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# Economic growth and military expenditure in the countries on NATO's Eastern flank in 1999–2021

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**Abstract**

This paper studies how military expenditure impacted economic growth in nine Central and Eastern European countries in 1999–2021 using a newly created dataset of disaggregated military expenditures. The results of estimating an ARDL growth model with military expenditure confirm that various kinds of military expenditure had a negative and statistically significant influence on economic growth in the longer run, and show that personnel expenditures and labour market adjustments were the most important channel of influence. Equipment purchases and army maintenance also have a negative influence on GDP growth, but that influence is smaller. Fiscal multipliers of military expenditure were estimated using the Local Projections method to measure the short-run effects, and values below unity were obtained. The short-run fiscal multipliers of military expenditure are 0.2–0.5 lower than the fiscal multipliers of non-military government consumption.

JEL Codes: H56, O11

Keywords: military expenditures; military expenditures and economic growth; fiscal multiplier; fiscal adjustments



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## Non-technical summary

This paper examines the short-run and long-run effects of military expenditure on economic growth in nine Central and Eastern European members of NATO in 1999–2021. The Russian invasion of Ukraine in 2022 caused a rapid increase in military spending in Western countries, especially in the countries on NATO's Eastern flank, posing an urgent question for policy-makers, forecasters and researchers about the economic effects of military build-ups.

Military expenditure affects the economy in complex and multifaceted ways. First, security is a public good that is crucial for protecting human lives, health, property, and the proper functioning of the markets. Government must spend money on the military to provide an optimal level of security, but government expenditure is not neutral for the economy.

Second, Keynesian theories argue that military expenditure can stimulate the economy in the short run. Equipment purchases, conscription of soldiers, and government investment may reduce unemployment, raise industrial production, and boost economic growth. At the same time though, an increase in military expenditure must lead to growth in public debt, rises in taxes, or crowding-out of other government expenditure. The effects of the fiscal adjustments can significantly reduce the Keynesian effects.

Third, military expenditure affects the supply-side of the economy. Military expenditure can support domestic industry and technological modernisation, and can provide substantial technological spill-overs like nuclear energy, the GPS system or night-vision devices. However, the military sector tends to absorb resources that could otherwise be used in civilian sectors of the economy. Soldiers who are serving in the army are not working in civilian jobs, and so expanding the army significantly diminishes the labour supply of the civilian sector.

The overall effect of military expenditure on the economy may be different in different countries and at different times. This paper presents two empirical methods that can help to explain the total effect of military expenditure on the economy.

The results of estimating the fiscal multipliers in almost every specification suggest that the fiscal multipliers of military expenditure are below unity on impact and gradually fall in subsequent years. Essentially this means that each euro spent on the armed forces leads to GDP growth of less than one euro. The estimates of the fiscal multipliers suggest that military expenditure in the Central and Eastern European countries did not stimulate economic growth in the short run. Fiscal multipliers for expenditure on personnel are especially negative a few years after the money has been spent on military personnel.

The results of the estimation of the ARDL growth model suggest that military expenditure also has a negative impact on the economy. The model uses three different sources of data on military expenditure, and the parameters for military expenditure in every specification of it are negative and statistically significant. They are also negative and statistically significant after expenditure is disaggregated into three or four categories. Expenditure on personnel seems to have the strongest negative impact on GDP. Increased spending on personnel is usually linked with hiring or conscripting new members of the armed forces, but those new members may have higher productivity if they remained in civilian sectors of the economy.

The theoretical discussion and the results of the estimations of the empirical models suggest that military expenditure had a negative impact on economic growth in the nine Central and Eastern European countries in 1999–2021. Military expenditure in Central and Eastern

European countries is now expected to grow rapidly after the Russian invasion of Ukraine. This increase will slow the growth in economic activity down, and all economic agents must be aware of that.

## Contents

## 1. Introduction

After the end of the Cold War, the countries of Central and Eastern Europe (CEE) experienced a period of peace and relative security that is sometimes called the peace bonus or peace dividend, during which their security was strengthened further by their accession to NATO in 1999 and 2004. That accession meant they had to switch to NATO standard arms and to participate in the military missions of the alliance, but even so the median level of military expenditure in the nine countries on NATO's Eastern Flank fell from 1.84% of GDP in 2003 to 1.02% of GDP in 2013. The annexation of Crimea and the war in Donbas significantly changed the attitude of the authorities in those countries towards increasing military expenditure though, and military expenditure has continued to grow year by year since then, reaching 1.95% in 2021.

Russia's invasion of Ukraine in 2022 forced further significant increases in military expenditure. At the end of 2022, NATO reported that the military expenditure of the whole alliance in 2023 was expected to grow by 25.8% year on year. Such a large and unprecedented increase in military expenditure in the countries in the region raises an urgent question for researchers, policy-makers and forecasters about how that expenditure will affect the economies of those countries. Allocating resources to the military is not neutral for the economy, and its influence needs to be investigated. Studying how military expenditure affects economic growth in the CEE countries is one of the main motivations for this research. Few works so far have looked at the region, making this work a significant contribution to the literature.

This paper contributes to the literature in other ways too. Researchers have previously used SIPRI or NATO data and studied the effect on economic growth from them. This article demonstrates that the SIPRI and NATO data are compiled using cash accounting, while GDP data use accrual-based accounts, resulting in expenditure to purchase arms and other military investments being included in GDP with a delay. Cash accounting may consequently bias the results. It is much more correct methodologically to use ESA2010 data for defence expenditure in the COFOG classification, though these data do not cover all military expenditure.

To show how military expenditure affects the change in GDP in the short run, this article presents the results of an estimation of fiscal multipliers based on the Impulse Response Function generated using the Local Projections method (Jordà 2005). These results show that the fiscal multiplier of military expenditure equals 0.7–1.0 on impact, after which the effect gradually decreases in subsequent years. The multipliers of military expenditure obtained are significantly lower than the fiscal multipliers of non-military government consumption as they are 0.2–0.3 smaller on impact and 0.4–0.5 in the second and third years after a shock. This suggests that fiscal expansion through increased military expenditure would be less effective at stimulating GDP growth in the CEE countries than expansion through increased non-military expenditure.

To show how military expenditure affects economic growth in the long run, this article presents the estimation results of an ARDL growth model with a set of control variables. The Pooled Mean Group estimator based on an error correction mechanism was used, as this allows the long-run relationships between military expenditure and economic growth to be estimated. The results show that military expenditure in the CEE countries in 1999–2021 found from all three of the SIPRI, NATO and Eurostat data sources had a negative effect on economic growth in the long run.

The article also presents an analysis of how the short-run and long-run disaggregated military expenditures taken from the Eurostat and NATO databases affect economic growth, and how the most important channels of influence of military burdens on economic growth can then be identified. The estimation results suggest that the largest negative impact was caused by spending on military personnel, which corroborates the results from Becker and Dunne (2021). Expenditure on equipment purchases and other military expenditure meanwhile also have a negative effect on GDP growth, but it is relatively smaller.

The rest of the article is organised as follows: Section 2 presents a review of the literature on the effect of military expenditure on economic growth and the literature on fiscal multipliers. Section 3 provides a description of the data used in the study. Section 4 describes the empirical research methodology. Section 5 contains the empirical results. Section 6 provides a summary.

## 2. Literature review

How military expenditure affects economic growth has been the subject of debate and study for decades. Since Emil Benoit (1973, 1978) suggested that military expenditure can have a positive effect on economic growth, dozens of publications have verified that hypothesis. A review of the literature by Dunne and Tian (2013) shows that 26.1% of the 46 works published between 2007 and 2013 had positive findings, 41.3% had negative findings, and 32.6% had unclear results. This indicates that the literature is far from reaching any consensus, which is most probably because the effect of military expenditure on economic growth is highly complex, and is time-variant and country-specific because of its heterogeneity.

Dunne et al. (2005) distinguish the three main channels through which military expenditure can affect economic growth as the security channel, the demand channel and the supply channel. Other works offer different classifications or descriptions of different possible channels, but the division into three channels appears to group the potential growth factors appropriately.

Countries invest in their armed forces above all to protect their borders and their citizens. Security is a public good that is necessary for the proper functioning of markets and the protection of life, health and property rights. Shieh et al. (2002) present a model that implies there is a certain optimal level of security generated by military expenditure that maximises economic growth. Military expenditure allows internal and external threats to be covered, while political stability reduces the level of uncertainty in economies and may encourage domestic and foreign investors to increase their spending on investment and FDI (Smaldone 2006). Political stability may also stimulate international trade. However, the military in non-democratic countries may focus on defending the property rights of the ruling elites rather than those of all citizens, and military expenditure may be driven not by security needs but by a rent-seeking military-industrial complex that is a powerful interest group which benefits from defence spending and so has an incentive to exaggerate international conflicts and hinder attempts to settle disputes by non-military means (Dunne and Sköns 2010).

The supply-side effects of military expenditure also work in two directions and can lead the pace of economic growth both to increase and to decrease. They can increase it because national expenditure on weapons may allow an arms industry and many other industries providing technology, components and semi-finished products to develop, since increased profits for companies working on public procurement can in the long run be used for investment that increases the production capabilities of those companies (Malizard 2015). The need to modernise an army to match the standards of potential opponents may stimulate faster modernisation and greater investment in arms manufacturing (Antonakis 1997). Furthermore, military spending on R&D may have beneficial technological spillovers for civilian sectors, as many inventions that were primarily developed for the military can be used by other sectors of economy (Yakovlev 2007, Dunne and Uye 2014, Mohanty et al. 2020).

