0.043)	(0.075)	(0.023)	(0.070)
Lagged debt	0.055***	0.009	-0.038***	0.039***	0.001	-0.027***
	(0.008)	(0.006)	(0.010)	(0.006)	(0.004)	(0.010)
Output gap	0.377***	-0.108***	-0.462***	0.294**	-0.113***	-0.253***
	(0.116)	(0.024)	(0.069)	(0.136)	(0.033)	(0.071)
HICP inflation	0.475***	0.286***	-0.254*	0.666***	0.281***	-0.365**
	(0.139)	(0.068)	(0.121)	(0.138)	(0.064)	(0.157)
Constant	-4.856***	4.076	19.864***	-3.990***	-0.989	11.522***
	(0.904)	(2.443)	(1.722)	(0.778)	(1.028)	(2.700)
Number of observations	276	276	276	276	276	276
R^2	0.709	0.814	0.777	..	..	..
Max lag	..	..	..	2	2	2
Hansen test	..	..	..	0.326	0.387	0.523
AR(1) test	..	..	..	0.069	0.005	0.046
AR(2) test	..	..	..	0.908	0.525	0.892

Notes: The sample consists of annual data for 12 euro area countries over the time period 1999-2021. Heteroskedasticity robust standard errors (in brackets) are used in all the regressions. Superscripts *, ** and *** denote significance at the level of 0.1, 0.05 and 0.01 respectively. A dummy variable accounting for the surge in the primary deficit of Ireland in 2010 is included but is not reported. FE is the fixed effects estimator. System GMM is the Blundell and Bond (1998) system GMM estimator, where the options orthogonal and collapse are used. Max lag denotes the upper limit on lags used in the set of instruments. The Hansen test is a p value for the Hansen test of over-identifying restrictions, whose null implies that the chosen instruments are valid. AR(1) and AR(2) provide p values for tests for the absence of first and second order autocorrelation in the differenced error term, respectively.

We first focus on the case where the primary balance in per cent of GDP is the dependent variable; the results are shown in columns 1 and 4. The results for the fixed effect estimator in column 1 are very close to those for the System GMM estimator in column 4, with the partial exception of the coefficient of the HICP inflation rate.

[9] We do not report the budget balance for Ireland for 2010 as this would affect the scale of the vertical axis unduly and the observation is anyway not included in the estimations.

The coefficient of the lagged dependent variable slightly exceeds 0.5, which suggests that there is substantial persistence in the primary budget balance, as is typically found in the literature. The coefficient of the lagged public debt is positive and around 0.04–0.05, so there is some feedback from the debt stock to the primary budget balance. The coefficient of the output gap is around 0.3–0.4 and is statistically and economically significant, and it reflects the impact of the automatic stabilisers and possibly of a countercyclical fiscal policy. The signs and magnitudes of the coefficients of the regressors are in line with those found in other studies using samples of Western European countries (Staehr 2008; Berti et al. 2016, Tkačevs and Vilerts 2019, Afonso et al. 2021, Gootjes and de Haan 2022).

The estimation results in columns 1 and 4 show a positive and statistically significant relationship between inflation and the primary balance. The coefficient is 0.48 when the fiscal reaction function is estimated using the fixed effect estimator and 0.67 when the System GMM estimator is used. The coefficient in column 4 is probably somewhat higher because the instrumentation removes the reverse and negative causal effects from the primary budget balance to inflation.[10] Given that there may be endogeneity in the fixed effect estimations, we prefer the System GMM estimates, which show that a rise of 1 percentage point in the rate of HICP inflation is associated with an improvement of 0.67 percentage point in the primary balance.

We provide further perspectives on the magnitude of the effect of inflation on the primary balance by using the estimated coefficient of 0.67 for inflation that was found using the System GMM (column 4) and taking two countries of different size, Germany and Belgium, as illustrative examples. The mean inflation rate and one standard deviation of it over the sample period were 1.5 per cent and 0.8 per cent for Germany, and 1.9 per cent and 1.1 per cent for Belgium. Moving one standard deviation above the mean, which raises the rate of inflation to 2.3 per cent in Germany and 3.0 per cent in Belgium leads to an improvement of 0.5 and 0.7 percentage point in the primary balance. This improvement represents approximately a quarter of the historic volatility of the primary balance, as proxied by one standard deviation, in both countries. Moving up from the mean to the maximum rate of inflation observed of 3.2 per cent in Germany and 4.5 per cent in Belgium implies an increase in the primary balance of 1.1 and 1.7 percentage points, which is 58 per cent and 50 per cent of one standard deviation of the primary balance. Hence, although the size of the estimated coefficient may seem large, it implies that the contributions to the improvement in primary balance are of reasonable size.

