Austerity and Productivity: Evidence from euro area Regions*

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Abstract

This paper provides novel empirical evidence on the causal link between fiscal austerity and productivity using granular data covering more than 120 regions from ten euro area countries for the period 1999-2019. We construct a new measure of regional total factor productivity (TFP) that accounts for capital and labor utilization. We identify exogenous reductions in regional public spending via a Bartik-type instrument that combines regional sensitivities to changes in national government expenditures with narrative national consolidation episodes. While lowering GDP, investment, and employment, fiscal consolidations trigger a significant and persistent increase in utilization-adjusted TFP. Our findings are consistent with a cleansing mechanism: austerity accelerates the exit of marginal producers, increasing average sector productivity, particularly in the sectors more exposed to the fiscal intervention. Austerity-driven recessions amplify the productivity gains of economic downturns considerably.

JEL classification: E32, E62, H53.

Keywords: Fiscal consolidation, total factor productivity, cleansing effect.

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1 Introduction

Over the last two decades, many European economies experienced a slowdown in productivity growth (OECD 2015; IMF 2023). Interestingly, the slowdown in productivity occurred in a period of significant fiscal policy interventions. In particular, several European countries have implemented large-scale fiscal consolidation measures to reduce high levels of public debt, thereby averting the risk of sovereign default. Growth performances were particularly dismal in Southern European countries that implemented sizeable fiscal austerity programs. Among policymakers, this occurrence has fueled the idea that contractionary fiscal policy *decreases* productivity growth (Board 2019). This policy narrative will further influence ongoing discussions regarding the design of fiscal policy in light of elevated public debt levels as a result of the Corona period and Russia's invasion of Ukraine. Against this background, this paper investigates the link between fiscal consolidations, productivity, and economic growth using granular data from euro area regions. In stark contrast to the policy narrative, we provide robust empirical evidence that fiscal austerity significantly *increases* productivity growth.

Our empirical investigation uses a rich dataset, ARDECO, which offers series on output, consumption, private investment, employment, hours worked, and wages at different regional aggregations. Our unit of observation is a so-called NUTS2 region which is roughly comparable to a U.S. state. Thus, we follow recent studies on the U.S. economy (Chodorow-Reich et al. 2012; Nakamura and Steinsson 2014; Bernardini et al. 2020) relying on regional variation in government spending to estimate how fiscal policy shapes the economy. Using regional variation to map the impact of fiscal policy has the advantage that all regions are part of the monetary union, they are all subject to the ECB's monetary policy. Thus, by including time-fixed effects in our regressions, we can control for confounding effects of monetary policy interventions, which is a common challenge when studying the effects of fiscal policy at the national level.

For our main dependent variable, we construct a novel measure of utilization-adjusted total factor productivity (TFP) growth at the NUTS2 level. The construction follows the approach pioneered by Imbs (1999) and adjusts simple TFP series for capital and labor utilization.[1] Our series is consistent with the adjusted TFP measures at the country-level provided by Huo et al. (2023). The final dataset covers 139 regions from ten Eurozone countries for the period 1999-2019. When comparing our regional to country-level TFP measures, we show that regional TFP growth provides substantially more identifying variation that improves the precision of our estimates of productivity responses to fiscal consolidations.

To test for the causal effects of austerity, we closely follow Gabriel et al. (2026) and iden-

[1] Alternative methods of utilization adjustment, e.g., Basu et al. (2006), assume exogenous productivity and thus are inconsistent with our endogenous TFP measure.

tify exogenous changes in regional public spending using a Bartik-type instrument (Bartik 1991) that combines regional sensitivities to changes in national government expenditures with the narrative national consolidation measure proposed by Alesina et al. (2020). The narrative series contains only those changes in the national primary balance-to-GDP ratio that are motivated by a desire to reduce budget deficits. The identified fiscal actions represent responses to past decisions and economic conditions rather than to current and prospective conditions. Therefore, there should be no systematic correlation between the identified national fiscal actions and other developments that affect economic activity in the short term. This narrative approach has been used in several studies to gauge the economic effects of fiscal consolidations at the national level (Guajardo et al. 2014; Jordà and Taylor 2016; Alesina et al. 2019). In contrast to these approaches, we use the narrative series as the shift component in a Bartik instrument to identify exogenous reductions in government spending at the regional level. We further employ an instrumental variable local projections approach to estimate the causal effect of reductions in regional public spending on economic outcomes. Importantly, our Bartik measure provides a strong instrument for regional government spending reductions, with a first-stage F-statistic well above the critical threshold, suggesting that weak instruments are unlikely to be a concern for our analysis.

Our main empirical results show that fiscal consolidations are associated with significant and persistent productivity gains: a 1% reduction in regional public spending leads to an increase in utilization-adjusted TFP by around 2%. Besides the rise in productivity, austerity also triggers a significant decline in regional GDP, employment, investment, and consumption. We use a forecast error variance decomposition (FEVD) exercise to quantify the magnitude of regional cuts in public spending in driving economic outcomes. Austerity explains around 10% of the variation in productivity and more than 15% of the variation in GDP, the latter amplified by the Great Recession period in our sample, consistent with the findings by House et al. (2020). These results further highlight the importance of austerity in understanding movements in productivity and economic growth experienced over the last decades. We conduct a battery of robustness checks to verify our findings. The results still hold for different samples and also remain unaffected when changing the construction of the national austerity measure or the share variable of the Bartik instrument.

We further decompose the drivers of the increase in productivity between a within sector effect and reallocation across sectors. Productivity increases within sectors might be related to efficiency gains, restructuring, or a cleansing mechanism that reallocates activity toward more productive firms. In addition, austerity may induce reallocation across sectors, whereby resources shift away from sectors that are highly exposed to government demand and toward sectors that are less dependent on public spending. We differentiate between the tradable and non-tradable sector and find that the majority of the aggregate TFP increase is accounted for by the within-

sector component, while reallocation still contributes to a non-trivial share. Moreover, the rise in TFP within sectors is well in line with a cleansing effect, whereby adverse demand conditions disproportionately eliminate low-productivity firms, raising average productivity among surviving producers (Caballero and Hammour 1994a; Osotimehin and Pappadà 2017). Austerity triggers a significant and persistent decline in business units in the tradable and non-tradable sectors.

Finally, we try to understand whether austerity-driven recessions yield different productivity outcomes than general economic downturns do. We differentiate between recessions that coincide with fiscal consolidations ("austerity recessions") and those not related to austerity ("non-austerity recessions") and estimate the TFP response in both episodes of economic slack. Our estimates imply that austerity recessions lead to a significantly larger increase in productivity than other recessions.

Related literature. Our paper is related to various strands of literature. We contribute to the recent and fast-growing literature that uses sub-national data to estimate the impact of fiscal policy (Nakamura and Steinsson 2014; Bernardini et al. 2020; Chodorow-Reich et al. 2012; Auerbach et al. 2020). While the studies are mainly interested in calculating output and employment multipliers, we provide new insights into how exogenous changes in fiscal spending affect productivity. Moreover, our dataset enables us to investigate how differences in the innovation efficacy across euro area regions drive the productivity and output responses to a fiscal spending shocks.

Several empirical studies are based on narratively identified fiscal consolidation episodes to estimate the aggregate impact of austerity shocks (Guajardo et al. 2014; Jordà and Taylor 2016; Alesina et al. 2015). In contrast, we combine narrative consolidation episodes at the aggregate level with regional sensitivities to national spending changes to identify fiscal policy shocks at the regional level. Therefore, by including more observations compared to studies at the country level, we are decreasing estimation uncertainty and allowing for an in-depth analysis of potentially significant differences across regions with high and low innovation efficacy.

Outline. The remainder of the paper is organized as follows. Section 2 describes the data we use and the construction of the TFP measure. Section 3 presents the methodology. Section 4 shows our empirical results. Finally, Section 5 concludes.

2 Data

In our analysis, we draw on a broad set of annual data covering the period from 1999 to 2019 for 139 regions in ten European countries: Austria, Belgium, Finland, France, Germany, Ireland, Italy, Netherlands, Portugal, and Spain. In the following, we describe the main variables used in

our analysis. Table A.1 in the Appendix provides more information on the regional structure, and A.2 provides additional information regarding data definitions and sources.

2.1 Economic data

To measure regional economic developments, we rely on data from the Annual Regional Database of the European Commission's Directorate General for Regional and Urban Policy (ARDECO), which is a highly disaggregated dataset across sectoral and regional dimensions. The database contains several long time-series indicators for European regions at different statistical scales and expands the Cambridge Econometrics Dataset used by much of the literature on European regional dynamics.

The database provides regional measures for output (gross domestic product (GDP) and gross value added (GVA)), investment, earnings, hours worked, and employment for different economic sectors like industry, construction, financial, non-financial, and non-market services. The dataset is an annual unbalanced panel starting in 1980 for the European Union (EU) and some European Free Trade Association (EFTA) and candidate countries.[2] By construction, ARDECO's regional data is consistent with the commonly used national accounts data.[3] In particular, the regional ARDECO time series are constructed in such a way that the country aggregates equal the corresponding time series in the National Accounts reported by the annual macro-economic database of the European Commission's Directorate General for Economic and Financial Affairs (AMECO).[4]

The data are divided into NUTS (Nomenclature of Territorial Units for Statistics) regions. NUTS is a geocode standard for referencing the subdivisions of countries for statistical purposes. The hierarchy of three NUTS levels (NUTS 1, 2, 3) is established by Eurostat in agreement with each member state, and for most countries, the respective NUTS level corresponds to a specific administrative division within the country. ARDECO provides most data series at these regional disaggregation levels except for NUTS 3, for which it only reports measures on population, employment, GDP, and GVA.[5]

Official data on final consumption expenditure of the general government (henceforth, gov-

[2]The data used for our analysis was collected in June 2024.

[3]See Lequiller and Blades (2014) for more details on the construction of the National Accounts data.

[4]See Gabriel et al. (2023) and Appendix A for more information.

[5]Our final dataset excludes the French overseas regions of Guadeloupe (FRY1), Martinique (FRY2), Guyane (FRY3), La Réunion (FRY4), and Saint-Martin (FRY5), as well as the Spanish autonomous cities of Ceuta (ES63) and Melilla (ES64), the Finnish autonomous region of Åland (FI20), the French overseas territory of Mayotte (FRM0), the Spanish island regions of Illes Balears (ES53) and Canarias (ES70), and the Portuguese autonomous regions of Açores (PT20) and Madeira (PT30). In addition, we exclude the Southern Region of Ireland (IE05) for 2015, which constitutes a clear outlier due to the well-documented distortion in Irish national accounts related to multinational firms' balance-sheet relocations.

ernment spending) is not available at the European regional level. Hereinafter, in the spirit of Brueckner et al. (2023) and closely following Gabriel et al. (2023) and Gabriel et al. (2026), we use the sum of GVA and intermediate consumption of the non-market sector as a proxy for government spending. GVA of the non-market sector is computed as the sum of compensation to employees (including social contributions), consumption of fixed capital (which measures the decline in the value of fixed assets owned as a result of normal wear, tear, and obsolescence), and taxes less subsidies on production. Because GVA of the non-market sector does not include intermediate consumption, which is, however, one of the main components of government spending, we use input-output (IO) tables from the PBL EUREGIO database to calculate regional intermediate consumption shares of the non-market sector, which we then add to the GVA of the non-market sector.

Our regional measure (GVA plus intermediate consumption of the non-market sector) is a valid proxy for government spending for several reasons. First, as previously mentioned, ARDECO's regional data is consistent with the national accounts data by construction. By definition, there exists a close link between government spending and the GVA of the non-market sector. Consequently, almost the entire variation in the GVA of the non-market sector refers to activities by the general government. Second, government spending and our proxy measure show very similar statistical properties. Both measures are very tightly linked—regressions at the national and regional level suggest a strong and significant relationship between both measures, with estimated coefficients close to 1. We will thus refer to our regional proxy for government spending as government spending throughout the paper. More details on the justification of our proxy choice are given in Appendix A.

Another novel contribution of our analysis is the use of regional private consumption data, which has been largely unavailable in existing European regional databases. While ARDECO provides comprehensive coverage of output, employment, and investment at the NUTS 2 level, regional consumption expenditure is notably absent. We obtain consumption data from Oxford Economics, which constructs estimates of consumer spending at the NUTS 2 level for all European regions.[6]

Finally, to compute our preferred measure of total factor productivity (TFP), it is necessary to use information on the private capital stock, which is not available at the NUTS 2 level. Using ARDECO's data, we estimate private capital stock as follows:

$$K_t^p = K_{t-1}^p + I_t^p - D_t^p \tag{1}$$

[6]We are grateful to Oxford Economics for sharing these data. The consumption series is measured on a 'residence basis,' capturing the spending of people living in each region rather than spending that occurs within the region. This measurement concept is more appropriate for our purposes as it better reflects actual household consumption behavior.

where K_t^p is the private capital stock, I_t^p is private investment, and D_t^p is the depreciation of private capital. The initial level of private capital stock is estimated using the total capital stock and the share of private investment: $K_0^p = K_0 \times \frac{I_t^p}{I_t}$. [7]

2.2 Regional utilization-adjusted TFP

2.2.1 Construction

We construct a measure of utilization-adjusted TFP for each NUTS 2 region in two steps. First, following the growth-accounting methodology of the Penn World Tables (PWT), we derive the private-sector Solow residual. This measure captures both productivity improvements and fluctuations in unobserved labor and capital utilization. Second, we remove the utilization component using a model-based adjustment adapted from Imbs (1999). This produces a measure of productivity that is insulated from cyclical factor-intensity movements.[8]

Production framework. For each region, private-sector output (private GVA) is produced according to

$$Y_t^p \;=\; A_t \,(u_t K_t^p)^{1-\alpha_t}\,(e_t H_t^p)^{\alpha_t} = \tilde{A}_t\,(K_t^p)^{1-\alpha_t}(H_t^p)^{\alpha_t}, \tag{2}$$

where K_t^p denotes the private capital stock, H_t^p private hours worked, u_t the rate of capital utilization, and e_t labor effort. The parameter α_t is the output elasticity of labor. The term A_t denotes utilization-adjusted TFP, while

$$\tilde{A}_t = A_t\, u_t^{1-\alpha_t}\, e_t^{\alpha_t}$$

is the corresponding (unadjusted) Solow residual. Equation (2) is the basis for our two-step TFP construction.

Step 1: Private-sector Solow residual. Abstracting from utilization, log-differentiating (2) yields

$$\Delta \ln \tilde{A}_t = \Delta \ln Y_t^p - (1-\alpha_t)\,\Delta \ln K_t^p - \alpha_t\,\Delta \ln H_t^p. \tag{3}$$

This variation in Solow residual ($\Delta \ln \tilde{A}_t$) captures both true productivity change and fluctuations in effort and capital utilization. Following standard practice in PWT and EU-KLEMS, we proxy α_t with the private-sector labor income share smoothed with a two-year moving average.

[7] Gardiner et al. (2020) estimates of private capital stock are available only until 2016. When using them to construct a new TFP measure as a robustness check, results remain unchanged.

[8] Several studies have constructed regional TFP measures (e.g. Beugelsdijk et al. 2018; Siller et al. 2021) relying on the Solow residual. For our purposes, it is essential to incorporate adjustments for time-varying utilization, as a large literature documents that fluctuations in labor effort and capital utilization account for a substantial share of the cyclicality in the Solow residual (see Burnside et al. 1995; Basu and Kimball 1997).

Step 2: Adjustment for labor effort and capital utilization. We adjust $\tilde{A}_t$ for variation in e_t and u_t. The adjustment formulas follow from the optimality conditions of households and firms in a model, where household utility depends on household consumption, hours worked, and effort. In this framework, firms choose variable capital utilization and labor effort, both of which enter the production function alongside TFP, hours, and the predetermined capital stock. Increases in capital utilization entail additional costs, while higher labor effort requires compensating wage premia. The resulting conditions governing the utilization adjustments are summarized below, and the full model and derivations are presented in Appendix B.

Effort adjustment. Optimizing households jointly choose hours and effort by equating the marginal disutility of each activity to its corresponding marginal return in labor income. Firms, in turn, choose labor services on both the extensive (hours) and intensive (effort) margins such that the marginal product of effective labor equals the marginal cost of supplying it. As shown in Appendix B, combining the household first-order conditions for hours and effort with the firm's optimality condition yields a stable mapping between hours worked and effort supplied. This implies

$$e_t = (H_t^p)^{\frac{1+\upsilon}{1+\upsilon_e}}, \tag{4}$$

where the elasticities (υ, υ_e) reflect the curvature of the disutilities from hours and effort. This mechanism aligns with the interpretation in Basu et al. (2006), who emphasize that fluctuations in hours serve as an observable proxy for broader movements in labor utilization and work intensity. Following Jordà et al. (2020), we set the curvature parameters of disutility from hours and effort to unity, $\upsilon = \upsilon_e = 1$.

Capital-utilization adjustment. The cost of capital utilization is increasing in the intensity of utilization u_t reflecting the additional depreciation, wear, and maintenance associated with operating capital more intensively. Accordingly, utilization costs are proportional to the existing capital stock K_t^p and the replacement-cost price of investment goods Q_t. Firms choose u_t by equating the marginal cost of higher utilization to the marginal product of utilized capital. Together with firms' optimal choice on hours, this yields the following proportional utilization index:

$$\frac{u_t}{\bar{u}} = \left(\frac{W_t H_t^p}{K_t^p Q_t} \Big/ \frac{\overline{WH^p}}{\overline{K^p Q}} \right)^{1/\beta_k}. \tag{5}$$

Here $W_t H_t^p$ is nominal private labor compensation, Q_t the investment-goods price index, and β_k reflects the curvature of utilization costs. Variables with a bar indicate steady-state values. Intuitively, with a predetermined capital stock, when firms face stronger demand, the optimal utilization rate comoves with the labor payments. We set $\beta_k = 4$ following Anzoategui et al. (2019). Trend values $(\overline{WH^p}/\overline{K^p Q})$ are obtained by HP-filtering the corresponding ratio.

