Economic growth and military expenditures with a fiscal policy perspective in NATO's Eastern flank countries 1999-2021

Abstract: Using a newly created dataset of detailed and disaggregated military expenditures, this paper studies the impact of military expenditures on economic growth in nine Central and Eastern European countries in 1999-2021. The results of the estimation of a Barro-type endogenous growth model with military expenditures confirm a negative and significant influence of different kinds of military expenditures on economic growth in the long run, and identify personnel expenditures and labour market adjustments as one of the most important channels of influence. To measure the impact of the short-run effect, fiscal multipliers of military expenditures were estimated using SVAR model and significantly negative values were obtained for aggregated and disaggregated military expenditures. Military expenditures tend to crowd-out non-military government expenditures in some cases.

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

JEL Codes: H56, O11

1. Introduction

After the end of the Cold War, the countries of the Central and Eastern Europe experienced a period of peace and relative security, sometimes referred to as "peace bonus" or "peace dividend," additionally strengthened by the accession of the said countries into NATO in 1999 and 2004. Despite these countries' necessity to switch to NATO arms standard and to participate in military missions of the alliance, the median level of military expenditure of nine countries of the so-called NATO's Eastern Flank decreased from 1.84% GDP in 2003 to 1.02% GDP in 2013. The annexation of Crimea and the war in Donbas significantly changed the attitude of authorities to increasing military expenditures. Since that time, military expenditures have continued to grow year by year, reaching 1.95% in 2021.

Russia's aggression against Ukraine in 2022 forced further significant increases of military expenditures. In Q1 and Q2 2022, Poland decided to raise the level of military expenditures from 2.2% GDP in 2022 to 3.0% GDP in 2023; Lithuania from 2.0% to 3.0%; Latvia from 2.0% to 2.25%; Estonia from 2.2% to 2.44%; Romania from 2.02% to 2.5%; Slovakia from 1.7% to 2.0%; and Germany from 1.6% to 2.0%; respectively. Such high and never seen before increases of military expenditures in the countries in the region raise an urgent question to policy-makers and forecasters about the effect of such expenditures on the economies of the countries in the region. Higher level of security generates costs and it is necessary to investigate these costs. An intention to study the effect of military expenditures on the economic growth of the countries of Central and Eastern Europe (hereinafter CEE) is one of the main motivations of the research. So far, there have been few works concerning the region, making this work a significant contribution to the literature.

This paper contributes to the literature in many other ways, too. The existing empirical works have focused on studying the effect of military expenditures on economic growth usually by creating panel regressions with cross-country data with economic growth on the left-hand side of the equation and military expenditures with control variables on the right-hand side of the equation. Results obtained this way vary; furthermore, result interpretations rarely include references to the definition of the GDP and national accounts. According to the ESA2010

European methodology (and OECD methodology), military expenditures are almost entirely included in government (collective) consumption or government gross fixed capital formation. These categories are included in the GDP sum; that is why an increase of military expenditures by EUR 1 billion causes, in theory, an automatic increase of the GDP by EUR 1 billion. In practice, however, the GDP growth is different due to the fiscal multiplier effect, crowding-out or crowding-in of other government expenditures, possible raise of tax rates or increase in sovereign debt level, fiscal spillovers, other economic adjustments, etc. The ratio between GDP growth and the increase of military expenditures is not 1:1; thus, from a fiscal policy perspective, estimating regression without lagged independent variables or with only one lag measures mainly fiscal adjustment effects. Due to different methods of accounting in the databases of OECD and EU (the accrual method) and databases of NATO and SIPRI (the cash accounting method), investments in the purchase of military equipment are included in the GDP with a lag of up to one year. Furthermore, military expenditures as a rule entail a large inertia (in CEE countries, year-to-year changes rarely exceeded 0.2 percentage points of the GDP), while a change in military expenditures can be correlated with the increase of other categories of collective consumption due to greater fiscal expansion or fiscal consolidation, whose macro-economic effects can be similar. Taking all these potential issues into consideration, regressions with one lag and basic variables used in growth models (e.g. Solow growth model) do not appear to be the best estimation tool.

A much better tool for the estimation of short-run effects of fiscal expansion in the form of increased military expenditures seems to be an estimation of fiscal multipliers using one of existing modelling methods. Surprisingly, such an approach is rarely found in the peace and defence economics literature. In typically macroeconomic literature, military expenditures are often used to estimate the value of the fiscal multiplier for many reasons. Above all, they seem to be a relevant instrument of economy reaction to fiscal shock, because they are driven mostly by external geopolitical factors and are exogenous to internal economic factors (Hall 2009). Moreover, they are usually unanticipated by consumers, they account for much of the variation in government purchases, they are assumed to be temporary and they influence many sectors of economy (Barro and Redlick 2011). However, these assumptions most of all pertain to the USA, while in CEE countries they are fulfilled to a lesser degree due to a lack of any sudden wars prior to 2021. Still, calculating fiscal multipliers using fiscal policy models appear to be a better tool for the estimation of short-run effects of changes in military expenditures due to including other fiscal variables. This article presents the results of multiplier estimation using the Blanchard-Perotti (2002) approach based on recursive ordering using Cholesky decomposition and restricted non-zero tax elasticities identification. The estimation results show that, although the fiscal multiplier is insignificantly positive after the first year, the accumulated multiplier in subsequent years is significantly negative and ranges from -0.7 to -0.9 in a period of 3-5 years from an impulse. After a disaggregation of military expenditures, it can be stated that the negative multiplier covers military personnel expenditures and positive multiplier covers infrastructure investments (which, however, are a small expenditures category). This provides a strong argument for stating that military expenditures in CEE countries have been contributing to a decrease of economic growth.

In order to study the long-run effect of military expenditures on economic growth, this article presents estimation results of a Barro-type endogenous growth model (Barro 1990, Barro and Sala-i-Matin 2003) with capital stock, population change, other government consumption, human capital, R&D expenditures and military expenditures as explanatory variables. The Pooled Mean Group estimator based on an error correction mechanism was used, which allows estimating long-run relationships between military expenditures and economic growth. The results show that in CEE countries in 1999-2021, military expenditures (from the databases of SIPRI, NATO and Eurostat) had a negative effect on economic growth in the long run.

Furthermore, this article presents an analysis of the effect of disaggregated military expenditures from NATO databases on economic growth in order to identify the most important channels of influence of military burdens on economic growth. The estimation results suggest that the largest negative impact was caused by military personnel expenditures (the obtained results corroborate with the results from Becker and Dunne (2021)). Meanwhile, investments in infrastructure development had a positive impact on economic growth, most likely due to their potential positive externalities. Control variables describing soldiers' participation in foreign missions, the relationship between the military personnel and the number of the working age population, obligatory military conscription, and the effect of arms imports are statistically insignificant.

The rest of the article is organised as follows: Section 2 presents a review of literature concerning the effect of military expenditures on economic growth as well as literature concerning fiscal multipliers. Section 3 provides a description of institutional conditions and data used in the study. Section 4 describes the identification strategy; whereas the results of model estimations are contained in Section 5. Section 6 provides a summary.

2. Literature review

The effect of military expenditures on economic growth has for decades been the subject of debates and studies. Since Benoit (1973, 1978) suggested in his works that military expenditures can have a positive effect on economic growth, there have been dozens of publications verifying the hypotheses raised by Emil Benoit. In spite of researchers' efforts, a consensus in this matter has not been reached yet. A review of literature of Dunne and Tian (2013) shows that out of 46 works published between 2007 and 2013, positive findings are provided by 26.1%, negative by 41.3%, and 32.6% provide unclear results. Such results indicate that the literature is far from reaching a consensus. This is most likely due to the fact that the effect of military expenditures on economic growth is highly complex as well as time-variant and country-specific due to its heterogeneity.

Dunne et al. (2005) distinguish three main channels through which military expenditures can affect economic growth: security channel, demand channel and supply channel. Other works offer different classifications or descriptions of different potential channels; however, the above-mentioned division into three channels appears to appropriately group potential growth factors.

Countries invest in the development of their armies in order to most of all protect their borders and their citizens. Security is a public good necessary for the proper functioning of markets, protection of life, health and property rights. Shieh et al. (2002) present a model which implies the existence of a certain optimal level of security generated by military expenditures that maximises economic growth. Military expenditures allow dealing with internal and external threats, while political stability decreases the level of uncertainty in economies and may encourage domestic and foreign investors to increase investment expenditures and FDI (Smaldone 2006). Political stability may also offer a stimulus for the development of international trade. On the other hand, however, the military in non-democratic countries may focus on defending the property rights of the ruling elites rather than those of all citizens. In addition, an increase of military expenditures in one country may lead to an increase of military expenditures in other countries, leading to an arms race causing a slow-down of growth in affected countries (Dunne et al. 2009). Also, military expenditures may be driven not by security needs but by a rent-seeking military industrial complex, which represents a powerful interest group that benefits from defence spending and thus has an incentive to exaggerate international conflicts and to hinder attempts to settle disputes by non-military means (Dunne, Sköns 2014).