The finding that the effect of inflation on the primary budget balance is positive and substantial in size is novel. Previous simulation studies focusing on the euro area or individual euro area countries have generally found that inflation has only small or even negative effects on the fiscal balance (Bańkowski et al. 2023, de Cos et al. 2016, Attinasi et al. 2016). However, simulation studies rely on various modelling and behavioural assumptions, while our findings are based on fiscal reaction functions without any such assumptions. Our

[10] A positive primary balance shock represents a discretionary fiscal tightening, which could reduce economic activity and inflation.

results are broadly consistent with those of Afonso and Jalles (2019), which is the only other study to use fiscal reaction functions to investigate the effects of inflation on fiscal outcomes. However, the setting and sample of our study are different to those used in that one.

To understand better how HICP inflation affects the primary balance, we examine its impact on both the total revenue and the primary expenditure components. The results for total revenue are shown in columns 2 and 5 in Table 1 and the results for primary expenditure are shown in columns 3 and 6.

Revenues are more persistent than primary expenditures are, possibly because various tax rates are changed relatively infrequently, while parts of expenditures are subject to discretionary decisions taken each year by policymakers. The coefficient of the lagged dependent variable is very large and actually around 1 when the System GMM estimator is used.[11] We find that an increase in the public debt ratio is followed by primary expenditure being lower but that it has no significant impact on revenues, as is evidenced by the coefficients of the lagged public debt ratio remaining small and statistically insignificant in the total revenue regressions. Similarly, an improvement in economic conditions reduces the expenditure ratio, while the coefficients of the output gap in the total revenue equations being negative and statistically significant points to the denominator effect.

In the total revenue regressions in columns 2 and 5, the coefficients of the rate of HICP inflation are around 0.3, and they are statistically significant at the 1 per cent level. In the primary expenditure regressions in columns 3 and 6, the coefficient of the rate of inflation is –0.25 when we use the fixed effects estimator and –0.37 when we use the System GMM estimator, though these coefficients are only statistically significant at the 10 per cent or 5 per cent levels. The effect on primary expenditures consequently attains lower statistical significance and is less robust than the effect on total revenues. Our finding is that inflation has a positive and substantial effect on the primary balance through both revenues and expenditures.

Components of revenues and expenditures

We next consider how inflation affects the individual key components of total revenues and the key components of primary expenditures so that we can shed some light on the channels through which inflation affects revenues and primary expenditures. The results of the estimations are presented in Table 2.

Our findings for the revenue components indicate that the coefficient of the lagged debt variable remains statistically insignificant across all specifications, while the negative effect of the output gap appears in contrast to operate through direct and indirect taxes but not social security contributions. Higher inflation raises the ratios of direct and indirect taxes, while its effect on social security contributions is negative and statistically insignificant.

[11] We have in light of the large coefficient of the lagged dependent variable tried to estimate the fiscal reaction function for total revenues in differenced form. The qualitative results are largely in line with those shown in column 5. The results are available upon request.

Table 2: The impact of inflation on different components of primary balance

Variable	Estimation method: System GMM. Dependent variables: (1) Indirect taxes	(2) Direct taxes	(3) Social security contributions	(4) Primary current expenditure	(5) Capital expenditure
Lagged dependent	0.940***	1.047***	0.963***	0.947***	0.245***
	(0.052)	(0.047)	(0.031)	(0.062)	(0.029)
Lagged debt	0.003	0.003	0.000	-0.026***	-0.003
	(0.002)	(0.003)	(0.001)	(0.009)	(0.004)
Output gap	-0.058***	-0.040**	0.003	-0.194**	-0.062***
	(0.011)	(0.019)	(0.014)	(0.098)	(0.008)
HICP inflation	0.162***	0.149***	-0.052	-0.284*	0.068
	(0.031)	(0.043)	(0.034)	(0.162)	(0.073)
Constant	0.184	-1.080	0.605	4.789**	3.486***
	(0.597)	(0.684)	(0.444)	(2.120)	(0.404)
Number of observations	276	276	276	276	276
Max lag	2	3	2	2	2
Hansen test	0.580	0.504	0.399	0.216	0.595
AR(1) test	0.009	0.004	0.023	0.003	0.161
AR(2) test	0.380	0.142	0.907	0.116	0.385

Notes: The sample consists of annual data for 12 euro area countries over the time period 1999-2021. Heteroskedasticity robust standard errors (in brackets) are used in all the regressions. Superscripts *, ** and *** denote significance at the level of 0.1, 0.05 and 0.01 respectively. A dummy variable accounting for the surge in the primary deficit of Ireland in 2010 is included but is not reported. System GMM is the Blundell and Bond (1998) system GMM estimator, where the options orthogonal and collapse are used. Max lag denotes the upper limit on lags used in the set of instruments. The Hansen test is a p value for the Hansen test of over-identifying restrictions, whose null implies that the chosen instruments are valid. AR(1) and AR(2) provide p values for tests for the absence of first and second order autocorrelation in the differenced error term, respectively.

