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Abstract

This paper delivers the first comprehensive estimate of the dynamic fiscal multiplier of defence spending for the EU-27 by exploiting exogenous accrual-based government defence outlays and a combination of linear and non-linear Local Projection methods. The linear estimates imply that a 1 percent-of-trend-GDP increase in defence outlays raises aggregate output by about 1.4 percent within one year, peaking at 1.6 percent in year two, and converging to zero in the medium-term, an effect mainly driven by capital-intensive procurement. Quantile Local Projections reveal pronounced multiplier convexity–multipliers exceed 1.75 percent in deep downturns but fall below 0.75 percent in expansions–while Smooth-Transition functions show that ample fiscal headroom and low import dependence each boost multipliers above unity, yet when both conditions reverse, the multiplier collapses to zero or negative values. These results underscore the importance of capital-intensive procurement, counter-cyclical timing, fiscal credibility, and domestic supply-chain resilience, and call for coordinated EU-wide fiscal rules and procurement standards to safeguard economic stability, fiscal policy effectiveness and collective security.

Keywords: Fiscal Policy; Fiscal Multiplier; Defence Spending; European Union; Local Projections; Quantile Local Projections; Non-Linearities

JEL Classification: C13, E32, E62, F47, H56, H61

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1 Introduction

Buy guns or buy roses? Is allocating public budget to defense spending worthwhile in terms of economic impact? In contexts where fiscal space is limited and there are clear budgetary constraints, the decision regarding public spending allocation becomes a zero-sum game. In such cases, increasing military expenditure may come at the expense of other spending categories, such as social welfare. Within this framework, the classical *guns-versus-butter* theory underscores this dilemma: for every euro allocated to *guns*, one that could otherwise be invested in *butter*, namely, social policies or productive infrastructure, is foregone. Indeed, governments may deliberately skew their expenditures toward social spending at the expense of military outlays during election periods (Bove, Efthyvoulou and Navas, 2017).

Once the decision is made to allocate part of the budget to military purposes, it is crucial to consider how that spending is executed: does it make a difference whether it is spent on wages, ammunition, or capital investment? The timing of the expenditure also plays a role. Intuitively, the crowding-in effect of a fiscal impulse on the private sector is potentially greater during periods of low resource utilization. Moreover, the domestic capacity to produce such resources could also influence the magnitude of the fiscal multiplier.

The literature has attempted to address some of these questions, focusing primarily on the United States (Ramey and Shapiro, 1998; Ramey, 2011*a*; Ramey and Zubairy, 2018), and more recently on a broad panel of countries (Sheremirov and Spirovska, 2022), yet without diving deep into composition effects or exploring sources of non-linearities beyond growth regime considerations. Moreover, the macroeconomic literature has yet to establish the magnitude, sign, persistence, composition effects, and potential non-linearities of the defense spending fiscal multiplier in the European context.

Thus, this paper provides the first comprehensive analysis of the economic impact of defense spending in Europe, focusing on offering evidence that what money is spent on matters, and on thoroughly exploring sources of non-linearity in the fiscal multiplier, such as the economys position within the output distribution, the available fiscal space, and external dependence in the provision of military goods at the time of implementing the fiscal stimulus. To this end, the paper estimates the dynamic cumulative fiscal multiplier using linear Local Projections (Jordà, 2005) by identifying exogenous defence shocks measured by accrual-based spending. The analysis is complemented with: (i) the estimation of Quantile Local Projections to explore the multiplier effect across the output distribution; (ii) the integration of Smooth Transition Functions *a la* Auerbach and Gorodnichenko (2012); (iii) the combination and embedding of quantile regressions with Smooth Transition Functions; and (iv) the joint consideration of multiple forms of state-dependence.

The empirical results presented in this paper reveal that defence spending in the EU-27 generates an above-unity multiplier in the short run: a one-percent-of-trend-GDP increase raises output by approximately 1.4 percent within one year, peaking at 1.6 percent in the second year before gradually converging to zero. Furthermore, the stimulus effect does not exhibit persistent structural impacts. Complementarily, defence spending shocks imply negative and significant effects on unemployment, which remain persistent to a larger extent than output. Disaggregation shows that capital-intensive procurement drives this aggregate effect, whereas personnel and intermediate consumption outlays have far more muted or even slightly negative impacts once offsetting budgetary adjustments are accounted for. Moreover, the strength of the defence multiplier is highly state-dependent and non-linear: in deep downturns, characterized by output gaps in the lowest quantiles, the first-year multiplier almost doubles compared with expansions. Also, under conditions of human capital under-utilization (high unemployment rates), the scope for improving labor market outcomes appears to be disproportionately greater than in times of low unemployment following a defence spending fiscal shock. Smooth-transition functions uncovers that limited fiscal space or heavy reliance on imported military goods can reduce the multiplier below unity or even render it contractionary at longer horizons, while it shifts to negative across all horizons when both sources of non-linearities are embedded. Finally, it is shown how fiscal space renders non-linear effects across the entire output distribution, specially 1 year after the fiscal shock.

Related Literature. Early work on the effects of government spending over the business cycle emphasizes the importance of identifying truly exogenous fiscal shocks. Ramey and Shapiro (1998) introduced a narrative approach using military news to isolate exogenous shifts in U.S. defense outlays and estimated multipliers well above unity, a finding later refined by Ramey (2011*b*) and Ramey and Zubairy (2018). Blanchard and Perotti (2002) developed a structural VAR framework to recover exogenous government-spending shocks, confirming sizable short-run output effects even under different identification schemes. The prevailing consensus in this foundational literature is that U.S. fiscal-spending multipliers lie within a broad range of 0.6 to 1.5. More recent long-run assessments, most notably Antolin-Diaz and Surico (2022), by utilizing military news-based shocks highlight that government R&D waves can amplify multipliers through innovation and capital-deepening channels, raising cumulative output gains by up to two dollars per dollar spent once research effects fully materialize.

Extending beyond single-country US studies, some papers exploit panels of advanced and emerging economies to gauge public spending multipliers in cross-national contexts (Perotti, Reis and Ramey, 2007; Leigh et al., 2010; Ilzetzki, Mendoza and Végh, 2013; Auerbach and Gorodnichenko, 2013; Sheremirov and Spirovska, 2022), among others. As regards to the application of military spending, Sheremirov and Spirovska (2022) apply LP-IV techniques to instrument total government spending by military outlays to a 129-country sample, finding that military purchases drive above 1.5 multipliers in advanced economies. Regional analyses, such as Nakamura and Steinsson (2014) for U.S. regions, corroborate the role of exogenous defense buildups in boosting local output, reinforcing the need to consider composition effects (Bom and Ligthart, 2014; Clemens and Miran, 2012).

A parallel strand of the literature examines non-linearities in fiscal policy transmission. Auerbach and Gorodnichenko (2012) pioneer smooth-transition VARs to allow state-dependent multipliers across recession and expansion regimes, finding larger multipliers in periods of economic slack. Quantile Local Projections (QLP), introduced in the government spending fiscal multipliers literature by Linnemann and Winkler (2016) and further developed in contexts of growth forecasts by Adrian, Boyarchenko and Giannone (2019) and financial shocks transmissions (Jordà et al., 2022), offer a flexible alternative that estimates impulse responses at each quantile of the output distribution, thus offering a complete image of output distribution effects. Linnemann and Winkler (2016) found that U.S. government-spending shocks raise output by more than one-for-one in the lowest GDP decile but have negligible effects in the upper half. Evidence on military-spending shocks evaluated *via* smooth transitions confirms this convexity: U.S. defense-news multipliers exceed unity only in slack states (Ramey and Zubairy, 2018; Alloza, 2022).

A growing strand of the literature highlights that fiscal multipliers are markedly non-linear once one accounts for fiscal space and trade openness. Regarding fiscal space, studies find that the level of public debt not only dampens the impact of spending shocks but does so in a non-linear way: higher debt burdens increase the sensitivity of output responses to interest-rate feedbacks, so that models omitting the snowball term (the combination of debt interest rate and growth) systematically overstate multipliers. Empirical work by Kirchner, Cimadomo and Hauptmeier (2010); De Cos and Moral-Benito (2013); Nickel and Tudyka (2014) show pronounced threshold effects in multiplier size as debt-to-GDP rises, while Favero and Giavazzi (2007); Di Serio, Fragetta and Melina (2021) demonstrate that including the snowball term uncovers even stronger non-linearities than debt levels alone would suggest. Moreover, Broner et al. (2022) test whether the extent of foreign holdings of public debt affects the drag-down effect of the fiscal impulse, using, among other instruments, Rameys defense-news shocks. More precisely, they investigate whether, when the funds used to finance the fiscal expansion come from domestic sources, consumption and investment may be adversely affected, thereby causing a crowding-out effect. They find that, indeed, a higher share of public debt held by foreigners is associated with larger fiscal multipliers, which reach above-unity levels in states of high foreign share.

In parallel, the openness of an economy to trade has been shown to shape both the sign and magnitude of fiscal multipliers: relatively closed economies exhibit multipliers above one, whereas highly open economies, where import leakages are large, can experience zero or even negative multipliers, as documented in cross-country panels (Ilzetzki, Mendoza and Végh, 2013; Sheremirov and Spirovska, 2022).

Despite this insightful progress, there is no existing estimate of the dynamic fiscal multiplier of defence spending in Europe that delves into potential composition effects and examines how critical dimensions, namely the timing and allocation of expenditure, fiscal constraints, and dependence on imported defence-specific goods, influence the propagation of public defence outlays. Moreover, to the best of my knowledge, the joint exploration of multiple non-linearities in this context remains unexplored. Notably, Ghassibe and Zanetti (2022) embed unemployment and inflation regimes in binary-indicator VARs in an alternative context.

Structure of the Paper. The remainder of the paper is organized as follows. Section 2 describes the data sources, variable construction, and key macroeconomic controls. Section 3 presents linear local-projection estimates of the aggregate defence multiplier. Section 4 decomposes these effects into procurement, personnel, and operating expenses. Section 5 explores non-linearities through (i) quantile local projections, (ii) smooth-transition projections for fiscal-space regimes and (iii) analogous analysis for import reliance. Section 6 reports robustness checks and additional tests including embedded models combining state-dependencies. Section 7 concludes with policy implications for the design and timing of defence-spending programmes.

2 Data

To analyze the impact of defense spending on economic activity, we compile data on defense and military expenditures, economic output, and other relevant macroeconomic variables for all EU27 countries over the period 1995 to 2023 at an annual frequency.

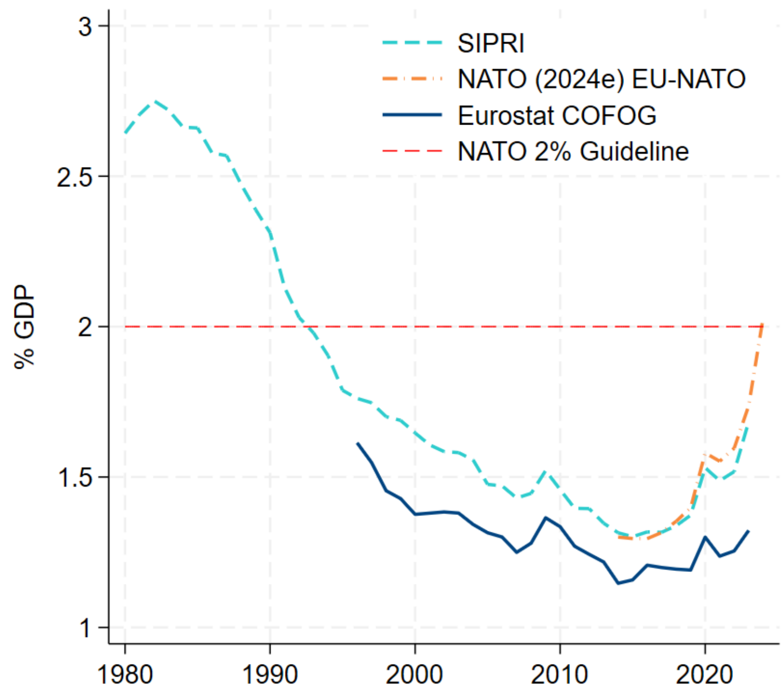
There are various sources of information on defense and military expenditure in the case of Europe. Each source differs in terms of the classification and breakdown of spending, the accounting methodology employed, and period and sample availability. Multiple sources provide relatively long time series for almost all EU countries: military spending from the Stockholm International Peach Research Institute (SIPRI)[1], North Atlantic Treaty Organization (NATO) defence spending data[2], European Defence Agency defence data[3], and Eurostat defence spending based on the Classification of the Functions of Government (COFOG). Since only SIPRI and Eurostat provide long time series for all EU-27 countries, both sources are used as defence spending variables. Figure 1 presents the historical evolution of aggregated EU27 defence and military spending from various sources: SIPRI, NATO and Eurostat. Although Eurostats defense expenditure as a share of GDP has consistently been lower than that reported by SIPRI and NATO, all three sources exhibit a common pattern: a decline in spending from the late 1990s, followed by a resurgence starting in 2016, driven by rising tensions in Ukraine, which have continued to intensify since then and is expected to reach the NATO 2% guideline in 2024, according to NATO.

[1]SIPRI data cover most EU27 countries from 1985 onwards, except for Bulgaria, Croatia, Czechia, Estonia, Latvia, Lithuania, Slovakia, and Slovenia, for which data are available only from 1993.

[2]NATO data, for reasons that are self-evident, only gathers cash-based defence spending data and composition for NATO member countries, where Austria, Cyprus, Ireland and Malta are not included. Note that SIPRI and NATO defence spending series present high similarity and correlation, explained by the fact that SIPRI information uses NATO data as a main source of information (SIPRI, 2025)

[3]The EDA, established on 12 July 2004, includes information of defence spending and components since 2006 for all EU-27 countries, and draws upon information received from the Ministries of Defence of the 27 Member States (EDA, 2025).

Figure 1: **Defence Spending Evolution: EU27 (1980-2024)**



Notes: The plot displays the weighted average (GDP-based) of defence spending over GDP of EU27 countries. Total defence spending is expressed in terms of GDP. The dashed light-blue line indicates the EU27 military spending over GDP from SIPRI, the orange point dashed line from NATO EU members over GDP from NATO, the solid dark blue line the EU27 defence spending over GDP from Eurostat (COGOF), and the dashed red line indicates the 2% defence spending NATO guideline.

The SIPRI provides annual estimates of military expenditure based on a broad definition that includes all current and capital expenditures on the armed forces, defense ministries, paramilitary forces, military space activities and military pensions. These figures typically encompass personnel costs, operations and maintenance, procurement, military R&D, and military aid. SIPRI uses a standardized methodology to ensure international comparability, but its estimates may include off-budget items and are not necessarily aligned with national accounting systems. SIPRI compiles military expenditure data using a hierarchy of sources: first, primary sources such as official national budget documents and government questionnaires; second, secondary sources that cite primary data, including NATO and IMF statistics; and third, other secondary sources like specialist journals and newspapers. Existing literature has employed SIPRIs military expenditure data to estimate fiscal multipliers in large cross-country panels, where its use appears justified due to its cross-national consistency (Sheremirov and Spirovska, 2022). However, cash-based SIPRI and NATO figures record equipment purchases upon payment rather than delivery, misaligning with GDP recognition (Eurostat, 2016) and thus potentially biasing or nullifying estimates of military spendings effect on GDP.

In contrast, Eurostat's COFOG data, derived from national accounts, follows a functional classification of government expenditure and is based on the European System of Accounts (ESA). The COFOG category for defense (code 02) includes expenditures on military defense, civil defense, foreign military aid, and R&D related to defense, but it is structured according to accounting practices consistent with GDP measurement. All expenditures are classified according to the ESA 2010 framework, allowing for the identification of military expenditures on an accrual accounting basis. Thus, in addition to using total defense expenditure, information is also extracted from the following components: personnel (compensation of employees, social benefits other than social transfers in kind and social transfers in kind), gross fixed capital formation, intermediate consumption and capital transfers. This makes COFOG data more appropriate for economic analysis, as it is directly compatible with other macroeconomic aggregates and allows for a more consistent estimation of the impact of defense spending on economic activity. Thus, this paper uses Eurostats defense expenditure and its components as the baseline variables. Additionally, SIPRIs military expenditure data is employed as a benchmark for comparison.

With regard to economic activity, the analysis employs real GDP (chained to 2015). In addition, the following variables are used as covariates and controls: trade (exports and imports), government revenue, total government expenditure excluding defense, public debt, unemployment rate, GDP deflator (2015), and the value of military goods imports (the extraction and construction of which are detailed later in the paper). The sources of all variables, along with their main descriptive statistics, are provided in Table 1 of the Appendix.

3 Linear Defence Fiscal Multiplier

To estimate the size of fiscal multipliers, ones needs to consider that an initial exogenous increase in government expenditure amounting to one monetary unit at time t may generate an output response, both immediately and over subsequent periods. However, this initial increase in spending is frequently accompanied by additional government expenditures in the following periods (something we will prove later on the paper). Accordingly, as proposed by Jordà and Taylor (2025), it is reasonable to articulate the effects of sustained fiscal interventions by estimating the total increase in output relative to the cumulative increase in government spending over a specified time horizon. A similar approach is applied by Sheremirov and Spirovska (2022); Ghassibe and Zanetti (2022), where cumulative public spending is instrumentalized through military expenditure, estimating the dynamic impact on output accumulation by combining local projections with instrumental variables (LP-IV).

Thus, given that the focus of this paper is to estimate the cumulative dynamic impact of defense spending on output, we estimate the following set of regressions via local projections (Jordà, 2005) for each horizon $h = 1, 2, ..., 6$[4]:

$$y^c_{i,t,h} = \alpha_{i,h} + \delta_{t,h} + \beta_h d^c_{i,t,h} + \sum_{j=1}^{\ell} \boldsymbol{\theta}^h_j \mathbf{X}_{i,t-j} + \epsilon_{i,t+h}, \tag{1}$$

where, following Ramey and Zubairy (2018), $d_{i,t}$ and $y_{i,t}$ are real defence spending and real GDP, respectively, both normalized by trend GDP, which is estimated by fitting real GDP on a quartic polynomial in time[5]. Note that superscript c denotes that both variables are expressed in cumulative terms from t to $t + h$, which is derived, following Jordà and Taylor (2025)'s notation, from general expression

[4]The choice of estimating the cumulative impact until 6 years is motivated by the objective of analyzing short- and medium-term effects and the sample period.

[5]Degree's polynomial choice relies on time extension of the sample. Alternatively, this paper includes sensitivity tests as regards to the size of degree's polynomial.

$w^c_{i,t,h} = (w_{i,t} + ... + w_{i,t+h}) = \sum_{j=0}^{h} w_{i,t+j}$. Thus, $w \in \{d, y\}$. Equation 1 presents an extension of Jordà and Taylor (2025)'s representation of directly-estimated cumulative fiscal multipliers[6]. Thus, β_h is interpreted as the effect at horizon h of cumulative defence spending from t to $t + h$ on a cumulative measure of output. Additionally, $y_{i,t}$ is specified as the annual real GDP growth rate to capture the impact of defense-related fiscal shocks not only on the business cycle but also on a broader measure that encompasses non-cyclical components of output. Comparing both IRFs provides information about the impact on structural output, that is, whether the fiscal shock implies structural and persistent effects or, on the contrary, cyclical and transitory effects. Recall that defence spending ($d_{i,t}$), used as the baseline fiscal shock, is the accrual-based measure of COFOG Eurostat spending.

Regressions also include country and year fixed effects ($\alpha_{i,h}$ and $\delta_{t,h}$, respectively). The specification also includes $l = 4$ lags[7] of vector of controls $\mathbf{X}_{i,t}$, which contains traditional fiscal multiplier specification covariates, all normalized by trend GDP (defence spending, output, trade, government revenue and government spending different from defence[8]). $\epsilon_{i,t+h}$ is the error term and to minimize autocorrelated errors standard errors consistent in the presence of heteroskedasticity and autocorrelation (HAC) are used.