Utilization-adjusted TFP. Combining (3)–(5), growth in utilization-adjusted TFP is given by

$$\Delta \ln A_t = \Delta \ln \tilde{A}_t - (1 - \alpha_t)\, \Delta \ln u_t - \alpha_t\, \Delta \ln e_t, \tag{6}$$

where the utilization terms are constructed using (4) and (5).

Alternative elasticity estimates. Using income shares to proxy α_t presumes perfect competition. Under imperfect competition, cost shares should be used instead (Comin et al. 2022). Because regional cost-of-capital data are not directly observable, constructing a cost-share–based elasticity requires additional assumptions. As a robustness check, we estimate the cost of capital following Comin et al. (2022) and compute TFP using the resulting cost-share–based elasticities. The corresponding series (Appendix C.3) are fully consistent with our baseline measure.

2.2.2 Properties of the regional TFP series

Summary statistics and spatial patterns. Across all NUTS 2 regions, the average annual utilization-adjusted TFP growth rate is 0.27 percent, with a standard deviation of 0.85. Figure 1 displays the average annual TFP growth rate for each region in our sample. Substantial heterogeneity emerges across the euro area : regions in Finland, Eastern and Southern Germany, and Eastern Austria exhibit persistently strong productivity growth over the sample period, whereas productivity declines are concentrated in Southern Italy and parts of Southern Spain.[9] These spatial patterns mirror the well-documented North–South divide in economic performance within the euro area .

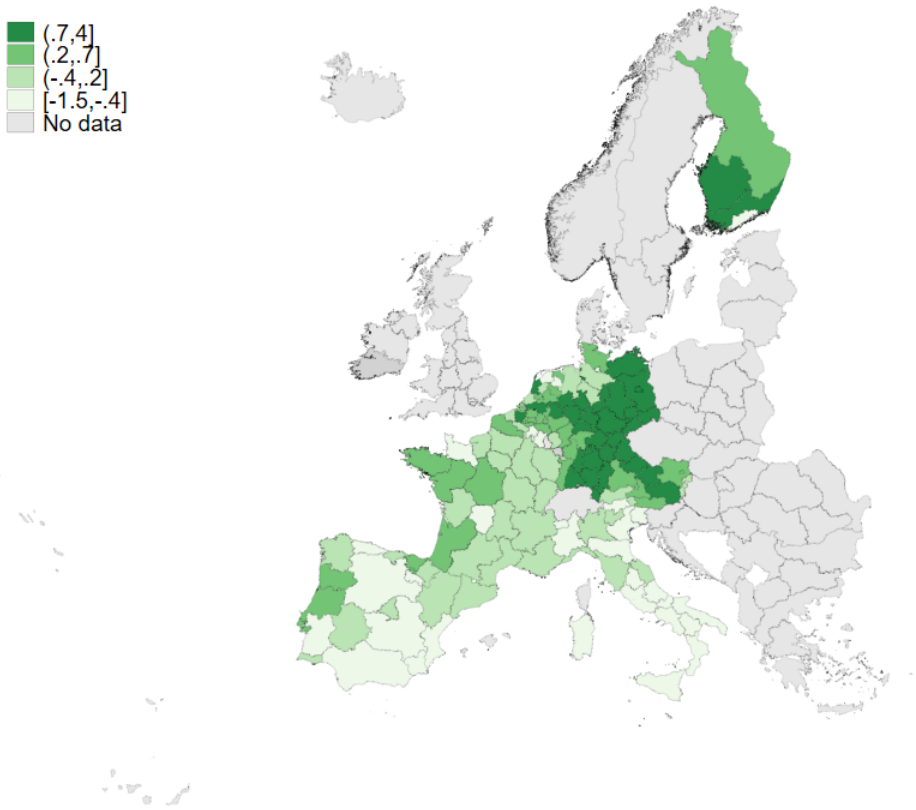
For comparison, labor productivity displays substantially higher average growth and considerably lower dispersion (Appendix Figure C.2).[10] Because labor productivity conflates productivity dynamics with changes in capital stock and factor utilization, it can obscure underlying differences in productivity performance across regions. Nevertheless, as shown below, our main empirical results are robust to using labor productivity instead of TFP.

Regional versus national dispersion. Figure 2 compares the distribution of annual TFP growth using regional versus country-level aggregates. Incorporating regional information markedly increases the observable dispersion in productivity dynamics. Ireland exhibits the highest average growth and the largest dispersion in both the regional and national series. The much wider dispersion in regional TFP growth provides substantially more identifying variation than national

[9] The regions with the highest average annual TFP growth are IE06 (Eastern and Midland, +4.00 percent), IE05 (Southern, +3.35 percent), and DE24 (Oberfranken, +1.97 percent). At the other end of the distribution, the lowest rates are observed in IE04 (Northern and Western, −1.54 percent), ITF2 (Molise, −1.29 percent), and ITF6 (Calabria, −1.12 percent).

[10] Across regions, mean annual labor-productivity growth is 2.05 percent with a standard deviation of 0.54.

Figure 1: Average Annual TFP Growth Rates



Notes: The figure displays a 20-year average annual utilization-adjusted TFP growth by NUTS 2 region over 1999–2019. Darker shades indicate higher productivity growth. The sample covers 139 regions across ten euro area countries: Austria, Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, and Spain. Regions in gray are outside the sample. See Table A.1 for details on sample coverage.

aggregates, thereby improving the precision of our estimated productivity responses to fiscal consolidations.

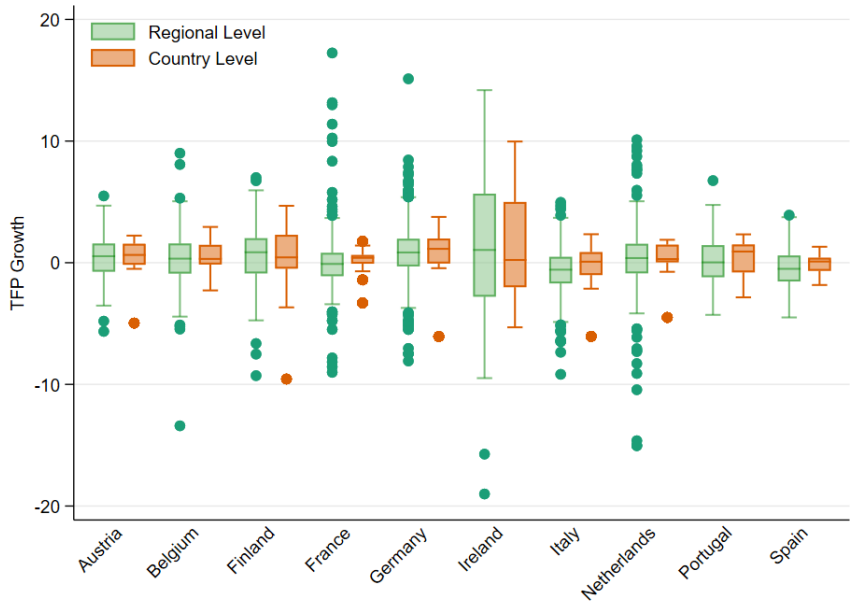
Cyclicality. TFP is, on average, procyclical: the correlation between annual TFP growth and annual output growth is 0.52, significant at the 1 percent level. Figure 3 illustrates the positive relationship at the regional level.[11]

2.2.3 Comparison with aggregate national TFP measures

National TFP measures are widely used in macroeconomic analysis, and we therefore benchmark our regional TFP series against comparable national aggregates. To do so, we aggregate

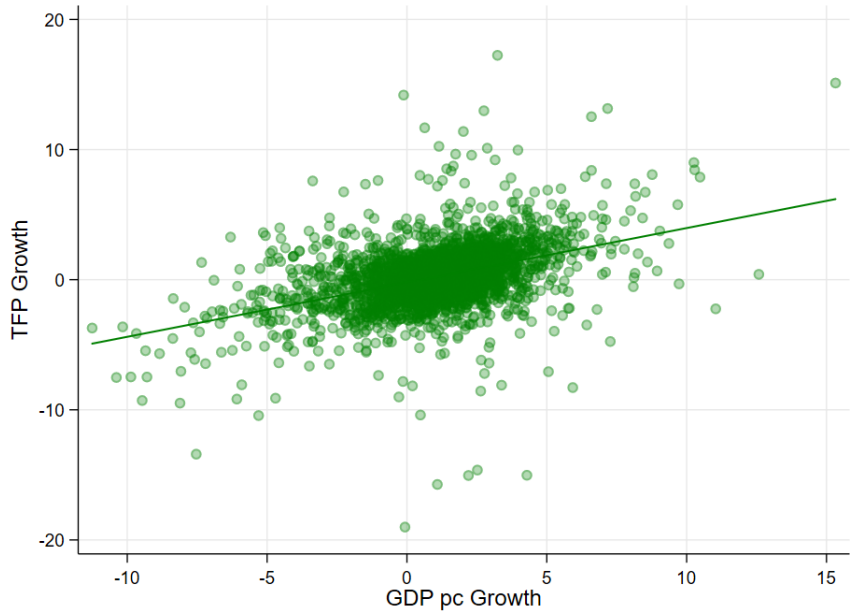
[11]The strength of cyclicality varies across countries. For example, TFP growth is negatively correlated with output growth in Spain (−0.35, significant), only weakly correlated in Portugal (−0.02, insignificant), and moderately correlated in the Netherlands (+0.19). In all other countries, correlations cluster around 0.5.

Figure 2: Distribution of Country- and Regional-Level Annual TFP Growth



Notes: Distribution of annual utilization-adjusted TFP growth for region-level and country-level series, 1999–2019. Excluded the 2015 outlier for Ireland at the country level as well.

Figure 3: Utilization-Adjusted TFP Growth and Output Growth



Notes: Scatter plot of annual utilization-adjusted TFP and GDP growth at the regional level, 1999–2019. The IE05 observation for 2015 is excluded due to an extreme output growth outlier.

regional Solow residual and utilization-adjusted TFP growth rates into national series using Tornqvist indices.[12]

Non–utilization-adjusted TFP. The national Solow residuals aggregated from our regional data is highly correlated with standard national measures that are also not utilization-adjusted. In particular, the correlation with non-adjusted TFP from the Penn World Table (PWT) and from EU-KLEMS is approximately 0.9 (Table 1).[13]

	PWT TFP	EU–KLEMS TFP
National Solow residual (growth)	0.892***	0.929***
	(0.000)	(0.000)

Table 1: Pairwise correlations: Solow residuals

Notes: The table shows pairwise correlations between the growth rate of the national Solow residual—constructed by aggregating regional Solow residuals using Tornqvist indices—and national TFP series from PWT and EU–KLEMS. All series are within-region demeaned and non–utilization-adjusted.

Utilization-adjusted TFP. When we aggregate our utilization-adjusted TFP series to the national level, the resulting measure remains positively and significantly correlated with the national utilization-adjusted TFP estimates of Comin et al. (2022), Basu et al. (2006), and Jordà et al. (2020) (Table 2). The somewhat lower correlation reflects methodological differences across approaches. Comin et al. (2022) estimate the output elasticity using cost rather than revenue shares, while Basu et al. (2006) and Comin et al. (2022) adjust the Solow residual using an instrumental-variables (IV) procedure based on utilization proxies. The IV approach relies on an exclusion restriction requiring TFP to be exogenous to the instruments used to purge utilization effects; this assumption is difficult to maintain in our setting, where the objective is to study whether TFP responds endogenously to demand fluctuations. By contrast, the utilization adjustment of Imbs (1999), which we adopt as our baseline, is derived from firms' and households' optimality conditions and does not require a regression-based identification strategy. Our utilization-adjusted TFP is therefore closest to that of Jordà et al. (2020), who also adopt the Imbs adjustment.[14]

Our baseline results remain robust when we recompute adjusted TFP using cost-share based elasticities (Appendix C.3) or when applying the instrumental variables procedure used in Basu

[12]National TFP growth is computed as the weighted average of regional growth rates, with weights equal to the two-year moving average of each region's share in national GVA.

[13]This strong relationship is noteworthy because our regional series is based exclusively on private-sector activity, whereas PWT and EU KLEMS provide economy-wide TFP measures. The high correlation indicates that private-sector dynamics account for most of the variation in aggregate TFP.

[14]We also aggregate our regional utilization indices using Tornqvist weights and compare them with national manufacturing capacity-utilization indicators from the European Commission's Business and Consumer Survey (BCS). Despite differences in sectoral coverage, the correlation is 0.5 and significant at the 1 percent level, further supporting the informational content of our utilization measure.

et al. (2006) and Comin et al. (2022) (Appendix C.4).

	Comin et al. (2024)	Basu et al. (2006)	Jorda et al. (2025)
National TFP	0.397 ***	0.463 ***	0.548 ***
	(0.000)	(0.000)	(0.000)

Table 2: Pairwise correlations: utilization-adjusted TFP

Notes: The table shows pairwise correlations between the growth rate of the national utilization-adjusted TFP—constructed by aggregating regional utilization-adjusted TFP using Tornqvist indices—and national TFP series from Basu et al. (2006), Comin et al. (2022), and Jordà et al. (2020). All series are within-region demeaned. Data for Comin et al. (2022) come from the Europrod database and cover Germany, France, Italy, Spain, and the Netherlands. The Basu et al. (2006) series are TFP measures constructed using the Basu et al. (2006) adjustment method and obtained from the data package of Comin et al. (2020); these series cover Germany, France, Italy, and Spain. Data for Jordà et al. (2020) are taken from the authors' publicly available data package.

2.3 Narrative austerity episodes

Our data for narrative fiscal consolidations comes from Adler et al. (2024) and spans from 1978 to 2020. Building on Devries et al. (2011), Alesina et al. (2015), and Alesina et al. (2020), we use this variable to address the potential endogeneity of shifts in fiscal variables using the "narrative" approach in the spirit of Romer and Romer (2010) and carefully dividing variables into spending- and tax-based consolidations.

The measure is constructed by examining contemporaneous OECD policy documents that outline the economic situation, fiscal consolidation strategy, and major consolidation measures for each of the OECD member countries. The country notes in each report are used to identify "exogenous" consolidations as they lay out the government's rationale for pursuing fiscal adjustment. To be precise, it is possible to identify consolidation periods that were motivated by a desire for deficit reduction, meant to correct its long-run trend, or driven by other motives unrelated to the state of the business cycle, thus excluding adjustments connected to short-run, countercyclical concerns. Consolidations are measured in terms of their impact on total revenue and expenditure (relative to a baseline without policy intervention) and scaled by the output level prior to the intervention announcement.

The main advantage of identifying fiscal consolidations via the narrative measure, compared to changes in the current account primary balance (CAPB) as suggested by Alesina and Ardagna (2010), is that they are exogenous to current economic developments, while changes in the CAPB are correlated with the business cycle. Guajardo et al. (2014) show that there is a significant positive correlation between GDP forecast revisions and changes in the CAPB, whereas the null hypothesis of no correlation between forecast revisions and the narrative measure cannot be rejected.

Alesina et al. (2020) classify as spending-based consolidations all measures related to government spending and investment, including expenditure on goods and services, salaries, managing costs of state-provided services (such as education and healthcare), and government gross fixed capital formation expenditures. Regarding tax-based consolidations, they account for all direct and indirect tax changes. Adler et al. (2024) harmonized, revised, and extended Guajardo et al. (2014) and Alesina et al. (2020) databases.

Throughout the paper, the narratively identified austerity episodes at time t in country I ($\tilde{g}_{I,t}$) measure only spending-based consolidations, excluding episodes driven by significant changes in the tax system. The regional government spending proxy used in the analysis does not include tax revenues. It mainly encompasses the public wage bill and, to a lesser extent, the consumption of fixed capital and intermediate consumption. Therefore, excluding consolidation episodes driven by significant changes in the tax system allows for a stronger and clearer relationship between the narrative national austerity episodes and the regional government spending measures.[15] Following the definition in Devries et al. (2011), Adler et al. (2024) construct $\tilde{g}_{I,t}$ as the sum of unanticipated shifts in government spending at time t – $(g^u_{I,t})$ – and changes in spending that are implemented at time t but had been announced in previous periods – $(g^a_{I,t-1,t})$.

