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A monetary policy perspective on the euro area fiscal reaction function

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Abstract

This paper examines how fiscal policy in the euro area reacts to monetary policy, by estimating fiscal policy reaction functions for the period 1999-2019. Inclusion of the monetary policy stance in the fiscal reaction function, approximated by a shadow interest rate, is a relatively novel aspect in this type of analysis. The findings suggest that fiscal policy acts in a substitutive manner, its stance moving in the opposite direction of monetary policy, though this effect may have ceased operating during ECB's quantitative easing. Using local projections, the substitutive effect is found to increase over time before turning broadly neutral. Analysing the fiscal response to other monetary policy relevant variables - government debt and the output gap -, outcomes suggests that budget balances react positively to government debt, supporting fiscal sustainability, and that fiscal policy acts countercyclically in recessions.

Key words: policy interactions, reaction function, debt sustainability, monetary policy transmission

JEL codes: E61, H11, H62

Non-technical summary

This paper takes a monetary policy perspective on fiscal developments, analysing how euro area fiscal authorities respond to ECB monetary policy. Specifically, it examines whether monetary policy tightening prompts fiscal tightening, thereby complementing monetary policy, or fiscal loosening, working in the opposite direction than monetary policy, e.g. because of other incentives and priorities such as countering the negative impact of monetary policy on growth. This topic has received limited attention in quantitative analyses of fiscal policy behaviour. Taking into account fiscal policy reactions to the monetary policy stance may enhance the calibration of monetary policy to achieve its price stability objective.

In addition, the paper explores how governments respond to elevated government debt levels, which is highly relevant to monetary policy. Unsustainable public finances may raise fears that monetary policy might be diverted from its primary objective of price stability. The study also considers fiscal policy's response to the business cycle, as a strong countercyclical fiscal stance, with fiscal policy expanding during downturns and contracting during upturns, may help to smooth out fluctuations in economic activity and inflation. Such may require a less intensive employment of monetary policy instruments to keep inflation at target.

To address these issues, fiscal policy reaction functions are estimated, showing the budgetary responses to key variables, including the monetary policy stance, government debt and the output gap. The fiscal policy measure used in the analysis is the structural budget balance, reflecting the budget balance excluding cyclical effects, interest payments and one-off measures. As ECB key interest rates do not fully capture the monetary policy stance over the entire period due to employing other monetary policy instruments such as asset purchases, shadow rates are used as the monetary policy stance measure. Shadow rates translate non-interest rate monetary policy measures into interest rate equivalents, providing a comprehensive measure of the monetary policy stance, though its estimates vary substantially depending on the assumed effectiveness of non-interest rate measures.

Several other relevant factors that are commonly included in estimates of fiscal policy reactions functions, such as long-term interest rates, fiscal rules, and current account balances, are also part of the analysis. The paper uses a Two-Stage Least Squares (2SLS) estimation method to account for expected interdependencies of variables. The

estimates relate to a panel of ten euro area countries over the period 1999-2019, using annual data.

The outcomes suggest that, in the short term, fiscal policy takes a substitutive role to monetary policy: tight monetary policy leads to loose fiscal policies, and vice versa. For instance, governments react to tight monetary policy by an expansionary fiscal policy, possibly reflecting government concerns about the adverse impact of monetary policy on economic growth. However, during the time of large-scale purchases of government debt (quantitative easing, QE), this substitutive role appears to have diminished, with fiscal policy becoming broadly muted or even slightly complementary to monetary policy. This QE-effect may reflect governments' perception of QE providing a monetary backstop to public finances, creating additional space for spending.

Alternative specifications of the monetary policy stance measure that give less weight to the non-interest rate monetary policy measures confirm the short-term substitutive role of fiscal policy, but do not consistently support the complementary effect of QE. This result suggests that some caution is warranted when interpreting the QE-related outcomes.

Complementing the short-term analysis, the paper uses local projection estimates to assess fiscal responses to monetary policy over the medium term. The results indicate that the substitutive effect increases in the first years but broadly fades out in the medium term.

Moreover, the study suggests that governments with elevated debt levels pursue high budgetary surpluses to maintain longer-run fiscal sustainability, abating concerns about fiscal policy negatively affecting the conditions under which monetary policy operates. Finally, the paper provides some evidence of countercyclical fiscal behaviour; fiscal policy tends to be expansionary when output is below potential while it adopts a neutral stance when output exceeds potential.

1. Introduction

Mounting government debt and large stocks of government bonds on central banks' balance sheets in the aftermath of the Global Financial Crisis (GFC), a period of stubborn low inflation, and the Covid-19 pandemic have reignited interest in the interaction between fiscal and monetary policies in the euro area.[1] The recent surge in inflation has further intensified the debate on the roles of fiscal and monetary policy. However, these discussions usually do not consider the extent to which fiscal policies already respond to monetary policy actions, or, in other words, the working of the fiscal policy transmission channel of monetary policy. This paper therefore adopts a monetary policy perspective to examining fiscal behaviour, analysing whether and how fiscal authorities react to ECB monetary policy decisions. Specifically, it investigates whether monetary policy loosening is followed by fiscal loosening, thus strengthening the monetary policy impulse, or whether it prompts fiscal tightening, which would counteract the monetary stimulus.[2] Any systematic response by fiscal authorities to the monetary policy stance should be taken into account when calibrating the monetary policy response to the inflation outlook.

This topic has received very limited attention in the existing literature. In addition to this relatively novel aspect in estimating fiscal policy reaction functions, the paper also examines fiscal responses to government debt levels. This is highly relevant for monetary policymakers as unsustainable debt may create (perceptions of) fiscal dominance, potentially constraining central banks' scope to achieve price stability. Another key issue is the countercyclical stance of fiscal policy. A strong countercyclical fiscal response to the different stages of the business cycle can mitigate economic fluctuations and their impact on inflation, potentially requiring a less intensive use of monetary policy.[3]

[1] See e.g. Schnabel (2021) who - in a context of constrained monetary policy- noted that "A public sector that is largely insensitive to interest rate changes significantly reduces the effectiveness of monetary policy, in particular in the euro area, where governments account for nearly half of total spending."

[2] Terms such as 'substitutive' used in this paper to describe fiscal-monetary policy interactions are descriptive rather than normative, as monetary and fiscal policymakers have different objectives.

[3] While the fiscal reaction to inflation is also a topic relevant for a central bank with an inflation target, this paper does not elaborate on this issue as the effect of inflation on fiscal balances captures both an automatic and a discretionary impact, while this paper analyses discretionary responses only.

Using annual data from ten euro area countries over the two decades since the start of the European Economic and Monetary Union (EMU) in 1999, the fiscal policy reaction function is estimated using a wide set of explanatory variables including the monetary policy stance, government debt and the output gap. The findings suggest that fiscal policies in the short term generally exhibit a substitutive relationship with monetary policy: monetary policy loosening (tightening) is followed by fiscal tightening (loosening). However, such effect may have ceased operating during the period of ECB's large-scale purchases of government securities (quantitative easing, QE). Over the medium term, the influence of monetary policy on fiscal policy initially increases before broadly converging to a neutral or slightly complementary relationship. Furthermore, the analysis shows that governments respond to fiscal sustainability concerns, as high debt levels bring forward improving fiscal balances. Regarding governments' reaction to cyclical swings in economic activity, the findings provide some evidence that economic downturns are countered by expansionary, countercyclical fiscal policies, with no systematic response detected in economic good times.

