The Causal Effects of Russia's Ukraine Invasion on NATO Defense Spending

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Abstract

This paper examines how the 2022 Russian invasion of Ukraine affected defense expenditures among NATO members. Using data from 2014 to 2024, we apply a difference-in-differences methodology to isolate the impact of invasion on defense spending as a share of GDP. We focus on NATO countries sharing a border with Russia (the treatment group). The findings show a statistically significant increase of approximately 0.64 points in military expenditures, reflecting increased security concerns in response to direct geopolitical threats.

JEL classification: F52, H56, C23

Keywords: NATO defense spending, Russia-Ukraine conflict, difference-in-differences.

1 Introduction

In February 2022, Russia invaded Ukraine, seizing significant portions of the eastern region of the country. This act was a violation of international law, explicitly the 1994 Budapest

Memorandum, under which Ukraine relinquished its nuclear arsenal in exchange for assurances of territorial integrity from Russia, the USA, and the United Kingdom.

Ukraine is one of several sovereign states that share a border with Russia, along with Finland, Estonia, Latvia, Lithuania, Poland, Belarus, Georgia, Azerbaijan, and Norway. Did the invasion cause an increase in defense capabilities among NATO countries bordering Russia (the treatment group)? If so, by how much relative to other NATO countries (the control group)?

We analyze data from NATO defense expenditure as a percentage of GDP from 2014 to 2024. We use difference-in-difference methods to test the hypothesis that the Russian invasion had a causal impact on defense spending. The average treatment effect of the treated (ATET) is estimated to be approximately 0.64. Satisfactory model diagnostics (parallel trends) add credence to our findings.

We contribute to growing research on how the Russian invasion is changing defense allocations (George and Sandler, 2022; Tian et al., 2023). Using SIPRI data, Tian et al. (2023) document a rise in defense expenditures across Europe, with especially pronounced increases among countries geographically close to Russia. Our paper differs from Tian et al. (2023) by using difference-in-difference to estimate the ATET to isolate the causal impact of proximity to Russia on defense spending trajectories.

2 Data and Empirical Strategy

2.1 Data

We used a balanced panel of NATO countries from 2014 to 2024. Data are from NATO official publications (North Atlantic Treaty Organisation (NATO), 2024). The dependent variable is the percentage of GDP allocated to defense spending, expressed in constant 2015 US dollars to adjust for inflation. The dataset includes 31 NATO member countries. Figures later in the panel are estimated by NATO.

2.2 Empirical Strategy

The analysis employs a Difference-in-Differences (DiD) framework to estimate the causal impact of the 2022 Russian invasion of Ukraine on NATO defense spending. The model is specified as:

$$y_{it} = \alpha_i + \lambda_t + \delta(D_i \cdot T_t) + \epsilon_{it},$$

where y_{it} is defense spending as a percentage of GDP for country i in year t. The terms α_i and λ_t denote country-specific fixed effects and year-specific fixed effects, respectively, capturing unobserved heterogeneity and time shocks common across all countries. The interaction term $D_i \cdot T_t$ is the DiD estimator, where D_i is a binary indicator for treatment group membership ($D_i = 1$ for countries bordering Russia, and $D_i = 0$ for other NATO countries), and T_t is a binary variable indicating the post-treatment period ($T_t = 1$ for years 2023 and beyond, and $T_t = 0$ otherwise). The coefficient of interest, δ, measures the Average Treatment Effect on the Treated (ATET), representing the causal impact of the invasion on defense spending for the treatment group relative to the control group. The error term, ϵ_{it}, captures all remaining unobserved influences.

Including 2022 in the treatment period risks understating the causal effect, as many countries had not fully implemented changes to their defense budgets immediately after the February 2022 invasion. Since policy decisions often take time to materialize, the minimal spending increases in 2022 would dilute the observed effect. The choice of 2023 reflects the period when significant spending changes became evident, aligning the analysis with actual policy responses. We report sensitivity analysis for this claim below.

The identification strategy relies on two key assumptions. First, the parallel trends assumption requires that, in the absence of treatment, defense spending trends in the treatment and control groups would evolve similarly. This assumption is tested visually and through formal statistical diagnostics. Second, the no-anticipation assumption posits that countries in the treatment group did not adjust their defense spending in advance of the invasion.

The model is estimated using Stata's `xtdidregress` command, which incorporates both country and year fixed effects and clusters standard errors at the country level to account for heteroskedasticity and serial correlation. This approach ensures robust inference on δ. To validate the results, additional robustness checks are conducted, including placebo tests and pre-treatment trend diagnostics.

