The Euro Area Government Spending Multiplier in Demand- and Supply-Driven Recessions*

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Abstract

We estimate government spending multipliers in demand- and supply-driven recessions for the Euro Area. Multipliers in a moderately demand-driven recession are 2-3 times larger than in a moderately supply-driven recession, with the difference between multipliers being non-zero with very high probability. More generally, multipliers are inversely correlated with the deviation of inflation from its trend, implying that the more demand-driven a recession, the higher the multiplier. Multipliers range from -0.5 in supply-driven recessions to about 2 in demand-driven recessions. The econometric approach leverages a factor-augmented interacted vector-autoregression model purified of expectations (FAIPVAR-X). The model captures the time-varying state of the business-cycle including strongly and moderately demand- and supply-driven recessions, by taking the whole distribution of inflation deviations from trend into account.

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1. INTRODUCTION

The world economy has recently undergone a major recession due to the COVID-19 pandemic and related containment measures, which triggered a combination of adverse supply and demand shocks. Policymakers across the globe have responded to these events with aggressive fiscal stimulus to address the shortfall in aggregate demand. However, if important drivers of the recession are aggregate supply constraints, a natural question presents itself: to what extent do the effects of fiscal stimulus packages depend on whether a recession is demand- or supply-driven?

This question is at the center stage of the current policy and scientific debate. Fiscal policymakers aim at designing effective stimulus packages that maximize the impact on economic activity. Monetary policymakers need to predict the effects of fiscal stimulus packages to gauge the implications for price stability and to tune the monetary policy stance.

When it comes to the output multiplier effects of such spending increases, recent theoretical studies assign a pivotal role to the making of a recession, that is, whether it is demand- or supply-driven. These contributions predict low inflation and larger multipliers in a demand-driven recession and the reverse in a supply-driven recession. For example, Jo and Zubairy (2022) develop a mechanism whereby, in a demand-driven recession, inflation declines, but a downward nominal wage rigidity prevents real wages from falling, generating involuntary unemployment. Alternatively, Ghassibe and Zanetti (2022) design a mechanism whereby, in a demand-driven recession, idle production is relatively large and unsatisfied private demand is relatively low. Both mechanisms provide scope for effective aggregate demand stimulus via government spending during demand-driven recessions.

Empirically, these studies provide time series and cross-sectional evidence for the United States, exploiting precisely the relationship between inflation and the nature of a recession, and confirming their models' theoretical predictions. In low-inflation (demand-driven) recessions the government spending multiplier is larger than in high-inflation (supply-driven) recessions. While there is hardly any such evidence for the Euro Area (EA), even before the Covid-19 pandemic, the region has experienced fiscal stimuli during recessions with different inflation behavior, making it an appropriate laboratory to test these theories empirically beyond the U.S. context.

Two recent examples of aggressive fiscal stabilization policy in the EA are the European Economic Recovery Plan (EERP) and the NextGenerationEU (NGEU). Both initiatives include significant stimulus packages (Trabandt et al., 2010; Debrun et al., 2021). The EERP was a response to the global financial crisis (GFC), while the NGEU is the current response to the Covid-19 recession. However, there is consensus that the making of the GFC differs from the Covid-19 recession—with Covid-19 triggering many more supply shocks—and that the EERP, the NGEU, and other packages were adopted during recessions of different macroeconomic nature.

Simply inspecting inflation data supports the view that these two EA recessions differed from one another. Figure 1 reports the histograms and estimated densities of inflation deviations from trend of ten individual EA countries. While during the GFC (Panel 1a) inflation deviations are negatively skewed, during the Covid-19 recession their skewness is positive (Panel 1b).[1] This confirms that the GFC was a predominantly demand-driven recession, whereas the Covid-19 recession can be classified as mainly supply-driven.

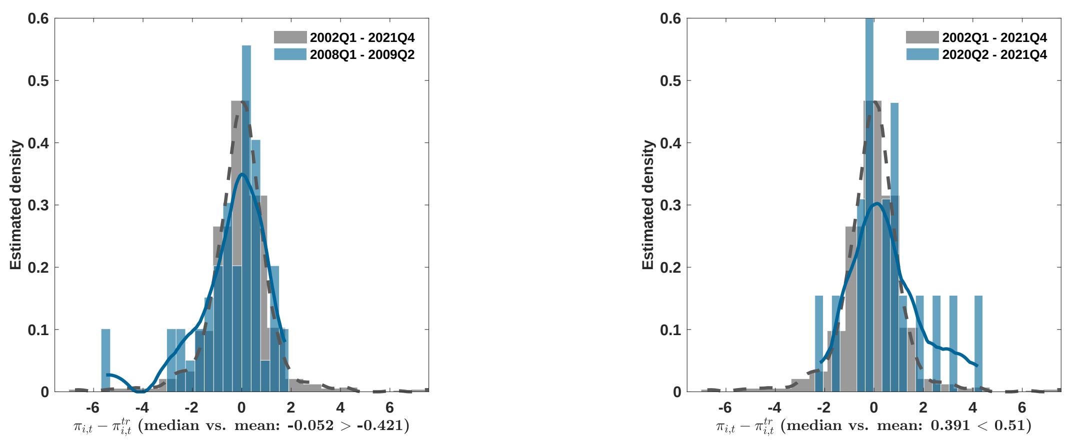
Against this background, this paper quantifies the effects of government spending shocks in demand- and supply-driven recessions in the EA, with time series information on ten founding members. We estimate the effects of government spending shocks with a factor-augmented interacted panel VAR purified of expectations (FAIPVAR-X, building on Towbin and Weber, 2013; Sá et al., 2014; Amendola et al., 2020; Di Serio et al., 2020), using two interaction terms: the OECD recession indicator of each EA country in our sample and their inflation deviations from trend.

[1] During the GFC (2008Q1 - 2009Q2) the mean inflation deviation (-0.421) is well below the median (-0.052) deviation, which indicates a negative skewness. Contrary, for the Covid-19 recession (2020Q2 - 2021Q4), comparing mean to median deviations reveals a positive skewness: 0.51 vs. 0.391.

Figure 1: Histograms and Estimated Densities of Inflation Deviations for 10 EA Countries

(a) Global financial crisis (2008Q1 to 2009Q2)

(b) Covid-19 recession (2020Q2 to 2021Q4)



Notes: Inflation is in deviation from trend (estimated using the Hamilton (2018) filter) for each country i, $\pi_{\mathrm{i,t}} - \pi_{\mathrm{i,t}}^{\mathrm{tr}}$. The countries are Austria, Belgium, Finland, France, Germany, Ireland, Italy, Netherlands, Portugal and Spain. The source is the Eurostat database available on the Thomson Reuters Datastream Economics database. Inflation is computed as the year-over-year change of the implicit price deflator. Gray indicates the 800 observations during the period 2002Q1 to 2021Q4. Blue indicates the respective subsample. The global financial crisis subsample (52 obs.) is based on the OECD based Recession Indicators for EA from the Period following the Peak through the Trough, while the Covid-19 recession subsample (19 obs.) is chosen by the authors. Note that for both subsamples an inflation deviation of country i is only used for the histogram and density estimate if country i is in a recession according to the country-specific indicator during this period.

Our main finding is that government spending multipliers in a low-inflation recession (demand-driven) are larger than the ones in a high-inflation recession (supply-driven). Even in a moderately demand-driven recession, the multiplier is about 2-3 times larger than in a moderately supply-driven recession, and the difference between the two multipliers is greater than zero with very high probability. A second important finding is that the multiplier is inversely correlated with the deviation of inflation from its trend. Thus, the multiplier is higher the more demand-driven a recession is. Third, we estimate median government spending multipliers ranging from -0.5 in supply-driven recessions to around 2 in demand-driven recessions. All told, our findings for the EA support those recent theories that predict a pivotal role for the making of a recession (demand- or supply-driven) in shaping the effects of government spending shocks.

It is worth emphasizing that we obtain these results in an empirical framework that is particularly suited for estimating state-dependent effects. The key advantage of our framework is that we can condition the government spending multiplier on each percentile of the entire distribution of inflation deviations from trend. This aspect is important because recessions can hardly be classified exclusively as demand- *or* supply-driven, but rather on a continuum of states.[2]

The bottom line of our results is robust to a number of alternative specifications and identification schemes. We reaffirm our baseline findings by substituting the OECD recession indicator with an unemployment metric in line with recent studies. This is important because it shows that our results do not depend on a particular definition of the business cycle. Further, our results remain consistent when employing alternative detrending techniques, as well as lag and factor structures. We also consider the literature's focus on the efficacy of fiscal policy at the effective lower bound (ELB) of interest rates by incorporating an additional interaction term as a dummy variable for periods when the ELB is binding. Moreover, we substitute the cyclical inflation deviation with country-specific demand and supply shocks following the approach of Blanchard and Quah (1989). In addition, we augment the specification with a net export measure to capture potentially important cross-country spillovers in the context of a monetary union. Finally, we validate our approach against the local projection method (Jordà, 2005), using a specification similar to that adopted by Ghassibe and Zanetti (2022).

While our paper is related to an important strand of the literature that examines state-dependence of the effects of fiscal policy, it is novel at least along four dimensions. First, most of this literature focuses on whether fiscal policy is more effective in recessions and when the ELB is binding (see, e.g., Auerbach and Gorodnichenko, 2012; Ramey and Zubairy, 2018; Miyamoto et al., 2018; Di Serio et al., 2020; Amendola et al., 2020). We focus, instead, on

[2]Even if one were to estimate a DSGE model similar to Jo and Zubairy's (2022) model, the historical decomposition of output and inflation based on the estimated shocks would most likely assign time-varying importance to demand and supply shocks rather than explaining the data exclusively by one shock at a time.

the nature of recessions, that is, whether these are supply- or demand-driven.

Second, while some previous studies already focused on this issue, they were conducted using U.S. data (as for instance in Ghassibe and Zanetti, 2022; Jo and Zubairy, 2022). In other words, the literature lacks empirical estimates of the government spending multiplier in demand- versus supply-driven recessions for the EA and we fill in this gap. This aspect is important as it allows to check whether previous findings are valid only for the U.S. economy or can be extended more generally. Previous studies on the EA focused on other sources of asymmetries for the multipliers, such as the ELB (Amendola et al., 2020), the interest-growth differential (Di Serio et al., 2021), and fiscal expansions versus contractions (Born et al., 2023).

