CHAPTER 2

DEFENSE SPENDING: MACROECONOMIC CONSEQUENCES AND TRADE-OFFS

ONLINE ANNEXES

Online Annexes 2.1 to 2.6 to Chapter 2 of the April 2026 World Economic Outlook lay out the data sources, sample coverage, variable definitions, and methodologies used in the main text. The first annex presents the sample of economies covered throughout the chapter and reports the data sources. The subsequent annexes follow the structure of the chapter and describe variable definitions and methodologies used in the exercises reported in the main text, together with extensions and robustness tests.

Online Annex 2.1. Sample Coverage and Data Sources

The analysis in the chapter covers up to 164 economies (Online Annex Table 2.1.1) over the period 1946–2024. All data sources used in the chapter are listed in Online Annex Table 2.1.2.

Online Annex Table 2.1.1. List of Economies

Advanced Economies	Australia; Austria; Belgium; Canada; Croatia; Cyprus; Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Iceland; Ireland; Israel; Italy; Japan; Korea; Latvia; Lithuania; Luxembourg; Malta; the Netherlands; New Zealand; Norway; Portugal; Singapore; Slovak Republic; Slovenia; Spain; Sweden; Switzerland; United Kingdom; United States
Emerging Markets and Developing Economies	Albania; Algeria; Angola; Argentina; Armenia; Azerbaijan; Bahrain; Bangladesh; Barbados; Belarus; Belize; Benin; Bhutan; Bolivia; Bosnia and Herzegovina; Botswana; Brazil; Brunei Darussalam; Bulgaria; Burkina Faso; Burundi; Cabo Verde; Cambodia; Cameroon; Central African Republic; Chad; Chile; China; Colombia; Comoros; Congo, Democratic Republic of the; Congo, Republic of; Costa Rica; Côte d'Ivoire; Djibouti; Dominican Republic; Ecuador; Egypt; El Salvador; Equatorial Guinea; Eswatini; Ethiopia; Fiji; Gabon; Gambia, The; Georgia; Ghana; Guatemala; Guinea; Guinea-Bissau; Guyana; Honduras; Hungary; India; Indonesia; Iran; Jamaica; Jordan; Kazakhstan; Kenya; Kuwait; Kyrgyz Republic; Lebanon; Lesotho; Liberia; Libya; Madagascar; Malawi; Malaysia; Maldives; Mali; Mauritania; Mauritius; Mexico; Moldova; Mongolia; Montenegro, Rep. of; Morocco; Mozambique; Myanmar; Namibia; Nepal; Nicaragua; Niger; Nigeria; North Macedonia; Oman; Pakistan; Panama; Papua New Guinea; Paraguay; Peru; Philippines; Poland; Qatar; Romania; Russia; Rwanda; Saudi Arabia; Senegal; Serbia; Seychelles; Sierra Leone; South Africa; Sri Lanka; Sudan; Suriname; Syria; São Tomé and Príncipe; Tajikistan; Tanzania; Thailand; Togo; Tonga; Trinidad and Tobago; Tunisia; Turkmenistan; Türkiye; Uganda; Ukraine; United Arab Emirates; Uruguay; Uzbekistan; Venezuela; Vietnam; Yemen; Zambia; Zimbabwe

Source: IMF staff compilation.

The main source used for defense spending data is the Stockholm International Peace Research Institute (SIPRI), which provides annual estimates of military expenditure based on a broad and internationally standardized definition that ensures broad cross-country comparability of both current and capital outlays. Its coverage includes personnel costs, operations and maintenance, procurement, military R&D, military aid, paramilitary forces, military space activities, and military pensions.[2] However, SIPRI figures are typically cash-based and may include off-budget items; equipment expenditures are recorded at the time of payment rather than delivery, which can generate timing discrepancies relative to GDP measurement and potentially affect short-run macroeconomic estimates. García-Serrador, Sarasa-Flores and Ulloa (2025) provide a comparison with Eurostat data derived from national accounts.

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[2] Details on the precise definition of military spending and data aggregation methods are available on SIPRI's website: https://www.sipri.org/commentary/topical-backgrounder/2017/monitoring-military-expenditure

Online Annex Table 2.1.2. Data Sources

Indicators	Sources and Data Construction (if applicable)
Defense spending	The main source is the Stockholm International Peace Research Institute (SIPRI) covering 164 countries during 1948–2024. Missing values are supplemented with data from Gethin (2024b) for 175 countries since 1980 and the World Human Capital Expenditure (WHCE) dataset for 48 countries since 1800 (created by Bharti and others 2026). Disaggregated data on four military spending subcomponents—equipment, personnel, infrastructure, and operating expenses—is obtained from Becker and others (2024) for a subsample of 35 North Atlantic Treaty Organization and European Union member countries during 1965–2020.
Arm imports and exports	SIPRI Arms Transfers Database
Number of military personnel, National material capabilities score, and arms technology	Correlates of War (COW), *Project Arms Technology* , version 1.0 (Hariri and Wingender 2025). COW National Material Capabilities, version 6.0 (Singer and others 1972).
Conflicts	Data on armed conflicts and their classification (onsite or belligerent) are defined in more detail in IMF *World Economic Outlook* April 2026 Chapter 3. Source data is obtained from the Uppsala Conflict Data Program (UCDP/PRIO Armed Conflict Dataset version 25.1; Gleditsch and others 2002; Davies and others 2025) for 1946–2024 and complemented with Correlates of War (COW) data spanning 1816–2007 (Correlates of War Non-State War data set, version 4.0; Intra-State War data set, version 5.1; Inter-State War data set, version 4.0, and Extra-State War data set, version 4.0 (Sarkees and Wayman 2010)).
Total government spending, revenues, fiscal balance, and debt as a share of GDP	The main source is the Public Finances in Modern History (PFMH) dataset covering 151 countries during 1800–2024. This data is complemented with information in the Global Macro Database (GMD) with global coverage during 1800–2024 (Müller and others 2025), and the IMF, *World Economic Outlook* (WEO). Additional information on governments' spending breakdown, including social spending components, is obtained from Gethin (2024b).
Real GDP (and its subcomponents), CPI, exchange rate, trade	Global Macro Database (Müller and others 2025); IMF, *World Economic Outlook* ; World Bank, *World Development Indicators* ; World Bank, *World Integrated Trade Solution* (WITS).

Source: IMF staff compilation.

To limit potential measurement errors, SIPRI gathers data on extra-budgetary and off-budget military spending when possible, and makes estimates if exact numbers are unavailable, using methodology tailored to country specificities when needed. Nevertheless, given the confidentiality of military budget data, the defense spending estimates used in this analysis can suffer from measurement errors. In addition, military expenditure will typically exclude spending on domestic security (e.g., police) or paramilitary forces.

Systematic and comparable data on functional spending are scarce and often fragmented. To address this limitation the chapter uses the recent dataset constructed by Gethin (2024b), who draws on primary sources to provide internationally comparable estimates of spending on education, healthcare, and social protection for 176 countries from 1980 to 2023. Other expenditure categories in the dataset are imputed residually after accounting for these three core social functions. See Gethin (2024a) for details on specific sources and methodological issues.

Online Annex 2.2. Defense Spending Booms

Defining defense spending booms

Defense spending booms are defined as periods during which the 2-year moving average of defense spending as a share of GDP rises by at least 1 percentage point, continuing for as long as defense spending does not decline.

Lacking a widely adopted way to identify defense spending booms, the chapter considers two alternative definitions of booms and uses them to test the robustness of the main findings. The first (Alternative I) maintains the same definition but lowers the threshold to 0.5 percentage point of GDP. The second (Alternative II) follows the definition used by Marzian and Trebesch (2025)—henceforth MT—and defines defense spending booms to begin when the 2-year moving average growth rate of defense spending as a share of GDP exceeds the standard

Online Annex Table 2.2.1. Defense Spending Booms: Baseline and Alternative Definitions

	Number of Booms					Boom Characteristics			
						Average Size		Average Duration	
Definition	Count Total	AEs	EMDEs	Wartime	Peacetime	AEs	EMDEs	AEs	EMDEs
Baseline	215	26	189	99	116	2.4	2.7	2.5	2.7
Peacetime Booms	116	20	96	0	116	1.6	1.7	2.3	2.5
Narrative Subset	59	16	43	0	59	1.7	1.6	2.4	2.8
Alternative Definitions:									
I (0.5 Percentage Point Threshold)	403	49	354	163	240	1.1	1.3	2.7	2.8
II (Marzian and Trebesch, 2025)	329	36	293	111	218	1.1	1.1	5.8	5.9

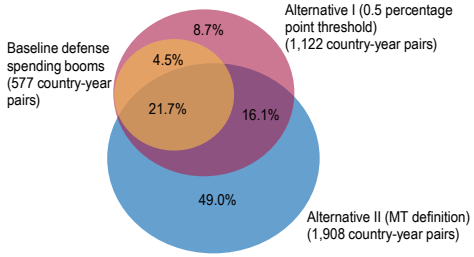
Source: IMF staff calculations.
Note: Defense spending booms in the baseline are defined as periods under which the two-year moving average of defense spending rises by at least 1 percentage point of GDP, continuing for as long as it does not decline. Boom episodes are classified as wartime (peacetime) if, in the previous year or within three years, the country experiences a conflict onsite (otherwise, including both belligerent and no conflict episodes). Narrative booms refer to the subset of peacetime booms that are classified as exogenous using narrative methods. Alternative definition I applies a threshold of 0.5 percentage point (instead of 1 percentage point in the baseline) whereas alternative definition II applies the method of Marzian and Trebesch (2025) in defining defense spending booms. Average size denotes the average annual increase in military spending (as a percent of GDP). Average duration is measured in years. AEs = advanced economies; EMDEs = emerging market and developing economies.

deviation of the in-sample growth rate of the defense spending-to-GDP ratio (10.5 percent) for two consecutive years, and to end when the growth rate falls below 0 for two consecutive years.[3]

The baseline analysis considers 215 military spending booms identified during 1946-2024. The number of booms rises to 403 when lowering the threshold to 0.5, and to 329 when using the MT approach (Online Annex Table 2.2.1). There is a high degree of overlap across the boom definitions (Online Annex Figure 2.2.1). In addition, the evolution of defense spending booms over time is consistent across definitions (Online Annex Figure 2.2.2).