The supply-side effects of military expenditures are also active in two directions and can lead both to an increase and decrease of the pace of economic growth. On the one hand, national expenditures for weapons may allow the development of an arms industry (and many other industries providing technology, components and semi-finished products), since increased profits of companies carrying out works under public procurement in a long run can be used for the purposes of investments enabling increasing their production capabilities (Malizard 2015). The necessity to modernise the army to match the standards of potential opponents may provide a stimulus for quicker modernisation and investments in the arms sector (Antonakis 1997). Furthermore, military expenditures on R&D may involve positive technological spillovers for civilian sectors, as many inventions primarily developed for the military can be used by other sectors of economy (Yakovlev 2007, Dunne and Uye 2014).

On the other hand, military expenditures may lead to weakened growth of potential output, because military and civilian sectors compete for the same resources, thus increasing the prices of investment and production goods. Moreover, as demonstrated by Ramey and Shapiro (1998), the allocation of capital between the civilian and military sectors is costly. Also, through demand-side effects, larger governmental spending may lead to crowding-out private investments. An increase of military expenditures may entail a drop in the efficiency of resource allocation, because they are not governed by market processes and they tend 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 of the labour market resulting from the employment of thousands of people as professional soldiers and compulsory military service. The draft (or conscription) is an in-kind tax (instead of fiscal tax) in the form of coerced and (usually) underpaid service. Due to the draft, young people usually work below their potential productivity levels resulting from their education, skills and other factors, which leads to a slow-down of economic growth (Poutvaara and Wagener 2007). The draft also stunts the pace of accumulation of the human capital (as during such time conscripts cannot learn and gain professional experience in other sectors of economy) and decreases the accumulation of savings and capital, since military wages that are lower than the potential salary on the market reduce the life-time income. Empirical studies confirm that mandatory conscription significantly decreases economic growth (Keller et al. 2009). Moving to an All-Volunteer Forces gives an incentive to increase efficiency of resource allocation, to rely more on capital (equipment) than soldiers, and leads to higher wages paid to fewer soldiers (Bove and Cavatorta 2012). It has been empirically demonstrated that high unemployment may drive an increase of military expenditures on personnel at the expense of equipment expenditures (Becker 2021).

Demand-side effects affect economy by stimulating aggregated demand. According to the New Keynesian economics, an increase of governmental spending while not using generation capacities in full and during high unemployment (i.e. the presence of a negative output gap) may lead to the rebuilding of aggregated demand. More specifically, a negative shock causing an increase in savings and, consequently, a drop in the output causes inflation and expected inflation to fall, which in turn causes an increase of the real interest rate and a further increase in savings, which worsens the crisis even more. Government intervention and increased governmental spending causes inflation and expected inflation to rise, which translates into a drop in savings and the real interest rate as well as an increase in consumption, and helps overcome the crisis (e.g. Christiano et al. 2011). Such approach requires adopting the assumptions of sticky prices, non-Ricardian consumers and involuntary unemployment (Galí et al. 2007)

The critics of this approach, especially with a neoclassical approach, argue that an increase of military expenditures causes an increase in taxes, increase in deficit or crowding-out of other expenditures. Each of these fiscal adjustments affects the economy. Tax raises have a distortionary effect on economic activity, an increase of the public debt may lead to an increase in household savings (Heo and Bohte 2011, Lorusso and Pieroni 2017) and higher expenditures 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 governmental spending. Military expenditures in the literature (in particular in the period of Great Recession) have very often been used to estimate the value of the fiscal multiplier. Military expenditures seem to be a good instrument for estimating the fiscal multiplier, because they are perceived to be exogenous to economic activity and driven by geopolitical factors, they are relatively unanticipated by consumers and firms (Hall 2009), they account for much of the variation in government purchases and they are assumed to be temporary (Barro and Redlick 2011; Dupor and Guerrero 2017). Researchers have developed appropriate methods of estimation of 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).

Unfortunately, the obtained results vary. Hall (2009) provides a fiscal multiplier of military expenditures in the USA in a range 1.0-1.7; Ramey (2011) in a range 0.6-1.2; Nakamura and Steinnson (2014) estimate "open economy relative multiplier" of approximately 1.5; Ramey and Zubairy (2018) in a range 0.6-1.0; Perotti (2014) close to 0.0; Barro and Redlick (2011) in a range 0.5-0.7. Based on a case study from the shipbuilding industry in the USA, a multiplier at the level of 0.77 was estimated (Biolsi 2019). In cross-country studies, the fiscal multiplier of military expenditures has been estimated in 0.0-0.5 interval (Dupor, Guerrero 2017) and in 0.3-1.7 interval (Sheremirov, Spirovska 2022). In their meta-analysis Gechert and Will (2012) show that fiscal multiplier of military expenditures is lower than fiscal multiplier of government consumption or government investments, while in other meta-analysis (Gechert and Rannenberg 2018) they claim that fiscal multiplier of military expenditures is regime-dependent and varies between -1.0 to 1.2. Other researchers point out that the value of the fiscal multiplier depends on multiple factors, being higher under Zero-Lower Bound (Christiano et al. 2011), lower in high-debt countries, countries with floating exchange rate and countries with open economies (Ilzetzki et al. 2013). The varying estimation results indicate that demand-side effects of military expenditures are difficult to estimate, conditioned by many factors and most likely heterogeneous and country-specific.

As mentioned above, the issue of the effect of military expenditures on economic growth has been addressed by dozens of works. Apart from the previously mentioned works on the estimation of the fiscal multiplier, the peace and defence literature also offers significant contributions. Cross-country studies based on large panel data have demonstrated a negative effect of military expenditures on economic growth (Knight et al. 1996), heterogeneous but generally significant negative short-run effect and insignificant long-run effect of military burden on per capita GDP growth (Dunne 2012), negative effect of military expenditures regardless of different levels of income, conflict experience, natural resources abundance, openness and foreign aid (Dunne and Tian 2013b); significant and persistent negative effect of military burden on economic growth (d'Agostino et al. 2017) as well as inconclusive results showing a slight positive effect of military expenditures on economic growth in developed countries (Kollias, Paleologou 2017).

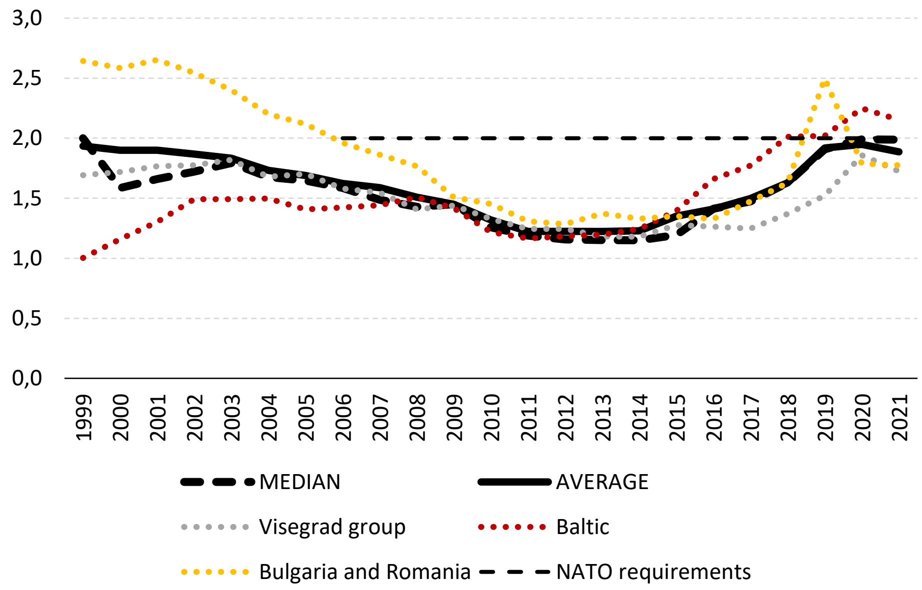
The aim of this study is to identify the effect of military expenditures on the economic growth of countries in the region of Central and Eastern Europe, thus it is worth focusing on the results of European countries. In their work, Kollias et al. (2007) demonstrate that military expenditures in EU-15 countries have a positive effect on economic growth; however, this study has been criticised e.g. in the work of Mylonidis (2008), which describes a negative impact of military expenditures on economic growth. The results of Chang et al. (2011) suggest that military expenditures in European countries decrease the rate of economic growth. Meanwhile, a study by Dunne and Nikolaidou (2012) presents results showing a lack of any significant effect of military expenditures on the change of output. A meta-analysis by Alptekin and Levine (2012) suggests that military expenditures have a positive effect on GDP growth in developed countries, similarly to the findings of Kollias and Paleologou (2017).