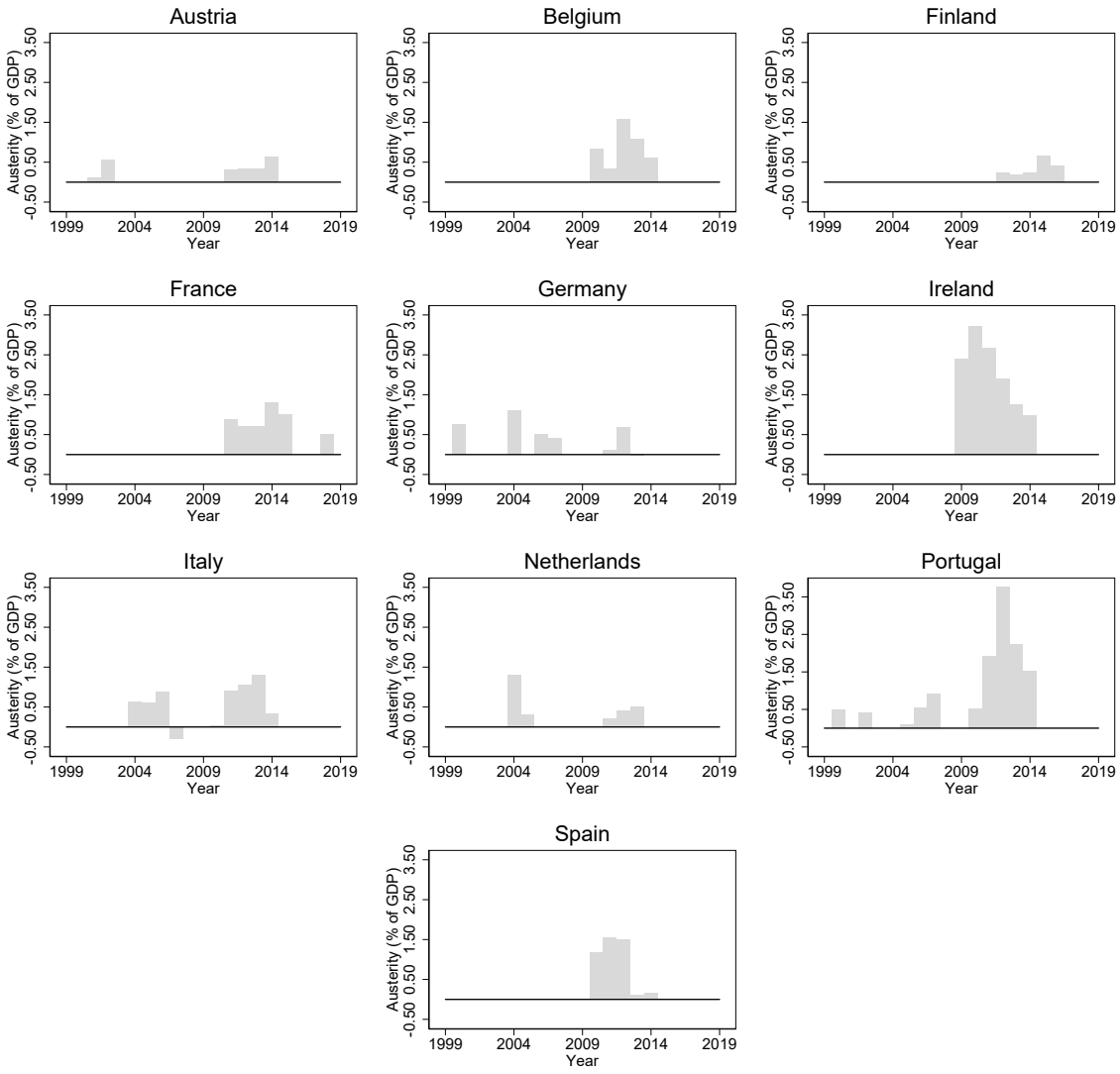
For our sample, we observe 62 consolidation episodes and 2 reversals of consolidations, which corresponds to 30% of all country-year observations. The consolidation episodes are expressed relative to GDP. The mean (median) consolidation amounts to 0.88% (0.65%) of GDP. The largest intervention of 3.76% of GDP occurred in Portugal in 2012 during the Sovereign Debt Crisis. Figure 4 presents the individual austerity episodes for each country.

We can see that there is no apparent difference in the number of episodes between European Core (Austria, Belgium, Finland, France, Germany, and the Netherlands) and Periphery (Ireland, Italy, Portugal, and Spain) countries. There were 29 episodes in the periphery and 33 in the core regions of our sample. It is important to note that for our proposed sample with 10 countries between 1999 and 2019, almost half of the fiscal consolidation episodes happened during the sovereign debt crisis.

Unconditional relationship between TFP growth and austerity-driven spending changes. Figure 5 provides some first insights into the relationship between government spending changes and TFP growth. It shows for the euro area regions in our sample and for one of the main consolidation years in the sample, namely 2012, the relation between austerity-driven government spending growth and TFP growth. There is a significant negative correlation, that is, reductions in public spending are associated with increases in productivity growth. While Figure 5 is infor-

[15]For the identification strategy described in section 3, focusing on spending-based fiscal adjustments implies maximizing the link between the exogenous shift variable and the outcome variable of the first-stage regression.

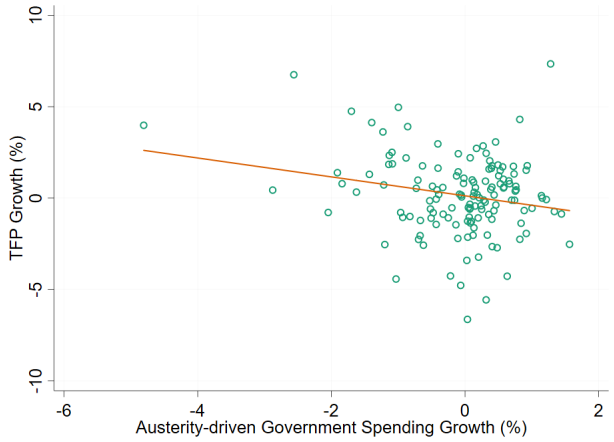
Figure 4: Austerity by Country



Notes: Austerity episodes are identified according to Adler et al. (2024) and present the size of fiscal consolidations based on the previous year's GDP in percent.

mative about the unconditional correlation between TFP growth and fiscal consolidations, it does not provide a causal interpretation. In the rest of the paper, we conduct a thorough econometric analysis to investigate whether austerity causes an increase in TFP.

Figure 5: TFP annual growth and austerity-driven spending changes in 2012



Notes: The chart plots on the y-axis one-year changes in TFP and on the x-axis one-year changes in austerity-driven government spending per capita. For this, government spending is first regressed on the austerity shocks and region and time fixed-effects. The correlation is 0.21 and statistically significant at 5% confidence level.

3 Empirical Strategy

In estimating the dynamic effects of austerity on regional economic outcomes, we closely follow the econometric specification by Gabriel et al. (2023, 2026):

$$\frac{Y_{i,t+h} - Y_{i,t-1}}{Y_{i,t-1}} = \beta_h \frac{G_{i,t} - G_{i,t-1}}{G_{i,t-1}} + \gamma_h(L)X_{i,t-k} + \alpha_{i,h} + \delta_{t,h} + \varepsilon_{i,t+h} \quad \forall h \in \{0,1,2,3,4\} \quad (7)$$

where $\frac{Y_{i,t+h}-Y_{i,t-1}}{Y_{i,t-1}}$ is the growth rate of TFP or other variables of interest such as other measures of productivity and economic activity like per capita GDP, employment, consumption, or investment; $(L)X_{i,t-k}$ is a vector of control variables and $\alpha_{i,h}$ are region fixed-effects to control for region-specific (unobserved) characteristics. $\delta_{t,h}$ are time fixed-effects that account for common aggregate trends. The vector of additional control variables includes two lags of the endogenous variable and two lags of regional per capita government spending, both in growth rates.[16] β_h directly yields the response of the variable of interest to a one percent decrease in per

[16]Tables 3 shows that adding other controls, including lags of per capita GDP, capital stock, and hours worked, does not change the baseline results.

capita government spending $G_{i,t}$. Throughout, we cluster the standard errors at the regional level to account for potential serial correlation and heteroskedasticity within regions over time.

Endogeneity concerns related to estimating equation (7) directly by OLS could arise from two sources. First, government spending, TFP, and other economic variables may respond to a common third factor, such as changes in demand or supply conditions, which could simultaneously influence regional fiscal balances and economic outcomes. Any estimated relationship will then be due to structural disturbances other than fiscal consolidations which would bias the results. Second, there might be a reverse causality problem, as higher productivity might result in lower public spending needs.

To overcome these endogeneity issues, we use an instrumental variable approach following Gabriel et al. (2026) and instrument the change in regional government spending with a Bartik-type instrument (Bartik 1991). In particular, the Bartik instrument is computed as follows:

$$\frac{\overline{G_i}}{\overline{G_I}} \times \tilde{g}_{I,t} \tag{8}$$

where $\tilde{g}_{I,t}$ is the narrative national consolidation measure as described in Section 2.3 and $\overline{G_i}$ and $\overline{G_I}$ are the averages of *per capita* government spending in region i and country I in the five years before the accession of country I to the Eurozone, respectively. Intuitively, if $\frac{\overline{G_i}}{\overline{G_I}}$ is greater than 1, region i spends more *per capita* than the national average, implying that a disproportionate amount is spent in this region. By interacting these regional sensitivities with narrative accounts of national fiscal consolidation programs, we assume that regions that rely more heavily on public spending cut back government expenditures more strongly when the national government implements austerity measures. Thus, the idea of the instrument is to scale national fiscal consolidation plans such that spending varies more in regions with a larger share of per capita national government spending.

Figure C.1 in the Appendix shows a heat map depicting the share $s_i = \frac{\overline{G_i}}{\overline{G_I}}$ for the NUTS 2 regions used in the sample. Even though the mean is approximately 1, there is considerable cross-sectional variation in this measure, ranging from 0.70 to 2.21. We calculate the lowest shares for Andalucía (Spain, 0.701), Niederösterreich (Austria, 0.702), and Norte (Portugal, 0.741), and the highest shares for Région de Bruxelles-Capitale (Belgium, 2.210), Lazio (Italy, 1.655), and Valle d'Aosta (Italy, 1.601). Variation in the shares over time is small — when calculating time-varying shares for each region between 1994 and 2019, we find that the average standard deviation is around 0.032.[17]

Our identifying assumption is that central governments do not adopt austerity measures be-

[17]Results remain robust when using a time-varying measure of the spending share (see Table 3).

cause regions that receive a disproportionate amount of government spending are experiencing certain economic conditions relative to other regions. For example, the government does not cut expenses because a certain region is doing better economically. This is likely for two reasons. First, we are using narrative-identified austerity shocks that are by construction not driven by economic conditions and primarily motivated by national budgetary motives. Second, the data used are disaggregated at the NUTS 2 level. Intuitively, this assumption might be violated when focusing on high levels of aggregation, which, given their relevance, could directly affect central government decisions.[18]

Figure 6 shows the results of the first stage regression, extended to a 5-year horizon:

$$\frac{G_{i,t+h} - G_{i,t-1}}{G_{i,t-1}} = \beta_h \frac{\overline{G_i}}{\overline{G_I}} \times \tilde{g}_{I,t} + \gamma_h(L) X_{i,t-k} + \alpha_{i,h} + \delta_{t,h} + \varepsilon_{i,t+h} \quad \forall h \in \{0,1,2,3,4\} \tag{9}$$

where the vector of controls includes lags of government spending and TFP growth.

The left panel depicts the estimated response of regional government spending to the consolidation shock, together with the 90% and 95% confidence bands. The response is normalized so that spending falls by 1% in year 0. We find a significant and persistent fall in regional government spending following the austerity shock. Three years after the shock materialized, the reduction in government spending reached its trough at around 2.7%. At the end of the forecast horizon, government spending is still significantly reduced by around 2%. Importantly, our instrument fulfills the relevance condition. The Kleibergen–Paap rk Wald F-statistic takes a value of 26.52 and is therefore above the Olea and Pflueger (2013) threshold of 23 for a 5% critical value, implying that a weak instrument are not a concern for our analysis.

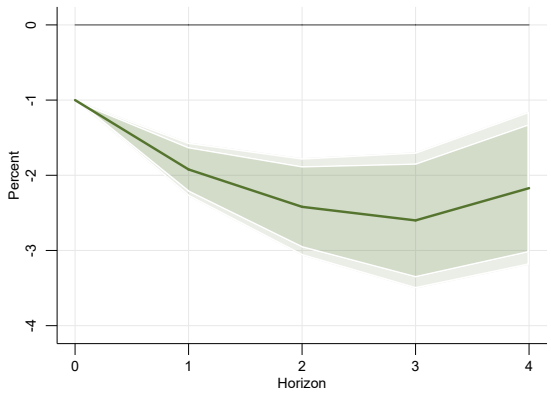
In what follows, we will use the estimated reduction in regional government spending and test whether there is a causal effect of lower public spending on regional productivity growth.

4 Results

In this section, we present the main empirical results. Before moving to the main object of interest, namely the response of utilization-adjusted TFP to the identified government spending shock, we start by investigating the responses of other main economic variables like GDP, investment and employment. Thereafter, we discuss our novel finding, a significant increase in productivity following an exogenous decline in government spending. We further investigate the responses of the individual sub-components of TFP and discuss the robustness of the main result.

[18] Gabriel et al. (2023) show that the level of variation in the increment increases substantially from the NUTS 1 to the NUTS 2 levels, supporting our identification strategy.

Figure 6: First Stage: Government Spending Response



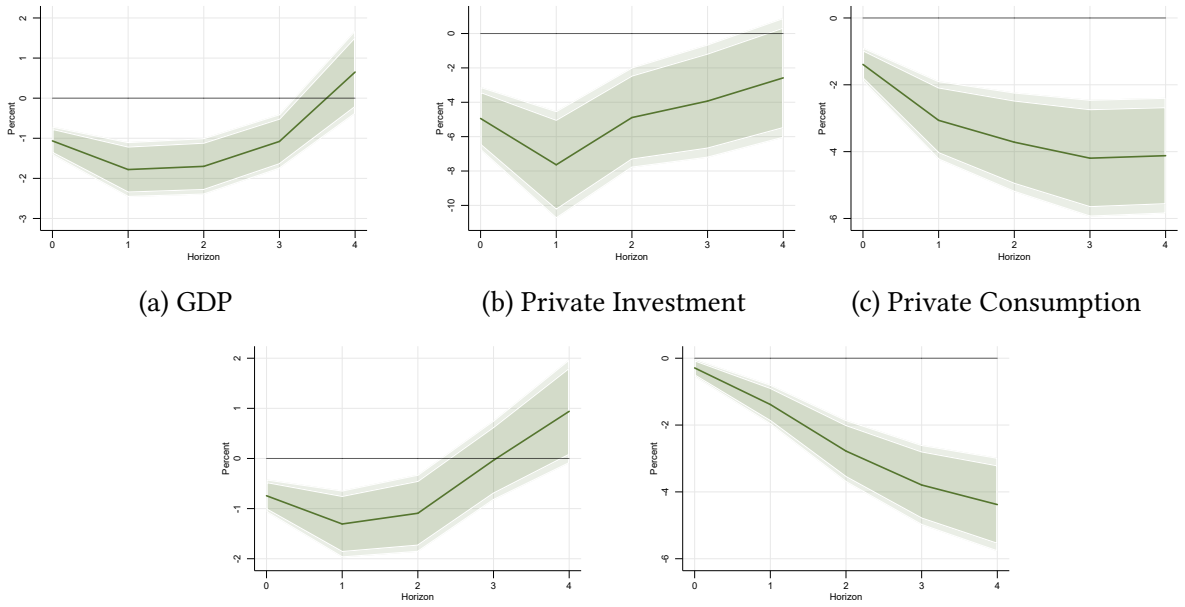
Notes: Figure 6 plots the percent change of per capita government spending in response to a one percent fiscal shock. Bands are 90% (dark) and 95% (light) confidence intervals.

4.1 GDP and Components

Before turning to the response of TFP, we first investigate the responses of other main economic variables to the regional government spending shock which helps understanding the overall economic effects of the identified fiscal intervention. Figure 7 shows the responses of several variables of interest. Overall, the results show that a fiscal consolidation induces a significant decline in economic activity very much in line with previous literature (Guajardo et al. 2014; Alesina et al. 2015; Gabriel et al. 2026).

The upper left panel of Figure 7 shows the response of regional GDP. There is a significant decline by roughly 1% already in the impact period and it reaches its through two years after the shock with a fall of almost 2%. Thereafter, GDP slowly converges back to its pre-shock level with the response becoming insignificant at the end of the forecast horizon. The middle and right panel of Figure 7 show the responses of the main private components, namely private investment and consumption expenditures. Both show a significant decline following the fiscal consolidation, with investment reaching the peak decline already one year after the shock materialized, whereas the decline in private consumption is more persistent with the through experienced three years after the shock. The second row of Figure 7 presents the responses of some labor market variables, in particular the impact on employment and wages. The fiscal interventions has some detrimental labor market consequences with employment significant lowered for a couple of years following the shock and wages significantly lowered even in the medium term. Thus, the overall economic consequences of our identified exogenous fall in regional government spending expenditures are a significant decline in real economic activity coupled with a fall in employment and a lowering in labor income.

Figure 7: Dynamics - Nuts 2 - 1999:2019



(a) GDP (b) Private Investment (c) Private Consumption

(d) Employment (e) Priv. Hourly Compensation

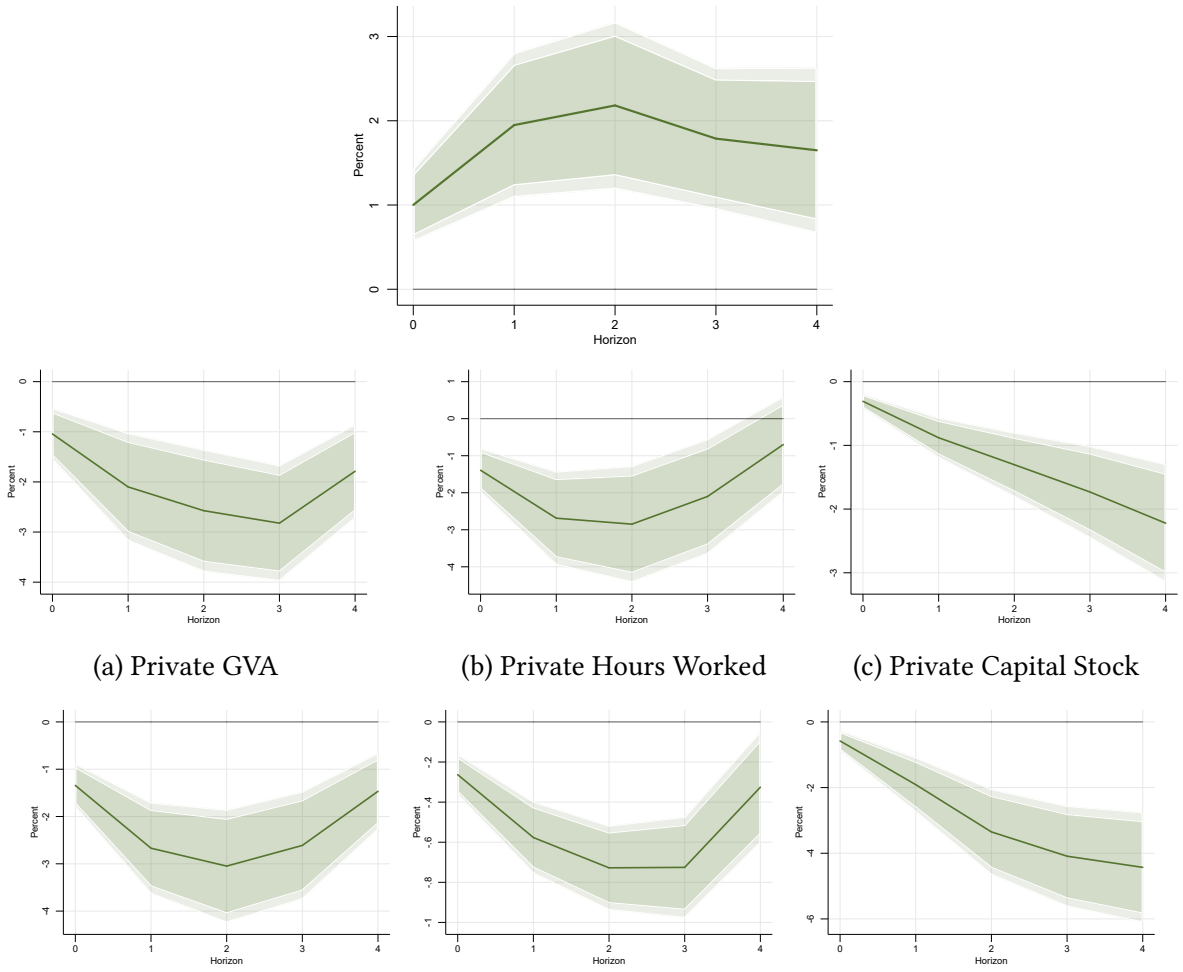
Notes: Impulse responses to a one percent austerity-driven decline in government spending, estimated as in equation 7. Bands are 90% (dark) and 95% (light) confidence intervals.