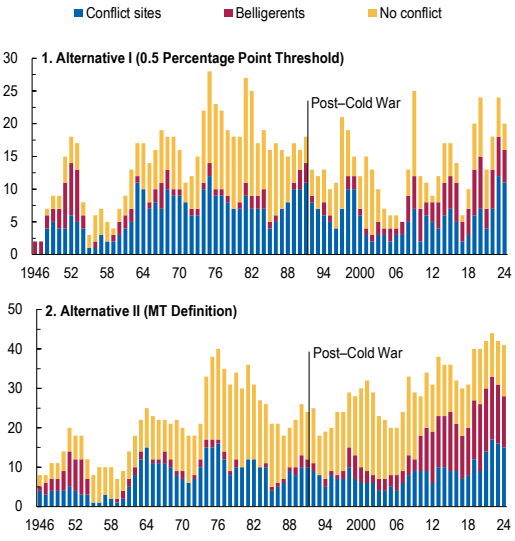
To mitigate concerns about the endogeneity of defense spending buildups, as discussed later in this section, part of the analysis focuses on *peacetime booms,* which exclude defense spending booms in wartime (defined as those that immediately follow a conflict or culminate in an onsite conflict taking place within the country's borders within three years), as well as fragile and conflict-affected states and emerging market and developing economies commodity exporters, to avoid confounding effects arising from domestic conflicts and commodity price cycles.

Online Annex Figure 2.2.1. Overlap of Defense Spending Boom-Country Year Pairs
(Share of 2,199 boom country-years by definition)



Source: IMF staff calculations.
Note:The MT definition refers to Marzian and Trebesch (2025). See text for details.

Online Annex Figure 2.2.2. Defense Spending Boom Episodes Using Alternative Definitions
(Number)



Source: IMF staff calculations.
Note: The panels shows the time evolution of defense spending booms using two alternative definitions. The MT definition refers to Marzian and Trebesch (2025). See text for details.

[3] The threshold differs from the one used by Marzian and Trebesch (2025), as the standard deviation of the growth rate of the defense spending-to-GDP ratio in their sample is 6.5 percent.

Defense spending booms identified via a narrative approach

To further strengthen identification, a narrative approach is used to construct a subset of more plausibly exogenous defense spending booms, identified as the subset of peacetime booms that are driven by external geopolitical factors or by alliances, and largely unrelated to local macro-fiscal conditions (such as commodity booms) and domestic security concerns. This approach analyzes boom episodes and excludes cases of violations of exogeneity, such as those associated with domestic security concerns, onsite conflicts, economic crises, and commodity price booms. As a result, 59 *narrative* boom episodes are identified in the post-World War II period.

Specifically, the 116 peacetime boom episodes are provided to GPT-5 along with the following prompt: "*You are a specialist in economics and military history. You are given a country and a year when a country experienced a military spending boom, characterized by a sharp increase in military spending lasting two or more years. Provide the following information:*

A. Describe the main reasons for the military spending increase. Multiple reasons are allowed.

B. Classify the main reason for the military spending boom as the following:

1. Exogenous-geopolitical, the boom is driven by: global or regional foreign threat / border tensions / arms races / colonial wars / internationalized conflicts / political shocks abroad

2. Exogenous-alliance-driven, the boom reflects: formal treaty obligations / bloc-wide mobilization / mandated defense commitments / coordinated rearmament

3. Endogenous-macrofiscal, the boom is linked to: recession / unemployment / commodity revenues / large general stimulus / domestic cyclical policy decisions

4. Endogenous-security-domestic, the boom is motivated by: domestic conflict / civil war / rebellion / separatist movements / coups / internal political violence / organized crime / policing expansions

5. Ambiguous: Evidence is insufficient or unclear. Use this when the motive cannot be linked confidently to any category.

C. If multiple reasons exist, is any of the reasons Endogenous-macrofiscal or Endogenous-security-domestic?

D. Provide justification for your reply.

Keep answers short and focused. Use the following JSON schema example for your reply.

Example: United States 1950.

Reply:{"motivation": "The main reason for this boom was the outbreak of the Korean War in June 1950. This increase was part of a broader Cold War strategy to counter Soviet influence globally.", "classification": "Exogenous-geopolitical", "endogeneity": "No", 'justification": "The reasons for this boom were exogenous. The boom was mainly part of an arms race."}

Example: Libya 1969.

Reply: {"motivation": "The reasons for this boom were multiple. Under the new leadership of Muammar Gaddafi following the September 1, 1969, coup, significantly increased military spending to shift the country away from Western influence, advance Pan-Arabist goals, and modernize its armed forces. Key reasons for the surge in military spending included: (1) Ideological Shift and Pan-Arabism: The Free Officers Movement, which took power in 1969, was heavily influenced by Gamal Abdel Nasser's Arab nationalism and socialism. The new government sought to actively support Arab causes, including the fight against Israel and the backing of "revolutionary" movements. (2) Removal of Foreign Influence:

The regime moved to eliminate Western, particularly American and British, influence by closing foreign military bases and initiating a policy of non-alignment. (3) Consolidation of Power: The Revolutionary Command Council (RCC) strengthened the military to solidify its control over the country after ousting the monarchy. (4) Oil Revenue Utilization: The 1959 discovery of oil provided the necessary funds to transform the military. Under Gaddafi, Libya became a major buyer of arms from Europe and the Soviet Union. (5) Regional Security Posture: The military buildup was in part a response to the Arab world's defeat by Israel in 1967, driving the new leadership to strengthen their defensive capabilities.", "classification": "Exogenous-geopolitical", "endogeneity": "Yes", 'justification": "The boom is linked to commodity revenues, among other reasons."}"

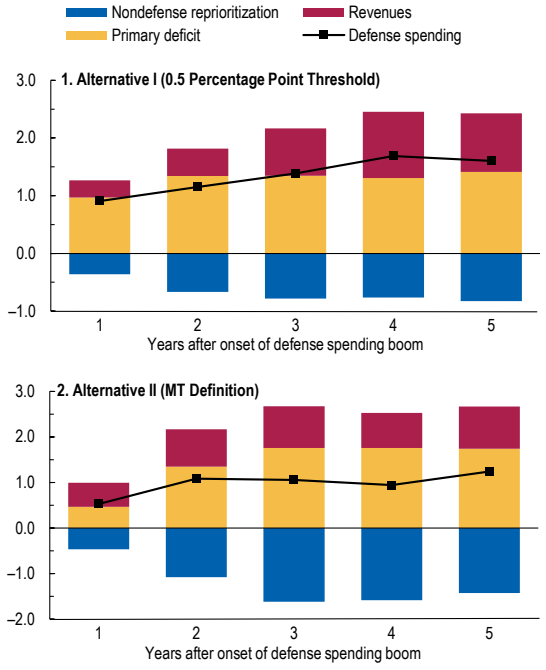
Each answer was then manually checked to assess whether the classification was correct. In the United States, we identify three exogenous boom episodes that start in 1949, 1965, and 1980, consistent with the narrative episodes identified in Ramey (2011).

Additional stylized facts

Financing defense spending booms

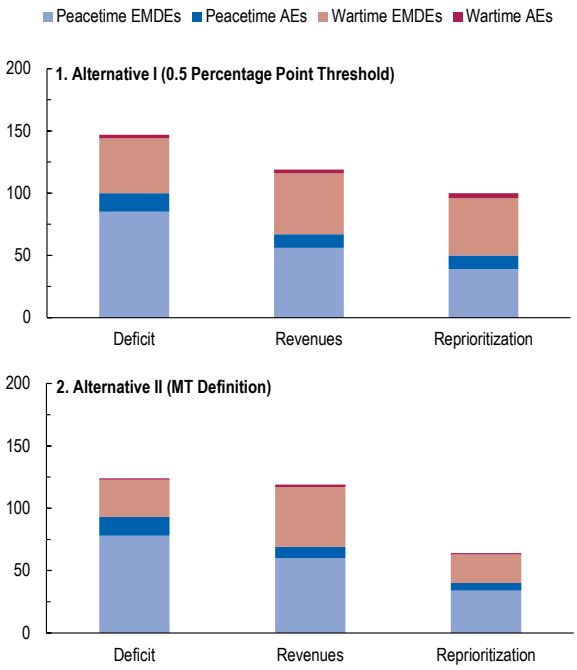
The main finding that defense spending booms are mostly deficit financed is robust across the two alternative definitions. Online Annex Figure 2.2.3 shows that an increase of the deficit is the main financing source, especially in the first years of the boom, whereas the role of spending reprioritization and revenue mobilization is limited, on average, and tends to emerge only in later

Online Annex Figure 2.2.3. Average Boom Financing Decomposition: Alternative Boom Definitions
(Cumulative change, percentage points of GDP)



Source: IMF staff calculations.
Note: The panels show the average financing decomposition of defense spending booms using two alternative definitions. The MT definition refers to Marzian and Trebesch (2025). See text for details. The black line denotes the cumulative increase in defense spending in percentage points of GDP. The horizontal axis measures the duration of the defense spending boom, in years. For each year, this increase is decomposed into its financing sources. Nondefense spending reprioritization is computed as the residual in this equation: *Change in Deficit = Change in Defense Spending + Change in Nondefense Spending - Change in Revenues.*

Online Annex Figure 2.2.4. Defense Spending Booms, by Main Financing Source: Alternative Boom Definitions
(Number)



Source: IMF staff calculations.
Note: The panels show the main financing sources of defense spending booms using two alternative definitions. The MT definition refers to Marzian and Trebesch (2025). See text for details. Wartime (peacetime) is defined based on whether (or not) an on-site conflict emerges one year before or within three years following the corresponding defense spending boom onset. AEs = advanced economies; EMDEs = emerging market and developing economies.

years. Yet, across alternative definitions there is considerable heterogeneity in how booms are financed (Online Annex Figure 2.2.4).

Temporary versus permanent booms

An important feature of defense spending booms is whether they lead to a permanent or transitory increase in defense spending, as this would affect the financing mix and the possible macroeconomic consequences of the buildup. Booms are defined as temporary if defense spending (as a share of GDP) returns to pre-boom levels within 10 years, while the remaining booms are classified as permanent. Permanent booms are, on average, larger and last longer than temporary ones. In addition, permanent and temporary booms are evenly split among emerging market and developing economies and advanced economies, and between wartime and peacetime (Online Annex Table 2.2.2).

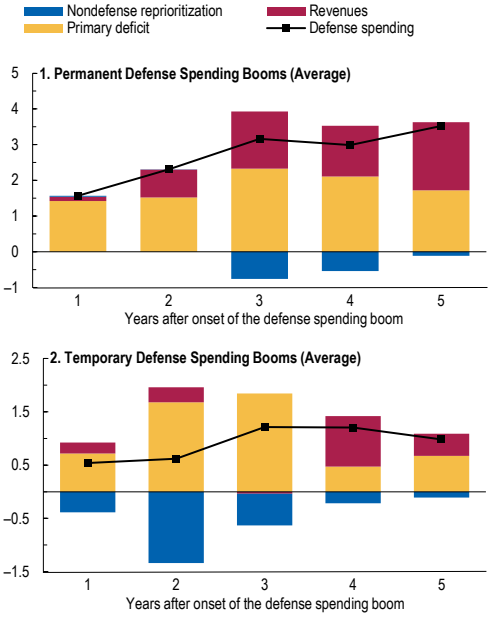
Online Annex Figure 2.2.5 points to differences in the financing mix. The first three years of permanent defense spending booms register an increase in the primary deficit and tax revenues, with limited role for defense reprioritization. In contrast, temporary booms are mostly deficit financed.