Equally however, military expenditure may lead to weaker growth in potential output because the military and civilian sectors compete for the same resources, thus increasing the prices of investment and production goods. As Ramey and Shapiro (1998) demonstrated moreover, the allocation of capital between the civilian and military sectors is costly. Demand-side effects may mean that larger government spending crowds out private investment. An increase in military expenditure may make resource allocation less efficient, because that spending is not governed by market processes and tends to create distortions in relative prices that result in a dead-weight loss to total productive capacity (Knight et al. 1996).

One of the major supply-side effects is the drain on the labour market that results from thousands of people being employed as professional soldiers or doing compulsory military service. Conscription is an in-kind tax, as opposed to a fiscal tax, that is paid in the form of coerced and usually underpaid service. Conscription means that the young people affected usually work at below their potential productivity levels given their education, skills and other factors, and this slows economic growth down (Poutvaara and Wagener 2007). Conscription also stunts the pace at which conscripts can accumulate human capital, as they cannot learn and gain professional experience in other sectors of economy while serving, and reduces the savings and capital they accumulate, since military wages that are lower than the potential salary they could earn in the market reduce their life-time incomes. Empirical studies confirm that mandatory conscription significantly reduces economic growth (Keller et al. 2009). Moving to an all-volunteer forces encourages more efficient resource allocation, greater reliance on capital in the form of equipment than on soldiers, and higher wages that are paid to fewer soldiers (Bove and Cavatorta 2012). It has been empirically demonstrated that high unemployment may drive an increase in spending on military personnel at the expense of spending on equipment (Becker 2021).

Demand-side effects reach the economy by stimulating aggregate demand. New Keynesian economics propose that an increase in government spending when generation capacities are not in full use and unemployment in high, meaning there is a negative output gap, may help rebuild aggregate demand. Government intervention and increased government spending causes inflation and expected inflation to rise, which translates into a drop in savings and the real interest rate and an increase in consumption, and helps overcome the crisis (e.g. Christiano et al. 2011). Such an approach requires sticky prices, non-Ricardian consumers and involuntary unemployment to be assumed (Galí et al. 2007)

The critics of this approach, especially those who take a neoclassical approach, argue that an increase in military expenditure causes an increase in taxes, an increase in the deficit, or the crowding-out of other expenditures. Each of these fiscal adjustments affects the economy. Tax rises have a distortionary effect on economic activity, an increase in the public debt may lead to an increase in household savings (Heo and Bohte 2011, Lorusso and Pieroni 2017), and higher expenditure may crowd out private investments through the interest rate channel.

The overall effect of fiscal expansion on output is called the multiplier effect. The fiscal multiplier describes the elasticity of output to an increase of government spending. Military expenditure in the literature, especially expenditure during the Great Recession, has very often been used to estimate the value of the fiscal multiplier. Military expenditure seems to be a good instrument for this because it is perceived to be exogenous to economic activity and driven by geopolitical factors, relatively unanticipated by consumers and firms (Hall 2009), and responsible for much of the variation in government purchases, while it is assumed that such expenditure is temporary (Barro and Redlick 2011; Dupor and Guerrero 2017). Researchers have developed appropriate methods for estimating the fiscal multiplier, especially SVAR models (e.g. Blanchard and Perotti 2002), expectations-augmented VAR models or EVAR models (Ramey and Shapiro 1998, Ramey 2011), and Local Projections (Jordà 2005).

The estimates for the fiscal multipliers of military expenditure differ significantly. Hall (2009) provides a fiscal multiplier of military expenditure in the USA in the range of 1.0–1.7; Ramey (2011) finds a range of 0.6–1.2; Nakamura and Steinsson (2014) find approximately 1.5; Ramey and Zubairy (2018) 0.6–1.0; Perotti (2014) close to 0.0; and Barro and Redlick (2011) 0.5–0.7. In cross-country studies, the fiscal multiplier of military expenditure has been estimated in the interval 0.0–0.5 (Dupor, Guerrero 2017) and the interval 0.3–1.7 (Sheremirov, Spirovska 2022). In their meta-analysis Gechert and Will (2012) show that the fiscal multiplier of military expenditure is lower than the fiscal multiplier of government consumption or government investment, while another meta-analysis (Gechert and Rannenberg 2018) claims that the fiscal multiplier of military expenditure is regime-dependent and varies between –1.0 and 1.2. Auerbach et al. (2019) estimate the combined local multiplier effects and spill-over effects of military expenditure to be above 1.6.

Other researchers point out that the value of the fiscal multiplier depends on multiple factors, as it is higher under the Zero-Lower Bound (Christiano et al. 2011), but lower in high-debt countries, countries with floating exchange rates, and countries with open economies (Ilzetzki et al. 2013). The varying estimation results indicate that the demand-side effects of military expenditure are difficult to estimate, conditioned by many factors, and most probably heterogeneous and country-specific.

As mentioned above, dozens of works have addressed the effect of military expenditure on economic growth. Alongside the works already noted on estimating the fiscal multiplier, significant contributions have been made in the literature on peace and defence. Cross-country studies using large panel data have variously demonstrated that the effect of military expenditure on economic growth is negative (Knight et al. 1996); heterogeneous but generally significant and negative in the short run, but insignificant in the long run for per capita GDP growth (Dunne 2012); negative regardless of different levels of income, conflict experience, abundance of natural resources, openness and foreign aid (Dunne and Tian 2013b); significant and persistent and negative (d'Agostino et al. 2017); and inconclusive, while slightly positive in developed countries (Kollias and Paleologou 2017), while ambiguous results have shown that military expenditure is time dependent and contingent upon whether the change is positive or negative (Emmanouilidis 2022).

The aim of this study is to identify how military expenditure affects economic growth in the countries of the Central and Eastern European region, so it is worth focusing on the results for European countries. Kollias et al. (2007) demonstrate that military expenditure in the EU-15 countries has a positive effect on economic growth, but their study has been countered by others such as Mylonidis (2008), which describes military expenditure having a negative impact on economic growth. The results of Chang et al. (2011) suggest that military expenditure in European countries reduces the rate of economic growth. The study by Dunne and Nikolaidou (2012) meanwhile presents results that show that military expenditure does not have any significant effect on the change of output. Meta-analysis by Alptekin and Levine (2012) suggests that military expenditure has a positive effect on GDP growth in developed countries, which is similar to the findings of Kollias and Paleologou (2017).

The results of case studies of CEE countries and similar European countries are also inconclusive. Daněk (2015) presents results showing that military expenditure has a negative effect on economic growth in the CEE countries, although with some positive externalities. A study by Lobont et al. (2019) shows that military expenditure has a positive impact on GDP growth in Romania, while Tao et al. (2020) reach the opposite conclusion. Topcu and Aras (2015) claim, however, that military expenditure does not Granger-cause economic growth in any CEE country. As there are so few studies of the CEE countries and the results differ so widely, it is reasonable to study how military expenditure affects growth in these countries.

## 3. Data

In a little over 20 years from 1999 to 2021, there were relatively large fluctuations in military expenditure in Central and Eastern Europe. There was though a clear trend in the amount spent on the military in the countries of the region, as the database from SIPRI shows that average military expenditure was only slightly below 2% of GDP in 1999–2004 and then subsequently began to fall gradually (Figure 1). Poland, Czechia and Hungary joined NATO in 1999, followed by Bulgaria, Estonia, Latvia, Lithuania, Romania and Slovakia in 2004. The higher level of military expenditure at the beginning of the 21st century is probably the result of modernisation of the military after the countries joined NATO and took part in NATO’s foreign military missions, particularly in Iraq and Afghanistan. After 2004 there was a gradual and systematic drop in military spending as a share of GDP, probably because of the gradual withdrawal of military contingents from Iraq and Afghanistan, cuts in military spending as part of fiscal austerity policies during the Great Recession after 2007, and overall solid geopolitical stability in that part of Europe. The turning point came in 2014, the year of Russia’s unrecognised annexation of Crimea and the start of the war in Donbas, together with the agreement at the Wales Summit to reverse the downward trend in military expenditure in NATO countries. From that time on, CEE countries began to increase their military spending gradually, so that their average spending in 2019 was nearing the level of 2% of GDP required by NATO since 2006.

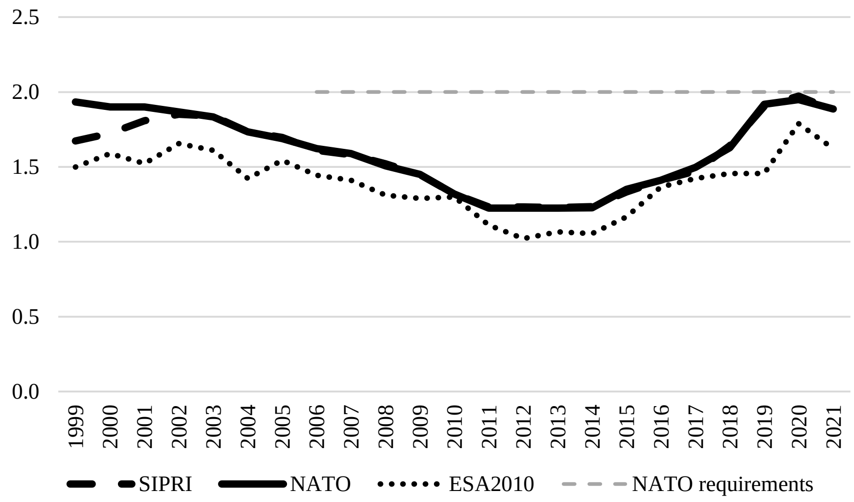



Figure 1. Military expenditure in CEE countries as a percentage of GDP
*Sources: SIPRI, NATO, Eurostat.*
*Note: Data from the NATO database cover only Poland, Czechia and Hungary in the period 1999–2003.*

This article presents estimation results for military expenditure taken from the database of SIPRI (Stockholm International Peace Research Institute) and Eurostat (the COFOG classification of expenditures) for the years 1999–2021, together with aggregated and disaggregated military expenditure taken from NATO publications for 1999–2021 for Poland, Czechia and Hungary, and for 2004–2021 for the other countries (Figure 2). The average differences between the totals for military expenditure in the databases of SIPRI and NATO are slight, as they are lower than 0.1% of GDP for 1999–2002, and lower than 0.01% of GDP for later years. This study also uses military expenditure from the Eurostat COFOG classification, which does not cover all military expenditure, but is calculated on an accrual basis and so is more appropriate in terms of methodology.