Results. Figure 2 presents the results of estimating regressions presented in equation 1 from 1 to 6 years after the fiscal shock for both forms of the dependent variable. Panel (a) illustrates the cumulative fiscal multiplier of a defense spending shock on EU27 output (normalized by trend GDP) over a six-year horizon. The multiplier starts around 1.4 in the first year, meaning that a 1% of trend GDP in-

[6] Jordà and Taylor (2025) presents a general form of directly estimating cumulative fiscal multipliers by regressing cumulative fiscal shocks on cumulative output by the following regressions (equation 19):

$$y^c_{t,h} = m(h)s^c_{t,h} + e_{t+h} \tag{2}$$

[7] Lag selection criteria conducted via the Akaike and Schwarz information criteria.

[8] Results are robust to the inclusion of additional covariates such as long-term yields, military imports and the GDP deflator.

crease in defense spending raises output by about 1.4% of trend GDP within one year. The multiplier peaks at roughly 1.6 by year 2, meaning that over two years, a defense spending increase of 1% of trend GDP cumulatively raises the level of GDP by about 1.6% above the no-shock baseline. The fact that the multiplier rises from 1.4 to 1.6 between year 1 and 2 indicates that the impact is not fully immediate; output continues to expand in the second year, compounding the first-year gains. After year 2, the decline in the cumulative multiplier implies some dissipation of the output gains. By year 6, $\beta_6 \approx 0.0$, suggesting the output level is back to trend (no long-run change), consistent with a temporary fiscal stimulus that does not permanently raise GDP.

In summary, panel (a) suggests that in the EU27, defense spending shocks imply above-unity short-run multipliers on output, peaking within 1-2 years, followed by a gradual return toward baseline as the stimulus effect wears off. Complementary, panel (b) shows the effect of the defense spending shock on the annual real GDP growth rate. The multiplier is above unity 1-2 years after the defence shock and suggests that the stimulus causes immediate acceleration in economic growth. However, cumulative effects on output growth vanish at a longer horizon suggesting that i) defense spending shocks give the economy a short-lived growth spurt and ii) that structural defence effects on output are not materialized.

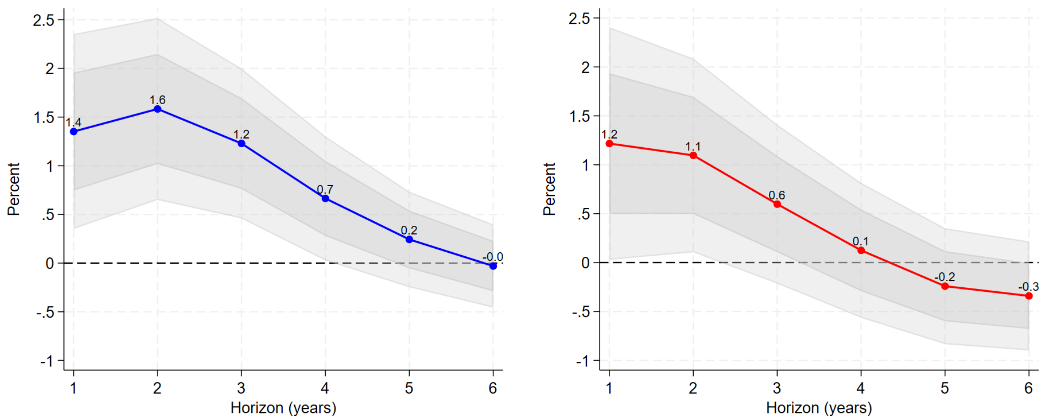
Relative to the broader fiscal-multiplier literature, the EU-27 defense-spending multiplier of 1.4-1.6 in panel (a) is clearly on the high side but still falls within the advanced-economy range once methodological and macro-environmental differences are taken into account. For instance, Ramey and Zubairy (2018), who identify U.S. defense-news shocks with local projections, report cumulative multipliers between 0.70 and 0.96 over the first two to four years, values that remain below unity across slack and normal states. Likewise, the cross-country study of Ilzetzki, Mendoza and Végh (2013) finds an impact multiplier of only 0.39 and a long-run (five-year) multiplier of 0.66 for high-income countries, with even lower (or negative) effects in very open or highly indebted economies. The existing size multiplier gap is readily explained by three forces that recent research highlights as multiplier-amplifiers: (i) the currency-union / fixed-exchange-rate setting of the euro area, which Ilzetzki, Mendoza and Végh (2013) show can boost multipliers relative to flexible-rate economies; (ii) the slack and zero-lower-bound conditions that characterized much of Europe's 2010-21 sample and are absent in the average periods examined by Ramey and Zubairy (2018); and (iii) the use of truly exogenous defence-spending shocks, which Sheremirov and Spirovska (2022) show can lift advanced-economy multipliers to roughly 1.75 in the first year, virtually identical to the peak 1.6 estimate in panel (a). By exploiting regional variation in military buildups, Nakamura and Steinsson (2014) estimate multipliers of approximately 1.5 as well.

Antolin-Diaz and Surico (2022), from a very long-run US perspective, find that a one-off rise in government outlays buys roughly 1½ to 2 of extra GDP once the associated public R&D wave has had time to work its way through innovation and capital deepening channels. Absent that R&D component, the multiplier is closer to (or even below) the unity[9]. Taken together, these comparisons suggest that the EU-27 result does not contradict but rather confirms the emerging consensus: in advanced economies facing slack and operating under fixed or common exchange rates, normalized-defence-spending shocks can raise output by about 1½ per euro spent in the short run, whereas studies that average across normal times, flexible rates, or broader government-consumption shocks naturally obtain smaller multipliers closer to or even below unity.

The identification strategy applied in this paper relies on the idea that defence

[9]For the case of European countries from 2001 to 2023, the period for which aggregate data on defence-related R&D are available, the share of R&D expenditure in total defence spending has been both relatively small and declining, decreasing from 3.44% in 2001 to 1.79% in 2023, as shown in Figure 10 in the Appendix. This stylized fact justifies the decision not to consider R&D spending in Europe, historically very limited in magnitude, as a fiscal shock in the paper. Moreover, disentangling which fraction of R&D expenditure belongs to intermediate consumption or gross fixed capital formation appears to be a hard task, since it can be identified as any of the mentioned national accounts spending components, as argued by Olejnik (2023).

Figure 2: **Cumulative Defence Fiscal Multipliers**



(a) **Trend-Normalized Output** (b) **Real GDP growth rate**

Notes: The plots display the estimated coefficient β from regressions of equation 1 for each horizon h, as well as its 68% and 90% confidence bands (grey shaded area). Panel (a) shows cumulative fiscal multiplier utilizing trend-normalized real GDP as the dependent variable, and panel (b) the results for using real GDP growth rate as the shocked variable. Estimated coefficient $\widehat{\beta_h}$ is interpreted as the cumulative defence spending fiscal multiplier at horizon h. The estimation includes country and year fixed effects, and all standard errors are robust.

spending only respond to geopolitical events rather than domestic economic conditions, specially in developed countries, as argued in many cases in the literature (Barro, 1981; Hall, 2009; Ramey and Shapiro, 1998; Sheremirov and Spirovska, 2022). However, it could be argued that defense spending plans may be influenced by the level of economic growth, especially through the growth expectations channel. In any case, we test for potential endogeneity of both variables by performing the panel version of the Durbin-Wu-Hausman (DWH) test. The DWH test is a statistical procedure used to determine whether an explanatory variable in a regression model is endogenous. Endogeneity violates one of the key assumptions of the classical linear regression model and can lead to biased and inconsistent estimates if not properly addressed. To conduct the test, we proceeded with the following steps: i) instrument normalized defense spending by using four lags of the dependent variable (all instruments are jointly valid), ii) extract the residuals from regressing normalized defence spending on the valid instruments, the rest of controls added in equation 1 and country and year fixed effects, which represent the non-exogenous variation in defense spending (fraction non explained by instruments and controls), iii) include those residuals in each horizon-regression, and iv) test for the significance of the estimated residuals at each horizon h. Significant residuals in this context indicate the presence of endogeneity between the shock and the shocked variable, thus supporting the use of an instrumental variable approach in the main analysis.

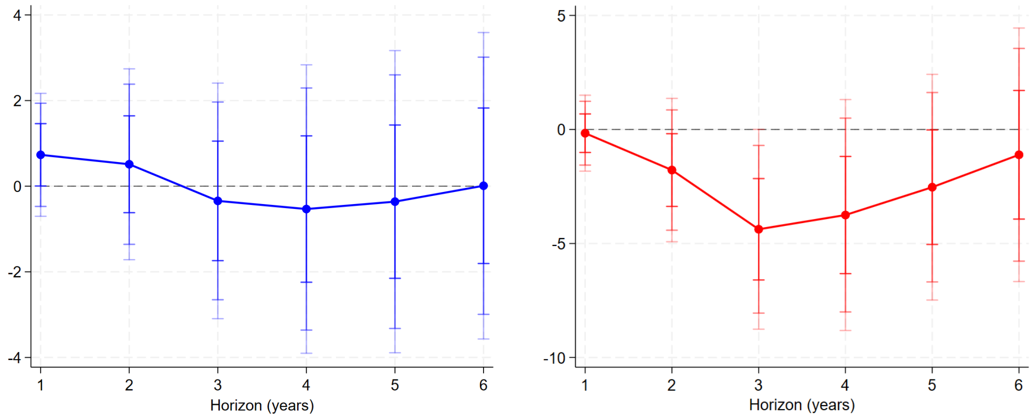
Figure 3 plots the magnitude and statistical significance of the estimated residuals entered as an additional regressor in equation (1) for each forecast horizon h. Panel (a) reports the results for trend-normalized output, whereas panel (b) presents those for the real GDP growth rate. At every horizon the residuals are statistically indistinguishable from zero, implying no evidence of endogeneity between normalized defence spending and trend-normalized output[10]. Consistent with these findings, the DWH test fails to reject the null hypothesis of exogeneity, indicating that endogeneity does not constitute a material concern for the present specification and identification strategy.

4 Defence Spending Composition

This section investigates whether the size and persistence of defence-spending multipliers vary across budget lines. The distinction is economically meaningful: compensation of employees (e.g., soldiers wages) raises disposable income and primarily boosts private consumption, whereas outlays for infrastructure, equipment and weapons systems expand the public capital stock, crowd-in private investment, and can generate durable productivity gains (Aschauer, 1989; Baxter and King, 1993; Abiad, Furceri and Topalova, 2016). Meta-evidence confirms this composition effect: Bom and Ligthart (2014) and Clemens and Miran (2012) find multipliers be-

[10]The only departure from this pattern arises at horizon 3 when real GDP growth is the dependent variable, where the residuals reach marginal significance at the 10 percent level.

Figure 3: **Durwin-Wu-Hausman Endogeneity Tests**



(a) **Trend-Normalized Output** (b) **Real GDP growth rate**

Notes: The plots display the estimated coefficient of extracted residuals from the first stage of the Durbin-Wu-Hausman endogeneity test included in regressions of equation 1 for each horizon h, as well as its 68%, 90% and 95% confidence bands (I-beams). Panel (a) shows estimated coefficient of the first-stage residual utilizing trend-normalized real GDP as the dependent variable, and panel (b) the results for using real GDP growth rate as the shocked variable.

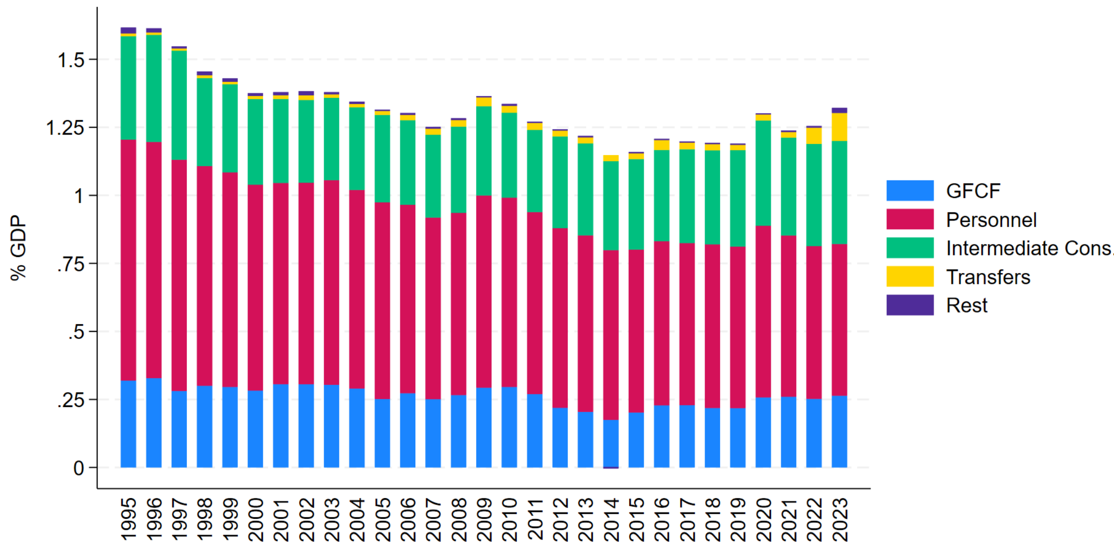
low unity for wage-intensive programmes but impact multipliers well above one for public investment, with cumulated effects that remain significantly positive several years after the shock. Similar patterns emerge inside defence budgets. Using U.S. narrative shocks, Ramey (2011*a*) shows that payroll surges yield modest, short-lived multipliers, whereas procurement booms tied to large materiel orders produce larger and more persistent output responses. Sheremirov and Spirovska (2022) corroborate this result in a 129-country panel: the >1.5 multipliers they estimate for advanced economies are driven almost entirely by capital-intensive military purchases, while intermediate-consumption items are macro-economically negligible. Recent evidence for NATOs eastern-flank countries reinforces the point: Olejnik (2023) exploits a new disaggregated dataset and finds that, over 1999-2021, personnel spending exerts the strongest negative drag on GDP both in the short run (fiscal multipliers 0.2-0.5 below unity) and in the long run, whereas equipment purchases and maintenance also depress growth but to a lesser extent; by contrast, non-military government consumption delivers larger short-run multipliers.

Guided by this evidence, we exploit the ESA-2010 functional classification of defence spending, which separately records compensation of employees (P.2), intermediate consumption (P.2), gross fixed capital formation (P.5g) and other capital transfers (D.9) on an accrual basis to construct component-specific fiscal shocks. Estimating local-projection impulse responses for each component allows to test whether the aggregate multiplier masks sizeable heterogeneity in both impact and durability, and to assess which categories of military outlays deliver the largest bang for the euro in the EU-27.

Figure 4 shows the composition of defence spending as a share of GDP in the EU27 from 1995 to 2023. Total defence spending declined from around 1.6% of GDP in 1995 to approximately 1.2% in 2023 a reduction of about 0.4 percentage points. Although spending remained relatively flat from the mid-2000s to the mid-2010s, a moderate increase is observed in recent years. The internal composition of spending has remained relatively stable, indicating that changes in total expenditure have occurred without major shifts in budget allocation priorities. Personnel expenditure, which is mainly componded by compensation of employees, consistently accounts for the largest share, followed by intermediate consumption and GFCF, while transfers and residual components remain marginal. On average, personnel expenditure, intermediate consumption and GFCF have historically and jointly accounted for almost 98% of total defence spending in the EU27, a motivation for analyzing component by component the size of their impact on economic activity.

Furthermore, increases in one category of defence expenditure may induce increases in others, suggesting the presence of synergistic and complementary relationships among spending components. For example, the acquisition of new military equipment, classified as gross fixed capital formation (GFCF), may necessitate a concurrent rise in intermediate consumption (such as ammunition and maintenance) as well as in military personnel, should existing human resources prove inadequate. Conversely, in the presence of binding fiscal constraints, substitution

Figure 4: **Defence Spending Composition: EU27**



Notes: The plot displays the weighted average (GDP-based) of defence spending over GDP of EU27 countries. Total defence spending is decomposed in gross fixed capital formation (GFCF), personnel expenditure (which includes compensation of employees and social benefits), intermediate consumption, capital transfers and rest (residual component).

effects between expenditure components may emerge. To account for both types of underlying inter-components effects, similar regressions to equation 1 are estimated:

$$y^c_{i,t,h} = \alpha_{i,h} + \delta_{t,h} + \beta^k_h d^{c,k}_{i,t,h} + \sum_{\substack{m=1 \\ m \neq k}}^{3} \gamma^m_h d^m_{i,t} + \sum_{j=1}^{\ell} \boldsymbol{\theta}^h_j \mathbf{X}_{i,t-j} + \epsilon_{i,t+h}, \tag{3}$$

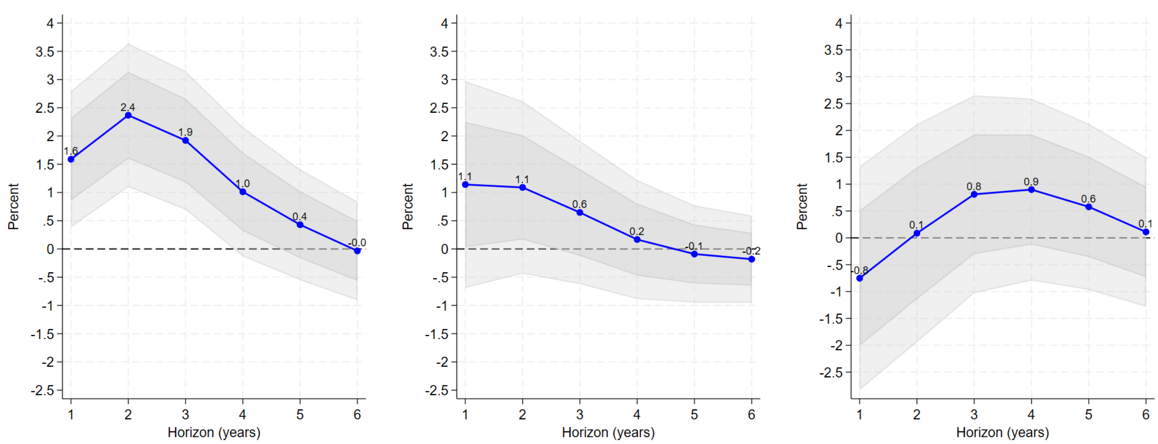
where $\{d^1_{i,t}, d^2_{i,t}, d^3_{i,t}\}$ denote three distinct defence spending variables: gross fixed capital formation (GFCF), personnel expenditures, and intermediate consumption. $k \in \{1, 2, 3\}$ indicates the fiscal shock of interest in each specification, and $m \neq k$ indexes the other two spending categories used as controls (evaluated at time t). A separate regression is estimated for each combination of fiscal spending-item shock k and horizon h, resulting in $3 \times H$ regressions in total. The rest of elements and features (including shock normalization) of equation (3) are equal to those from equation (1). Thus, β^k_h is interpreted as the cumulative fiscal multiplier of defence spending component k at horizon h. Shocked variable $y^c_{i,t,h}$ will take the form of trend-normalized output. In addition, it is of particular interest to examine whether using real GDP growth as the dependent variable yields different results when the fiscal shock is defined as expenditure on gross fixed capital formation (GFCF). GFCF may potentially generate effects that go beyond the business cycle, possibly shifting the output path upward and influencing potential GDP. Conversely, if only transitory and statistically insignificant effects are found, this would suggest that defence-related GFCF does not exert a structural impact on economic output.

Results. Disaggregating defence outlays reveals marked heterogeneity in the cumulative multiplier profile, as displayed in Figure 5. Capital spending (GFCF, panel a) delivers the largest stimulus: the cumulative output gain jumps to 2.4% of trend GDP after two years per 1%-of-GDP capital shock, remains clearly above unity through year 3, and only fades to insignificance by year 6. Personnel expenditure (panel b) generates much smaller effects; the multiplier never exceeds 0.8, peaks in year 3, and is statistically indistinguishable from zero, thereafter consistent with a largely transitory boost to private consumption but little lasting impact on production capacity. Intermediate consumption (panel c) is initially contractionary (-1% in year 1, likely reflecting import leakage or inventory drawdowns), turns positive by year 2, and reaches a modest plateau of 0.9 in years 3-4 before tapering. Only the GFCF remains significant until 3 years after the cumulative shock at the 90% confidence level.