4.2 Baseline TFP Response

After having established that the consolidation shock leads to a decline in regional economic outcomes, we turn to the main variable of interest, namely the response of our proposed utilization-adjusted TFP measure. Figure 8 shows the response of our baseline TFP measure to the exogenous fall in regional government spending. The fiscal consolidation leads to a significant increase in productivity. On impact, productivity rises by almost 1% and further increases over the forecast horizon. Four years after the shock, TFP is still elevated at around 1.5%. The response is highly significant throughout the horizon considered with relatively tight confidence bands. Thus our main results suggest that while fiscal consolidations lower general economic activity, they tend to significantly increase productivity in the short and medium term.

To better understand the driving forces of the overall TFP response, we next turn to the subcomponents of our TFP measure. Figure 8 also presents the responses of the main TFP components. The upper left and middle panel shows the responses of private GVA and private hours worked, respectively. Both variables significantly decline following the fiscal interventions. However, because total labor input fall stronger than output, at least in the first couple of years, labor productivity somewhat increases following the fiscal consolidation. The response of the second main input factor, capital, is shown in the upper right panel of Figure 8. The fall in government

Figure 8: Response of TFP and Growth components to Austerity Shock



(a) Private GVA (b) Private Hours Worked (c) Private Capital Stock

(d) L effort (e) K utilization (f) Alpha

Notes: Impulse responses of TFP and other growth components to a one percent austerity-driven decline in government spending, estimated as in equation 7. Bands are 90% (dark) and 95% (light) confidence intervals.

spending induces a significant and persistent fall in the capital stock. At the end of the forecast horizon, capital is reduced by around 2%. Together with a reduced labor and capital input, also labor effort and capital utilization significantly decline as shown in the lower left and middle panel of Figure 8. Finally, the consolidation lowers the labor income share (see lower right panel of Figure 8) which is an important ingredient of our TFP measure. Taken together, these results indicate that the significant increase in TFP following the fiscal consolidation is due to strong declines in labor and capital inputs coupled with lower labor effort and capital utilization that together even outweigh the fall in private output.

4.3 Robustness Checks

Our main result of a significant increase in TFP following an exogenous decline in regional government spending is highly robust to several modifications of the baseline model. Table 3 presents the results of different robustness checks. For completeness, we repeat the estimates of the baseline specification in the first panel of the table. First, we include additional controls in local projections. In particular, we include lags of the growth rates of GDP per capita, capital stock, and hours worked. As shown in the second panel of Table 3, the estimated TFP response following the fiscal consolidation barely changes with this specification. In our baseline estimation, we clustered the standard errors at the regional level. To also take into account serial correlation and heteroskedasticity among the residuals over time, we rerun the baseline model using Driscoll and Kraay (1998) standard errors. As shown in the third panel of Table 3, standard errors become slightly larger when relying on the Driscoll and Kraay (1998) adjustment, but statistical significance remains. In the baseline sample, we excluded particular islands from the analysis. When including these islands, results do not change much, as shown in the fourth panel of Table 3.[19]

For our baseline TFP measure, we constructed a capital stock series using the perpetual inventory method. As an alternative, we can use the capital stock series published by Gardiner et al. (2020) for constructing data on regional TFP. As shown in the fifth panel of Table 3, relying on this alternative capital stock series does not significantly affect the estimated TFP response to fiscal consolidations. Given the dynamic sequences of the local projections, the estimated coefficients are based on slightly different sample sizes. In particular, while the on-impact effect is based on the longest sample, the time dimension sub-sequentially shrinks with each forecast horizon. To rule out any problems regarding different sample sizes, we can restrict the local projections to a balanced panel such that the estimated coefficients are based on the same sample. The sixth

[19]Besides excluding the French overseas departments and regions, we also drop the islands of Åland, Corsica, Madeira, Azores, Balearic Islands, and Canary Islands in the baseline model. These islands are often autonomous regions, with a lower population density than continental regions, creating outliers in terms of spending per capita and TFP growth.

Table 3: Robustness Checks

	0	1	2	3	4
(1) Baseline	1.00***	1.95***	2.18***	1.79***	1.65***
	(0.22)	(0.44)	(0.51)	(0.43)	(0.50)
F-Stat	26.03	26.03	26.03	26.03	26.03
# Obs	1,940	1,940	1,940	1,940	1,940
(2) Extra Controls	0.70***	1.67***	1.73***	1.32**	1.31
	(0.25)	(0.49)	(0.56)	(0.57)	(0.83)
F-Stat	13.90	13.90	13.90	13.90	13.90
# Obs	1,940	1,940	1,940	1,940	1,940
(3) DK Std. Errors	1.00***	1.95***	2.18***	1.79***	1.65***
	(0.35)	(0.61)	(0.51)	(0.29)	(0.41)
F-Stat	6.17	4.75	5.11	6.05	7.71
# Obs	1,940	1,940	1,940	1,940	1,940
(4) Extended Sample w/ Islands	1.02***	1.92***	2.08***	1.70***	1.53***
	(0.20)	(0.38)	(0.44)	(0.38)	(0.42)
F-Stat	36.24	36.24	36.24	36.24	36.24
# Obs	2,024	2,024	2,024	2,024	2,024
(5) Gardiner's Capital Stock	0.93***	1.64***	1.68***	1.51***	1.32***
	(0.24)	(0.37)	(0.44)	(0.44)	(0.47)
F-Stat	23.58	23.58	23.58	23.58	23.58
# Obs	1,561	1,561	1,561	1,561	1,561
(6) Time-Varying Share	1.00***	1.95***	2.18***	1.78***	1.61***
	(0.22)	(0.43)	(0.49)	(0.41)	(0.48)
F-Stat	27.15	27.15	27.15	27.15	27.15
# Obs	1,940	1,940	1,940	1,940	1,940

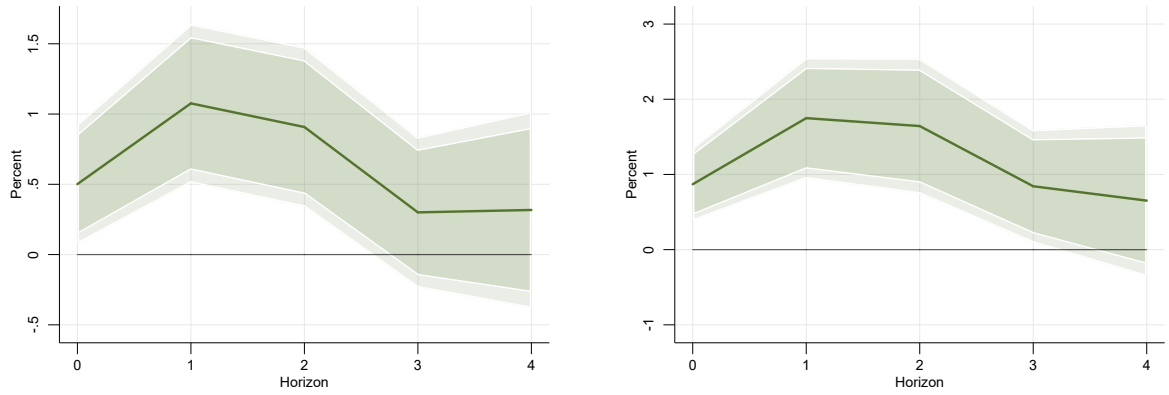
Notes: In row (2), extra controls include lags of GDP per capita growth, capital stock growth, and hours worked growth. In (5), Gardiner et al. (2020) capital stock is used to compute private sector TFP until 2016. In row (6), the instrument is computed with a time-varying regional share of government spending, instead of the pre-euro accession average. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

panel of Table 3 presents the corresponding results. The estimates do not significantly differ from our baseline findings. As an additional check, we recalculate our Bartik instrument by using the lagged value of $s_{i,t}$ instead of the average value s_i as used in the baseline specification. Thus, we allow for a time-varying regional elasticity to national public spending changes and use its lag to rule out any contemporaneous correlation between the national consolidation measure and the regional spending share. Again, as presented in the seventh panel of Table 3, the results are very similar to the baseline estimates, indicating that our finding is robust to different ways of calculating the share measure used in the construction of the Bartik instrument.

To assess how important any individual country is for the results, we re-estimate the baseline regressions by sequentially dropping one country at a time. The obtained results, reported in Table 4, are comparable to the baseline in every case.

Furthermore, we test whether our finding of a significant increase in productivity following a fiscal consolidation is robust to other proxies for productivity. Figure 9 presents the responses of different labor productivity series to the fiscal shock. The left panel shows the response of total GVA relative to total hours worked and the right panel shows the response of private GVA relative to total private sector hours. The regional fiscal consolidation induces a significant rise in both labor productivity measures. The increase in labor productivity is less pronounced and more short-lived compared to the utilization-adjusted TFP series as shown in Figure 8, but still highly significant.

Figure 9: Regional-level Labor Productivity responses - 1999:2019



(a) GVA/Hours

(b) Private Sector GVA/Hours

Table 4: Robustness Check: Excluding Countries

	0	1	2	3	4
Baseline	1.00***	1.95***	2.18***	1.79***	1.65***
	(0.22)	(0.44)	(0.51)	(0.43)	(0.50)
# Obs	1,940	1,940	1,940	1,940	1,940
Austria	1.02***	2.02***	2.23***	1.83***	1.64***
	(0.23)	(0.45)	(0.52)	(0.44)	(0.51)
# Obs	1,814	1,814	1,814	1,814	1,814
Belgium	0.91***	1.84***	2.01***	1.71***	1.67***
	(0.18)	(0.39)	(0.44)	(0.38)	(0.45)
# Obs	1,786	1,786	1,786	1,786	1,786
Finland	1.01***	1.95***	2.16***	1.80***	1.67***
	(0.22)	(0.44)	(0.51)	(0.44)	(0.52)
# Obs	1,884	1,884	1,884	1,884	1,884
France	0.83***	1.72***	2.09***	1.65***	1.46***
	(0.19)	(0.40)	(0.46)	(0.38)	(0.42)
# Obs	1,646	1,646	1,646	1,646	1,646
Germany	1.66***	2.95***	3.38***	2.89***	2.61***
	(0.48)	(0.86)	(1.03)	(0.91)	(0.99)
# Obs	1,409	1,409	1,409	1,409	1,409
Ireland	0.93***	1.71***	1.93***	1.62***	1.46**
	(0.28)	(0.43)	(0.56)	(0.59)	(0.71)
# Obs	1,903	1,903	1,903	1,903	1,903
Italy	0.94***	1.90***	2.08***	1.77***	1.70***
	(0.19)	(0.40)	(0.45)	(0.39)	(0.47)
# Obs	1,646	1,646	1,646	1,646	1,646
Netherlands	0.89***	1.72***	1.90***	1.45***	1.22***
	(0.20)	(0.41)	(0.48)	(0.37)	(0.39)
# Obs	1,772	1,772	1,772	1,772	1,772
Portugal	1.04***	2.18***	2.56***	2.06***	1.96***
	(0.26)	(0.52)	(0.56)	(0.43)	(0.58)
# Obs	1,870	1,870	1,870	1,870	1,870
Spain	1.11***	1.92***	1.97***	1.52***	1.47**
	(0.32)	(0.62)	(0.70)	(0.57)	(0.64)
# Obs	1,730	1,730	1,730	1,730	1,730

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4.4 Within-Sector Productivity vs. Reallocation across Sectors

Austerity shocks may raise utilization-adjusted TFP through two channels. First, productivity may increase *within* sectors, for instance through efficiency gains, restructuring, or a cleansing mechanism that reallocates activity toward more productive firms. Second, austerity may induce *reallocation* across sectors, whereby resources shift away from sectors that are highly exposed to government demand and toward sectors that are less dependent on public spending.

This reallocation mechanism is particularly relevant in the presence of heterogeneous exposure to the non-market sector. Using input–output (IO) tables, we measure for each sector the share of private gross output absorbed by the non-market sector and find that non-tradables are substantially more exposed than tradables, indicating a much stronger dependence on government demand.[20] Because non-tradables also exhibit persistently lower average annual TFP growth, -0.8 percent versus 1.7 percent for tradables, a contraction in government demand is likely to reduce the relative weight of non-tradables and shift activity toward higher-productivity-growth sectors. As a result, aggregate private-sector TFP may increase mechanically even in the absence of within-sector productivity improvements.

In what follows, we quantify the relative importance of within-sector productivity gains and between-sector reallocation using a standard within–between decomposition of the impulse response of aggregate TFP.

Decomposition framework. We focus on decomposing the TFP response for horizons $h = 0$ and $h = 1$, for which the first-order approximation underlying the within–between decomposition is most reliable. To illustrate the procedure, we present the decomposition for $h = 0$; the year-one case ($h = 1$) follows analogously.

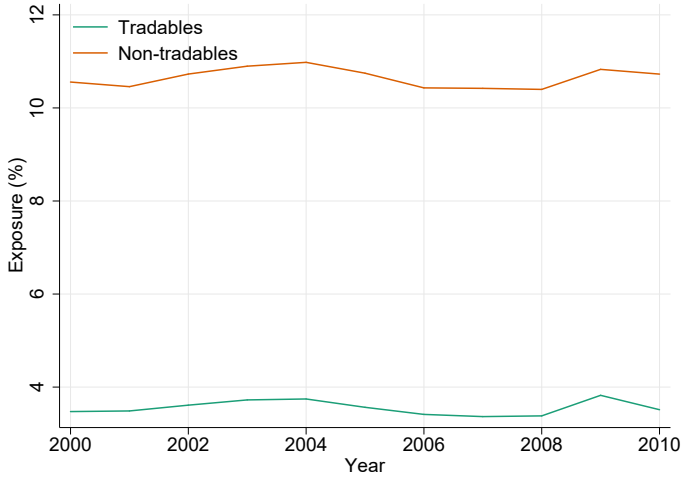
Let $s \in \{\text{tradable}, \text{non-tradable}\}$ index sectors. Aggregate private-sector TFP growth satisfies (Hulten 1978)

$$\frac{A_{i,t} - A_{i,t-1}}{A_{i,t-1}} \approx \sum_s D^s_{i,t} \frac{A^s_{i,t} - A^s_{i,t-1}}{A^s_{i,t-1}}, \tag{10}$$

where $A^s_{i,t}$ denotes sectoral TFP and $D^s_{i,t}$ is the sector's Domar weight. In our baseline estimation, the coefficient β_0 measures the impact response of aggregate TFP growth to a government spending shock. Sector-specific local projections (using the same specification) yield sectoral impact responses β^s_0, and a local projection for the weights $D^s_{i,t}$ delivers δ^s_0, the impact response of sectoral Domar weights. Taking a first-order approximation of the aggregation identity with respect

[20] ARDECO provides industry-level data at the 10-sector NACE aggregation. We classify sector A-E (Agriculture, forestry, and fishing; Mining and quarrying; Manufacturing; Electricity, gas, steam, and air-conditioning supply; Water supply, sewerage, waste management, and remediation activities) as tradable, and the remaining market sectors (NACE codes F–N) as non-tradable.

