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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. Median 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.

JEL-Codes: C320, C330, C380, E320, E620.

Keywords: fiscal multiplier, business cycle, interacted panel VAR, factor models, Euro Area.

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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 (2021) 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 (2021) 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.

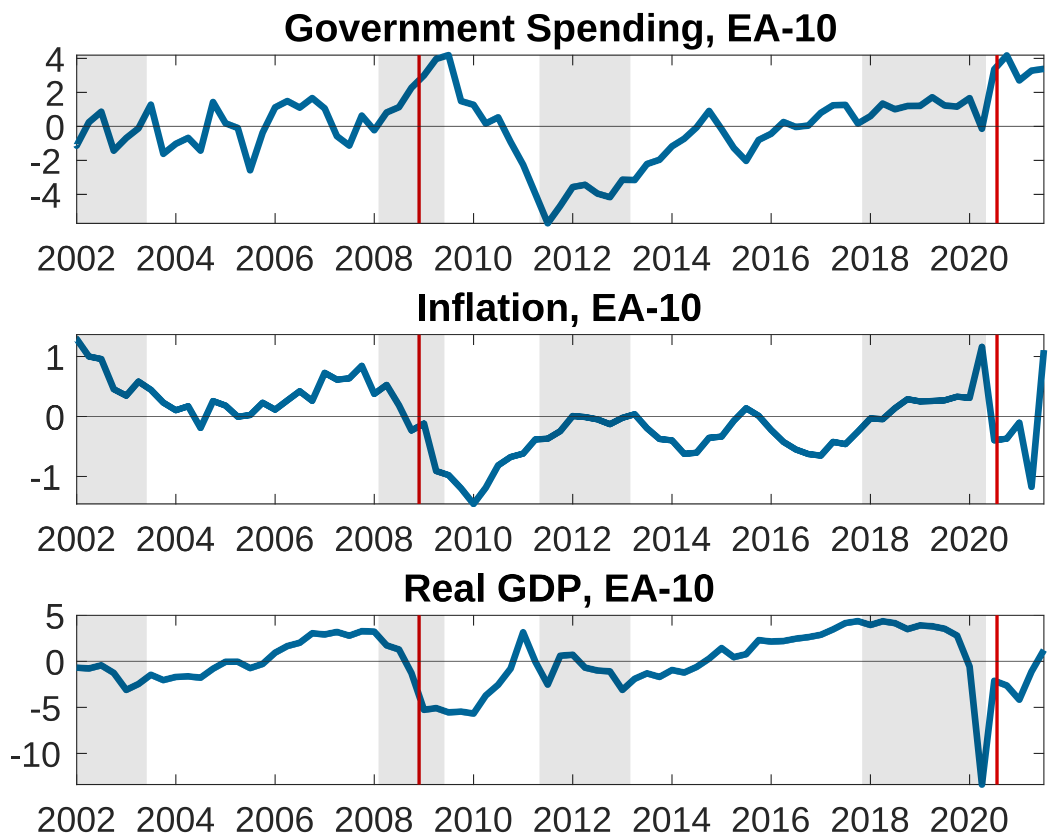
Empirically, these studies provide time series and cross-sectional evidence for the United States, exploiting precisely the relationship between inflation and the nature of a recession, and confirming their models' theoretical predictions. In low-inflation (demand-driven) recessions the government spending multiplier is larger than in high-inflation (supply-driven) recessions. While there is hardly any such evidence for the Euro Area (EA), the region has experienced fiscal stimuli both in demand- and supply-driven recessions, 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, while the NGEU is the current response to the Covid-19 recession. Moreover, there is consensus that the making of the financial crisis differs from the Covid-19 recession. For instance, the aggregate data for the EA-10 countries in Figure 1 suggests that the bulk of the EA economy in November 2008 and thereafter was characterized by inflation below trend, making the Great Recession a predominantly demand-driven recession. In contrast, the second half of 2020 and thereafter exhibits higher inflation, mostly above trend, making the recession moderately supply-driven. Thus, the EERP and NGEU package were adopted during recessions of different macroeconomic nature.

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 of the EA. 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 and inflation deviations from trend.