The strong, 1-3 years front-loaded response to defence-related capital formation accords with the canonical finding that public investment multipliers exceed one and display durable level effects (Bom and Ligthart, 2014; Abiad, Furceri and Topalova, 2016). It also mirrors the defence-procurement booms studied for the United States, Ramey (2011*a*)'s narrative shocks and the cross-country panel of Sheremirov and Spirovska (2022), where capital-intensive orders drive multipliers above 1.5. By contrast, the muted impact of personnel outlays corroborates evidence that wage-heavy programmes yield multipliers below unity (Clemens and Miran, 2012) and may even dampen medium-term growth in NATOs eastern-flank economies (Olejnik, 2023). The hump-shaped but ultimately sub-unitary path for intermediate consumption is consistent with studies showing that operating expenditures have limited stimulus once supply chains and import leakage are accounted for (Bom and Ligthart, 2014).

Overall, Figure 5 supports the emerging consensus that what the money is spent on matters as much as how much is spent: capital purchases deliver the highest and most persistent defence multipliers, while payroll and intermediate items yield modest or transient effects. Complementarily, Figure 11 in the Appendix displays the estimated fiscal multiplier of GFCF expenditure when output is measured as real GDP growth. The magnitude of the effects is marginally attenuated, with statistically significant impacts observed during the initial three years. However, the multiplier gradually declines and converges to zero by the sixth year. These results indicate that GFCF-related spending does not produce long-lasting or structural effects on economic growth.

Figure 5: **Cumulative Defence Fiscal Multipliers: Spending Composition**



(a) **GFCF** (b) **Personnel** (c) **Int. Cons.**

Notes: The plots display the estimated coefficient β from regressions of equation 3 for each horizon h, as well as its 68% and 90% confidence bands (grey shaded area). Panel (a) shows cumulative fiscal multiplier of normalized GFCF utilized as the fiscal shock, and panel (b) for personnel expenditure, and panel (c) for intermediate consumption. Estimated coefficients $\widehat{\beta_h}$ are interpreted as the cumulative defence spending component-specific fiscal multiplier at horizon h. The estimation includes country and year fixed effects, and all standard errors are robust.

5 Non-Linearities

5.1 Output Distribution: Quantile Local Projections

Periods of fiscal expansion rarely hit an economy that is exactly average. In practice, governments step in when output is collapsing (COVID-19), when it is merely sluggish, or occasionally when it is already at full capacity (wartime booms). Because the marginal household, firm and monetary authority differ across these states, theory predicts the output response to a spending shock should be state-contingent, not constant. Detecting such state-dependence is therefore crucial for calibrating policy: a one-euro rise in defence outlays may deliver far greater bang for the buck when GDP is two standard deviations below trend than when the economy is humming. Standard linear multipliers, which average over booms and busts, conceal this heterogeneity.

To uncover these potential non-linearities we combine Koenker and Bassett (1978)s quantile-regression idea with Jordà (2005)'s local projections (see, eg., Linnemann and Winkler (2016); Adrian, Boyarchenko and Giannone (2019); Jordà et al. (2022)). Quantile local projections (QLP) estimate impulse responses at each quantile of the conditional output distribution, allowing the multiplier to differ smoothly between a deep-recession decile and a boom decile. This approach offers two advantages over both linear models and the regime-switching smooth-transition VARs used by Auerbach and Gorodnichenko (2012).

First, whereas linear projections pin the effect of a fiscal shock to the conditional mean, quantile projections let the entire distribution shift non-uniformly; we can test directly whether a 1 percent-of-GDP defence shock raises output more in the left tail than around the median. Second, unlike smooth-transition methods that require an ex-ante partition of the sample into recessions and expansions and a specific transition function, QLPs impose no pre-classification of states. The data themselves reveal how multipliers evolve across all observed output levels, sidestepping the thorny issue of regime dating and persistence that can bias state-dependent estimates. This flexibility is especially useful when output is influenced by both cyclical and secular forces that blur the conventional business-cycle dichotomy. In short, QLPs provide a transparent, distribution-wide lens on fiscal non-linearities, complementing and in many cases improving on the more restrictive regime-based methods in the existing literature.

Building on these foundations, a nascent and scarce literature applies QLPs to fiscal policy. Linnemann and Winkler (2016) find that U.S. government-spending shocks raise output by more than one-for-one in the lowest GDP decile but have negligible effects in the upper half, overturning the state-invariant multipliers implied by linear models.

In particular, we am interested in examining how defence spending shocks affect the distribution of output conditional on observables. Denote $y_{i,t+h} = y^c_{i,t,h}$, that is the cumulative of trend-normalized output from t to $t+h$ (alternatively, real GDP growth is utilized as well in the Appendix). Let the defence fiscal shock, controls from equation 1 and the fixed effects ($\alpha_{i,h}$ & $\delta_{t,h}$) be collected in $\mathbf{X}_{i,t}$. Within this framework, QLPs at each horizon h and quantile $\tau \in (0,1)$ are obtained by computing the following expression, where $\hat{\boldsymbol{\psi}}_{h,\tau}$ is selected to minimize the quantile-weighted absolute sum of errors:

$$\begin{aligned}\hat{\boldsymbol{\psi}}_{h,\tau} = \arg\min_{\boldsymbol{\psi}_{h,\tau}} \sum_{t=1}^{T-h} \Big(& \tau\, \mathbb{1}\left(y_{i,t+h} \geq \mathbf{X}_{i,t}\boldsymbol{\psi}_{h,\tau}\right) \left| y_{i,t+h} - \mathbf{X}_{i,t}\boldsymbol{\psi}_{h,\tau} \right| \\ & + (1-\tau)\, \mathbb{1}\left(y_{i,t+h} < \mathbf{X}_{i,t}\boldsymbol{\psi}_{h,\tau}\right) \left| y_{i,t+h} - \mathbf{X}_{i,t}\boldsymbol{\psi}_{h,\tau} \right| \Big),\end{aligned} \tag{4}$$

where $\mathbb{1}(.)$ represents the indicator function and quantile τ ranges from 0.05 to 0.95 by 0.05, thus resulting in 20 different quantiles of the output distribution. Hence, the quantile of output $y_{i,t+h}$ conditional on $\mathbf{X}_{i,t}$ is given by:

$$Q_\tau\left(y_{i,t+h} \mid \mathbf{X}_{i,t}\right) = \mathbf{X}_{i,t}\boldsymbol{\psi}_{h,\tau} \equiv q^h_{\tau,t}, \tag{5}$$

where $\boldsymbol{\psi}_{h,\tau}$ captures the effect of all independent variables on the τ quantile of the conditional distribution of $y_{i,t+h}$. Equation 5 can be directly expressed in an analogous form to equation 1:

$$Q_\tau\left(y_{i,t+h} \mid d^c_{i,t,h}, \mathbf{X}_{i,t-j}\right) = \alpha_{i,h}(\tau) + \delta_{t,h}(\tau) + \beta_h(\tau) d^c_{i,t,h} + \sum_{j=1}^{\ell} \boldsymbol{\theta}^h_j(\tau)\, \mathbf{X}_{i,t-j} + \epsilon_{i,t+h}(\tau), \tag{6}$$

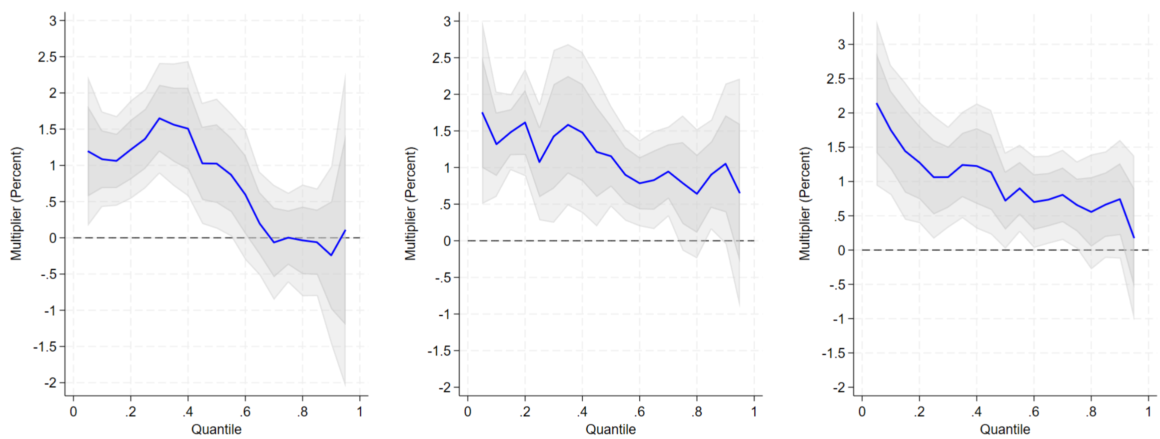
where $\beta_h(\tau)$ measures the effect of detrended defence spending shocks on the conditional distribution of $y_{i,t+h}$. Finally, $h \times \tau$ regressions are estimated, yielding $h \times \tau$ corresponding $\beta_h(\tau)$ multiplier coefficients, which provide insight into the potential non-linearity of the fiscal multiplier as a function of the distribution of normalized output.

Results. Figure 6 presents the distribution and statistical significance of the estimated coefficients $\widehat{\boldsymbol{\beta}_h(\tau)}$ across values of τ for selected horizons. The objective is to assess the conditional response of output at horizons where the average (unconditional) response is statistically significant, namely for ($h \in \{1, 2, 3\}$). Note that the impact is evaluated in terms of trend-normalized output.

The QLP estimates reported in Figure 6 reveal pronounced state dependence in the cumulative defence–spending multiplier. At every horizon $h \in \{1, 2, 3\}$ the multiplier declines monotonically as one moves from the lower to the upper tail of the output distribution. The gradient is already visible one year after the shock, but it becomes economically and statistically salient at longer horizons. Two years after the defence shock ($h = 2$) the multiplier attains $\approx 1.75\%$ of trend GDP in the 5th percentile of the output distribution, compared with barely 0.75% in the 95th percentile, a gap that lies well outside the 90 % confidence band. The non-linearity intensifies at the three-year mark: the lower-tail multiplier reaches roughly

2%, whereas at the opposite extreme of the distribution the point estimate hovers around zero. Confidence regions narrow in the centre but widen in the tails, yet the downward slope of the response remains significant throughout, indicating that the effectiveness of defence spending is disproportionately larger when the economy starts from a depressed level of activity.

Figure 6: **Quantile Local Projections: Cumulative Defence Fiscal Multipliers by Output Quantile ($h \in \{1, 2, 3\}$)**



(a) $h = 1$ (b) $h = 2$ (c) $h = 3$

Notes: The plots display the estimated coefficient $\beta_h(\tau)$ from regressions of equation 6 for each horizon h and quantile τ (joint blue lines), as well as its 68% and 90% confidence bands (grey shaded area). Panel (a) presents estimated coefficients at horizon 1 ($\beta_1(\tau)$) for all specified quantiles ($\tau \in [0.05, 0.10, \ldots, 0.95]$), panel (b) for horizon 2, and panel (c) for horizon 3. Estimated coefficients $\widehat{\beta_h(\tau)}$ are interpreted as the cumulative defence spending fiscal multiplier at horizon h of quantile τ^{th} of output conditional on all equation covariates. The outcome variable is trend-normalized output. The estimation includes country and year fixed effects, and all standard errors are robust.

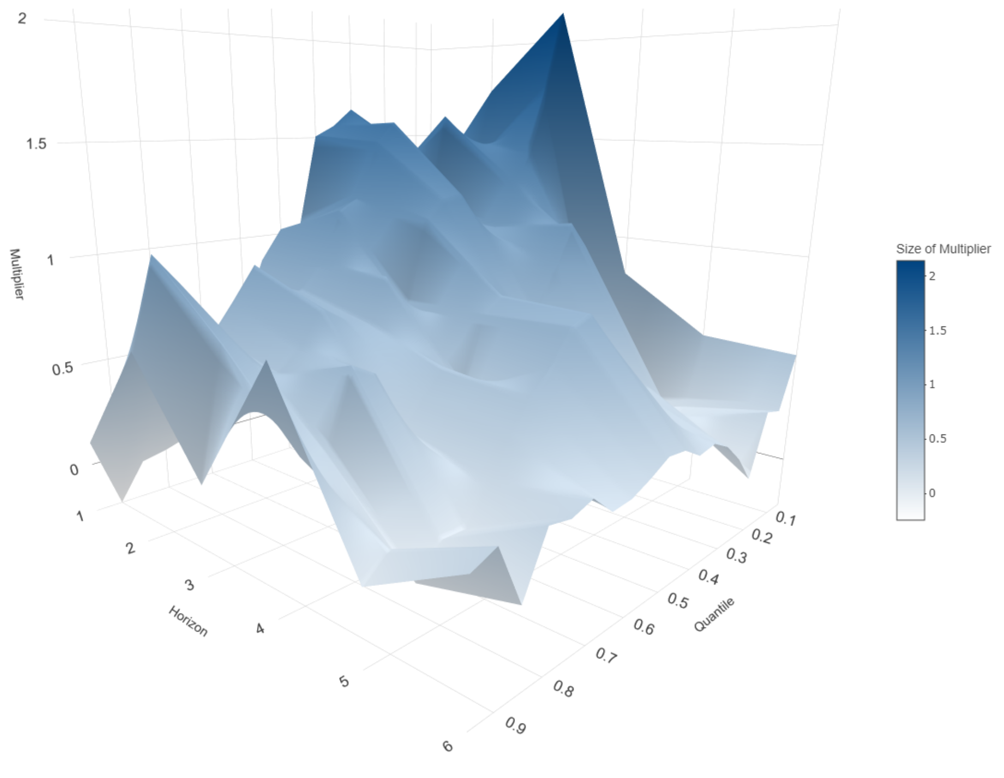
These findings corroborate the theoretical and empirical consensus that fiscal stimulus (consolidation) is more prominent (harmful) when output is below potential (De Cos and Moral-Benito, 2013; Auerbach and Gorodnichenko, 2012; Jordà and Taylor, 2016). Although some studies have presented evidence suggesting no differential multipliers depending on economic slack states, which is influenced by the future information used in constructing the state variable in a Smooth Transtition Function framework *a la* Auerbach and Gorodnichenko (2012) (Ramey and Zubairy, 2018; Alloza, 2022).

By eschewing ex-ante regime classification, the QLP framework employed here generalises this result: rather than a discrete shift, the multiplier tapers smoothly across the entire distribution, with the largest gains concentrated in the left tail. The presented estimates align closely with the QLP evidence of Linnemann and Winkler (2016) for the United States, which find that government-spending shocks exert markedly stronger effects at low quantiles of output. Taken together, both regime-based and fully distributional approaches converge on the conclusion that fiscal multipliers are materially larger when economic slack is greatest, and the present results extend that evidence to defence spending in the European context.

The left-tail peak accords with standard theory. When output is well below trend, idle labour and capital curb crowding-out, so extra government demand lifts production almost one-for-one. Liquidity-constrained households, more prevalent in downturns, spend a larger share of the income created by defence contracts, while slack factor markets keep prices in check, limiting a monetary offset. Moreover, with rates near the lower bound, fiscal stimulus relaxes the ZLB constraint (Christiano, Eichenbaum and Rebelo, 2011), further enlarging the multiplier.

Moreover, Figure 7 offers a three-dimensional view of these results, plotting the cumulative multiplier $\hat{\beta}_h(\tau)$ on the z-axis against the horizon h and the output quantile τ. The surface highlights three salient features. First, the ridge that peaks around $h = 3$ and $\tau \leq 0.15$ confirms that the largest multipliers (> 2) occur when fiscal shocks hit the economy at its most depressed states and after a two-to-three-year transmission lag. Second, the surface slopes downward monotonically as one moves toward higher quantiles: regardless of horizon, multipliers in the upper half of the output distribution rarely surpass unity and quickly converge to zero, visually reinforcing the left-tail dominance documented in Figure 6. Third, the plateau along $h \in [2, 4]$ and $\tau \in [0.10, 0.35]$ suggests that the stimulus effect is not purely one-off: it persists for several years in moderately weak conditions before tapering. The combination of a sharp peak at low quantiles and a flat valley at

Figure 7: **Quantile Local Projections: Cumulative Defence Fiscal Multipliers by Output Quantile**



Notes: The plots display the estimated coefficient $\beta_h(\tau)$ from regressions of equation 6 for each horizon h and quantile τ from a 3D perspective, where the size of the multiplier is the z axis. Darker blue colours indicate higher multipliers. Estimated coefficients $\widehat{\beta_h(\tau)}$ are interpreted as the cumulative defence spending fiscal multiplier at horizon h of quantile τ^{th} of output conditional on all equation covariates. The outcome variable is trend-normalized output. The estimation includes country and year fixed effects, and all standard errors are robust.

high quantiles underscores that the marginal efficacy of defence spending is highly non-linear, with a pronounced payoff only when substantial slack remains in the economy. Results and conclusions are equivalent when treating real GDP growth rate as the outcome variable, as presented in Figures 12 and 13 in the Appendix.

5.2 Fiscal Space

A second dimension of potential non-linearity arises from the governments ability to finance current and future defence outlays, the so-called fiscal space. Standard theory predicts that the output payoff of discretionary spending hinges on the credibility of public finances: when debt sustainability is in doubt, private agents may anticipate future consolidation, risk premia can rise, and monetary authorities may react pre-emptively, all of which attenuate the multiplier. Conversely, ample fiscal space allows the public sector to inject demand without triggering credibility concerns or financial-market stress, thereby amplifying the stimulus.

To operationalise fiscal space in a way that is both dynamic, forward-looking and public finances sustainability-focused, we focus on the *snowball effect*: the portion of debt-ratio dynamics that is independent of the primary balance and therefore captures the mechanical pressure of interest payments relative to growth conditioned on past debt. Some studies show how the level of public debt is also one of the potential channels feeding non-linearities in the size of the fiscal multiplier (Nickel and Tudyka, 2014; Kirchner, Cimadomo and Hauptmeier, 2010; De Cos and Moral-Benito, 2013). Moreover, empirical evidence shows that including the snowball term consistently uncovers strong non-linearities in fiscal multipliers, and models that omit this channel and uniquely consider debt levels therefore bias multipliers upward by ignoring the debt-interest feedback loop (Di Serio, Fragetta and Melina, 2021; Favero and Giavazzi, 2007). Following the standard debt dynamics representation:

$$s_{i,t} = (r_{i,t} - g_{i,t}) \frac{B_{i,t-1}}{Y_{i,t-1}}, \tag{7}$$

where $r_{i,t}$ is the average nominal interest rate on public debt, $g_{i,t}$ the nominal GDP-growth rate, $B_{i,t-1}$ the stock of debt in $t-1$, and $Y_{i,t-1}$ nominal GDP in $t-1$. A high snowball effect implies that debt is accumulating mechanically even in the absence of new primary deficits, thus requiring primary surpluses merely to stabilise the debt ratio; conversely, a low or negative snowball effect signals ample fiscal space, even allowing states to run primary deficits. Using $s_{i,t}$ as a state variable therefore provides a direct measure of the sustainability constraints that may alter the transmission of fiscal shocks.