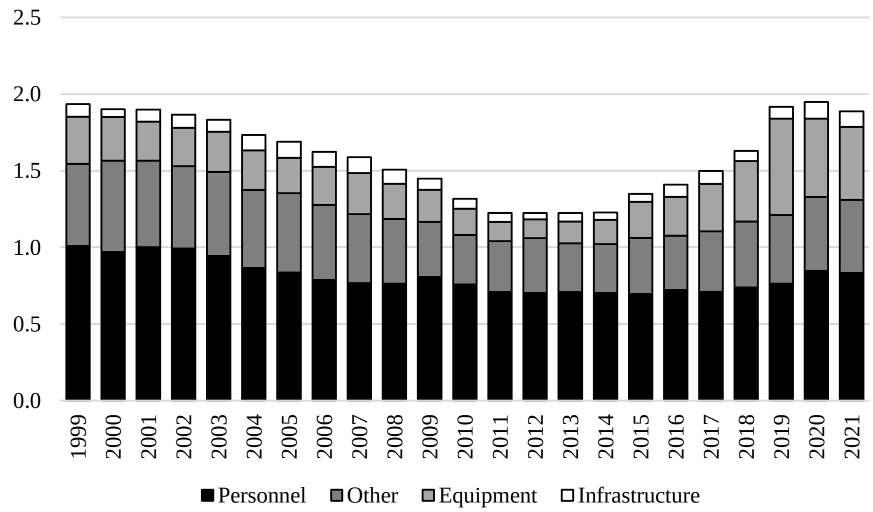



Figure 2. Disaggregated military expenditures in CEE countries as a percentage of GDP (averages)
*Source: NATO.*

The data on GDP come from Eurostat and are consistent with the standard methodology of the European System of Accounts 2010 (ESA2010), which is a European form of the System of National Accounts 2008 (SNA08) applied by OECD countries. The differences between them are slight and do not concern military expenditures (OECD 2014; Eurostat 2019). In studying the effect of military expenditure on GDP growth from a fiscal policy point of view, it is very important to describe how military expenditure is included in GDP. The peace and defence literature that considers GDP growth typically does not feature any analysis of which components of military expenditure are directly included in GDP. Smith (2017) discusses the validity, reliability and comparability of the data, but the discussion about the definition of GDP and about using data on a cash or accrual basis is limited.

Table 1. Military expenditure in national accounts

| Detailed expenditures | Expenditure category | Part of government consumption | Part of government investment | ESA2010 code |
|---|---|---|---|---|
| Compensation and social contributions of military personnel | Compensation of employees | YES | | D.1 |
| Military pensions | Social benefits other than social transfers in kind | | | D.62 |
| Uniforms, fuel, ammunition, training, accommodation, food, heating, energy, spare parts etc. | Intermediate consumption | YES | | P.2 |
| Military infrastructure maintenance | Intermediate consumption | YES | | P.2 |
| Foreign missions costs | Intermediate consumption | YES | | P.2 |
| Military universities and academies | Intermediate consumption and compensation of employees | YES | | P.2 |
| Research and development expenditures | Intermediate consumption and gross fixed capital formation | YES | YES | P.2 and P.51g |
| Infrastructure investments | Gross fixed capital formation | | YES | P.51g |
| Equipment and armament investments | Gross fixed capital formation | | YES | P.51g |
| Capital utilisation | Consumption of fixed capital | | | P.51c |
| Contributions of international organisations | Other current transfers | | | D.7 |
| Subsidies to the arms industry | Other current transfers | | | D.7 |
| Transfers of military equipment abroad | Consumption of fixed capital and other current transfers | | | P.51c and D.7 |

*Source: author's work based on Eurostat (2019).*

Table 1 presents a method for recognising military expenditures in national accounts. It shows that the vast majority of military expenditure is a component of government consumption or gross fixed capital formation. Both of these categories are components of GDP; only some capital transfers, capital amortisation and military pensions are not directly included in GDP.

Military investments are recorded in GDP with a lag up to one year, since expenditures are recorded in the accounts under the ESA2010 methodology using the accrual method. This means that investments in purchasing military equipment are included in GDP when they are delivered and not when they are paid for (Eurostat 2019, pp. 443–444). Investments in military equipment that takes many years to produce are recorded by their milestone payments or other indicators, such as the cost incurred by the producer in a given year. This causes some inconsistency, since the databases of NATO and SIPRI present military expenditure using the cash method, and so it is recorded upon payment, not upon delivery. This inconsistency affects the settlement of some military expenditures in a period of not more than one year, though purchases of complex weapons systems account for quite a large part of total military spending at 37.9% of total expenditure.

Unfortunately the databases of SIPRI and NATO do not present military expenditure using the accrual method, and so the vast majority of studies use cash-based data. This means that a part of the spending on military equipment recorded in the databases of SIPRI and NATO at time $t$ enters GDP at $t+1$ in the methodology of the EU and OECD. This inconsistency means that using models with no lags or only one lag can cause severe estimation problems and give insignificant, false positive or false negative results, depending on the general trends in spending on military equipment. Models that use year-to-year variation in the variables are especially vulnerable to this bias, so models with an error correction term and long-run coefficients or those that estimate the fiscal multiplier using fiscal models with a higher number of lags are better for measuring how military expenditure affects economic growth.

Data can be collected about some military expenditures that are registered on an accrual basis, but these data do not cover all military expenditure. Eurostat presents data on government spending on an accrual basis using the Classification of the functions of government (COFOG), in which the second category is Defence (GF02), including expenditures on military defence, civil defence, foreign military aid, R&D in Defence, and other government expenditures. All expenditures are divided into ESA2010 categories, so it is possible to find military expenditures on an accrual basis.

Regrettably these data are also problematic to use because they do not cover all the military expenditures in the NATO and SIPRI databases. NATO and SIPRI use a broader definition of military expenditures than that in the COFOG methodology. The defence (GF02) category in the COFOG classification excludes expenditure on military hospitals, benefits for veterans, aid missions, equipment used during peacetime natural disasters, military schools and universities, basic research and pension schemes. It can be discussed which definition is more appropriate for describing defence capabilities, but the differences between the NATO and SIPRI methodology and the ESA2010 methodology are substantial.

Average Slovakian military expenditure in 1999–2020 for example was 1.44% of GDP according to the SIPRI database, but only 1.01% according to the COFOG classification. Similar differences occur for Poland at 1.91% and 1.61%, Bulgaria at 1.98% and 1.67%, Czechia at 1.37% and 1.14%, and others. Moreover, it is difficult to split the ESA2010 data into the categories used in the NATO databases. Gross fixed capital formation (P.51g) covers infrastructure investments, equipment purchases and R&D expenditures, which are three separate NATO categories. Nonetheless, military expenditure from the ESA2010 COFOG classification was used for the estimations as one of three data sources. Three variables were created for expenditure on military personnel covering compensation of employees plus social transfers;

expenditure on military equipment and infrastructure as gross fixed capital formation; and other military expenditure.

This study also uses a number of control variables to study how military expenditure affects economic growth. The model uses capital stock from the AMECO database OKND code, government consumption from ESA2010, and the size of the working-age population aged 15–65, which are all normally used, and it includes expenditures on research and development (R&D) and the share of people with higher education in the working age population aged 15–65. These variables allow a better explanation of the dynamics of growth in developed countries. The source of all the data apart from those from the NATO and SIPRI databases is Eurostat. All the variables in all the models were normalised into per capita values in real terms at constant prices. The descriptive statistics of the variables used in this paper are presented in Table 2.