Online Annex Table 2.2.2. Permanent and Temporary Military Spending Boom Episodes

Type of Boom	Total	AEs	EMDEs	Wartime	Peacetime
			Count		
Baseline	215	26	189	99	116
Permanent	112	13	99	51	61
Temporary	103	13	90	48	55
			Average Size		
Baseline	2.7	2.4	2.7	3.4	2.1
Permanent	3.0	2.7	3.0	3.9	2.2
Temporary	2.3	2.1	2.4	2.8	1.9
			Average Duration		
Baseline	2.7	2.5	2.7	2.8	2.5
Permanent	3.1	2.8	3.2	3.2	3.0
Temporary	2.2	2.3	2.2	2.4	2.0

Source: IMF staff calculations.
Note: Average duration is measured in years. Average size is measured as percent of GDP. AEs = advanced economies; EMDEs = emerging market and developing economies.

Online Annex Figure 2.2.5. Average Boom Financing Decomposition: Permanent versus Temporary Booms
(Cumulative change, percentage points of GDP)



Source: IMF staff calculations.
Note: The figure shows the average financing decomposition of defense spending booms, separating permanent and temporary booms. Changes in defense spending are defined as permanent if the direction of change in defense spending over GDP in year *t* is the same as in the following 10 years, and temporary otherwise. The black line denotes the cumulative increase in defense spending in percentage points of GDP. The horizontal axis measures the duration of the defense spending boom, in years. For each year, this increase is decomposed into its financing sources. Nondefense spending reprioritization is computed as the residual in this equation: *Change in Deficit = Change in Defense Spending + Change in Nondefense Spending - Change in Revenues.*

Endogeneity of defense spending

Estimating the macroeconomic effects of defense spending requires identifying changes in defense spending that are (i) unanticipated and (ii) plausibly unrelated to the business cycle (exogenous). While anticipation effects are to some extent mitigated by the use of low frequency (annual) data, fully addressing this concern is difficult without available procurement data or news-based measures of defense spending announcements for a large sample of countries. In other words, military spending increases may be announced before the actual spending takes place, leading economic agents to react in advance, and implemented over a long period of time, which could bias estimated effects downward. Nevertheless, this caveat applies broadly to cross-country studies of defense spending multipliers. Moreover, the boom episodes identified for the

Online Annex Table 2.2.3. Endogeneity of Defense Spending: Panel Regressions

	All Countries					Excluding FCS					Excluding FCS and Commodity-Exporting EMDEs				
Dependent Variable: Defense Spending$_{i,t}$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Panel 1: Post-World War II															
Armed onsite conflict$_{i,t-1}$	6.650***				6.909***	5.593***				6.015***	5.031**				5.185**
	(1.651)				(1.565)	(1.823)				(1.712)	(2.187)				(2.018)
GDP Growth$_{i,t-1}$		0.061			0.057		0.065			0.082		0.074			0.080
		(0.061)			(0.076)		(0.067)			(0.091)		(0.080)			(0.101)
Government Revenue over GDP$_{i,t-1}$			0.195***		0.210***			0.184**		0.196**			0.135		0.150*
			(0.067)		(0.066)			(0.078)		(0.076)			(0.090)		(0.088)
Recession$_{i,t-1}$				-0.267	0.239				-0.144	0.476				-0.004	0.641
				(0.536)	(0.712)				(0.480)	(0.724)				(0.547)	(0.768)
Number of Observations	9,516	9,393	8,903	9,468	8,855	8,040	7,934	7,528	8,000	7,487	6,098	6,012	5,715	6,066	5,680
R^2	0.179	0.164	0.186	0.161	0.211	0.205	0.198	0.220	0.194	0.236	0.267	0.259	0.277	0.256	0.292
Panel 2: Post-Cold War															
Armed Onsite Conflict$_{i,t-1}$	3.738**				4.322**	2.394				2.786	2.076				2.236
	(1.785)				(1.759)	(1.750)				(1.863)	(1.935)				(1.938)
GDP Growth$_{i,t-1}$		0.155**			-0.000		0.198**			0.057		0.149*			0.003
		(0.073)			(0.088)		(0.077)			(0.096)		(0.078)			(0.079)
Government Revenue over GDP$_{i,t-1}$			0.350***		0.350***			0.331***		0.326***			0.369***		0.369***
			(0.076)		(0.077)			(0.090)		(0.091)			(0.101)		(0.102)
Recession$_{i,t-1}$				-1.654***	-0.578				-1.742***	-0.428				-1.016*	-0.228
				(0.603)	(0.634)				(0.518)	(0.539)				(0.541)	(0.532)
Number of Observations	5,382	5,382	5,253	5,382	5,253	4,541	4,541	4,428	4,541	4,428	3,389	3,389	3,301	3,389	3,301
R^2	0.080	0.074	0.121	0.073	0.134	0.099	0.103	0.148	0.100	0.153	0.120	0.121	0.181	0.118	0.185
Number of Countries	164	164	164	164	164	138	138	138	138	138	103	103	103	103	103
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: IMF staff calculations.

Note: This table shows ordinary least squares (OLS) estimates where defense spending as a share of trend GDP is regressed on the one-year lag of: a dummy indicator for armed conflicts that occur onsite, GDP growth, government revenues as a share of trend GDP, and a recession dummy (defined as years of negative GDP growth), in addition to country and year fixed effects. Trend GDP is constructed considering a 6th order polynomial time trend. Standard errors (in parentheses) are clustered at the country level. EMDEs = emerging market and developing economies; FCS = fragile and conflict-affected states.

*** $p<0.01$; ** $p<0.05$; * $p<0.1$.

Online Annex Table 2.2.4. Predictors of Defense Spending Booms, Alternative Definitions

	Baseline Booms															Alternative Booms	
	All Countries					Excluding FCS					Excluding FCS and Commodity-Exporting EMDEs						
Dependent Variable: Defense Spending Boom$_{i,t}$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Armed Onsite Conflict$_{i,t-1}$	3.061***				2.958***	2.650***				2.435***	2.389***				2.347***	3.029***	1.624**
	(0.469)				(0.540)	(0.561)				(0.643)	(0.637)				(0.742)	(0.976)	(0.758)
GDP Growth$_{i,t-1}$		-0.023			-0.044		-0.047			-0.058		-0.002			-0.039	0.027	0.111
		(0.052)			(0.063)		(0.058)			(0.072)		(0.061)			(0.085)	(0.076)	(0.100)
Government Revenue over GDP$_{i,t-1}$			0.046*		0.045*			0.068**		0.063**			0.036		0.028	-0.005	0.005
			(0.027)		(0.025)			(0.030)		(0.028)			(0.032)		(0.029)	(0.033)	(0.031)
Recession$_{i,t-1}$				-0.159	-0.866				0.111	-0.680				-0.273	-0.470	-0.801	0.527
				(0.551)	(0.605)				(0.561)	(0.585)				(0.530)	(0.619)	(0.845)	(0.938)
Number of Observations	9,613	9,221	8,774	9,284	8,731	8,140	7,803	7,425	7,859	7,389	6,197	5,932	5,659	5,979	5,627	5,630	5,636
R^2	0.025	0.021	0.023	0.022	0.027	0.028	0.025	0.027	0.025	0.030	0.032	0.027	0.029	0.026	0.032	0.041	0.032
Number of Countries	164	164	164	164	164	138	138	138	138	138	103	103	103	103	103	103	103
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: IMF staff calculations.

Note: This table shows ordinary least squares (OLS) estimates where a dummy for defense spending booms is regressed on the one-year lag of: a dummy indicator for armed conflicts that occur onsite, GDP growth, government revenues as a share of trend GDP, and a recession dummy (defined as years of negative GDP growth), in addition to country and year fixed effects. Trend GDP is constructed considering a 6th order polynomial time trend. The alternative booms are the Alternative I, which maintains the same definition but lowers the threshold to 0.5 percentage point of GDP, and the Alternative II, which follows the definition used by Marzian and Trebesch (2025). Standard errors (in parentheses) are clustered at the country level. EMDEs = emerging market and developing economies; FCS = fragile and conflict-affected states.

*** $p<0.01$; ** $p<0.05$; * $p<0.1$.

United States yield the same boom start years as identified by Ramey and Shapiro (1998)'s news-based approach, providing reassurance on the timing of identified shocks.

As regards exogeneity, the literature on fiscal multipliers—focusing mainly on advanced economies such as the United States—considers defense spending to be largely exogenous to local economic conditions. However, in the sample used in the chapter, the evidence suggests that defense spending cannot be taken as exogenous. A simple exercise to test the predictability of defense spending based on macroeconomic conditions shows that defense spending can be anticipated by the past fiscal position (government revenues) and armed conflicts occurring onsite (Table 2.2.3). These results also hold when considering separately advanced economies and emerging market and developing economies, or when restricting the sample to the post-Cold War period. Defense spending increases after conflicts erupt and in periods of higher GDP growth or increasing government revenue, as countries can increase defense spending because of

windfall commodity revenues. Similarly, spending could be motivated by domestic security issues. Yet, dropping commodity exporters and fragile and conflict states from the sample does not resolve endogeneity. As a result, the OLS estimates can be upward biased because of the positive correlation between local economic conditions and defense spending.

Similar considerations hold for defense spending booms. However, in the case of booms, Table 2.2.4 shows that, once fragile and conflict states and emerging market and developing economies commodity exporters are excluded from the sample, boom start dates can be predicted by armed conflicts, but not by GDP growth, government revenues, or economic recessions. Thus, once defense spending booms associated with conflicts are discarded, the remaining *peacetime booms* can be considered largely exogenous to local economic conditions. These results hold also for the two alternative boom definitions, as shown in the last two columns.