Because the non-linearity originates from an exogenous fiscal variable rather than from the outcome itself, we follow Auerbach and Gorodnichenko (2012) and embed a continuous smooth-transition function into the local-projection framework:

$$y^c_{i,t,h} = \alpha_{i,h} + \delta_{t,h} + F(z_{i,t})\beta^A_h d^c_{i,t,h} + (1 - F(z_{i,t}))\beta^B_h d^c_{i,t,h} + \sum_{j=1}^{\ell} \boldsymbol{\theta}^h_j \mathbf{X}_{i,t-j} + \epsilon_{i,t+h}, \quad (8)$$

where $F(z_{i,t}) = \frac{exp(-\gamma z_{i,t})}{1+exp(-\gamma z_{i,t})}$, $\gamma = 1.5$ and z is the negative of the snowball effect $(-s_{i,t})$, thus letting $F(z_{i,t}) \approx 1$ describe high snowball behavior (the opposite refers to low snowball when $1 - F(z_{i,t}) \approx 1$). Unlike a hard split around an arbitrary debt-threshold, this logistic specification lets the multiplier shift *gradually* as the snowball effect worsens or improves, preserving the full sample and avoiding discontinuities at regime borders. It therefore captures richer fiscal-space non-linearities while maintaining the interpretability and simplicity of local projections. Estimated coefficients $\widehat{\boldsymbol{\beta}^A_h}$ and $\widehat{\boldsymbol{\beta}^B_h}$ are interpreted as the cumulative defence spending fiscal multiplier at horizon h when fiscal space is compressed (high snowball effect) and expanded (low snowball effect), respectively.

Results. Figure 8 presents estimated coefficients $\widehat{\boldsymbol{\beta}^A_h}$ and $\widehat{\boldsymbol{\beta}^B_h}$ as well as its 68% and 90% confidence intervals, and shows that the output payoff of defence-spending shocks hinges on fiscal space. Under compressing fiscal space and stress the output boost is roughly half as large (below unity) than under a state of low snowball and softer fiscal stress (> 1.5 during years 1 and 2). Ample fiscal space amplifies the stimulus from defence spending, whereas a heavy snow-ball all but nullifies it over time. These results align in sign and magnitude with those from Di Serio, Fragetta and Melina (2021), who estimated clear fiscal multiplier non-linearities depending on the size of the $r - g$ differential (1.13-1.77 when $r - g < 0$ and 0.54-1.26 when $r - g > 0$). As regards to the utilization of real GDP growth rate as the shocked variable, conclusions are equivalent, albeit slightly more depressing for high snowball states (Figure 14 in the Appendix).

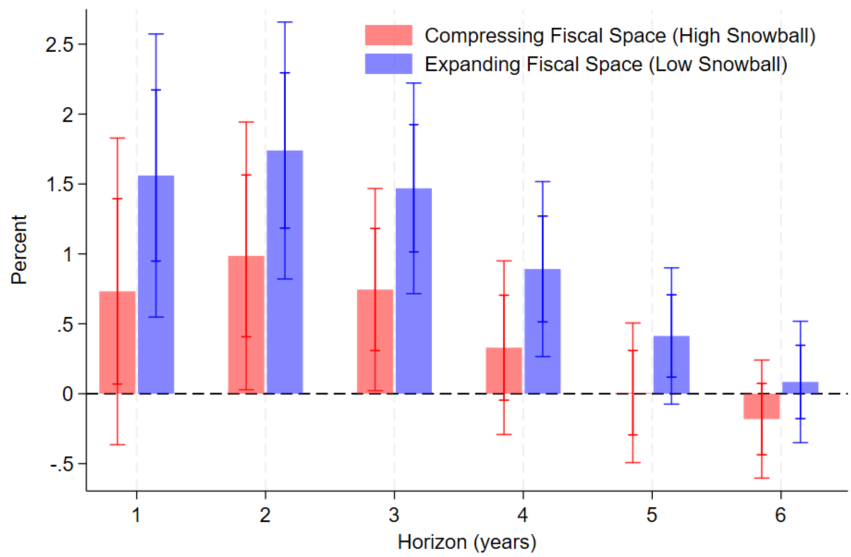
In addition, we am interested in contrasting these results by estimating the marginal effect of the snowball effect on the fiscal multiplier. To this end, we regress trend-normalized output (panel a) or real GDP growth rate (panel b) on the same regressors as in equation 1 for each horizon h, albeit including the interaction between the normalized defence shock and the snowball effect ($s_{i,t}$). As presented in Figure 15 in the Appendix, the marginal effect is negative, indicating that an additional unit of the snowball effect (fiscal stress) depresses the fiscal multiplier.

As an additional test, we proceed with an alternative measure of fiscal space, which is merely the $r - g$ differential, without considering past debt. The results yield equivalent conclusions, as shown in Figure 20 in the Appendix for both detrended output and real GDP growth rate. Moreover, we test whether the results are influenced by the selection of parameter γ of the logistic transition function, as suggested by Granger and Teräsvirta (1993). As explained by Auerbach and Gorodnichenko (2012), γ is calibrated to 1.5 to express that the economy spends 20% of time in recessionary regime, something consistent with duration of recessions in the U.S. Figure 21 in the Appendix shows iterative exercises with alternative values of γ. Overall, the results are not sensitive to the selection of the parameter. In addition, the results are similar when the state variable $s_{i,t}$ is converted to mean 0 and variance 1.

5.3 Imports Dependence

Finally, we explore a third dimension of potential non-linearity: the reliance on foreign sources for military goods. When a large fraction of defence procurement and consumption leaks abroad, the domestic demand impulse is diluted, ceasing to produce a significant fraction of what is consumed nationally. The existing literature has underscored the impact of trade openness on both the magnitude and direction of fiscal multipliers. It finds that relatively closed economies tend to exhibit multipliers greater than one, whereas more open economies may experience

Figure 8: **Cumulative Defence Fiscal Multipliers: Fiscal Space State-Dependence**



Notes: The plots display the estimated coefficients β_h^A (red vertical bars) and β_h^B (blue bars) from regressions of equation 8 for each horizon h, as well as its 68% and 90% confidence bands (red and blue I-beams, respectively). The dependent variable is normalized-output. State A refers to be proximate to a high snowball effect scenario (compressing fiscal space), and B refers to a low snow-ball scenario (expanding fiscal space). Estimated coefficients $\widehat{\beta_h^A}$ and $\widehat{\beta_h^B}$ are interpreted as the cumulative defence spending fiscal multiplier at horizon h when fiscal space is compressed and expanded, respectively. The estimation includes country and year fixed effects, and all standard errors are robust.

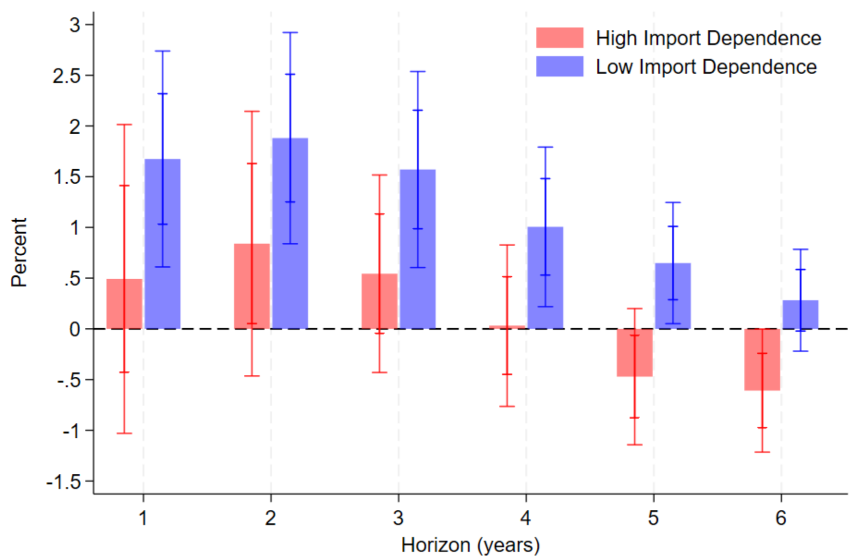
negative fiscal multipliers. (Ilzetzki, Mendoza and Végh, 2013; Sheremirov and Spirovska, 2022)

Thus, it seems appropriate to measure external dependence in the acquisition of military goods relative to total defense expenditure. To this end, the value of annual total imports (including both extra-European and intra-European) of military goods by country i in year t is calculated using data from the UN Comtrade database. In this context, the following categories are considered as military imports: *tanks and other armoured fighting vehicles* (code 871000), *vessels and warships* (code 890619) and *arms and ammunition* (code 93). The resulting variable is defined as the ratio of the total value of military imports to the total defense expenditure incurred in the same year.

Figure 22 in the Appendix presents the ratio for each EU-27 member in 2005 (light blue) and 2023 (dark blue), highlighting pronounced cross-country and time variation. Import dependence in 2023 spans from nearly 45% of Slovakia's defence budget to close to zero in Greece and Bulgaria, with Central-Eastern countries such as Slovakia, Czechia and Poland exhibiting the largest upward shifts since 2005. By contrast, several Western and Nordic members, including Germany, Sweden and France, show declining or flat import shares, signalling an eastward relocation of procurement reliance and widening dispersion in domestic arms-production capacity across the Union.

To investigate the potential non-linear effects of defence goods military reliance on the fiscal multiplier, we estimate the same regressions as in equation 8, yet letting the indicator variable $z_{i,t}$ be the inverse of total military imports relative to total defence spending.

Figure 9: **Cumulative Defence Fiscal Multipliers: Imports Reliance State-Dependence**



Notes: The plots display the estimated coefficients β_h^A (red vertical bars) and β_h^B (blue bars) from regressions of equation 8 for each horizon h, as well as its 68% and 90% confidence bands (red and blue I-beams, respectively). The dependent variable is normalized-output. State A refers to be proximate to a high defence imports reliance scenario, and B refers to a low import dependence scenario. The state variable is the inverse of the ratio between total military goods imports and total defence spending. Estimated coefficients $\widehat{\beta_h^A}$ and $\widehat{\beta_h^B}$ are interpreted as the cumulative defence spending fiscal multiplier at horizon h when imports reliance is elevated is and low, respectively. The estimation includes country and year fixed effects, and all standard errors are robust.

Results. Figure 9 displays the estimated coefficients for the two import-reliance regimes: State A represents high import dependence, while State B corresponds to low import dependence. The results are consistent with existing evidence on the role of import reliance in shaping the magnitude and direction of the fiscal multiplier (Ilzetzki, Mendoza and Végh, 2013; Sheremirov and Spirovska, 2022). Specifically, under conditions of low reliance on military imports relative to total defence expenditure, the fiscal multiplier exceeds 1.5 and remains positive across all horizons. In contrast, high import dependence is associated with multipliers below unity for the first three years following the shock, turning negative by the sixth year.

It could be argued that, given a large proportion of total European defense expenditure has historically been allocated to personnel costs (primarily salaries), the most appropriate variable to normalize the state variable of imports would be defense spending that is potentially importable. This refers to expenditure on gross fixed capital formation (which largely includes equipment and machinery) and intermediate consumption (which encompasses ammunition typically associated with the acquired equipment, as well as the maintenance of machinery, usually provided by the selling company). Accordingly, the potential dependence on the fiscal multiplier is re-estimated, using as the reference variable the ratio of total imports of military goods to defense spending on GFCF and intermediate consumption, thereby excluding the wage remuneration component, which is provided domestically. Figure 16 in the Appendix presents these results, which yield equivalent conclusions as the previous results.

Moreover, it may be contended that, in assessing the potential source of non-linearity in the importation of military goods, the shock to be considered should pertain to components that are plausibly importablenamely, capital expenditure and intermediate consumption, as in the preceding case. To this end, a comparable analytical exercise to the previous is undertaken–wherein the variable representing the source of non-linearity is defined as the ratio of the value of military goods imports to defense spending on capital formation and intermediate inputs–while allowing the shock to be defined as the sum of capital expenditure (GFCF) and intermediate consumption, thereby excluding personnel expenditure. Figure 17 illustrates that the underlying pattern remains consistent: fiscal multipliers are markedly higher when the economy is converging toward a state of low external dependency in military terms, whereas the crowding-in effect converges to approximately -1% in the medium term under conditions of high dependency. The pronounced magnitude of the multipliers observed in contexts of reduced external reliance is attributable to the elevated fiscal multiplier associated with capital-intensive expenditure.

Regarding the use of the real GDP growth rate as the shocked variable, the estimated fiscal multipliers do not differ significantly across import-reliance regimes. However, while the multipliers under low import reliance are statistically significant at several horizons, those associated with high import reliance are not significant at any horizon (Figure 18 in the Appendix). As presented in the last section, we have conducted the similar marginal effect exercise, thus interacting the main regressor of equation 1 with the ratio of military imports relative to total defence spending, as presented in Figure 19 in the Appendix for detrended output (panel (a) and real GDP growth (panel (b). The marginal effect becomes negative and significant in the medium-term, thus supporting the presented evidence on the negative fiscal multiplier under high imports reliance. Finally, we also test whether the results are influenced by the selection of parameter γ of the logistic transition function. Figure 23 in the Appendix shows how results are not sensitive to the selection of the parameter.

6 Additional Tests

Spending Accounting: Accrual- vs Cash-based. In the accounting of defence expenditure, methodological differences are pronounced, as explained earlier in the Data section. The variable that exhibits a clear and direct correspondence with the national-accounts measurement of gross domestic product is the accrual-based series, in line with the ESA 2010 classification employed by Eurostat. By contrast, the literature estimating fiscal multipliers for country panels typically treats transformations of SIPRI military expenditure as the fiscal shock, an approach that facilitates homogeneous cross-country comparisons over time (Sheremirov and Spirovska, 2022).

To ensure comparability under a common fiscal shock, Figure 24 in the Appendix reports the results obtained by re-estimating regressions from equation 1 with normalised SIPRI military expenditure as the shock, and detrended output, following Sheremirov and Spirovska (2022), as the dependent variable (panel a), alongside real GDP growth (panel b). The coefficients are similar in both magnitude and sign, and closely match those in Sheremirov and Spirovska (2022), indicating that the accounting treatment of expenditure does not materially affect its spill-over impact on the economy.

Sensitivity to Trend GDP Degree Polynomial. The consensus in the literature is to treat and transform both output and the fiscal variable by normalising them with respect to an estimate of trend GDP based on real GDP, as detailed above. However, the order of the polynomial used to extract the trend can influence the estimated path of potential output, thereby affecting the final calculation of the shocked fiscal variable and the normalisation of the other model variables. Accordingly, we compute the cumulative fiscal multiplier using polynomial trends of varying orders, from a third- to a sixth-degree polynomial. The choice of orders greater than or equal to three is motivated by the time series employed in this study, which spans episodes of both structural expansion and contraction in European GDP; a quadratic polynomial is therefore ill-suited to capture dynamics beyond the squared term.

Figure 25 in the appendix presents the results from estimating equation 1 under each polynomial specification, using detrended output (panel a) and real GDP growth (panel b) as alternative dependent variables. The findings suggest that the estimates are not highly sensitive to the polynomial order, although orders above four yield a somewhat smaller multiplier. It should nevertheless be emphasized that higher-order polynomials are generally advisable only when the temporal coverage of the sample is substantially longer than the one used here, typically because higher-frequency data are available (Ramey and Zubairy, 2018; Antolin-Diaz and Surico, 2022).

Defence Expenditure Mechanical Persistence. Defence-spending programmes are generally set on a multi-year horizon, which implies a potential correlation between current and future outlays. Consequently, the estimate of the cumulative spending multiplier on cumulative output may be influencedand hence biasedby a purely inertial component of expenditure. To mitigate this concern, and following the standard practice in the fiscal-multiplier literature, we estimate the following forecast regressions of the normalised defence shock as follows:

$$d_{i,t+h} = \alpha_{i,h} + \delta_{t,h} + \rho_h d_{i,t} + \sum_{j=1}^{\ell} \boldsymbol{\theta}_j^h \mathbf{X}_{i,t-j} + \epsilon_{i,t+h}, \tag{9}$$

where the dynamic elasticity of defence spending at horizon h after defence spending shocks is defined by ρ_h. Note that the rest of the specification features are identical to those from equation 1. Panel (a) from Figure 26 in the Appendix presents the estimated coefficients $\widehat{\rho}_h$. Observe that the sum of the estimated coefficients from t to $t+h$ coincides with the coefficient obtained when the dependent variable is specified as the cumulative defence expenditure over the interval $[t, t+h]$. The findings indicate that defence spending indeed exhibits a significant inertial effect. Once the persistent mechanical effect of the fiscal shock has been estimated, it can be employed to adjust the impulse-response function of cumulative output to cumulative spending shocks by means of the following expression:

$$\widehat{\beta}_h^{\text{adj}} = \frac{\widehat{\beta}_h}{\sum_{j=0}^{h} \widehat{\rho}_j}, \tag{10}$$

where the IRF estimated from equation 1 is adjusted by the cumulative from t to

$t+h$ of the autoregressive coefficient of equation 9. Panel (b) from Figure 26 in the Appendix presents the adjusted fiscal multiplier, when detrended output is used as the dependent variable. Results present front-loaded fiscal multipliers, where after-1-year multipliers experience downward adjustment stemming from the shock's positive inertial behavior.

Discussion on Output Treatment. Typically, the literature on the estimation of fiscal multipliers Ramey and Zubairy (2018); Sheremirov and Spirovska (2022); Ilzetzki, Mendoza and Végh (2013) adopts, as a baseline, a transformation of the variables of interest relative to trend output, so as to express all variables in comparable units (as presented in this paper). However, alternative normalizations have been proposed, most notably by Hall (2009) and Barro and Redlick (2011), in which both government expenditure and output are scaled by the previous periods output (Y_{t-1}). This approach likewise preserves interpretability through the use of common units. Accordingly, we reestimate the regressions in equation 1, dividing defense spending, output, and the remaining covariates by lagged output. Figure 27 in the Appendix presents the results of expressing all variables in terms of lagged output in panel (a), and the results of expressing all variables in the same units albeit utilizing as the dependent variable real GDP growth rate (which indeed is already expressed in such units). Note that in the latter case, the shock and the remaining variables are transformed to be expressed in terms of lagged output. Results yield the same conclusions as in Figure 2: similar magnitude, significance and sign of defence spending fiscal multipliers in both cases.

Spender-driven Effects?. One could argue that average defence spending fiscal multipliers are largely driven by those countries contributing the greatest share to total European defence outlays, since these high-spending states possess both the scale and institutional capacity to generate not only stronger domestic demand effects but also substantive crossborder spill-overs. Indeed, when a major defence expenditure country increases its procurement, it stimulates demand for military and dual-use inputs throughout its supply chains, many of which are located in partner economies, promoting technology transfers, reinforcing industrial linkages, and boosting export receipts in neighbouring states. Consequently, the elevated spending by leading contributors can exert a positive, multiplier-enhancing effect across the entire European bloc, conditioned to an efficient and productive integration of EU economies.

France, Germany, and Italy, in that order, have been the largest defence spenders in Europe from 1995 through 2023, together accounting for approximately 60% of total expenditure on average, as shown in Figure 28 in the Appendix. Note the relative increase in contributions from the remainder of Europe beginning in 2016, driven by escalating tensions between Ukraine and Russia, which have, since that time, compelled those European countries bordering the conflict zone to raise their defence outlays in relative terms.

Given this stylized fact and the potential spill-over effects of these countries on the broader European economy, we reestimate the regressions presented in equation 1, excluding France, Germany, and Italy from the sample. Figure 29 in the Appendix reports these results for both output transformations described above. Excluding Germany, France, and Italy from the sample does not materially alter the estimated defense spending multipliers, indicating that the results are not driven by the largest economies in the EU. This suggests that defense-related fiscal policy is not only effective in large economies, but also exerts comparable average effects in smaller member states. The similarity in estimated multipliers points to a relatively homogeneous effectiveness of defense spending across the EU, which may reflect shared institutional constraints such as common fiscal rules and the unified monetary policy under the European Central Bank. Furthermore, the persistence of high carry-over effects in the remaining countries could be partly explained by cross-border spillovers from the larger economies, supporting the view that defense spending potentially contributes to an effective and productive economic integration within the EU.