Inflation may cause the observed increase in revenues for direct taxes through the bracket creep effect or inflationary fiscal drag, as the countries in our sample mostly have progressive personal income tax systems. This means that as inflation, and presumably also wages, rise, individuals find themselves in higher tax brackets paying more in tax. Furthermore, inflation erodes the real value of allowances, tax credits, capital gains, dividends, and interest income, which are adjusted infrequently. For corporate taxes, inflation reduces the real value of depreciation allowances, which are based on historical acquisition costs.

In contrast to direct taxes, social security contributions are paid as a constant rate on income, with some regressive element from caps on contributions. Adjustments to those caps are automatic in a few countries like Austria, where they are made with a lag (Prammer et al. 2015), but in most cases, adjustments are made periodically on an ad hoc basis.

The results of our estimations for indirect taxes are less straightforward. One reason for this might be possible simultaneity, such that a change in statutory indirect tax rates translates simultaneously into higher inflation and indirect tax receipts. We addressed this by replacing the headline inflation rate with an inflation rate at constant tax rates (HICP inflation at constant tax rates), and we found that the results were qualitatively and quantitatively similar to those reported in Table 2. (The results are available upon request.)

On the expenditure side, the fiscal reaction function for current primary expenditure exhibits very substantial persistence, a negative feedback from the lagged debt stock, and a negative effect from the output gap. We also find that inflation has a negative effect of around –0.3 on current primary expenditure in per

cent of GDP, though the statistical significance of the estimated coefficient is low. The negative effect could result from the fact that adjustments of social benefits, pensions and government sector salaries take place with a lag, in which case higher inflation leads to a decline in expenditures in per cent of GDP in the short term.[12] Introducing subsidies to compensate for a rise in prices, in response to energy price rises for example, may attenuate the effect of wage and benefit erosion.

Capital expenditure exhibits little persistence but is strongly pro-cyclical. Perhaps surprisingly, HICP inflation does not appear to affect it in a discernible way.

5 Inflation surprises

Several contributions to the conceptual literature on inflation and fiscal outcomes have highlighted the importance of unexpected changes in inflation; see for instance Tanzi (1977), Patinkin (1993), Cardoso (1998), Afonso and Jalles (2019) and the overview by Bańkowski et al. (2023). Budget planning and execution rely on inflation forecasts so it is useful to investigate the extent to which the effect of inflation on fiscal outcomes can be attributed to sudden or unexpected changes in inflation; see also Bańkowski et al. (2023) and IMF (2023)).

We begin with a simple specification where there are adaptive or static expectations so that the expected inflation in the current year is the inflation a year ago. The inflation surprise can then be computed as the annual change in HICP inflation rate. Table 3 shows how the inflation surprise computed this way affects the primary balance, total revenues and primary expenditure. The coefficient estimates of the lagged dependent variables, the output gap and lagged public debt are in line with those obtained in the baseline estimations in Table 1. Importantly, the signs and the size of the coefficients of the change in inflation are broadly similar to those reported for the inflation itself in Table 1, though the coefficient of the change in inflation for primary expenditure is somewhat larger in numerical terms than the coefficient of inflation itself.[13]

The planning and execution of the budget rely in practice on inflation forecasts produced by ministries or other institutions. The 12 euro area countries coordinate their forecasts with the European Commission and we therefore turn to the forecasts of HICP inflation published by the European Commission in the autumn forecast of the previous year. The inflation surprise is then the inflation forecast error computed as the realised HICP inflation minus the HICP inflation forecast from the autumn of the previous year. Some forecasts are not available at the beginning of the sample period and so there are fewer observations than in the baseline estimation.

The results when the inflation forecast error is used in the fiscal reaction functions are shown in columns

[12] While pensions are adjusted to inflation on a regular basis with a short time lag, sometimes during the same year, most advanced economies do not explicitly link public wages to inflation; see IMF (2023).

[13] The fairly similar results for the change in the rate of inflation and for inflation would be consistent with the two variables being positively and closely correlated, as evidenced by a correlation coefficient of 0.51.