The paper is organised as follows: Section 2 reviews the principal findings of prior research on fiscal policy reaction functions. Section 3 outlines the data and methodological framework used in the analysis. Section 4 presents the empirical results while Section 5 concludes.

2. Literature review

Analysing fiscal policy behaviour by estimating fiscal policy reaction functions has a long and rich tradition, with papers focusing on a wide range of factors potentially affecting fiscal policy. Below, the principal issues discussed in the literature on fiscal policy reaction functions are summarised, quoting important and recent contributions to this research area, as the basis for variables to be included in the estimations.[4] The focus is on studies covering euro area developments.

The prospect of EMU starting in 1999 gave rise to academic research on fiscal-monetary policy interactions. Melitz (1997) concluded that a tightening in one policy area leads to loosening in the other policy area, using a panel of 19 OECD countries over the period 1960-1995. Some more recent studies, as for instance Ahrend et al. (2006) and Afonso

[4] For more encompassing overviews, see e.g. Checherita-Westphal and Žďárek (2017) and Heimberger (2023).

and Martins (2015), conclude that monetary policy contributed to successful episodes of large-scale fiscal consolidations and possibly even non-Ricardian effects ("expansionary fiscal consolidations"). Afonso and Sousa (2024) estimate a fiscal policy reaction function for the period 1995-2019 that includes ECB's policy interest rate as a determinant, concluding that a 1 percent-point decrease in the policy interest rate leads to a 0.66% higher cyclically adjusted budget balance, thus implying a substitutive relationship. The long-term interest, added to capture ECB forward guidance effects, did not exert significant value-added.[5] While this study did not account for non-conventional monetary policy measures, Afonso and Gomes-Pereira (2025) added a shadow interest rate to the fiscal reaction function. Contrary to the findings of the studies above, they conclude that fiscal policies in the period 2003-2022 reacted complementary to monetary policy. Moreover, they find that expansionary monetary policy has a smaller effect on primary balances than contractionary monetary policy. However, this study takes little account of the endogeneity of the independent variables and of other factors affecting fiscal policy behaviour.

A factor that received much attention in estimating fiscal policy reaction functions is the sustainability of fiscal policy, following seminal work by Bohn (1998). A necessary condition for sustainability of public finances, as derived from the intertemporal government budget constraint, is that the budget balance reacts positively to government debt, i.e. elevated debt levels prompt high primary balances. Some contributions to the literature also consider non-linear reactions to debt, e.g., reflecting a lower responsiveness of the deficit to debt at very high debt levels because of fiscal fatigue (e.g., Ghosh et al., 2013).

Another major topic in the literature concerns governments' responsiveness to the business cycle.[6] A countercyclical fiscal policy may mitigate macroeconomic fluctuations in economic activity and inflation. At the same time, such policy intentions may turn out pro-cyclical because of detection, decision and implementation lags, while political incentives or borrowing constraints fluctuating in tandem with cyclical conditions may also contribute to pro-cyclicality. See e.g., Schalck (2012), Huart (2013), Mohl et al.

[5] Long-term interest rates capture more elements than just central bank forward guidance and therefore are not unequivocal monetary policy indicators. The same holds for proxying monetary policy by inflation and the real long-term interest rate as in Dascher and Greiner (2023).
[6] The analysis in this paper focusses on the discretionary fiscal response to economic fluctuations: the role of automatic stabilisers in smoothing economic activity is outside the scope of the analysis.

(2019), Larch et al. (2021) and Gootjes and De Haan (2022) for an overview of the diverging empirical results on the cyclical response of fiscal policies.

Financial markets that perceive the soundness of fiscal positions to be at risk may require a higher interest rate for holding these government bonds. Assuming such reaction, the next question is whether rising borrowing costs induce governments to improve fiscal balances. De Groot et al. (2015) show for a panel of 14 EMU countries that higher borrowing costs prompted fiscal consolidation in the period 1970-2011, especially after 1992. Tkacevs and Vilerts (2019) argue that low long-term interest rates as a result of non-conventional monetary policy undermine fiscal discipline, especially in peripheral countries. Klaassen et al. (2023) estimate that a 1 percentage-point higher interest rate on average leads to a higher primary balance of around 1 percentage-point in developed countries.

Inflation also often makes its way in fiscal policy reaction functions (e.g. Briodeau and Checherita-Westphal, 2023). This may capture any automatic effects on fiscal balances, e.g., due to bracket-creep in taxation or inflation-indexed expenditures. It may also reflect central bank seignorage revenues from higher inflation that is passed on to governments as main shareholder of the central bank, an internalisation of the central bank objective, or additional spending to alleviate social consequences of high inflation. Moreover, current account balances are commonly included in fiscal policy reaction functions, reflecting room for/constraints on the fiscal policy space (see e.g. Staehr et al., 2024).

Additionally, the fiscal impact of institutional restrictions, such as fiscal rules from the European Treaty (3% of GDP deficit threshold, and 60% threshold for debt ratio) and from the Stability and Growth Pact (SGP) has been studied intensively (see Elsener and Brändle, 2023, for an overview). Other institutional factors that have been included in fiscal policy reaction functions include election dates (reflecting a political business cycle, as e.g., in Tujula and Wolswijk, 2007), the political orientation of the government (left-wing versus right-wing), and the degree of parliamentary support (majority-minority government).

While for most of the above variables there are clear expectations on the direction of their effect, such is not the case for the monetary policy stance, as it partly also depends on government priorities. A case of complementarity may arise if in a (demand-driven) downturn monetary loosening to increase inflation to target is supported by fiscal

loosening to combat the recession, facilitated by lower short- and long-term borrowing costs. Also, higher GDP growth following monetary loosening may play a role, resulting in a fiscal dividend through the operation of automatic fiscal stabilisers. Specifically as regards monetary accommodation via large-scale central bank purchases of sovereign bonds, governments may perceive such purchases as a backstop to government finances. Being assured of a large and non-price sensitive buyer taking part of the debt out of the market, governments may exercise less constraint on net spending.[7] However, a contrary, substitutive fiscal policy reaction, i.e. tight budget balances following loose monetary policy, could arise if the government prioritises fiscal sustainability, using the fiscal space created by monetary loosening to reduce deficits and debt.[8]

Given that several channels may be operating, the reaction of fiscal policy to monetary policy is a priori uncertain, requiring empirical analysis to shed light on this issue.