Figure 10: Exposure to the Non-Market Sector **Updated 9/29**



Notes: Exposure is defined as the ratio of output supplied to the non-market sector to total gross output, computed separately for tradables and non-tradables using IO tables. The figure reports average exposure over time.

to the shock and evaluating it at sample averages of Domar weights and TFP-growth rates yields

$$\beta_0 \approx \underbrace{\sum_s \bar{D}^s \beta_0^s}_{\text{within-sector response}} + \underbrace{\sum_s \overline{\frac{A_{i,t}^s - A_{i,t-1}^s}{A_{i,t-1}^s}} \delta_0^s}_{\text{between-sector (reallocation) response}} . \tag{11}$$

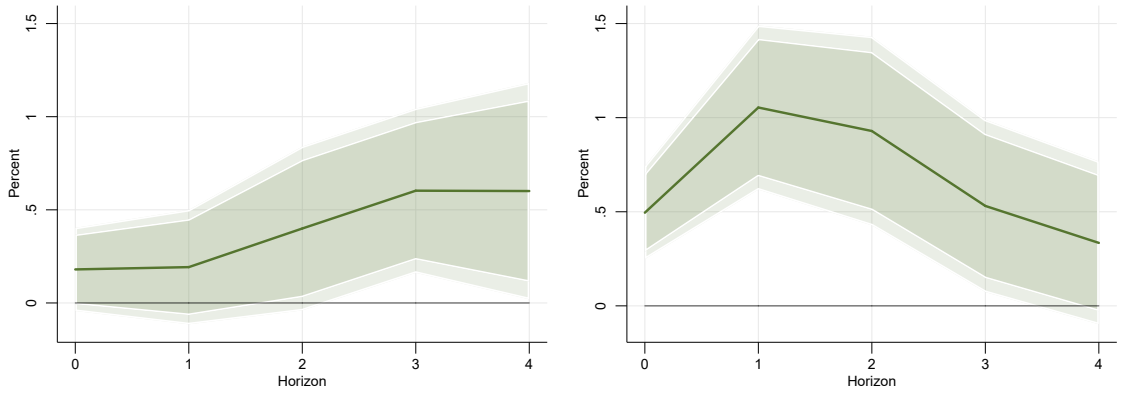
The first term captures how the shock affects aggregate TFP by changing sectoral TFP growth, holding sectoral weights fixed at their sample averages $\bar{D}^s$. The second term captures how the induced reallocation of Domar weights across tradable and non-tradable activities contributes to the aggregate impact response.[21]

Within-sector productivity responses. Figure 11 reports sectoral impulse responses of TFP following an austerity shock. To maintain comparability with the baseline aggregate specification—normalized to a government spending shock equivalent to one percentage point of output—we rescale sectoral responses by each sector's private GVA share. Both sectors' TFP rises after the shock. The tradable sector responds gradually, reaching roughly 0.5 percent four years after the shock. The non-tradable response is front-loaded: about 0.5 percent on impact and

[21] Formally, define aggregate and sectoral TFP growth over $[t-1, t+h]$ as $\psi_{i,t+h}(\varepsilon_t) \equiv (A_{i,t+h} - A_{i,t-1})/A_{i,t-1}$ and $\psi_{i,t+h}^s(\varepsilon_t) \equiv (A_{i,t+h}^s - A_{i,t-1}^s)/A_{i,t-1}^s$, where we make explicit the dependence on the spending shock ε_t. The aggregation result implies $\psi_{i,t+h}(\varepsilon_t) \approx \sum_s D_{i,t}^s(\varepsilon_t)\, \psi_{i,t+h}^s(\varepsilon_t)$. Differentiating both sides with respect to ε_t gives $\frac{\partial \psi_{i,t+h}}{\partial \varepsilon_t} \approx \sum_s \frac{\partial D_{i,t}^s}{\partial \varepsilon_t} \psi_{i,t+h}^s + \sum_s D_{i,t}^s \frac{\partial \psi_{i,t+h}^s}{\partial \varepsilon_t}$. Evaluating this expression at the sample means $(\bar{D}^s, \bar{\psi}_h^s)$, links the aggregate impulse response at horizon h to the sectoral impulse responses and the response of the Domar weights: $\beta_h \approx \sum_s \bar{\psi}_h^s \delta_h^s + \sum_s \bar{D}^s \beta_h^s$.

peaking near 1 percent after one year.[22]

Figure 11: TFP Responses in Tradable and Non-Tradable Sectors

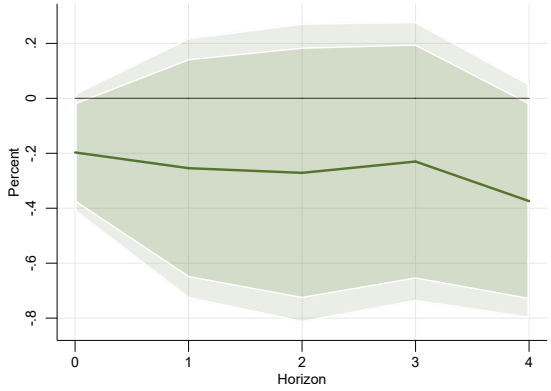


(a) Tradable sectors (b) Non-tradable sectors

Notes: Notes: Sectoral TFP responses are rescaled by the private GVA share of each sector.

Sectoral shares and reallocation. Sectoral weights are constructed using value-added shares: $D^s_{i,t} = \text{ValueAdded}^s_{i,t}/\text{Total Value Added}_{i,t}$.[23] Figure 12 shows that the non-tradable value-added share declines following an austerity shock, consistent with a shift in activity away from government-exposed sectors.

Figure 12: Value-Added Share Response of Non-Tradable Sectors



Notes: Notes: Impulse response of the non-tradable sector's share in private value added.

[22] Appendix D presents TFP and labor-productivity impulse responses at a finer sectoral level. These results confirm that the increase in productivity is systematically larger in non-tradable sectors.

[23] Ideally, weights would be based on gross output, $D^{s\ GO}_{i,t} = \text{GrossOutput}^s_{i,t}/\text{Total Value Added}_{i,t}$, because gross output internalizes intermediate-input linkages (Hulten 1978; Baqaee and Farhi 2019). However, sector-level gross-output data are not available for NUTS 2 regions over the full sample. Using value-added shares may therefore understate the reallocation due to input-output linkages.

Quantifying within and between contributions. Table 5 summar the decomposition expressed as fractions of the overall TFP response. The "Within-sector TFP" rows show each sector's contribution relative to the total effect, while the "Total within-sector contribution" sums these shares across tradable and non-tradable sectors. The "Reallocation (Shares)" rows analogously report the proportion of the total TFP response attributable to changes in sectoral weights, with the sum across sectors yielding the "Total reallocation contribution". At both horizons, the within-sector channel explains the majority of the total TFP effect, whereas reallocation accounts for a slightly smaller but economically meaningful positive share, consistent with a declining weight of the government-dependent non-tradable sector.

Table 5: Decomposition of the Aggregate TFP Response

Horizon		**Impact**	$h = 1$
Within-sector TFP	Tradables	0.16	0.08
	Non-tradables	0.44	0.44
	Total within-sector contribution	*0.60*	*0.52*
Reallocation (Shares)	Tradables	0.27	0.32
	Non-tradables	0.13	0.16
	Total reallocation contribution	*0.40*	*0.48*

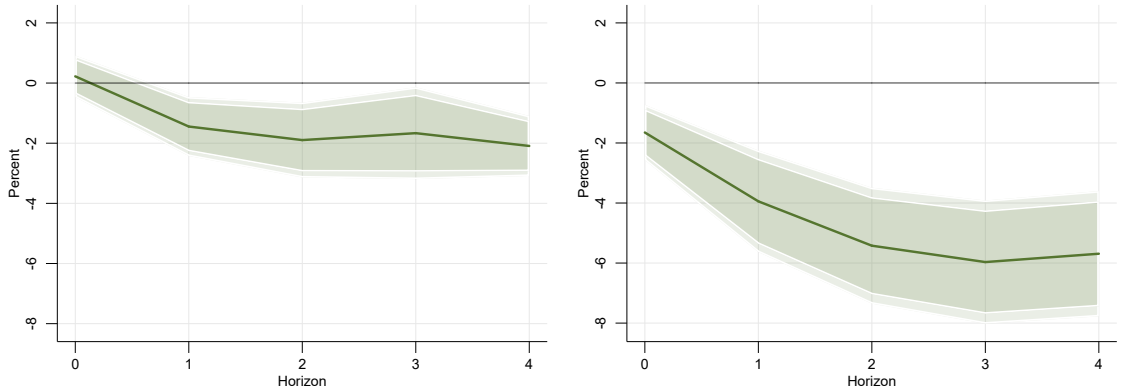
Notes: Notes: Values are expressed as a fraction of the total TFP effect. The within-sector component sums sectoral TFP responses weighted by average sectoral shares. The reallocation component captures changes in aggregate TFP due to shifts in sectoral value-added shares, holding sectoral TFP constant.

4.5 Austerity Shocks and Firm Dynamics Within Sectors

The decomposition results raise the question of why utilization-adjusted TFP rises within sectors following an austerity shock. One potential explanation is a cleansing mechanism, whereby adverse demand conditions disproportionately eliminate low-productivity firms, raising average productivity among surviving producers.[24] To assess whether this mechanism is operative in our setting, we examine how austerity shocks affect firm dynamics in the tradable and non-tradable sectors. Using the same local-projection specification as in the baseline analysis, but replacing the TFP outcome with the cumulative change in the number of local units, we estimate sector-specific impulse responses of net firm exit. Figure 13 displays the results.

[24]The idea that recessions may have a "cleansing" effect dates back to Schumpeter (1942). In this view, emphasized by Caballero and Hammour (1994b), downturns disproportionately eliminate low-productivity firms, thereby improving the average efficiency of surviving producers. As we discuss in the next section, the productivity effect of an austerity-induced recession may extend beyond those of a typical cyclical downturn.

Figure 13: Number of Local Units by Sectors



(a) Tradable sectors

(b) Non-tradable sectors

Notes: Data for agriculture is not available. The sample begins in 2008, and the tradable and non-tradable local units series are the sum of the sub-sectors conditional on data availability for all of the sub-sectors. Impulse responses to a one percent austerity-driven decline in government spending, estimated as in equation 7. Bands are 90% (dark) and 95% (light) confidence intervals.

Austerity shocks lead to net exit of firms in both sectors. The magnitudes are economically meaningful: after three years, the number of local units declines by roughly 6 percentage in the non-tradable sectors and by about 2 percentage in the tradable sectors. The larger contraction in the non-tradable sectors aligns with its greater exposure to government demand.[25]

These differences in firm dynamics parallel the sectoral TFP responses documented above. The non-tradable sector exhibits both a sharper decline in activity and a larger increase in utilization-adjusted TFP. This joint pattern is consistent with a cleansing mechanism: the shock appears to accelerate the exit of marginal producers, increasing average sectoral productivity, particularly in sectors more exposed to the austerity shock.

We emphasize, however, that our data do not permit a clean separation among cleansing, restructuring, and other within-sector channels (such as improvements in managerial efficiency). Establishment-level productivity measures would be required for sharper identification. Nonetheless, the combination of net exit and rising sectoral productivity suggests that cleansing dynamics plausibly contribute to the within-sector component of the regional TFP response.

4.6 Austerity-recessions and non-austerity recessions

We have shown that fiscal consolidations significantly increase TFP. At the same time austerity lowers economic activity. Related literature has also shown that a cleansing effect generally

[25]Results are robust to an alternative construction of the series, without conditioning on all sub-sectors being available within a the tradables and non-tradables. Results are presented in Figure D.19

boosts productivity in economic downturns (Caballero and Hammour 1994a; Osotimehin and Pappadà 2017). This might raise the question of whether our main findings are simply a reflection of economic recessions leading to higher TFP. In other words, do austerity-driven recessions lead to different productivity outcomes than other economic downturns? In the following, we will show that the productivity effects of economic downturns are significantly amplified when recessions are indeed driven by fiscal consolidations.

We extend our baseline Equation (7) and estimate for each horizon $h = 0, ..., 4$ the following regression:

$$\begin{aligned} z_{i,t+h} =& I^{ra}_{i,t}\left[\zeta^{ra}_h + \beta^{ra}_h \frac{G_{i,t} - G_{i,t-1}}{G_{i,t-1}} + \gamma^{ra}_h(L)X_{i,t-1}\right] \\ &+ I^{r}_{i,t}\left[\zeta^{r}_h + \beta^{r}_h \frac{G_{i,t} - G_{i,t-1}}{G_{i,t-1}} + \gamma^{r}_h(L)X_{i,t-1}\right] \\ &+ (1 - I^{ra}_{i,t} - I^{r}_{i,t})\left[\zeta^{e}_h + \beta^{e}_h \frac{G_{i,t} - G_{i,t-1}}{G_{i,t-1}} + \gamma^{e}(L)X_{i,t-1}\right] + \alpha_{i,h} + \delta_{t,h} + u_{i,t+h}. \end{aligned} \tag{12}$$

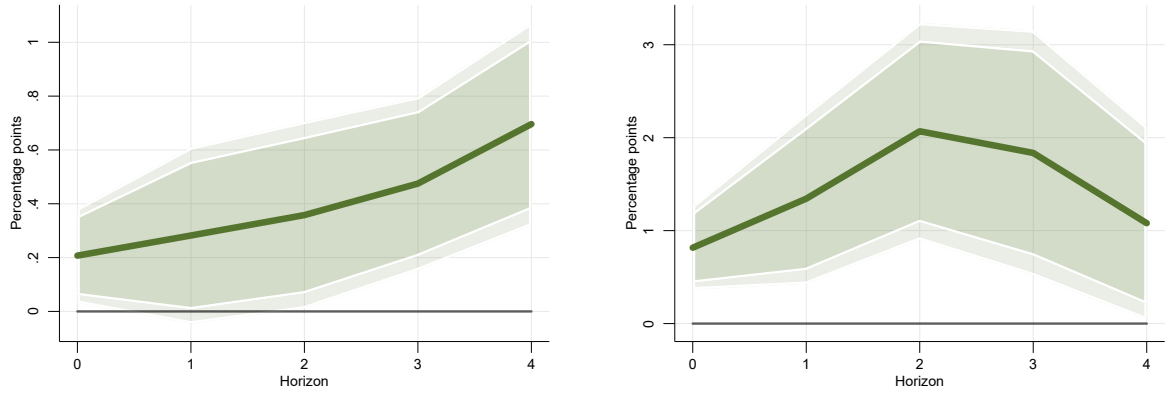
$I^{ra}_{i,t}$ is a dummy variable that takes a value of one in year t when region i contemporaneously experiences negative per capita GDP growth and implements fiscal consolidation measures (i.e., when the Bartik instrument is larger than zero). On the other hand, $I^{r}_{i,t}$ is a dummy variable that takes a value of one when the regional per capita GDP growth rate is negative and we identify no fiscal consolidation (when our Bartik instrument is equal to zero). Thus, $I^{ra}_{i,t}$ captures recessions that coincide with austerity ("austerity-recessions"), and $I^{r}_{i,t}$ measures economic downturns that are not directly related to fiscal consolidations but can be described as a combination of different negative shocks that lead to lower economic activity ("non-austerity recessions"). We also include a dummy for all remaining episodes when there is positive economic growth (economic expansions), $1 - I^{ra}_{i,t} - I^{r}_{i,t}$, to use the entire variation of the sample. The coefficients ζ^{ra}_h and ζ^{r}_h capture the average impact of austerity recessions and non-austerity recessions, respectively, on productivity growth. In addition, β^{ra}_h and β^{r}_h indicate the marginal effect of lowering regional government spending by 1% in austerity recessions and non-austerity recessions, respectively.[26] If ζ^{ra}_h is larger (smaller) than ζ^{r}_h, this would imply that economic downturns driven by fiscal consolidations lead to a larger (smaller) increase in productivity than other downturns. The same logic also applies to the marginal effect coefficients β^{ra}_h and β^{a}_h.

The first row of Figure 14 presents the estimation results, where the upper left panel shows the difference between ζ^{ra}_h and ζ^{r}_h and the upper right panel shows the difference between β^{ra}_h and

[26] As before, we normalize the responses such that regional government spending falls by 1% in the impact period.

β_h^r. The difference in the average recession effect (ζ_h^{ra}-ζ_h^r) is positive and statistically significant after year 2. Thus, austerity recessions lead to a larger increase in productivity than non-austerity recessions in the medium run. Furthermore, the difference in the marginal coefficients is also estimated to be positive and statistically significant. This implies that in recessions coinciding with fiscal consolidations, a reduction in regional government spending implies a larger increase in productivity compared to lowering public spending in non-austerity recessions. These results suggest that austerity recessions are special in the sense that they considerably amplify the productivity gains after economic downturns. Thus, our main results do not simply capture a general tendency of productivity growth during economic downturns but instead, point toward a specific transmission mechanism underlying fiscal consolidations.

Figure 14: Difference in responses between austerity-recessions and non-austerity recessions



(a) Marginal effect (β_h^{ra}-β_h^r)

(b) Average effect (ζ_h^{ra}-ζ_h^r)

Notes: Panels 14b and 14a on the first row show the difference of the average and marginal effects between austerity recessions and normal recessions on the TFP growth estimated through Equation 12. Bands are 90% (dark) and 95% (light) confidence intervals.

5 Conclusion

This paper provides causal evidence that fiscal austerity raises productivity growth at the regional level in the euro area, despite exerting contractionary effects on GDP, employment, and investment. Decompositions indicate that both within-sector improvements and cross-sector reallocation contribute meaningfully to the aggregate effect. The within-sector gains are consistent with a cleansing mechanism, while reallocation reflects a shift of resources toward tradable sectors with higher productivity growth. Moreover, recessions associated with austerity yield larger productivity increases than other downturns.

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APPENDIX

Appendix A Data Appendix

ARDECO - Regional European Data ARDECO is the Annual Regional Database of the European Commission's Directorate General for Regional and Urban Policy and is maintained and updated by the Joint Research Centre. It is a highly disaggregated dataset across both sectoral and sub-regional dimensions. The database contains a set of long time-series indicators for EU regions at various statistical scales (NUTS 0, 1, 2, and 3 level) using the NUTS 2016 regional classification. The dataset includes data on demography, labor markets, capital formation and domestic product by six sectors. The six sectors are (1) agriculture, forestry and fishing; (2) industry excluding construction; (3) construction; (4) wholesale, retail, transport, accommodation, and food services; (5) information and communication, financial and business services; and (6) non-market services.

ARDECO data is an annual unbalanced panel covering the period 1980–2023 for the European Union (EU) and some European Free Trade Association (EFTA) and candidate countries; our sample uses data from 1999–2019. Its main data source is Eurostat (the Statistical Office of the European Commission), supplemented, where necessary, by other appropriate national and international sources. ARDECO is constructed in such a way that the country aggregates of its various time series equal the corresponding time series in the AMECO dataset referring to the National Accounts. Starting in 2002, Eurozone countries have published national series in EUR. National currency data for all years prior to the switch of the country to EUR have been converted using the irrevocably fixed EUR conversion rate. We use the series with real variables expressed in 2015 constant prices in EUR.

Regional government spending measure We now explain in detail why GVA (plus intermediate consumption of the non-market sector) is a valid proxy for government spending following the argument in Gabriel et al. (2023).

First, as previously mentioned, ARDECO's regional data is consistent with the national accounts data by construction. By definition, there exists a close link between government spending and the GVA of the non-market sector, however, they differ in two dimensions: actors and composition. Regarding the first, even though the non-market sector includes other institutional units, the general government is the main actor responsible for changes in non-market GVA.