Third, the empirical framework allows us to condition the government spending multiplier on each percentile of the entire distribution of inflation deviations from trend. In other words, this approach does not require splitting the sample to distinguish between a small number of states or to impose thresholds (as for instance in Ghassibe and Zanetti, 2022; Jo and Zubairy, 2022). This is especially important for rather small samples, as in the case of EA data, as it allows using all available observations to obtain each multiplier estimate.

Fourth, another advantage, relative to threshold approaches, is that our methodology captures the effects of both small and large deviations of inflation from trend, allowing us to establish an inverse correlation between the deviations of inflation from trend and the size of fiscal multipliers. In other words, the more demand-driven a recession is, the larger the multiplier. As previously discussed, this aspect is important because recessions are better classified on a continuum rather than strictly supply- or demand-driven.[3]

The remainder of the paper proceeds as follows. Section 2 outlines the FAIPVAR-X model, our baseline specification and data, our inference and identification approach, and

[3]We discuss further important advantages of applying the Interacted Vector Autoregressive (IVAR) methodology and its generalizations in quantifying state-dependent policy effects in the methodological section of the paper and in Amendola et al. (2020) and Di Serio et al. (2020).

how we calculate the multipliers. Section 3 discusses the main results. Section 4 addresses robustness concerns. Section 5 discusses the relation between the main results and the theoretical literature. Finally, Section 6 concludes.

2. METHODOLOGY

2.1. Empirical model

The empirical strategy builds on the Interacted Panel Vector Autoregression (IPVAR) approach developed by Towbin and Weber (2013) and Sá et al. (2014) to estimate a Factor-Augmented IPVAR model purified of expectations (FAIPVAR-X), which extends the model of Di Serio et al. (2020). The recursive form is given by

$$B_t Y_{i,t} = \kappa_i + \sum_{k=1}^{L} \Gamma_k Y_{i,t-k} + \upsilon Z_{i,t|t-1:t-4} + \sum_{m=1}^{N} \kappa_m^1 X_{i,t,m} + \sum_{k=1}^{L} \sum_{m=1}^{N} \Gamma_{k,m}^1 X_{i,t,m} Y_{i,t-k} + \varepsilon_{i,t}, \quad (1)$$

where $t = 1, \ldots, T$ denotes time, $i = 1, \ldots, I$ denotes countries, $k = 1, \ldots, L$ denotes the lag structure and $m = 1, \ldots, N$ denotes the number of interaction terms. $Y_{i,t}$ is a $q \times 1$ vector containing explanatory variables, κ_i are country fixed effects, Γ_k is a $q \times q$ matrix of autoregressive coefficients, and $\varepsilon_{i,t} \sim \mathrm{N}(0, \Sigma)$ is the vector of residuals. $Z_{i,t|t-1:t-4}$ is an exogenous variable accounting for fiscal foresight (discussed below). Moreover, $X_{i,t,m}$ is a $m \times q$ matrix, which denotes the interaction terms. These interaction terms can influence both the dynamic relationship between endogenous variables and their level, through $\Gamma_{k,m}^1$ and κ_m^1, respectively. The vector $X_{i,t}$, in our case, is composed of two state variables, one indicating different states of the business cycle, with the other indicating the time-varying nature of the shocks (supply and demand) driving the business cycle that could affect the transmission of shocks. Differently from other studies (in single-country VARs) with stochastic time-varying coefficients (see, e.g., Primiceri, 2005), time variation is a function of structural determinants in this model. The matrix B_t is a $q \times q$ lower triangular matrix with ones on the main diagonal. Each component $B_t(w, q)$ represents the contemporaneous effect of the q*th*-ordered variable on the w*th*-ordered variable. It is constructed as follows:

$$B_t = \begin{cases} B_t(w,q) = 0 & \text{for} \quad q > w \\ B_t(w,q) = 1 & \text{for} \quad q = w \\ B_t(w,q) = B(w,q) + \sum_{m=1}^{N} B_m^1(w,q) X_{i,t,m} & \text{for} \quad q < w \end{cases}$$

where $B_m^1(w,q)$ are regression coefficients capturing the relation with the contemporaneous marginal effects of a change in the interaction terms. The recursive form of matrix B_t implies that the covariance matrix of the residuals, Σ, is diagonal (for more details on the interacted VAR framework see, for example, Sá et al., 2014).

2.2. Baseline specification

We estimate the model using quarterly data covering the period from 2002Q1 to 2019Q4.[4] We consider ten of the eleven countries that joined the EA when it came into existence: Austria, Belgium, Finland, France, Germany, Ireland, Italy, Netherlands, Portugal and Spain.[5] In our baseline specification (1) the vector of endogenous variables,

$$Y_{i,t}^{'} = [\mathrm{G}_{i,t}, \mathrm{GDP}_{i,t}, \mathrm{T}_{i,t}, \mathrm{SR}_t, \mathrm{F}_t],$$

includes mostly variables that are commonly used in the literature (dating back to, Blanchard and Perotti, 2002). $\mathrm{G}_{i,t}$, $\mathrm{GDP}_{i,t}$, $\mathrm{T}_{i,t}$ represent real government purchases (the sum of government gross fixed capital formation and government consumption), real gross domestic product and real net taxes (the sum of government receipts of direct and indirect taxes minus transfers to businesses and individuals), respectively. These variables are considered in levels

[4]The beginning of our sample is dictated by the availability of the Economist Intelligence Unit forecasts of government spending, the use of which is explained below. Based on the considerations in Lenza and Primiceri (2022), we choose to end the sample before the Covid-19 pandemic.

[5]In line with Auerbach and Gorodnichenko (2013b), we exclude Luxembourg being a small economy, which exhibits large and volatile changes in government spending series.

and are normalized with an estimate of real potential GDP.[6]

We also include the European Central Bank's shadow monetary policy rate developed by Wu and Xia (2016), denoted by SR_t. This allows us to take the endogenous response of monetary policy in the Eurozone into account. Since this rate is available from 2004Q3 onward, for the very beginning of the sample, we complement it with the Main Refinancing Operations (MRO) rate, given that the two, until 2008, are virtually indistinguishable.

Next, we augment $Y_{i,t}$ with the 5×1 vector F_t, which captures the first five principal components of an informational dataset.[7] In doing so, we address two kinds of model specification concerns. First, the choice of variables in $Y_{i,t}$ is to some extent discretionary. Second, given the considerations and results in Fragetta and Gasteiger (2014), an IPVAR model is potentially affected by a generic limited information problem. By augmenting $Y_{i,t}$ with F_t, both of these concerns can be addressed (see Di Serio et al., 2020, for further details).

Moreover, $Z_{t|t-1:t-4}$ in equation (1) represents the forecast of time-t government spending over the past 12 months (four quarters), published by the Economist Intelligence Unit. This way we address fiscal foresight, which is a *specific* limited information problem. The private sector may anticipate changes in government spending in response to fiscal announcements and change its behavior even before the policy change is implemented. Thus, by adding $Z_{t|t-1:t-4}$ to our model, we account for this limited information problem (for a detailed discussion of fiscal foresight see Leeper et al., 2013).

Finally, we use the OECD-based recession indicators for each EA country in our sample and cyclical inflation based on their GDP deflator (i.e., deviations of inflation from trend).[8]

[6] We normalize $\mathrm{G}_{i,t}$, $\mathrm{GDP}_{i,t}$ and $\mathrm{T}_{i,t}$ to avoid biases in the government spending multiplier calculation as discussed in detail below.

[7] We implement Bernanke et al.'s (2005) two-step estimation procedure. Our informational dataset comprises 230 publicly available time series from the Eurostat Database. The series included in the informational dataset are listed in Appendix B and comprise country-specific statistics regarding national accounts, government, output and income, employment and hours, stock prices, exchange rates, money and credit quantity aggregates, and interest rates. We transform the variables to guarantee stationarity according to the Phillips and Perron (1988) and Kwiatkowski et al. (1992) tests. To select the number of static factors to extract, we use the Bai and Ng (2007) IC_{p2} criterion.

[8] Trend inflation is estimated with the Hamilton (2018) filter.

As described in Section 1, we investigate the effects of a government spending shock when EA economies are in a recession and inflation is below (demand-driven recession) or above its trend (supply-driven recession). Figure 6 in Appendix B reports inflation deviations from trend and the number of countries in recession in each quarter. Clearly, our sample features demand- and supply-driven recession observations for most recessionary quarters. Half or more countries are in a recessionary state during the Early 2000s recession, Global Financial Crisis, Sovereign Debt Crisis, and, toward the end of the sample.

To this end, the interaction matrix, $X_{i,t,m}$, includes two distinct country-specific indicators. The first are OECD recession indicators, which are binary variables that assume a value of 1 if a country is experiencing a recession, and 0 otherwise. The second are inflation deviations from trend, that is, continuous variables, which vary per country and period, and measure the extent to which recessions may be supply- or demand-driven. Positive values suggest the former, while negative values indicate the latter. After obtaining the recursive-form parameters from the posterior distribution, these are evaluated at predetermined values of the interaction terms. This approach renders a portion of the regression coefficients as functions of the OECD recession indicators and inflation deviations from trend.[9] For estimating government spending multipliers during a demand-driven recession, the OECD recession indicators are set to 1, and the inflation deviations from trend are set to the 26th percentile of its distribution. Alternatively, in a supply-driven recession scenario, the inflation deviations from trend are set to the 76th percentile of its distribution, with the OECD recession indicators also equaling 1. These specific percentiles represent the median of observations for inflation deviations from trend, both above and below zero. Additionally, the government spending multipliers are estimated considering all the ventiles, expanding the understanding of how different degrees of inflation deviation from trend might affect the estimation.

In fact, a recession is almost never completely demand- or supply-driven, while demand or

[9] Differently from other studies (single-country VARs) with stochastic time-varying coefficients (see, e.g., Primiceri, 2005), in this model time variation is a function of vector $X_{i,t}$ (as, e.g., in Sá et al., 2014).

supply shocks may be more or less dominant, driving the sign and the magnitude of inflation fluctuations. Thanks to the FAIPVAR model, we can condition on a wide range of percentiles of the cyclical inflation distribution and therefore consider strongly and moderately demand- and supply-driven recession. We use the first lag of the interaction variables to address potential endogeneity concerns.

Given that the model requires the estimation of a large number of parameters, for the sake of parsimony, we produce the baseline results with a uniform lag structure of one quarter ($L = 1$). We re-run the estimation also with four lags (Section 4) and two lags (Appendix A) for robustness.