Also inconclusive are the results of case studies of CEE countries and similar European countries. The results of Antonakis (1997) show that in the case of Greece military expenditures decrease the growth of the GDP. Waszkiewicz (2020) demonstrates a lack of a similar significant effect in the case of Poland, Hungary and Slovakia, although in relatively short time-series. Daněk (2015) presents results showing a negative effect of military expenditures on the economic growth of CEE countries, although with some positive externalities. A study by Lobont et al. (2019) shows that military expenditures have a positive impact on GDP growth in Romania; whereas the authors of Tao et al. (2020) study reach opposite conclusions. Topcu and Aras (2015) claim, however, that military expenditures do not Granger-cause economic growth in any CEE country. The inconclusive results obtained in studies on the fiscal multiplier of military expenditures as well as in peace and defence economics studies together with a lack of a sufficient number of studies for CEE countries create an urgent need to carry out a similar study that would be based on current data and focused on Central and Eastern European countries.

3. Military expenditures in CEE national accounts

During a time of over 20 years in the 1999-2021 period, the countries of Central and Eastern Europe experienced quite large fluctuations in military expenditures. These changes, however, were not abrupt, as the average annual year-to-year change did not exceed 0.2 percentage points of the GDP. The amounts of military expenditures in the region's countries show a certain trend. In 1999-2004, average military expenditures (from SIPRI database) were only slightly below 2% GDP, and subsequently began to fall gradually (Graph 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 expenditures in this period is most likely the result of a necessity to modernise the military after joining NATO and participating in NATO's foreign military missions (in Iraq and Afghanistan in particular). After 2004, there was a gradual and systematic drop in the share of military expenditures in the GDP, which most likely resulted from the gradual withdrawal of military contingents from Iraq and Afghanistan, economic policies during the Great Recession after 2007, cuts in military expenditures as part of fiscal austerity policies, and, probably, an overall solid geopolitical stability in this part of Europe. The turning point was the year 2014, which saw Russia's annexation of Crimea and the start of war in Donbas, as well as the arrangements of the Wales Summit in 2014 to reverse the decreasing trend of military expenditures in NATO countries. From that time on, CEE countries began to gradually increase military expenditures, with their average in 2019 nearing a level of 2% GDP required by NATO from 2006.

Graph 1. Military expenditures as a percent of GDP.

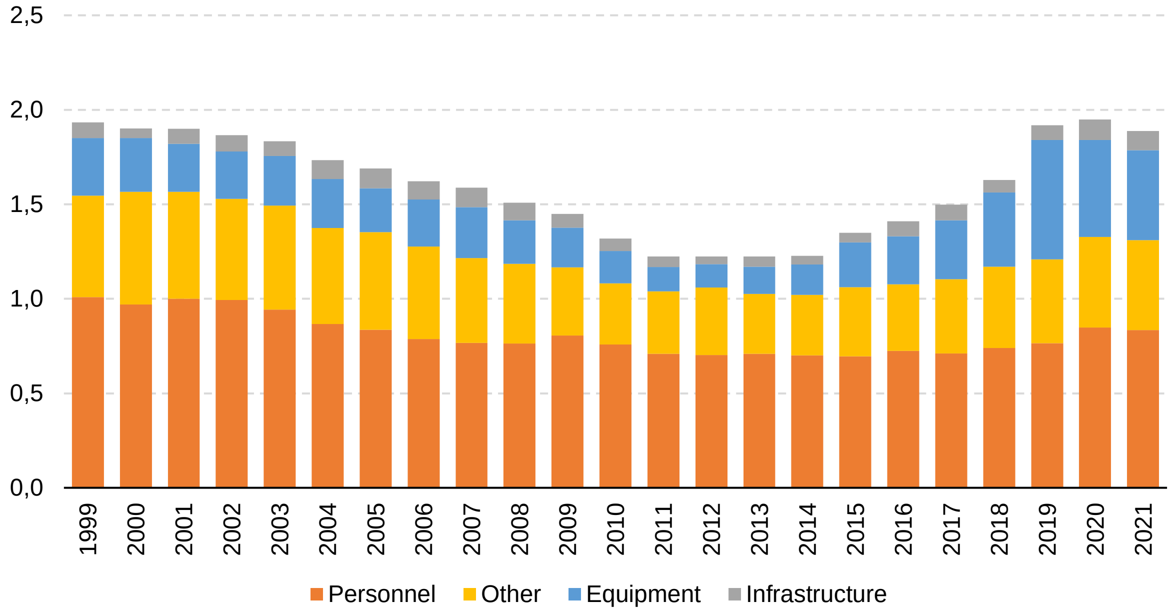


Source: SIPRI

This article presents estimation results based on military expenditures from the database of SIPRI (Stockholm International Peace Research Institute) from the years 1999-2021 as well as aggregated and disaggregated military expenditures from NATO publications from the years 1999-2021 for Poland, Czechia and Hungary, and from the years 2004-2021 for other countries. ESA2010 military expenditures COFOG from the years 1999-2020 were used as a part of robustness checks. An unbalanced panel is a result of the lack of data for these countries from a time before they joined NATO. Average differences for total military expenditures total between the databases of SIPRI and NATO are slight: for the years 1999-2003, they are lower than 0.1% GDP; and for later years, lower than 0.01% GDP. As a part of robustness checks, military expenditures from Eurostat COFOG classification were used.

NATO databases also provide data on military expenditures after disaggregation into four categories: personnel, equipment, infrastructure and other expenditures. In CEE countries in the studied period, there were no significant changes in the shares of individual categories of expenditures in total expenditures (Graph 2.). The largest differences pertain to other expenditures, which fell noticeably from 2000 to 2012, and then rose in subsequent years. This is most likely connected with the gradual withdrawal of contingents of CEE countries from missions in Iraq and Afghanistan. Similar drops, although on a smaller scale, can be seen also in expenditures on military equipment, infrastructure and personnel, which was most likely the result of decreasing the military burden during the Great Recession and the introduction of fiscal austerity policies.

Graph 2. Military expenditures in CEE countries after disaggregation (averages)



Source: NATO

Data on the GDP comes from Eurostat and is consistent with the European Standard Accounting 2010 (ESA2010) methodology. This methodology is a European form of the System of National Accounts 2008 (SNA08) methodology applied by OECD countries. The differences between them are slight and do not pertain to military expenditures (OECD 2014; Eurostat 2019). In studying the effect of military expenditures on GDP growth from a fiscal policy point of view, it is very important to describe how military expenditures are included in the GDP. Surprisingly, to my best knowledge, the peace and defence literature in works devoted to GDP growth has never featured an analysis of the components of military expenditures directly included in the GDP.

Table 1. Military expenditures in national accounts

Detailed expenditures	Expenditures 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
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 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: own elaboration based on Eurostat (2019)

Table 1. presents a method of recognising military expenditures in national accounts. It shows that a vast majority of military expenditures is a component of government consumption or gross fixed capital formation. Both these categories are components of the GDP; only some capital transfers, capital amortisation and military pensions are not directly included in the GDP. However, the payment of pensions to soldiers largely translates into increased consumption soon after their payment. This means that an increase of military expenditures automatically leads to an increase in the GDP. Simply put, an increase of military expenditures making up consumption by EUR 1 billion by definition leads to an increase of the GDP by EUR 1 billion. In practice, however, such an increase may differ significantly from EUR 1 billion due to the demand-side and supply-side effects described in Section 2.

In the case of military investments, changes in the GDP are postponed. According to the ESA2010 methodology, expenditures are recorded in accounts using the accrual method. This means that investments in the purchase of military equipment are included in the GDP upon their delivery and not upon paying for them. In the case of military equipment built over many years, investments are recorded according to milestone payments or other indicators such as the cost incurred by the constructor during a given year. This causes a certain inconsistency, since the databases of NATO and SIPRI present military expenditures using the cash method, and so they are recorded upon payment, not upon delivery. This inconsistency pertains to the settlement of some military expenditures in an interval not greater than one year, while expenditures for the purchase of complex weapons systems constitute quite a large part of total military expenditures (37.9% of total expenditures). Unfortunately, the databases of SIPRI and NATO do not present military expenditures using the accrual method, and thus the study needs to use cash-based data. This means that a part of expenditures on military equipment recorded in the databases of SIPRI and NATO at t enter the GDP at $t+1$ (in the methodology of the EU and OECD). Due to this inconsistency, 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 general trends in military equipment expenditures. Thus, using models with error correction term and long-run coefficients or estimating the fiscal multiplier using fiscal models with higher number of lags is better for measuring how military expenditures affect economic growth.