3. Data and set-up

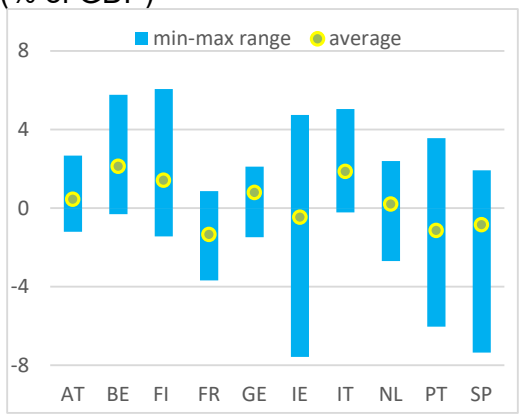
As to the choice of the relevant fiscal measure, the focus in this paper is on the fiscal stance, i.e. the discretionary part of the fiscal balance. The fiscal gauge used here is the structural balance, defined as general government net lending net off interest payments, business cycle effects and one-offs, as a percentage of potential GDP.[9] Excluding net interest payments from the fiscal gauge is common in the literature on debt sustainability, and removes any automatic effects of ECB policy interest rates and long-term interest rates on the budget. Adjusting the budget balance for the effect of automatic stabilisers in addition eliminates the effect of the business cycle on the budget, allowing for examining whether discretionary fiscal policy acted pro- or counter-cyclically. Although adjusting fiscal balances for the cycle is known to be tedious given wide ranges of estimates and frequent significant revisions over time, it is nonetheless preferred here to avoid spurious correlation between the budget balance and the explanatory variables. While cyclically-adjusted primary balances have been used

[7] In this respect, Broeders et al. (2023) argue that QE decreased the sovereign bond risks of lower-rated euro area countries, especially for asset purchases aimed at supporting monetary policy transmission.
[8] Aguilar et al. (2024) estimate that asset purchases between 2015 and 2022 may have reduced the Spanish public debt-to-GDP ratio by 13 to 21 percent-point at end-2022.

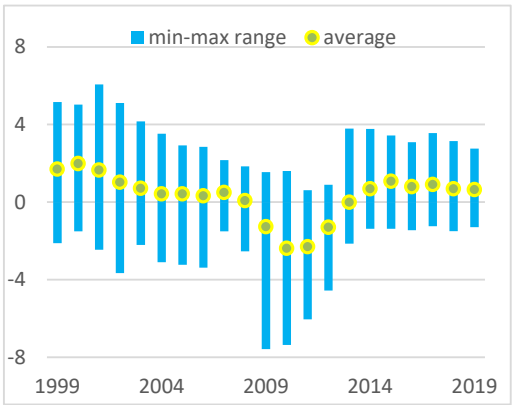
frequently in fiscal policy reaction functions[10], in this paper the budget balance has also corrected for one-off factors, to remove any estimation bias that may arise from their expanded use especially when fiscal policy is in dire straits.[11]

Key characteristics of structural balances across countries and time are shown in Chart 1.[12] The left-hand side of Chart 1 reveals limited variability in structural budget balances in the largest euro area countries (e.g., France, Germany) and higher volatility in smaller, more vulnerable countries like Ireland, Portugal and Spain, also reflecting the impact of the sovereign debt crisis around 2010-2012. The right-hand side of Chart 1 depicts a gradual reduction in average structural balances in the early years of the euro. They turned into deficits at the time of the GFC and the sovereign debt crisis, followed by a reversal when debt ratios rose substantially, and financial markets started questioning the sustainability of the finances of various governments. Following a period of fiscal constraint, surpluses slightly declined again towards the end of the period under consideration (2019).

Chart 1. Structural balances across countries and across time
(% of GDP)



Source: OECD Economic Outlook.



Source: OECD Economic Outlook.
Note: unweighted averages.

As to factors potentially affecting the fiscal stance, the choice of the monetary policy summary measure is key in this study. While in pre-crisis circumstances, the short-term main policy interest rate was the obvious candidate, the intensive use of non-interest

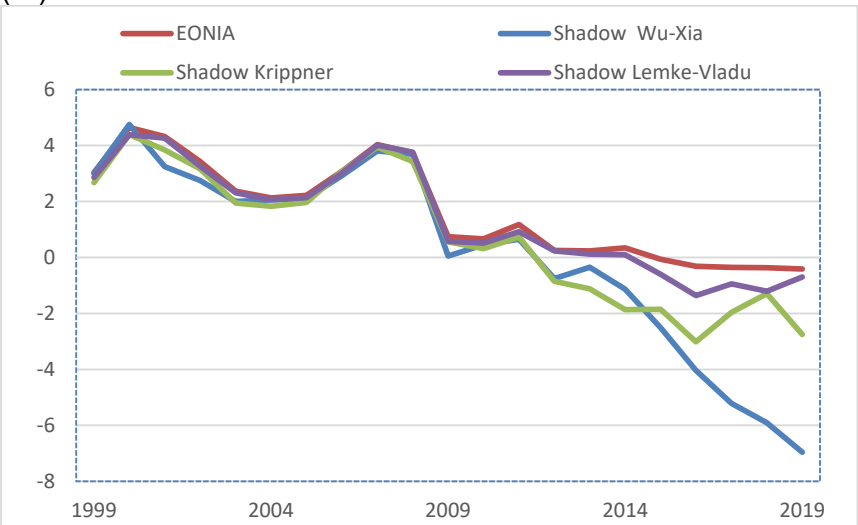
[10] See e.g. Huart (2013), Afonso et al. (2019), and Afonso and Sousa (2024).
[11] See Joumard et al. (2008) for details on adjusting fiscal balances for one-offs. One-offs amount to close to 0.25% per year on average, with values ranging from +2% to -20% of GDP. A positive sign indicates balance-improving one-off operations.
[12] Charts showing structural balances over time for each country are shown in Annex 1.

monetary policy measures such as asset purchases (including government bonds) when policy interest rates approached the lower bound renders this measure inapt. Instead, the monetary policy stance is approximated here by shadow interest rates, calculated by adding to the policy interest rate all non-interest monetary policy measures after converting them to interest rate-equivalents. The measure employed here principally is the ECB shadow rate constructed by Wu-Xia (2016). It deviates from the overnight interest rate (EONIA[13]) as a result of ECB's longer-term refinancing operations, asset purchases and forward guidance, causing the shadow rate to drop to close to -7% in 2019, against a -0.4% EONIA rate (Chart 2). Wu-Xia's measure is preferred in view of its wide use in economic research, and updates being available regularly, although it should be noted that estimates of shadow rates can differ widely, as shown in Chart 2 by the shadow rates calculated by Krippner (2019) and Lemke-Vladu (2017).

The macroeconomic stabilisation role of government budgets is captured by including the output gap. Taking into account decision and implementation lags in budgetary policymaking, output gaps enter the equation with a one-year lag, which also reduces any spurious relation between the structural budget and the output gap as a result of any remaining cyclical elements in the structural balance.

Chart 2. Monetary policy stance measures

(%)



Sources: ECB, Haver Analytics, Wu-Xia, Krippner, Lemke and Vladu.

[13] Using EONIA in the estimates is preferred over ECB's Main Refinancing Rate (MRO) rate or the Deposit Facility Rate (DFR) as EONIA captures the gradual shift from the MRO to the DFR as the main ECB rate affecting money market conditions in conditions of excess liquidity.

Government debt also enters the equation with a lag, to account for efforts to restore fiscal sustainability. A squared debt variable also has been added to capture any non-linear effects, reflecting either additional consolidation efforts when debt is very high, or, to the contrary, signs of fiscal fatigue.

In addition, the potential roles of fiscal rules, general election dates, inflation, long-term interest rates and the current account balance are taken into account. Most variables enter the equation lagged one year to account for lags in budgetary decision-making.

Considering previous estimates of fiscal policy reaction functions as described in section 2, the one-year lagged structural balance has also been added, to enable capturing policy inertia, the short-term irrevocability of many government spending laws and tax rates, and any policy aimed at deficit smoothing. Being common practice in the area of estimating fiscal policy reaction functions, it also increases comparability with previous results though adding a lagged dependent variable is known to potentially give rise to a bias in the estimates.