2.3. Inference and identification

As in Sá et al. (2014), to capture parameter uncertainty, we use Bayesian estimation by setting an uninformative normal-Wishart prior. We start with the estimation of the structural recursive model described in equation (1). Since the covariance matrix Σ is diagonal by construction, we can proceed by estimating the model equation by equation. We draw the recursive-form parameters from the posterior.[10] We evaluate them at pre-specified values of the interaction terms and compute reduced form parameters by inverting matrix B_t.

Given the reduced form, we use a Cholesky identification strategy to identify an unexpected government spending shock. The strategy follows Blanchard and Perotti (2002): the government spending shock is identified by ordering government spending as the first variable. Thus, we assume that government spending does not respond contemporaneously to any of the other variables in the model due to implementation and legislation lags.

We make 20.000 draws from the posterior distribution and, after discarding the first 10.000 parameter draws as burn-in draws, we use the median over the last 10.000 draws as our central estimate of interest. We account for parameter uncertainty by saving the $5th$

[10] As in Sá et al. (2014) and Cogley and Sargent (2005), we avoid the possibility to have explosive IRFs by discarding the explosive draws from the unrestricted posterior.

and 95th percentile of the impulse response function (IRF) distribution as confidence bands.

Numerous contributions have proposed alternative methods for identifying fiscal shocks. Early literature focused on instances of significant reductions in the cyclically adjusted budget deficit (Giavazzi and Pagano, 1990; Alesina and Ardagna, 1998). However, this approach has its limitations, as even cyclically adjusted fiscal balances can still encompass other tax and spending changes influenced by the economy's state (Perotti, 2012). In the case of taxes, Romer and Romer (2010) introduced the narrative approach as an alternative, identifying exogenous fiscal adjustments by examining the motivations behind US legislative decisions. Alesina et al. (2019) expanded on the narrative approach, using the dataset from Devries et al. (2011) to analyze expenditure and tax-based fiscal retrenchments. Ben Zeev and Pappa (2017) investigated the effects of anticipated spending shocks by identifying news shocks related to US defense spending. The use of defense spending is dictated by the fact that the authors rely on the methodology of Barsky and Sims (2011), which requires an exogenous spending series. Their findings revealed that these shocks account for a larger portion of macroeconomic fluctuations than the news shocks identified by Ramey (2011). Our paper focuses on unanticipated government spending shocks and employs the Blanchard and Perotti (2002) identification approach. We believe this method, supplemented by the aforementioned safeguards addressing limited information and fiscal foresight issues, is the most suitable approach within the IPVAR context.

2.4. Multipliers

As mentioned above, we estimate the model after dividing all endogenous variables (with the exception of the shadow rate and factors) by real potential GDP of the corresponding country.[11] This data transformation ensures that our estimates for the government spending multiplier are not biased by an *ex-post* conversion procedure.[12]

[11]We compute real potential GDP using the Hamilton (2018) filter.

[12]Ramey and Zubairy (2018) show that the usual approach of using log levels requires an *ex-post* conversion to currency equivalents of the estimated elasticities that can produce serious bias. The problem is even more

Multipliers can then be computed directly as the ratio of discrete approximations of the integral of the median IRFs of real output and government purchases over a given time horizon $h = 1, \ldots, H$:

$$\mathcal{M}_H = \frac{\sum_{h=0}^{H} dGDP_h}{\sum_{h=0}^{H} dG_h}, \tag{2}$$

where $dGDP_h$ and dG_h denote the value of the respective IRF at horizon h.[13]

3. MAIN RESULTS

This section reports our baseline results. We start by showing, in Subsection 3.1, impulse responses of important macroeconomic variables to an unexpected shock to government spending when the economy is in a recession, distinguishing between demand-driven versus supply-driven recessions. Based on these impulse responses, in Subsection 3.2, we compute the associated cumulative government spending multipliers at various time horizons.

3.1. Impulse responses

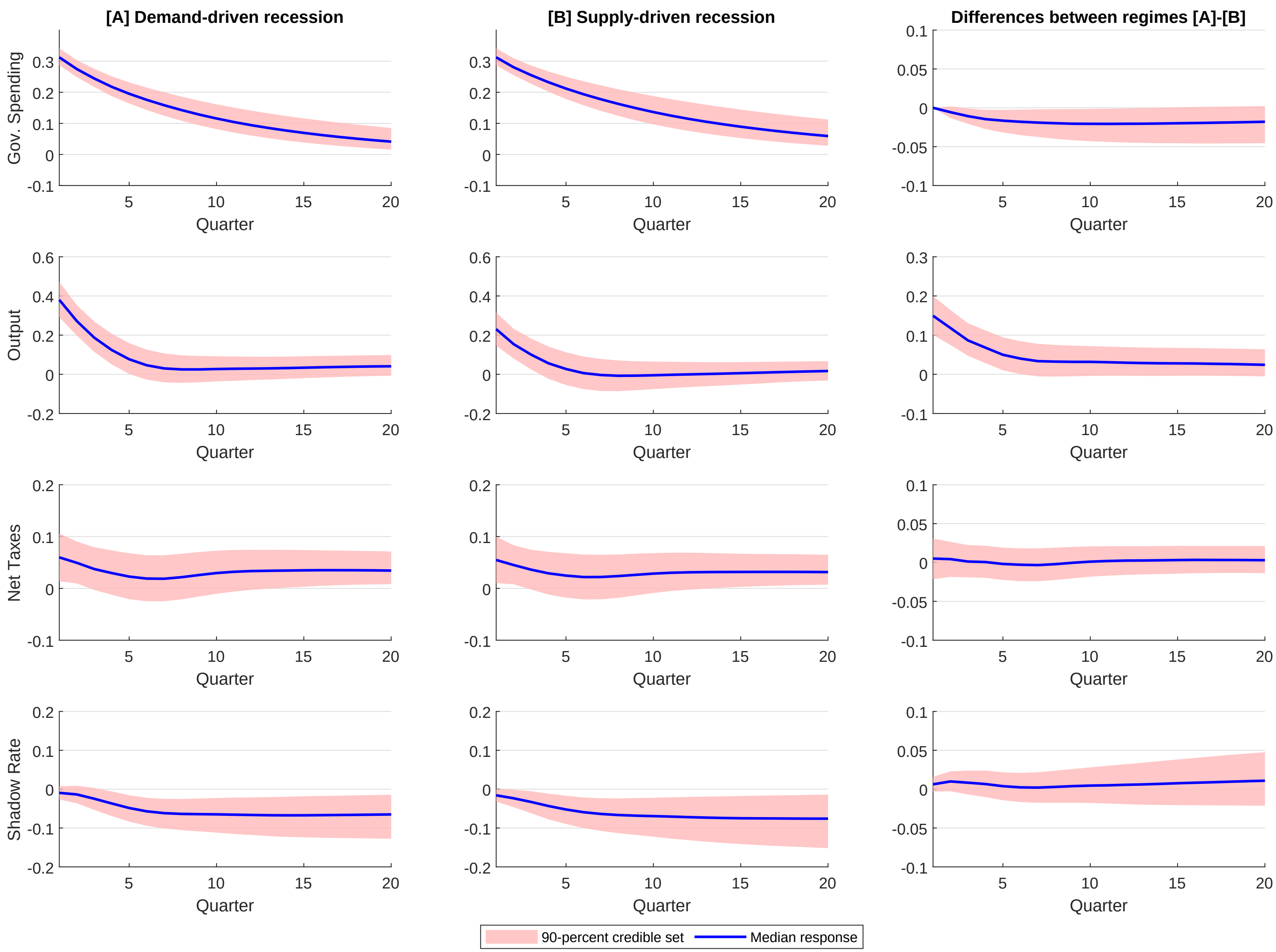
In this subsection, we report IRFs of government spending, output, net taxes (all in real terms), and the shadow monetary policy rate to an unexpected shock to government spending. One of the advantages of the FAIPVAR-X model is that it allows conditioning the IRFs on the shock occurring in a recession state and the inflation deviation from its trend being at a specific percentile of its distribution. In particular, we condition IRFs on the inflation deviation to be at its $26th$ percentile to capture a moderately demand-driven recession and at its $76th$ percentile to capture a moderately supply-driven recession.[14]

acute in nonlinear models and in particular in our model, where it is possible to calculate several multipliers, since the *ex-post* conversion typically employs a constant factor based on the sample average ratio of GDP to government spending, which displays significant cross-country and time variation in our sample.

[13] Following Mountford and Uhlig (2009), we also computed the present value multipliers by using the average Eonia rate over the sample in the discount factor. It turns out that the results are almost indistinguishable (after rounding to two digits), given low interest rates over much of the sample period.

[14] In Subsection 3.2, we report government spending multipliers derived from IRFs obtained by conditioning on all ventiles of the inflation deviation distribution.

Figure 2: Impulse Responses to a Government Spending Shock in Demand- and Supply-Driven Recessions



Notes: Impulse responses (in percent) to a shock of size one standard deviation. Bold lines represent median responses. Shadowed areas represent 90 percent credible sets.

The left and middle columns of Figure 2 report the IRFs for demand- and supply-driven recessions, while the right column reports the difference in the IRFs across the two regimes. In the figure, bold lines represent the median responses of each endogenous variable to the government spending shock, while the shaded areas represent the 90-percent credible set of the IRFs.

A few remarks are in order. First, in both cases a shock to government spending keeps the response of government spending itself persistently above zero, and it takes about five years for the effect of the shock to die out. Second, output and net taxes respond positively to the shock, although the credible set of the responses of net taxes includes zero after two quarters. Third, the shadow rate responds negatively and persistently, indicating monetary policy accommodation following the fiscal stimulus in a recession. Finally, the 90-percent credible set of the difference in the response of output between the demand- and supply-driven recession regimes excludes zero up to a horizon of 6 quarters; it includes zero in the case of the other endogenous variables.

3.2. Cumulative government spending multipliers

Based on these impulse responses, we can compute the cumulative government spending multipliers at several time horizons, as in Eq. (2). Results are reported in Table 1. Both in the short and the medium term the multiplier is systematically higher if the fiscal shock occurs in a demand-driven recession (inflation deviation at its $26th$ percentile), relative to the supply-driven recession case (inflation deviation at its $76th$ percentile). At a one-year horizon, the point estimate is 0.84 in the demand-driven recession and 0.44 in the supply-driven recession. Beyond the one-year horizon, the multiplier is about 0.6 in a demand-driven recession and about 0.2 in a supply-driven recession.