In particular, the non-market sector consists of six sub-sectors: "Public administration and defense", "Education", "Human health and social work", "Arts, entertainment and recreation", "Other service activities," and "Activities of household and extra-territorial organizations and bodies." The first sub-sector, "Public administration and defense," refers to activities by the general

government, but not all government bodies are automatically classified under this sub-sector. For example, a secondary school administered by the central or local government is classified as "Education," and a public hospital is allocated to "Human health and social work." Thus, the two sub-sectors "Education" and "Human health and social work" are also closely linked to the general government in the national accounts, while the last three sub-sectors are linked only loosely.

Concerning the second dimension, we now describe the compositional differences between non-market GVA and government spending. In the national accounts, government spending is defined as follows:

Final consumption expenditure of the general government
=Gross value added of the general government
+Intermediate inputs of the general government
+Social transfers in kind purchased market production
-Market output and output for own final use
-Payments for non-market output

GVA of the general government is the major component of government spending and fully accounted in the GVA of the non-market sector. Country level data show that GVA of the general government accounts for approximately 71.1% of the final consumption expenditure of the general government.[1] Thus, our proxy measures the single-most dominant source of government expenditures. However, the main difference between government spending and the GVA of the general government are the intermediate inputs and the social transfers in kind. When again looking at country level data, we find that GVA and intermediate consumption account for about 99% of government spending.

To include intermediate consumption in our government spending measure, we use input-output tables from the PBL EUREGIO database. This is the first time-series (annual, 2000–2010) of global IO tables with regional detail for the entire large trading bloc of the European Union. This database allows for a regional analysis at the NUTS 2 level consistent with our baseline method. The tables merge data from World Input-Output Database (the 2013 release) with regional economic accounts and inter-regional trade estimates developed by PBL Netherlands Environmental Assessment Agency and complemented with survey-based regional input-output data for a limited number of countries. All data used are survey data, and only non-behavioral assumptions have been made to estimate the EUREGIO dataset. These two general rules of data construction

[1] According to data collected from Eurostat for the sample between 1995 and 2016.

allow empirical analyses focused on impacts of changes in behavior without endogenously having this behavior embedded already by construction. More detailed information can be found in Thissen et al. (2018).

The PBL EUREGIO database provides estimates for intermediate consumption of the non-market sector at the NUTS 2 level from 2000–2010. Thus, we adjust regional GVA of the non-market sector by a region-specific time-invariant scaling factor to include intermediate consumption in our government spending measure to obtain our proxy for regional government spending.

Table A.1: NUTS 2 Regions in Final Sample

Country	NUTS 2 Regions
Austria	9
Belgium	11
Finland	4
France	21
Germany	38
Ireland	3
Italy	21
Netherlands	12
Portugal	5
Spain	15
Total	139

Notes: Our final dataset excludes the French overseas regions of Guadeloupe (FRY1), Martinique (FRY2), Guyane (FRY3), La Réunion (FRY4), and Saint-Martin (FRY5), as well as the Spanish autonomous cities of Ceuta (ES63) and Melilla (ES64), the Finnish autonomous region of Åland (FI20), the French overseas territory of Mayotte (FRM0), the Spanish island regions of Illes Balears (ES53) and Canarias (ES70), and the Portuguese autonomous regions of Açores (PT20) and Madeira (PT30).

Sample and Variables Description

Table A.2: Variables Description

Variable Name	**Computation**	**Definition [Source]**
Capital Stock (Private)	$K^p_{t-1} + I^p_t - D^p_t$	Private capital stock estimated via perpetual inventory method [ARDECO]
Capital Utilization	See Equation (5)	Rate of capital utilization derived from firm optimality conditions [ARDECO]
Depreciation		Consumption of fixed capital in private sector [ARDECO]
Domar Weights	Sectoral GVA / Total GVA	Sectoral value-added shares used in TFP decomposition [ARDECO]
Employment		Total employment [ARDECO]
GDP*pc*	GDP / population	Regional gross domestic product per capita [ARDECO]
Gov. Spending*pc*	(Non-market GVA + intermediate consumption) / population	Regional government spending proxy per capita [ARDECO, PBL EUREGIO]
Hours Worked (Private)		Total hours worked in private sector [ARDECO]
Hourly Wage	Compensation / total hours worked	Regional average compensation per hour [ARDECO]
Intermediate Consumption		Non-market sector intermediate consumption shares [PBL EUREGIO]
Investment*pc*	Private GFCF / population	Private gross fixed capital formation per capita [ARDECO]
Investment Price Index		Price index for investment goods [ARDECO]
Labor Effort	See Equation (4)	Labor effort index derived from household optimality conditions [ARDECO]
Labor Productivity	GVA / Hours	Value added per hour worked [ARDECO]
Labor Share	Private compensation / Private GVA	Private sector labor income share [ARDECO]
Local Units		Number of business establishments by sector [Eurostat]
Narrative Austerity		Spending-based fiscal consolidation episodes [Adler et al. 2024]
Population		Total regional population [ARDECO]
Private Consumption		Consumer spending of people living in the region [Oxford Economics]
Private GVA		Gross value added of the private sector [ARDECO]
TFP (utilization-adjusted)	See Equation (6)	Total factor productivity adjusted for capital utilization and labor effort [ARDECO]

Notes: See Section 2 for detailed variable construction. We thank Ricardo Amaro and Anthony Light from Oxford Economics for sharing the data on private consumer spending with us.

Appendix B Utilization and Effort Adjustment: Model and Derivation

We adjust the TFP series for capital utilization and labor effort using a model-based procedure similar to that developed in Imbs (1999). This appendix presents the model and the derivation of the adjustment formulas used in the main text.

B.1 Model environment

Consider a representative household and firm. Time is discrete and infinite. Households consume c_t, supply hours H_t^p at effort level e_t, and invest in one-period bonds B_t, paying the nominal interest rate R_t. Preferences are given by GHH utility:

$$E_t \sum_{k=0}^{\infty} \beta^k u(c_{t+k}, H_{t+k}^p, e_{t+k}), \tag{A.1}$$

$$u(c_t, H_t^p, e_t) = \frac{(c_t - \psi(H_t^p)^{1+\upsilon} - \psi_e e_t^{1+\upsilon_e})^{1-\sigma} - 1}{1-\sigma}, \tag{A.2}$$

with parameters $\beta \in (0,1)$, $\upsilon > 0$, $\upsilon_e > 0$, $\psi, \psi_e > 0$, and $\sigma > 0$. Consumption goods are purchased at price P_t.

The household's budget constraint is

$$c_t + \frac{B_t}{P_t} = \frac{W_t(e_t)}{P_t} H_t^p + \frac{B_{t-1} R_{t-1}}{P_t} + \frac{D_t}{P_t}, \tag{A.3}$$

where $W_t(e_t)$ is the nominal wage inclusive of effort premia and D_t denotes firms' dividend payments.

B.2 Firms

Private-sector output is produced according to

$$Y_t^p = (e_t H_t^p)^{\alpha_t} (u_t K_t^p)^{1-\alpha_t}, \tag{A.4}$$

where K_t^p is tangible private capital and $u_t \in (0,1)$ is the utilization rate. The elasticity α_t corresponds to the labor share in output.

Capital evolves according to

$$K_{t+1}^p = (1-\delta_k) K_t^p + \Psi\left(\frac{K_{t+1}^p}{K_t^p}\right) K_t^p, \tag{A.5}$$

where $\Psi(\cdot)$ is the adjustment-cost function, satisfying $\Psi(\tilde{g}) = \delta_k$, $\Psi'(\tilde{g}) = 1$, and $\Psi''(\tilde{g}) = \epsilon_k > 0$. Capital utilization generates maintenance costs $a(u_t)K_t^p$, where $a(u_t) = \psi_k u_t^{\beta_k}$ with $\psi_k, \beta_k > 0$.

Firms maximize expected discounted profits:

$$\max_{H_t^p, e_t, u_t, K_{t+1}^p} E_t \sum_{k=0}^{\infty} \tilde{\beta}_{t,t+k} \Big[P_{t+k} Y_{t+k}^p - W_{t+k}(e_{t+k}) H_{t+k}^p - Q_{t+k} \Psi\left(\frac{K_{t+k+1}^p}{K_{t+k}^p} \right) K_{t+k}^p \tag{A.6}$$

$$- Q_{t+k} a(u_{t+k}) K_{t+k}^p \Big], \tag{A.7}$$

where Q_t is the investment-goods price.

B.3 Effort adjustment

The household's first-order conditions imply:

$$\frac{W_t(e_t)}{P_t} = \psi (1+\upsilon)(H_t^p)^{\upsilon}, \tag{A.8}$$

$$\frac{W_t'(e_t) H_t^p}{P_t} = \psi_e (1+\upsilon_e) e_t^{\upsilon_e}. \tag{A.9}$$

Profit maximization implies:

$$\alpha_t P_t \frac{Y_t^p}{H_t^p} = W_t(e_t), \tag{A.10}$$

$$\alpha_t P_t \frac{Y_t^p}{e_t} = W_t'(e_t) H_t^p. \tag{A.11}$$

Combining these gives:

$$\frac{(H_t^p)^{1+\upsilon}}{e_t^{1+\upsilon_e}} = \frac{\psi_e}{\psi} \frac{1+\upsilon_e}{1+\upsilon}. \tag{A.12}$$

Normalizing constants to one and setting $\upsilon = \upsilon_e = 1$ (following Jordà et al. 2020), we obtain the effort index:

$$e_t = (H_t^p)^{\frac{1+\upsilon}{1+\upsilon_e}} = H_t^p. \tag{A.13}$$

B.4 Capital-utilization adjustment

From the firm's FOCs we obtain:

$$\alpha_t P_t \frac{Y_t^p}{u_t} = a'(u_t) K_t^p Q_t = \psi_k \beta_k u_t^{\beta_k - 1} K_t^p Q_t. \tag{A.14}$$

Combining with the labor FOC and rearranging yields:

$$u_t^{\beta_k} = \left(\frac{W_t(e_t) H_t^p}{K_t^p Q_t} \Big/ \frac{\overline{WH^p}}{\overline{K^p Q}} \right), \tag{A.15}$$

and thus the proportional index:

$$\frac{u_t}{\bar{u}} = \left(\frac{W_t H_t^p}{K_t^p Q_t} \Big/ \frac{\overline{WH^p}}{\overline{K^p Q}} \right)^{1/\beta_k}. \tag{A.16}$$

Trend values $\overline{WH^p}/\overline{K^p Q}$ are obtained using the HP filter. We set $\beta_k = 4$ following Anzoategui et al. (2019).

B.5 Utilization- and effort-adjusted TFP

Given the production function (A.4), utilization-adjusted TFP is defined as:

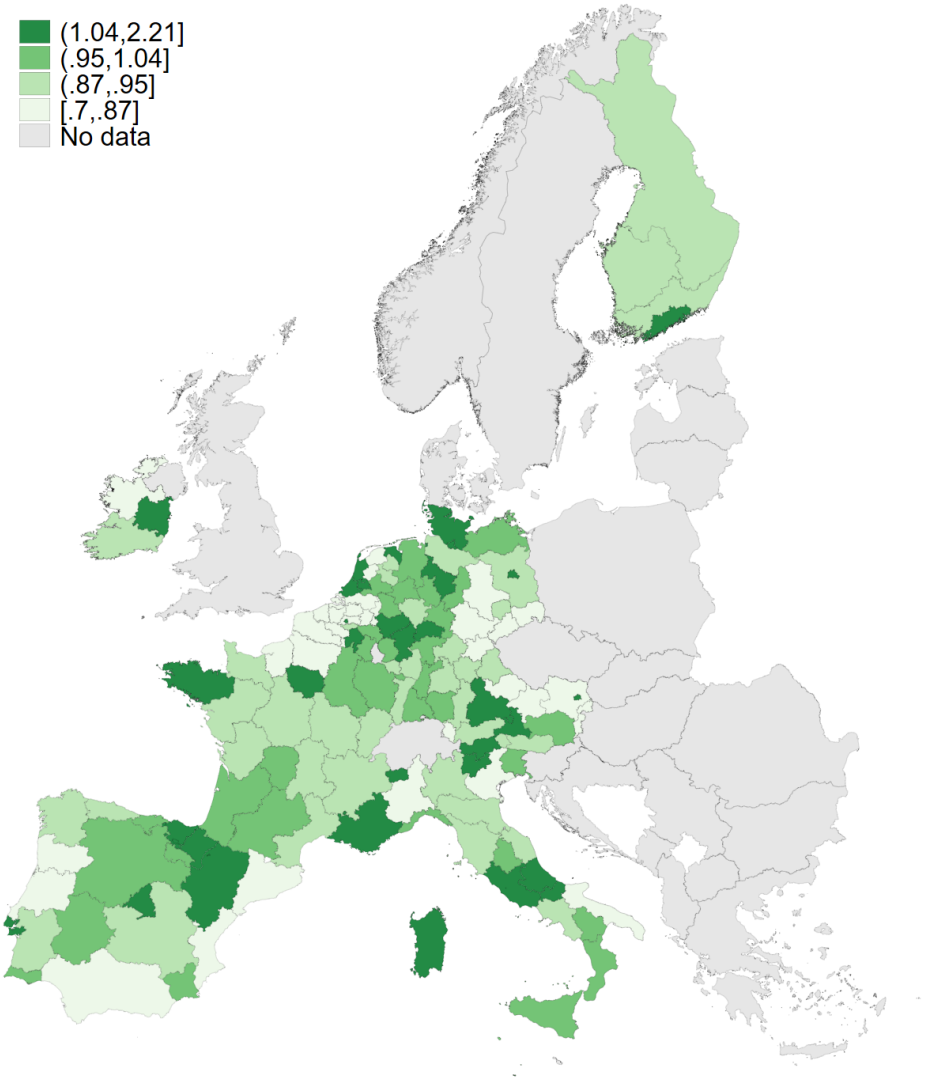
$$A_t = \frac{Y_t^p}{(u_t K_t^p)^{1-\alpha_t} (e_t H_t^p)^{\alpha_t}}. \tag{A.17}$$

With time-varying α_t, following PWT we compute growth rates as:

$$\Delta \ln A_t = \Delta \ln Y_t^p - (1-\alpha_t)(\Delta \ln K_t^p + \Delta \ln u_t) - \alpha_t (\Delta \ln H_t^p + \Delta \ln e_t). \tag{A.18}$$

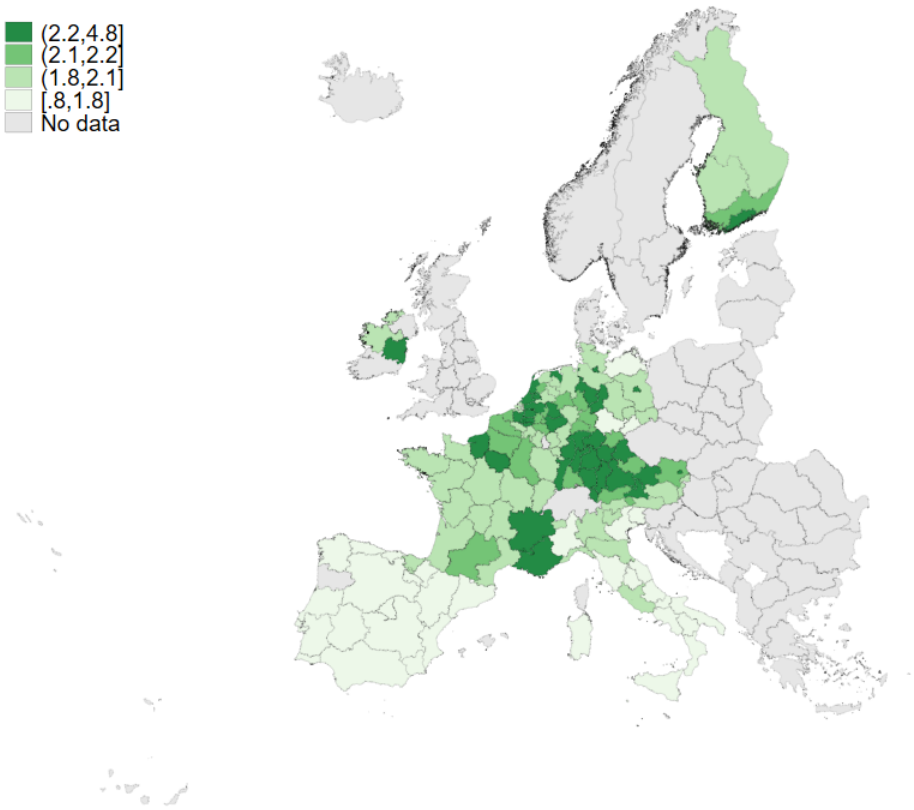
Appendix C Additional results

Figure C.1: Sample regions and the share s_i



Notes: The figure depicts the map of European NUTS 2 regions with the share s_i used in Bartik instrument construction.

Figure C.2: Average Annual Labor Productivity Growth

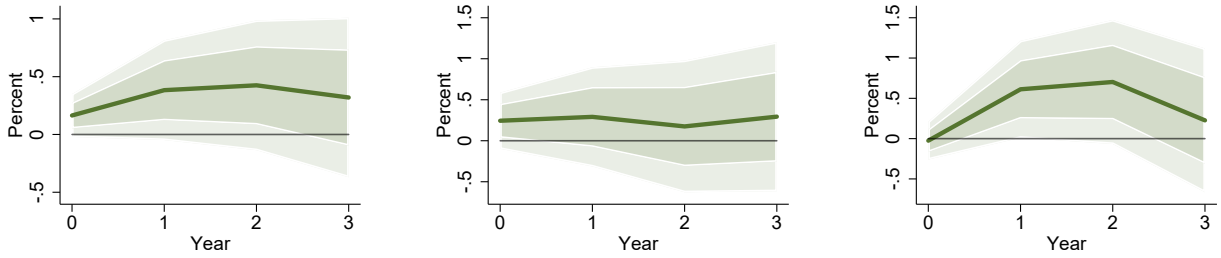


Notes: Sample: 10 euro area countries, average annual growth between 1999-2019

C.1 Country-level analysis

Using the 6^{th} release of the country-level data from the Macrohistory database (Chen et al. 2022) and thus an entirely different dataset at the country level from 1980 to 2019 for 9 countries (all in our sample except Austria), but using the same empirical design, we obtain noisier responses of TFP to an austerity shock.