Embedded Non-linearities. This paper has explored several sources of non-linearity in the fiscal multiplier, most notably fiscal space and external dependence in military procurement, by incorporating logistic transition functions. Typically, smooth-transition functions *a la* Auerbach and Gorodnichenko (2012) are introduced separately and individually. Nevertheless, it would be both interesting and useful to refine the identification of these non-linearities further and to perform scenario analysis by combining them. In doing so, one can estimate the sign and magnitude of the dynamic multiplier under the joint presence of both non-linearities, thereby providing information on its size when multiple adverse scenarios coexist, specifically, when a state simultaneously faces severely limited fiscal space and a high degree of reliance on foreign suppliers of military goods. Few examples in the literature explore the combination of sources of non-linearities to define state-dependent impulse responses. Using a set of binary indicators, Ghassibe and Zanetti (2022) combine unemployment (split by an unconditional threshold) and inflation deviations from its trend value to define expansion, demand-driven recession and supply-drive recession regimes.

As we have shown previously, constrained fiscal space and, separately, substantial external dependence each attenuate the output effects. The question, therefore, is: to what extent would the multiplier be affected under the worst-case scenario?[11] To address this issue, we combine both sources of non-linearity by estimating the following regressions, which can be characterised as Embedded-Smooth-Transition Local Projections (ESTLP):

$$\begin{aligned} y^c_{i,t,h} = \alpha_{i,h} + \delta_{t,h} + \beta^0_h d^c_{i,t,h} + F^A(z_{i,t})\beta^1_h d^c_{i,t,h} + F^B(z_{i,t})\beta^2_h d^c_{i,t,h} + \\ F^A(z_{i,t})F^B(z_{i,t})\beta^3_h d^c_{i,t,h} + \sum_{j=1}^{\ell} \boldsymbol{\theta}^h_j \mathbf{X}_{i,t-j} + \epsilon_{i,t+h}, \end{aligned} \tag{11}$$

where $F^A(z_{i,t})$ represents the smooth transition function when $z_{i,t}$ is the measure

[11]Regressions and correlation analyses were conducted to examine whether a latent relationship exists between the two states, which could potentially bias forthcoming estimates. The correlation between these variables was found to be statistically insignificant, with values close to zero, indicating no meaningful linear relationship.

of fiscal space (instrumented by the snowball effect, thus, indicating compressed fiscal space) (first source of logistic non-linearity), $F^B(z_{i,t})$ represents the logistic function expressing high imports dependence (second source of logistic non-linearity), and the product of both ($F^A(z_{i,t})F^B(z_{i,t})$) represent the marginal impact on the cumulative multiplier of converging towards a compressed fiscal space and high import dependence. Thus, different combinations of estimated coefficients β_h provide different combinations of state-dependent IRFs: β_h^0 is interpreted as the cumulative fiscal multiplier at horizon h when the economy is likely positioned under a high fiscal space and low imports dependence regime, ($\beta_h^0 + \beta_h^1$) is the multiplier in a state of low fiscal space and low imports reliance, ($\beta_h^0 + \beta_h^2$) in a regime of high fiscal space and high imports dependence and finally, ($\beta_h^0 + \beta_h^1 + \beta_h^2 + \beta_h^3$) provides the fiscal multiplier under a situation (worst case) of compressed fiscal space and high imports dependence.

Figure 30 in the Appendix presents the results. The figure shows that the cumulative defence-spending multiplier is strongly positive and statistically distinct from zero at short horizons only when fiscal space is ample and import-leakage is low (blue bars), peaking at over 1.5 percent after one year. When only one constraint binds, either tight fiscal space with low imports (light blue) or high space with high imports (orange), the multiplier is still positive but smaller (around 1-1.5 percent at year 1) and the confidence bands begin to overlap zero by horizon 3. In the worst-case regime, where fiscal space is compressed and import dependence is high (red bars), the multiplier is effectively zero or even negative at all horizons, with wide 68% and 90% bands showing statistical insignificance except possibly at the very shortest horizons. Standard errors, and posterior confidence intervals, are calculated from the variance-covariance matrix of the regression coefficients. Across all regimes the effect decays over time, converging toward zero (or negative territory in the red case) by years 5-6. These results are consistent with the evidence presented in this paper and existing literature.

Moreover, this exercise underscores that not only does the existence of a hypothetically adverse regime matter for the spill-over effect of a fiscal shock on the economy, but that combining two individually adverse conditions generates synergistic effects, potentially driving the multiplier into negative territory. Specifically, when fiscal space is already constrained, investors require a premium that appreciates the real exchange rate (capital-inflows channel). Such appreciation exacerbates the import leakage from any incremental demand. Consequently, the conjunction of high debt and substantial import dependence is likely to yield an even smaller (and possibly negative) multiplier than the simple aggregation of each condition's individual penalties.

Effectiveness of Fiscal Policy, Fiscal Space and Output Distribution. Fiscal interventions have (as proved in this paper) different impacts in recessions versus expansions, and these effects can be amplified or dampened by government's fiscal capacity. Jordà, Schularick and Taylor (2016) suggests that countries with greater fiscal space can implement more effective stabilization policies following financial crises. Conversely, limited fiscal space can constrain policy responses, potentially leading to suboptimal outcomes. With sufficient fiscal headroom, government borrowing doesnt compete for scarce credit in downturns and may strengthen private-sector confidence. Low debt-service burdens may improve long-run growth prospects, which may lift all parts of the output distribution, and potentially to a larger extent in times where slack capacity is greatest. Exploring this interaction helps uncover whether fiscal constraints disproportionately limit policy effectiveness during downturns or whether ample fiscal space enhances stabilization across all segments of the economy, offering important insights for countercyclical policy design.

Thus, we present an extension of Quantile Local Projections regressions presented in equation 6, where fiscal space state-dependence smooth transition function in the form of equation 8 is integrated:

$$Q_\tau\left(y_{i,t+h} \mid F(z_{i,t})d^c_{i,t,h}, (1-F(z_{i,t}))d^c_{i,t,h}, \mathbf{X}_{i,t-j}\right) = \alpha_{i,h}(\tau) + \delta_{t,h}(\tau) + F(z_{i,t})\beta^A_h(\tau)d^c_{i,t,h} + (1-F(z_{i,t}))\beta^B_h(\tau)d^c_{i,t,h} + \sum_{j=1}^{\ell} \boldsymbol{\theta}^h_j(\tau)\,\mathbf{X}_{i,t-j} + \epsilon_{i,t+h}(\tau), \tag{12}$$

where $\beta^A_h(\tau)$ ($\beta^B_h(\tau)$) is interpreted as the cumulative defence spending fiscal multiplier at horizon h of quantile τ^{th} of output conditional on all equation covariates in times of limited fiscal space (ample fiscal space). Thus, we allow the quantile-specific fiscal multiplier vary on the available space to conduct fiscal maneuvers.

Estimated coefficients for both states and all quantiles for horizons from 1 to 3, together with their 90% confidence intervals, are presented in Figure 31 in the Appendix. The observed patterns, where i) fiscal multipliers are systematically larger one year after a defense spending shock under conditions of ample fiscal space, ii) with pronounced effects in the lower tail of the output distribution at two years, and iii) convergence across quantiles by the third year, highlights the dynamic and state-dependent nature of fiscal policy effectiveness. In the short term, expanded fiscal space likely enhances policy credibility and mitigates concerns about debt sustainability, enabling governments to implement more aggressive and effective fiscal interventions. As firms and investors gain confidence that financing costs will remain manageable, they are more willing to maintain or expand production, driving a larger initial boost in aggregate demand when slack capacity is greatest. By the third year, however, the narrowing of multiplier differences across quantiles likely reflects economy-wide adjustment mechanisms, such as restored investor expectations and emerging supply-side constraints, that temper the early confidence-driven divergence in fiscal impact. These dynamics underscore how low debt-service burdens improve long-run growth prospects and support output across all quantiles, while tight fiscal constraints can dampen confidence and weaken multipliers disproportionately in deeper recessions. These results are consistent with literature highlighting the role of fiscal space and confidence channels in shaping both the magnitude and persistence of fiscal multipliers (Auerbach and Gorodnichenko, 2012).

How is Defence Spending Financed?: The Role of Taxes. An increase in defense spending can be offset by reductions in expenditures elsewhere or by taxation. Should it be financed through a tax hike, the stimulative impact of the fiscal impulse could be partially counterbalanced by the detrimental effect of higher taxes on economic activity. To this end, we first examine whether defense spending exerts any influence on revenue generation; that is, whether increases in expenditure are financed by corresponding increases in income. we estimate regressions in equation 1 where the dependent variable takes the form of the cumulative of the first difference of detrended government revenues[12]. Secondly, we estimate again regressions in equation 1 yet controlling for the cumulative first difference of detrended revenues. Thus, the effects of defence spending on output is net and controlled for the cumulative changes in revenues[13].

Figure 32 in the Appendix presents these results: panel (a) plots the dynamic response of changes in revenues after defence spending shocks, and panel (b) displays the dynamic cumulative fiscal multiplier net of the effects of taxes. The effect of defense expenditure on public revenues is positive during the first year, albeit of marginal statistical significance. Thereafter, it approximates zero. This finding implies that defense outlays are only marginally offset by revenue increases beyond the initial year. With reference to panel (b), the fiscal multiplier net of revenue effects is essentially indistinguishable from the estimate obtained without cumulatively accounting for revenue changes. Such evidence indicates that defense spending does not appear to be financed by revenues and that, moreover, the impact of revenues on output is effectively negligible.

[12]Note that government revenue is not included as a control in this set of regressions.
[13]Note that the dependent variable remains unchanged; detrended output.

Unemployment Effects. In addition to approximating the economic impact of defence spending in Europe by using real GDP (both normalized and in growth rates) as the shocked variable, it is essential to complement the analysis with an alternative indicator of economic activity that captures the degree of resource utilization. In this context, and following a similar approach to that applied by Linnemann and Winkler (2016), this section estimates the fiscal multiplier of defence spending in terms of human capital, by utilizing the unemployment rate. This serves as a robustness check of the output effects, aimed at assessing whether fiscal shocks to defence spending are mirrored in their effects on the labor market and the utilization of human capital. The analysis is not only conducted within a linear framework, but also evaluates whether the impact on the unemployment rate itself depends on the prevailing level of unemployment.

From a lineal perspective, we re-estimate regressions presented in equation 1 albeit using the unemployment rate as the dependent variable. The rest of equation features remain equal. As presented in Figure 33 in the Appendix, the unemployment fiscal multiplier is statistically significant across all horizons and remain negative and above 1% in absolute terms. This effect is consistent with the impact observed on output, although it exhibits a higher degree of persistence, such that the reduction in unemployment observed in the initial years is sustained into the medium term. This persistence reflects structural frictions in the labor market and the inherently gradual adjustment of employment. It also suggests that job gains from defence spending may become partially entrenched over time.

As regards to across-the-distribution effects, we re-estimate regressions from equation 6 (for all previous quantiles and horizons) substituting the dependent variable by the unemployment rate. Figure 34 in the Appendix presents the results of the total 120 estimated coefficients from a 3D perspective. The results indicate that the unemployment fiscal multiplier varies across the predicted quantiles of the unemployment distribution: during periods of anticipated high unemployment, the impact is more negative across all horizons compared to periods of low unemployment. In other words, under conditions of human capital underutilization, the scope for improving labor market outcomes appears to be disproportionately greater following a defence spending fiscal shock. Figure 35 in the Appendix presents a mirror image of the output effects: as the unemployment quantile increases, the estimated impact becomes more negative and statistically significant across all time horizons. This finding is consistent with the results reported in Linnemann and Winkler (2016).

7 Conclusion

This paper delivers the first comprehensive estimate of the dynamic fiscal multiplier for defence spending across the EU-27, revealing that a 1 percent-of-trend-GDP increase in defence outlays raises aggregate output by approximately 1.4 percent within one year and peaks at about 1.6 percent in the second year, before gradually reverting to trend by the sixth year. A detailed decomposition shows that capital-intensive procurement is the primary engine of this stimulus, generating cumulative multipliers of up to 2.4 percent of trend GDP after two years, while personnel and intermediate consumption expenditures exhibit much smaller or even slightly negative effects.

Building on this linear benchmark, this study introduces two strands of non-linear analysis previously unexplored for European defence shocks. First, the application of Quantile Local Projections uncovers a pronounced convexity in the multiplier: economies located in the lower tail of the output distribution experience multipliers more than twice as large during deep downturns as those in the upper tail during expansions. Second, by embedding Smooth-Transition functions for both fiscal space and import dependence into the Local Projections framework, we document that ample fiscal headroom and low reliance on foreign military goods each independently boost multipliers above unity, whereas tight debt constraints or high import leakage can nullify or even reverse the stimulus. Crucially, when both adverse conditions coincide, a high snowball effect and heavy import dependence, the multiplier collapses to zero or negative values at all horizons, highlighting a synergistic drag not previously reported in the literature. Moreover, fiscal space acts as a source of non-linearities across the entire output distribution.

These findings carry important implications for European defence and fiscal policy coordination. They suggest that maximizing the macroeconomic return to defence outlays requires prioritizing capital-intensive procurement, deploying additional spending counter-cyclically during downturns, preserving fiscal headroom to avoid destabilizing debt-interest feedback loops, and strengthening domestic defence supply chains to curb leakages abroad. In combination, coordinated EU-wide fiscal rules and procurement standards can help member states avoid the worst-case regime in which fiscal credibility and external dependence jointly erode the effectiveness of public defence spending, ensuring that defence augmentation simultaneously bolsters Europe's security and its macroeconomic stability.

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Appendix

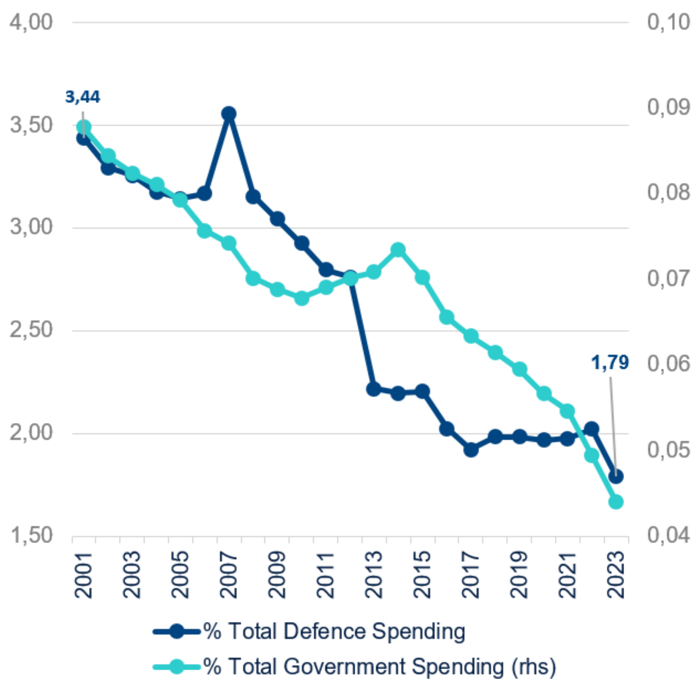
.1 Data descriptive statistics

Table 1: **Data: Desctiptive Statistics**

Category	Variable	Units	Mean	SD	Min	Median	Max	Source
Defence Variables	Total defence expenditure	% GDP	1,32	0,57	0,18	1,25	3,74	Eurostat
	Gross Fixed Capital Formation (GFCF)	% GDP	0,26	0,23	0,00	0,22	1,89	Eurostat
	Personnel	% GDP	0,71	0,33	0,13	0,65	1,93	Eurostat
	Intermediate Consumption	% GDP	0,32	0,20	0,00	0,29	1,31	Eurostat
	Research and Development (R&D)	% GDP	0,02	0,05	0,00	0,00	0,26	Eurostat
	Military Expenditure	% GDP	1,52	0,79	0,22	1,43	9,18	SIPRI
Output	Nominal GDP	€ Bill.	401492	671103	2838	154972	4185550	Eurostat
	Real GDP	€ Bill. (2015)	461283	744247	6646	188724	3625206	Eurostat
	GDP Deflator	Base 2015	82,59	18,94	24,71	85,04	134,72	Eurostat
Covariates	Government Gross Debt	% GDP	58,71	35,12	3,90	53,35	209,40	Eurostat
	Trade (exports + imports)	% GDP	117,29	63,71	33,58	101,40	395,15	Eurostat
	Government Revenue	% GDP	42,34	7,01	21,79	42,42	57,88	Eurostat
	Government Expenditure	% GDP	44,95	7,29	20,66	45,31	66,82	Eurostat
	Real long term gov. bond yield	%	1,29	3,23	-10,77	1,46	22,97	IMF
	Military Imports	% GDP	0,08	0,17	0,00	0,04	1,88	Comtrade
	Unemployment Rate	%	8,75	4,40	1,89	7,73	27,48	Eurostat

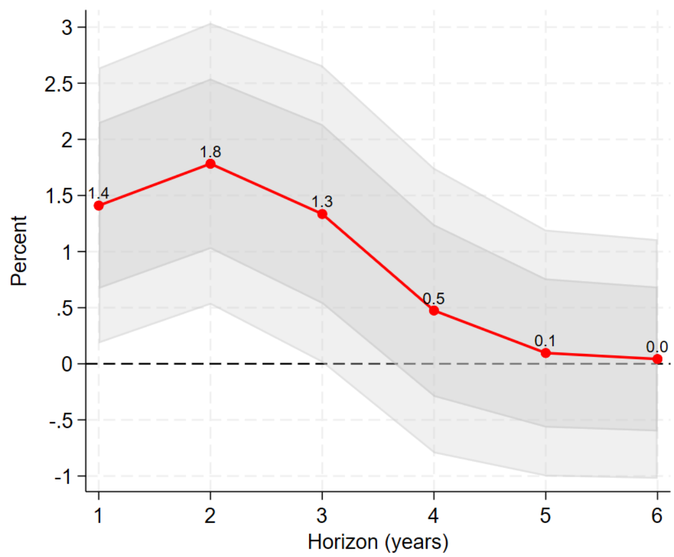
.2 Additional Figures

Figure 10: **Historical R&D Defence Spending in the EU27 (2001-2023)**



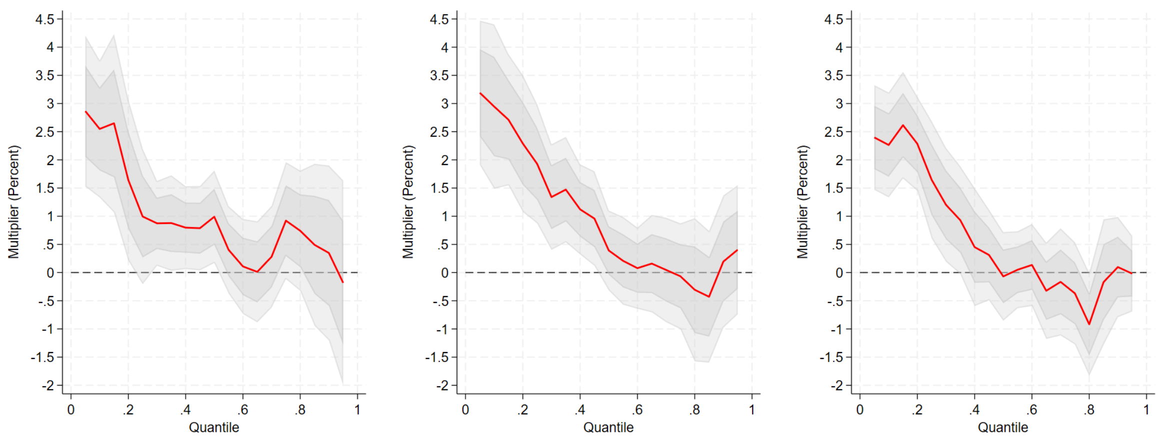
Notes: The plot displays the historical evolution of research and development (R&D) spending in the EU27 as a share of i) total defence spending (dark blue line and points), and ii) total government spending (light blue line and points) (right-hand axis). Data based on Classification of the Functions of Government (COFOG) from Eurostat. Aggregate EU27 R&D defence spending only available since 2001.