An important question is whether the difference between the two sets of multipliers is statistically significant. Bayesian inference does not allow us to construct a test as in the frequentist approach. Therefore, we follow an approach compatible with Bayesian inference.

Table 1: Cumulative Government Spending Multipliers in Demand- and Supply-Driven Recessions[a]

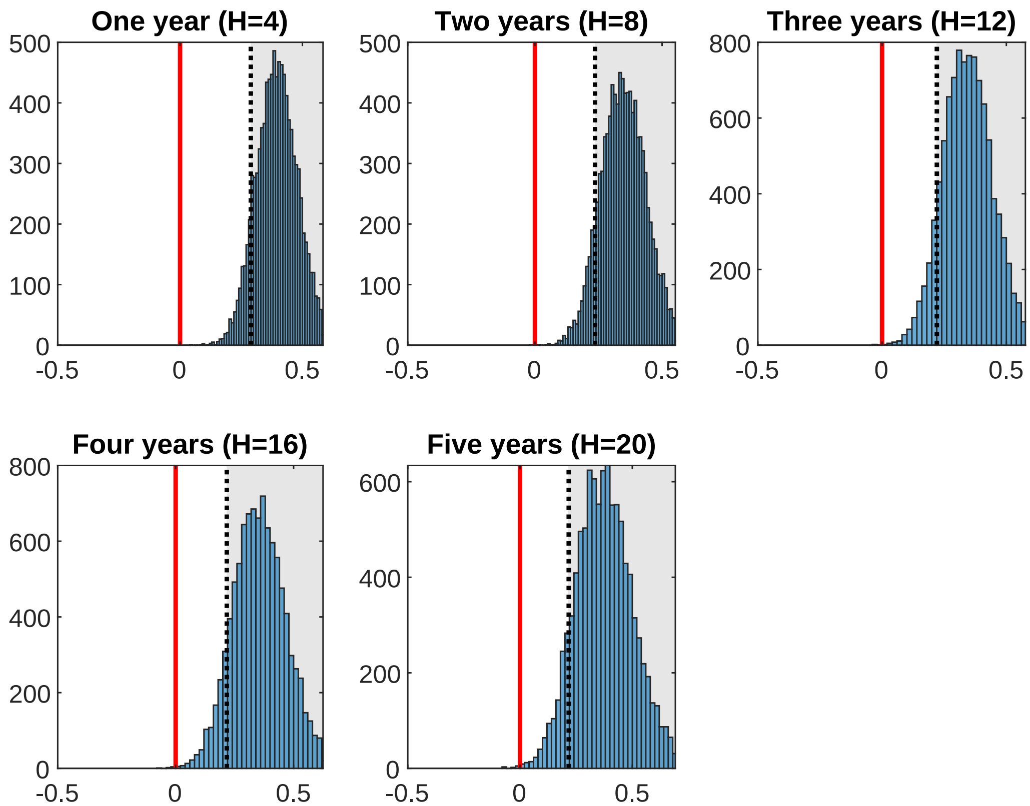
Horizon	H	Infl. dev. percentile		Prob($26^{th} > 76^{th}$)
		26^{th}	76^{th}	
1 year	4	0.84	0.44	1.0000
2 years	8	0.63	0.28	0.9999
3 years	12	0.57	0.22	0.9997
4 years	16	0.57	0.21	0.9993
5 years	20	0.59	0.21	0.9990

[a] Multipliers are computed as in Eq. (2) conditional on the economy being in a recession and the inflation deviation from trend (cyclical inflation) being at the 26th (demand-driven recession) and the 76th percentiles of its distribution (supply-driven recession) at the time of the government spending shock. H identifies the number of quarters after the shock.

Analogously to previous studies (see, e.g., Caggiano et al., 2015; Amendola et al., 2020; Di Serio et al., 2020) we compute empirical distributions of the differences computed as multipliers conditional on the economy being in a demand-driven recession minus multipliers conditional on the economy being in a supply-driven recession and verify whether a very large part of the distributions is located above zero. For each of the 10,000 parameter draws from the posterior distribution, we compute the multipliers as in Eq. (2), evaluate them for the two regimes, and compute the difference between the two. Figure 3 plots the distributions of the difference between the respective cumulative multipliers at various time horizons together with 90 percent credible sets. It turns out that, at all horizons, more than 90 percent of each distribution is located above zero, indicating that the difference between the two multipliers is positive with very high probability.

Given that, with the FAIPVAR-X model, IRFs are computed conditional on specific percentiles of the inflation deviation distribution, we can compute distributions of the cumulative government spending multipliers, at various time horizons, for any inflation deviation percentile. Figure 4 reports these distributions for all inflation ventiles and various time horizons. In line with the results for $26th$ and $76th$ inflation-deviation percentiles, repre-

Figure 3: Distributions of Differences in Cumulative Government Spending Multipliers between Demand- and Supply-Driven Recessions

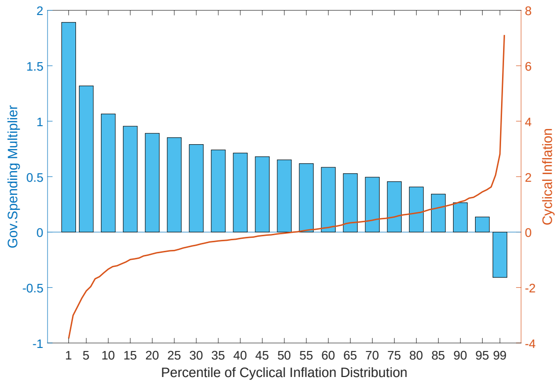


Notes: Empirical distributions of the differences are computed as multipliers conditional on the economy being in a demand-driven recession minus multipliers conditional on the economy being in a supply-driven recession. Multipliers are computed as in Eq. (2) for each of the 10,000 parameter draws from the posterior distribution. The vertical dotted line represent the $10th$ percentile of the distribution of differences. The vertical bold line represents zero. H identifies the number of quarters after the shock.

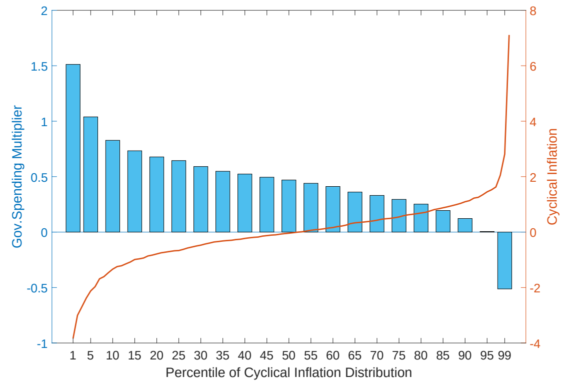
sentative of moderate demand- and supply-driven recessions, these charts highlight a strong inverse correlation between the inflation deviation from its trend and the size of the government spending multiplier (the correlation coefficient is -0.99, on average, across the horizons of cumulative multipliers). In other words, during a recession, the stronger demand shocks are (and, therefore, the more negative the inflation deviation), the higher the government spending multiplier is. Conversely, the stronger supply shocks are (i.e., the more positive the inflation deviation from its trend) the lower the government spending multiplier is.

Figure 4: Distributions of Cumulative Government Spending Multipliers in a Recession, Conditional on Percentiles of the Distribution of Inflation Deviations from Trend

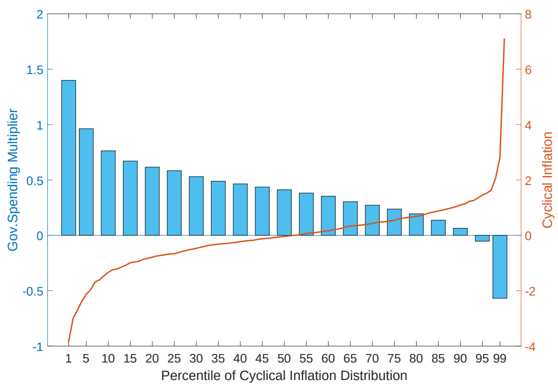
(a) One year (H=4)



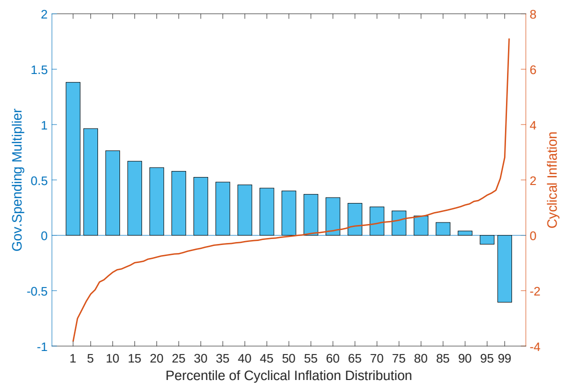
(b) Two years (H=8)



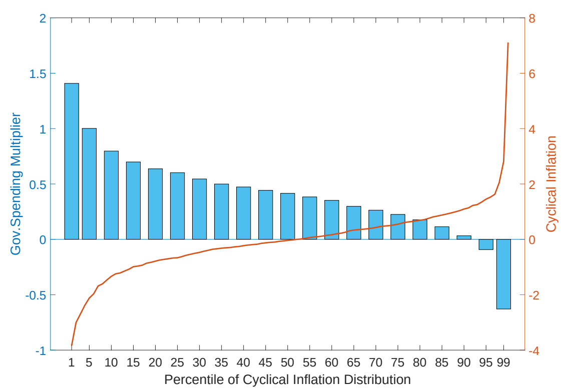
(c) Three years (H=12)



(d) Four years (H=16)



(e) Five years (H=20)



Notes: Multipliers are computed as in Eq. (2) conditional on the economy being in a recession and the inflation deviation from trend (cyclical inflation) being at a specified percentile of its distribution at the time of the government spending shock. H identifies the number of quarters after the shock. Vertical bars represent conditional multipliers, while bold lines represent cyclical inflation.

In Section 4, we substantiate the primary findings of our analysis through the application of a threshold approach implemented with local projections. Nevertheless, our just-discussed results highlight a key advantage inherent to the FAIPVAR-X model compared to threshold approaches. Specifically, the FAIPVAR-X model offers multipliers spanning all quantiles of the inflation distribution, thereby unveiling a broad array of magnitudes. The cumulative multipliers notably surpass one at the left tail of the distribution and turn negative at the right tail. These subtle but crucial nuances, enriching our overall understanding, are beyond the reach of threshold approaches.