Figure C.3: National-level TFP responses



(a) Penn World Tables: rtfpna (1980-2019)

(b) Huo et al. (2023) TFP domar (1980-2019)

(c) Our TFP Measure (1999-2019)

C.2 FEVD exercise

Whereas our main analysis focuses on characterizing whether austerity shocks affect productivity, below we also assess the quantitative importance of this relationship. In doing so, we conduct a forecast error variance decomposition (FEVD) exercise. The local projection framework allows computing the contribution of the austerity shocks to the forecast error variance of our variables of interest. First, we consider the share of the variance in the TFP that can be accounted for by austerity shocks from 1999 until 2019. The fraction of the variance in the productivity at different horizons accounted for by austerity shocks can be recovered directly from the estimates of Equation (7). This measure therefore provides a metric of the extent to which austerity shocks are quantitatively important in driving productivity dynamics.

We closely follow Born et al. (2020), who extend the approach by Coibion et al. (2017); Gorodnichenko and Lee (2020) to a panel setting. In particular, we compute the variance share of the regional consolidation shock at horizon h as the R^2 of the following regression:

$$\hat{u}_{i,t+h} = \lambda_0 \hat{\epsilon}_{i,t+h} + ... + \lambda_h \hat{\epsilon}_{i,t} + v_{i,t+h}. \tag{A.19}$$

where $\hat{u}_{i,t+h}$ is the forecast error of the local projection (7) at horizon h and $\hat{\epsilon}_{i,t+h}$ are the (horizon-specific) predicted values of the first-stage regressions (9).

Table C.3: Forecast error variance decomposition

Horizon	TFP	GDP	Employment
1	4.6 %	11.0 %	31.6 %
2	8.4 %	15.2 %	35.1 %
3	10.5 %	15.6 %	30.7 %
4	8.3 %	11.9 %	25.6 %

Notes: Forecast error variance decomposition of productivity based on local projections (A.19).

C.3 Cost-share-based TFP

As an alternative to our baseline measure, we compute TFP using *cost shares* instead of revenue shares to estimate input elasticities, thereby relaxing the assumption of perfect competition and allowing for firm markups. In particular, the output elasticity of labor is given by

$$\frac{\text{Total private-sector labor compensation}_t}{\text{Total private-sector labor compensation}_t + \text{Private-sector capital costs}_t}. \tag{A.20}$$

While data on the labor compensation is available at ARDECO, capital costs have to be estimated.

The private-sector capital costs equal the product of the rental rate of capital, R_t, and the nominal capital stock, $K_t Q_t$. The rental rate of capital is computed following Hall and Jorgenson (1967):

$$R_t = 1 + r_t - (1 - \delta^k)\frac{Q_t}{Q_{t-1}}, \tag{A.21}$$

where r_t is the interest rate and δ^k the depreciation rate. For each country, we estimate

$$r_t = \text{GovBondYield}_t + \text{BaaSpread}_t. \tag{A.22}$$

This corresponds to a simplified version of the equation used in Comin et al. (2022). In their baseline, Comin et al. (2022) estimate r_t as the sum of a risk-free rate and a weighted average of the risk premia on debt and equity. Since equity risk premia are available for only five countries in our sample, we adopt this simplified specification that omits the equity premium. For those five countries, the correlation between our r_t and the estimate using equity premium is high (0.83).

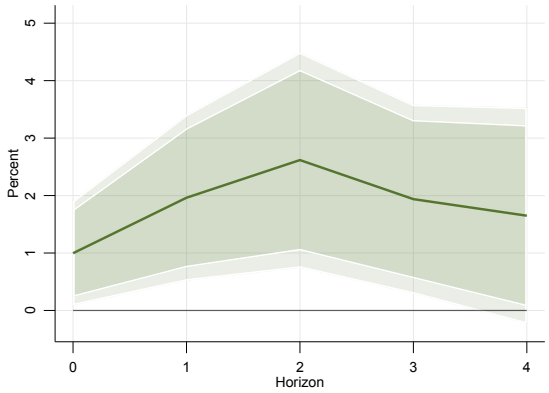
For the government bond yield, we use the 10-year benchmark rate reported by the OECD. The Baa spread is defined as the yield differential between euro-area BBB-rated and AAA-rated corporate bonds, as obtained from Datastream.[2] The price of capital goods is measured using

[2]The exact series from Datastream we use are (1) SPEIA3E for the Eurozone AAA corporate bond yield, and (2) SPEIB3E for the Eurozone BBB corporate bond yield.

national-level investment goods price indices from the ARDECO database. The depreciation rate is constructed at the NUTS2 level and corresponds to the implicit rate inferred from the evolution of the regional capital stock. Except for the estimation of the output elasticity, all remaining steps in the computation of TFP follow the baseline specification.

Figure C.4 demonstrates that our baseline findings are robust to computing TFP using cost shares rather than revenue shares.

Figure C.4: Cost-share-based TFP Response



Notes: Cost-share-based TFP's response to a one percent austerity-driven decline in government spending, estimated as in equation 7. Bands are 90% (dark) and 95% (light) confidence intervals.

C.4 BFK utilization adjustment

As an alternative to our baseline TFP measure, which is adjusted for utilization following Imbs (1999), we implement the approach of Basu et al. (2006) (BFK). This method corrects the Solow residual for variations in capacity utilization and effort by estimating an instrumental-variable regression of the Solow residual on changes in a utilization proxy, typically hours worked or a survey-based measure.[3] Common instruments in this framework include monetary policy and oil price shocks.

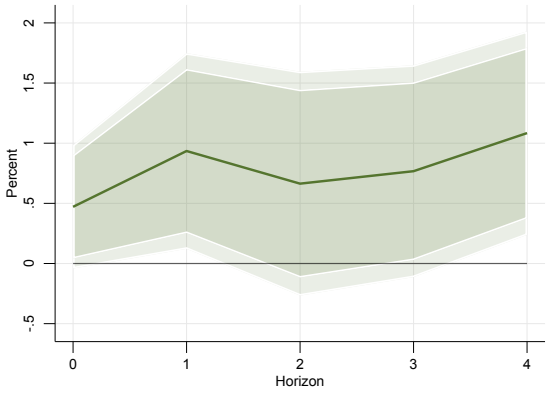
We apply the BFK adjustment to our regional Solow residual by estimating an IV regression with regional fixed effects, where changes in hours per worker (following Basu et al. (2006)) serve as the proxy for utilization. As instruments, we use oil price shocks and high-frequency monetary policy surprises (Jarociński and Karadi 2020). The resulting BFK-adjusted TFP growth rate is highly correlated with our baseline Imbs-adjusted TFP (correlation = 0.74, significant at the 1% level). When using the BFK-adjusted regional TFP, we continue to find that productivity

[3]See, among others, Comin et al. (2022) and Huo et al. (2023).

increases following an austerity shock (Figure C.5), though the magnitude of the response is somewhat muted relative to the baseline.

The BFK approach relies on the exclusion restriction that TFP is exogenous to the chosen instruments. This assumption may be difficult to sustain in our setting, as TFP itself responds endogenously to demand shocks.[4] By contrast, the utilization adjustment proposed by Imbs (1999) does not rely on a regression framework and therefore avoids such identification assumptions, which is why we maintain the Imbs-adjusted TFP as our baseline measure.

Figure C.5: BFK-adjusted TFP Response



Notes: Response of utilization-adjusted TFP, adjusted following the method of Basu et al. (2006), to a one-percent austerity-driven decline in government spending, estimated using equation 7.

[4]Moreover, recent evidence suggests that monetary policy shocks can affect both productivity (Jordà et al. 2020) and innovation activity (Ma and Zimmermann 2023).

Appendix D Sector-level additional results

D.1 Exposures and summary statistics

Figure D.6: Exposure to Non-market Sector

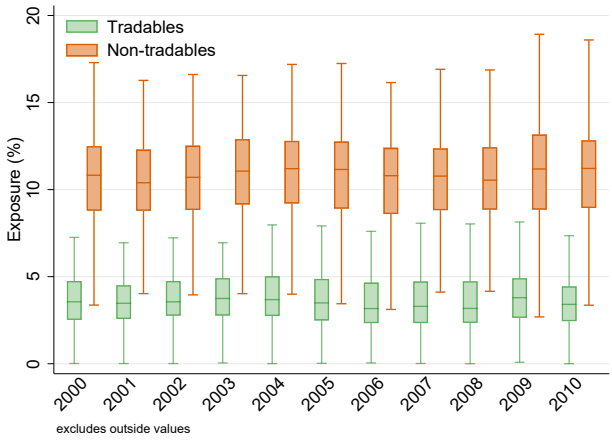


Figure D.7: Distribution of exposure over time

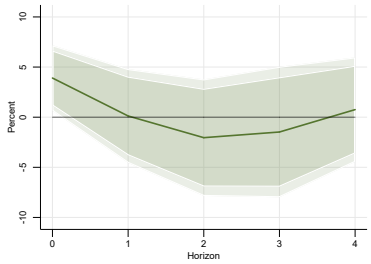
Notes: Ratio of outputs to the non-market sector over total outputs in tradables and non-trabables.

Table D.4: Summary Statistics of Exposure Tradables and Non-tradables by Country

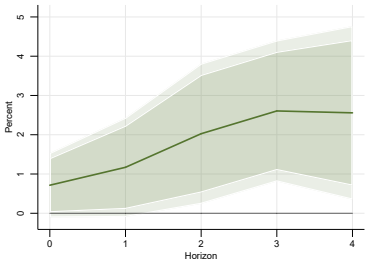
Country	Variable	Obs	Mean	Std. Dev.	Min	Max
All	Tradables	1,617	3.56	1.67	0.00	10.47
All	Nontradables	1,617	10.65	3.41	0.00	28.45
AT	Tradables	99	3.31	0.47	2.35	4.28
AT	Nontradables	99	9.99	1.31	7.09	13.72
BE	Tradables	121	1.66	0.59	0.71	3.17
BE	Nontradables	121	7.82	1.44	5.08	11.98
DE	Tradables	451	3.20	0.96	0.12	5.77
DE	Nontradables	451	12.27	2.33	0.32	20.26
ES	Tradables	209	5.05	1.71	0.00	10.47
ES	Nontradables	209	9.60	3.52	1.38	20.02
FI	Tradables	55	3.30	1.36	0.47	5.98
FI	Nontradables	55	12.86	4.43	7.51	23.49
FR	Tradables	242	4.73	1.24	1.11	6.93
FR	Nontradables	242	10.83	1.60	6.88	15.05
IE	Tradables	22	2.74	0.81	1.49	4.10
IE	Nontradables	22	8.99	1.38	6.28	11.01
IT	Tradables	231	2.33	2.00	0.00	7.22
IT	Nontradables	231	8.07	5.18	0.00	28.45
NL	Tradables	132	3.91	1.01	1.99	6.27
NL	Nontradables	132	12.67	1.57	8.43	16.60
PT	Tradables	55	5.18	0.85	3.37	6.60
PT	Nontradables	55	12.43	1.33	9.96	15.33

D.2 Not rescaled results

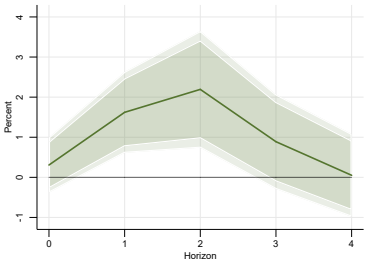
Figure D.8: TFP Response by Sector



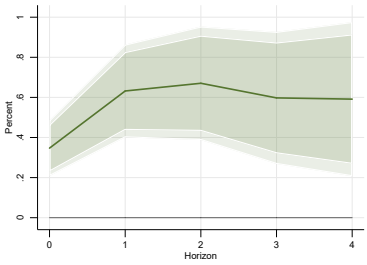
(a) TFP - Agriculture



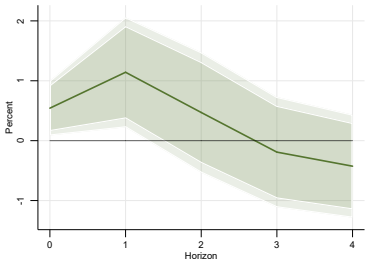
(b) TFP - Industry



(c) TFP - Construction



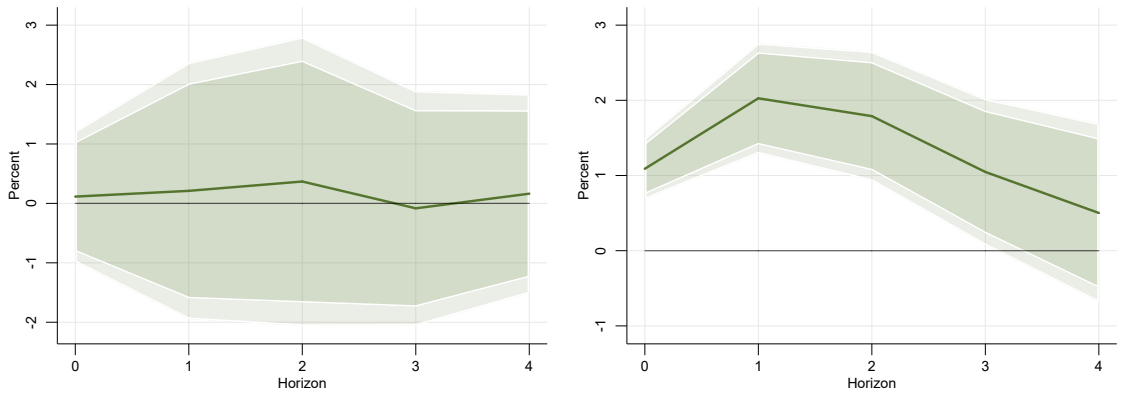
(d) TFP - Services



(e) TFP - Financial Services

Notes: Impulse responses to a one percent austerity-driven decline in government spending, estimated as in equation 7. Bands are 90% (dark) and 95% (light) confidence intervals.

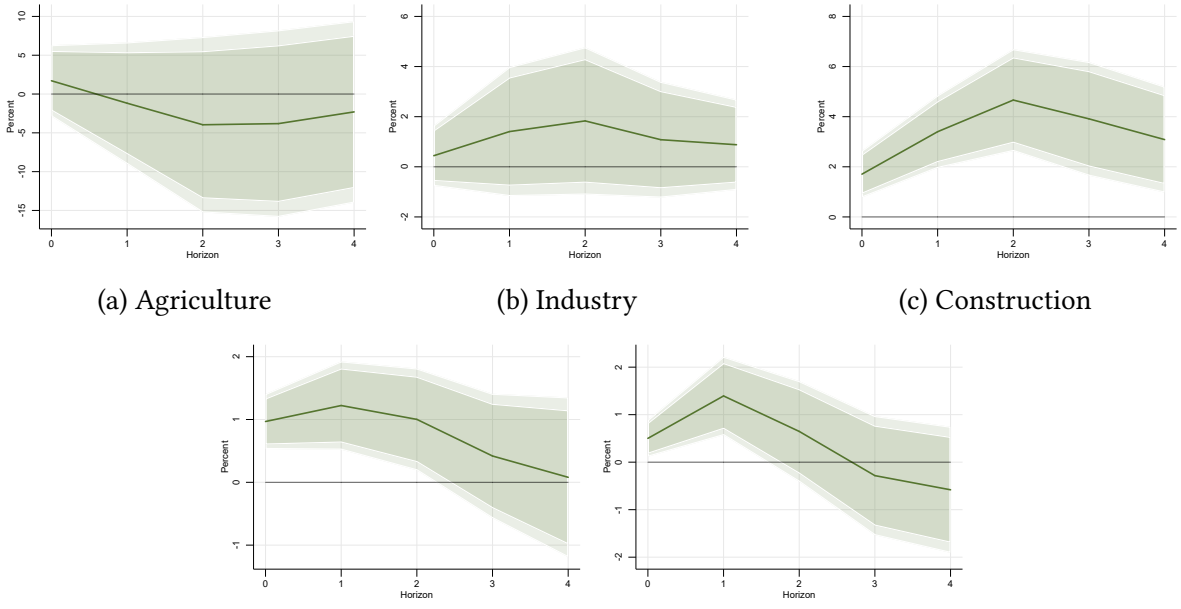
Figure D.9: Labor Productivity by Hour for Tradables and Non-tradables Sectors



(a) Tradables (b) Non-Tradable

Notes: Impulse responses to a one percent austerity-driven decline in government spending, estimated as in equation 7. Bands are 90% (dark) and 95% (light) confidence intervals.

Figure D.10: Labor Productivity by Hour

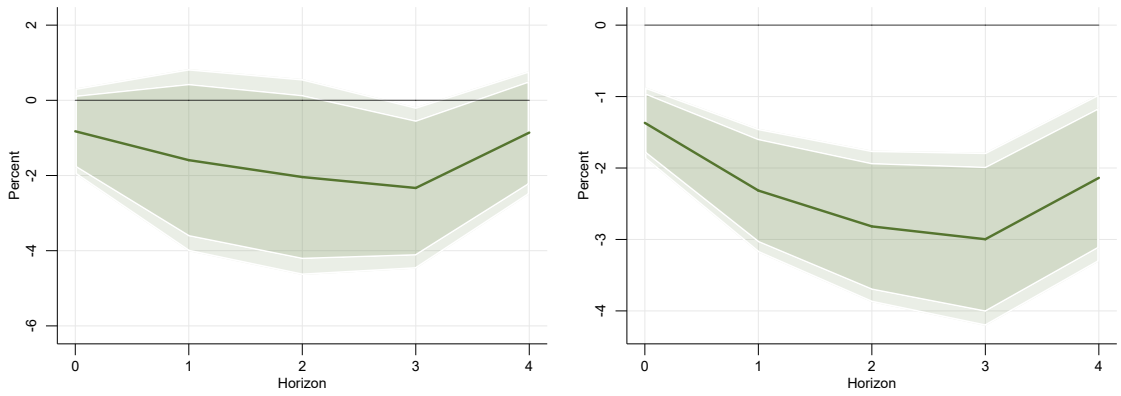


(a) Agriculture (b) Industry (c) Construction

(d) Services (e) Financial Services

Notes: Impulse responses to a one percent austerity-driven decline in government spending, estimated as in equation 7. Bands are 90% (dark) and 95% (light) confidence intervals.