Online Annex 2.3. Macroeconomic Dynamics Following Booms

Main specification

To study the macroeconomic consequences of defense spending, this section starts by analyzing the dynamics of key macroeconomic variables following booms. The analysis uses a standard local projections framework estimated with OLS:

$$Y_{i,t+h} - Y_{i,t-1} = \alpha_h + \beta_h Boom_{i,t} + \xi_h(L)\boldsymbol{X}_{i,t-1} + \vartheta_{i,h} + \delta_{t,h} + \varepsilon_{i,t+h}$$

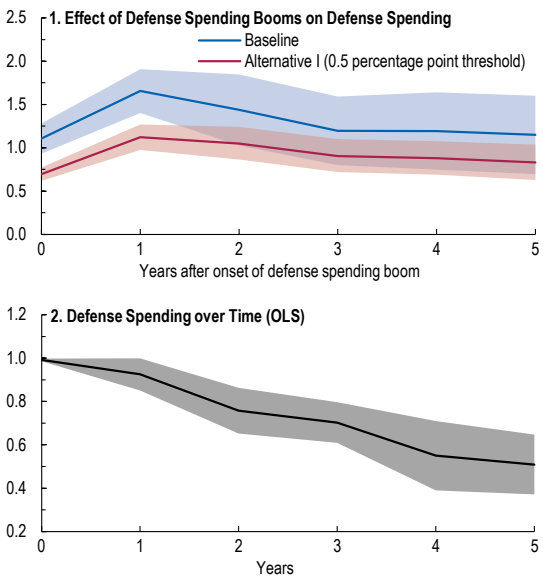
Where the dependent variable $Y_{i,t}$ is measured for country i as the cumulative change over a 5-year window. The set of dependent variables include the following fiscal and macroeconomic indicators: GDP and its subcomponents (government consumption, private consumption, investment, imports, exports, as well as factors of production—capital stock, employment, and total factor productivity), fiscal indicators (governments' defense and nondefense spending, overall balance, debt, and social spending on health, education, and social protection), and the consumer price index. The key explanatory variable is a dummy indicating the start of the defense spending boom ($Boom_{i,t}$) in country i in year t. The specification includes a vector ($\boldsymbol{X}_{i,t-1}$) of controls which includes the 1-year lag of the dependent variable and 4 lags of the boom variable. The inclusion of country and year fixed effects accounts for unobserved country heterogeneity and common shocks (such as a rise in geopolitical risk), which could drive both defense spending and economic outcomes. Standard errors are clustered at the country level.

Macroeconomic Dynamics After Defense Spending Booms

Robustness

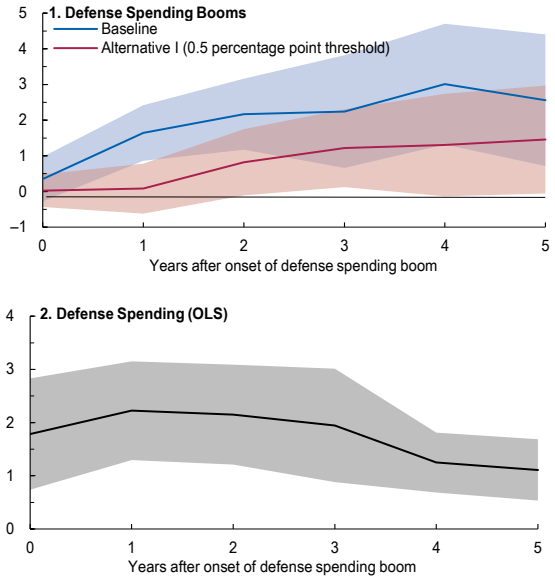
This section tests the robustness of the main findings reported in the chapter considering: (i) the alternative boom definition with the 0.5 threshold (Alternative I), and (ii) an OLS specification that uses defense spending as a share of potential GDP instead of defense spending booms. The OLS specification further controls for lagged GDP and a contemporaneous war dummy, to partially account for the timing of defense spending increases being related to local economic conditions and conflicts

Online Annex Figure 2.3.1. Evolution of Defense Spending over Time
(Percentage points of GDP)



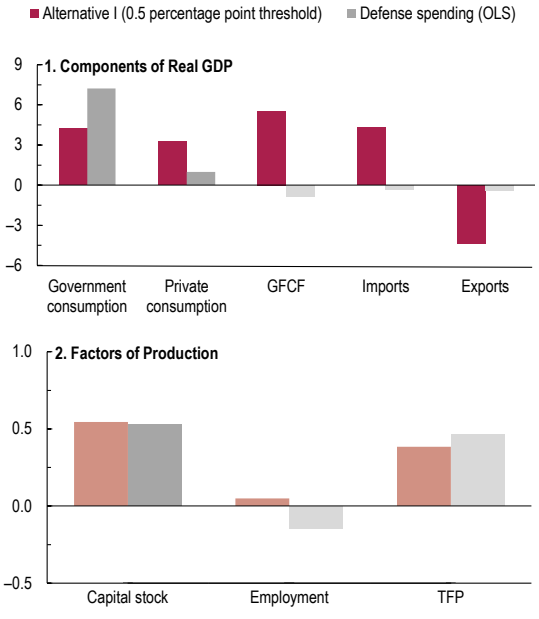
Source: IMF staff calculations.
Note: The panels plot local-projection responses to peacetime defense spending booms (panel 1) and to defense spending (panel 2). Fragile and conflict-affected states and commodity-exporting emerging market and developing economies are excluded from the sample. Solid lines denote point estimates, and shaded areas denote 90 percent confidence intervals. OLS = ordinary least squares.

Online Annex Figure 2.3.2. Effect of Defense Spending on Real GDP: Robustness
(Percent change)



Source: IMF staff calculations.
Note: The panels plot local-projection responses to peacetime defense spending booms (panel 1) and to defense spending (panel 2). Fragile and conflict-affected states and commodity-exporting emerging market and developing economies are excluded from the sample. Solid lines denote point estimates, and shaded areas denote 90 percent confidence intervals. OLS = ordinary least squares.

Online Annex Figure 2.3.3. Macroeconomic Effects - GDP Components: Robustness
(Real percent change, three years ahead)



Source: IMF staff calculations.
Note: The panels plot the three-year-ahead coefficient of local-projection responses to peacetime defense spending booms and to defense spending. Fragile and conflict-affected states and commodity-exporting emerging market and developing economies are excluded from the sample. Darker-colored bars denote coefficients significant at the 10 percent level. GFCF = gross fixed capital formation; TFP = total factor productivity; OLS = ordinary least squares.

Since post-1990 changes in former communist bloc countries represent a structural break, the robustness of the baseline results is further tested excluding Russia and the post-Soviet states. Unreported results confirm that results are robust to the exclusion of those countries.

Online Annex Figure 2.3.1 plots the size of defense spending booms (as a share of potential GDP) and shows that, on average, booms are sizable and highly persistent across alternative definitions.

When considering output and its components, the sample focuses on peacetime booms and excludes fragile and conflict states and emerging market and developing economies commodity exporters. The increase in real GDP following peacetime booms (Online Annex Figure 2.3.2) and the macroeconomic transmission channels (Online Annex Figures 2.3.3) are broadly robust across boom definitions and alternative specifications, despite wide uncertainty bands. The effects of the defense spending booms are shown in terms of real

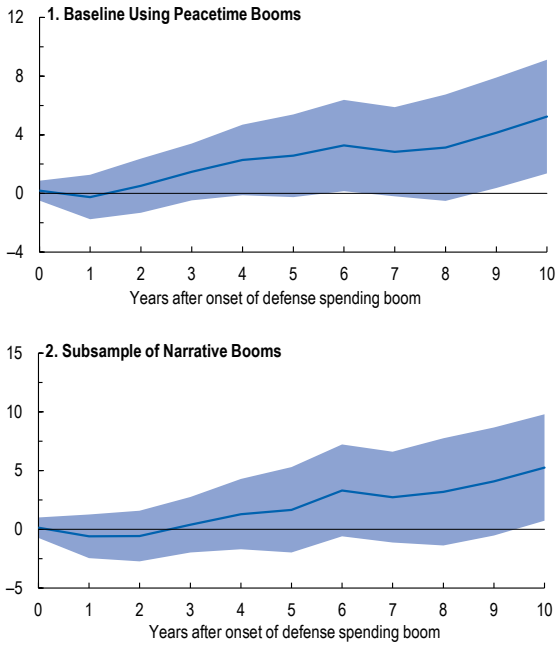
percent changes whereas effects of a 1 percent rise in defense spending are shown as percent of potential GDP.

Additional Results

Long-run total factor productivity

The baseline results show that peacetime defense spending booms are followed by an increase in total factor productivity three years after the boom onset. This finding could be explained by learning by necessity (Ilzetzki 2024) and improvements in capacity utilization. In fact, when accounting for capacity utilization in the economy, the coefficient of defense spending increases on total factor productivity becomes muted in the short-term.[1] However, extending the horizon of the local projection estimates reveals that the coefficient increases over time and becomes significant in the longer run, 10 years after the start of the boom. Results are robust to using the subset of *narrative* booms (Online Annex Figure 2.3.4).

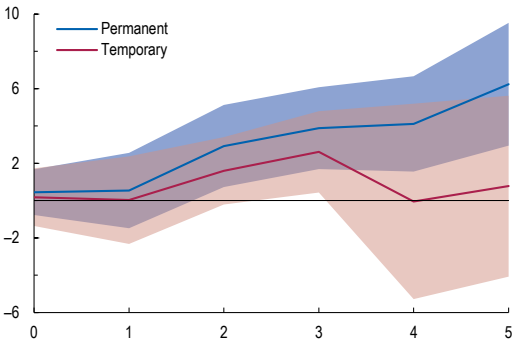
Online Annex Figure 2.3.4. Long-Term Effects on Utilization-Adjusted TFP
(Percent)



Source: IMF staff calculations.
Note: The panels plot local-projection responses to peacetime (panel 1) and narrative (panel 2) defense spending booms. Fragile and conflict-affected states and commodity-exporting emerging market and developing economies are excluded from the sample. Solid lines denote point estimates, and shaded areas denote 90 percent confidence intervals. TFP = total factor productivity.

Temporary vs Permanent Booms

Online Annex Figure 2.3.5. Output After Permanent and Temporary Defense Spending Booms
(Percent)



Source: IMF staff calculations.
Note: The panels plot local-projection responses to temporary and permanent peacetime defense spending booms. Fragile and conflict-affected states and commodity-exporting emerging market and developing economies are excluded from the sample. Solid lines denote point estimates, and shaded areas denote 90 percent confidence intervals.

The baseline result that peacetime defense spending booms are followed, on average, by a 3 percent increase in GDP over five years is driven by booms that lead to a permanent increase in the ratio of defense spending over GDP. A permanent expansion tends to trigger a durable increase in military procurement, which can encourage firms to expand capacity and invest in specialized capital—such as dedicated production lines, R&D, and supplier networks—that would be difficult to justify under a temporary spending increase. These effects usually crowd in private investment and employment, rather than merely shifting activity over time. Moreover, a permanent increase in government spending could induce stronger labor

[1] The adjustment for capacity utilization is made by taking the residual from a panel fixed effect regression of TFP (in real terms) on an output gap (measured as the ratio of GDP to trend GDP, proxied by a 6th order time polynomial).

supply responses, as households anticipate persistently higher taxes and adjust labor effort accordingly. The real GDP increase associated with permanent booms is sustained and reaches over 6 percent by year 5. As the average size of permanent booms is 3 percent of GDP, the implied multiplier is about 2. In contrast, booms that are linked to a temporary hump in defense spending are followed by a temporary increase in GDP which peaks in year three before fading away (Online Annex Figure 2.3.5).

Robustness to Additional Control Variables

The effect of defense spending booms on output estimated under the baseline specification is similar when considering an expanded set of control variables, which allow for comparability to the specification used to estimate fiscal multipliers in Section 2.5. (Online Annex Figure 2.3.6).

