

MILITARY SPENDING AND PERSONNEL DYNAMICS: A PANEL DATA ANALYSIS OF NATO MEMBERS

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Abstract: This study examines the relationship between public defense expenditures and military personnel levels across 28 NATO countries from 2000 to 2021. Using fixed-effects panel regressions, we assess how total and disaggregated military spending—covering personnel, equipment, infrastructure, and other categories—affects both total armed forces (including civilians) and active military personnel. The analysis controls economic and demographic factors such as GDP (PPP), population, and net migration. Results show that increases in personnel and infrastructure spending are positively associated with defense-sector employment, particularly among active military personnel. In contrast, equipment and other expenditures show limited effects. GDP (PPP) and net migration are negatively associated with military staffing, suggesting that economic development and labor mobility may reduce the attractiveness or necessity of military employment. These findings offer evidence for more targeted and efficient defense budgeting to support sustainable military workforce planning.

Keywords: military expenditure, defense employment, fixed-effects model, NATO countries, public budgeting

1. Introduction

The allocation of public resources to military functions has long been a point of contention in both economic and defense policy literature. Governments face the challenge of balancing national security priorities with economic efficiency and social welfare. A central dimension of this debate is the effect of defense expenditures on employment in the military sector. Public defense budgets cover a broad range of expenditures, from personnel salaries and pensions to the acquisition of equipment and the construction of infrastructure. Each of these categories may exert distinct effects on labor dynamics, both within the defense sector and across the broader economy.

While some theoretical perspectives argue

that defense spending can stimulate demand and create employment, others warn of potential inefficiencies and resource misallocation. The attractiveness of military careers, especially in an era of professionalized armed forces, is influenced not only by security needs but also by the quality and scale of public investment in military human capital. In this context, understanding the specific channels through which public spending affects military personnel becomes essential. This study aims to empirically assess the extent to which total and category-specific military expenditures contribute to changes in military staffing, offering new insights based on data from NATO countries over two decades.

2. Literature review

The effects of military expenditure on employment have been examined through various theoretical lenses. The Keynesian school of thought suggests that military spending stimulates demand, increases purchasing power, and generates employment opportunities [1]. In contrast, the classical economic perspective argues that increased military spending leads to resource misallocation, reducing private sector investment and overall economic efficiency [2].

Studies analyzing the employment effects of military expenditures present mixed results. Another paper found a negative relationship between military spending and employment in Turkey, suggesting that military expenditure reallocates resources from productive civilian sectors, thus inhibiting job creation [3]. Similarly, [4] examined the impact of defense spending on unemployment across five Asian countries and concluded that increased defense spending often correlates with higher unemployment, as funds are diverted from sectors that generate more jobs [4].

Empirical studies on military expenditures and their impact on military personnel highlight both direct and indirect effects. Research by NATO economists indicates that while military expenditures can support employment in defense-related industries, they may also impose fiscal constraints that limit broader employment opportunities [5]. The study further suggests that the effectiveness of defense spending in job creation depends on whether investments are directed toward labor-intensive or capital-intensive military activities.

A report on NATO member states found that military spending does not consistently contribute to lower unemployment rates, with some economies experiencing adverse employment effects due to the capital-intensive nature of defense investments [6]. However, [7] observed that in the United States, higher defense spending correlated with lower unemployment between 1948

and 1988, highlighting regional and temporal variations in the employment effects of military spending. Additional research by [8] on shifts in defense spending indicates that while military budgets create short-term employment opportunities, long-term effects may result in structural employment shifts, favoring capital-intensive military sectors over labor-intensive industries [8]. The literature emphasizes that although military spending generates jobs, it is often less efficient in job creation compared to investments in education and health [9]. A study by [10] analyzed budget allocations for personnel expenses in the national security system and highlighted the challenges in maintaining a competitive military workforce due to unattractive salaries and work conditions [10]. Similarly, research on Bangladesh's armed forces budget indicated the necessity of optimizing budgetary allocations to improve personnel efficiency and economic sustainability [11]. The sustainability of military expenditures has significant policy implications, particularly in economies facing fiscal constraints. [12] highlights the importance of balancing military personnel compensation with broader public service expenditures to avoid inefficiencies in government budgeting [12]. Furthermore, research on the economic cost of war suggests that reallocating defense budgets toward sectors such as education and healthcare could yield higher employment multipliers and long-term economic benefits [11]. A study on military expenditures in Bangladesh suggests that defense budgets must be optimized to avoid excessive fiscal burden, with recommendations for increased efficiency in military allocations while ensuring national security [11]. The analysis of NATO defense expenditures by [6] found that while military spending contributed to employment in some member states, its overall impact varied significantly across countries [6]. The impact of public expenditures on military

personnel is multifaceted and depends on economic conditions, the nature of military spending, and governance structures. While defense spending can provide employment opportunities within the armed forces and defense-related industries, it may also lead to inefficiencies and job losses in other sectors due to resource misallocation. Policymakers must weigh these trade-offs carefully, ensuring that defense budgets are managed efficiently to maximize economic and security benefits.