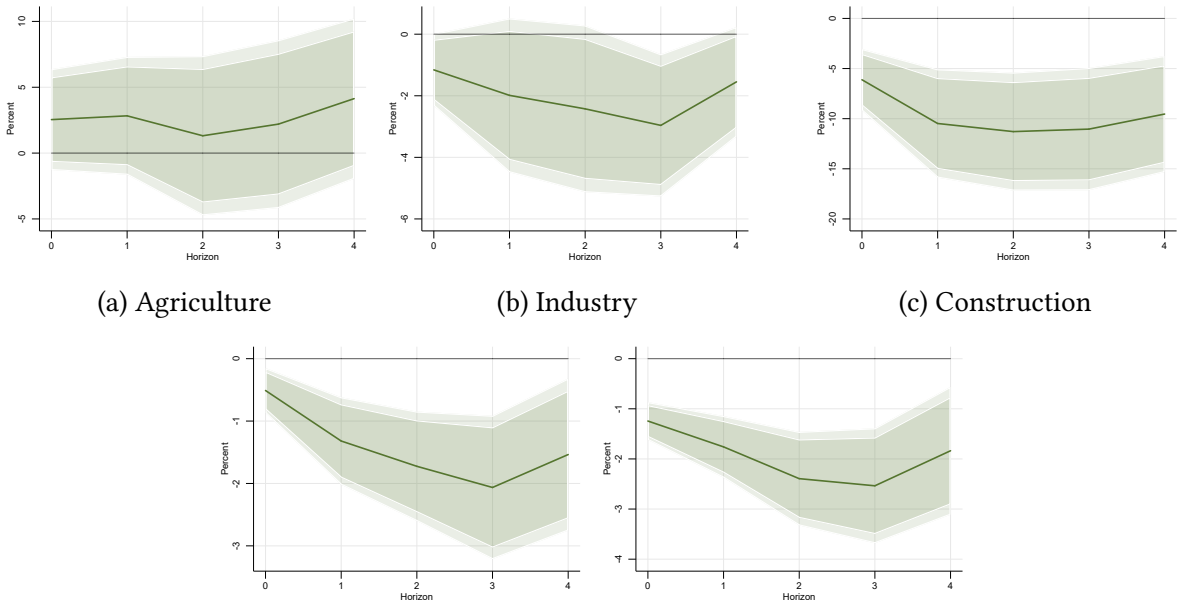
Figure D.11: GVA by Tradables and Non-tradables Sector



(a) Tradables (b) Non-tradables

Notes: Impulse responses to a one percent austerity-driven decline in government spending, estimated as in equation 7. Bands are 90% (dark) and 95% (light) confidence intervals.

Figure D.12: GVA by Sector

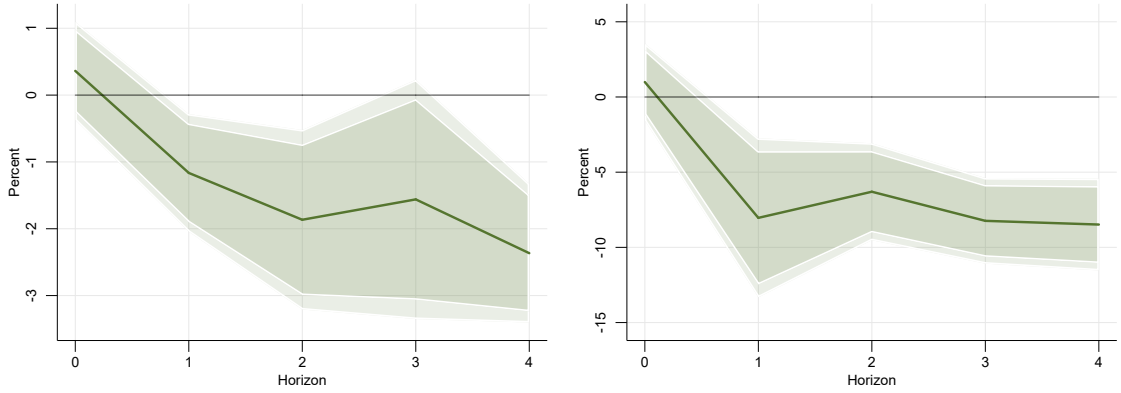


(a) Agriculture (b) Industry (c) Construction

(d) Services (e) Financial Services

Notes: Impulse responses to a one percent austerity-driven decline in government spending, estimated as in equation 7. Bands are 90% (dark) and 95% (light) confidence intervals.

Figure D.13: Number of Local Units by Sector

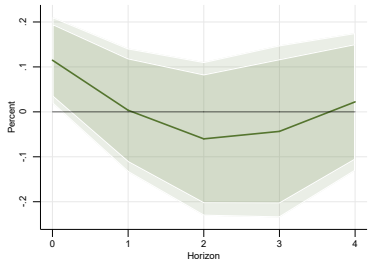


(a) Tradables (b) Non-Tradables

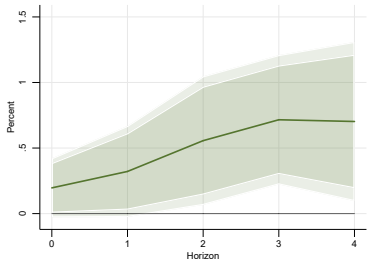
Notes: Data on local units starts in 2008. Impulse responses to a one percent austerity-driven decline in government spending, estimated as in equation 7. Bands are 90% (dark) and 95% (light) confidence intervals.

D.3 Rescaled by the average share of GVA by each sector to the total private sector GVA.

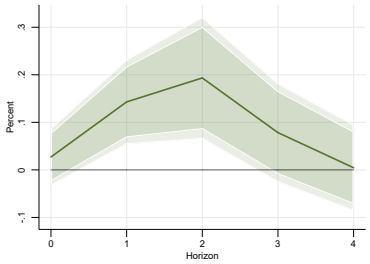
Figure D.14: TFP Response by Sector - Rescaled



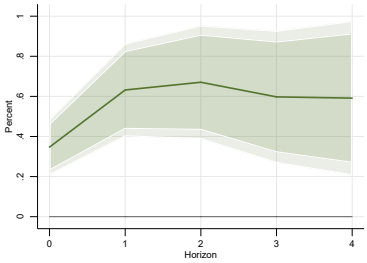
(a) TFP - Agriculture



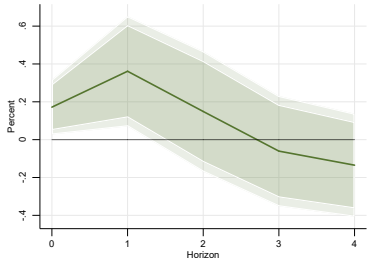
(b) TFP - Industry



(c) TFP - Construction



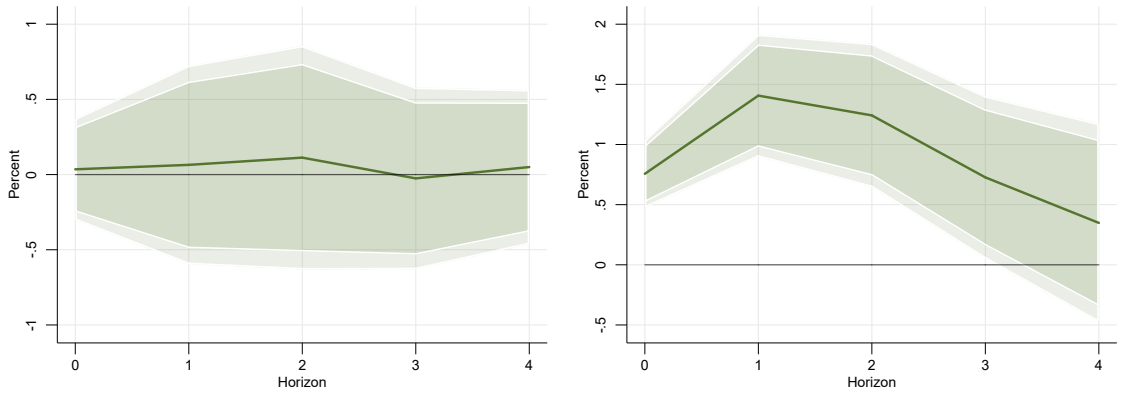
(d) TFP - Services



(e) TFP - Financial Services

Notes: Impulse responses to a one percent austerity-driven decline in government spending, estimated as in equation 7. Bands are 90% (dark) and 95% (light) confidence intervals. The responses were rescaled by the average share of GVA by each sector to the total private sector GVA.

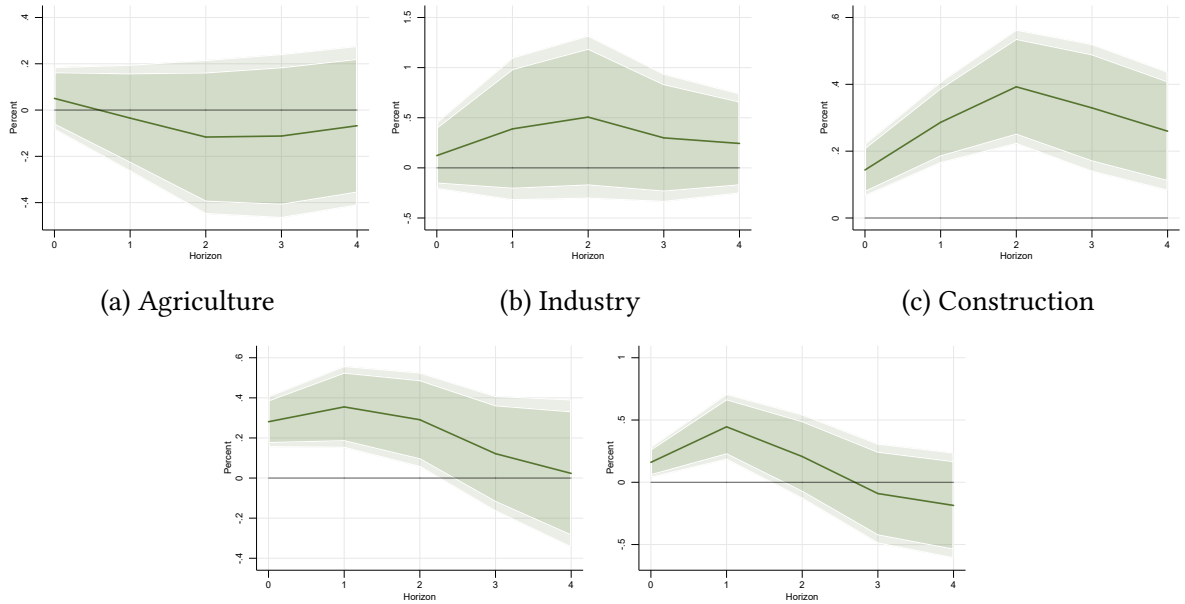
Figure D.15: Labor Productivity by Hour for Tradables and Non-tradables Sectors - Rescaled



(a) Tradables (b) Non-Tradables

Notes: Impulse responses to a one percent austerity-driven decline in government spending, estimated as in equation 7. Bands are 90% (dark) and 95% (light) confidence intervals. The responses plotted are rescaled by the average GVA share for each sector.

Figure D.16: Labor Productivity by Hour - Rescaled

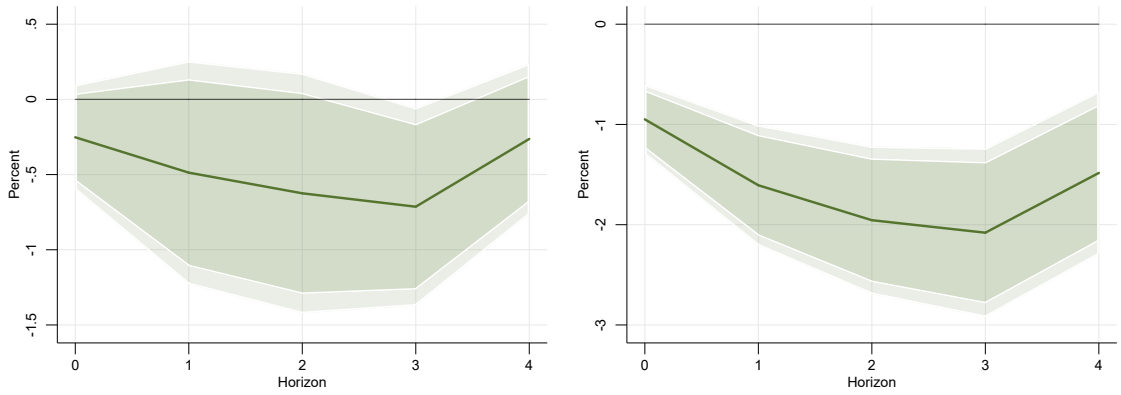


(a) Agriculture (b) Industry (c) Construction

(d) Services (e) Financial Services

Notes: Impulse responses to a one percent austerity-driven decline in government spending, estimated as in equation 7. Bands are 90% (dark) and 95% (light) confidence intervals. The responses plotted are rescaled by the average GVA share for each sector.

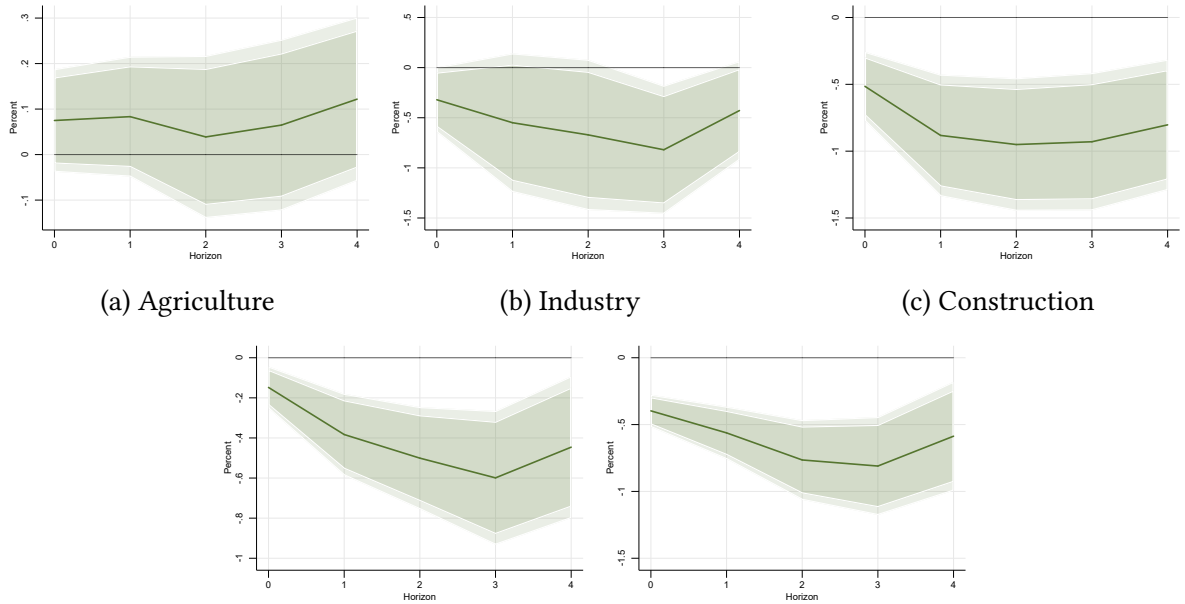
Figure D.17: GVA by Tradables and Non-tradables Sector - Rescaled



(a) Tradables (b) Non-Tradables

Notes: Impulse responses to a one percent austerity-driven decline in government spending, estimated as in equation 7. Bands are 90% (dark) and 95% (light) confidence intervals. The responses plotted are rescaled by the average GVA share for each sector.

Figure D.18: GVA by Sector - Rescaled

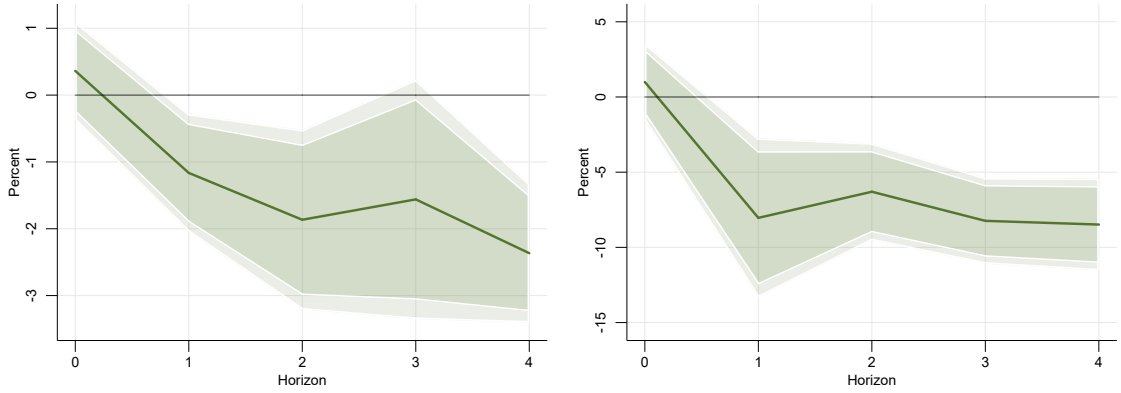


(a) Agriculture (b) Industry (c) Construction

(d) Services (e) Financial Services

Notes: Impulse responses to a one percent austerity-driven decline in government spending, estimated as in equation 7. Bands are 90% (dark) and 95% (light) confidence intervals. The responses plotted are rescaled by the average GVA share for each sector.

Figure D.19: Number of Local Units by Sector - no need to rescale



(a) Tradables (b) Non-Tradables

Notes: Data on local units starts in 2008. Impulse responses to a one percent austerity-driven decline in government spending, estimated as in equation 7. Bands are 90% (dark) and 95% (light) confidence intervals.