Taken together, these results suggest that in the EA whether recessions are demand- or supply-driven makes an important difference in the size of the government spending multiplier. More specifically, our findings can be summarized as follows: (i) in a moderately demand-driven recession the multiplier is about 2-3 times larger than in a moderately supply-driven recession, and the difference between the two multipliers is greater than zero with very high probability; (ii) the multiplier is inversely correlated with the deviation of inflation from its trend, meaning that the multiplier is higher the more demand-driven a recession is; (iii) median multipliers range between about -0.5 and 2, depending on the inflation deviation level and the time horizon (Figure 4).

4. ROBUSTNESS

In this section, we present the results of several robustness checks (reported in Figure 5, Table 2, and Table 3) addressing issues commonly discussed in the literature, which may be applicable also to our analysis (further robustness checks are reported in Appendix A).[15]

1. *Alternative definition of the business cycle.* The baseline results are obtained by identifying recessions using the OECD indicator. This indicator classifies a recession as a

[15]We report results for robustness exercises 5 and 6 below in tables rather than in Figure 5. This deviation in reporting is necessary as the graphical illustration similar to robustness exercises 1 to 4 is not feasible by construction. In exercise 5 we have differing distributions for demand and supply shocks. In the case of exercise 6, we use a dummy variable instead of the distribution of inflation deviations from the trend.

peak-to-trough period, which is in line with a strand of the related literature using the growth rate of output as a recession indicator (see, e.g., Auerbach and Gorodnichenko, 2012, 2013a,b; Caggiano et al., 2015). An alternative approach employed in the literature is to distinguish between high and low economic activity based on a threshold, i.e., to emphasize the output or unemployment gap (see, e.g., Alpanda et al., 2021). On this, Ramey and Zubairy (2018) discuss that there is a mismatch in the US between quarters in a recession as qualified by the NBER recession dates (based on peak-to-trough periods) and quarters with high unemployment (based on a threshold). In our view, such a mismatch is likely due to two reasons. First, if unemployment adjusts sluggishly, a period may be already classified as a recession, despite unemployment still being below the chosen threshold. Second, a constant unemployment threshold could generate this mismatch. The choice of a particular threshold corresponds to making an assumption on the natural rate of unemployment, say 6.5%. However, as Jo and Zubairy (2022) discuss, the natural rate of unemployment may be time-varying.

Nevertheless, analyzing the robustness to an alternative definition of the business cycle is important as many related studies (e.g., Ghassibe and Zanetti, 2022; Jo and Zubairy, 2022) use unemployment as an indicator. Thus, we replace the OECD recession indicator with unemployment being above its 50^{th} percentile in the sample as suggested by Barro and Redlick (2011) or its 64^{th} percentile as suggested by Jo and Zubairy (2022). The latter threshold corresponds to the percentile used in Ramey and Zubairy (2018) for the U.S. to discern between low and high economic activity, which ranges between 5.4 (Austria) and 19.4 (Portugal) in our sample.

2. *Boosted HP filter and Hall transformation.* To produce baseline results, endogenous variables $G_{i,t}$, $GDP_{i,t}$ and $T_{i,t}$ are normalized with an estimate of real potential GDP based on the Hamilton (2018) filter. While using a filter to estimate real potential GDP is an accepted practice, the choice of the filter is debated in the literature (Hodrick, 2020). Therefore, we assess the robustness of our main results to two alternative

estimates of real potential GDP: (i) the boosted HP filter (Phillips and Shi, 2021)[16] and the Hall (2009) transformation.[17]

3. *Three factors and four lags.* The model requires the estimation of a large number of parameters, owing to the inclusion of five common factors to tackle the limited information problem, among other variables. Therefore, the baseline results are produced with a lag structure of one quarter for the sake of parsimony. To assess the robustness of results to include a larger number of lags for the endogenous variables, we reduce the number of factors to the first three principal components of the same informational dataset and we extend the lag structure to four ($L = 4$).

4. *Normal times vs. interest rate lower bound.* Much of the related literature so far focuses on whether fiscal policy is more effective in recessions and when the effective interest rate lower bound (ELB) is binding (see, e.g., Auerbach and Gorodnichenko, 2012; Ramey and Zubairy, 2018; Miyamoto et al., 2018; Di Serio et al., 2020; Amendola et al., 2020). Several papers find that spending multipliers are indeed larger at the ELB. In this paper, consistent with Ghassibe and Zanetti (2022) or Jo and Zubairy (2022), we find that the EA spending multiplier is larger in demand-driven recessions. Thus, a natural question is whether the nature of the recession or the ELB drives our result. Therefore, we run a robustness exercise, where we add a third interaction term as a dummy variable taking value 1 when the ELB is binding and 0 otherwise.[18]

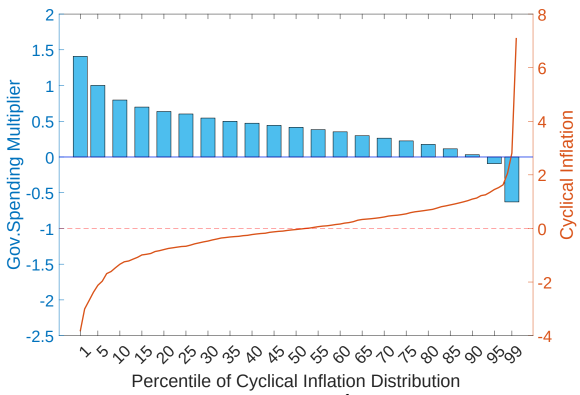
[16] Phillips and Shi (2021) introduce a machine learning-enhanced HP filter for extracting trends in macroeconomic business cycle data. This boosted HP filter introduces a secondary parameter controlling the degree of boosting, enhancing the HP filter's performance. The authors defend the use of HP filter, showing it can estimate various trends, even with structural breaks.

[17] As in Hall (2009), we normalize $\text{G}_{i,t}$, $\text{GDP}_{i,t}$ and $\text{T}_{i,t}$ using $Z_{i,t} = (z_{i,t} - z_{i,t-1})/\text{GDP}_{i,t-1}$, where $z \in \{\text{G}, \text{GDP}, \text{T}\}$. As in the baseline case, thanks to this transformation, we can compute multipliers directly, without the need of ex-post conversion to euro equivalents.

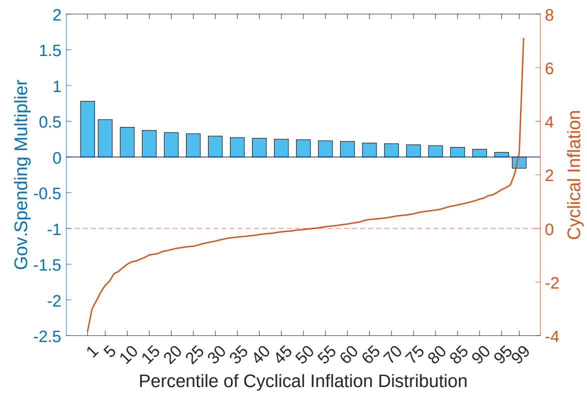
[18] A binding ELB present until the end of the sample across all countries does not preclude distinguishing between economic states thanks to cross-sectional variation. Figure 6 in Appendix B shows that over the whole sample – including when the ELB was binding – (i) there is variation in terms of number of countries being in a recession in each quarter; and (ii) within those countries in a recession, there is variation in terms of sign and magnitudes of inflation deviations from trend.

Figure 5: Distributions of Cumulative Government Spending Multipliers for a five year (H=20) horizon in a Recession, Conditional on Percentiles of the Distribution of Inflation Deviations from Trend–Robustness checks

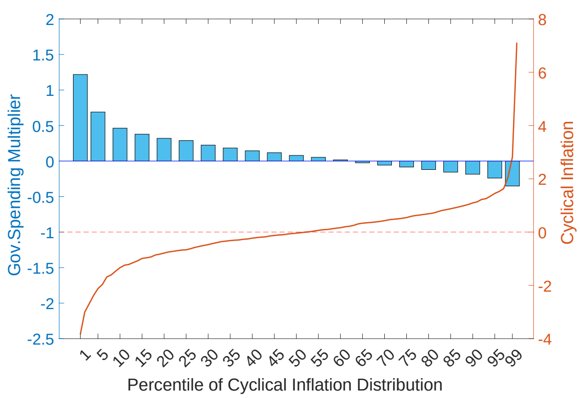
(a) Baseline



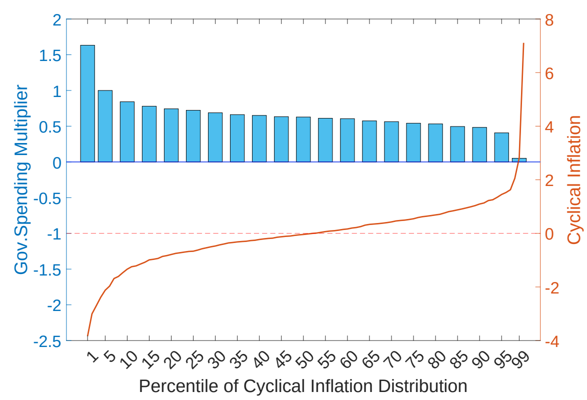
(b) Unemployment at 50^{th} percentile



(c) Unemployment at 64^{th} percentile



(d) Three factors, four lags (p=4)

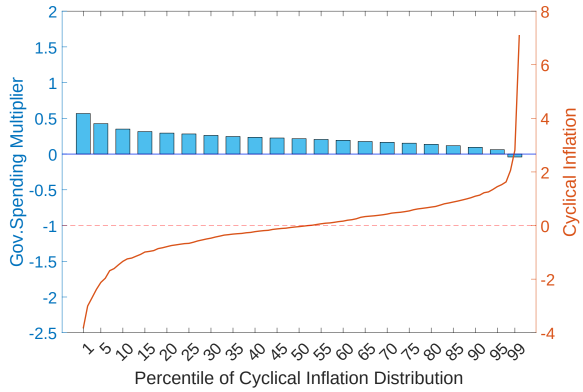


Notes: Multipliers are computed as in Eq. (2) at a five-year horizon ($H = 20$) conditional on the economy being in a recession and the inflation deviation from trend (cyclical inflation) being at a specified percentile of its distribution at the time of the government spending shock. Vertical bars represent conditional multipliers, while bold lines represent cyclical inflation.