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

Figure 1: Aggregate Real Government Spending, Inflation and Real GDP for 10 EA Countries from 2002Q1 to 2021Q3



Notes: All variables are in deviation from trend (following Hamilton, 2018). 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. Real government spending is the quarterly sum of national real final consumption expenditure and real gross fixed capital formation of general government. Real GDP is the quarterly sum of national levels. Inflation is computed as the year-over-year change of the implicit price deflator. We compute the latter based on our measure of EA-10 real GDP and an analogous measure of EA-10 nominal GDP obtained as the quarterly sum of national nominal GDP. The red vertical lines mark the announcements of the European Economic Recovery Plan (EERP) on November 26th, 2009 and the NextGenerationEU (NGEU) on July 21st 2020. The grey-shaded areas indicate the recession dates according to the OECD based Recession Indicators for EA from the Period following the Peak through the Trough.

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 worthwhile 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. In other words, this approach does not require splitting the sample to distinguish between a small number of states (as for instance in Ghassibe and Zanetti, 2021; Jo and Zubairy, 2021), and this is especially important in the light of the available EA data.

As suggested by Figure 1, recessions can hardly be classified exclusively as demand- *or* supply-driven recession, but rather on a continuum of states. According to theory, a dominance of demand shocks is mirrored in more or less strong negative deviations of inflation from its trend, while the reverse applies to the case of dominant supply shocks. We discuss further important advantages of applying the Interacted Vector Autoregressive (IVAR) methodology and its generalizations in quantifying state-dependent policy effects in Amendola et al. (2020) and Di Serio et al. (2020).

Our paper is also related to an important strand of the literature that examines state-dependence of the effects of fiscal policy. However, most of this literature focuses on whether fiscal policy is more effective in recessions and when the zero interest rate lower bound (ZLB) 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).

The paper proceeds as follows. Section 2 outlines the FAIPVAR-X model, our baseline specification and data, our inference and identification approach, and how we calculate the multipliers. Section 3 discusses the main results. Section 4 addresses robustness concerns. Finally, Section 5 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, trough $\Gamma_{k,m}^1$ and κ_m^1, respectively. 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 qth-ordered variable on the wth-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 the 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.[1] 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.[2] 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 and are normalized with an estimate of real potential GDP.[3]

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 control for the overall monetary policy stance in the Eurozone. 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.[4] In doing so, we address two kinds of model specifi-

[1]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 (2021), we choose to end the sample before the Covid-19 pandemic.

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

[3]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.

[4]We implement Bernanke et al.'s (2005) two-step estimation procedure. Our informational dataset com-

cation 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 (e.g., by forecasting government spending) 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 EA countries and cyclical inflation based on the GDP Deflator (i.e., deviations of inflation from trend).[5] 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). In practice, a recession is almost never completely demand- or supply-driven, while demand or 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 two lags for robustness (Section 4).

prises 230 publicly available time series from the Eurostat Database. 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.

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

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.[6] 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 $5th$ and $95th$ percentile of the impulse response function (IRF) distribution as confidence bands.

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.[7] This data transformation ensures that our estimates for the government spending multiplier are not biased by an *ex-post* conversion procedure.[8]

[6] 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.

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

[8] 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 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 can be highly state-dependent.

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.