However, it is possible to collect data about some military expenditures registered on accrual basis, but this data do not cover all military expenditures. Eurostat presents government expenditures data on accrual basis using Classification of the functions of government (COFOG) and the second category is Defence (GF02) including expenditures on military defence, civil defence, foreign military aid, R&D Defence and other government expenditures. All expenditures are divided into ESA2010 categories, so it is possible to obtain military expenditures on accrual basis.

Regrettably, using this data is also problematic, because they do not cover all military expenditures. For example, average Slovakian military expenditures in the period 1999-2020 amounted to 1.44% GDP according to SIPRI database, but only to 1.01% according to COFOG classification. Similar differences occur for Poland (1.91% and 1.61%), Bulgaria (1.98% and 1.67%), Czechia (1.37% and 1.14%, respectively), etc. Moreover, it is difficult to split ESA2010 data into the same categories which are present in NATO databases. Especially gross fixed capital formation (P.51g) covers infrastructure investments, equipment purchases and R&D expenditures, which are included in three NATO categories. Nonetheless, military expenditures from ESA2010 COFOG classification were used for models estimation as a part of robustness checks. Three variables were created: military personnel expenditures (compensation plus employees plus social transfers), military equipment and infrastructure expenditures (gross fixed capital formation) and other military expenditures.

4. Identification strategy

The aim of this work is to study the effect of military expenditures on economic growth in CEE countries, and then to study the effect of disaggregated military expenditures on economic growth. Due to the availability of data, the study encompasses the 1999-2021 period.

In the peace and defence literature, the study of the effect of military expenditures on economic growth usually uses models based on the neoclassical production function. For many years, the dominant model was Feder-Ram model (Biswas and Ram 1986). Over time, however, it was replaced by Augmented Solow models (Mankiw et al. 1992) as well as Barro-type endogenous growth models (Barro 1990, Barro and Sala-i-Martin 2003). The Augmented Solow model with Harrod-neutral technological progress was expanded to include military expenditures and used to measure the effect of military expenditures on growth by Knight et al. (1996), and later by Dunne et al. (2005), Dunne (2012), Dunne and Nikolaidou (2012), Dunne and Tian (2013b) and Becker and Dunne (2021).

Endogenous growth models proposed by Barro (1990), Barro and Sala-i-Martin (2003) extend existing models by a number of factors, especially human capital, tax-financed government expenditures and research and development expenditures. In later works, these models were further developed to include a division into productive and non-productive governmental expenditures, distortionary and non-distortionary taxes, while the results produced by these models allow stating that governmental expenditures and governmental fiscal policies can have a large impact on economic growth (e.g. Bleaney et al. 2001). These models are extended by Aizenman and Glick (2006) by allowing the dependence of growth on the severity of external threats, and on the productive military expenditure used to prevent them. In the peace and defence literature on the studies of military expenditures on economic growth, this model has been used multiple times, e.g. in the works of Mylonidis (2008), Pieroni (2009) and d'Agostino et al. (2017), among others.

The Barro-type model creates a framework which allows incorporating a variety of variables (commonly referred to as control variables) thought to be possible determinants of long-term growth. The inclusion of capital stock, population change, human capital proxy and government consumption is justified by the endogenous growth theory. In many empirical works, researchers do not explicitly derive theoretical equations, but use the endogenous growth theory to suggest control variables. In this article, military expenditures are one of potential factors affecting economic growth.

This work also uses a number of control variables to study the effect of military expenditures on economic growth. Apart from the normally used capital stock (AMECO database, OKND code) and the change in the working-age population size (15-65 years), the model also includes expenditures on research and development (R&D) as well as the share of people with higher education in the working age population (15-65 years). These variables allow a better explanation of the dynamics of growth in developed countries. In addition, the model also incorporates government consumption, which results from the previously described models (e.g. Bleaney et al. 2001). According to the ESA2010 methodology, government consumption includes most of all expenditures on primary and secondary education, health-care expenditures, expenditures on the judiciary system and other services provided by the state; these expenditures may have large positive externalities and may constitute "productive" government expenditures. Since military expenditures and a part of R&D expenditures are included under government consumption, then, in order to avoid variable collinearity, military expenditures and government R&D expenditures have been subtracted from government consumption. The source of all data, apart from NATO and SIPRI databases, was Eurostat. All variables in all models (apart from changes in population sizes) were normalised into per capita values in real terms (constant prices).

In addition to the above-described variables, some models also incorporate a variable describing the net arms export (in Trend Indicator Value per 1 million population) created based on a database on exports and imports of weapons from SIPRI database. Including this variable in the model will allow studying whether countries which rely mostly on arms imports (in the sample analysed in this work, they are most of all Lithuania, Latvia and Estonia) record a lower rate of economic growth due to a significant deterioration of their current accounts. Studies on the impact of arms imports on economic growth in NATO countries have already been carried out, and they provide mixed results (e.g. Pamp, Thurner 2017).

In order to study the effect of adjustments on the labour market on economic growth due to the outflow of employees from the civilian sector to the military sector, some models also include a dummy variable with a value of 1 in countries with compulsory military service. In the studied 1999-2021 period, seven out of nine studied countries had abandoned military conscription in favour of All-Volunteer Forces. Hungary did so in 2004, Czechia in 2005, Romania and Slovakia in 2006, Bulgaria and Latvia in 2007, and Poland in 2009. Different years in which changes were introduced allow identifying this effect on economic growth. The models also include a variable describing the labour share of military personnel to total population in working age (based on NATO database) as well as the share of soldiers in foreign missions in total population in working age (based on a database of the Institute for Strategic Studies). These variables may allow identifying the effect of adjustments on the labour market and increasing the costs of foreign missions on the economic growth of countries in the sample.

The econometric method used for estimation is the ARDL (Autoregressive Distributed Lag) model estimated using the Pooled Mean Group method (Pesaran and Smith 1995, Pesaran et al. 1999). With relatively small differences between N and T in panel data, this method may provide unbiased estimates 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 studying long-run relationships between dependent and independent variables. Taking into account methodological reservations presented in Section 3, this model allows a proper assessment of the effect of military expenditures, because, thanks to the estimation of parameters for long-run equilibrium, it is possible to assess long-run relationships between military expenditures and economic growth. After the reparametrizing of the ARDL(p,q) dynamic panel specification into the error correction form, the equation can be presented as (Blackburne, Frank 2007):

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

where φ_i measures the speed at which the model returns to equilibrium after a shock, θ_i and δ_{ij} measures long-run and short-run relationships between output and control variables, respectively; ϵ_{it} denotes residuals and μ_i is the group specific effect for every observation. Parameters μ_i capture time-invariant country-specific effects, which sometimes are referred as country-specific fixed effects. All variables used to estimate the model must be first-order integrated, I(1), and variables included in error correction form must be cointegrated. Thus, Table 2. presents the results of panel Im-Pesaran-Shin and Levin-Lin-Chu unit root tests for every variable included in the model and results of modified Dickey-Fuller and modified Phillips-Perron test for panel data cointegration. Almost all variables included in the models are I(1) and cointegrated, which allows valid model identification. To establish the correct order of ARDL(*p*,*q*) lags, the approach of Pesaran and Shin (1996) is applied. After running 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 countries.

Table 2. Unit root and cointegration tests for variables used in the models

Unit-root tests for panel data (Null hypothesis: panels contains 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	2,7001	0,9965
	YES	-6,1317	0,0000	-6,4755	0,0000
Population change (%)		-4,9463	0,0000	-0,2536	0,3999
	YES	-2,2934	0,0109	-0,9548	0,1698
Capital stock		0,3509	0,6372	8,7846	1,0000
	YES	-3,9643	0,0000	-1,7754	0,0379
Government consumption		2,0332	0,9790	7,6641	1,0000
	YES	-2,6524	0,0040	-4,6624	0,0000
Tax revenues		1,3358	0,9092	6,1387	1,0000
	YES	-6,2376	0,0000	-5,2803	0,0000
R&D expenditures		1,8243	0,9659	4,6178	1,0000
	YES	-6,9969	0,0000	-6,6465	0,0000
Higher education		0,3580	0,6398	6,6327	1,0000
	YES	-19,3383	0,0000	-5,3064	0,0000
Military expenditures (SIPRI)		2,2173	0,9867	5,5553	1,0000

	YES	-1,8066	0,0354	-4,9447	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	-1,4960	0,0673
	YES	-7,3225	0,0000	-7,5759	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 than personnel)		0,6044	0,7272	3,8629	0,9999
	YES	-3,2814	0,0005	-5,1316	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)		-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)-(2)		-10,5997	0,0000	3,4852	0,0002
(3)		-6,8673	0,0000	2,6452	0,0041
(4)		-14,2681	0,0000	3,5396	0,0002
(5)-(6)		-7,6591	0,0000	3,3950	0,0003
(7)		-13,9492	0,0000	3,6916	0,0001
(8)-(10)		-9,5632	0,0000	3,7594	0,0001

Model estimation using the ARDL method is the first econometric method applied in this study. It allows studying the long-run effect of aggregated and disaggregated military expenditures on economic growth. It has already been used in the peace and defence literature (see d'Agostino et al. 2017, Becker and Dunne 2021). However, it is also important to study the short-run effect of military expenditures on the GDP. Commonly used models with one lag in this case may be biased due to the endogeneity problem and methodological problems explained in Section 3. A much better method is to estimate the value of the fiscal multiplier using SVAR the methodology, which is one of the most commonly used is fiscal studies (Gechert and Will 2012).