3. Data

This study relies on a balanced panel dataset comprising annual observations from 2000 to 2021 for 28 NATO member countries. The dataset comprises 28 NATO member countries, including a mix of large and small economies, as well as varying levels of military capacity and geopolitical influence. The countries included in the analysis are Albania, Belgium, Bulgaria, Canada, Croatia, Czechia, Denmark, Estonia, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Luxembourg, North Macedonia, Montenegro, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Turkey, the United Kingdom, and the United States. This diverse sample allows for a comparative assessment of defense expenditure impacts across different national contexts, institutional capacities, and stages of economic development. The analysis investigates how public expenditures—both total and disaggregated by category (personnel, infrastructure, and equipment)—influence the number of military personnel. The guiding hypothesis is that variations in defense spending shape the attractiveness of the military sector from a human capital perspective, potentially affecting recruitment, retention, and overall force size.

The core variables used in this research include two indicators of military labor: armed forces personnel and active military

personnel. The former refers broadly to all individuals serving in a country's armed forces, while the latter focuses on professional soldiers actively employed. Data for these indicators, along with defense expenditures, are drawn from the Stockholm International Peace Research Institute (SIPRI) Military Expenditure Database and official NATO defense reports. All financial data are converted to constant 2015 U.S. dollars to ensure consistency and comparability across countries and time.

To account for structural economic and demographic differences that might affect defense employment independently of spending levels, we include several exogenous control variables. These are: GDP per capita (a proxy for opportunity costs and economic alternatives to military service), net migration (capturing labor supply dynamics and demographic pressures), and total population (indicating the potential recruitment base). These control variables are sourced from the World Development Indicators (WDI) provided by the World Bank. The dataset encompasses a diverse group of countries in terms of economic development, military capacity, and geopolitical role. This rich panel structure allows for econometric modeling that accounts for both country-specific fixed effects and year-specific shocks. As a result, the analysis can provide robust estimates of how changes in defense spending—particularly spending on personnel—affect military employment levels over time and across different national contexts.

4. Methodology

This study adopts a quantitative econometric approach to examine the relationship between public defense expenditures and employment in the defense sector across NATO countries. Using panel data from 28 member states over the period 2000–2021, we estimate fixed-effects regression models that control

for unobserved heterogeneity across countries and allow for the isolation of within-country variation over time. The fixed-effects (within) estimator is suitable for capturing the impact of changes in military spending on employment while accounting for persistent structural characteristics specific to each country.

The analysis focuses on two dependent variables: the logarithm of total armed forces personnel, which includes both military and civilian staff employed in the defense sector ($\log_arm_for$), and the logarithm of active military personnel, which includes only uniformed service members ($\log_military$). This dual specification allows us to explore both the general employment dynamics of the defense sector and the specific responsiveness of military enlistment to shifts in public spending.

The main independent variable—military expenditure in absolute terms (USD)—is analyzed in two stages. First, we assess the overall effect of total military expenditure. Then, we disaggregate spending into four functional categories: personnel expenditure, equipment expenditure, infrastructure expenditure, and other defense-related expenditures. This enables a more detailed understanding of which types of expenditures are most strongly associated with defense employment outcomes.

To control for structural economic and demographic factors, three exogenous variables are included: total population (log-transformed), capturing the size of the recruitment base; GDP in purchasing power parity (PPP, log-transformed), as a proxy for the opportunity cost of military service; and net migration (log-transformed), reflecting demographic and labor market pressures that may influence the availability of eligible recruits. All continuous variables are log-transformed to reduce heteroskedasticity and to interpret the estimated coefficients as elasticities.

The first model investigates the association between total military expenditure (in absolute terms) and the number of armed forces personnel. The model includes three exogenous control variables—total population, GDP expressed in Purchase Power Parity (PPP), and net migration—selected to reflect demographic scale, labor market dynamics, and economic opportunity structures. The baseline model is specified as:

$$\log (arm_for_{it}) = \alpha_i + \beta_1 \log (milexp_abs_{it}) + \beta_2 \log (pop_tot_{it}) + \beta_3 \log (gdp_ppp_{it}) + \beta_4 \log (net_migrat_{it}) + \varepsilon_{it} \quad (1)$$

where:

- $\log (arm_for_{it})$ is the log of armed forces personnel in country i and year t ,
- $\log (milexp_abs_{it})$ is the log of military expenditures in absolute values in country i and year t ,
- $\log (pop_tot_{it})$ is the log of total population in country i and year t ,
- $\log (gdp_ppp_{it})$ is the log of GDP in PPP in country i and year t ,
- $\log (net_migrat_{it})$ is the log of net migration in country i and year t ,
- α_i captures country fixed effects,
- ε_{it} is the idiosyncratic error term.