3. MAIN RESULTS

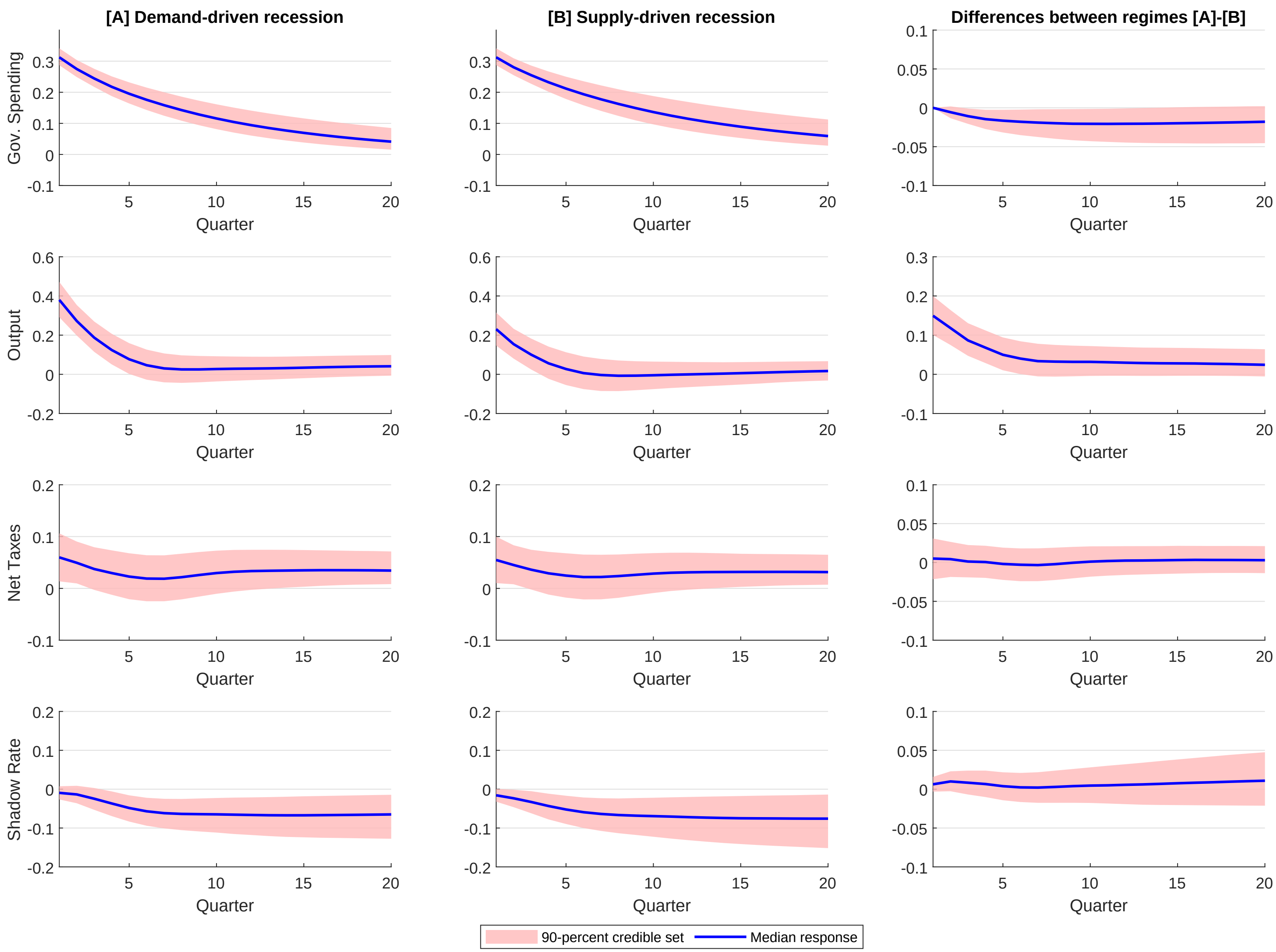
This section reports our baseline results. We start by showing, in Subsection 3.1, impulse responses of important macroeconomic variables to an unexpected shock to government spending when the economy is in a recession, distinguishing between demand-driven versus supply-driven recessions. Based on these 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 of 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 this subsection we show IRFs obtained by conditioning 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. In Subsection 3.2, we report government spending multipliers derived from IRFs obtained by conditioning on all quintiles of the inflation deviation distribution.

The left and middle columns of Figure 2 report the IRFs for demand- and supply-driven

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.

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, capturing a monetary policy accommodation following the fiscal stimulus occurred in a recession. 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. Analogously to previous studies (see, e.g., Caggiano et al., 2015; Amendola et al., 2020;