One of the main methods to calculate the value of fiscal multiplier is the use of structural vector autoregression (SVAR) models. Since there is an infinite number of solutions for the model, model identification can be achieved by applying appropriate assumptions or restrictions in the model. The literature on fiscal multipliers distinguishes three methods (Caldara and Kamps 2017): Ramey-Shapiro narrative approach with non-fiscal instrumental variables (Ramey 2011); penalty function approach with recursive ordering and restrictions on the sign of the response functions (Uhlig 2005); and Blanchard-Perotti approach, which adds to the recursive ordering and Cholesky decomposition an external coefficient representing the elasticity of taxes to other variables (Blanchard and Perotti 2002). The first method cannot be used due to a lack of appropriate data; the second one cannot be used either due to the intention to study the signs of the response functions.

The Blanchard-Perotti approach is a method commonly used to identify output reaction to unexpected fiscal shocks in economy. By default, it includes three variables (GDP, government expenditures and government tax revenues); however, it is often extended to include e.g. GDP deflator, government bonds yields (Burriel et al. 2009) or public debt. In the structural approach, after using a VAR to eliminate predictable responses of endogenous variables, it is assumed that any remaining correlation between the residual (unpredicted) components of government spending and output is due to the impact of government spending on output.

The SVAR model adopted in the study has the following standard form:

$$\Gamma Y_t = B(L)X_t + e_t$$

where Y_t is a vector of the endogenous variables in period t, X_t denotes lagged endogenous variables, Γ and $B(L)$ are contemporaneous and lagged coefficients matrices, and vector e_t contains residuals (so-called common economic shocks). After reformulating this model to a reduced-form SVAR:

$$Y_t = B^*(L)X_t + u_t$$

where $B^*(L) = \Gamma^{-1}B(L)$ and $u_t = \Gamma^{-1}e_t$ is the reduced-form error term which contains idiosyncratic shocks (disturbances). Vector u_t is often described as a shock to the economy unanticipated by consumers and firms, which in this case may be interpreted as an unexpected change in government's fiscal policy. A change in the value of military expenditures – if unexpected – can be considered such fiscal shock. In CEE countries in the 1999-2021 period, there were a few such unexpected events (9/11 in the USA and sending soldiers to Iraq and Afghanistan, Russia's annexation of Crimea, start of war in Donbas); also, military expenditures are often changed in these countries depending on the arrangements of NATO summits or unexpected political decisions. Furthermore, military expenditures for a subsequent year are established in budget legislation adopted at the end of each year. They frequently include major changes, so consumers and companies are often unsure of the shape of the fiscal policy in the coming year. Therefore, changes in military expenditures in CEE countries can be considered largely unanticipated and unpredictable.

The identification of SVAR models according to Blanchard-Perotti approach is achieved through recursive ordering using Cholesky decomposition and imposing non-zero restrictions on parameters of tax elasticities to changes in other variables (which is equal to assuming that tax system and tax rates are not changing automatically and contemporaneously to changes in government expenditures). This study assumes the following order of variables: $Y_t = [M_t \quad G_t \quad T_t \quad GDP_t]$. This means that military expenditures, government consumption and taxes affect the GDP; government consumption affects taxes and the GDP; and taxes only affect the GDP. A reverse ordering would mean that fiscal variables have no effect on the GDP (Fatas and Mihov 2001), which is not true because they are directly included in the GDP. Following Lüthepohl (2005), the relationship between e_t and u_t can be presented as

$$Ae_t = Bu_t$$

In this article, it is assumed that $B = I$, and thus idiosyncratic shocks are uncorrelated and the A matrix is lower (left) triangular matrix with ones along the diagonal. The elasticity of taxes to expenditure changes was determined with simple panel regression on logs and takes the value of 0.4303 (p-value 0.006); whereas the elasticity of taxes to military expenditures was determined at 0.0449 (p-value 0.011). Table 2. presents the results of tests confirming that variables in the model are I(1); that is why the estimation of parameters of the SVAR model used stationary first differences of variables. Based on the Akaike Information Criterion, the best value of lags was determined as 2 or 3, depending on the model. In order to maintain consistency in the presented results, the estimation results present results of estimation for models with three lags. As an element of post-estimation diagnostics, VAR residual serial correlation LM Tests were conducted, demonstrating that there is no serial correlation in residuals at lags 2 or 3 in almost every equation. In addition, likelihood ratio (LR) tests for over-identification were conducted, generally providing good results.

Section 5 presents a description of the results of estimation of parameters of both models for aggregated and disaggregated military expenditures. Impulse reaction functions are presented in normal and accumulated forms. To save space, only ten (instead of one hundred sixty) graphs of responses of GDP to change in military expenditures (aggregated and disaggregated) and responses of government consumption to change in military expenditures (without military expenditures obviously) are presented.

5. Results

The results of estimation of ARDL(1,1) model are presented in Table 3. Variables included in the long-run term are first lags and variables presented in the short-run term are first differences. φ parameters (error correction parameters) are statistically significant, with estimated values in a range from -1 to 0. Therefore, the model achieves equilibrium in the long run, and so the values of estimated parameters can be interpreted as long-run factors affecting economic growth.

Table 3. contains the results of estimation of nine models. In model 1 and 2, SIPRI data was used, and it is a balanced panel covering the 1999-2021 period. The first column presents results for nine CEE countries, the second column for ten countries, including Finland. There are many arguments for including Finland into the study, because the country is an EU member state and is in a similar geopolitical situation as the nine CEE countries. However, Finland is not a post-communist country, and its GDP per capita is much higher in the studied period, especially soon after 1999, when CEE countries were still in a phase of economic transition. Furthermore, Finland is not a NATO country as at the time of completion of this study.

Models 3, 5-6 and 8-10 use aggregated and disaggregated NATO data. It is an unbalanced panel that covers the years during which the nine CEE countries were NATO members. Thus, data for Poland, Czechia and Hungary covers the years 1999-2021, while data for other countries cover the 2004-2021 period. Model 3 contain aggregated military expenditures, models 5-6 contain expenditures disaggregated into personnel expenditures and other than personnel expenditures, while models 8-10 contain military expenditures disaggregated into four categories. The models differ between each other in terms of the selection of control variables. In some models, the short-run term includes the percentage of military personnel in relation to working age population (15-65 years), dummy variable for countries with compulsory military conscription in a given year, and the share of soldiers in foreign missions in the overall working age population. These variables were included in order to better study how the costs of foreign missions and the adjustment of labour supply between the military sector and the civilian sector affect economic growth.