Table 2. Descriptive statistics

| Variables (per capita, constant prices, in euros) | Data source | Period | Min | Mean | Median | Max | Std. dev. |
|---|---|---|---|---|---|---|---|
| Gross domestic product in PPP | Eurostat | 1999–2021 | 3 191.1 | 10 678.6 | 10 547.1 | 19 282.4 | 3 727.3 |
| Capital stock | Eurostat | 1999–2021 | 2 106 | 99 968 | 19 447 | 1 087 748 | 2 338 942 |
| Population (in millions) | Eurostat | 1999–2021 | 1.3 | 10.9 | 7.4 | 38.7 | 11.1 |
| Government consumption | Eurostat | 1999–2021 | 314.3 | 838.5 | 838.8 | 1 580.0 | 303.2 |
| Research and development expenditures | Eurostat | 1999–2021 | 15.2 | 105.5 | 78.1 | 360.4 | 81.7 |
| Percentage of population with higher education | Eurostat | 1999–2021 | 7.0 | 20.2 | 19.4 | 39.8 | 7.7 |
| Tax revenues | Eurostat | 1999–2021 | 1 057.8 | 3 450.1 | 3 414.5 | 6 550.3 | 1 355.8 |
| Military expenditures | NATO | 1999/2004–2021 | 78.7 | 176.1 | 157.2 | 418.7 | 74.9 |
| Military expenditures (equipment) | NATO | 1999/2004–2021 | 0.8 | 32.4 | 23.5 | 139.0 | 27.1 |
| Military expenditures (personnel) | NATO | 1999/2004–2021 | 47.0 | 84.7 | 79.8 | 149.2 | 24.2 |
| Military expenditures (infrastructure) | NATO | 1999/2004–2021 | 0.3 | 9.7 | 6.6 | 41.0 | 9.8 |
| Military expenditures (other) | NATO | 1999/2004–2021 | 8.7 | 49.2 | 40.9 | 167.0 | 29.9 |
| Military expenditures | Eurostat | 1999–2021 | 51.9 | 143.9 | 121.9 | 415.4 | 67.7 |
| Military expenditures (equip.+infra.) | Eurostat | 1999–2021 | 0.2 | 32.0 | 20.8 | 155.8 | 31.7 |
| Military expenditures (personel) | Eurostat | 1999–2021 | 32.0 | 71.5 | 66.9 | 142.6 | 25.8 |
| Military expenditures (other) | Eurostat | 1999–2021 | 0.2 | 40.5 | 34.9 | 174.1 | 25.3 |
| Military expenditures | SIPRI | 1999–2021 | 42.7 | 165.4 | 146.5 | 421.1 | 73.8 |
| Output gap (in per cent) | AMECO | 1999–2021 | –11.20 | –0.09 | –0.20 | 11.43 | 3.49 |

*Source: Eurostat.*

## 4. Research methodology

The aim of this work is to study how military expenditure affects economic growth in CEE countries, and then to study the effect of disaggregated military expenditure on economic growth. The availability of data means that the study covers the period 1999–2021. Two methods of empirical analysis were used to carry out empirical verification. The first method studies the long-run effect of military expenditure on economic growth, and includes an estimation of the parameters of the Autoregressive Distributed Lag (ARDL) model, as the Error Correction Mechanism that is part of the model allows the parameters to be assessed in a long-run balance. The other method focuses mainly on the short-run effect of military expenditure on GDP and includes an estimation of fiscal multipliers using the Local Projections (LP) method. An analysis of the Impulse Response Functions obtained through the LP method allows a better understanding of the short-run changes in GDP caused by military expenditure in the perspective of fewer years than in the ARDL model, with a relatively small number of delays.

### 4.1 Estimations of the long-run effects of military expenditure

The study in the peace and defence literature of how military expenditure affects economic growth usually uses models based on the neoclassical production function. The dominant model for many years was the Feder-Ram model (Biswas and Ram 1986), but over time it was replaced by Augmented Solow models that were expanded to include military expenditure[1], and endogenous growth models with military expenditure as one of explanatory variables[2].

This article exploits the ARDL estimation method, which allows a variety of control variables that are thought to be possible determinants of long-term growth to be incorporated. Including capital stock, population size, a human capital proxy, research and development expenditures, and government consumption is justified by endogenous growth theory. The writers of many empirical works do not explicitly derive theoretical equations, but use the endogenous growth theory to suggest control variables. This paper uses military expenditure as one of the potential factors that could affect economic growth.

The econometric method used for the estimation is the ARDL (Autoregressive Distributed Lag) model estimated using the Pooled Mean Group method (Pesaran and Smith 1995, Pesaran et al. 1999). This method can provide unbiased estimates when there are relatively small differences between N and T in the panel data, in contrast to other "small T, big N" or "big T, small N" popular methods (Pesaran et al. 1999). By using the Error Correction Mechanism (ECM) form, this method allows the long-run relationships between dependent and independent variables to be studied. ARDL models have already been used in the peace and defence literature (see d'Agostino et al. 2017, Becker and Dunne 2021, Emmanoulidis 2022). Accepting the methodological reservations presented in Section 3, this model allows a proper assessment of the effect of military expenditures because its estimation of the parameters for the long-run

[1] The Augmented Solow model with Harrod-neutral technological progress was used to measure the effect of military expenditure on growth by Knight et al. (1996), Dunne et al. (2005), Dunne (2012), Dunne and Nikolaidou (2012), Dunne and Tian (2013b) and Becker and Dunne (2021).

[2] Theoretical models including external threats or empirical studies based on the Barro (1991) growth model can be found in Aizenman and Glick (2006), Mylonidis (2008), Pieroni (2009) and d'Agostino et al. (2017), among others.

equilibrium means it can assess long-run relationships between military expenditure and economic growth. As Emmanouilidis and Karpetis (2018) showed, the ARDL approach to the data on US growth and military expenditure seemed to be more advantageous than other econometric techniques.

After reparametrising the ARDL(p,q) dynamic panel specification into the error correction form, the equation can be presented as (Blackburne, Frank 2007):

$$\Delta y_{it} = \varphi_i\left(y_{i,t-1} - \theta'_i X_{it}\right) + \sum_{j=0}^{p-1} \lambda_{ij}^{*}\, \Delta \mathrm{y}_{i,t-p} + \sum_{j=0}^{q-1} \delta'^{*}_{ij}\, \Delta X_{i,t-j} + \mu_i + \epsilon_{it} \qquad (1)$$

where $\varphi_i$ measures the speed at which the model returns to equilibrium after a shock, $\theta_i$ and $\delta_{ij}$ measure the long-run and short-run relationships between output and control variables respectively, $\epsilon_{it}$ denotes residuals, and $\mu_i$ is the group-specific effect for each observation. The parameters $\mu_i$ capture time-invariant country-specific effects, which are sometimes referred to as country-specific fixed effects. All the variables used to estimate the model must be cointegrated, so modified Dickey-Fuller and modified Phillips-Perron tests for panel data cointegration were conducted. The results are presented in Appendix 1 together with the results for the unit root tests. Almost all the variables included in the models are cointegrated, which means the model estimation is valid. To establish the correct order of the ARDL($p$,$q$) lags, the approach of Pesaran and Shin (1996) is applied. After running the ARDL models for every country in the sample, the Akaike Information Criterion shows that an ARDL(1,1) lag choice is the best for almost all the countries.

### 4.2 Estimations of the short-run effects of military expenditure

Model estimation using the ARDL method is the first econometric method applied in this study. It allows the short-run and long-run effects on economic growth of aggregated and disaggregated military expenditures to be studied. However, it is also important to study the short-run effect of military expenditure on GDP using a higher number of lags. Commonly used models with one lag may in this case be biased because of the endogeneity problem and the methodological problems explained in Section 3. Moreover, the results of the ARDL(1,1) model estimation do not provide any information about the dynamics of variables with more than one lag. A much better method for investigating the dynamic, complex and possibly non-linear relationships between GDP and military expenditure is to calculate the fiscal multiplier using the Local Projections method, which is one of the two methods commonly used in fiscal studies together with Structural Vector Autoregression (SVAR) models (Gechert and Will 2012).

The Local Projection method (Jordà 2005) is used to determine how a shock to selected variables impacts other variables, for example how fiscal shocks impact economic outcomes. Several recent studies emphasise the advantages of the Local Projection method over SVAR models and the benefits it offers. Jordà (2005) argues that the local projections can be estimated using simple regression techniques and are known for their robustness to misspecification and their ability to handle non-linear and flexible specifications with ease. Auerbach and Gorodnichenko (2013, 2017) highlight that using this method to estimate fiscal multipliers allows a quick estimation of models with numerous parameters and does not limit the estimated responses to a specific shape. Furthermore, this method can easily be expanded to estimate the potentially non-linear effects of shocks and is ideal for dealing with error terms that are correlated across countries and over time. Local Projections can also be applied to panel data (Adämmer 2019).

The Local Projection method calculates Impulse Response Functions by estimating a series of regressions for each horizon, $h$. The linear model for each horizon $h = 0,1,2,\dots,H$ is:

$$y_{i,t+h} = \alpha_h + \psi_h(L)z_{i,t-1} + \beta_h x_{it} + \varepsilon_{i,t+h} \tag{2}$$

where $y$ is the variable of interest (GDP in this paper), $z$ is a vector of control variables, $x$ is a measure of the fiscal shock from government consumption or selected military expenditures, $\alpha_i$ is country fixed effects, $\gamma_t$ is time effects, $\psi_h(L)$ is a polynomial in the lag operator, and $\beta_h$ is the response of $y$ at horizon $h$. In the Local Projections method, the coefficients in the polynomial lag are not used only to determine the Impulse Response Functions, but they also serve as a means of controlling and minimising the impact of the control variables on the dynamics. This lets the IRFs be built directly from the $\beta_h$ coefficients. The Local Projection approach is based on regressing the variable of interest, here GDP, for each $t$+$h$ on a change of fiscal variable at time $t$, and in the next step constructing the average response of the dependent variable periods after the shock (Deleidi et al. 2021).