Table 3: The effect of a change in inflation on the primary balance, total revenue and primary expenditure

Variable	Estimation method: System GMM. Dependent variables: (1) Primary balance	(2) Total revenue	(3) Primary expenditure
Lagged dependent	0.602***	0.995***	0.915***
	(0.090)	(0.049)	(0.047)
Lagged debt	0.020*	-0.003	-0.010
	(0.011)	(0.005)	(0.015)
Output gap	0.233	-0.104***	0.011
	(0.214)	(0.037)	(0.061)
Change in HICP inflation	0.558**	0.142**	-0.838***
	(0.226)	(0.066)	(0.119)
Constant	-1.397**	0.410	4.772***
	(0.665)	(2.012)	(1.362)
Number of observations	276	276	276
Max lag	2	2	2
Hansen test	0.254	0.716	0.187
AR(1) test	0.076	0.007	0.025
AR(2) test	0.972	0.691	0.651

Notes: The sample consists of annual data for 12 euro area countries over the time period 1999-2021. Heteroskedasticity robust standard errors (in brackets) are used in all the regressions. Superscripts *, ** and *** denote significance at the level of 0.1, 0.05 and 0.01 respectively. A dummy variable accounting for the surge in the primary deficit of Ireland in 2010 is included but is not reported. System GMM is the Blundell and Bond (1998) system GMM estimator, where the options orthogonal and collapse are used. Max lag denotes the upper limit on lags used in the set of instruments. The Hansen test is a p value for the Hansen test of over-identifying restrictions, whose null implies that the chosen instruments are valid. AR(1) and AR(2) provide p values for tests for the absence of first and second order autocorrelation in the differenced error term, respectively.

Table 4: The impact of the inflation forecast error on the primary balance, total revenues and primary expenditure

Variable	FE (1) Primary balance	FE (2) Total revenue	FE (3) Primary expenditure	System GMM (4) Primary balance	System GMM (5) Total revenue	System GMM (6) Primary expenditure
Lagged dependent	0.570***	1.004***	0.881***	0.627***	1.001***	0.903***
	(0.070)	(0.028)	(0.058)	(0.056)	(0.038)	(0.060)
Lagged debt	0.026***	-0.001	-0.024*	0.025***	0.003	-0.032**
	(0.005)	(0.004)	(0.013)	(0.005)	(0.003)	(0.013)
Output gap	0.254*	-0.104***	-0.092**	..	..	..
	(0.151)	(0.038)	(0.041)			
Output gap forecast error	..	..	..	0.401***	-0.074**	-0.373***
				(0.117)	(0.036)	(0.129)
HICP inflation forecast error	0.698***	0.355***	-0.835***	0.538***	0.372***	-0.562**
	(0.197)	(0.072)	(0.117)	(0.208)	(0.079)	(0.217)
Constant	-1.977***	-0.182	7.344***	-2.174***	-0.143	7.281***
	(0.429)	(1.172)	(1.750)	(0.469)	(1.558)	(1.877)
Number of observations	256	256	256	239	239	239
Max lag	2	2	2	2	2	2
Hansen test	0.225	0.434	0.191	0.329	0.344	0.497
AR(1) test	0.091	0.018	0.031	0.113	0.027	0.079
AR(2) test	0.938	0.993	0.695	0.836	0.944	0.515

Notes: The sample consists of annual data for 12 euro area countries over the time period 1999-2021. Heteroskedasticity robust standard errors (in brackets) are used in all the regressions. Superscripts *, ** and *** denote significance at the level of 0.1, 0.05 and 0.01 respectively. A dummy variable accounting for the surge in the primary deficit of Ireland in 2010 is included but is not reported. Output gap forecast and inflation forecast are European Commission year t autumn forecasts for year t+1. Forecast error stands for the difference between the realised and the forecast values. System GMM is the Blundell and Bond (1998) system GMM estimator, where the options orthogonal and collapse are used. Max lag denotes the upper limit on lags used in the set of instruments. The Hansen test is a p value for the Hansen test of over-identifying restrictions, whose null implies that the chosen instruments are valid. AR(1) and AR(2) provide p values for tests for the absence of first and second order autocorrelation in the differenced error term, respectively.

1–3 in Table 4. The coefficients of the inflation forecast error take the same signs and are of broadly the same magnitudes as those found for the inflation rate in Table 1 and the change in the inflation rate in Table 3.[14] Forecasts of the output gap may also influence the fiscal outcome, so columns 4–6 include the

[14]To confirm that inflation impacts the fiscal outcome because it comes as a surprise for policy makers, we also used only

autumn forecast for the output gap as well as the output gap forecast error. The results are in line with those obtained previously.