Summarising, the estimation-equation is as follows:

$$Sbal_{it} = \beta_1\, Sbal_{it-1} + \beta_2\, R^s_{t-1} + \beta_3\, Debt_{it-1} + \beta_4\, Debt^2_{it-1} + \beta_5\, Ygap_{it-1} + \beta_6\, R^l_{it-1} + \beta_7\, FRule_{it} + \beta_8\, \Pi_{it-1} + \beta_9\, Elec_{it} + \beta_{10}\, CA_{it-1} + \beta_{11}\, y_i + \beta_{12}\, u_t + \varepsilon_{it} \quad (1)$$

with

$Sbal_{it}$ = structural budget balance, percentage of potential GDP, in country *i* at time *t*

R^s_{t-1} = shadow interest rate

$Debt_{it-1}$ = gross government debt, percentage of GDP

$Ygap_{it-1}$ = output gap, percentage of potential GDP

R^l_{it-1} = long-term interest rate

$FRule_{it}$ = fiscal rule index

Π_{it-1} = inflation rate

$Elec_{it}$ = dummy with value 1 in years with national parliamentary elections

CA_{it-1} = current account balance, percentage of GDP

y_i = country-specific intercepts

u_t = year effects

ε_{it} = residuals

Data have been taken mainly from the OECD Economic Outlook, as explained in more detail in Annex 1.

Estimates are based on Two-Stage Least Squares (2SLS) estimators. Allowing for instrumental variables is essential as some of the main variables (shadow rate, output gap, long-term interest rate) are likely to interact and therefore are endogenous. 2SLS is preferred over system GMM estimates in view of the large number of instruments compared to the limited number of country observations. Panel estimates are used as for the single central bank in the euro area, it is the common element in the fiscal policy reaction that is most relevant. It moreover allows for more robust conclusions, based on experiences of several countries, therefore being less affected by the specifics of one country. Unobserved country heterogeneity is taken into account by using a fixed-effects estimator. While such could give rise to Nickell's bias, it is expected to be limited as the number of year observations is (just) above 20. All estimates are robust to autocorrelation and heteroscedasticity using a robust Bartlett kernel (bandwidth two) and clustered observations.

The endogenous shadow rate, national long-term interest rates and output gaps are instrumented on their one-year lagged values as well as on lagged deficit and debt variables and lagged national inflation rates.[14] Additionally, ECB's 2-year ahead inflation projections for the euro area are added as instrument to mitigate concerns about endogeneity of the shadow rate. Moreover, to reduce any covariation between the key variables, the financial market volatility index VIX, national stock market growth rates and the US long-term interest rate are also included as instruments.[15] Despite these additional instruments, a caveat about the findings should be in place given imperfect instruments.

The time-period covered is 1999-2019. The sample starts at the beginning of EMU when the common euro area monetary policy was introduced, together with deficit and debt thresholds on national fiscal positions. The estimation period ends in 2019, thus excluding the Covid-19 pandemic period that gave rise to extraordinary and simultaneous fiscal and monetary policy responses. The joint effort to counter the economic consequences of the pandemic shock that hit all countries is of a different nature than the crises experienced before, and therefore may have given rise to different dynamics of interest rates, government debt and the output gap. Moreover, the speed

[14] In later estimations, one-year lagged values of all variations of the endogenous variables have been included as instruments.

[15] Adding lagged real GDP growth rates and unemployment rates did not materially contribute to the estimation results and therefore have not been included in the estimates presented here.

of the monetary policy and fiscal policy responses in this case would favour using quarterly or monthly data instead. Ending the estimation period in 2019 also has the advantage that cyclically-adjusted budget data are less prone to further revisions. Countries covered are those euro area member states for which sufficiently long data series are available, being Austria, Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, and Spain.

4. Empirical results

The outcomes of estimating equation 1 do not suggest a systematic response of fiscal policy to monetary policy as the coefficient on the shadow rate is in the non-significant area (Column 1 of Table 1). Elevated government debt leads to a restrictive budget (at the 10% significance level), in line with expectations from the debt sustainability literature, with the coefficient (0.06) falling within the common range of 0.001 – 0.10 (Checherita-Westphal and Žďárek, 2017). This effect is linear as the squared debt variable is not significant. The results moreover hint at a countercyclical fiscal policy stance, but again only at the 10% significance level. Moreover, budget balances show a fair degree of persistence (0.653), fiscal policy loosens in election years (0.4% of GDP), long-term interest rates have a deterrent effect on fiscal policy while there is weak evidence of fiscal rules and current account surpluses contributing to sound fiscal balances.

As to the fit of the equation, the P-value on the Hansen J-statistic is satisfactory, while F-tests on the individual equations for the endogenous variables (Annex 2, Table A1) show statistically significant results. However, given multiple endogenous variables, the result from the Kleinbergen-Paap underidentification test is more informative, with critical values -depending on the exact specification– around 20 (Stock and Yogo, 2005). The results on this statistic are also satisfactory.

The above estimate assumes a constant fiscal policy response to monetary policy. This assumption can be contested as the fiscal policy reaction may well vary according to economic and financial circumstances, and to the dominant monetary policy instrument used. While before 2008, monetary policy and fiscal policies in the euro area can be broadly characterised as working on their own, the GFC marks a period of low growth and low inflation, with monetary policy gradually easing more, and fiscal policy expansionary until the sovereign debt crisis set in. The QE period saw the intensification

of loose monetary policy to address too low inflation, including via large-scale purchases of government bonds. This could have prompted a shift in fiscal policy, as governments may have interpreted the central bank's role as a large, non-interest-sensitive buyer that takes a substantial part of the bond portfolio out of the market, as alleviating concerns about fiscal sustainability. Therefore, dummies capturing the periods of the GFC (2008-2012) and of QE (2015-2019) interacted with the shadow rate were added to the estimation-equation, as well as by themselves.[16]

The revised estimation-equation therefore is as follows:

$$Sbal_{it} = \beta_1 Sbal_{it-1} + \beta_2 R^s_{t-1} + \beta_3 R^s_{t-1} . GFC_{t-1} + \beta_4 R^s_{t-1} QE_{t-1} + \beta_5 Debt_{it-1} + \beta_6 Debt^2_{it-1} + \beta_7 Ygap_{it-1} + \beta_8 R^l_{it-1} + \beta_9 FRule_{it} + \beta_{10} \Pi_{it-1} + \beta_{11} Elec_{it} + \beta_{12} CA_{it-1} + \beta_{13} GFC_{t-1} + \beta_{14} QE_{t-1} + \beta_{15} y_i + \beta_{16} u_t + \varepsilon_{it} \quad (2)$$

with

GFC_t = Dummy taking value 1 between 2008 and 2012

QE_t = Dummy taking value 1 between 2015 and 2019

The results of estimating equation 2 (Table 1, column 2) now indicate that fiscal policy reacts in a substitutive way to monetary policy: a 1 percent-point tighter monetary stance leads to a -0.5 percent-point of GDP expansion of the budget balance, i.e. a loosening. This finding is broadly in line with the outcome of Afonso and Sousa (2024), reporting a policy interest rate coefficient of -0.66.[17] The outcomes for the GFC-related variables do not suggest a change in the fiscal policy reaction in that period. However, this is not the case in the QE-period: the QE-dummy interacted with the shadow rate takes a positive sign (0.85), as does the dummy by itself (1.82).