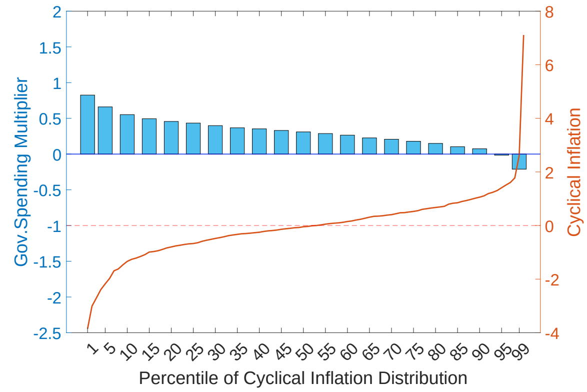
5. *Net exports as an additional variable.* In our study, the government spending multiplier derived from the IPVAR model represents the multiplier of the average EA country. As suggested by Nakamura and Steinsson (2014) our multipliers can be compared to multipliers estimated in open economies with fixed exchange rate. The related literature explores local versus aggregate multipliers within the monetary union formed by U.S. states (Nakamura and Steinsson, 2014; Dupor and Guerrero, 2017) or fixed exchange rate regimes (Corsetti et al., 2012; Ilzetzki et al., 2013). These studies find that local

Figure 5: *(Continued)* Distributions of Cumulative Government Spending Multipliers for a five year (H=20) horizon in a Recession, Conditional on Percentiles of the Distribution of Inflation Deviations from Trend–Robustness checks

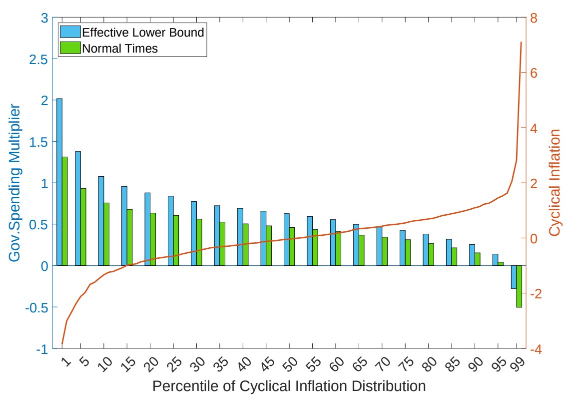
(e) Boosted HP filter



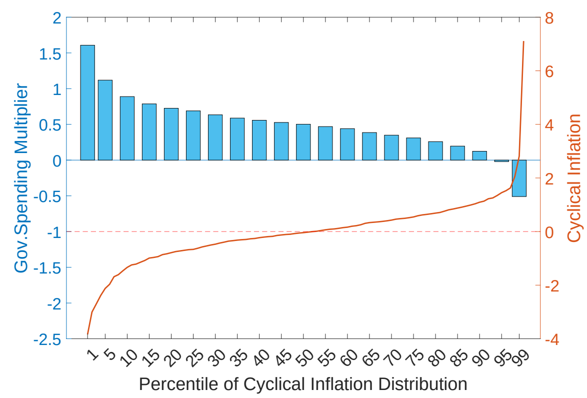
(f) Hall transformation



(g) Normal times vs. ELB



(h) Net exports as an additional variable



Notes: Multipliers are computed as in Eq. (2) at a five-year horizon ($H = 20$) conditional on the economy being in a recession and the inflation deviation from trend (cyclical inflation) being at a specified percentile of its distribution at the time of the government spending shock. Vertical bars represent conditional multipliers, while bold lines represent cyclical inflation.

multipliers (as opposed to aggregate ones) and multipliers under fixed exchange rates (versus flexible ones) tend to be larger. It is also important to note that, within a monetary union, asymmetric shocks can significantly impact other member countries, particularly if these economies are deeply integrated through trade and capital flows and a common monetary policy. To ensure our results are not unduly influenced by spillovers, we augment our model by incorporating net exports of each country as an additional endogenous variable.

6. *Supply and demand shocks with Blanchard and Quah (1989) identification.* As an alternative to cyclical inflation deviations, we estimate country-specific demand and supply shocks with bi-variate VARs, following Blanchard and Quah (1989).[19] We use these shocks to replace inflation deviations as the second interaction term.[20] The resulting interaction term matrix includes the OECD recession indicator and estimated demand and supply shocks. We estimate government spending multipliers in demand-driven (supply-driven) recessions considering a recessionary period in which the distribution of negative demand (supply) shocks is at its median level.

7. *Local projection method.* Much of the recent literature on state-dependent fiscal multipliers relies on local projections (Jordà, 2005). Thus, a natural question may be whether our results are robust to this alternative estimation method. We address this concern using a specification similar to Ghassibe and Zanetti (2022). The notable difference is that we maintain our baseline specification of variables for the control variables. Moreover, we add country- and time-fixed effects. Besides to the OECD recession indicator we also consider the unemployment rate.

As shown in Figure 5 and Tables 2 and 3, subjecting our estimates to these robustness checks changes the median estimates of the multiplier, but does not change the bottom line of the analysis: EA government spending multipliers are systematically larger in a demand-driven recession relative to a supply-driven recession.[21]

In greater detail, Figure 5 shows distributions of the cumulative government spending multipliers for all inflation ventiles, across robustness checks that allow this type of exercise.

[19] We use output growth and unemployment to identify the effects of demand and supply shock. The assumption is that a demand-side shock has no long-run effects on output (in other words its cumulative effect on GDP is zero in the long-run). A supply-side shock does imply a long-run effect on GDP.

[20] In our sample, some recession quarters are characterized by both negative demand and positive supply shocks. This simultaneous occurrence complicates the task of determining whether a particular quarter should be classified as driven by a demand or a supply recession. To overcome this difficulty, we have excluded these ambiguous quarters from the estimation.

[21] Further robustness exercises that corroborate our findings can be found in Appendix A.

Table 2: Cumulative Government Spending Multipliers in Demand- and Supply-Driven Recessions: supply and demand shocks with the Blanchard and Quah (1989) identification[a]

Horizon	H	Blanchard and Quah (1989) shocks		Prob(Demand>Supply)
		Demand	Supply	
1 year	4	0.65	0.56	0.6443
2 years	8	0.50	0.21	0.9108
3 years	12	0.43	0.06	0.9433
4 years	16	0.40	0.00	0.9396
5 years	20	0.41	-0.02	0.9234

[a] Multipliers are computed as in Eq. (2). Government spending multipliers in demand-driven recessions are estimated considering a recessionary period in which the distribution of negative demand shocks is at its median level. Government spending multipliers in supply-driven recessions are estimated considering recessionary periods in which the distribution of positive supply shock is at its median level. H indicates the number of quarters after the shock.

Especially at the left tail of the distribution, multipliers are smaller than in the baseline if using unemployment as a recession indicator and with the two alternative detrending methods. Conversely, they are larger if using the different factor and lag structure.[22] In line with other studies, spending multipliers are larger at the ELB, but also larger in demand-driven recessions. Thus, both the ELB and the nature of the recession contribute to shaping the size of the spending multiplier.[23] Importantly, all charts reported in the figure confirm the inverse correlation between the inflation deviation from its trend and the size of the multiplier found under the baseline specification. Although not reported, the probability of the differences between the multipliers at the 26th and the 76th percentiles of the inflation deviations from trend is above 90 percent in most of the cases reported in Figure 5.

Table 2 reports cumulative government spending multipliers at demand- and supply-driven recessions identified using the Blanchard and Quah (1989) identification approach. Relative to our baseline results, multipliers are somewhat smaller in demand-driven reces-

[22] The scale of the axes in Figure 5d may lead to the impression that the multiplier is less dependent on the inflation percentile except for the most extreme percentiles. However, redoing the test outlined above reveals that the difference between the multipliers at the 26th and 76th percentile of the inflation distribution is positive with very high probability. The latter ranges from 0.93 to 0.97 depending on the horizon $H \in \{4, 8, 12, 16, 20\}$.

[23] Using three lags and three factors (to keep the number of estimated parameters manageable) lead to very similar results.

sions, and, decay much faster at longer timer horizons in supply-driven recessions. Accordingly, the probability of the 1-year multiplier being higher in demand-driven recessions is smaller than in the baseline results (0.64 versus 1). At longer horizons, while somewhat smaller than in the baseline results, this probability exceeds 0.9.

Finally, Table 3 reports the results based on the local projection method. The first set of results is obtained with our baseline specification based on OECD recession indicators and supports our baseline finding: spending multipliers in demand-driven recessions are larger than in supply-driven recessions. Standard errors and p-values indicate that these differences are significant up to a horizon $H = 8$.

Note, however, that the local projection (LP) results are not directly comparable to our baseline results for at least two reasons. First, we calculate multipliers based on the FAIPVAR model at specific percentiles of the inflation distribution, whereas with the LP model, we define a threshold and do so for two specific states (below or above trend). Second, while the FAIVAR model uses inflation deviations, the LP model uses a dummy variable to indicate high or low inflation.

Next, in order to put our LP findings into perspective, it is important to take the recent theoretical literature on linear VAR and LP models into account. In particular, Plagborg-Møller and Wolf's (2021) results suggest that similarly specified linear VAR and LP models with lag order p should deliver approximately similar results up to horizon $H \leq p$ for finite samples.[24] For $H > p$ there is a *'bias-variance trade-off'*: VARs can introduce bias into the impulse response estimates if the selected number of lags does not accurately reflect the true underlying dynamics of the data; conversely, they generally exhibit lower variability in their estimates compared to LP models (see also Kilian and Kim, 2011; Kilian and Lütkepohl, 2017; Li et al., 2022).[25] As argued by Plagborg-Møller and Wolf (2021), due to this trade-

[24] Theoretically, LPs and VARs should produce exactly the same impulse responses in the population under the conditions of weak stationarity and unrestricted lag structures.

[25] For a discussion of further issues related to state-dependent local projections in comparison to state-dependent VARs, see Gonçalves et al. (2023).

off, it is not straightforward to determine which method is preferable to the other. Moreover, it is an open question whether these theoretical findings generalize to non-linear VAR and LP models.