This model allows us to estimate the elasticity of armed forces personnel with respect to total military expenditure while holding demographic and macroeconomic factors constant. To identify which components of military expenditure are more closely associated with defense-sector employment levels, the second model decomposes total expenditure into aforementioned four functional categories, such as:

$$\log (arm_for_{it}) = \alpha_i + \beta_1 \log (persexp_abs_{it}) + \beta_2 \log (eq_exp_abs_{it}) + \beta_3 \log (infraexp_abs_{it}) + \beta_4 \log (otherexp_abs_{it}) + \beta_5 \log (pop_tot_{it}) + \beta_6 \log (gdp_ppp_{it}) + \beta_7 \log (net_migrat_{it}) + \varepsilon_{it} \quad (2)$$

In this model, is alternately specified as $\log(\text{arm_for}_{it})$ and $\log(\text{military}_{it})$. Where: $\log(\text{persexp_abs}_{it})$, $\log(\text{eq_exp_abs}_{it})$, $\log(\text{infraexp_abs}_{it})$, $\log(\text{otherexp_abs}_{it})$ represent the military expenditure disaggregated into: personnel, equipment, infrastructure and other expenditures, transformed into logarithms in country i and time t .

This dual specification enables a comparative assessment of how expenditure categories are associated with broader defense employment (including civilians) versus strictly military staffing. The inclusion of fixed effects α_i helps account for unobserved, time-invariant country characteristics such as institutional settings, strategic posture, or national defense doctrines. All independent variables are expressed in natural logarithms, which facilitates the interpretation of estimated coefficients as elasticities and reduces issues related to non-linearity and heteroskedasticity.

5. Results

This section presents the findings from four fixed-effects panel regression models that examine the relationship between public defense expenditures and defense-sector

employment across 28 NATO member states between 2000 and 2021. The analysis separately models two dependent variables: the logarithm of armed forces personnel (including both military and civilian defense staff) presented in Table 1 and 2 and the logarithm of active military personnel in Table 3 and 4. Each dependent variable is first regressed on total defense expenditure and then on disaggregated spending components (personnel, equipment, infrastructure, and other). Key demographic and economic control variables are included in all models.

In the first model, where armed forces personnel is regressed on total military expenditure, the results indicate that a 1% increase in total military spending is associated with an estimated 0.30% increase in the number of personnel employed in the defense sector. In the corresponding model for military personnel, the effect is slightly stronger, with a 1% increase in total military expenditure associated with a 0.46% increase in active military staffing. These results suggest a positive elasticity between aggregate defense budgets and defense employment.

Table 1. Regression results for baseline model with total defense employees

log_arm_for	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
log_milexp_abs	.302	.059	5.14	0	.186	.418	***
log_pop_tot	1.226	.234	5.24	0	.766	1.686	***
log_gdp_ppp	-.777	.058	-13.31	0	-.892	-.663	***
log_net_migrat	-.017	.01	-1.83	.068	-.036	.001	*
R-squared		0.419	Number of obs			397	

Source: Own estimation. Sig refers to *** $p < .01$, ** $p < .05$, * $p < .1$.

Table 2. Regression results for baseline model with military employees only

log_arm_for	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
log_persexp_abs	.157	.058	2.69	.007	.042	.272	***
log_eq_exp_abs	.053	.02	2.64	.009	.014	.092	***
log_infraexp_abs	.036	.017	2.15	.033	.003	.069	**
log_otherexp_abs	.009	.046	0.19	.852	-.082	.099	
log_pop_tot	1.072	.252	4.25	0	.575	1.568	***
log_gdp_ppp	-.695	.066	-10.57	0	-.824	-.565	***
log_net_migrat	-.019	.01	-1.91	.057	-.038	.001	*
R-squared		0.420	Number of obs			397	

Source: Own estimation. Sig refers to *** $p < .01$, ** $p < .05$, * $p < .1$.

Table 3. Regression results for disaggregated model with total defense employees

log_military	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
log_milexp_abs	.459	.077	5.94	0	.307	.611	***
log_pop_tot	.63	.308	2.05	.041	.026	1.235	**
log_gdp_ppp	-.897	.077	-11.67	0	-1.048	-.746	***
log_net_migrat	-.038	.013	-3.04	.003	-.063	-.013	***
R-squared	0.373		Number of obs		397		

Source: Own estimation. Sig refers to *** $p < .01$, ** $p < .05$, * $p < .1$.