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

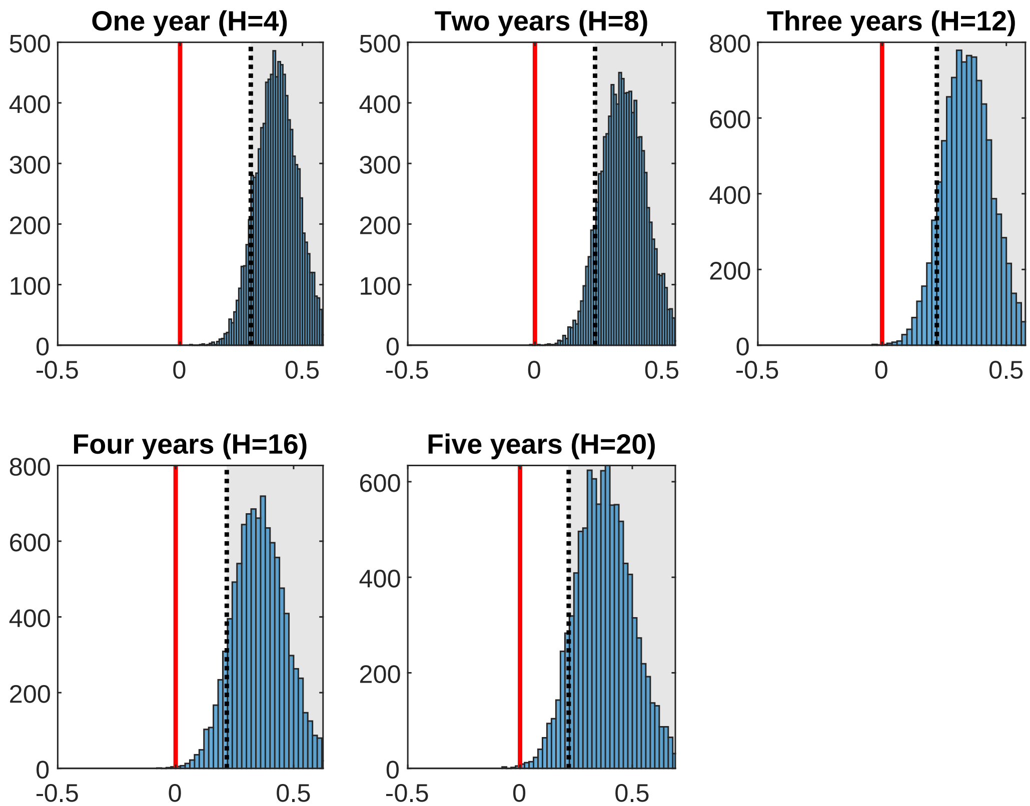
Horizon	H	Infl. dev. percentile		Prob($26^{th} > 76^{th}$)
		26^{th}	76^{th}	
1 year	4	0.84	0.44	1.0000
2 years	8	0.63	0.28	0.9999
3 years	12	0.57	0.22	0.9997
4 years	16	0.57	0.21	0.9993
5 years	20	0.59	0.21	0.9990

[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.

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 quintiles and various time horizons. In line with the results for $26th$ and $76th$ inflation-deviation percentiles, representative of moderately demand- and supply-driven recessions, these charts highlight a strong