[16] Year dummies coinciding with the GFC or QE period have been left out of the estimation equation to avoid collinearity of period dummies with year dummies and interacted variables.

[17] Comparison of results with the findings in the Afonso and Gomes-Pereira 2025 paper are not feasible as their estimates are based on first differences in variables.

Table 1. Estimates focussing on the monetary stance measure

	(1)	(2)	(3)	(4)	(5)
Monetary policy measure	Shadow rate Wu-Xia	Shadow rate Wu-Xia	Shadow rate Krippner	Shadow rate Lemke/Vladu	EONIA & PSPP
Sbal $_{-1}$	0.653*** (9.46	0.634*** (9.14)	0.642*** (9.19)	0.657*** (9.37)	0.633*** (9.15)
Shadow rate$_{-1}$[1]	0.142 (1.55)	-0.505*** (-2.67)	-0.424*** (-2.60)	-0.550** (-2.32)	-0. 629** (-2.34)
Shadow rate$_{-1}$[1] * GFC		-0.004 (-0.02)	-0.133 (-0.73)	-0.084 (-0.36)	-0.162 (-0.62)
Shadow rate$_{-1}$[1] * QE		0.848*** (3.42)	-0.104 (-0.23)	1.756 (1.47)	-7.378* (-1.73)
Debt$_{-1}$	0.059* (1.66)	0.067** (1.99)	0.064* (1.89)	0.066* (1.96)	0.076** (2.23)
Debt$^2_{-1}$	-0.0003 (-1.39)	-0.0003 (-1.56)	-0.0003 (-1.54)	-0.0003 (-1.54)	-0.0004* (-1.72)
Output gap$_{-1}$	0.142* (1.66)	0.176** (2.16)	0.162** (1.92)	0.163* (1.86)	0.221** (2.57)
Long-term interest rate$_{-1}$	0.324** (2.09)	0.401*** (2.71)	0.434*** (2.67)	0.381** (2.54)	0.418** (2.51)
Fiscal rule	0.496* (1.93)	0.414 (1.62)	0.364 (1.44)	0.456* (1.88)	0.546** (2.03)
Inflation$_{-1}$	-0.012 (-0.10)	0.074 (0.69)	0.015 (0.15)	0.052 (0.47)	0.546** (2.03)
Election year	-0.373** (-2.42)	-0.328** (-2.02)	-0.370** (-2.36)	-0.337* (1.96)	-0.365** (-2.35)
Current account$_{-1}$	0.082* (1.93)	0.083* (1.90)	0.084* (1.91	0.073 (1.57)	0.077* (1.78)
GFC$_{-1}$		0.171 (0.42)	0.437 (1.15)	0.135 (0.27)	0.075 (0.13)
QE$_{-1}$		1.815*** (2.67)	-0.418 (-0.45)	0.099 (0.79)	
PSPP stock$_{-1}$					-0.002** (-2.39)
R^2	0.75	0.75	0.74	0.74	0.75
# of observations	200	200	200	200	200

Note: [1] EONIA for estimates presented in column nr 5.
Standard errors in brackets. ***, **, * denote statistical significance at the 1, 5 and 10% level respectively.

Taken together, these outcomes suggest a substitutive role of fiscal policy to monetary policy except for the QE-period when the fiscal policy reaction was broadly muted.[18] This complementary QE-effect may reflect governments' perception that QE provided a monetary backstop to government finances, reducing fiscal sustainability concerns as a

[18] The muted effect is calculated by summing up the coefficient on the shadow rate, the shadow rate interacted with QE, and the separate QE effect at the shadow rates prevailing at that time.

significant part of debt was taken 'out of the market' for a considerable time, creating room for additional spending. Another channel that may explain the complementary effect of QE is that, by flattening the yield curve, it may have encouraged governments to lengthen the maturity of new debt, thereby limiting governments' short-term exposure to interest rates, resulting in higher deficits (Afonso et al. 2024).

The other results reported in column 2 are broadly identical to those in column 1 in terms of the size of the coefficients but there are few gains in statistical significance. This applies especially for the other two main variables of monetary policy interest, the debt ratio and the output gap, now each being significant at the 5% level. Other factors that affect the conduct of fiscal policy are the long-term interest rate and the occurrence of national elections.

The relevant scores on the statistics (Hansen J-statistic, F-tests on individual equations for endogenous variables, and Kleinbergen-Paap underidentification test) are satisfactory (Annex 2, Table A1) with F-test values for the shadow interest rate, and for the shadow rate interacted with the QE dummy being very high, which may reflect the downward trend in the shadow rate in the second half of the period considered. While the relatively high number of independent variables in the estimation equation could give rise to multicollinearity issues, correlation coefficients do not confirm this. Low correlation coefficients dominate (Annex 1), with high values found where expected (e.g. between government debt and squared debt), and for some interactions of the shadow rates with other variables, where multicollinearity is no major concern given that these are endogenous variables estimated using instrument variables.

Estimates of the shadow interest rate are subject to much uncertainty and variation, as mentioned in Section 2. Therefore, equation 2 was re-estimated using the ECB shadow rate as calculated by Krippner (2019), as also used by Afonso and Gomes-Pereira (2025). This rate turns much less negative in the period of QE (around -3% in 2019 instead of -7% for the Wu-Xia estimate, see Chart 2). The estimation results (Table 1, column 3) confirm the previous finding as to the main monetary-policy relevant variables. However, the overall impact of the shadow rate no longer turns neutral during the QE phase, which may well reflect the lesser effectiveness of QE assumed in Krippner's shadow rate estimate. Similar outcomes, albeit with generally somewhat lower significance levels, are found when using yet another shadow rate measure, as prepared by Lemke and Vladu (2017), reaching a value of -0.9% in 2019. (Table 1, column 4).

Given different outcomes for the various measures of the shadow rate, equation 2 was also re-estimated using the euro area money market rate (EONIA) for capturing standard monetary policy, supplemented by the stock of government securities bought under ECB's public sector purchase programme (PSPP), as ECB's main non-interest rate monetary policy measure relevant for financing conditions of governments.[19] Such estimation allows examining whether more straight-forward monetary policy indicators are also able to capture an impact of monetary policy on the fiscal policy stance. Results (Table 1, column 5) again reveals a contrary fiscal response to monetary policy, witnessing the negative coefficient on the EONIA rate. The central bank holdings of government debt under the PSPP prompted an expansionary fiscal stance, at the 5% significance level, in line with the loosening effect of QE found in column 2. The results for government debt and the output gap are comparable to the main previous results.[20] These outcomes provide some confidence in the results obtained when using the Wu-Xia shadow rate, which therefore will be used as basis for the additional estimates below.

Turning to the role of government debt in setting fiscal policy, outcomes presented so far hint at positive feedback from government debt to the budget balance, indicating debt sustainability, though sometimes at low significance levels. No evidence was found of fiscal fatigue or higher fiscal aspirations in case of very high debt levels. To further test this finding, a cubic debt variable was added to the estimation-equation, which may better capture changes in fiscal policy efforts at very high debt levels (Ghosh et al., 2013). The coefficient on the cubic debt variable is positive (Table 2, column 2), suggesting above-average consolidation at very high debt levels (broadly above 110% of GDP) but being significant only at the 10% level, no strong conclusions can be drawn from this.