3 Results and Discussion

Table 1 presents summary statistics for defense spending as a percentage of GDP and military spending (in constant 2015 USD) for both treatment and control groups over the period 2014–2024. The treatment group consists of six NATO countries bordering Russia (Estonia, Latvia, Lithuania, Poland, Finland, and Norway), while the control group includes the remaining 25 NATO countries.

The data reveal that the treatment group consistently allocated a higher share of GDP to defense compared to the control group throughout the observed period. Pre-treatment (2014–2022), the treatment group averaged 1.79% of GDP on defense spending, while the control group averaged 1.47%. Post-treatment (2023–2024), these averages increased to 2.84% and 1.87%, respectively, reflecting a relative increase in the treatment group.

In absolute terms, military spending for the treatment group increased from an average of $3.92 billion pre-treatment (2014–2022) to $6.94 billion post-treatment (2023–2024). The control group experienced a more modest increase, from $37.95 billion pre-treatment to $43.60 billion post-treatment. These trends highlight the disproportionate response of the treatment group, which is likely driven by their geographic proximity to Russia and heightened security concerns following the invasion.

Table 2 reports the results of the Difference-in-Differences (DiD) analysis, estimating the causal impact of the Russian invasion of Ukraine on defense spending among NATO member countries. The ATET (Average Treatment Effect on the Treated) is estimated at 0.640 with a standard error of 0.191, indicating that, on average, countries bordering Russia (treatment group) increased their defense spending as a percentage of GDP by approximately 0.64 percentage points relative to the control group after the treatment period began in 2023. This effect is statistically significant at the 1% level.

As a diagnostic, we used an alternative treatment period beginning in 2022. The ATET estimate is 0.449 (p=0.008), indicating that countries bordering Russia increased defense spending by 0.45 percentage points of GDP relative to the control group. This effect is statistically significant but smaller than the ATET of 0.640 estimated in the preferred model, which begins the treatment period in 2023. These results support the earlier claim that including 2022, when spending increases were likely minimal, understates the causal effect of the invasion on defense spending.

Pre-treatment effects, represented by Lead 2 and Lead 1, show coefficients of -0.103 and -0.129, respectively, both of which are statistically insignificant. These results support the parallel trends assumption, as there is no evidence of a divergence in defense spending trends between the treatment and control groups prior to the treatment.

Post-treatment effects, represented by Lag 1 and Lag 2, capture the persistence of the treatment's impact over time. Lag 1 shows a statistically significant increase of 0.526 percentage points ($p<0.001$), and Lag 2 shows an even larger increase of 0.658 percentage points ($p<0.01$). These results suggest that the treatment effect was not only immediate but also sustained, with defense spending among the treatment group continuing to rise in the years following the initial impact of the invasion.

The parallel trends assumption was tested using both a formal pre-treatment trends test and joint significance testing of pre-treatment leads. The formal parallel-trends test (pretreatment period) fails to reject the null hypothesis that trends are parallel, with an F-statistic of 0.52 and a p-value of 0.4765. Additionally, a joint test of the pre-treatment leads (Lead 2, Lead 3, Lead 4) confirms their insignificance, with an F-statistic of 2.55 and a p-value of 0.0744. These results collectively provide strong evidence that the parallel trends assumption holds, satisfying a key requirement for the validity of the Difference-in-Differences estimation.

Figure 1 illustrates the diagnostic results for the parallel trends assumption and the dynamic effects of the Russian invasion on defense spending as a percentage of GDP. The top left panel shows observed means for the treatment and control groups over time, with parallel trends clearly visible prior to the treatment in 2023. The top right panel confirms this with a linear-trends model, further supporting the validity of the parallel trends assumption.

The dynamic effects plot (bottom panel) demonstrates no significant pre-treatment anticipation effects, as evidenced by the insignificant coefficients for leads. Post-treatment, significant increases in defense spending are observed, with coefficients for lagged effects indicating a persistent and growing impact through 2023 and 2024. Together, these diagnostics validate the assumptions underpinning the Difference-in-Differences model and confirm the robustness of the estimated treatment effect.

4 Conclusion

This paper quantifies the impact of the 2022 Russian invasion of Ukraine on defense spending among NATO countries using a Difference-in-Differences framework. The analysis finds that NATO member states bordering Russia increased their defense spending as a percentage of GDP by an estimated 0.64 percentage points relative to other NATO countries, a statistically significant effect at the 1% level. This result highlights the critical role of geographic proximity in shaping defense responses to heightened security threats.

The findings contribute to the literature by providing causal evidence on the fiscal and strategic consequences of regional conflicts for defense policy. Future research could incorporate additional geopolitical factors, such as alliance dynamics or domestic political considerations, to further explore the mechanisms driving these responses.