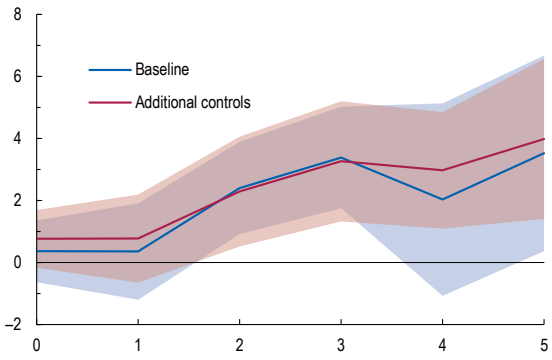
Fiscal Costs of Defense Spending Booms: Robustness

This section provides additional results on the fiscal effects of defense spending booms. The analysis considers both peacetime and wartime boom episodes, using the alternative boom definition that follows Marzian and Trebesch (2025) (Alternative II).

Defense spending booms lead to a significant rise in the fiscal deficit, on average. Governments' debt-to-GDP ratio does not rise on average, but this is the result of an increase in wartime and an opposite decline in peacetime. Consistent with this, nondefense spending as a share of GDP declines in wartime but moderately increases in peacetime (Online Annex Figure 2.3.7, panel 1).

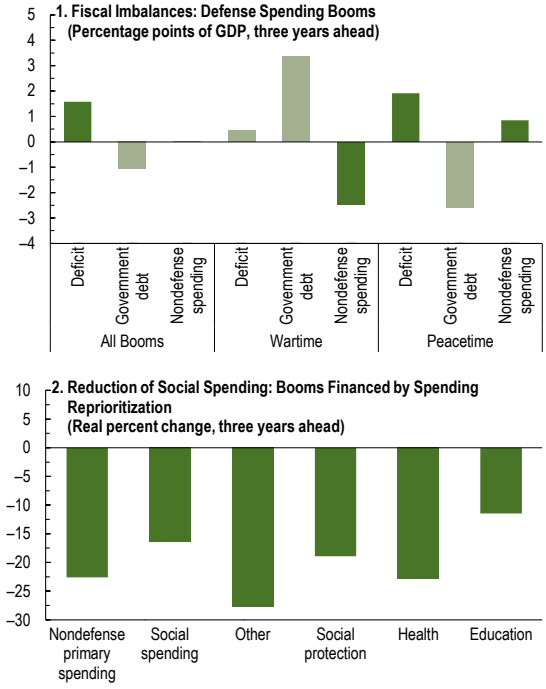
Debt decomposition analysis for a subset of boom episodes (covering around one third of episodes due to data availability), suggests that the rise in debt is driven by the primary deficit and interest on past debt (contributing roughly equally to the rise in debt), while GDP growth and the stock-flow adjustment contribute negatively to

Online Annex Figure 2.3.6. Real GDP after Defense Spending Booms: Robustness to Additional Controls
(Percent)



Source: IMF staff calculations.
Note: This figure plots local-projection estimates of cumulative responses to peacetime defense spending booms, for the baseline specification as in Figure 2.6 (blue line) and using an expanded set of controls (red line) including 4 lags of the dependent and shock variables, nondefense government spending and government revenue (as a share of potential GDP), and a contemporaneous war dummy. Fragile and conflict-affected states, as well as commodity-exporting emerging market and developing economies, are excluded from the sample. The sample period spans 1946–2024. Solid lines denote point estimates, and shaded areas denote 90 percent confidence intervals.

Online Annex Figure 2.3.7. Fiscal Consequences of Defense Spending Booms: Robustness

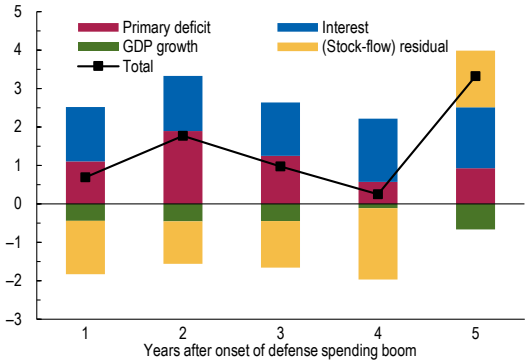


Source: IMF staff calculations.
Note: The panels plot the three-year-ahead coefficient of local-projection responses to defense spending booms, using the MT definition that refers to Marzian and Trebesch (2025). Wartime (peacetime) booms are defined based on whether (or not) an onsite conflict emerges one year before or within three years following the corresponding defense spending boom onset. Darker-colored bars denote coefficients significant at the 10 percent level.

changes in debt (Online Annex Figure 2.3.8). A strong GDP contraction during wartime (see Chapter 3) contributes to denominator effects that raise the stock of debt.

During booms mainly financed by reprioritizing spending (accounting for around one fourth of total booms), strong crowding out effects are seen for non-defense spending, including for social spending—and, in particular, social protection and health, highlighting the classic *guns versus butter* trade-offs (Online Annex Figure 2.3.7, panel 2).

Online Annex Figure 2.3.8. Debt Decomposition during Defense Spending Booms
(Annual change, percentage points of GDP)



Source: IMF staff calculations.
Note: The horizontal axis measures the duration of the defense spending boom, in years. For each year, the total change in debt-to-GDP ratio is decomposed into driving factors following Escolano (2010).

Online Annex 2.4. Firm-level Analysis

Data and research design

This section complements the macroeconomic analysis with firm-level evidence based on a large sample of over 4.6 million private non-financial firms in 41 countries between 1995 and 2023.[2] Data are sourced from the Orbis dataset, which contains corporate balance sheet and income statement information for both public and private firms, retrieved. The cleaning procedure follows the steps discussed by Kalemli-Özcan and others (2024), and Díez, Fan, and Villegas-Sanchez (2021). The sample drops firms with less than 5 observations and includes non-financial private sector firms, both in manufacturing and trade. The sample is restricted to countries with at least 5,000 observations over the sample period.

The analysis tests whether the sensitivity of investment to internal funds—a standard indicator of the presence of credit constraints—differs during periods of defense spending booms, considering separately episodes which are associated or not with an increase of the public debt-to-GDP ratio. On the one hand, additional spending, especially when financed through borrowing, risks crowding out private investment, as public debt tightens firms' financing constraints. On the other hand, spending can boost investment, especially for firms in defense-related sectors which directly benefit from the demand push.

To tease out these channels, the chapter estimates a simple investment-to-cash flow sensitivity regression, conditional on the occurrence of defense spending booms. The regression specification follows Huang, Panizza, and Varghese (2018):

$$I/A_{i,s,c,t} = \alpha_1 I/A_{i,s,c,t-1} + \alpha_2 S/A_{i,s,c,t} + \beta_1 CF/A_{i,s,c,t} \times DS\ Boom_{c,t} + \vartheta_i + \eta_{s,c} + \delta_{c,t} + \mu_{s,t} + \varepsilon_{i,s,c,t} \quad (1)$$

[2] The countries are: Austria, Australia, Belgium, Bulgaria, Brazil, Canada, Switzerland, Czech Republic, Germany, Estonia, Spain, Finland, France, United Kingdom, Greece, Hungary, Indonesia, Israel, India, Iceland, Italy, Japan, South Korea, Luxembourg, Morocco, Malaysia, Netherlands, Norway, New Zealand, Philippines, Poland, Portugal, Romania, Serbia, Russia, Sweden, Slovenia, Slovakia, Thailand, United States, and Vietnam.

where I, S and CF are the values in USD in year t of investment, sales, and cash-flow of firm i, operating in sector s and headquartered in country c. All variables are winsorized at the 2.5 and 97.5 percentiles and are scaled by total assets A (winsorized at the 97.5 percentile).

The coefficient β_1 measures the sensitivity of firm investment to cash flows and allows this sensitivity to vary across firms headquartered in countries that experience or not a defense spending boom ($DS\ Boom$) in year t. In particular, the defense spending boom variable could assume three values depending on whether country c in year t: (i) is not in a boom, (ii) is in a boom which is not associated with an increase in public debt, or (iii) is in a boom which is associated with an increase in public debt.

The model includes firm fixed effects (ϑ_i), as well as sector-year ($\mu_{s,t}$) and country-year ($\delta_{c,t}$) fixed effects, to mitigate concerns about the endogeneity of defense spending booms, as unobserved shocks at the sector and country level, like changes in demand that drive firm investment decisions, are controlled for. Standard errors are clustered at the firm level.

Results

Table 2.4.1 reports the regression results. Those in columns 2-4 are reflected in Figure 2.8. The positive coefficient β_1 indicates that, even absent defense spending booms, firm investment is sensitive to the availability of internal cash flow. However, this sensitivity declines when there is a boom which is not associated with increasing public debt, suggesting that positive demand effects due to the increased defense spending ease firms' financing constraints. This is more evident when restricting the sample to defense-related sectors (column 3), as the coefficient is not statistically different from zero. Defense-related sectors are identified using NACE Rev.2 at the 4-digit level. They include core defense manufacturing industries (NACE 25.40, 30.30, and 30.40), which correspond to weapons, military aerospace, and military vehicles, and defense-relevant electronics and explosives industries (NACE 26.30, 26.51, 26.70, 20.51) and naval shipbuilding (30.11)

Online Annex Table 2.4.1. Firm-Level Analysis

Dependent Variable: $(I/A)_{i,s,c,t}$	(1)	(2)	(3)	(4)
$(I/A)_{i,s,c,t-1}$	-0.0419***	-0.0617***	-0.0137***	-0.1053***
	(0.000)	(0.000)	(0.004)	(0.001)
$(S/A)_{i,s,c,t}$	-0.0054***	-0.0093***	-0.0129***	-0.0093***
	(0.000)	(0.000)	(0.001)	(0.000)
$(CF/A)_{i,s,c,t}$ x $(DS\ Boom)_{c,t}$ = 0	0.0237***	0.0207***	0.0589***	
	(0.000)	(0.000)	(0.003)	
$(CF/A)_{i,s,c,t}$ x $(DS\ Boom)_{c,t}$ = 1, without Rising Debt	-0.0087***	0.0126***	0.0042	
	(0.001)	(0.002)	(0.044)	
$(CF/A)_{i,s,c,t}$ x $(DS\ Boom)_{c,t}$ = 1, with Rising Debt	0.0025	0.0270***	0.0818*	
	(0.007)	(0.007)	(0.047)	
$(CF/A)_{i,s,c,t}$ x $(DS\ Boom)_{c,t}$ = 0				0.0384***
				(0.001)
$(CF/A)_{i,s,c,t}$ x $(DS\ Boom)_{c,t}$ = 1				0.0381***
				(0.003)
Number of Observations	44,119,720	44,119,343	152,879	3,025,050
R^2	0.21	0.30	0.27	0.45
Firm Fixed Effects	Yes	Yes	Yes	Yes
Country Year Fixed Effects	No	Yes	Yes	Yes
Sector Year Fixed Effects	No	Yes	Yes	Yes
Sample	All	All	Defense-sectors	Arms Importers

Source: IMF staff calculations.
Note: The table shows the ordinary least squares (OLS) estimates of equation (2). Standard errors (in parentheses) are clustered at the firm level. A = assets; CF = cash flow; DS = defense spending; I = investment; S = sales.
*** p<0.01; ** p<0.05; * p<0.1.