The conclusion from Table 3 and Table 4 is that both of the proxies for inflation surprises affect fiscal outcomes in broadly the same way as inflation itself does.[15] Given this and the relatively close correlation between the rate of inflation and the inflation surprises, it is reasonable to assume that the rate of inflation is a good proxy of inflation surprises in the sample of euro area countries.

6 Extensions and sensitivity

There may be non-linearities in how inflation affects fiscal outcomes. We investigate whether the effect is different at high and low rates of inflation by introducing a term where HICP inflation is interacted with a dummy variable that takes the value 1 when the rate of inflation exceeds the country-specific median value and 0 otherwise. We then examine whether the effect when inflation is rising is different to that when it is falling. We do this by interacting the inflation variable with another dummy that takes the value 1 when inflation is higher than in the previous year and 0 otherwise. The estimation results are shown in Table 5.

Table 5: Non-linear effects of inflation on the primary balance, revenues and primary expenditure

Variable	FE (1) Primary balance	FE (2) Total revenue	FE (3) Primary expenditure	System GMM (4) Primary balance	System GMM (5) Total revenue	System GMM (6) Primary expenditure
Lagged dependent	0.561***	1.011***	0.796***	0.512***	1.009***	0.783***
	(0.074)	(0.023)	(0.074)	(0.055)	(0.021)	(0.077)
Lagged debt	0.037***	0.000	-0.027**	0.041***	0.002	-0.030**
	(0.007)	(0.004)	(0.012)	(0.006)	(0.003)	(0.012)
Output gap	0.311**	-0.111***	-0.249***	0.432***	-0.096***	-0.306***
	(0.141)	(0.034)	(0.092)	(0.081)	(0.047)	(0.080)
Inflation	0.782***	0.201**	-0.518	0.542***	0.302***	-0.306
	(0.207)	(0.103)	(0.318)	(0.193)	(0.066)	(0.240)
HICP inflation#high inflation	-0.166	0.070	0.126	..	..	..
	(0.175)	(0.094)	(0.267)			
HICP inflation#rising inflation	..	..	..	-0.110	-0.048	-0.034
				(0.134)	(0.054)	(0.086)
Constant	-3.823***	-1.000	11.888***	-3.695***	-1.042	12.452***
	(0.797)	(1.037)	(2.866)	(0.777)	(0.963)	(2.993)
Number of observations	276	276	276	276	276	276
Max lag	2	2	2	2	2	2
Hansen test	0.523	0.824	0.517	0.673	0.868	0.500
AR(1) test	0.067	0.005	0.046	0.066	0.005	0.041
AR(2) test	0.832	0.607	0.923	0.752	0.425	0.978

Notes: The sample consists of annual data for 12 euro area countries over the time period 1999-2021. In all regressions heteroskedasticity robust standard errors (in brackets) are used in all the regressions. Superscripts *, ** and *** denote significance at the level of 0.1, 0.05 and 0.01 respectively. A dummy variable accounting for the surge in the primary deficit of Ireland in 2010 is included but is not reported. System GMM is the Blundell and Bond (1998) system GMM estimator, where the options orthogonal and collapse are used. Max lag denotes the upper limit on lags used in the set of instruments. The Hansen test is a p value for the Hansen test of over-identifying restrictions, whose null implies that the chosen instruments are valid. AR(1) and AR(2) provide p values for tests for the absence of first and second order autocorrelation in the differenced error term, respectively.

the forecast inflation rate in the estimations but we did not find that it had any impact on the fiscal policy variables (results available upon request).

[15] Interestingly, the effect on expenditure is estimated with higher statistical significance than in the expenditure regressions in the baseline estimations shown in Table 1. This suggests that it is inflation being above or below expectations that drives the expenditure in per cent of GDP, which may indicate that governments fail to incorporate it by indexation or discretionary policies to keep values in per cent of GDP unchanged.

The results in columns 1–3 reveal that the coefficients of the interaction term are relatively small in numerical terms and far from statistically significant.[16] The effects of inflation on fiscal outcomes seem to be largely independent of whether the rate of inflation is relatively low or relatively high.[17] It follows from columns 4–6 that the coefficient of the interaction term between the rate of inflation and the dummy indicating rising inflation is statistically insignificant. We conclude that there is no empirical support for the non-linearities specified in Table 5.[18]

We run two robustness tests to ensure the validity of our results. For the first, we replace the output gap with the rate of GDP growth, as the output gap is known to be unstable across estimation vintages. Table 6 shows that this change has very little impact on our results, though it reduces the coefficient of HICP inflation slightly in the primary balance and primary expenditure regressions. For the second test, we incorporate two political variables to account for discretionary policy decisions that are motivated by upcoming elections and constrained by fiscal rules. Including these variables brings the estimated inflation coefficient closer to the baseline coefficient.