Table 3. Estimation results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Source of data:	SIPRI incl. Finland	SIPRI excl. Finland	NATO	ESA2010	NATO	NATO	ESA2010	NATO	NATO	NATO
Long-run equation										
Capital stock	0.1566***	0.1703***	0.0680**	0.1402***	0.0780**	0.1289***	0.2243***	0.1236***	0.1493***	0.0673***
	(0.0185)	(0.0203)	(0.0281)	(0.0347)	(0.0354)	(0.0192)	(0.0372)	(0.0239)	(0.0159)	(0.0186)
Change in working age population	-0.004***	-0.004***	-0.0025	-0.006***	-0.0031**	-0.002***	-0.005***	-0.003***	-0.0003	-0.0029***
	(0.0003)	(0.0003)	(0.0023)	(0.0019)	(0.0016)	(0.0005)	(0.0018)	(0.0007)	(0.0004)	(0.0005)
Government consumption	1.5737***	1.0971***	2.1358***	-0.4661	3.4451***	2.7711***	0.9059	3.1260***	2.4194***	1.9536***
	(0.2608)	(0.3960)	(0.2788)	(0.5176)	(0.5158)	(0.2127)	(0.5916)	(0.2593)	(0.1931)	(0.2273)
R&D expenditures	0.3564***	0.4028***	0.1930*	1.0757*	0.1282	0.2124***	0.0825	0.2775***	0.1674***	0.3678***
	(0.0590)	(0.0664)	(0.0998)	(0.5511)	(0.3452)	(0.0450)	(0.1137)	(0.0519)	(0.0391)	(0.0446)
Higher education (%)	-0.027***	-0.0250**	0.1449***	-0.0207**	-0.0010	0.0701***	-0.033***	0.0757***	0.0879***	0.0854***
	(0.0103)	(0.0100)	(0.0531)	(0.0096)	(0.0557)	(0.0204)	(0.0112)	(0.0253)	(0.0141)	(0.0227)
Military expenditures	-2.654***	-2.1560**	-3.799***	-11.18***						
	(0.9292)	(1.0041)	(1.0388)	(3.2197)						
Military personnel expenditures					-21.73***	-15.81***	-4.5154	-25.07***	-9.2556**	-15.256***
					(6.0501)	(4.2454)	(5.2446)	(4.5663)	(3.8651)	(3.9448)
Military expenditures other than personnel					-25.34***	-1.5255	-12.183**			
					(4.7897)	(1.1331)	(4.9456)			
Military other expenditures								6.5438*	0.2929	8.8312***
								(3.4279)	(3.0259)	(2.7108)
Military equipment expenditures[1]							-6.5980**	-6.602***	-2.4011*	1.3010
							(3.2921)	(1.6435)	(1.3184)	(1.1819)
Military infrastructure expenditures								17.0715*	11.9675	28.6595***
								(9.9487)	(9.0744)	(5.2111)
Short-run equation										
Error correction term (ϕ)	-0.638***	-0.567***	-0.710***	-0.418***	-0.3622**	-0.834***	-0.593***	-0.736***	-0.960***	-1.0415***
	(0.1005)	(0.1059)	(0.0698)	(0.1018)	(0.1469)	(0.1074)	(0.0817)	(0.1247)	(0.1356)	(0.2584)
Capital stock	1.0845***	0.9747***	0.9593***	0.7902***	0.9829***	0.8063***	1.0959***	0.7844***	0.7502***	0.6516***
	(0.2106)	(0.1852)	(0.1884)	(0.1951)	(0.3038)	(0.2008)	(0.1830)	(0.1612)	(0.2722)	(0.2426)

Change in working age population	-0.1733	-0.1836	-0.1213	-0.0202	-0.7616	-0.0313	-0.0241	-0.1460	0.1444	0.0590
	(0.1813)	(0.1831)	(0.1296)	.0261351	(0.8028)	(0.0348)	(0.0424)	(0.1461)	(0.1418)	(0.0469)
Government consumption	1.0388***	0.9395**	1.5310***	0.8766**	1.3255***	2.2162***	0.5763	1.4009***	1.8023***	3.3389
	(0.3875)	(0.4221)	(0.4175)	(0.3761)	(0.4948)	(0.6607)	(0.4195)	(0.4039)	(0.6803)	(2.1256)
R&D expenditures	1.2689*	1.2877*	0.4397	1.0476**	1.1242	0.7576*	0.1605	0.6537	0.5498	-0.0199
	(0.6503)	(0.7283)	(0.4289)	(0.4324)	(1.2554)	(0.4454)	(0.3166)	(0.8058)	(0.8336)	(0.9439)
Military expenditures	0.1572	0.4238	-0.1254	3.2990***						
	(1.4009)	(1.4348)	(1.6423)	(1.0580)						
Military personnel expenditures					1.9680	3.1766	-1.2763	-7.5528	3.4929	-1.2805
					(9.9832)	(9.3215)	(3.7928)	(5.1164)	(11.3702)	(12.2026)
Military expenditures other than personnel[1]					-3.6447	1.7020	-1.2763			
					(3.7405)	(2.2636)	(3.7928)			
Military other expenditures							-1.7164	8.0506**	2.8811	7.2236
							(4.0289)	(3.4800)	(9.3483)	(6.9556)
Military equipment expenditures							-1.5226	0.4464	4.1299	3.2380
							(2.2847)	(2.2519)	(4.0003)	(3.0587)
Military infrastructure expenditures								13.8887	31.6850*	26.7127
								(9.9774)	(17.6948)	(17.7586)
Compulsory military service	-19.2646	-23.1216				12.3590	-25.9270		-149.7644	5.4972
	(16.7524)	(20.1474)				(22.2035)	(23.5505)		(123.8421)	(28.9943)
Military personnel as a percentage of working age population						-31.5403			-9.9672	-99.7964
						(53.5086)			(43.2632)	(90.6937)
Personnel on foreign missions as a percentage of working age population										14.1538
										(85.5781)
Net arm export per 1 million population, Trend Indicator Values (SIPRI database)	-0.1903	-0.2604								
	(0.2270)	(0.2976)								
Constant	108.7009	131.1852	1437.650	277.6422	36.2614	98.6364	494.0102	93.7989	73.0003	212.2709
	(79.7666)	(101.3884)	(1450.259)	(340.896)	(25.1832)	(70.0893)	(579.820)	(67.0402)	(63.5242)	(166.4201)
Wooldridge serial correlation test on residuals (p-value)	0.2534	0.2373	0.6200	0.0302	0.3913	0.1404	0.0589	0.1032	0.1513	0.1574
Observations	220	198	168	198	168	168	198	168	168	168

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1 [1] Military equipment and infrastructure expenditures for ESA2010 data

The results of ARDL(1,1) model estimation using the Pooled Mean Group method confirm that military expenditures lead to a slow-down of economic growth. GDP per capita increments are significantly lower than in countries in which military expenditures per capita increase. The significance of variables, their sign as well as the values of parameters provide strong evidence that military expenditures (from SIPRI, NATO and Eurostat databases) have a negative effect on the GDP growth rate. These results corroborate conclusions from a number of works presented in Section 2. (among others, Mylonidis 2008, Daněk 2015, Dunne and Tian 2013b, d'Agostino et al. 2017

After disaggregation of military expenditures, first into two and then into four categories NATO categories, it can be observed that military personnel expenditures have a significant and strong negative effect on economic growth in the long run. They are closely connected with compulsory military conscription, the number of civilian employees in the military and the size of the military; thus, it can be assumed that it is the outflow of employees from civilian sectors to the military sector and the resulting drop in labour supply for civilian sectors that is one of the main causes of the negative effect of military expenditures on GDP growth, as military personnel expenditures constitute the major part of total military expenditures. These conclusions align with the results of the study by Becker and Dunne (2021), which obtained similar results on a sample of all NATO countries.

In the case of the remaining three categories of military expenditures, conclusions are more difficult to achieve, since variables in some equations are insignificant. Expenditures for the purchase of military equipment have a negative impact on economic growth, while other military expenditures have a positive impact. These results need to be treated with caution, yet they still provide an argument for claiming that demand side-effects can have effect in both directions, and expenditures for maintaining an army that lead to increased government consumption may affect the aggregated demand in economy.

As a part of robustness checks, military expenditures registered on ESA2010 accrual basis were used. Although these expenditures do not cover all military expenditures, results are similar to result obtained using SIPRI and NATO databases. Aggregated military expenditures as well as disaggregated military expenditures have significantly negative influence on economic growth. Military personnel expenditures are insignificant, but gross fixed capital formation and other military expenditures have significantly negative impact on output. This significance is most likely a result of using accrual data which are comparable with GDP calculated on accrual basis.

Control variables included in the model based on the Barro-type model are statistically significant and have expected signs in almost all cases, which proves that the model appropriately describes the process of economic growth in CEE countries. What comes as a certain surprise is the significantly negative sign of the variable describing changes in working age population; although it most likely results from the ageing of populations in CEE countries and increased percentage of people in pre-retirement age.

The control variables included in the models prove statistically insignificant in all cases. This serves as a basis to conclude that using such detailed variables does not influence the results. It may be the case that their effect on GDP growth is too small to be detected in a sample of 168 observations, and studies on more expanded samples could provide different conclusions. In any case, the demonstration of a lack of statistical significance of some control variables also contributes to the literature.

The results of estimation of the fiscal multiplier using SVAR method are presented in Graphs 3-12 and in Table 4. To save space, this article only presents the graphs of Impulse Reaction Functions of GDP changes in response to change (innovation) in military expenditures and government consumption changes (excluding government R&D expenditures and military expenditures) in response to change in the amount of military expenditures. The graphs present IRFs after standard structural decomposition computed using analytical (asymptotic) method and the standard error 68% bands, similarly to other works on the fiscal multiplier (e.g. Ramey 2011). Unfortunately, the study uses annual data rather than quarterly data due to a lack of quarterly data on military expenditures. For this reason, the shape of the IRFs may deviate from standard hump-shaped IRFs based on quarterly data. However, this does not mean that less smoothed functions provide incorrect results. The graphs show that fiscal multipliers converge to zero in the long run, which is in line with the definition of an impulse after structural decomposition.