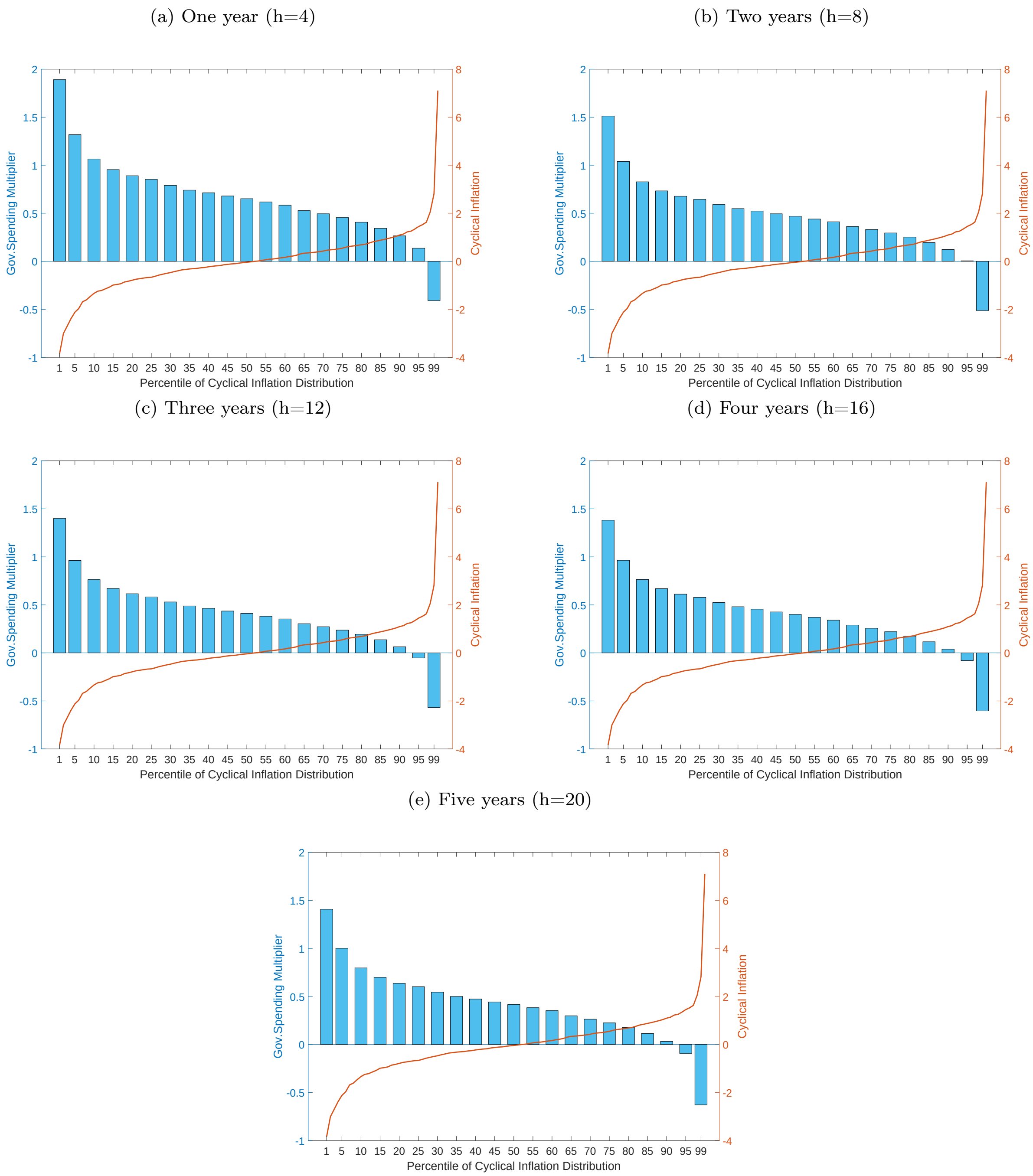
Figure 3: Distributions of Differences in Cumulative Government Spending Multipliers between Demand- and Supply-Driven Recessions



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.

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 from its trend), the higher the government spending multiplier is. Conversely, the stronger supply shocks are (leading to inflation being greater and greater than 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



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.

Taken together, these results suggest that in the EA whether recessions are demand- or supply-driven makes an important difference for the size of the government spending multiplier. More specific 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 addressing issues commonly discussed in the literature, which may be applicable also to the analysis presented in this paper.

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 $L = 2$.

4. *Unemployment as a recession indicator.* The baseline results are obtained by identifying recessions using the OECD indicator. Given that unemployment tends to increase during recessions and other studies in the literature (e.g., Jo and Zubairy, 2021; Ghassibe and Zanetti, 2021) use unemployment as an indicator of recessions, we check whether results are robust to replacing the OECD recession indicator with unemployment being at its $80th$ percentile in the sample. Using alternative unemployment percentiles above its median leads to similar results.

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

6. *Replacing deflator inflation with core CPI-inflation.* Our baseline specification follows other studies in the literature (e.g., Jo and Zubairy, 2021) 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.

As shown in Table 2, 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.

5. CONCLUSIONS

When a recession occurs, a typical response of governments around the world is to adopt fiscal stimulus packages to mitigate the depth of the output collapse. The response to the COVID-19 pandemic was no exception, as policymakers committed to alleviate the contraction in economic activity and accelerate 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 created equal. 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 asso-

Table 2: Cumulated 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. *Unemployment as a recession indicator*				
1 year	4	0.92	0.46	1.0000
2 years	8	0.54	0.15	0.9986
3 years	12	0.33	-0.04	0.9928
4 years	16	0.22	-0.14	0.9818
5 years	20	0.19	-0.20	0.9728
5. *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
6. *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

[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.

ciated with fiscal shocks occurred 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, with the key advantage lying 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.

These results are important both from an academic and from 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 contribute to the recovery from the COVID-19 recession, adverse supply factors may limit their stimulative effects.

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APPENDIX

A. 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 diving by real potential GDP. The European Central Bank's shadow rate, is developed by Wu and Xia (2016).

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; Manufacturing; 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.