The second and third set of results in Table 3 are obtained with local projection estimates based on the unemployment rate as an alternative recession indicator. Taken together, the magnitude and patterns of the estimates are again broadly in line with the first set of results in Table 3 and imply the same bottom line: multipliers are higher in demand-driven recessions. Considering the 64^{th} percentile as the threshold suggests significant differences in multipliers between demand- and supply-driven recessions at a horizon of $H = 4$. Thus, also for unemployment as a recession indicator, both methods tend to agree at shorter horizons $H = 4$. In contrast, considering the 50^{th} percentile as the threshold points to insignificant differences in multipliers between demand- and supply-driven recessions. A potential reason may be that the mismatch problem elaborated above becomes more severe with this threshold.[26]

5. RELATION TO THE THEORETICAL LITERATURE

Our main empirical result underscores the necessity of differentiating between demand- and supply-driven recessions when evaluating fiscal policy effectiveness. Although this aspect has been addressed in recent theoretical research, earlier works primarily focus on elucidating why fiscal policy is more potent during recessions.

Michaillat (2014) utilizes a New Keynesian model with a search-and-matching labor market, revealing that the public-employment multiplier is larger during recessions, particularly when unemployment rates rise. Canzoneri et al. (2016) expand the understanding of state-

[26] Validating our primary findings through estimation of country-specific cumulative spending multipliers in both demand- and supply-driven recessions would be beneficial, especially in the context of the EA where fiscal policy is largely implemented at a national level. It would provide valuable insights on whether the results are consistent across the countries in our sample, or if specific countries contribute more significantly to our main findings. However, the limited available sample length presents a challenge. The proposed classification of recessions would result in a modest number of observations, making the exercise impractical.

dependent multipliers by incorporating countercyclical bank intermediation costs in a banking model. They present a financial friction mechanism that yields state-dependent multipliers by varying financial intermediation costs over the business cycle, indicating that fiscal interventions are more effective during recessions. Shen and Yang (2018) offer an alternative theoretical channel for business cycle-dependent multipliers through downward nominal wage rigidity (DNWR) in recessions, with simulations suggesting larger output multipliers during recessions than expansions. Albertini et al. (2021) introduce a model incorporating search and matching frictions in the labor market. Unemployment risk gives rise to a precautionary-saving motive that affects consumption decisions and thus the spending multiplier. The model yields larger spending multipliers than under perfect insurance and substantial asymmetry in the aggregate government spending effects over the business cycle.

Table 3: Cumulative Government Spending Multipliers in Demand- and Supply-Driven Recessions Obtained with Local Projections[a]

Horizon	H	OECD recession indicator			Unemployment rate[b]					
					50^{th} percentile			64^{th} percentile		
		Inflation[c]		p-value[d]	Inflation		p-value	Inflation		p-value
		$\mathbb{1}(H(\pi_{t-1}))$	$\mathbb{1}(L(\pi_{t-1}))$	$\beta_{DD} = \beta_{SD}$	$\mathbb{1}(H(\pi_{t-1}))$	$\mathbb{1}(L(\pi_{t-1}))$	$\beta_{DD} = \beta_{SD}$	$\mathbb{1}(H(\pi_{t-1}))$	$\mathbb{1}(L(\pi_{t-1}))$	$\beta_{DD} = \beta_{SD}$
1 year	4	1.23	0.17	0.01	1.36	0.38	0.23	0.88	0.38	0.06
		(0.36)	(0.26)		(0.60)	(0.44)		(0.28)	(0.31)	
2 years	8	0.84	-0.06	0.00	1.29	0.72	0.32	0.72	0.40	0.33
		(0.22)	(0.30)		(0.72)	(0.34)		(0.32)	(0.25)	
3 years	12	0.10	-0.50	0.11	0.39	0.03	0.43	0.22	0.00	0.69
		(0.37)	(0.43)		(0.21)	(0.51)		(0.32)	(0.55)	
4 years	16	-0.11	-0.66	0.19	0.00	-0.23	0.58	-0.16	-0.35	0.74
		(0.37)	(0.46)		(0.34)	(0.62)		(0.33)	(0.65)	
5 years	20	-0.33	-0.93	0.26	-0.06	-0.13	0.86	-0.09	-0.18	0.87
		(0.50)	(0.67)		(0.41)	(0.47)		(0.44)	(0.51)	

[a] HAC standard errors are in parentheses. Multipliers are computed conditional on the economy being in a recession and the inflation deviation from trend (cyclical inflation) being below zero (demand-driven recession) and above zero (supply-driven recession) at the time of the government spending shock. H identifies the number of quarters after the shock. Regressions include as controls the first lag of variables listed in section 2.2, where parameters are state-specific. Country and time effects are also added.

[b] The recession state is defined by the country-specific unemployment rate being either greather than the 50^{th} (Barro and Redlick, 2011) or 64^{th} (Jo and Zubairy, 2022) percentile of its distribution.

[c] $\mathbb{1}(L(\pi_{t-1}))$ denotes periods of demand-driven recession and $(\mathbb{1}(H(\pi_{t-1})))$ denotes periods of supply-driven recession.

[d] The last column reports p-values of the null-hypothesis that multipliers are equal in demand- and supply-driven recessions.

Recent theoretical studies, more closely linked to our paper, emphasize the need to distinguish the nature of recessions for fiscal policy formulation. Jo and Zubairy (2022) investigate state-dependent government spending multipliers and their economic recovery implications. By analyzing unemployment and inflation interactions, they establish the spending multiplier's variability depending on recession types. Employing a New Keynesian model with DNWR, the authors demonstrate that real wage frictions, influenced by nominal wages and inflation, result in differing fiscal policy outcomes during demand- and supply-driven recessions. Empirical evidence from historical macroeconomic data and U.S. regional analysis supports the model's predictions, showing larger spending multipliers in demand-driven recessions with low inflation and high unemployment, compared to supply-driven recessions with high inflation. Ghassibe and Zanetti (2022) create a comprehensive theoretical framework for state-dependent fiscal multipliers, influenced by the business cycle and economic fluctuations. In their model, fiscal policy effectiveness depends on goods market congestion levels. They establish that multipliers for fiscal instruments stimulating aggregate demand, such as government consumption spending increases and consumption tax cuts, are countercyclical under demand-driven fluctuations and procyclical under supply-driven fluctuations. Conversely, multipliers for interventions stimulating aggregate supply, like reductions in taxes on firms' payroll, sales, and household labor income, are countercyclical under supply-driven fluctuations and procyclical under demand-driven fluctuations. The study also proposes an econometric specification for model-free testing of theoretical predictions, finding spending multipliers to be high in demand-side and low in supply-side recessions, especially at shorter horizons, with inverse patterns for tax cut multipliers.

6. CONCLUSIONS

When a recession occurs, one typical response of governments in many countries is to adopt fiscal stimulus packages to mitigate the depth of the output collapse. This holds true despite the fact that fiscal policy is procyclical in many developing and also in some developed countries (e.g., Talvi and Végh, 2005; Alesina et al., 2008). The response to the COVID-19 pandemic was no exception, as policymakers committed to alleviating the contraction in economic activity and accelerating the recovery with programs that ultimately increased government expenditures. The success of these government spending programs will be measured by the size of the associated fiscal multiplier.

The point of departure of this paper is that not all recessions are alike. For instance, in recent history, the Great Recession was a predominantly demand-driven recession. In contrast, during the COVID-19 recession, while demand shocks were at play, inflation was mostly above trend, meaning that supply factors dominated. A natural question is then: when governments launch fiscal stimulus packages during a recession, does the size of the government spending multiplier depend on whether the recession is demand- or supply-driven?

Exploiting data on ten EA countries, we estimate government spending multipliers associated with fiscal shocks occurring during recessions. The multiplier turns out to be inversely correlated with the deviation of inflation from its trend, implying that the more demand-driven a recession is, the higher the multiplier. Median estimates of the multiplier range from -0.5 in supply-driven recessions to around 2 in demand-driven recessions. Multipliers in a moderately demand-driven recession are 2-3 times larger than in a moderately supply-driven recession, with the difference being non-zero with very high probability.

These calculations are based on the estimates of a factor-augmented interacted panel vector-autoregressive model purified of expectations (FAIPVAR-X). This empirical framework is a powerful tool for estimating these state-dependent effects of fiscal shocks. The key advantage lies in the possibility to condition the government spending multiplier on each percentile of the entire distribution of inflation deviations from trend. Putting it differently, this approach does not require splitting the sample to distinguish between a small number of states, as in previous contributions, but it allows considering a continuum of states. In addition, the methodology deals with several technical problems highlighted in the empirical macroeconomic literature, including the issues of fiscal foresight and limited information.

Our results are important both from an academic and a policy perspective. A first academic contribution consists in confirming with EA data evidence so far confined to the U.S. A second academic contribution entails further validating emerging theories, which assign an important role to the nature of a recession for the size of government spending multipliers. From a policymaking perspective our findings suggest that, while the ambitious stimulus packages adopted recently, such as NextGenerationEU, may have contributed to the recovery from the COVID-19 recession, adverse supply factors may have limited their stimulative effects.

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APPENDIX

A. FURTHER ROBUSTNESS

Herein we present further robustness checks:

1. *Adding exogenous U.S. variables.* The baseline specification includes only variables pertaining to the EA countries included in the sample. This choice essentially treats the EA as a closed economy because it does not explicitly allow for external shocks to affect the endogenous variables. Therefore, in order to account for potentially important international factors that may influence our variables of interest, we add as exogenous variables also a set of U.S. variables (see, e.g., Amendola et al., 2020), including the U.S. output gap, U.S. inflation and the U.S. shadow monetary policy rate developed by Wu and Xia (2016).

2. *Replacing the shadow rate with the Eonia rate.* The baseline specification features the shadow monetary policy rate as an endogenous variable. This choice is motivated by the fact that unconventional monetary policy measures were adopted in the EA, because of a binding effective lower bound (ELB) on the monetary policy rate, and therefore the shadow rate better captures the overall monetary policy stance. For the sake of robustness, we conduct an exercise in which we replace the shadow rate with the Eonia rate (a proxy of the conventional monetary policy stance) in the specification.

3. *Lag structure of two quarters.* Given that the FAIPVAR-X model requires the estimation of a large number of parameters, for the sake of parsimony, we produce the baseline results with a uniform lag structure of one quarter. Bearing in mind that the use of a long lag structure would not be feasible as we would run out of degrees of freedom, we check whether results are robust to the use of a lag structure of two quarters $L = 2$.