Moreover, an interaction term between government debt and the shadow rate was added to the equation, for detecting any acceleration or slow-down in the fiscal response to government indebtedness depending on the level of shadow rate, as in Afonso and Gomes-Pereira (2025). The positive coefficient in Table 2, column 3, suggests that the substitutive effect somewhat diminishes when government debt is high: an expansionary

[19] Net asset purchases under the PSPP started in 2015, with cumulative net purchases reaching more than EUR 2 trillion in 2019. In the estimate including PSPP holdings, the QE dummy as a separate variable has been excluded.

[20] Of note is that inflation in this estimate now exerts a significant balance-improving effect, which is in line with the findings of e.g. Briodeau and Checherita-Westphal (2023).

monetary policy, for instance, results in a smaller fiscal tightening effect the higher the level of government debt, suggesting a weakening of fiscal discipline. However, the variable is significant only at the 10% level, and therefore the finding is not conclusive.

As to the role of fiscal policy in reducing macroeconomic volatility, the estimates so far suggest a countercyclical fiscal policy response. Looking closer at this result, differences in fiscal reactions depending on whether the output gap is positive or negative were allowed. The results (Table 2, column 4) signal marked differences; fiscal policy is expansionary in case of negative output gaps, thus acting counter-cyclically (at 1% significance) but does not respond to output being above trend. However, the test results for the instrumental variables, notably as regards the positive output gap, warrant some caution in drawing strong conclusions.

It is open to debate whether fiscal policymakers react to the level of the output gap or to its change. In other words, are governments primarily concerned about the GDP level being above or below potential or about high or low economic growth rates. Rerunning the estimation with the change in the output gap instead of its level (Table 2, column 5), outcomes again indicate a countercyclical fiscal policy but when distinguishing again between positive and negative values (column 6) no differences in responses can be detected.

Next, considering that output gap calculations are highly uncertain and vary across organisations, the estimates as in columns 2-4 were re-run using IMF's output gap measures. The outcomes are very similar to those using the OECD gap estimates. Illustrating this, column 7 includes the results differentiating between positive and negative output gaps based on IMF's gap calculations. These again indicate that governments do not respond to positive output gaps but take a countercyclical approach when output falls below potential GDP, though statistical test results again call for some caution in drawing strong conclusions.

Table 2. Estimates focussing on government debt and output gap measures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Debt/gap measure	Basis	Cubic debt	Debt * Shadow rate	Pos/neg output gap	Δ Output gap	Δ Pos/neg gap	IMF Pos/neg gap
Sbal $_{-1}$	0.634*** (9.14)	0.641*** (9.17)	0.605*** (8.53)	0.661*** (9.40)	0.644*** (9.03)	0.645*** (8.94)	0.660*** (9.03)
Shadow rate$_{-1}$	-0.505*** (-2.67)	-0.553*** (-2.90)	-0.611*** (-3.10)	-0.431** (-2.20)	-0.311* (-1.85)	-0.336* (-1.77)	-0.396** (-2.14)
Shadow rate$_{-1}$ * GFC$_{-1}$	-0.004 (-0.02)	-0.006 (-0.03)	-0.027 (-0.14)	-0.085 (-0.51)	-0.100 (0.51)	-0.067 (-0.33)	-0.041 (-0.22)
Shadow rate$_{-1}$ * QE$_{-1}$	0.848*** (3.42)	0.916*** (3.41)	0.762*** (3.08)	0.825*** (3.38)	0.558*** (2.61)	0.585** (2.44)	0.828*** (3.24)
Debt$_{-1}$	0.067** (1.99)	0.238* (1.96)	0.033 (0.77)	0.058* (1.73)	0.042 (1.31)	0.042 (1.31)	0.028 (0.88)
Debt$^2_{-1}$	-0.0003 (-1.56)	-0.0026* (-1.77)	-0.0001 (-0.35)	-0.0003 (-1.44)	-0.0003 (-1.25)	-0.0003 (-1.24)	-0.0002 (-0.86)
Debt$^3_{-1}$		0.00001* (1.65)					
Debt$_{-1}$ * Shadow rate$_{-1}$			0.0023* (1.69)				
Output gap$_{-1}$	0.176** (2.16)	0.217** (2.39)	0.160* (1.95)				
Output gap pos$_{-1}$				-0.080 (-0.39)			-0.265 (-1.34)
Output gap neg$_{-1}$				0.300*** (2.82)			0.312*** (2.90)
Δ Output gap$_{-1}$					0.119** (2.00)		
Δ Output gap pos$_{-1}$						0.155 (0.81)	
Δ Output gap neg$_{-1}$						0.085 (1.06	
Long-term interest rate$_{-1}$	0.401** (2.71)	0.379*** (2.71)	0.334** (2.25)	0.489*** (3.06)	0.326** (2.35)	0.341** (2.07	0.566*** (3.19)
Fiscal rule	0.414 (1.62)	0.235 (0.86)	0.416 (1.63)	0.415* (1.73)	0.442* (1.74)	0.444* (1.75)	0.556** (2.22)
Inflation$_{-1}$	0.074 (0.69)	0.090 (0.86)	0.096 (0.89)	0.083 (0.75)	0.106 (1.11)	0.122 (1.24)	0.105 (1.00)
Election year	-0.328** (-2.02)	-0.335** (-2.07)	-0.315** (-1.98)	-0.333** (-2.09)	-0.351** (-2.23)	-0.339** (-2.13)	-0.310* (-1.96)
Current account$_{-1}$	0.083* (1.90)	0.079* (1.87)	0.088** (1.98)	0.085* (1.92)	0.087* (1.91)	0.085* (1.74)	0.090** (2.07
GFC$_{-1}$	0.171 (0.42)	0.121 (0.32)	0.188 (0.49)	-0.044 (-0.10)	0.501 (1.24)	0.410 (1.01)	-0.274 (-0.64)
QE$_{-1}$	1.815*** (2.67)	1.847** (2.43)	1.739*** (2.62)	1.969*** (3.02)	1.520** (2.43)	1.530** (2.28)	2.169*** (3.19)
R^2	0.75	0.75	0.75	0.75	0.75	0.75	0.76
# of observations	200	200	200	200	200	200	200

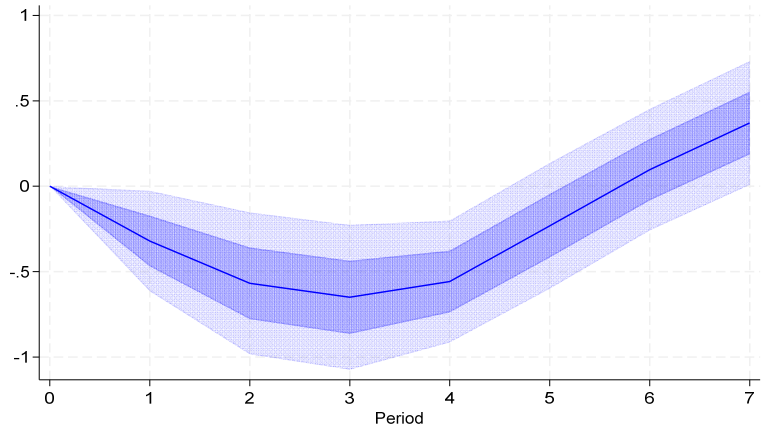
Standard errors in brackets. ***, **, * denote statistical significance at the 1, 5 and 10% level respectively.