Table 6: The impact of a change in inflation on the primary balance, total revenue and primary expenditure: alternative regressors

Variable	FE (1) Primary balance	FE (2) Total revenue	FE (3) Primary expenditure	System GMM (4) Primary balance	System GMM (5) Total revenue	System GMM (6) Primary expenditure
Lagged dependent	0.584***	0.986***	0.713***	0.468***	0.941***	0.815***
	(0.092)	(0.028)	(0.059)	(0.042)	(0.052)	(0.094)
Lagged debt	0.012**	0.009***	0.001	0.049***	0.009*	-0.039***
	(0.006)	(0.003)	(0.011)	(0.011)	(0.005)	(0.012)
GDP growth rate	0.345***	-0.050**	-0.439***	..	..	..
	(0.047)	(0.020)	(0.051)			
Output gap	..	..	..	0.481***	-0.096**	-0.277***
				(0.051)	(0.039)	(0.051)
Fiscal rules	..	..	..	1.775**	0.121	-1.096**
				(0.817)	(0.227)	(0.515)
Elections	..	..	..	-0.332	-0.011	0.043
				(0.208)	(0.139)	(0.280)
HICP inflation	0.492***	0.213***	-0.234***	0.679***	0.286**	-0.584***
	(0.134)	(0.059)	(0.103)	(0.141)	(0.113)	(0.190)
Constant	-2.444***	-0.276	14.101	-5.812***	1.297	13.129***
	(0.602)	(1.190)	(1.596)	(1.442)	(2.442)	(3.736)
Number of observations	276	276	276	264	264	264
Max lag	2	2	3	2	1	2
Hansen test	0.199	0.416	0.541	0.562	0.862	0.250
AR(1) test	0.031	0.003	0.087	0.063	0.006	0.076
AR(2) test	0.792	0.568	0.805	0.514	0.438	0.813

Notes: The sample consists of annual data for 12 euro area countries over the time period 1999-2021. Heteroskedasticity robust standard errors (in brackets) are used in all the regressions. Superscripts *, ** and *** denote significance at the level of 0.1, 0.05 and 0.01 respectively. A dummy variable accounting for the surge in the primary deficit of Ireland in 2010 is included but is not reported. System GMM is the Blundell and Bond (1998) system GMM estimator, where the options orthogonal and collapse are used. Max lag denotes the upper limit on lags used in the set of instruments. The Hansen test is a p value for the Hansen test of over-identifying restrictions, whose null implies that the chosen instruments are valid. AR(1) and AR(2) provide p values for tests for the absence of first and second order autocorrelation in the differenced error term, respectively.

[16] We have also run the estimations with an alternative threshold inflation rate of 2 per cent, but the results are very similar to those presented in Table 5.

[17] It should be noted however the rate of HICP inflation was relatively low in the EA12 in the sample period and the findings may thus not be applicable in situations with much higher rates of inflation such as those in 2022.

[18] It is notable that the coefficient of the inflation rate in the primary expenditure regressions turns insignificant when the interaction terms are included. The coefficients of the rate of inflation appear to lack statistical significance in some of the specification of the expenditure reaction function.

We have also investigated how sensitive the baseline results are to changes in the time sample. We sequentially excluded periods of three years that may include unusual features, covering the first three years after the euro was introduced, the three years around the global financial crisis, and the last three years of which the Covid-19 pandemic affected the last two year. The results are shown in Table B.1 in Appendix B and the conclusion is that the results are not affected to any large extent by the changes in the time sample.

Lastly, we seek to ascertain how much individual countries can affect the results for the panel of euro area countries. We run the estimations for the primary balance, revenues and primary expenditure with each country excluded one by one. The results of this test are displayed in Table B.2 in Appendix B. Excluding Greece or Ireland affects the estimates of the coefficient of the inflation rate somewhat, but excluding both countries simultaneously leaves the coefficient closer to the baseline estimate.

7 Final comments

This paper uses fiscal reaction functions to study the impact of inflation and inflation surprises on fiscal outcomes in the euro area, covering the first 12 countries to join the euro area. The annual data run from 1999 when the euro area was formed until 2021, the last year before the extreme inflation of 2022.

We regress the primary balance and its various components on HICP inflation or measures of inflation surprises and use the lagged dependent variable, the debt stock, and the output gap as control variables. Including the inflation variable is of interest in itself, but it may also reduce the risk of omitted variables bias affecting the estimated coefficient of the output gap, for instance. The estimations are run using the System GMM estimator to address the possible Nickell bias and the bias from reverse causality.