Table 4. Estimation results

	Impact multipliers (years after shock)									
Response of GDP on innovation:	1	2	3	4	5	6	7	8	9	10
Military expenditures	0,115	-0,372*	-0,470**	-0,140	-0,038	-0,128	-0,133*	-0,102*	-0,070	-0,061
Military expenditures (personnel)	0,056	-0,393*	-0,661**	-0,033	0,122	-0,023	-0,050	-0,019	-0,001	-0,013
Military expenditures (other)	-0,513**	-0,094	0,021	-0,099	-0,005	0,104	0,090	-0,026	-0,046	-0,011
Military expenditures (infrastructure)	-1,349***	0,382**	1,107**	0,352*	-0,379	-0,133	0,136	0,051	-0,072	-0,069
Military expenditures (equipment)	-1,314***	-0,443	0,685	0,295	-0,100	-0,165	-0,055	0,050	0,001	-0,031
Response of other government consumption on innovation:										
Military expenditures	0,461	-1,138***	-1,376***	-0,304	-0,312	-0,208	-0,218	-0,169	-0,175	-0,175
Military expenditures (personnel)	0,235	-0,513	-0,273	-0,429	-1,378***	0,485*	0,069	0,092	0,084	0,004
Military expenditures (other)	-0,393	-0,468	-0,097	-0,795**	0,096	0,215	-0,010	0,051	0,048	-0,017
Military expenditures (infrastructure)	-0,208	-1,053**	-0,050	-0,340	0,678*	0,511**	-0,120	-0,284	-0,049	0,054
Military expenditures (equipment)	-1,328***	-0,879**	0,956**	-0,189	-0,113	0,557**	-0,082	-0,167	0,024	-0,078
	Accumulated multipliers (years after shock)									
Response of GDP on innovation:	1	2	3	4	5	6	7	8	9	10
Military expenditures	0,115	-0,257	-0,728*	-0,878*	-0,906*	-1,034**	-1,167**	-1,269**	-1,339**	-1,400**
Military expenditures (personnel)	0,056	-0,337	-0,998**	-1,031**	-0,909**	-0,932**	-0,982**	-1,001**	-1,003**	-1,015**
Military expenditures (other)	-0,513**	-0,607	-0,587	-0,686	-0,691	-0,587	-0,497	-0,523	-0,569	-0,581
Military expenditures (infrastructure)	-1,349***	-0,967**	0,139	0,491	0,113	-0,020	0,116	0,167	0,095	0,025
Military expenditures (equipment)	-1,314***	-1,757***	-1,072	-0,777	-0,878	-1,043	-1,097*	-1,048	-1,047	-1,078
Response of other government consumption on innovation:										
Military expenditures	0,461	-0,677	-2,052***	-2,356***	-2,668***	-2,875***	-3,094***	-3,263***	-3,438***	-3,612***
Military expenditures (personnel)	0,235	-0,278	-0,551	-0,989**	-2,358***	-1,873***	-1,804***	-1,712***	-1,629***	-1,625***
Military expenditures (other)	-0,393	-0,861*	-0,958*	-1,753***	-1,658***	-1,443***	-1,453***	-1,402***	-1,354***	-1,371***
Military expenditures (infrastructure)	-0,208	-1,260**	-1,310**	-1,651**	-0,972	-0,461	-0,582	-0,866*	-0,915*	-0,861*
Military expenditures (equipment)	-1,328***	-2,208***	-1,252**	-1,441**	-1,554***	-0,997	-1,079	-1,245*	-1,221*	-1,299*

The results of estimation of impact and accumulated fiscal multipliers allow stating that military expenditures have a significantly negative effect on output changes, in particular in a period of 2-4 years after the occurrence of a shock (Table 4.). It is consistent with intuition, because military expenditures are included in the GDP, and so the GDP is higher in the year of their occurrence. Based on the methodological reservations made in Section 3., it can be concluded that a purchase of military equipment can be entered in national accounts with a delay. For this reason, fiscal multipliers in the first year after a shock can be insignificant, while in subsequent years short-run effects fade and long-run effects begin to count more.

In this study, the fiscal multiplier of military expenditures is significantly negative and falls in a range from -0.4 to -0.5 within a period from 2 to 3 years from a fiscal shock; whereas the accumulated multiplier of military expenditures is significantly negative in a period after 3 years from a shock and within 3-5 years after a fiscal shock it is in a range from -0.7 to -0.9. These results are consistent with results obtained after the estimation of ARDL model using the PMG method.

The estimation of fiscal multipliers of disaggregated military expenditures also produces results similar to the results for the previously-described multiplier of total military expenditures. The fiscal multiplier of expenditures for military equipment is positive, but statistically significant only in one period, while the accumulated multiplier is significantly negative. The multipliers of other expenditures can be deemed statistically insignificant. The fiscal multiplier of military personnel expenditures is significantly negative, and falls in a range from -0.4 to -0.6. It is most likely military personnel expenditures that have the largest impact on the value of the fiscal multiplier of total military expenditures, because military personnel expenditures make up their largest part in CEE countries. An increase of military personnel expenditures as a rule involves compulsory military service, employing additional staff in the army or an increased number of civilian employees. This causes a drop in labour supply in civilian sectors of economy and may lead to a drop in GDP growth rate through supply-side effects described in Section 2.

In turn, the multiplier of infrastructure expenditures is significantly positive. In CEE countries, military infrastructure expenditures include telecommunications investments, building local roads to military training grounds, investments in aviation and port infrastructure, etc.; that is why such investments can have positive externalities and consequently can positively contribute to economic growth. This multiplier takes statistically significant values from 0.4 to 1.0 in a period of 2-4 years after a fiscal shock. The accumulated multiplier is statistically insignificant; however, it needs to be noted that investments may be booked with delays of up to one year.

The properties of the SVAR model as well as the inclusion of fiscal variables into the model also allows studying the response of the fiscal policy to changes in military expenditures. While the response of tax revenues to military expenditures innovations is restricted, the response of expenditures for government consumption can be assessed. In most cases, it is statistically insignificant. Only in the case of military equipment and other expenditures fiscal multiplier is statistically significant and negative, in some categories of military expenditures in certain periods is the accumulated multiplier statistically significant; this, however, is not enough to draw far-reaching conclusions. Therefore, it can be concluded that some government purchases crowd-out other government consumption, but this conclusion is not well-supported by estimation results.

The estimation of econometric models using two different methods provides similar results. Long-run term coefficients of ARDL model analysis provide similar results to an analysis of fiscal multipliers calculated with SVAR methodology in a period of 2-5 years and of accumulated multipliers. The inclusion of additional control variables into the ARDL model does not change the results significantly. All this allows stating that the results are robust in relation to a change in an approach to modelling and econometric methods. It can therefore be concluded that military expenditures have a negative effect on economic growth in CEE countries in the period 1999-2021.

6. Conclusions

This work presents the results of a study of the effect of military expenditures on economic growth in Central and Eastern European (CEE) countries in the 1999-2021 period. The study of this effect is particularly important in the context of Russia's aggression against Ukraine in 2022 and the planned significant increase of military expenditures in the studied region.

In accordance with economic theory, military expenditures may both increase and decrease the rate of economic growth (e.g. Dunne et al. 2005). On the one hand, larger security expenditures provide better protection of life, health and property of citizens, and thus they may support economic growth. On the other hand, the military in non-democratic states can be used to protect the interests of elites rather than those of all citizens. On the one hand, fiscal expansion through increased military expenditures can stimulate demand and decrease unemployment; and on the other hand, it can lead to crowding-out private consumption and investments, and forcing fiscal adjustments by increasing debt, taxes or by decreasing other expenditures. On the one hand, military expenditures can support development and modernisation of the industry; but on the other hand, they may stunt the development of non-military industries and decrease labour supply due to employing workers in the army or due to compulsory conscription.