Table 4. Regression results for disaggregated model with military personnel only

log_military	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
log_persexp_abs	.501	.074	6.79	0	.356	.646	***
log_eq_exp_abs	-.036	.025	-1.42	.156	-.086	.014	
log_infraexp_abs	.074	.021	3.50	.001	.033	.116	***
log_otherexp_abs	.034	.058	0.58	.565	-.081	.148	
log_pop_tot	.514	.319	1.61	.109	-.114	1.142	
log_gdp_ppp	-.841	.083	-10.11	0	-1.005	-.677	***
log_net_migrat	-.038	.012	-3.07	.002	-.062	-.014	***
R-squared	0.419		Number of obs		397		

Source: Own estimation. Sig refers to *** $p < .01$, ** $p < .05$, * $p < .1$.

Disaggregating the components of defense expenditure provides additional insight. Personnel expenditure shows the strongest relationship across all models. In the model using armed forces personnel as the dependent variable, a 1% increase in personnel expenditure corresponds to a 0.16% increase in total defense staffing. When focusing on military personnel, the effect is even more pronounced: a 1% increase in personnel expenditure is associated with a 0.50% increase in active military staffing. This suggests that labor-related spending is a key determinant of recruitment and retention in the military. Infrastructure expenditure also has a consistently positive association with both types of defense employment. A 1% increase in infrastructure spending is linked to a 0.04% increase in armed forces personnel and a 0.07% increase in military personnel. This indicates that capital investments in defense facilities and logistics may play a supportive role in sustaining and expanding military capacity. Equipment expenditure presents a more nuanced pattern. In the model for *armed forces personnel*, a 1% increase in equipment expenditure is associated with a 0.05% increase in personnel, suggesting a

modest but significant effect. However, in the model focused solely on *military personnel*, the coefficient is negative and statistically insignificant, implying no clear relationship between equipment investment and military staffing.

Other expenditures do not show any statistically significant association with defense-sector employment in either specification, suggesting that miscellaneous or non-classified budgetary items are not strong predictors of personnel changes.

Turning to the control variables, total population is positively and significantly associated with *armed forces personnel* in both relevant models. A 1% increase in population is linked to a 1.23% increase in armed forces personnel in the aggregate expenditure model and to a 1.07% increase in the disaggregated model. In contrast, population is only weakly significant for *military personnel* in one specification and becomes statistically insignificant in the other, indicating that broader demographic size may shape civilian defense employment more than uniformed recruitment.

GDP in purchasing power parity (PPP) shows a consistent and statistically significant negative association with

defense-sector employment across all models. Specifically, a 1% increase in GDP (PPP) is associated with a 0.70–0.90% decrease in defense employment, depending on the model and employment type. This negative elasticity may reflect higher opportunity costs of public-sector military employment in more developed economies. Net migration is also negatively associated with defense-sector employment. In the *armed forces personnel* models, a 1% increase in net migration is associated with a 0.02% decrease in employment. The relationship is stronger and more robust in the *military personnel* models, where a 1% increase in net migration is linked to a 0.04% reduction in military staffing. This suggests that migratory flows may shift labor market dynamics in ways that reduce reliance on domestic military recruitment. In summary, the results indicate that targeted increases in personnel and infrastructure expenditures are the most effective fiscal instruments for expanding defense-sector employment, particularly among uniformed personnel. In contrast, higher levels of economic development and net migration are consistently associated with declines in military staffing, highlighting the complex interplay between fiscal inputs, labor market alternatives, and national defense personnel structures.

6. Conclusions

The findings of this study highlight the nuanced relationship between public

defense expenditures and military personnel levels. Among the various categories of military spending, personnel and infrastructure expenditures are the most effective in sustaining and expanding employment within the defense sector. The elasticity of active military personnel with respect to personnel spending is particularly notable, suggesting that targeted fiscal commitments to salaries, training, and career incentives can significantly influence the size of the uniformed workforce.

In contrast, expenditures on equipment and other categories show limited or inconsistent effects, pointing to the need for careful prioritization within defense budgets. Moreover, the negative associations observed between military employment and both GDP (PPP) and net migration imply that broader economic conditions and labor market trends play an important role in shaping the appeal and necessity of defense-sector jobs. From a policy perspective, these results underscore the importance of aligning military workforce planning with broader economic and demographic realities. Effective personnel policy cannot rely solely on budgetary expansions; it must also consider the structure of that spending. This study contributes to a more evidence-based approach to defense budgeting, supporting decisions that can ensure military readiness while maintaining fiscal responsibility and labor market coherence.

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