This study uses panel data, and so a dynamic two-way fixed effects model was used. Including country-specific and time-specific effects means the substantial heterogeneity from the sample can be captured. Auerbach and Gorodnichenko (2017) and Deleidi et al. (2021) find that the model to be estimated can be presented in the following form:

$$\Delta y_{i,t+h} = \alpha_i^h + \delta_t^h + \sum_{p=0}^{P} \beta_p^h \Delta x_{i,t-p} + \sum_{p=1}^{P} \psi_p^h \Delta y_{i,t-p} + \sum_{p=1}^{P} \phi_p^h z_{i,t-p} + \varepsilon_{ith} \tag{3}$$

Estimating the parameters in this equation produces specific fiscal elasticities. Like in Sheremirov and Spirovska (2015), Deleidi (2021) and others, GDP and fiscal variables in per capita values are defined as first differences of logarithms, $\log(y_{it}) - \log(y_{i,t-1})$. After the estimated elasticities have been multiplied by the conversion factor ($\beta^h y_i / x_i$), where $y_i$ denotes GDP and $x_i$ denotes the fiscal variable to be analysed, the dynamic fiscal multiplier can be derived from the estimated elasticities. Ramey and Zubairy (2018) note that the conversion factor may differ over time, but the data presented in Section 3 suggest that the ratio of military expenditure to GDP is relatively stable over time. The number of lags P for each fiscal variable is chosen using the Akaike Information Criterion. To determine the full impact of the fiscal variable on GDP, the accumulated fiscal multipliers are calculated. A problem associated with the Jordà method is the potential for serial correlation in the error terms induced by the successive leading of the dependent variable. To avoid this problem, the Newey-West correction for standard errors was applied.

This method was used to estimate the fiscal multipliers of total military expenditure and of more detailed categories of military expenditure. As it transpired from the review of research presented in Section 2, the value of the fiscal multiplier can be affected by multiple factors, such as whether the economy is in a state of expansion or recession, or the exchange rate regime. For this reason, some equations also include independent variables multiplied by a transition function $F(s_{it})$ that defines the probability of an economy being in a state of recession. After modifying equation (3), the specification of the equation that takes account of the state of economy is:

$$\Delta y_{i,t+h} = \alpha_i^h + \delta_t^h + \sum_{p=0}^{P} \beta_p^h \Delta x_{i,t-p} + \sum_{p=0}^{p} \delta_p^h \Delta x_{i,t-p} F(s_{it}) + \sum_{p=1}^{P} \psi_p^h \Delta y_{i,t-p} + \\ + \sum_{p=1}^{P} \eta_p^h \Delta y_{i,t-p} F(s_{it}) + \sum_{p=1}^{P} \phi_p^h z_{i,t-p} + \sum_{p=1}^{P} \mu_p^h z_{i,t-p} F(s_{it}) + \pi F(s_{it}) + \varepsilon_{ith} \quad (4)$$

where

$$F(s_{it}) = \frac{\exp(-\gamma s_{it})}{1+\exp(-\gamma s_{it})} \quad (5)$$

The transition function $F(s_{it})$ takes values from 0 for strong expansion, to 1 for a deep recession. In accordance with Auerbach and Gorodnichenko (2013, 2017), $\gamma$ takes the value 1.5, assuming that the typical economy spends around a fifth of its time in recession, while $s_{it}$ defines the output gap in a given country expressed as a percentage. Estimated values for the output gap were taken from the Autumn Forecast 2022 of the European Commission.

The Local Projections method allows control variables to be included in the equations. The control variables in this model are tax revenues and civilian government consumption, which is total government consumption minus military government consumption in ESA2010. It is particularly important in the context of military expenditure whether that expenditure is financed by taxation, debt or spending cuts, so including these two fiscal variables may capture the effects of fiscal adjustments. Some equations also include a dummy variable that takes the value 1 in countries that maintain a fixed and predetermined exchange rate regime in a given year and 0 otherwise. In 1999–2021, all the CEE countries apart from Poland and Bulgaria changed their exchange rate regimes or changed their national currencies for the euro, and so it is justified to include this variable, since it has been demonstrated that fiscal multipliers are higher in countries with a fixed exchange rate (e.g. Ilzetzki et al. 2013, Born et al. 2019). To allow the value of the multiplier of military expenditure to be compared with the multiplier of non-military government consumption, the multiplier for this kind of expenditure was also estimated, and the only difference in the model specification is that the only independent variable is the volume of tax.

Section 5 presents a description of the results of the estimation of the parameters of both models for aggregated and disaggregated military expenditures. The impulse reaction functions are presented in accumulated form. The estimation of multipliers uses data on military expenditure from ESA2010, while the multipliers estimated from the NATO data are presented in Appendix 2 as a robustness check. To save space, only the IRFs of the baseline multipliers and multipliers are shown.

## 5. Results

### 5.1 Results of estimations of the long-run effects of military expenditure

The results of the estimation of the ARDL(1,1) models are presented in Table 3. The variables in the term for the long run are first lags, and those in the term for the short run are first differences. The error correction parameters φ are statistically significant, with estimated values ranging from –1 to 0. This means the model achieves equilibrium in the long run, and so the values of the estimated parameters can be interpreted as long-run factors that affect economic growth. Control variables are included in the model in line with endogenous growth theory and are statistically significant and have the expected signs in almost all cases, which proves that the model appropriately describes the process of economic growth in the CEE countries.

Table 3 contains the results of the estimation of nine models. Model 1 uses SIPRI data and is a balanced panel covering the years 1999–2021. The models in columns 2, 4 and 6 use aggregated and disaggregated NATO data and an unbalanced panel that covers the years in which the nine CEE countries were NATO members. This means the data for Poland, Czechia and Hungary cover the years 1999–2021, while the data for the other countries cover 2004–2021. The models in columns 3 and 5 use aggregated and disaggregated ESA2010 data.

The results of the ARDL(1,1) model estimation using the Pooled Mean Group method confirm that military expenditure leads to slower economic growth. Incremental increases in GDP per capita are significantly smaller in countries where military expenditure per capita increases. The significance of the variables, their signs and the values of the parameters provide strong evidence that military expenditure as found from the SIPRI, NATO and Eurostat databases has a negative effect on the GDP growth rate. These results corroborate the conclusions from a number of the works presented in Section 2 (among others, Mylonidis 2008, Daněk 2015, Dunne and Tian 2013b, d'Agostino et al. 2017).

After military expenditures are disaggregated first into three categories and then into four NATO categories, it can be observed that expenditure on military personnel has a significant and strong negative effect on economic growth in the long run. This expenditure is closely connected with compulsory military conscription, the number of civilian employees in the military, and the size of the military forces, so it can be assumed that the outflow of employees from civilian sectors to the military sector and the resulting drop in the labour supply for civilian sectors is one of the main causes of the negative effect that military expenditure has on GDP growth, as expenditure on military personnel is the major part of total military expenditure. This conclusion is in line with the results of the study by Becker and Dunne (2021), which obtained similar results from a sample of all NATO countries. The conclusions from Emmanoulidis (2022) using data from the US military budget are different, as they suggest that expenditure on military personnel has a positive short-run impact on the economy but is insignificant in the long run.

Similar conclusions can be reached by analysing the significance and sign of the parameters for the two other categories of other expenditure and expenditure on equipment. Military expenditure in these categories also has a negative effect on GDP growth, although the values of the parameters are lower than those of the parameters for personnel expenditure. Both these categories cover above all expenditure on purchasing arms, maintaining the army with uniforms, heating, fuel, ammunition, and so forth, and expenditure on military missions abroad. Although they may cause demand-side effects in the short run, their effect in the long-run balance is negative.

The estimation results from column 6 may imply that investment in military infrastructure has a significant and positive effect on economic growth in the long run. This investment is usually in building and modernising roads, bridges, railways, telecommunications installations and harbour facilities, and so the civilian sector may also benefit from them. However, it should be remembered that investment in military infrastructure constituted only 4.8% of total military expenditure in the CEE countries.