Table 4: Cumulative Government Spending Multipliers in Demand- and Supply-Driven Recessions: Robustness Checks[a]

Horizon	H	Infl. dev. percentile		Prob($26^{th} > 76^{th}$)
		26^{th}	76^{th}	
1. *Adding exogenous U.S. variables*				
1 year	4	0.87	0.43	1.0000
2 years	8	0.61	0.20	1.0000
3 years	12	0.51	0.11	0.9999
4 years	16	0.50	0.09	0.9994
5 years	20	0.53	0.11	0.9990
2. *Replacing the shadow rate with the Eonia rate*				
1 year	4	0.86	0.48	1.0000
2 years	8	0.65	0.31	1.0000
3 years	12	0.59	0.26	0.9998
4 years	16	0.58	0.24	0.9998
5 years	20	0.58	0.23	0.9994
3. *Lag structure of two quarters*				
1 year	4	1.03	0.50	1.0000
2 years	8	0.85	0.40	1.0000
3 years	12	0.75	0.34	0.9999
4 years	16	0.68	0.29	0.9993
5 years	20	0.64	0.27	0.9980
4. *Inflation as an endogenous variable*				
1 year	4	0.63	0.28	0.9999
2 years	8	0.43	0.07	0.9970
3 years	12	0.34	-0.03	0.9866
4 years	16	0.33	-0.07	0.9714
5 years	20	0.37	-0.07	0.9605
5. *Replacing deflator inflation with core CPI-inflation*				
1 year	4	0.87	0.55	1.0000
2 years	8	0.57	0.23	0.9998
3 years	12	0.46	0.10	0.9992
4 years	16	0.42	0.04	0.9982
5 years	20	0.42	0.03	0.9972
6. *Alternative recession indicator*				
1 year	4	0.77	0.37	1.0000
2 years	8	0.54	0.20	0.9998
3 years	12	0.42	0.10	0.9969
4 years	16	0.35	0.05	0.9907
5 years	20	0.30	0.01	0.9801
7. *Government spending forecast as an endogenous variable*				
1 year	4	0.74	0.39	0.9998
2 years	8	0.47	0.24	0.9926
3 years	12	0.38	0.17	0.9730
4 years	16	0.36	0.14	0.9627
5 years	20	0.37	0.14	0.9580

[a] Multipliers are computed as in Eq. (2) conditional on the economy being in a recession and the inflation deviation from trend (cyclical inflation) being at the 26th (demand-driven recession) and the 76th percentiles of its distribution (supply-driven recession) at the time of the government spending shock. H identifies the number of quarters after the shock.

4. *Inflation as an endogenous variable.* While the deviation of inflation from its trend is an interaction variable in our baseline specification, for the sake of parsimony the inflation rate is not included among the endogenous variables. Therefore, we deem it

appropriate to check whether the results are robust to the inclusion of the inflation rate among the endogenous variables.

5. *Replacing deflator inflation with core CPI-inflation.* Our baseline specification follows other studies in the literature (e.g., Jo and Zubairy, 2022) by adopting the deviation of the GDP deflator from its trend as the indicator that determines whether, and to what extent, a recession is demand- or supply-driven. This is also in line with closed-economy theoretical models in which the consumer price index (CPI) and the GDP deflator coincide. Given that in the policy arena, the inflation rate is typically based on the CPI, we replace the GDP deflator inflation with inflation based on the EU Harmonized Index of Consumer Prices (HICP) excluding energy, food, alcohol and tobacco. This is a measure of core inflation with the advantage of excluding the excessive volatility typical of food and energy prices.

6. *Alternative recession indicator.* Our baseline estimation employs the OECD indicators to identify the recession periods in our countries. Here we check whether our results are robust to an alternative recession indicator constructed as those quarters in which the standardized four-quarter moving average of real (quarter-on-quarter) GDP growth is within its 20^{th} percentile as in Caggiano et al. (2015). A non-standardized moving average or the simple GDP growth rate lead to similar results.

7. *Government spending forecast as an endogenous variable.* To address the fiscal foresight problem, our baseline specification includes the forecast of time-t government spending over the four quarters as an exogenous variable. We also explore an alternative, initially proposed by Auerbach and Gorodnichenko (2012), consisting of including the government spending forecast as the first endogenous variable, to purify government spending shocks from expectations.

As shown in Table 4, subjecting our estimates to these robustness checks changes the median estimates of the multiplier, but does not change the bottom line of the analysis:

EA government spending multipliers are systematically larger in a demand-driven recession relative to a supply-driven recession, with the differences between the two sets of multipliers being greater than zero with very high probability.

B. DATA

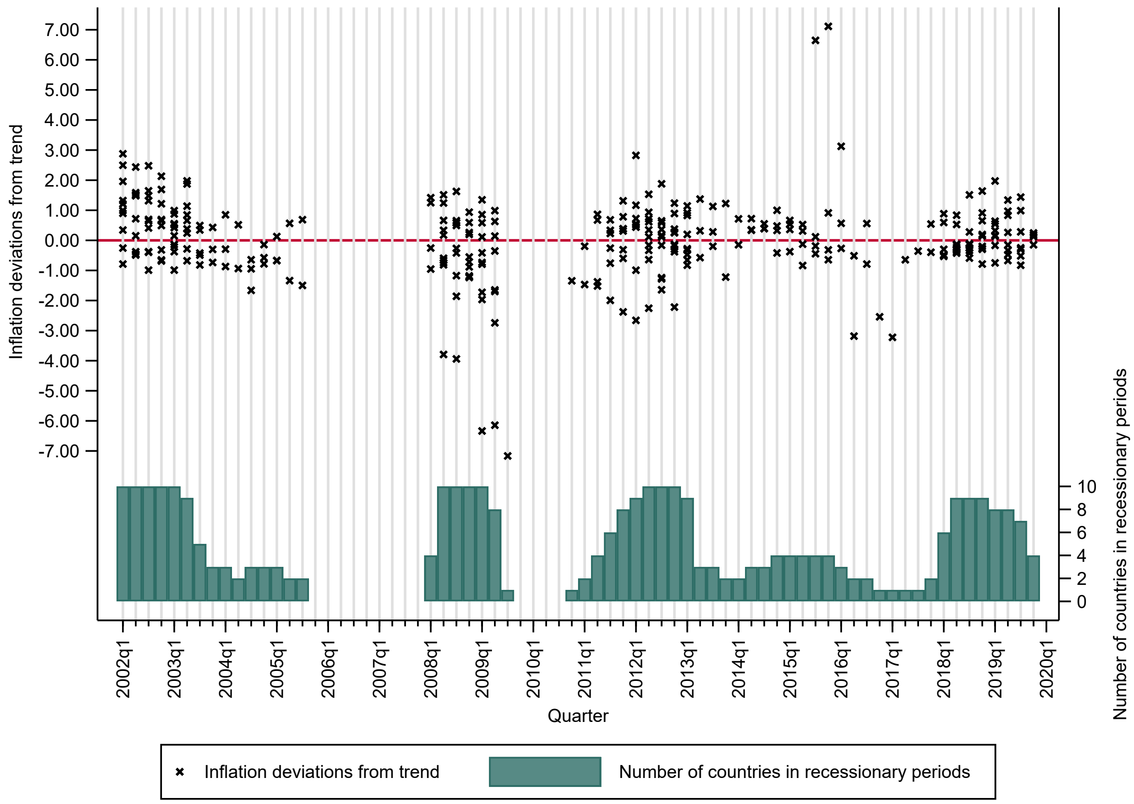
Endogenous variables. Our endogenous variables are gross domestic product, net taxes, government spending, the European Central Bank's shadow rate and the cyclical inflation based on GDP deflator. As standard in the literature, we construct net taxes as the sum of government receipts of direct and indirect taxes minus transfers to businesses and individuals. The government spending series is constructed as the sum of government gross fixed capital formation and government consumption. The cyclical inflation based on GDP deflator is estimated using the Hamilton (2018) filter. All the variables are downloaded from the Eurostat database available on the Thomson Reuters Datastream Economics database. Gross domestic product, net taxes and government spending are transformed in real terms using the implicit GDP price deflator. Then they are normalized by dividing by real potential GDP. The European Central Bank's shadow rate, is developed by Wu and Xia (2016).

Interaction terms. Figure 6 provides information on the indicator variables used in the interaction terms.

Informational dataset. The informational dataset we use to extract common factors is composed by 230 series downloaded from the Eurostat database available on the Thomson Reuters Datastream Economics database. Specifically, we downloaded the following variables for each country considered:

- National Account: Domestic Demand; Export of Goods and Services; Imports of Goods and Services; Gross Capital Formation; Final Consumption Expenditure of Households.
- Government Statistics: Government Consolidated Gross Debt: Central Govt.
- Output and income: Industrial Production Index (Mining and Quarrying; Manufac-

Figure 6: Inflation Deviations from Trend and Number of Countries in Recessionary Periods



Notes: Inflation deviations from trend (following Hamilton, 2018) at every quarter t are reported for all countries i, $\pi_{\mathrm{i,t}} - \pi_{\mathrm{i,t}}^{\mathrm{tr}}$ that are in a recession in quarter t according to the country-specific indicator. Inflation is computed as the year-over-year change of the implicit price deflator. The OECD based Recession Indicators for EA from the Period following the Peak through the Trough are used.

turing; Electricity, Gas, Steam and Air Conditioning Supply); Nominal Unit Labor Cost based on persons; Production - Total Industry Excl. Construction; Production of Total Construction; Wages and Salaries; Change in Inventories.

- Employment and hours: Early Estimates of Labor Productivity - Total Economy; Employees Domestic Concept; Unemployment: Total.
- Stock prices: S&P BMI - Price Index.
- Exchange rates: REER: 19 trading partners EA; NEER: 37 Trading Partners.
- Money and credit quantity aggregates: Money Supply: M1 - Contribution to Euro M1; Money Supply: M2 - Contribution to Euro M2; Money Supply: M3 - Contribution to Euro M3; Official Reserve Assets.

- Interest Rate: Harmonized Government 10-Year Bond Yield.

Where appropriate, we transform variables to guarantee stationarity tested by the Dickey and Fuller (1979) and Kwiatkowski et al. (1992) tests.

C. ESTIMATED SHOCKS

Figure 7 shows the cross-country average of identified government spending shocks. Most of the shocks fall within the range comprised between -0.2 and 0.2 percent. In absolute value, the largest shocks are observed at the beginning of the sample (2002q4-2003q1), during the European Sovereign Debt Crisis (2010q1-2012q2), and to a lesser extent during the Global Financial Crisis. The period after the Sovereign Debt Crisis is characterized by more moderate shocks on average.

Figure 7: Average Government Spending Shocks