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The Estimation of Italian Regional Fiscal Multipliers

A Methodological Note

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Executive Summary

This methodological note describes the econometric methodology used to produce the result summarized in the Policy Brief "Understanding Italian Regional Fiscal Multiplier: Policy Insight for Enhancing Fiscal Policy Effectiveness" by Cavaliere G., Fanelli L., and Mazzali M., which documents the effectiveness of Italian local fiscal policy through the estimation of regional government spending multipliers at the NUTS-2 and NUTS-1 levels.[1]

The analysis is based on Factor-Augmented Vector Autoregressive (FA-VAR) models estimated region-wise, intended to capture the heterogeneous responses to regional fiscal policy, while accounting for cross-sectional dependence. To circumvent the use of fiscal instruments for fiscal shocks in a context of limited cross-sectional data, a single external instrument constructed from factor analysis is used to identify regional output shocks and estimate regional fiscal reaction functions. This non-fiscal instrument captures the "common" (national) component

[1] The policy brief is based on the technical working paper Cavaliere, Fanelli, Mazzali (2025) "*The Size and Uncertainty of Government Spending Multipliers in Italian Regions*". The working paper includes an extensive explanations of the methodology, data, and empirical results upon which this policy brief is based.

driving Italian regional output and is by construction orthogonal to regional government spending shocks.

Summary of Empirical Results

In the policy brief "*Understanding Italian Regional Fiscal Multiplier. Policy Insight for Enhancing Fiscal Policy Effectiveness*", we presented estimates of fiscal multipliers at the Italian regional (NUTS-2) and macro-area (NUTS-1) levels using annual data from 1995 to 2021. We evaluated how shocks to government consumption (gc) and government investment (gi) affect output focusing on two metrics of the fiscal multiplier: (i) the impact multiplier, measuring the immediate effect of an intervention on GDP, and (ii) the long-run multiplier, capturing the effect at the tenth period (used as an approximation of the "infinite-horizon" outcome). For a clearer interpretation of policy effectiveness we provided confidence bands computed with bootstrap.

Our empirical findings confirm that expansionary government spending shocks exert a positive effect on regional output. However, we also observed significant differences in fiscal policy effects across regions and across different types of spending. Public investment shocks produce larger and comparatively more persistent effects than government consumption shocks. Bootstrap confidence intervals for the estimated regional multipliers suggest that the evaluation of the effectiveness of regional fiscal policy in Italy is complicated by the high uncertainty characterizing output responses to fiscal spending shocks, especially at long horizons.

Below we complete the analysis by providing the main details of the methodology used to produce our results.

Econometric Framework

In this section, we illustrate the econometric methodology we applied to estimate fiscal multipliers.

Model and Fiscal Policy Rules

For each region i, with $i = 1, \dots, n = 20$, we consider a m-dimensional vector $Y_{i,t}$

containing $m = 3$ variables:

$$Y_{i,t} = \begin{pmatrix} p_{i,t} \\ gdp_{i,t} \\ f_{gdp,t} \end{pmatrix}$$

where $p_{i,t}$ is the (log of per capita) policy variable in region i, with $p \in \{gc, gi\}$, $gdp_{i,t}$ is the log of per capita output in region i and $f_{gdp,t}$ is a factor extracted from the set of regional GDPs: $\{gdp_{1,t}, \dots, gdp_{20,t}\}$ by Principal Component Analysis (PCA), common to all regions. The variable $f_{gdp,t}$ is intended to capture the cross-sectional interrelations that might characterize fiscal policy.

For ease of exposition, and without loss of generality, throughout, we omit the subscript i to indicate a region and assume that Y_t follows a FA-VAR(l) of the form:

$$Y_t = \Pi X_t + u_t, \qquad t = 1, \dots, T \tag{1}$$

where $X_t = (Y'_{t-1}, \dots, Y_{t-\mathrm{l}})$ collects the l lags of Y_t, $\Pi = (\Pi_1, \dots, \Pi_{\mathrm{l}})$ is a $m \times m\mathrm{l}$ matrix of autoregressive parameters and $u_t = \left[u_{p,t}, u_{gdp,t}, u_{f,t}\right]'$ is an m-vector of reduced form disturbances with $E(u_t) = 0$ and $E(u_t u'_t) = \Sigma_u$, Σ_u being positive definite. The specification in (1) omits deterministic terms for notation brevity (a constant and a linear trend are included region-wise in the estimation.)