Table 1: Summary Statistics for Defense Spending as % of GDP and Military Spending (Million USD, Constant 2015 Prices)

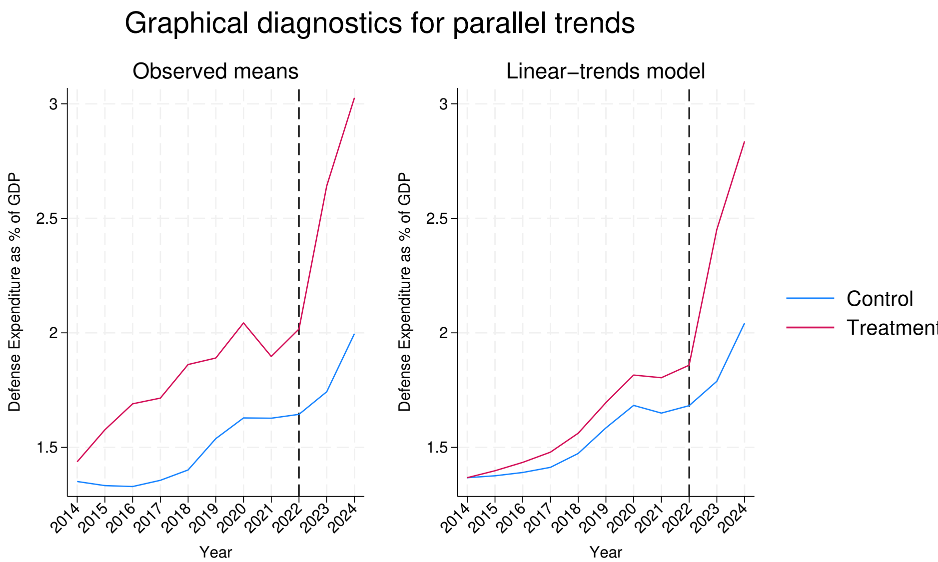
Year	Defense Spending (% of GDP)			Military Spending (Million USD)		
	Control (0)	Treatment (1)	Total	Control (0)	Treatment (1)	Total
2014	1.35	1.44	1.37	36,009.08	3,140.50	29,647.42
2015	1.33	1.58	1.38	35,319.68	3,557.83	29,172.23
2016	1.33	1.69	1.40	36,010.32	3,594.00	29,736.19
2017	1.36	1.72	1.43	35,626.12	3,634.00	29,434.10
2018	1.40	1.86	1.49	36,584.00	3,917.83	30,261.52
2019	1.54	1.89	1.61	39,341.96	4,119.17	32,524.65
2020	1.63	2.04	1.71	40,055.72	4,412.83	33,157.10
2021	1.63	1.90	1.68	41,682.48	4,349.67	34,456.77
2022	1.64	2.02	1.72	40,904.68	4,556.83	33,869.61
2023	1.74	2.64	1.92	41,647.48	6,182.33	34,783.26
2024	2.00	3.03	2.20	45,546.04	7,690.83	38,219.23
Total	1.54	1.98	1.63	38,975.23	4,468.71	32,296.55

Notes: The dataset includes 31 countries observed over 11 years (2014–2024), resulting in 341 total observations. The treatment group consists of 6 NATO countries bordering Russia: Estonia, Latvia, Lithuania, Poland, Finland, and Norway. The treatment period starts in 2023 to reflect when significant changes in defense spending are observed. The control group includes the remaining 25 NATO countries: Albania, Belgium, Bulgaria, Canada, Croatia, Czechia, Denmark, France, Germany, Greece, Hungary, Italy, Luxembourg, Montenegro, Netherlands, North Macedonia, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden, Türkiye, United Kingdom, and United States. Mean spending values for both groups are shown.

Table 2: Regression Results: ATET and Dynamic Effects

Statistic	*Coefficient*	*Std. Error*
ATET (treated 1 vs 0)	0.640**	(0.191)
Lead 2	-0.103	(0.106)
Lead 1	-0.129	(0.260)
Lag 1	0.526***	(0.141)
Lag 2	0.658**	(0.230)
Observations	341	
Adjusted R^2	0.869	

Notes: Standard errors are reported in parentheses. ATET represents the Average Treatment Effect on the Treated, capturing the causal impact of the treatment. Lead 2 and Lead 1 measure pre-treatment effects two and one periods before the treatment, respectively, and help assess the parallel trends assumption. Lag 1 and Lag 2 capture the post-treatment effects one and two periods after the treatment, showing the persistence of the treatment's impact. * p<0.05, ** p<0.01, *** p<0.001.



(a) Granger Causality Diagnostics

(b) Parallel Trends Diagnostics

Figure 1: Diagnostic Plots: Granger Causality and Parallel Trends

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