Figure 11: **Cumulative Defence Fiscal Multipliers: GFCF Impact on Real GDP Growth Rate**



Notes: The plots display the estimated coefficient β^k from regressions of equation 3 for each horizon h when normalized gross fixed capital formation is used as the fiscal shock variable, as well as its 68% and 90% confidence bands (grey shaded area). The dependent variable takes the form of real GDP growth rate. Estimated coefficient $\widehat{\beta_h^k}$ is interpreted as the cumulative defence spending fiscal multiplier at horizon h when k refers to GFCF. The estimation includes country and year fixed effects, and all standard errors are robust.

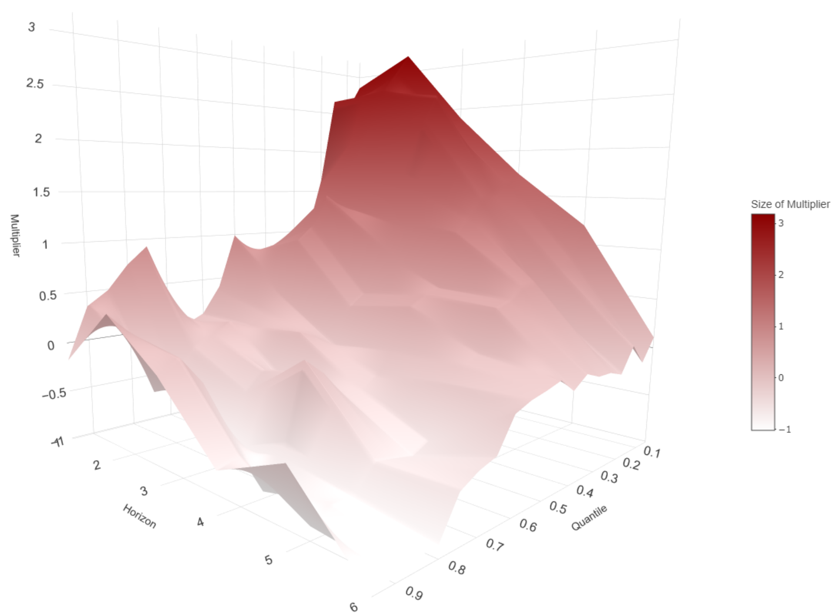
Figure 12: **Quantile Local Projections: Cumulative Defence Fiscal Multipliers by Output Quantile ($h \in \{1, 2, 3\}$ (real GDP growth)**



(a) $h = 1$ (b) $h = 2$ (c) $h = 3$

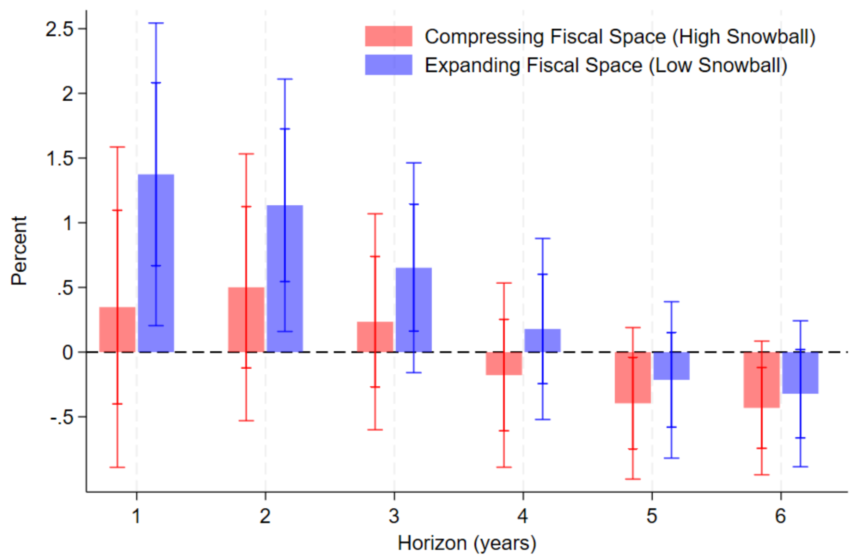
Notes: The plots display the estimated coefficient $\beta_h(\tau)$ from regressions of equation 6 for each horizon h and quantile τ (joint red lines), as well as its 68% and 90% confidence bands (grey shaded area). Panel (a) presents estimated coefficients at horizon 1 ($\beta_1(\tau)$) for all specified quantiles ($\tau \in [0.05, 0.10, \ldots, 0.95]$), panel (b) for horizon 2, and panel (c) for horizon 3. Estimated coefficients $\widehat{\beta_h(\tau)}$ are interpreted as the cumulative defence spending fiscal multiplier at horizon h of quantile τ^{th} of output conditional on all equation covariates. The outcome variable is real GDP growth rate. The estimation includes country and year fixed effects, and all standard errors are robust.

Figure 13: **Quantile Local Projections: Cumulative Defence Fiscal Multipliers by Output Quantile (real GDP growth)**



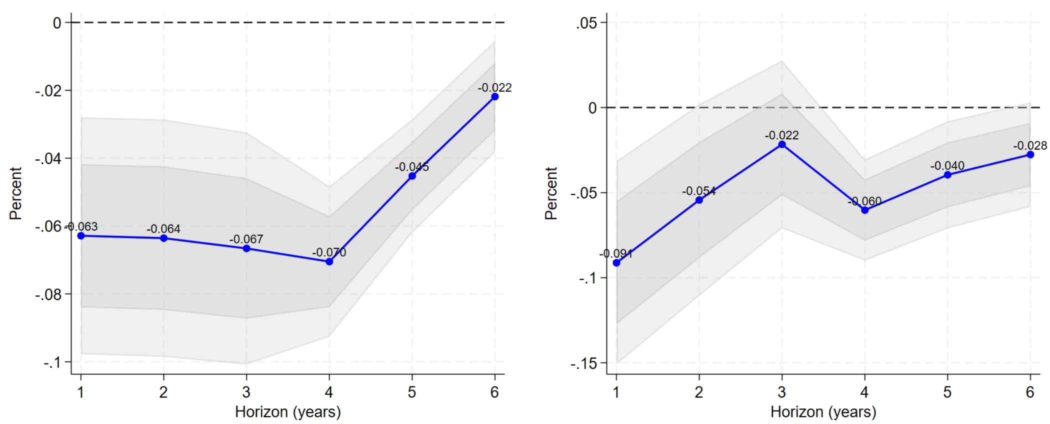
Notes: The plots display the estimated coefficient $\beta_h(\tau)$ from regressions of equation 6 for each horizon h and quantile τ from a 3D perspective, where the size of the multiplier is the z axis. Darker red colours indicate higher multipliers. Estimated coefficients $\widehat{\beta_h(\tau)}$ are interpreted as the cumulative defence spending fiscal multiplier at horizon h of quantile τ^{th} of output conditional on all equation covariates. The outcome variable is trend-normalized output. The estimation includes country and year fixed effects, and all standard errors are robust.

Figure 14: **Cumulative Defence Fiscal Multipliers: Fiscal Space State-Dependence (real GDP growth)**



Notes: The plots display the estimated coefficients β_h^A (red horizontal bars) and β_h^B (blue bars) from regressions of equation 8 for each horizon h, as well as its 68% and 90% confidence bands (red and blue I-beams, respectively). The dependent variable is real GDP growth. State A refers to be proximate to a high snowball effect scenario (compressing fiscal space), and B refers to a low snow-ball scenario (expanding fiscal space). Estimated coefficients $\widehat{\beta_h^A}$ and $\widehat{\beta_h^B}$ are interpreted as the cumulative defence spending fiscal multiplier at horizon h when fiscal space is compressed and expanded, respectively. The estimation includes country and year fixed effects, and all standard errors are robust.

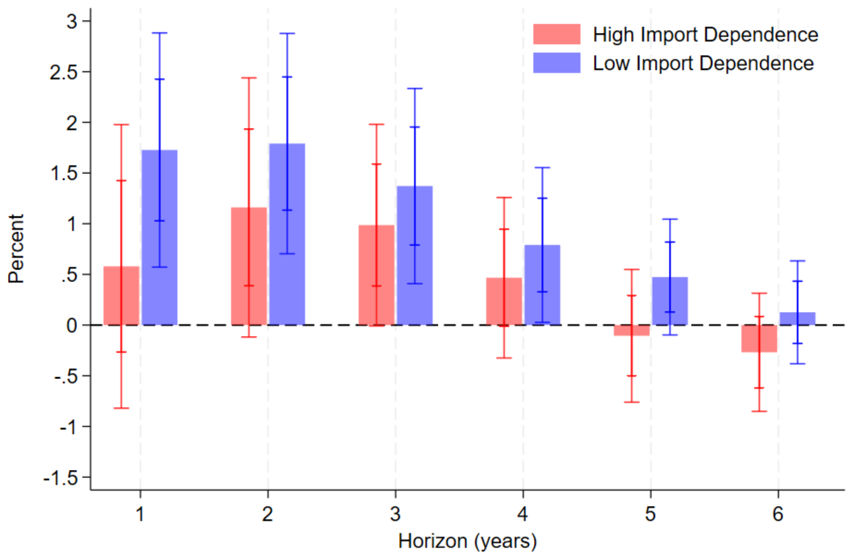
Figure 15: **Cumulative Defence Fiscal Multipliers: Fiscal Space Marginal Effect**



(a) **Trend-Normalized Output** (b) **Real GDP growth rate**

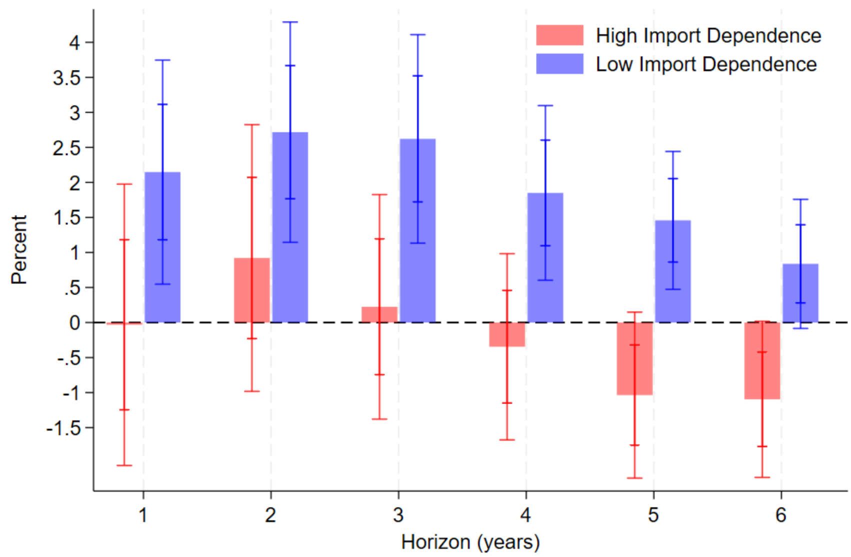
Notes: The plots display the results from regressing trend-normalized output (panel a) or real GDP growth rate (panel b) on the same regressors as in equation 1 for each horizon h, as well as its 68% and 90% confidence bands (grey shaded areas), albeit including the interaction between the normalized defence shock and the snowball effect. The estimated coefficient belonging to the interaction is depicted. Estimated coefficients are interpreted as the marginal effect of incrementing the snowball effect in one unit on the fiscal multiplier; in terms of detrended output (panel a) and real GDP growth rate (panel b). The estimation includes country and year fixed effects, and all standard errors are robust.

Figure 16: **Cumulative Defence Fiscal Multipliers: Imports Reliance State-Dependence (over GFCF and Intermediate Consumption Spending)**



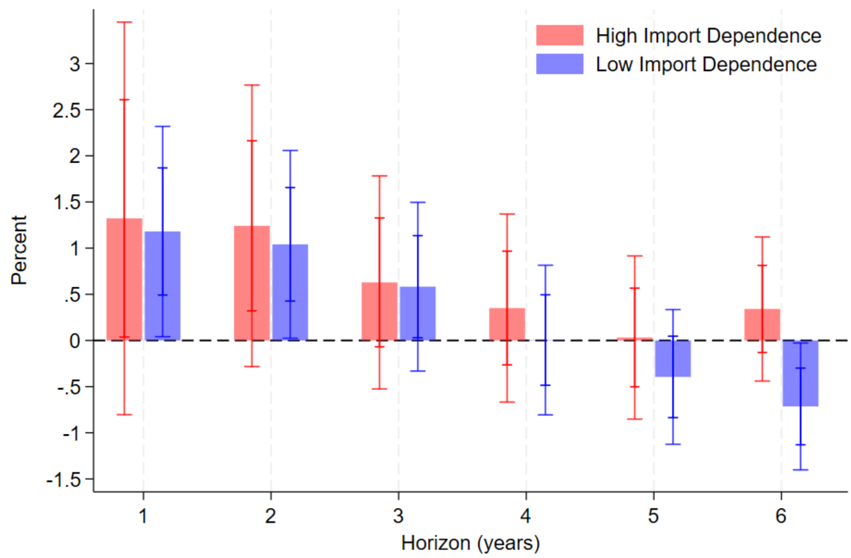
Notes: The plots display the estimated coefficients β_h^A (red vertical bars) and β_h^B (blue bars) from regressions of equation 8 for each horizon h, as well as its 68% and 90% confidence bands (red and blue I-beams, respectively). The dependent variable is normalized-output. State A refers to be proximate to a high defence imports reliance scenario, and B refers to a low import dependence scenario. The state variable is the inverse of the ratio between total military goods imports and total defence spending on GFCF and intermediate consumption (excluding personnel and rest of spending). Estimated coefficients $\widehat{\beta_h^A}$ and $\widehat{\beta_h^B}$ are interpreted as the cumulative defence spending fiscal multiplier at horizon h when imports reliance is elevated is and low, respectively. The estimation includes country and year fixed effects, and all standard errors are robust.

Figure 17: **Cumulative Defence Fiscal Multipliers (GFCF & Intermediate Consumption Shock): Imports Reliance State-Dependence (over GFCF and Intermediate Consumption Spending)**



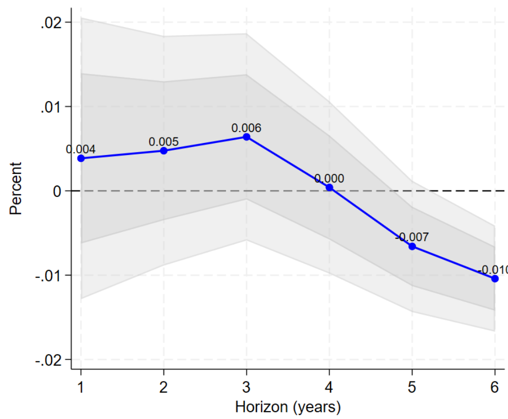
Notes: The plots display the estimated coefficients β_h^A (red vertical bars) and β_h^B (blue bars) from regressions of equation 8 for each horizon h, as well as its 68% and 90% confidence bands (red and blue I-beams, respectively). The dependent variable is normalized-output. State A refers to be proximate to a high defence imports reliance scenario, and B refers to a low import dependence scenario. The state variable is the inverse of the ratio between total military goods imports and total defence spending on GFCF and intermediate consumption (excluding personnel and rest of spending). The shock is defined as the sum of GFCF and intermediate consumption spending (also normalized by trend GDP). Estimated coefficients $\widehat{\beta_h^A}$ and $\widehat{\beta_h^B}$ are interpreted as the cumulative defence spending fiscal multiplier at horizon h when imports reliance is elevated is and low, respectively. The estimation includes country and year fixed effects, and all standard errors are robust.

Figure 18: **Cumulative Defence Fiscal Multipliers: Imports Reliance State-Dependence (real GDP growth)**

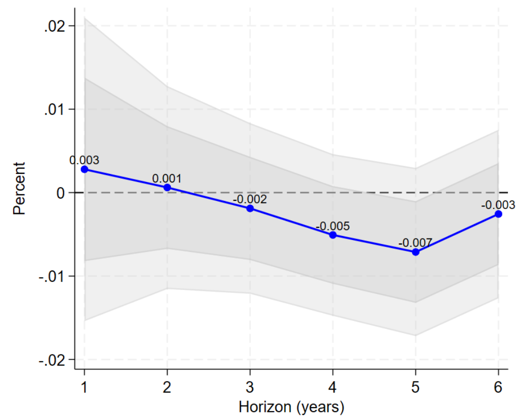


Notes: The plots display the estimated coefficients β_h^A (red horizontal bars) and β_h^B (blue bars) from regressions of equation 8 for each horizon h, as well as its 68% and 90% confidence bands (red and blue I-beams, respectively). The dependent variable is real GDP growth. State A refers to be proximate to a high defence imports reliance scenario, and B refers to a low import dependence scenario. Estimated coefficients $\widehat{\beta_h^A}$ and $\widehat{\beta_h^B}$ are interpreted as the cumulative defence spending fiscal multiplier at horizon h when imports reliance is elevated is and low, respectively. The estimation includes country and year fixed effects, and all standard errors are robust.

Figure 19: **Cumulative Defence Fiscal Multipliers: Imports Reliance Marginal Effect**



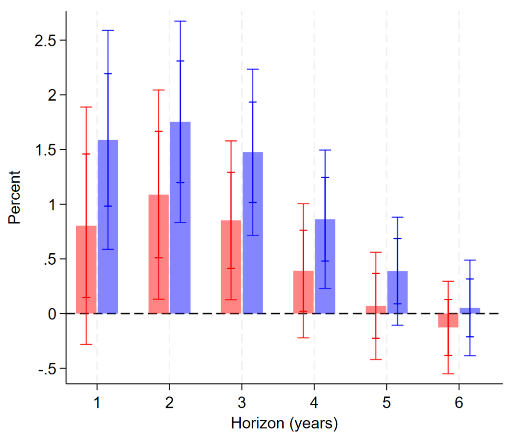
(a) **Trend-Normalized Output**



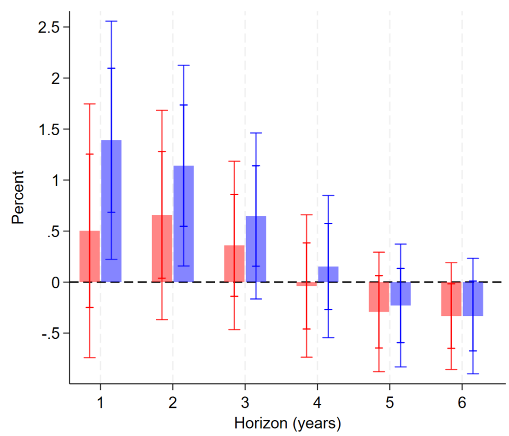
(b) **Real GDP growth rate**

Notes: The plots display the results from regressing trend-normalized output (panel a) or real GDP growth rate (panel b) on the same regressors as in equation 1 for each horizon h, as well as its 68% and 90% confidence bands (grey shaded areas), albeit including the interaction between the normalized defence shock and the share of total defence imports over total defence spending. The estimated coefficient belonging to the interaction is depicted. Estimated coefficients are interpreted as the marginal effect of incrementing imports reliance in 1% of total defence spending on the fiscal multiplier; in terms of detrended output (panel a) and real GDP growth rate (panel b). The estimation includes country and year fixed effects, and all standard errors are robust.