Overall, therefore, the results hint at countercyclical fiscal responses to lacklustre economic conditions, and a neutral, a-cyclical response to positive economic developments.

Finally, while the focus so far has been on the initial response of fiscal policies to monetary policy, i.e. the response to the monetary policy stance of the previous year, the budgetary reactions to monetary policy further down the road are also investigated. To that end, local projections have been prepared (Jordà, 2005), representing a useful alternative to VARs to estimate impulse responses.[21] The local projections show the dynamic effect of an intervention on an outcome, in this case the effect of a one-off shock to the shadow rate on the structural budget balance.[22] The estimation equation used is identical to the one underlying column 2 in Table 1, with no restrictions imposed.

The outcomes (Chart 3) show that the substitutive role of fiscal policy in year 1 doubles in year 3. After that, the structural balance gradually turns to neutral in the medium term and a somewhat complementary stance beyond that.

Chart 3. Structural balance response to a policy rate shock
(% of GDP)



Note: light purple area indicates the 95% interval, the dark-purple area the 68% interval.

[21] Local projections were estimated using STATA's locproj (Ugarte-Ruiz, 2023).
[22] Focussing on the 'normal' reaction function, interactions of the shadow rate with the period dummies (GFC and QE) have been ignored in these projections.

5. Conclusion

Analysing the reaction of fiscal policy to the monetary policy stance contributes to a deeper understanding of the transmission of monetary policy. This paper is one of the first to empirically examine the short-term fiscal response to the monetary policy stance since the ECB introduced non-interest rate monetary policy measures. Other factors of interest to monetary policy, being government debt sustainability and countercyclicality of the fiscal stance, were also considered.

The findings suggest a substitution effect between the two types of policy until the start of QE: tight monetary policy – approximated by shadow interest rates - induces loose fiscal policy, and loose monetary policy is met by a tight fiscal policy. The effect is material, with a 1 percent-point monetary tightening inducing a fiscal loosening of around 0.5% of GDP. Such fiscal response may reflect efforts by governments to mitigate the impact of monetary policy on economic growth. The paper finds some evidence of ECB's QE introducing a complementary effect that counters the substitutive effect, with fiscal policy overall turning broadly indifferent to the monetary policy stance. Extending the horizon of the fiscal response to the medium term, the short-term substitutive effect initially increases but then reverses over the medium term.

Additionally, the findings hint at fiscal policymakers reacting to mounting government debt, which is relevant for the conditions under which central banks operate. Specifically, elevated debt levels appear to prompt governments to seek high primary surpluses to maintain long-term fiscal sustainability, abating concerns about fiscal dominance. As to the cyclical properties of fiscal policy, results suggest that governments react countercyclically to negative output gaps but do not respond to positive gaps, with further analysis needed here to draw definitive conclusions. Other common findings across the estimates include that fiscal policymakers respond to market forces (reducing fiscal imbalances if long-term rates are high), expand budgets during election years, and fiscal balances move in tandem with current account balances.

Alternative specifications point to broadly similar conclusions, but some caution is warranted given measurement issues around the shadow rate, notably about deriving interest-rate equivalents for non-standard monetary policy measures, and the validity of few instrumental variables.

Future research may help underpinning these initial results, for instance by analysing the stability of coefficients and including the pandemic experience. Additionally, further

investigation into the channels through which governments respond to monetary policy could be undertaken as the presented results indicate the direction of fiscal responses to monetary policy but not the underlying mechanism.

Annex 1: Sources and data

Sources of the data used in this paper are listed in the below table.

Data sources

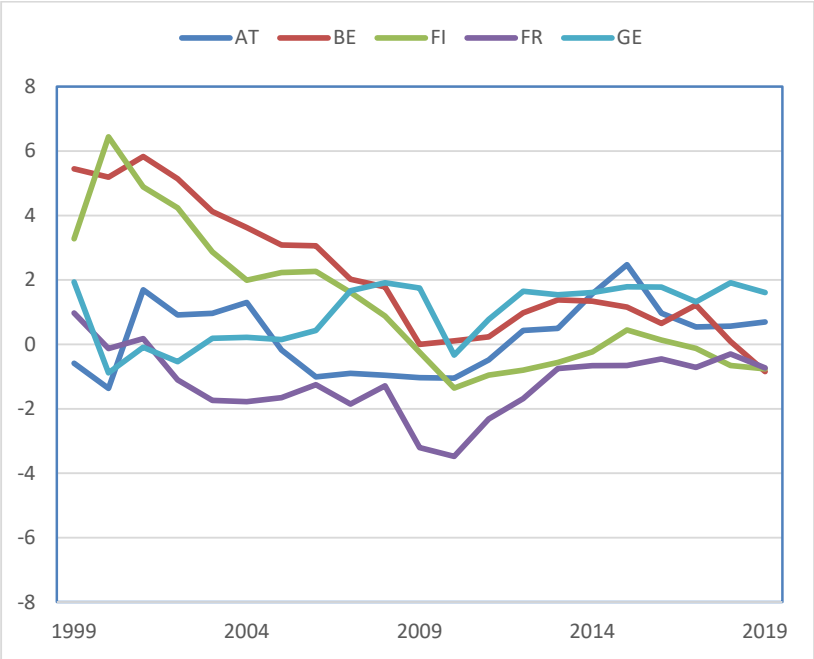
Variable	Source
Wu-Xia shadow rate	Website Jing Cynthia Wu, data taken January 2023. https://sites.google.com/view/jingcynthiawu/shadow-rates
Krippner shadow rate	Website Krippner, data taken data taken January 2023. https://www.ljkmfa.com/
Lemke-Vladu shadow rate	Lemke and Vladu (2017). Updated series obtained from the authors
EONIA	ECB
Government debt (% of GDP)	OECD Economic Outlook 122 (November 2022)
Government structural balance (% of potential GDP)	OECD Economic Outlook 122 (November 2022)
Inflation rate	OECD Economic Outlook 122 (November 2022)
Euro area inflation projection	Eurosystem Summer projections for year t+2
Output gap (% of potential GDP)	OECD Economic Outlook 122 (November 2022)
Long-term interest rates	OECD Economic Outlook 122 (November 2022)
US long-term interest rate	AMECO database
Fiscal rule index	European Commission (3 March 2021) https://ec.europa.eu/info/publications/fiscal-rules-database_en
Current account balance (% of GDP)	OECD Economic Outlook 122 (November 2022)
Global Financial Crisis (GFC)	Dummy with value 1 between 2008 and 2012
Quantitative Easing (QE)	Dummy with value 1 as of 2015
National election dates	IDEA (http://www.idea.int/)
Stock markets	OECD Monthly Monetary and Financial Statistics
VIX	Haver
PSPP stock of government debt	ECB

Euro area countries included in the analysis are Austria (AT), Belgium (BE), Finland (FI), France (FR), Germany (GE), Ireland (IE), Italy (IT), the Netherlands (NL), Portugal (PT), and Spain (SP).