Table 3. Estimation results of ARDL models

| Source of data: | (1) SIPRI | (2) NATO | (3) ESA2010 | (4) NATO | (5) ESA2010 | (6) NATO |
|---|---|---|---|---|---|---|
| | **Long-run equation** | | | | | |
| Capital stock | 0.1401***<br>(0.0189) | 0.1688***<br>(0.0206) | 0.1852***<br>(0.0306) | 0.1074***<br>(0.0237) | 0.1671***<br>(0.0302) | 0.1236***<br>(0.0239) |
| Working age population | 0.0014***<br>(0.0004) | 0.0013**<br>(0.0005) | 0.0046**<br>(0.0018) | 0.0027***<br>(0.0006) | 0.0045**<br>(0.0017) | 0.0025***<br>(0.0007) |
| Non-military government consumption | 2.7151***<br>(0.3164) | 2.4293***<br>(0.2503) | 0.6671*<br>(0.3798) | 3.2956***<br>(0.2649) | -0.1621<br>(0.5176) | 3.1260***<br>(0.2593) |
| R&D expenditures | 0.3942***<br>(0.0751) | 0.2640***<br>(0.0486) | -0.1236<br>(0.1937) | 0.2720***<br>(0.0511) | 0.1291<br>(0.1052) | 0.2775***<br>(0.0519) |
| Higher education (% change) | -0.0191<br>(0.0342) | 0.0512**<br>(0.0235) | -0.0111<br>(0.0105) | 0.0727***<br>(0.0217) | 0.0285**<br>(0.0118) | 0.0757***<br>(0.0253) |
| Military expenditures | –9.5595***<br>(1.3891) | -5.1906***<br>(1.1168) | -6.7291***<br>(2.0001) | | | |
| Military personnel expenditures | | | | -21.543***<br>(4.559) | -14.256***<br>(3.3688) | -25.070***<br>(4.5663) |
| Military other expenditures | | | | -9.8243***<br>(3.2913) | -16.948***<br>(5.1647) | -6.5438*<br>(3.4279) |
| Military equipment and infrastructure expenditures | | | | -7.8152***<br>(1.5924) | -6.6839**<br>(3.1939) | |
| Military equipment expenditures | | | | | | -6.6017***<br>(1.6435) |
| Military infrastructure expenditures | | | | | | 17.0714*<br>(9.9487) |
| | **Short-run equation** | | | | | |
| Error correction term (φ) | –0.5167***<br>(0.1036) | –0.7258***<br>(0.0931) | –0.5506***<br>(0.0905) | –0.7434***<br>(0.1165) | –0.5645***<br>(0.0909) | –0.7356***<br>(0.1247) |
| Capital stock | 0.9497***<br>(0.2091) | 0.8755***<br>(0.2017) | 1.0306***<br>(0.228) | 0.8287***<br>(0.1764) | 0.9791***<br>(0.215) | 0.7844***<br>(0.1612) |
| Working age population | 0.3688<br>(0.3741) | –0.1052<br>(0.1022) | 0.0315<br>(0.0502) | 0.2054<br>(0.1955) | 0.0324<br>(0.0526) | 0.1460<br>(0.1461) |
| Government consumption | 1.5133***<br>(0.4423) | 1.6362***<br>(0.4391) | 1.0462***<br>(0.3509) | 1.7267***<br>(0.5223) | 0.6917*<br>(0.4043) | 1.4009***<br>(0.4039) |
| R&D expenditures | 1.5068**<br>(0.7487) | 1.2433***<br>(0.4689) | 0.6090<br>(0.4208) | 0.7712<br>(0.5836) | 0.6111***<br>(0.1886) | 0.6537<br>(0.8058) |
| Military expenditures | –1.6924<br>(2.2674) | 0.6030<br>(1.5277) | –2.0152<br>(2.0226) | | | |
| Military personnel expenditures | | | | –5.9085<br>(4.9082) | –0.8915<br>(3.3468) | –7.5528<br>(5.1164) |
| Military other expenditures | | | | –7.0600*<br>(4.0206) | –3.5463<br>(3.5743) | –8.0506**<br>(3.48) |
| Military equipment and infrastructure expenditures | | | | 0.8540<br>(2.0825) | –2.0899<br>(2.4819) | |
| Military equipment expenditures | | | | | | 0.4464<br>(2.2519) |
| Military infrastructure expenditures | | | | | | 13.8887<br>(9.9774) |
| Constant | 55.3017<br>(48.1461) | 61.9157<br>(51.7605) | 459.548<br>(590.514) | 84.7885<br>(56.9701) | 500.2381<br>(617.261) | 93.7989<br>(67.0402) |
| Wooldridge serial correlation test on residuals (p-value) | 0.6777 | 0.1693 | 0.4850 | 0.0746 | 0.3880 | 0.1032 |
| Observations | 198 | 168 | 198 | 168 | 198 | 168 |

*Note: Standard errors in parentheses: *** p<0.01 ** p<0.05 * p<0.1*

## 5.2 Results of estimations of the short-run effects of military expenditure

The estimates of the fiscal multiplier using the Local Projections method and impulse response functions are presented in Figures 3–12 and in Table 4. To save space, this paper only presents the figures for the impulse response functions of GDP changes in response to changes (shocks) in civilian, meaning non-military, government consumption or to different categories of military expenditure. The fiscal multiplier of each shock variable is presented in two forms, with and without state-dependent explanatory variables. The figures present the IRFs estimated by Local Projections using the analytical method and 68% standard error bands, like other works on the fiscal multiplier (e.g. Ramey 2011). The study uses annual data rather than quarterly data because there is a lack of quarterly data on military expenditure, so the shape of the IRFs may deviate from the standard hump-shaped IRFs found from quarterly data.

The results of the estimation of the accumulated fiscal multipliers allow it to be stated that the fiscal multipliers of military expenditure are significant and smaller than 1 (Table 4) on impact. The fiscal multipliers of military expenditure are higher during recessions, as they are close to unity on impact and fall in the years after the shock. This is consistent with intuition, because military expenditure is included in GDP, and so GDP is highest in the year it occurs. In the second and subsequent years after a shock, there is a gradual drop in the value of the multiplier to around zero, though it is then insignificant or barely statistically significant. Such a drop implies that military expenditure has no long-run effect on economic growth. The exchange rate regime in the CEE countries had only a very limited effect on the change in the value of the estimated multipliers.

Table 4. Estimates of accumulated fiscal multipliers (ESA2010)

| | Accumulated multipliers (years after shock) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Government consumption | 1.0071*** | 1.3285*** | 0.8709*** | 0.4778 | 0.2951 | 0.592** | 0.5076 | 0.5406 | 0.8615*** | 0.7073** |
| Military expenditures | 0.7708 | 0.6919 | 0.2429 | 0.5016 | 0.2374 | 0.0355 | 0.0088 | 0.1671 | -0.1211 | 0.2958 |
| Military expenditures (personnel) | 1.0802* | 0.3685 | -1.9497*** | -1.4054* | -1.4273* | -2.3255*** | -0.2288 | -1.2412 | -0.5377 | -0.0393 |
| Mil. expenditures (equipment and infra.) | 0.8593*** | 0.9505*** | 0.5601* | 1.0853*** | 0.7099** | 0.8024*** | 0.9747*** | 0.6238 | 0.4747 | 0.5578* |
| Military expenditures (other) | 0.8229 | -1.0785 | 0.2065 | 1.5062 | -0.4607 | -1.3141 | 0.1686 | -1.8107 | -1.7497 | -1.5044 |
| | Accumulated multipliers - Military buildup since outbreak of war in Donbas (years after shock) | | | | | | | | | |
| Military expenditures | 0.5764 | 1.0745*** | 0.2683 | 0.5235 | 0.5122 | 1.0160 | -0.8395 | | | |
| Military expenditures (personnel) | 0.7968 | 1.4989* | -2.2689*** | -0.9117 | -1.3574* | -1.4146 | -1.2697 | | | |
| Mil. expenditures (equipment and infra.) | 0.0029 | 0.5807 | -0.4898 | 0.3438 | 0.2817 | 1.2285* | -0.0635 | | | |
| Military expenditures (other) | 1.0142 | 0.4884 | 0.2307 | 0.4550 | 0.3631 | 0.2430 | 2.4477** | | | |
| | Accumulated multipliers in recession (years after shock) | | | | | | | | | |
| Government consumption | 1.2479*** | 1.3474*** | 1.0876*** | 0.4302 | 0.1880 | 0.4737 | 0.1610 | 0.3438 | 0.8344** | 0.6228* |
| Military expenditures | 0.9968** | 0.9341 | 0.6968 | 0.8776* | 0.8052 | 0.1948 | 0.8309 | -0.4441 | -0.0159 | 0.5153 |
| Military expenditures (personnel) | 1.3258*** | 0.8718* | -0.5374 | -0.1856 | 0.3479 | -1.1354 | 0.2464 | 0.0602 | -0.8095 | -0.3513 |
| Mil. expenditures (equipment and infra.) | 1.0235* | 1.2712** | 0.6330 | 1.8987*** | 1.5348** | 1.34645*** | 1.3277** | 0.3782 | 0.8277 | 0.3406 |
| Military expenditures (other) | 0.8793** | 0.8465 | 0.9410 | -0.1698 | 0.2693 | -0.7518 | -1.0384 | -1.602* | -0.2033 | -1.2277 |
| | Accumulated multipliers in recession and fixed exchange rate regime (years after shock) | | | | | | | | | |
| Government consumption | 1.2494*** | 1.362*** | 1.1005*** | 0.4597 | 0.2506 | 0.5769* | 0.2103 | 0.3704 | 0.8467** | 0.6356* |
| Military expenditures | 0.9968** | 0.9300 | 0.6942 | 0.8775* | 0.7630 | 0.0793 | 0.8311 | -0.4503 | -0.0037 | 0.4682 |
| Military expenditures (personnel) | 1.32676*** | 0.858* | -0.5572 | -0.2067 | 0.2756 | -1.3435 | 0.2101 | 0.0013 | -0.8371 | -0.2986 |
| Mil. expenditures (equipment and infra.) | 1.0232* | 1.2755** | 0.6384 | 1.9039*** | 1.5297** | 1.3201** | 1.3152** | 0.3821 | 0.8152 | 0.3318 |
| Military expenditures (other) | 0.8798** | 0.8453 | 0.9409 | -0.1393 | 0.2862 | -0.7307 | -1.0055 | -1.4618* | -0.0366 | -1.2695 |

Test of significance: *** p<0.01, ** p<0.05, * p<0.1

By contrast though, the fiscal multipliers of non-military government consumption are larger than the multipliers of military expenditures by 0.2–0.3 on impact and by 0.4–0.5 in the second and third years after a shock. They are significant and are higher than 1 in the two to three years after a shock, and higher during recessions. They reach their peaks two years after the shock occurs, suggesting that there are short-run, demand-side effects in the CEE countries. This allows the conclusion that although military expenditure has fiscal multipliers that are statistically significant and close to 1, it is not the most effective tool for boosting economies in the short run. The results obtained suggest an increase in non-military government consumption would cause a greater GDP response than an increase in military expenditure, both during a recession and in normal times. These results are consistent with the conclusions of the meta-analysis by Gechert and Will (2012).

The fiscal multipliers of other disaggregated military expenditures perform similarly to the multiplier of total military expenditure. They are statistically insignificant, though larger during recessions. The multiplier of military expenditure on equipment and infrastructure in normal times is statistically significant and remains in the range of 0.8–1.0 during the first two years after a shock, and it also takes relatively high values in subsequent years. This is probably the result of short-run effects on the demand side and minor long-run effects on the supply side, as investment in infrastructure can have a positive effect on the economy by increasing public capital, and expenditure on purchasing arms can increase the productivity of domestic suppliers.