Figure 20: **Cumulative Defence Fiscal Multipliers: Fiscal Space State-Dependence ($r - g$)**



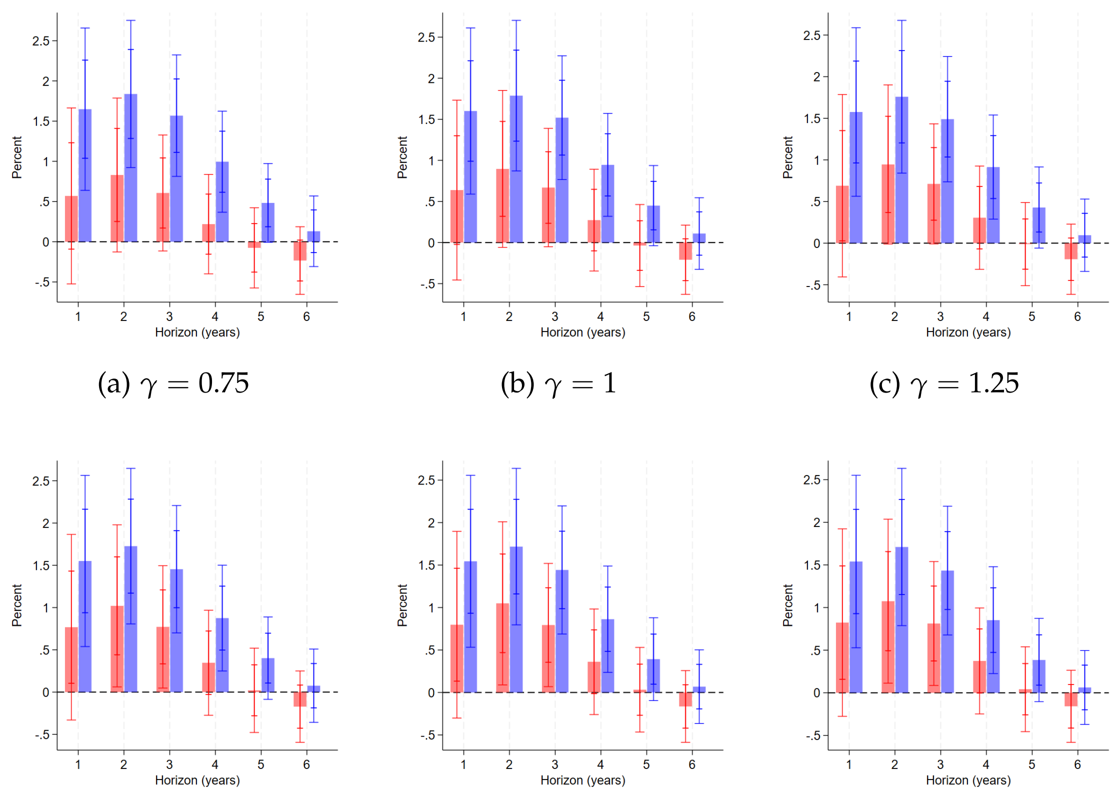
(a) **Trend-Normalized Output**



(b) **Real GDP growth rate**

Notes: The plots display the estimated coefficients β_h^A (red horizontal bars) and β_h^B (blue bars) from regressions of equation 8 for each horizon h, as well as its 68% and 90% confidence bands (red and blue I-beams, respectively). The dependent variable is normalized-output. State A refers to be proximate to a high snowball effect scenario (compressing fiscal space), and B refers to a low snow-ball scenario (expanding fiscal space), both measured by the $r - g$ differential. Estimated coefficients $\widehat{\beta_h^A}$ and $\widehat{\beta_h^B}$ are interpreted as the cumulative defence spending fiscal multiplier at horizon h when fiscal space is compressed and expanded, respectively. The estimation includes country and year fixed effects, and all standard errors are robust.

Figure 21: **Cumulative Defence Fiscal Multipliers: Fiscal Space State-Dependence: Sensitivity to parameter γ**



(a) $\gamma = 0.75$

(b) $\gamma = 1$

(c) $\gamma = 1.25$

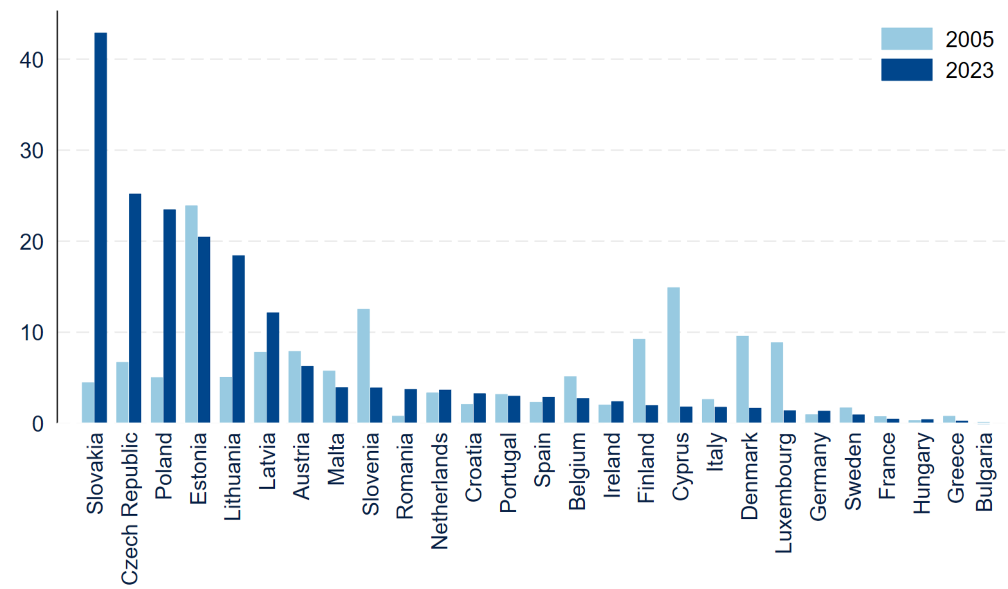
(d) $\gamma = 1.75$

(e) $\gamma = 2$

(f) $\gamma = 2.25$

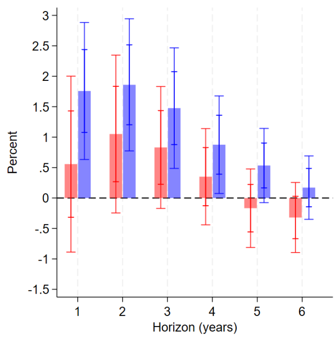
Notes: The plots display the estimated coefficients β_h^A (red horizontal bars) and β_h^B (blue bars) from regressions of equation 8 for each horizon h, as well as its 68% and 90% confidence bands (red and blue I-beams, respectively). The dependent variable is normalized-output. State A refers to be proximate to a high snowball effect scenario (compressing fiscal space), and B refers to a low snow-ball scenario (expanding fiscal space). Panel (a) refers to the application of parameter $\gamma = 0.75$ in the smooth transition logistic function, panel (b) for $\gamma = 1$, panel (c) for $\gamma = 1.25$, panel (d) for $\gamma = 1.75$, panel (e) for $\gamma = 2$ and panel (f) for $\gamma = 2.25$. Estimated coefficients $\widehat{\beta_h^A}$ and $\widehat{\beta_h^B}$ are interpreted as the cumulative defence spending fiscal multiplier at horizon h when fiscal space is compressed and expanded, respectively. The estimation includes country and year fixed effects, and all standard errors are robust.

Figure 22: **Military Imports Reliance Relative to Total Defence Spending across the EU27**

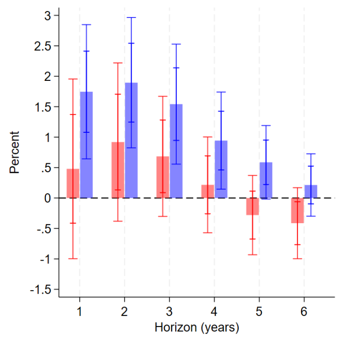


Notes: The plot displays the comparison between 2005 (light blue bars) and 2023 (dark blue bars) of total military imports relative to total defence spending by EU27 country. Total military imports data is sourced from UN Comtrade database, from which goods *tanks and other armoured fighting vehicles* (code 871000), *vessels and warships* (code 890619) and *arms and ammunition* (code 93) are classified as military. The denominator is total defence spending from COFOG Eurostat. The ratio is interpreted as the fraction of total defence spending outsourced from abroad, including intra-EU imports.

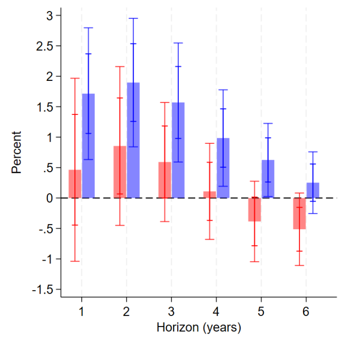
Figure 23: **Cumulative Defence Fiscal Multipliers: Imports Reliance State-Dependence: Sensitivity to parameter γ**



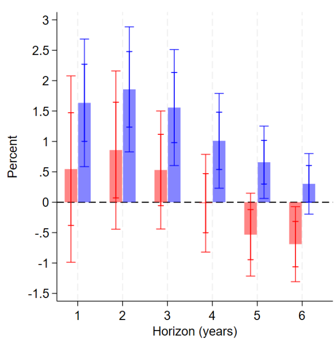
(a) $\gamma = 0.75$



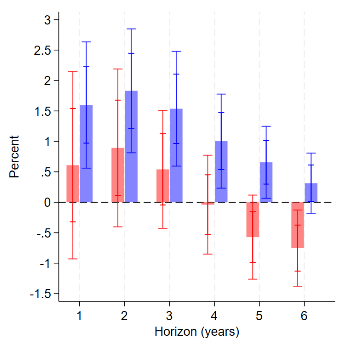
(b) $\gamma = 1$



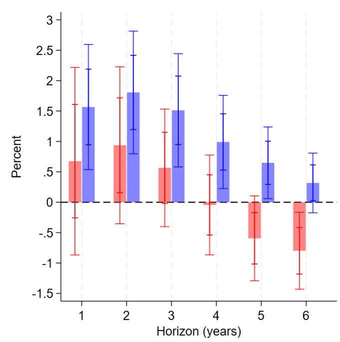
(c) $\gamma = 1.25$



(d) $\gamma = 1.75$



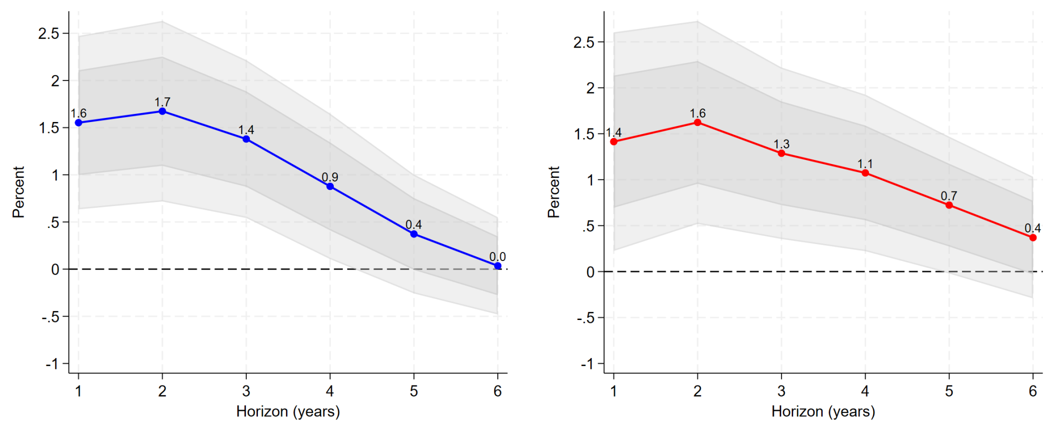
(e) $\gamma = 2$



(f) $\gamma = 2.25$

Notes: The plots display the estimated coefficients β_h^A (red horizontal bars) and β_h^B (blue bars) from regressions of equation 8 for each horizon h, as well as its 68% and 90% confidence bands (red and blue I-beams, respectively). The dependent variable is normalized-output. State A refers to be proximate to a high military imports relative to total defence spending state, and B refers to a low imports dependence state. Panel (a) refers to the application of parameter $\gamma = 0.75$ in the smooth transition logistic function, panel (b) for $\gamma = 1$, panel (c) for $\gamma = 1.25$, panel (d) for $\gamma = 1.75$, panel (e) for $\gamma = 2$ and panel (f) for $\gamma = 2.25$. Estimated coefficients $\widehat{\beta_h^A}$ and $\widehat{\beta_h^B}$ are interpreted as the cumulative defence spending fiscal multiplier at horizon h when imports dependence is high and low, respectively. The estimation includes country and year fixed effects, and all standard errors are robust.

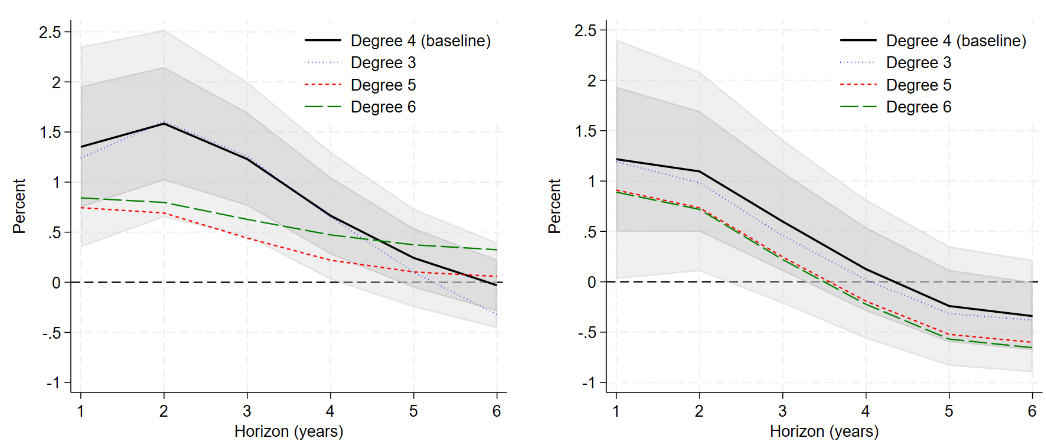
Figure 24: **Cumulative Defence Fiscal Multipliers: SIPRI Data**



(a) **Trend-Normalized Output** (b) **Real GDP growth rate**

Notes: The plots display the estimated coefficient β from regressions of equation 1 for each horizon h, as well as its 68% and 90% confidence bands (grey shaded area). Panel (a) shows cumulative fiscal multiplier utilizing trend-normalized real GDP as the dependent variable, and panel (b) the results for using real GDP growth rate as the shocked variable. In this particular case, the defence fiscal shock variable is the cash-based military expenditure from Stockholm International Peace Research Institute (SIPRI). Estimated coefficient $\widehat{\beta_h}$ is interpreted as the cumulative defence spending fiscal multiplier at horizon h. The estimation includes country and year fixed effects, and all standard errors are robust.

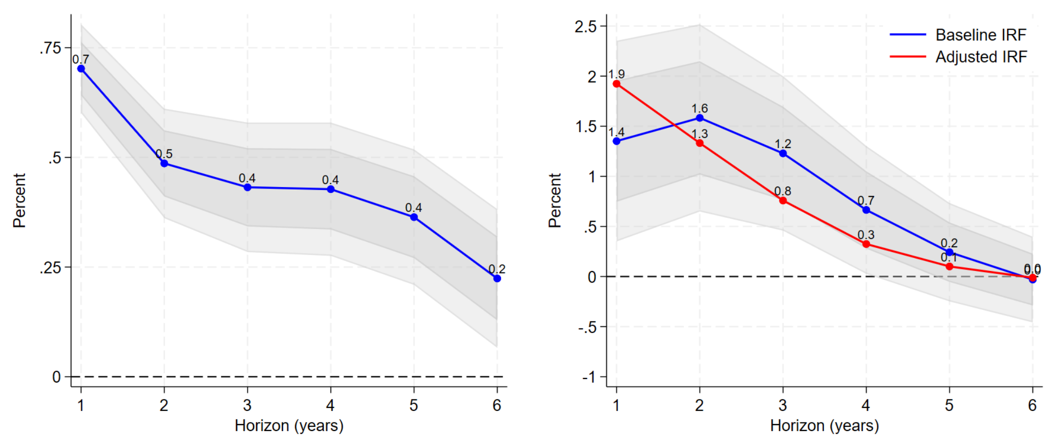
Figure 25: **Cumulative Defence Fiscal Multipliers: Alternative Trend GDP Polynomial Degrees**



(a) **Trend-Normalized Output** (b) **Real GDP growth rate**

Notes: The plots display the estimated coefficient β from regressions of equation 1 for each horizon h, as well as its 68% and 90% confidence bands (grey shaded area). Panel (a) shows cumulative fiscal multiplier utilizing trend-normalized real GDP as the dependent variable, and panel (b) the results for using real GDP growth rate as the shocked variable. For each case, different polynomial degrees have been utilized both to construct the dependent variable in panel a and to normalize all independent variables in both cases. Estimated coefficient $\widehat{\beta_h}$ is interpreted as the cumulative defence spending fiscal multiplier at horizon h. The estimation includes country and year fixed effects, and all standard errors are robust.

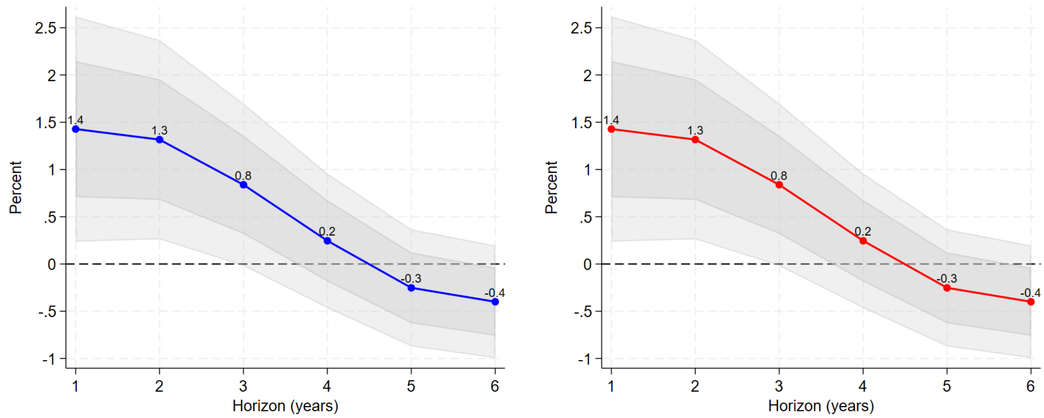
Figure 26: **Cumulative Defence Fiscal Multipliers: Defence Mechanical Persistence Adjustment**



(a) **Autoregressive Model** (b) **Effect on Trend-Normalized Output**

Notes: The plots display i) the estimated coefficient ρ from regressions of equation 9 (panel a), and ii) the estimated coefficient β from regressions of equation 1 for each horizon h adjusted by the cumulative autoregressive coefficient of equation 9, as well as its 68% and 90% confidence bands (grey shaded area). Panel (b) shows cumulative fiscal multiplier utilizing trend-normalized real GDP as the dependent variable adjusted by the inertial component of defence spending. The estimation includes country and year fixed effects, and all standard errors are robust.