Main statistics, 1999-2019

Variable	Number of observations	Average	Standard deviation	Minimum	Maximum
Structural balance	210	0.22	2.24	-7.58	6.06
Output gap	210	-0.11	2.72	-8.81	7.97
Government debt	210	77.19	27.35	23.86	135.37
Shadow rate Wu-Xia	21	0.22	3.34	-6.96	4.75
Shadow rate Krippner	21	0.82	2.37	-3.01	4.39
Shadow rate Lemke/Vladu	21	1.42	1.88	-1.36	4.39
Shadow rate Wu-Xia * government debt	210	-17.06	275.71	-933.17	520.52
EONIA	21	1.66	1.71	-0.41	4.64
Long-term interest rate	210	3.38	1.85	-0.25	10.55
US long-term interest rate	21	3.54	1.25	1.80	6.03
Inflation rate	210	1.79	1.18	-1.69	5.28
Current account	210	0.69	4.70	-19.90	10.20
Fiscal rule	210	0.37	0.90	-1.02	2.76
VIX	21	19.74	6.12	11.10	32.66
Stock market (% change)	210	3.60	19.56	-44.70	91.00
Projected euro area inflation rate	21	1.75	0.47	1.37	3.46
PSPP stock of government debt	21	384.20	759.01	0.00	2198.10

Structural budget balances, 1999-2019
(% of potential GDP)



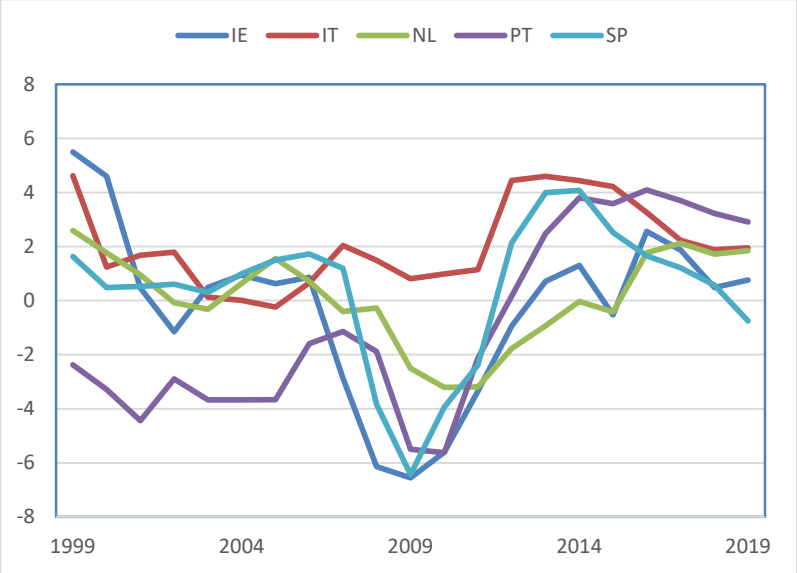


Table correlation coefficients

	Sbal $_{-1}$	Shad. rate$_{-1}^{1}$	Shad. rate$_{-1}^{1}$ *GFC	Shad. rate$_{-1}^{1}$ * QE	Debt$_{-1}$	Debt$^{2}_{-1}$	Y gap$_{-1}$	L-t rate$_{-1}$	Fisc. rule	Infl.$_{-1}$	Elec-tion	CA$_{-1}$	GFC$_{-1}$	QE$_{-1}$
Sbal $_{-1}$	1.00													
Shadow rate$_{-1}^{1}$	0.02	1.00												
Shadow rate$_{-1}^{1}$ * GFC$_{-1}$	-0.20	0.23	1.00											
Shadow rate$_{-1}^{1}$ * QE$_{-1}$	-0.09	0.85	0.11	1.00										
Debt$_{-1}$	0.18	-0.40	-0.10	-0.23	1.00									
Debt$^{2}_{-1}$	0.23	-0.38	-0.10	-0.22	0.99	1.00								
Y- gap$_{-1}$	0.14	0.42	0.20	0.03	-0.50	-0.46	1.00							
L-t rate$_{-1}$	-0.06	0.74	0.12	0.67	-0.06	-0.01	0.08	1.00						
Fisc. rule	0.17	-0.74	-0.15	-0.61	0.36	0.36	-0.39	-0.61	1.00					
Infl.$_{-1}$	0.03	0.44	0.27	0.28	-0.30	-0.27	0.49	0.37	-0.36	1.00				
Election	-0.02	-0.07	-0.04	-0.10	0.01	0.00	0.06	-0.07	0.07	-0.02	1.00			
CA$_{-1}$	0.46	-0.20	-0.12	-0.17	0.00	-0.01	-0.09	-0.31	0.37	-0.24	0.00	1.00		
GFC$_{-1}$	-0.43	0.02	0.43	0.26	0.10	0.07	-0.28	0.22	-0.15	0.11	-0.03	-0.11	1.00	
QE$_{-1}$	0.10	-0.84	-0.12	-0.95	0.26	0.25	-0.08	-0.71	0.63	-0.36	0.08	0.17	-0.27	1.00

Note: calculations cover the 1999-2019 period.

Annex 2. Additional estimation results

Table A1. Test results underlying estimates in Table 1

	(1)	(2)	(3)	(4)	(5)
Stance measure	Shadow rate	Shadow-rate * GFC & QE	Shadow rate Krippner	Shadow rate Lemke & Vladu	EONIA & PSPP
F-test shadow rate	11930.88	1679.57	2505.93	739.35	462.64
F-test shadow rate * GFC		113.00	72.31	558.27	104.47
F-test shadow rate*QE		8719.52	5.94	4.28	18.78
F-test output gap	27.54	24.53	24.42	25.85	20.83
F-test long-term rate	10.28	19.79	24.86	26.18	23.38
Hansen J test	12.22	12.41	14.87	11.54	9.975
Hansen p value	0.142	0.134	0.062	0.173	0.270
Kleinbergen-Paap rk LM statistic	29.49	23.04	28.90	21.57	33.91
KP p value	0.000	0.006	0.001	0.010	0.000

Table A2. Test results underlying estimates in Table 2

	(2)	(3)	(4)	(5)	(6)	(7)
New debt/gap element in the estimation	Debt^3	Debt * shadow rate	Output gap pos/neg	Δ Output gap	Δ Output gap pos/neg	IMF Output gap pos/neg
F-test shadow rate	1642.52	1460.91	1605.46	1942.75	1851.58	1676.46
F-test shadow rate * GFC	114.28	104.27	93.69	155.99	144.66	116.97
F-test shadow rate * QE	8188.23	9167.46	9504.85	10147.86	9373.55	8890.74
F-test output gap	21.36	22.33				
F-test debt * shadow rate		256.80				
F-test output gap positive			5.41			12.57
F-test output gap negative			42.14			25.64
F-test Δoutput gap				10.64		
F-test Δoutput gap pos					3.48	
F-test Δoutput gap neg					10.49	
F-test long-term rate	16.18	18.87	19.63	20.26	19.17	17.55
Hansen J-test	12.64	12.53	10.44	7.97	8.70	10.51
Hansen p value	0.180	0.129	0.236	0.436	0.368	0.231
Kleinbergen-Paap rk LM statistic	28.29	23.83	19.68	34.46	22.28	26.83
KP p value	0.002	0.005	0.020	0.000	0.008	0.002

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