The VAR disturbances u_t are linked to the structural shocks ε_t through the linear mapping $u_t = B\varepsilon_t$, where $\varepsilon_t = (\varepsilon_{p,t}, \varepsilon_{gdp,t}, \varepsilon_{f,t})'$ and the $m \times m$ matrix $B = (B_{\cdot p}, B_{\cdot gdp}, B_{\cdot f})$ is non-singular and contains, under proper identification restrictions, the on-impact coefficients, i.e., the instantaneous impact of the structural shocks on the variables. The structural shocks ε_t are assumed cross-uncorrelated and are normalized such that $E(\varepsilon_t \varepsilon'_t) = I_m$, implying $\Sigma_u = BB'$. We have:

$$u_t = B_{\cdot p}\varepsilon_{p,t} + B_{\cdot gdp}\varepsilon_{gdp,t} + B_{\cdot f}\varepsilon_{f,t} \tag{2}$$

Let us define the h periods ahead responses of the j-th variable to $\varepsilon_{p,t}$ as

$$IRF_{j,p}(h) = e'_j\left(S_m C^h S'_m\right)B_{\cdot p} \tag{3}$$

where $S_m = \left(I_m, 0_{m \times m(\mathrm{l}-1)}\right)$, C is the companion matrix associated with the FA-VAR in (1) and e_j is the j-th column of I_m.

As finding reliable proxies for fiscal shocks is problematic—especially at the regional level—we employ an alternative (inverse) strategy that entails instrumenting the non-target shocks to recover the target ones (see also Caldara and Kamps, 2017, and Angelini, Cavaliere, Fanelli, 2024).

For $A = B^{-1}$, we can rewrite the VAR in (1) as

$$AY_t = A\Pi X_t + \varepsilon_t \tag{4}$$

where $Au_t = \varepsilon_t$ and the matrix A captures the structural relationships characterizing the variables. The equation system in (4) defines the structural shocks in ε_t as a function of current and past values of Y_t.

The equation of $Au_t = \varepsilon_t$ associated with the target shock reads

$$A_p.u_t = a_{p,p}u_{p,t} + a_{p,gdp}u_{gdp,t} + a_{p,f}u_{f,t} = \varepsilon_{p,t} \tag{5}$$

For $a_{p,p} \neq 0$ and imposing $a_{p,f} = 0$, we rearrange terms and obtain the regional policy reaction function

$$u_{p,t} = \psi_p u_{gdp,t} + \sigma_p \varepsilon_{p,t} \tag{6}$$

where $\psi_p = -a_{p,p}^{-1}a_{p,gdp}$ is the elasticity of the policy variable to output and $\sigma_p = a_{p,p}^{-1}$ is the standard deviation of the fiscal shock.

If we can estimate the policy rule above, we can retrieve the coefficients in $A_p.$. The estimation of $B._p$ and the $IRFs$ in (3) follows indirectly from the relation $B._p = \Sigma_u A_p'$. (see Angelini, Cavaliere, Fanelli, 2024).

Confidence intervales are computed by the Moving Block Bootstrap, see Jentsch and Lunsford (2022).

Identification

The identification of structural shocks requires restrictions on the matrix B or A. The standard proxy-SVAR approach imposes covariance restrictions by means of a set of $r > k$ observable instruments, w_t, that are correlated with the structural fiscal shocks of interest $\varepsilon_{p,t}$, and orthogonal to all other structural shocks in the system, denoted as $\varepsilon_{-p,t}$. To consistently identify the relevant entries in the sub-matrix $B._p$ the vector w_t must satisfy two key conditions:

$$\mathrm{E}(w_t\varepsilon_{p,t}') = \Phi_p \neq 0 \qquad (relevance)$$

$$E(w_t\varepsilon'_{-p,t}) = 0_{k\times(m-k)} \qquad (exogeneity)$$

Under these conditions, the impulse responses to fiscal shocks can be directly estimated, as in Mertens and Ravn (2013) , using fiscal instruments.

An alternative strategy, discussed in Caldara and Kamps (2017), is to use non-fiscal proxies to estimate the coefficients of the fiscal policy rule, recovering the fiscal shock from the latter. This strategy is particularly useful when the instruments w_t for the fiscal shocks are unavailable or are suspected to be weak for $\varepsilon_{1,t}$, while valid instruments for the non-target shocks are potentially available (see Angelini, Cavaliere, Fanelli 2024).

Let z_t be a vector of $s \leq m-k$ non-policy instruments satisfying the following conditions

$$\mathrm{E}\left(z_t \varepsilon'_{-p,t}\right) = \Phi_{-p} \neq 0 \qquad (relevance) \tag{7}$$

$$\mathrm{E}\left(z_t \varepsilon'_{p,t}\right) = 0_{s\times k} \qquad (exogeneity) \tag{8}$$

where Φ_{-p} is $s \times (m-k)$. These conditions imply that z_t must be correlated with the non-policy shocks and orthogonal to fiscal shocks. When satisfied, z_t can be used to instrument the non-policy reduced-form disturbances $u_{-p,t}$. In our framework, we require just one valid non-policy instrument, i.e. $s = 1$,—specifically, for the output shock—to estimate the fiscal reaction coefficient ψ_p.

The next section details how we construct the proxy variable z_t using a factor-based approach tailored to the regional data context.