The coefficient of HICP inflation on the primary fiscal balance is positive and around 0.7, suggesting that 1 percentage point higher inflation leads to the primary fiscal balance in per cent of GDP improving by 0.7 percentage point. The positive effect of inflation on the primary budget balance stems from both the revenue side and the expenditure side of the fiscal balance. On the revenue side, higher inflation is associated with higher income taxes and higher indirect taxes, but not with higher social security contributions. On the expenditure side, higher HICP inflation is associated with primary current expenditure in per cent of GDP being lower, but surprisingly not with any change in capital expenditure in per cent of GDP.

The key hypotheses about the linkages between inflation and fiscal outcomes rest on the assumption that realised inflation is different from the expected rate of inflation which is used for planning and executing the budget. We use two proxies of inflation surprises, which are the change in the rate of inflation and the difference between realised inflation and the inflation forecast published by the European Commission the previous autumn. The coefficient of the inflation surprises is in both cases comparable to the coefficient of inflation itself. The upshot is that inflation surprises likely play a key role for the results obtained for the

rate of inflation.

It is important to emphasise that the effects of inflation on the fiscal outcomes obtained in this study are short-term effects that occur basically within one year. Including the lagged dependent in the estimation is largely meant to mop up slow-moving, country-specific variation and thus reduce the risk of omitted variables bias. If the horizon is extended beyond one year, there will also be effects from for instance the stock of debt to GDP. The results obtained here may nevertheless be of some use in analysis of debt dynamics and longer-term fiscal sustainability.

The study found few signs of non-linear effects in the relationship between inflation and the fiscal variables. It should be remembered however that the finding is derived from a sample in which inflation was generally relatively low and was often below the 2 per cent target for inflation in the euro area.

The results in this study have notable policy implications for the preparation, execution and evaluation of fiscal policies. Spells of high and unexpected inflation may improve the fiscal balance in the year of the occurrence and thus to an extent mask the underlying fiscal stance. It is also likely that unexpectedly low inflation may lead to a deterioration of the fiscal balance. The study implies that the business cycle may impact the fiscal stance not only through the output gap or other business cycle effects but also through the rate of inflation, highlighting the importance of forecasts for this variable.

Given the novelty of this study, several issues have been left unexplored. First, it would be useful to shed further light on the mechanisms and channels through which inflation affects fiscal outcomes. Structural models or detailed decomposition may be helpful for this. Second, it would be important to investigate whether the effect of inflation on fiscal outcomes differs depending on the underlying sources of the inflation, including whether it is induced from the supply side or the demand side of the economy. Finally, it would be insightful to examine how well the estimated effect applies to other countries or country groupings. These issues are left for future studies.

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Appendices

A Appendix A: Data

Table A.1: List of variables used in the study, their definition and source

Variable	Data source	Definition
Primary balance	Eurostat	General government net lending, excl. interest payable, % of GDP
Total revenue	Eurostat	General government total revenue, % of GDP
Primary expenditure	Eurostat	General government total expenditure, excl. interest payable, % of GDP
Direct taxes	Eurostat	General government current taxes on income and wealth, % of GDP
Indirect taxes	Eurostat	General government taxes linked to imports and production, % of GDP
Social security contributions	Eurostat	General government actual social contributions, % of GDP
Primary current expenditure	Eurostat	General government current expenditure, excl. interest payable, % of GDP
Capital expenditure	Eurostat	General government capital expenditure, % of GDP
HICP inflation	Eurostat	Annual average rate of change in HICP, %
Output gap	AMECO	Gap between actual and potential GDP, % of potential GDP
Public debt	Eurostat	General government consolidated gross debt, % of GDP
Inflation forecast	European Commission	EC forecast of the HICP inflation rate made in October the previous year, %
Output gap forecast	European Commission	EC forecast of the output gap made in October the previous year, % of potential output
GDP growth rate	Eurostat	Relative change in GDP in constant prices, %
Fiscal rule dummy	IMF	Dummy taking the value 1 if there is a budget balance, expenditure or revenue rule; 0 otherwise
Election dummy	Database of Political Institutions	Dummy taking the value 1 if there is a legislative election in this year; 0 otherwise