The fiscal multipliers of expenditure on military personnel in normal times are close to 1 and statistically significant in the first year after a shock, which suggests there are short-run effects on the demand side connected with higher spending on compensation and possibly with a reduction in unemployment. The multipliers are negative and statistically significant in the three to six years after a shock, which suggests that the long-run effects of increasing expenditure on compensation, largely in connection with expanding the army, have a strong effect on slowing GDP growth. Removing thousands of young people from the labour market through mandatory conscription or expanding the professional army may cause negative supply effects, as the people who are serving cannot work in the civilian sectors of economy, where their labour productivity may be higher.

The estimation of equations using the Jordà method for Local Projections and an analysis of the Impulse Response Functions leads to similar conclusions to those from the model estimations using the ARDL method. Both methods show that an increase in military expenditure in the CEE countries in 1999–2021 led GDP growth to slow down. There can be positive short-run demand effects in a perspective of one or two years from an increase of military expenditure, particularly in a recession, but they fade in subsequent years. The long-run effect, particularly from expenditure on military personnel, is a decrease in GDP growth, possibly because of negative adjustments on the supply side of the economy. The same conclusions are reached by analysis of the long-run balance estimated in the ARDL model. The results suggest that the only type of military expenditure that has a positive effect on GDP growth is expenditure on infrastructure investment. However, that remains a very small part of total military expenditure. The results of the estimations of the same multipliers using NATO data instead of ESA2010 data are presented in Appendix 2 and confirm the robustness of the results obtained.

**Accumulated fiscal multiplier**

**Accumulated fiscal multiplier in a recession and with a fixed exchange rate regime**

Figure 3. GDP to non-military government consumption

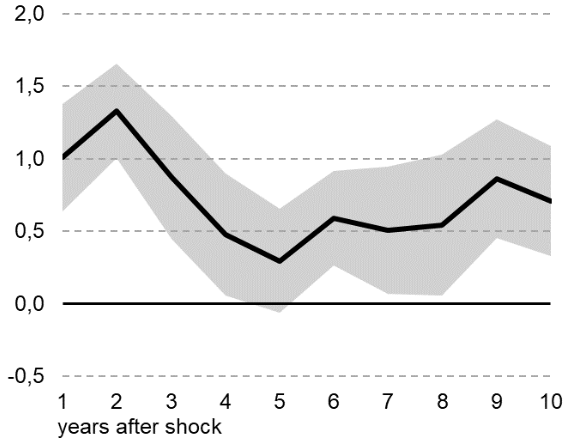



Figure 4. GDP to non-military government consumption


Figure 5. GDP to military expenditures (ESA2010)


Figure 6. GDP to military expenditures (ESA2010)


Figure 7. GDP to military expenditures (personnel)

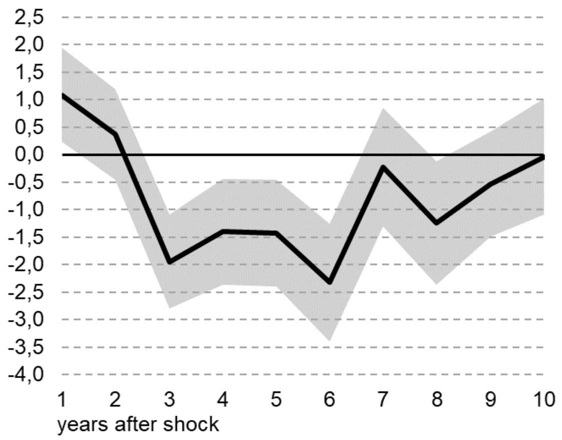



Figure 8. GDP to military expenditures (personnel)

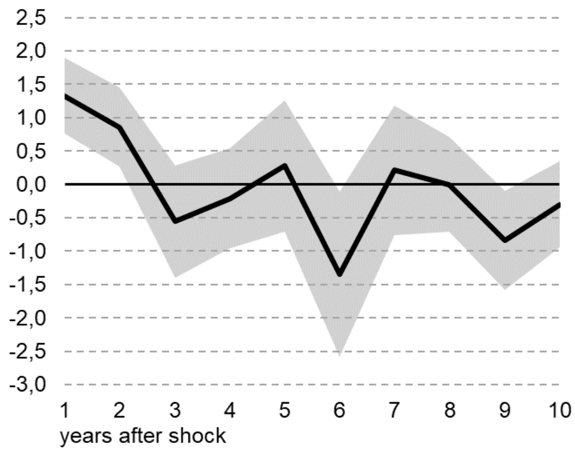


Figure 9. GDP to military exp. (equipment, infrastructure)

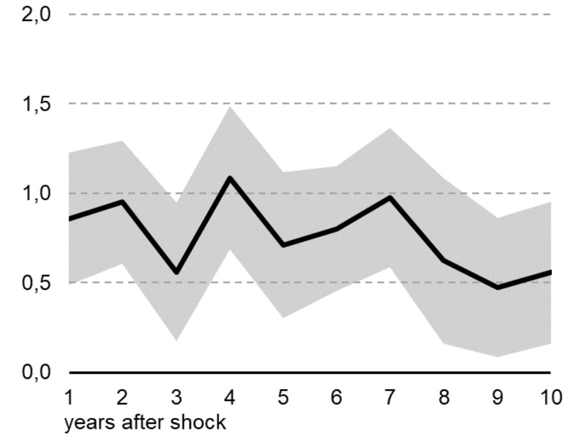



Figure 10. GDP to military exp. (equipment, infrastructure)


Figure 11. GDP to military expenditures (other)

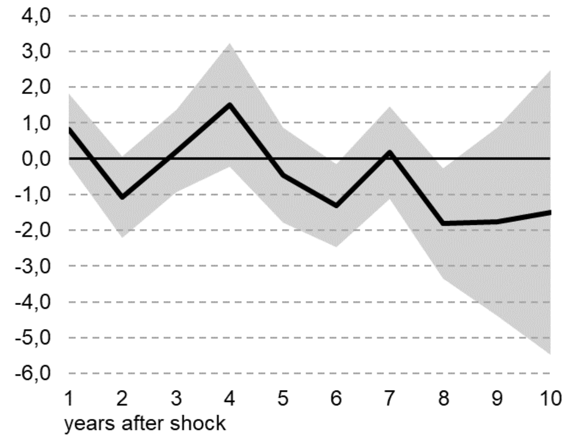
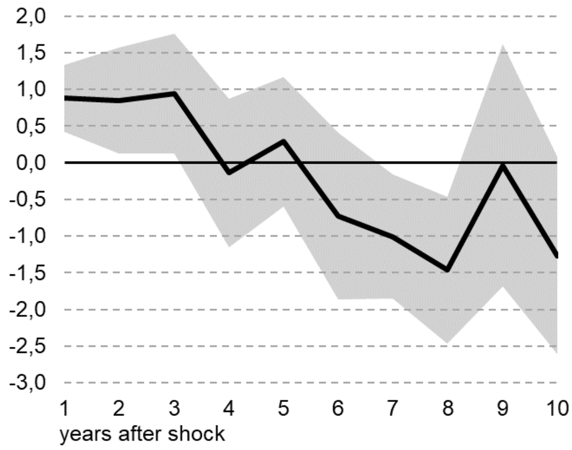



Figure 12. GDP to military expenditures (other)




Figures 3–12. Responses of GDP to a shock in selected fiscal variables

## 6. Conclusions

This work presents the results of a study of how military expenditure affected economic growth in the Central and Eastern European (CEE) countries in 1999–2021. Understanding this effect is particularly important following Russia’s invasion of Ukraine in 2022 and the planned significant increase in military expenditure in the region.

Economic theory suggests that military expenditure may either increase or decrease the rate of economic growth (e.g. Dunne et al. 2005). Higher spending on security provides better protection of the life, health and property of citizens and so may support economic growth, but equally the military in non-democratic states can be used to protect the interests of elites rather than those of all citizens. Fiscal expansion through increased military expenditure can stimulate demand and reduce unemployment, but it may at the same time crowd out private consumption and investment, and force fiscal adjustments through increases in debt or taxes, or cuts to other expenditure. Military expenditures can support the development and modernisation of industry but may equally stunt the development of non-military industries and reduce the labour supply by employing workers in the professional army or through compulsory conscription.

The results presented in this article confirm that military expenditure reduced the GDP growth rate in the CEE countries in the years 1999–2021. The results of a long-run equilibrium estimation indicate that both total military expenditure as found from the SIPRI, NATO and Eurostat databases, and disaggregated military expenditure contributed to a decline in the GDP growth rate. After military expenditure was disaggregated first into three categories and then into four, it was demonstrated that the largest effect on slowing the rate of economic growth was caused by expenditure on military personnel, which was most probably because of the adjustment of the labour market and the drop in the supply of employees in non-military sectors. The decrease in GDP growth also came from expenditure on purchasing arms and other military expenditure, though to a lesser degree. These results are consistent with those of a similar recent study by Becker and Dunne (2021). It has also been demonstrated that spending on military infrastructure can have a positive effect on economic growth because of its potential positive externalities.