Building External Instruments in a Data-Scarce Environment

As discussed above, estimating the fiscal policy rule in equation (6) requires a valid instrument for the regional output shock. With such a proxy at hand, we can estimate the elasticity parameter ψ_p by standard IV regressions and then recover the implied structural fiscal shock $\varepsilon_{p,t}$.

In the absence of suitable external instruments for our regional context, and to avoid to rely on Bartik-type instruments, we define a novel strategy where an instrument, common to all regions, is used for regional output shock.

Let $f_{gdp,t}$ denote the first principal components, obtained via PCA, from the full set of regional per-capita GDP series, $\{gdp_{1,t}, \dots, gdp_{20,t}\}$. Similarly, for each fiscal variable of interest—public consumption and public investment—we extract a common factor from the corresponding set of regional series, obtaining $f_{p,t}$ with $p \in \{gi, gc\}$.

We then project, separately for each fiscal instrument, the factor $f_{gdp,t}$ onto the space generated by $f_{p,t}$ and $f_{dgp,t-1}$:

$$f_{gdp,t} = \beta_p f_{p,t} + \beta_{gdp} f_{gdp,t-1} + z_{p,t}$$

obtaining the projection residual $z_{p,t}$. In the case of public investment, we consider a one-period lag in the fiscal factor to account for the delayed transmission typically associated to capital spending.

In all cases, $z_{p,t}$ represents, by construction, the component of aggregate regional output that is orthogonal to fiscal policy—i.e., the variation in GDP not explained by the common dynamics driving the corresponding fiscal aggregate. We interpret this as a non-fiscal output proxy to use as an instrument for $u_{gdp,t}$ region-wise.

To be valid, this proxy must satisfy the standard relevance and exogeneity conditions in (7)-(8) As is common in the literature, we evaluate proxy strength running a battery of first-stage regressions. Specifically, for each region i, we regress the estimated non-policy residuals $u_{gdp,t}$ on the constructed proxy $z_{p,t}$. According to Stock, Wright, Yogo (2002) and a simple rule-of-thumb, an F-statistic below 10 signals a weak instrument.

As for exogeneity, we argue that each $z_{p,t}$ plausibly satisfies this condition for two main reasons. First, by construction, $z_{p,t}$ is the projection residual resulting from the regression of the GDP factor on the spending factor, making it orthogonal to common fiscal dynamics. Second, from an economic perspective, the proxy captures output fluctuations unrelated to fiscal policy—such as commodity prices or productivity shocks—which are likely exogenous to regional government decisions.

Definition of Fiscal Multipliers

We define the fiscal multiplier as the euro response of output to an effective one-euro change in the fiscal variable. Following Mountford and Uhlig (2009), we compute the *cumulative multiplier* at period h as the ratio of the cumulative response of output over the entire h –period horizon to the cumulative response of the fiscal variable over the same period:

$$M_p(h) = \frac{\sum_{j=0}^{h} IRF_{gdp,p}(j)}{\sum_{j=0}^{h} IRF_{p,p}(j)} \times \alpha_p$$

where α_p is a policy-specific scaling factor converting elasticities to euro equivalent. This is necessary because the variables are expressed in log changes, thus the ratios between the two IRFs are interpreted as elasticities. We set the policy-specific scaling factor to the sample average of the ratio $\exp(gdp) / \exp(p)$—see *inter alia* Caldara and Kamps (2017) and Angelini, Cavaliere, Fanelli (2024).

Policy Remarks

The methodological framework presented in this note offers concrete guidance for designing more effective and context-aware fiscal policies. Its main strength lies in enabling a credible identification of spending shocks at the regional level, even when granular fiscal instruments are unavailable or weak.

By providing region-specific estimates of output responses to different types of government spending, the method allows to target resources more effectively. This means moving away from uniform allocations and toward strategic differentiation, giving governments the tools to correct for asymmetries and reduce long-standing territorial divides.

Moreover, the model's structure allows for ex ante simulations and ex post evaluation of fiscal interventions, giving national and regional authorities a transparent, replicable framework for planning and monitoring. The use of bootstrap-based confidence intervals also promotes risk-aware policymaking, offering a realistic range of expected outcomes and supporting more resilient fiscal design.

Conclusions

This note describes the methodology used for estimating regional fiscal multipliers in Italy, in data-scarce environments, as previously suggested by Cavaliere, Fanelli, Mazzali (2025). By combining a FA-VAR structure with a novel identification strategy based on instruments derived from factor analysis, the method allows us to isolate the effect of fiscal shocks without using subnational fiscal instruments. This makes it possible to quantify the effects of public spending across regions and types of expenditure, providing useful insights for fiscal policies tailored to local objectives. The approach is replicable, easily extendable to other NUTS levels, and suited for

both ex ante policy simulation and ex post evaluation. As such, it offers a valuable tool for improving the design, monitoring, and coordination of regional interventions—especially in the context of the PNRR and broader territorial cohesion strategies.

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