On the other hand, when the boom is associated with rising public debt, the investment-cash flow sensitivity is higher than when there is no boom (columns 2 and 3). This evidence is consistent with a crowding out effect of public debt, which could increase borrowing costs and tighten firms' financing constraints.

Finally, when considering only firms in countries which are large arms importers (defined as those where the average defense imports-to-defense spending ratio is above the sample median), the investment-cash flow sensitivity does not vary with the presence or not of a defense spending boom (regardless of how it is financed), in line with the presence of large import leakages, which attenuate any positive demand effect from the boom (column 4). In this final exercise, the reduction in the number of countries does not allow to further separate booms with or without rising public debt.

Online Annex 2.5. Fiscal Multipliers: Empirical Estimates

Main specification

Cumulative direct defense spending multipliers are estimated on a large panel of 138 countries over the period 1946-2024 following the methodology proposed by Ramey and Zubairy (2018). Panel local projection methods are used to regress cumulative output ($Y_{i,t}$) of country *i* between year *t* and *t+h* (where *h = 1, …, 5*) on cumulative defense spending ($D_{i,t}$), computed over the same horizon:

$$\sum_{j=0}^{h} Y_{i,t+j} = \beta_h \sum_{j=0}^{h} D_{i,t+j} + \xi_h(\boldsymbol{L})\boldsymbol{X}_{i,t-1} + \vartheta_{i,h} + \delta_{t,h} + \varepsilon_{i,t+h}$$

Both output and defense spending are normalized by potential GDP, as proposed by Gordon and Krenn (2010).[3] The specification controls for a vector ($\boldsymbol{X}_{i,t}$) of (1 to 4-year) lags of GDP, defense spending, non-defense spending (measured as a share of potential GDP), a contemporaneous war dummy, and country and year fixed effects. Standard errors are clustered at the country level.

Heterogeneous multipliers

The analysis also explores heterogeneity across several dimensions, such as country groups, time (post-World War II and post-Cold War), wartime versus peacetime, and country characteristics. This is done by estimating local projections with interactions using the following specification similar to Ramey and Zubairy (2018):

$$\sum_{j=0}^{h} Y_{i,t+j} = I_{t-1}\left[\beta_{A,h}\sum_{j=0}^{h} D_{i,t+j} + \xi_{A,h}(L)\boldsymbol{X}_{i,t-1}\right]$$
$$+(1 - I_{t-1})\left[\beta_{B,h}\sum_{j=0}^{h} D_{i,t+j} + \xi_{B,h}(L)\boldsymbol{X}_{i,t-1}\right] + \vartheta_{i,h} + \delta_{t,h} + \varepsilon_{i,t+h}$$

[3] Potential GDP is estimated by detrending GDP by a sixth-order time polynomial. Results are robust to considering linear, quadratic, and fourth-order time polynomials as alternatives. As discussed by Ramey and Zubairy (2018), this normalization allows to estimate the multiplier directly without requiring an ex-post conversion of elasticities into multipliers (as required when using the variables in logs), which can bias multiplier estimates.

where I is a dummy variable that indicates the state of the economy (or respective heterogeneity) when the defense spending shock hits. The coefficients capture horizon-specific multipliers across the two different regimes. The two regimes capture: advanced economies versus emerging market and developing economies, peacetime versus wartime, temporary versus permanent defense buildups, arms importers versus exporters, deficits versus other main sources of financing, and current versus capital spending. In particular, changes in defense spending are defined as temporary if the direction of change in defense spending as a share of GDP relative to the previous period is the same for the next ten years. Arms importers (exporters) refer to economies where the average share of arms exports in their arms trade is below (above) the median. Deficit-financing is defined based on whether the annual change in defense spending is mostly driven by a change in the deficit (rather than by changes in revenues or nondefense spending). Current spending comprises personnel and operating expenses, whereas capital spending comprises spending on equipment and infrastructure.

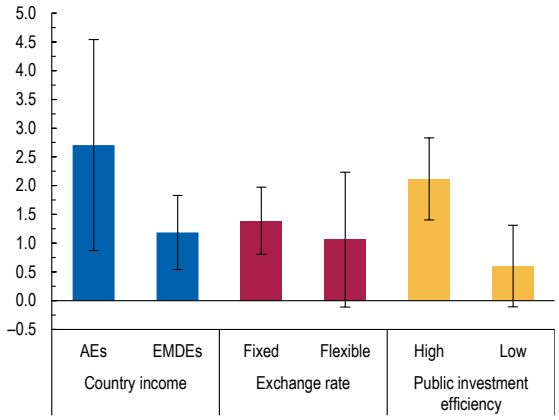
Online Annex Table 2.5.1. Nonlinear Defense Spending Multipliers, Horizons 0–5

	Income Group		Conflict Condition		Duration	
Horizon	AEs	EMDEs	Peace	War	Temporary	Permanent
0	0.432***	1.842***	1.935***	0.959	1.196***	2.273***
1	0.596***	2.186***	2.031***	1.634***	1.510***	2.580***
2	0.726***	2.422***	2.126***	1.926***	1.717***	2.638***
3	0.825***	2.540***	2.245***	1.896***	1.859***	2.613***
4	0.823***	2.477***	2.268***	1.620***	1.896***	2.403***
5	0.828***	2.359***	2.166***	1.462***	1.906***	2.137***

	Arms Industry		Deficit-Financed		Spending Type	
Horizon	Importer	Exporter	No	Yes	Current	Capital
0	0.671**	3.073***	1.077***	1.009*	1.722***	0.994
1	1.101***	3.143***	1.189***	1.725***	2.031***	1.348**
2	1.403***	3.119***	1.271***	2.118***	2.245***	1.291*
3	1.607***	3.134***	1.33***	2.244***	2.352***	1.198
4	1.684***	2.983***	1.294***	2.26***	2.284***	1.205
5	1.713***	2.775***	1.254***	2.203***	2.173***	1.094

Source: IMF staff calculations.
Note: War (peace) is defined based on whether (or not) an onsite conflict occurs in the past year or within three years ahead. Importer (exporter) refers to economies where the average share of arms exports in their arms trade is below (above) the median. Deficit-financing is defined based on whether the annual change in defense spending is mostly driven by a change in the deficit (rather than by changes in revenues or nondefense spending). Current spending comprises personnel and operating expenses, whereas capital spending comprises spending on equipment and infrastructure. Changes in defense spending are defined as permanent if the direction of change in defense spending over GDP in year t is sustained over the subsequent 10 years, and as temporary otherwise. Standard errors are clustered at the country level. AEs = advanced economies; EMDEs = emerging markets and developing economies. *** $p<0.01$; ** $p<0.05$; * $p<0.1$.

Online Annex Figure 2.5.1. Differences in Defense Spending Multipliers: Additional Results, Post–Cold War
(Cumulative multipliers, three years ahead)



Source: IMF staff calculations.
Note: This figure shows nonlinearities in the size of three-year-ahead cumulative multipliers by income group, exchange rate regime, and public investment efficiency. Exchange rate regimes are categorized as fixed (flexible) based on the classification of Ilzetzki and others (2019)—depending on whether the coarse classification code is below (equal or larger than) two. Public investment efficiency is high (low) if the country's average investment efficiency score—as computed in the October 2025 Fiscal Monitor—is above (below) the median. AEs = advanced economies; EMDEs = emerging market and developing economies.

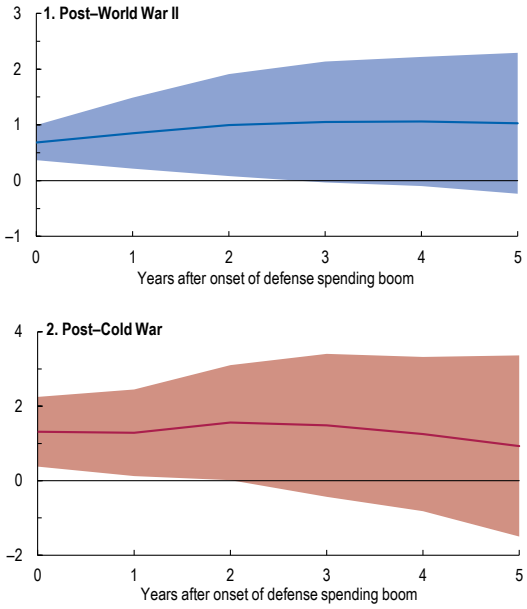
Online Annex Table 2.5.1 reports the estimated nonlinear defense spending multipliers shown in Figure 2.11.

This section reports additional tests for nonlinearities in defense spending multipliers for the post-Cold War sample considering exchange rate regime and public investment efficiency. Exchange rate regimes are categorized as fixed versus flexible based on the classification of Ilzetzki and others (2019, 2021)—depending on whether the coarse classification code is below

versus equal/larger than 2.[4] Public investment efficiency is considered to be high (low) if the country's average investment efficiency score—as computed in the October 2025 *Fiscal Monitor*—is above (below) the median. Online Annex Figure 2.5.1 shows that defense spending multipliers are higher under fixed exchange rate regimes and when public investment efficiency is high. The chart also shows higher multipliers for advanced economies than for emerging market and developing economies, reversing the pattern observed when extending the sample to 1946.

Finally, Online Annex Figure 2.5.2 shows OLS multipliers for the European Union, separately for the post-World War II and the post-Cold War periods. Especially for the latter period, defense spending multipliers in Europe seem to be greater than one, consistent with recent findings and studies examining spending in monetary unions (Ben Zeev, Pappa, and Scola Gagliardi 2025; García-Serrador, Sarasa-Flores and Ulloa 2025; Furceri and others 2026).

Online Annex Figure 2.5.2. Defense Multipliers: European Union
(Cumulative multipliers)



Source: IMF staff calculations.
Note: The panels plot local-projection estimates of cumulative responses of output to defense spending for members of the European Union. Solid lines denote point estimates, and shaded areas denote 90 percent confidence intervals.

Online Annex Table 2.5.2. Defense Spending Multipliers using Alternative Approaches to Reduce Endogeneity, Horizons 0–5

	OLS Approach, Post-Cold War		IV approach	
Horizon	NATO	IMCTC	Post-WWII	Post-Cold War
0	0.544	0.781**	0.938**	0.702
1	0.872	0.72**	1.075***	0.857
2	1.166	0.607*	1.36***	1.347***
3	1.052	0.594	1.408***	1.451***
4	0.806	0.581	1.288***	1.216**
5	0.562	0.527	1.239***	1.186*

Source: IMF staff calculations.
Note: IMCTC = Islamic Military Counter Terrorism Coalition; IV = instrumental variable; NATO = North Atlantic Treaty Organization; OLS = ordinary least squares.
*** $p<0.01$; ** $p<0.05$; * $p<0.1$.