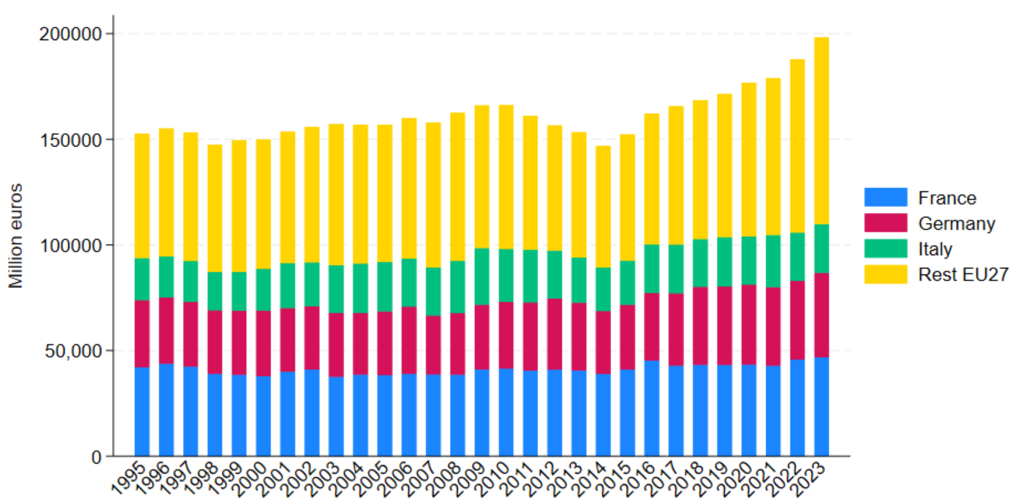
Figure 27: **Cumulative Defence Fiscal Multipliers: Hall-Barro-Redlick Transformation**



(a) **Trend-Normalized Output** (b) **Real GDP growth rate**

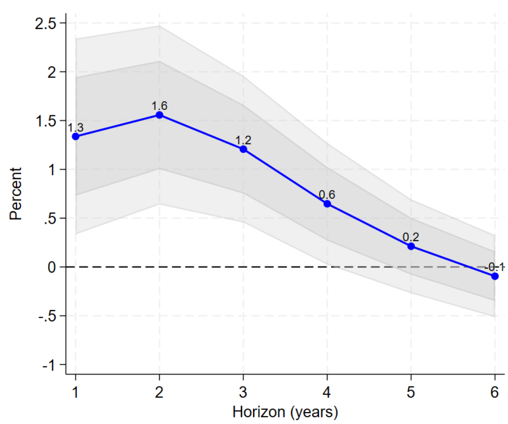
Notes: The plots display the estimated coefficient β from regressions of equation 1 for each horizon h, as well as its 68% and 90% confidence bands (grey shaded area). Panel (a) shows cumulative fiscal multiplier utilizing real GDP normalized by lagged real GDP *a la* Hall-Barro-Redlick as the dependent variable, and panel (b) the results for using real GDP growth rate as the shocked variable where the defence spending shock is normalized as well by lagged output. In both cases, the rest of covariates are expressed in terms of lagged output. Estimated coefficient $\widehat{\beta_h}$ is interpreted as the cumulative defence spending fiscal multiplier at horizon h. The estimation includes country and year fixed effects, and all standard errors are robust.

Figure 28: **Historical Total Defence Spending in the EU27 (2001-2023): Weight of France, Germany and Italy**

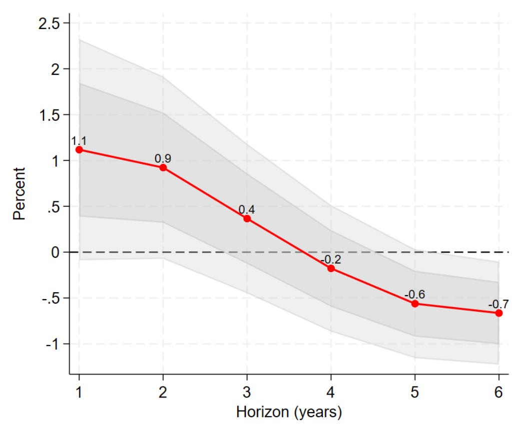


Notes: The plot displays the historical evolution of total EU27 defence spending highlighting the total amount spent by the three greatest contributors to total spending: France, Germany and Italy, in that specific order, and the remaining spent by the rest of EU27 countries. Data based on Classification of the Functions of Government (COFOG) from Eurostat.

Figure 29: **Cumulative Defence Fiscal Multipliers: Exluding Top-3 Spenders (France, Germany and Italy)**



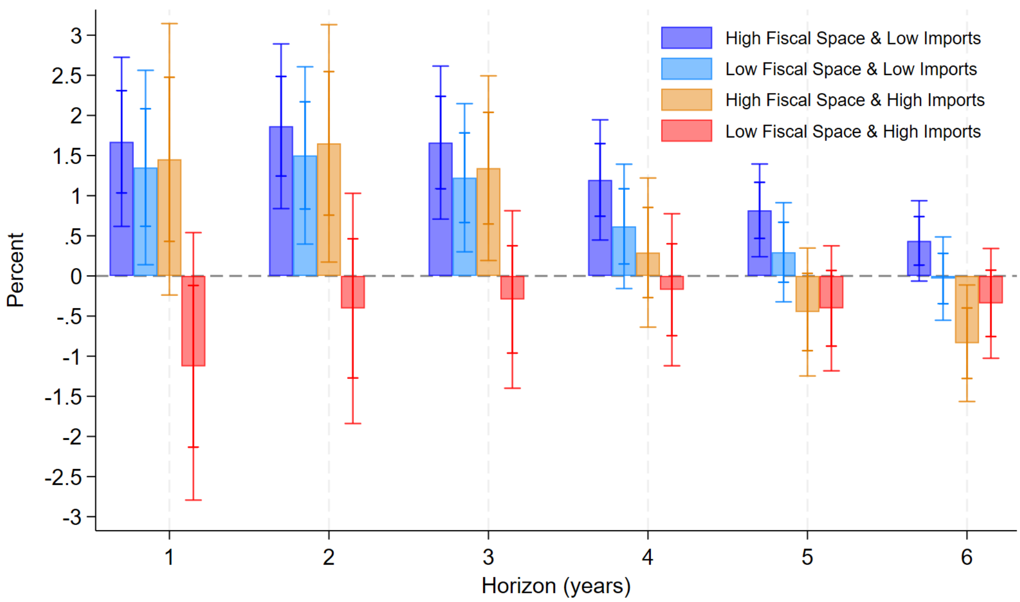
(a) **Trend-Normalized Output**



(b) **Real GDP growth rate**

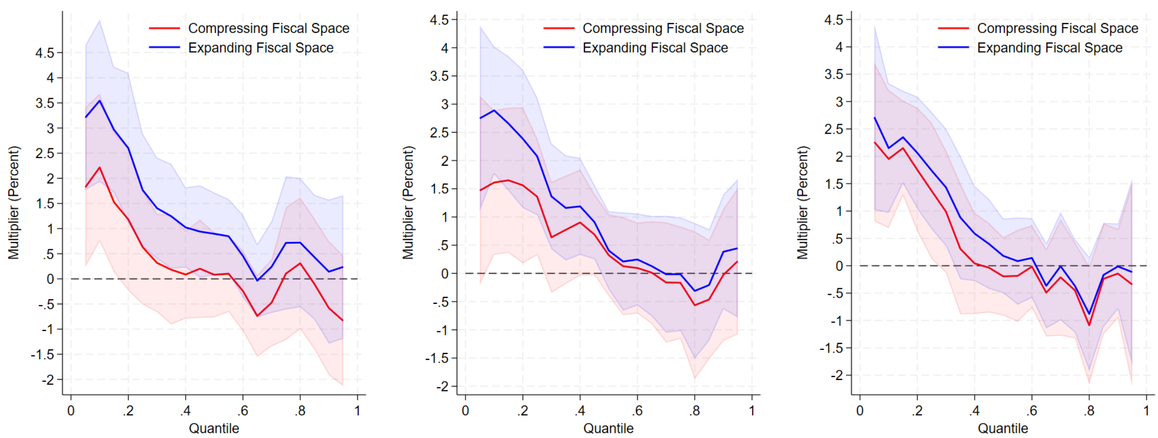
Notes: The plots display the estimated coefficient β from regressions of equation 1 for each horizon h, as well as its 68% and 90% confidence bands (grey shaded area), although excluding France, Germany and Italy from the sample. Panel (a) shows cumulative fiscal multiplier utilizing trend-normalized real GDP as the dependent variable, and panel (b) the results for using real GDP growth rate as the shocked variable. Estimated coefficient $\widehat{\beta_h}$ is interpreted as the cumulative defence spending fiscal multiplier at horizon h. The estimation includes country and year fixed effects, and all standard errors are robust.

Figure 30: **Cumulative Defence Fiscal Multipliers: Embedded-State-Dependence**



Notes: The plots display the estimated coefficients β_h^0 (blue vertical bars), $(\beta_h^0 + \beta_h^1)$ (light blue bars), $(\beta_h^0 + \beta_h^2)$ (orange bars) and $(\beta_h^0 + \beta_h^1 + \beta_h^2 + \beta_h^3)$ (red bars) from regressions of equation 11 for each horizon h, as well as its 68% and 90% confidence bands (I-beams, respectively). The dependent variable is normalized-output. The blue bars refer refers to be proximate to a low snowball effect scenario (expanded fiscal space) and low imports reliance, the light blue to a regime where there is low fiscal space and low imports reliance, the orange bars to a state where high fiscal space and high imports are combined, and the red bars to whe worst-case scenario, where a compressed fiscal space is combined with a high degree of military imports reliance.The estimation includes country and year fixed effects, and all standard errors are robust.

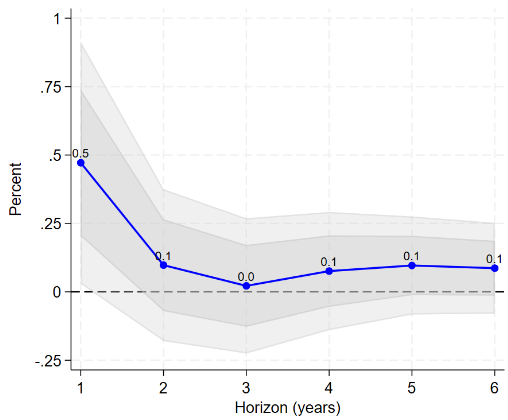
Figure 31: **Quantile-Smooth-Transition Local Projections: Cumulative Defence Fiscal Multipliers by Output Quantile and Fiscal Space State ($h \in \{1, 2, 3\}$)**



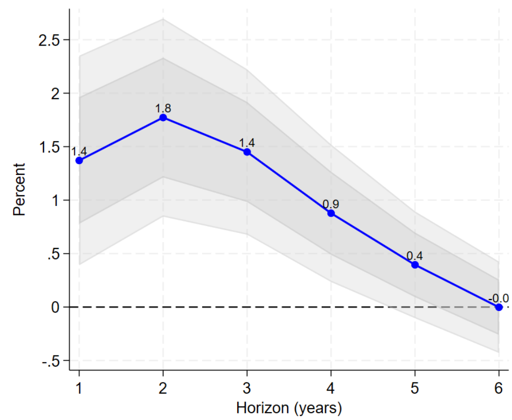
(a) $h = 1$ (b) $h = 2$ (c) $h = 3$

Notes: The plots display the estimated coefficients $\beta_h^A(\tau)$ and $\beta_h^B(\tau)$ from regressions of equation 12 for each horizon h and quantile τ (joint red and blue lines, respectively), as well as its 90% confidence bands (red and blue shaded areas). Panel (a) presents both estimated coefficients at horizon 1 for all specified quantiles ($\tau \in [0.05, 0.10, \ldots, 0.95]$), panel (b) for horizon 2, and panel (c) for horizon 3. Estimated coefficients $\widehat{\beta_h^A(\tau)}$ ($\widehat{\beta_h^B(\tau)}$) are interpreted as the cumulative defence spending fiscal multiplier at horizon h of quantile τ^{th} of output conditional on all equation covariates in times of limited fiscal space (ample fiscal space). The outcome variable is trend-normalized output. The estimation includes country and year fixed effects, and all standard errors are robust.

Figure 32: **Cumulative Defence Fiscal Multipliers: Net of Taxes Effects**



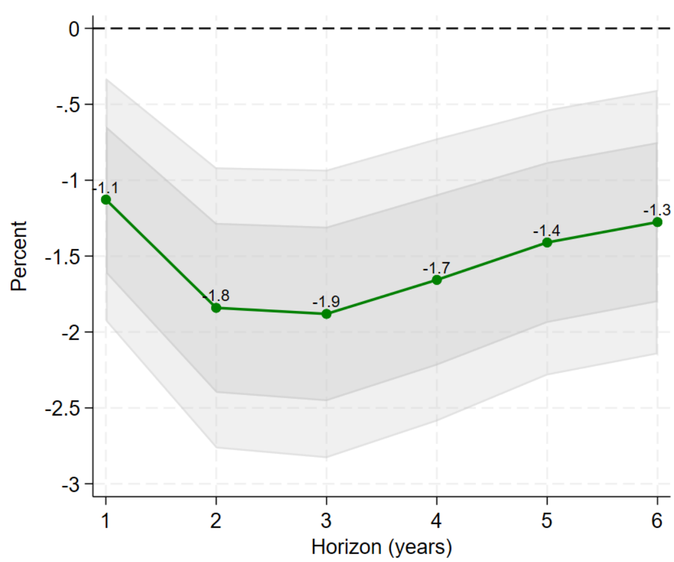
(a) **Effects on Revenues**



(b) **Net Fiscal Multiplier**

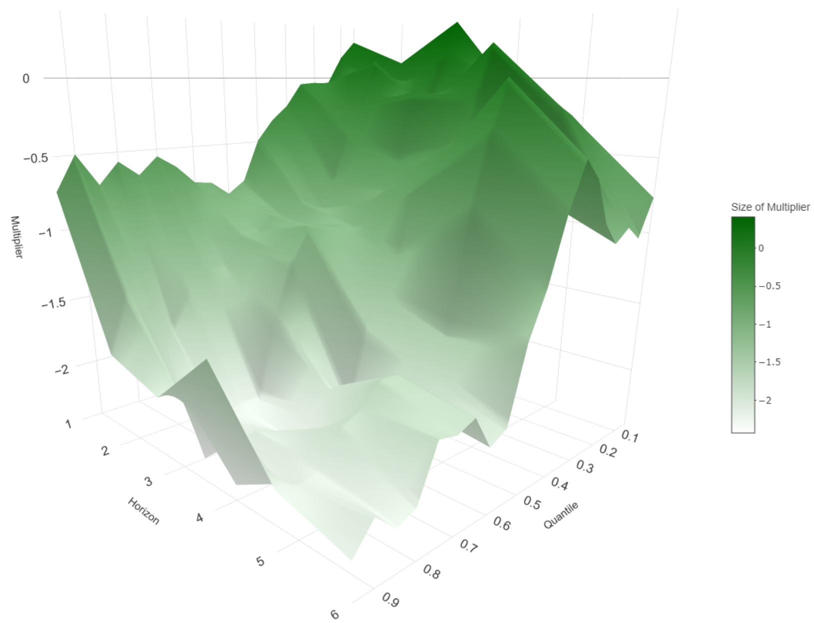
Notes: The plots display the estimated coefficient β from regressions of equation 1 for each horizon h, as well as its 68% and 90% confidence bands (grey shaded area). Panel (a) shows the cumulative response of changes in detrended government revenues after defence spending shocks, and panel (b) the results for estimating the cumulative fiscal multiplier net of the effects of taxes on detrended output. Note that regressions from panel (b) include the cumulative of the first difference of detrended government revenues as an additional control. The estimation includes country and year fixed effects, and all standard errors are robust.

Figure 33: **Cumulative Defence Fiscal Multipliers: Impact on Unemployment**



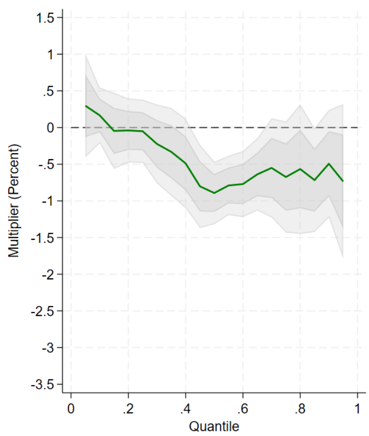
Notes: The plots display the estimated coefficient β^k from regressions of equation 1 for each horizon h when unemployment rate is used as the shocked variable and the shock variable is normalized defence spending, as well as its 68% and 90% confidence bands (grey shaded area). Estimated coefficient $\widehat{\beta_h^k}$ is interpreted as the cumulative defence spending impact on unemployment at horizon h. The estimation includes country and year fixed effects, and all standard errors are robust.

Figure 34: **Quantile Local Projections: Cumulative Defence Fiscal Multipliers by Unemployment Quantile**

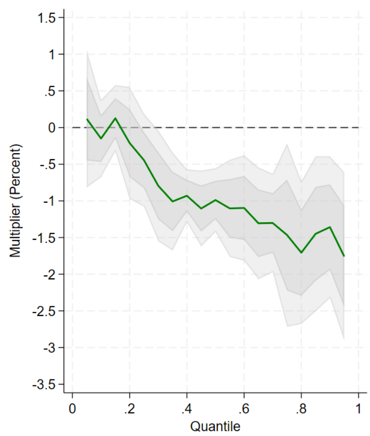


Notes: The plots display the estimated coefficient $\beta_h(\tau)$ from regressions of equation 6 for each horizon h and quantile τ from a 3D perspective, where the size of the multiplier is the z axis and the dependent variable is the unemployment rate. Darker green colours indicate higher unemployment multipliers. Estimated coefficients $\widehat{\beta_h(\tau)}$ are interpreted as the cumulative defence spending fiscal multiplier at horizon h of quantile τ^{th} of unemployment conditional on all equation covariates. The estimation includes country and year fixed effects, and all standard errors are robust.

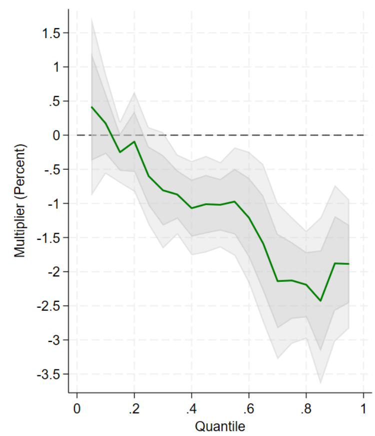
Figure 35: **Quantile Local Projections: Cumulative Defence Fiscal Multipliers by Unemployment Quantile ($h \in \{1, ..., 6\}$)**



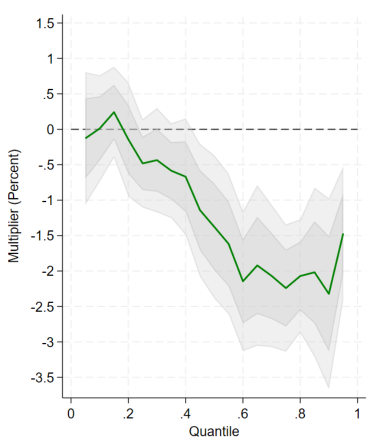
(a) $h = 1$



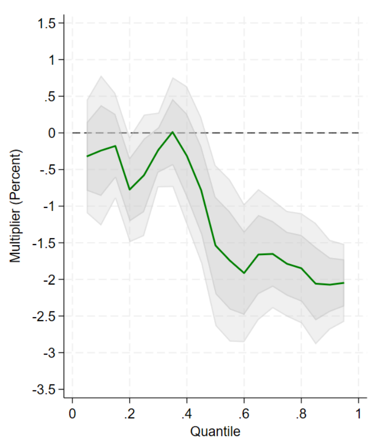
(b) $h = 2$



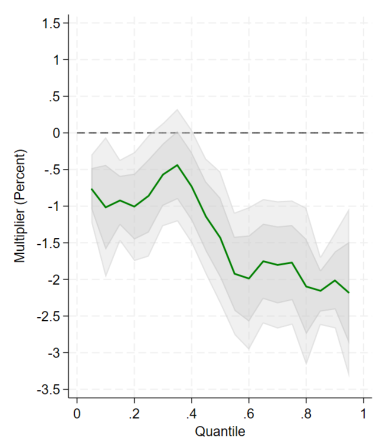
(c) $h = 3$



(d) $h = 4$



(e) $h = 5$



(f) $h = 6$

Notes: The plots display the estimated coefficient $\beta_h(\tau)$ from regressions of equation 6 for each horizon h and quantile τ (joint green lines), as well as its 68% and 90% confidence bands (grey shaded area). Panels (a)(f) correspond to horizons 1 through 6. Estimated coefficients $\widehat{\beta_h(\tau)}$ are interpreted as the cumulative defence spending fiscal multiplier at horizon h of quantile τ^{th} of unemployment rate conditional on all equation covariates. The outcome variable is unemployment rate. The estimation includes country and year fixed effects, and all standard errors are robust.

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