To understand the short-run effects of military expenditure better, a second research method was used, which was the estimation of fiscal multipliers using the Jordà Local Projections method to generate Impulse Response Functions. The results obtained imply that military expenditures cause short-run GDP growth on impact in the first year, with a multiplier of 0.7–1.0, but have a lower and statistically insignificant effect in subsequent years. The fiscal multipliers of military expenditure are significantly lower than the fiscal multipliers of non-military government consumption, as they are smaller by 0.2–0.3 on impact and by 0.4–0.5 in the second and third years after a shock. This shows that fiscal expansion through increased military expenditure in the CEE countries was a worse fiscal policy tool than expansion through increased non-military expenditure. The fiscal multipliers of military expenditure are larger in recessions, but are still lower than the multipliers of non-military expenditure. The fiscal multipliers of expenditure on purchasing arms and developing infrastructure are relatively high, while expenditure on personnel has a relatively high multiplier on impact at 1.1–1.3, but negative multipliers in the three to six years after a shock. This suggests that increasing the size of the army and excluding young people from the labour market has strong, negative, long-run effects on the supply side of the economy.

Using disaggregated military expenditures to estimate fiscal multipliers is one of the main contributions of this paper to the literature. The fiscal policy literature uses military expenditure as an instrument for calculating the government expenditures multiplier, and this paper provides estimates showing that the fiscal multipliers of military expenditure and non-military government consumption are different, and that non-military consumption has the higher multiplier. This article also discusses the validity of the data used in the literature on peace and defence economics and points out that using military expenditures on an accrual basis is more methodologically correct.

It can be concluded from the empirical analysis that higher military expenditure in the CEE countries affected GDP growth negatively in 1999–2021. The planned increase in military expenditures from 2023 onwards implies from historical data analysis that policy-makers and forecasters may expect a lower rate of economic growth in these countries. Providing security after a rise in geopolitical instability in the region needs higher opportunity costs from the larger military burden to be handled. It seems that one of the most important factors that has a negative impact on economic growth is the outflow of workers from non-military sectors to the military sector as they do their compulsory military service, which forces employees to work at below their potential productivity in the civilian labour market, or as they join the professional army. Since it is possible to substitute capital and labour to some degree in the military (e.g. Bove and Cavatorta 2012), it may be worth considering increasing capital expenditure and purchasing more advanced weapons instead of conscripting more recruits.

The effect of military expenditure on economic growth is a very complex and multi-sided issue. Researchers should remember that the data from the SIPRI and NATO databases are recorded on a cash basis, while the data on GDP in the EU and OECD methodologies are recorded on an accrual basis. This may lead to inconsistencies, since the data in the EU and OECD methodologies may be recorded with delays, so that using regressions with no lags or with only one lag may provide biased results because of the methodology used for collecting data in the national accounts. Another interesting stream of research concerns the individual channels through which military-related activities influence economic growth, in particular supply-side effects and the labour market channel.

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## Appendix 1

Table 5. Unit root and cointegration tests

| Unit-root tests for panel data (Null hypothesis: panel contains a unit root) | | | | | |
|---|---|---|---|---|---|
| Variable (in per capita terms) | First differences | Levin-Lin-Chu | | Im-Pesaran-Shin | |
| | | Test statistic | P-value | Test statistic | P-value |
| GDP | | –0.8541 | 0.1965 | 3.1965 | 0.9993 |
| | YES | –6.1317 | 0.0000 | –6.1097 | 0.0000 |
| Working-age population | | –4.9463 | 0.0000 | –0.5275 | 0.2989 |
| | YES | –2.2934 | 0.0109 | –2.2583 | 0.0120 |
| Capital stock | | 0.3509 | 0.6372 | 9.0936 | 1.0000 |
| | YES | –3.9643 | 0.0000 | –1.6966 | 0.0449 |
| Government consumption | | 2.0332 | 0.9790 | 8.4907 | 1.0000 |
| | YES | –2.6524 | 0.0040 | –4.9510 | 0.0000 |
| R&D expenditures | | 1.8243 | 0.9659 | 5.1324 | 1.0000 |
| | YES | –6.9969 | 0.0000 | –6.5361 | 0.0000 |
| Higher education | | 0.3580 | 0.6398 | 6.8651 | 1.0000 |
| | YES | –19.3383 | 0.0000 | –5.1462 | 0.0000 |
| Military expenditures (SIPRI) | | 2.2173 | 0.9867 | 5.2874 | 1.0000 |
| | YES | –1.8066 | 0.0354 | –5.2878 | 0.0000 |
| Military expenditures (NATO) | | 1.3753 | 0.9155 | 5.6484 | 1.0000 |
| | YES | –3.4152 | 0.0003 | –4.4464 | 0.0000 |
| Military expenditures (ESA2010) | | –1.4030 | 0.0803 | 0.2279 | 0.5902 |
| | YES | –7.3225 | 0.0000 | –7.2271 | 0.0000 |
| Military expenditures (personnel) | | 2.5527 | 0.9947 | 6.0655 | 1.0000 |
| | YES | –3.0222 | 0.0013 | –4.4990 | 0.0000 |
| Military expenditures (other) | | 1.6002 | 0.9452 | 2.3294 | 0.9901 |
| | YES | –5.5085 | 0.0000 | –6.1510 | 0.0000 |
| Military expenditures (equipment and infrastructure) | | –0.1126 | 0.4552 | 1.8769 | 0.9697 |
| | YES | –6.0166 | 0.0000 | –5.7165 | 0.0000 |
| Military expenditures (equipment) | | –1.2748 | 0.1012 | 1.0978 | 0.8639 |
| | YES | –4.2194 | 0.0000 | –6.1526 | 0.0000 |
| Military expenditures (infrastructure) | | 1.4460 | 0.9259 | 0.8015 | 0.7886 |
| | YES | –3.4267 | 0.0003 | –6.1618 | 0.0000 |
| Cointegration of variables in the long-run term tests (Null hypothesis: no cointegration) | | | | | |
| Equation numbers | | Modified Dickey-Fuller | | Modified Phillips–Perron | |
| | | Test statistic | P-value | Test statistic | P-value |
| (1) | | –10.0921 | 0.0000 | 3.2155 | 0.0007 |
| (2) | | –6.8673 | 0.0000 | 2.6452 | 0.0041 |
| (3) | | –8.4075 | 0.0000 | 3.2774 | 0.0005 |
| (4) | | –9.2499 | 0.0000 | 3.4935 | 0.0002 |
| (5) | | –11.8547 | 0.0000 | 3.6916 | 0.0001 |
| (6) | | –13.9492 | 0.0000 | 3.0806 | 0.0010 |

# Appendix 2

Table 6. Accumulated fiscal multipliers (NATO database)

| | Accumulated multipliers (years after shock) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Government consumption | 1.0071*** | 1.3285*** | 0.8709*** | 0.4778 | 0.2951 | 0.592* | 0.5076 | 0.5406 | 0.8615*** | 0.7073** |
| Military expenditures | 0.7708* | 0.6919 | 0.2429 | 0.5016 | 0.2374 | 0.0355 | 0.0088 | 0.1671 | -0.1211 | 0.2958 |
| Military expenditures (personnel) | 1.0802* | 0.3685 | -1.9497** | -1.4054* | -1.4273* | -2.3255** | -0.2288 | -1.2412 | -0.5377 | -0.0393 |
| Mil. expenditures (equipment and infr.) | 0.8593*** | 0.9505** | 0.5601 | 1.0853*** | 0.7099* | 0.8024* | 0.9747** | 0.6238 | 0.4747 | 0.5578 |
| Military expenditures (other) | 0.8229 | -1.0785 | 0.2065 | 1.5062 | -0.4607 | -1.3141 | 0.1686 | -1.8107 | -1.7497 | -1.5044 |
| | Accumulated multipliers in expansion (years after shock) | | | | | | | | | |
| Government consumption | 1.0094*** | 1.3364*** | 0.8742*** | 0.4917 | 0.3241 | 0.6424* | 0.5213 | 0.5465 | 0.8628*** | 0.7137** |
| Military expenditures | 0.6702 | 0.5479 | -0.0936 | 0.2728 | -0.1544 | -0.514 | -0.2257 | -0.5815 | -0.5988 | -0.0455 |
| Military expenditures (personnel) | 1.0259 | 0.5166 | -2.4576* | -1.3278 | -1.3737 | -3.0982** | -0.3897 | -1.6164 | -0.7924 | -0.0169 |
| Mil. expenditures (equipment and infr.) | 0.7114 | 0.8352 | 0.281 | 1.0211* | 0.4645 | 0.58004 | 0.8685 | 0.2438 | 0.3685 | 0.2859 |
| Military expenditures (other) | 1.1797 | -1.521 | 0.303 | 2.2102 | -0.6515 | -1.7807 | 0.3715 | -2.4152 | -2.7609 | -2.362 |
| | Accumulated multipliers in expansion and floating exchange rate regime (years after shock) | | | | | | | | | |
| Government consumption | 0.9949*** | 1.2995*** | 0.837*** | 0.4538 | 0.2736 | 0.5651* | 0.4517 | 0.5066 | 0.8295** | 0.6908** |
| Military expenditures | 0.6817 | 0.5469 | -0.0948 | 0.2709 | -0.139 | -0.4005 | -0.1434 | -0.5283 | -0.5657 | 0.0028 |
| Military expenditures (personnel) | 1.08003 | 0.6696 | -2.3499* | -2.1278** | -2.1737** | -2.6967** | -0.0532 | -1.3214 | -0.6471 | 0.0652 |
| Mil. expenditures (equipment and infr.) | 0.6716 | 0.7213 | 0.1898 | 0.9267 | 0.3313 | 0.3701 | 0.6246 | 0.0155 | 0.1246 | 0.1959 |
| Military expenditures (other) | 1.1646 | -1.6422 | 0.1907 | 2.126 | -0.5916 | -1.6591 | 0.3962 | -2.6967 | -2.5525 | -1.8971 |

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