Empirical strategies to mitigate endogeneity

To mitigate endogeneity concerns, the analysis follows two approaches, yielding defense spending multipliers closer to unity (the estimates shown in Figure 2.12, are presented in Online Annex Table 2.5.2):

- *Narrative approach*. This strategy uses the subset of *narrative* defense spending booms as an instrument for defense spending to estimate defense spending multipliers. In addition to their more plausible exogeneity, *narrative* booms are a strong instrument for defense spending. Online Annex Table 2.5.3 shows that *narrative* booms cause defense spending to

[4] Exchange rates coarse classification codes take the value of 1 in the cases of: no separate legal tender, pre-announced peg or currency board arrangement, pre-announced horizontal band that is narrower than or equal to +/- 2 percent, and de-facto pegs.

rise significantly and yield first-stage weak-instrument F-statistics exceeding the rule of thumb value of 10 at all forecast horizons.

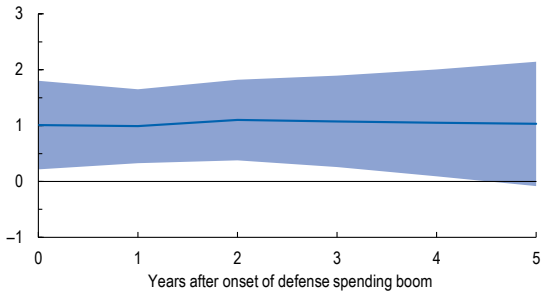
- *Defense alliances*. This strategy considers (i) subsamples of countries for which the exogeneity of defense spending may be justified by the significant geopolitical role that they play in international relations—members of NATO and IMCTC[5], and (ii) focuses on the most recent post-Cold War period. In that sample, defense spending booms are not anticipated by either conflicts or local economic conditions (Online Annex Table 2.5.4).
- These approaches intend to reduce concerns that shocks with direct impact on the domestic economy such as conflicts, domestic security concerns, and commodity cycles can bias the estimates of the multiplier. In addition, controlling for countries' geopolitical risk index (for the subset of countries for whom this is available) yields defense multipliers even closer to unity (Online Annex Figure 2.5.3).

Online Annex Table 2.5.3. IV First-Stage Diagnostics

	IV Coefficient		Weak IV F-Statistics	
Horizon	Post-WWII	Post-Cold War	Post-WWII	Post-Cold War
0	0.01***	0.01***	161.0	154.4
1	0.03***	0.03***	196.4	87.3
2	0.05***	0.05***	118.4	37.8
3	0.07***	0.06***	92.3	22.6
4	0.08***	0.08***	77.8	15.5
5	0.10***	0.08***	74.6	14.4

Source: IMF staff calculations.
Note: IV = instrumental variable.
*** $p<0.01$; ** $p<0.05$; * $p<0.1$.

Online Annex Figure 2.5.3. IV Defense Spending Multiplier, Controling for Geopolitical Risk
(Cumulative multipliers)



Source: IMF staff calculations.
Note: The figure plots cumulative local-projection responses of output to defense spending. The specification additionally controls for historical geopolitical risk index (Caldara and Iacoviello 2022) available for a subset of 42 countries. IV approach refers to using narrative defense spending booms as an instrument for defense spending. The solid line denote point estimates, and the shaded area denotes a 90 percent confidence interval. IV = instrumental variable.

Online Annex Table 2.5.4. Exogeneity of Defense Spending: Alliance Members

	NATO Countries					IMCTC Countries				
Dependent Variable: Defense Spening Boom$_{i,t}$	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Armed On-site Conflict$_{i,t-1}$	12.333				12.720	-0.670				-0.763
	(8.979)				(9.398)	(2.607)				(2.393)
GDP Growth$_{i,t-1}$		0.024			-0.086		-0.017			-0.109
		(0.111)			(0.141)		(0.160)			(0.209)
Government Revenue over GDP$_{i,t-1}$			0.220		0.246			0.177		0.182
			(0.160)		(0.184)			(0.216)		(0.230)
Recession$_{i,t-1}$				0.003	-0.328				-0.389	-0.726
				(0.598)	(0.639)				(1.319)	(1.156)
Number of Observations	1,055	1,055	1,020	1,055	1,020	888	888	888	888	888
R^2	0.209	0.186	0.199	0.186	0.226	0.257	0.257	0.266	0.257	0.267
Number of Countries	32	32	32	32	32	27	27	27	27	27
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: IMF staff calculations.
Note: This table shows ordinary least squares (OLS) estimates of regression where defense spending as a share of trend GDP is regressed on the one-year lag of: a dummy indicator for armed conflicts that occur on-site, GDP growth, government revenues as a share of trend GDP, and a recession dummy (defined as years of negative GDP growth), in addition to country and year fixed effects. Trend GDP is constructed considering a 6th order polynomial time trend. Standard errors (in parentheses) are clustered at the country level. IMCTC = Islamic Military Counter Terrorism Coalition; NATO = North Atlantic Treaty Organization.
*** $p<0.01$; ** $p<0.05$; * $p<0.1$.

[5] This choice of alliances is based on Sheremirov and Spirovska (2022). The North-Atlantic Treaty Organization (NATO) includes 32 member countries whereas the Islamic Military Counter Terrorism Coalition (IMCTC) includes 41 countries. In both cases, contemporaneous membership is treated as a proxy for cooperation going back in time. Fragile and conflict states are excluded from the sample.

Defense Spending Multipliers: A Literature Review

Estimates of defense spending multipliers vary significantly across studies (Online Annex Table 2.5.5). Foundational work by Hall (2009) and Barro and Redlick (2011) reported multipliers below unity, whereas later research adjusted these estimates upwards, approaching values near 1.5. More recent studies have expanded the discussion beyond the United States, indicating defense multipliers ranging from 1.3 to 2 among European countries after the Cold War. The majority of analyses focus on advanced economies, with limited estimates available for emerging and developing economies.

Online Annex Table 2.5.5. Literature Review of Defense Spending Multipliers

Papers	Authors	Outlet	Year of Publication	Estimate	Estimation Method	Country Sample	Period
By How Much Does GDP Rise If the Government Buys More Output?	Robert Hall	Brookings Papers on Economic Activity	2009	About 0.5 on impact	OLS panel	US	1930–2008
Using Stock Returns to Identify Government Spending Shocks.	Jonas D. M. Fisher and Ryan Peters	Economic Journal	2010	1.5 cumulative over 20 months	VAR	US	1947–2007
Macroeconomic Effects From Government Purchases and Taxes	Robert Barro and Charles Redlick	Quarterly Jounral of Economics	2011	0.4 to 0.5 on impact and 0.6 to 0.7 over 2 years	OLS panel	US	1930–2006
Identifying Government Spending Shocks: It's all in the Timing	Valerie Ramey	Quarterly Jounral of Economics	2011	0.6 to 1.2 for peak and cumulative multipliers	VAR	US	1939–2008
Fiscal Stimulus in a Monetary Union: Evidence from US Regions	Emi Nakamura and Jón Steinsson	American Economic Review	2014	1.5 over 2 years	IV panel with State-level variation in defense contracts	US - State-level	1966–2006
Investment, growth, and defense expenditure in the EU15: Revisiting the nexus using SIPRI's new consistent dataset	Christos Kollias and Suzanna-Maria Paleologou	The Economics of Peace and Security Journal	2016	Zero	VAR	EU	1961–2014
Chronicle of a War Foretold: The Macroeconomic Effects of Anticipated Defence Spending Shocks	Nadav Ben Zeev and Evi Pappa	Economic Journal	2017	1.3 or 2.14 cumulative multiplier, depensing on shock idenitification strategy	VAR	US	1947–2007
Local and Aggregate Fiscal Policy Multipliers	Bill Dupor and Rodrigo Guerrero	Journal of Monetary Economics	2017	Between zero and 0.5 cumulative multipliers over 2 to 4 years	GMM panel with State-level variation in defense contracts	US - State-level	1951–2014
Government Spending Multipliers in Good Times and in Bad: Evidence from US Historical Data	Valerie A. Ramey and Sarah Zubairy	Journal of Political Economy	2018	Around 0.7	LP	US	1889–2015
Short-run multiplier effects of military expenditures in NATO's Eastern Flank countries in 1999–2021	Łukasz Wiktor Olejnik	Journal of Comparative Economics	2023	0.6 on impact and 1.5-1.6 at year 2 and 3	LP	Central and Eastern European countries	1999–2021
The Long-Run Effects of Government Spending	Juan Antolin-Diaz and Paolo Surico	American Economic Review	2025	Below or around 1 at business cycle frequencies, rising to exceed 1 at long horizons	VAR	US	1890–2015
The Offensive Power of Defense News in Europe	Nadav Ben Zeev, Evi Pappa, and Elena Scola Gagliardi	Working Paper	2025	2 on impact, falling to 0.92 after 10 years	VAR	European countries	1960–2024
Buy Guns or Buy Roses?: EU Defence Spending Fiscal Multipliers	Agustín García, David Sarasa-Flores, and Camilo Ulloa	BBVA Research 25-06, Banco Bilbao Vizcaya Argentaria, Madrid	2025	1.4 on impact with a peak at 1.6 at year 2	LP	EU	1995–2023
Macroeconomic Impacts of EU Defense Spending	Davide Furceri, Pedro Juarros, Saurabh Mishra, Anh Dinh Minh Nguyen, Ana Sofia Pessoa, and Alexandre Sollaci	IMF Working Paper	2026	1.3 on impact rising to 1.9 after 2 years 1.5 to 1.9 over 3 years using procurement data	LP	EU	1989–2023

Source: IMF staff compilation.
Note: GMM = generalized methods of moments; LP = local-projections; OLS = ordinary least squares; VAR = vector autoregression.

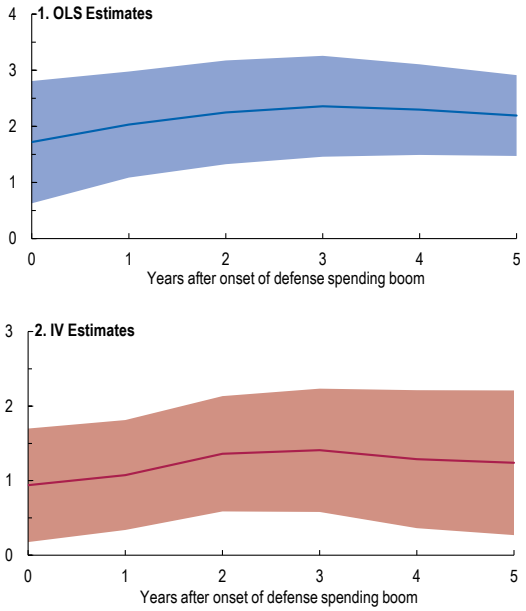
Historical Defense Spending Booms

The availability of historical data allows to extend the sample period back to 1800, yielding defense spending multipliers above 2, when using standard OLS, but closer to 1 when using narrative booms as instruments (Online Annex Figure 2.5.4).