Table A.2: Descriptive statistics

Variable	Mean	Median	Standard Deviation	Min	Max
Primary balance	0.103	0.5	3.368	–11.9	9.6
Total revenue	44.711	44.4	6.032	22.3	54.8
Primary expenditure	44.608	44.7	6.492	23.0	60.2
Direct taxes	12.554	12.7	2.531	7.8	20.4
Indirect taxes	12.929	13.1	1.885	6.4	17.4
Social security contributions	12.067	12.3	3.209	3.2	17.2
Primary current expenditure	40.019	40.7	6.331	20.3	55.0
Capital expenditure	4.589	4.4	1.385	2.0	17.1
HICP inflation	1.799	1.9	1.263	–1.7	5.3
Output gap	–0.940	–0.4	3.774	–19.4	5.5
Public debt	78.967	69.9	38.605	7.4	206.3
Inflation forecast	1.771	1.729	0.743	–0.815	4.4
Output gap forecast	–1.514	–1.1	2.120	–14.361	2.2
Inflation forecast error	–0.015	0.0	0.978	-3.8	3.3
Output gap forecast error	0.145	0.7	2.988	–12.38	6.2
GDP growth rate	1.732	1.884	3.582	–11.325	24.4
Fiscal rule dummy	0.756	1.0	0.430	0	1
Election dummy	0.274	0.0	0.447	0	1

B Appendix B: Supplementary estimations

Table B.1: The impact of inflation on the primary balance estimated using different time samples

Variable	Dependent variable: Primary balance. Time period: (1) 2002-2021	(2) 1999-2007, 2011-2021	(3) 1999-2018
Lagged dependent	0.543***	0.503***	0.612***
	(0.069)	(0.079)	(0.089)
Lagged debt	0.036***	0.033***	0.029***
	(0.005)	(0.010)	(0.008)
Output gap	0.248*	0.350***	0.229
	(0.149)	(0.100)	(0.099)
HICP inflation	0.654***	0.514***	0.458***
	(0.145)	(0.185)	(0.116)
Constant	–3.904***	–3.009***	–2.912***
	(0.871)	(1.110)	(0.723)
Number of observations	240	240	240
Max lag	2	2	2
Hansen test	0.236	0.334	0.241
AR(1) test	0.074	0.157	0.052
AR(2) test	0.972	0.471	0.691

Notes: The sample consists of annual data for 12 euro area countries over three different samples. Heteroskedasticity robust standard errors (in brackets) are used in all the regressions. Superscripts *, ** and *** denote significance at the level of 0.1, 0.05 and 0.01 respectively. A dummy variable accounting for the surge in the primary deficit of Ireland in 2010 is included but is not reported. The estimation is performed using the Blundell and Bond (1998) System GMM estimator, where the options orthogonal and collapse are used. Max lag denotes the upper limit on lags used in the set of instruments. The Hansen test is a p value for the Hansen test of over-identifying restrictions, whose null implies that the chosen instruments are valid. AR(1) and AR(2) provide p values for tests for the absence of first and second order autocorrelation in the differenced error term, respectively.

Table B.2: The coefficient of HICP inflation in the fiscal reaction functions for the primary balance, revenues and primary expenditure, excluding individual countries

	Primary balance		Total revenues		Primary expenditures	
Omitted country	Coeff	SE	Coeff	SE	Coeff	SE
Austria	0.661***	0.137	0.289***	0.066	–0.378**	0.161
Belgium	0.608***	0.126	0.264***	0.065	–0.308*	0.160
Finland	0.630***	0.140	0.266***	0.066	–0.398***	0.148
France	0.733***	0.124	0.295***	0.068	–0.386**	0.168
Germany	0.677***	0.136	0.288***	0.067	–0.365**	0.159
Greece	0.429**	0.168	0.303***	0.078	–0.362*	0.204
Ireland	0.856***	0.139	0.231***	0.075	–0.454***	0.170
Italy	0.641***	0.120	0.285***	0.067	–0.392**	0.161
Luxembourg	0.685***	0.145	0.299***	0.054	–0.405**	0.177
Netherlands	0.745***	0.145	0.309***	0.063	–0.437**	0.172
Portugal	0.648***	0.133	0.250***	0.069	–0.335**	0.144
Spain	0.652***	0.147	0.290***	0.068	–0.239*	0.146

Notes: The table shows the inflation coefficients alongside their standard errors. The coefficient estimates are based on estimations of the baseline regressions (Table 1). Countries shown in column 1 of this Table are excluded one at a time from the sample. The sample consists of annual data for 12 euro area countries over the time period 1999–2021. Heteroskedasticity robust standard errors are used in all the regressions. Superscripts *, ** and *** denote significance at the level of 0.1, 0.05 and 0.01 respectively. A dummy variable accounting for the surge in the primary deficit of Ireland in 2010 is included but is not reported. System GMM is the Blundell and Bond (1998) system GMM estimator, where the options orthogonal and collapse are used.