Online Annex 2.6. Fiscal Multipliers: Modeling Simulations

The model-based simulations rely on the Flexible System of Global Models (FSGM), a semi-structural model combining both micro-founded and reduced-form formulations of various economic sectors. The interested reader can find a detailed description of FSGM's theoretical structure and its simulation properties in Andrle and other (2015). Each FSGM module is an

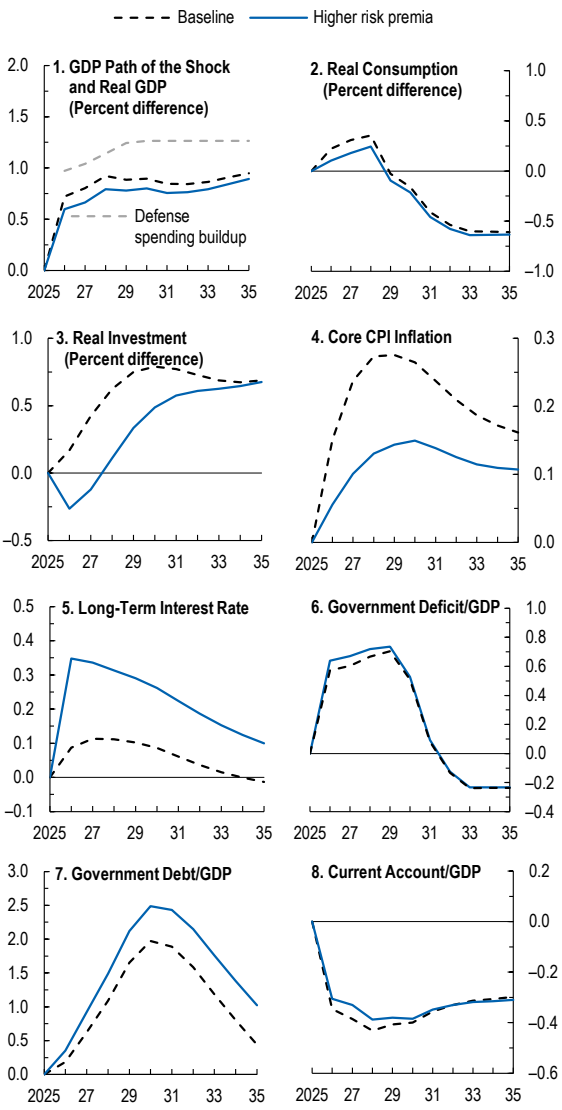
Online Annex Figure 2.5.4. Defense Multipliers, since 1800
(Cumulative multipliers)



Source: IMF staff calculations.
Note: The panels plot local-projection estimates of cumulative responses of output to defense spending. Solid lines denote point estimates, and shaded areas denote 90 percent confidence intervals. IV = instrumental variable; OLS = ordinary least squares.

annual, multi-region, general equilibrium model of the global economy. Each country/regional block is structurally identical, but with potentially different key steady-state ratios and behavioral parameters. The analysis presented in this chapter use the EUROMOD module of FSGM, which includes a bloc for each of the 11 major euro area countries plus 13 other blocs, covering the major economies as stand-alone blocs (China, India, Japan, Switzerland, Sweden, United Kingdom, and United States) and six other regions.

Online Annex Figure 2.6.1. Higher Risk Premia
(Percentage point difference, unless noted otherwise)



Source: IMF staff calculations.
Note: The figure presents model simulations calibrated to defense spending shock in the European Union, as plotted in panel 1. The higher risk premia scenario (blue lines) assumes a 50 basis points increase in terms premia in 2026. CPI = consumer price index.

Additional Scenarios

Online Annex Figure 2.6.1 shows the results of an alternative scenario that considers a one-off increase in risk premia by 50 basis points, to model the possible implications of rising spreads in response to higher spending, especially in countries with limited fiscal space, lacking any coordination. The scenario shows a more muted output and price response, and a larger increase in public debt.

References

Andrle, M., P. Blagrave, P. Espaillat, K. Honjo, B. Hunt, M. Kortelainen, R. Lalonde, and others. 2015. "The Flexible System of Global Models – FSGM." IMF Working Paper 15/64, International Monetary Fund, Washington, DC.

Barro, R. J., and C. J. Redlick. 2011. "Macroeconomic Effects from Government Purchases and Taxes." *The Quarterly Journal of Economics* 126 (1): 51–102.

Becker, J., S. Benson, J. P. Dunne, and E. Malesky. 2025. "Disaggregated Defense Spending: Introduction to Data." *Journal of Peace Research*, 62 (3): 772–88.

Ben Zeev, N., and E. Pappa. 2017. "Chronicle of A War Foretold: The Macroeconomic Effects of Anticipated Defence Spending Shocks." *The Economic Journal* 127 (603): 1568–97.

Ben Zeev, N., E. Pappa, and E. Scola Gagliardi. 2025. "The Offensive Power of Defense News in Europe." CEPR Discussion Paper 20637, Centre for Economic Policy Research, London.

Davies, Shawn, Therése Pettersson, Margareta Sollenberg, and Magnus Öberg. 2025. "Organized Violence 1989–2024, and the Challenges of Identifying Civilian Victims." *Journal of Peace Research* 62 (4): 1223–1240.

Díez, F., J. Fan, and C. Villegas-Sanchez. 2021. "Global Declining Competition?" Journal of International Economics 132: 103492.

Dupor, B., and R. Guerrero. 2017. "Local and aggregate fiscal policy multipliers." *Journal of Monetary Economics* 92: 16-30.

Escolano, J. 2010. "A practical guide to public debt dynamics, fiscal sustainability, and cyclical adjustment of budgetary aggregates" IMF Technical Guidance Note 10/02, International Monetary Fund, Washington, DC.

Fisher, J. D. M., and R. Peters. 2010. "Using Stock Returns to Identify Government Spending Shocks." *The Economic Journal* 120 (544): 414–36.

Furceri, D., P. Juarros, S. Mishra, A. D. M. Nguyen, A. S. Pessoa, and A. Sollaci. 2026. "Macroeconomic Impacts of EU Defense Spending." IMF Working Paper 26/53, International Monetary Fund, Washington, DC.

García-Serrador, A., D. Sarasa-Flores, and C. Ulloa. 2025. "Buy Guns or Buy Roses?: EU Defence Spending Fiscal Multipliers." BBVA Research 25-06, Banco Bilbao Vizcaya Argentaria, Madrid.

Gethin, A. 2024a. "A New Database of General Government Revenue and Expenditure by Function, 1980-2022." Unpublished, available at https://amory-gethin.fr/research.html.

Gethin, A. 2024b. "Revisiting Global Poverty Reduction: Public Services and the World Distribution of Income, 1980-2022." Unpublished, available at https://amory-gethin.fr/research.html.

Gleditsch, Nils Petter, Peter Wallensteen, Mikael Eriksson, Margareta Sollenberg, and Håvard Strand. 2002. "Armed Conflict 1946–2001: A New Dataset." *Journal of Peace Research* 39 (5): 615–37.

Gordon, R. J., and R. Krenn. 2010. "The End of the Great Depression: VAR Insight on the Roles of Monetary and Fiscal Policy." Working Paper No. 16380, NBER, Cambridge, MA.

Hariri, Jacob Gerner, and Asger Mose Wingender. 2025. "A new data set on arms technology adoption 1816-2023". Version 1.0.

Ilzetzki, E., C. Reinhart. and K. Rogoff. 2019. "Exchange Arrangements Entering the 21st Century: Which Anchor Will Hold?" *Quarterly Journal of Economics* 134:2, 599–646.

Ilzetzki, E., C. Reinhart, and K. Rogoff. 2021. "Rethinking Exchange Rate Regimes." *Handbook of International Economics* Vol. 5, G. Gopinath, E. Helpman and K. Rogoff, eds.

Ilzetzki, E. 2024. "Learning by Necessity: Government Demand, Capacity Constraints, and Productivity Growth." *American Economic Review* 114 (8): 2436–71.

Hall. R. 2009. "By How Much Does GDP Rise If the Government Buys More Output?" *Brookings Papers on Economic Activity* 40 (Fall): 183–249.

Kalemli-Ozcan, S., B. Sorensen, C. Villegas-Sanchez, V. Volosovych, and S. Yesiltas. 2024. "How to Construct Nationally Representative Firm Level Data from the ORBIS Global Database: New Facts on SMEs and Aggregate Implications for Industry Concentration." *American Economic Journal: Macroeconomics* 16 (2): 353-374.

Kollias, C., and S.M. Paleologou. 2016. "Investment, growth, and defense expenditure in the EU15: Revisiting the nexus using SIPRI's new consistent dataset." *The Economics of Peace and Security Journal*, 11(2).

Marzian, J., and C. Trebesch. 2025. "Guns and Butter: The Fiscal Consequences of Rearmament and War." Kiel Working Paper 2310, Kiel Institute for the World Economy, Kiel, Germany.

Müller, K., C. Xu, M. Lehbib, and Z. Chen. 2025. "The Global Macro Database: A New International Macroeconomic Dataset (Version 2026-01)." NBER Working Paper 33714, National Bureau of Economic Research, Cambridge, Massachusetts.

Nakamura, E., and J. Steinsson. 2014. "Fiscal Stimulus in a Monetary Union: Evidence from US Regions." American Economic Review 104 (3): 753–92.

Olejnik, Ł. W. 2023. "Short-run multiplier effects of military expenditures in NATO's Eastern Flank countries in 1999–2021." *Journal of Comparative Economics* 51(4): 1344-1355.

Ramey, V. A. 2011. "Identifying Government Spending Shocks: It's All in the Timing." *Quarterly Journal of Economics* 126 (1): 1–50.

Ramey. V. A., and M. D. Shapiro. 1998. "Costly Capital Reallocation and the Effects of Government Spending." *Carnegie-Rochester Conference Series on Public Policy* 48: 145–94.

Ramey, V. A., and S. Zubairy. 2018. "Government spending multipliers in good times and in bad: evidence from US historical data." *Journal of Political Economy* 126 (2): 850–901.

Sarkees, Meredith Reid and Frank Wayman. 2010. "Resort to War: 1816 – 2007." Washington DC: CQ Press.

Sheremirov, V. and S. Spirovska. 2022. "Fiscal multipliers in advanced and developing countries: Evidence from military spending." *Journal of Public Economics* 208: 104631.