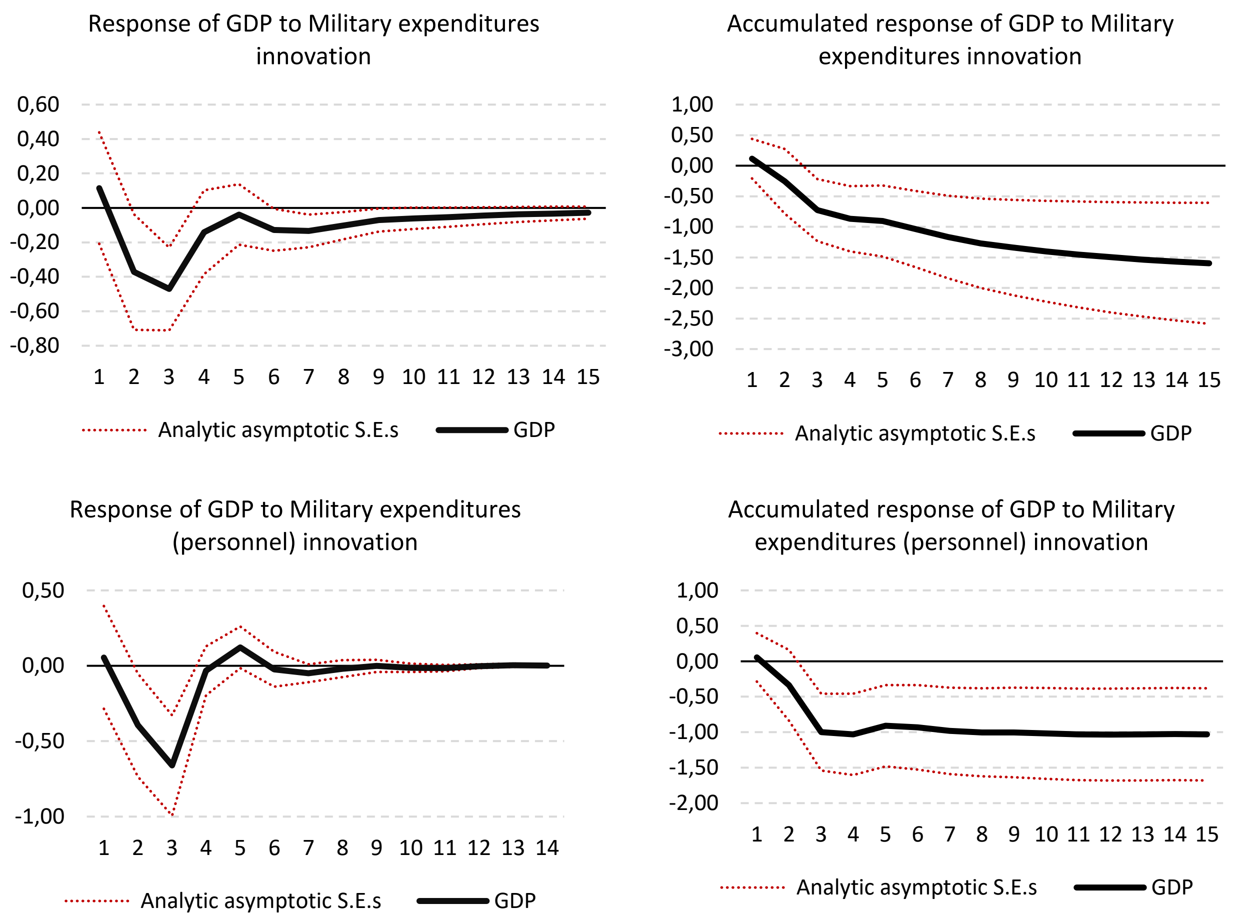
The results presented in this article confirm that military expenditures in CEE countries in the years 1999-2021 reduced the GDP growth rate. The results of a long-run equilibrium estimation indicate that both total military expenditures (from NATO and SIPRI databases) and military expenditures after disaggregation contributed to a decrease of the GDP. After disaggregation of military expenditures, first into two and then into four categories, it was demonstrated that the largest effect on the decrease of the rate of economic growth was caused by military personnel expenditures, most likely due to the adjustment of the labour market and the drop in the supply of employees in non-military sectors. These results are consistent with a similar recent study by Becker and Dunne (2021). It has also been demonstrated that expenditures for military infrastructure can have a positive effect on economic growth due to their potential positive externalities.

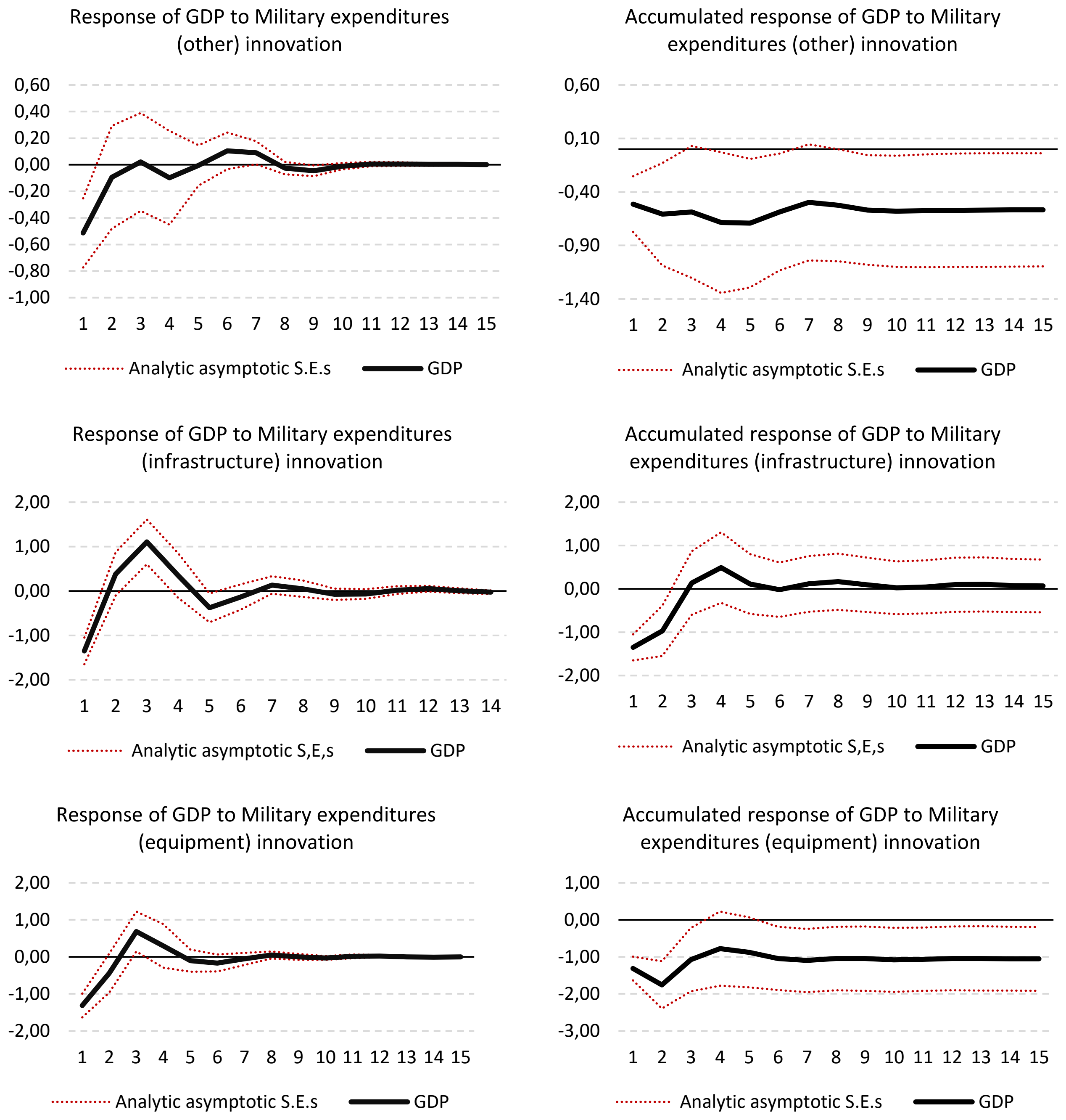
The second research method was the estimation of fiscal multipliers using SVAR model. The macroeconomic literature has often used military expenditures as an instrument to study the response of output to changes in fiscal policy (e.g. Ramey 2011). Military expenditures have been perceived by researchers as unanticipated and exogenous and resulting from geopolitical factors, not from internal economic factors. Conclusions on the value of the multiplier of military expenditures have been mixed and no scientific consensus has been reached regarding its approximate value. This study estimated the fiscal multipliers of military expenditures in CEE countries in the 1999-2021 period. Their value, estimated using SVAR models with the Blanchard-Perotti approach, is significantly negative in two and three years after fiscal expansion, and takes an approximate value of -0.4 to -0.5. The accumulated multiplier is also negative and takes an approximate value of -0.7 to -0.9 in the period of 3 to 5 years after a fiscal shock. Also the fiscal multipliers of disaggregated personnel expenditures are statistically significant and negative in a period of 1-3 years after a fiscal shock, which is consistent with the results of estimation using the first statistical method in the article. This shows that supply-side effects of military expenditures in CEE countries can be negative and have a short-run negative effect on the output growth. In turn, the fiscal multipliers of expenditures for infrastructural investments are statistically significant and positive in a period of 2-3 years after expansion. The study observe some effects of crowding out other government consumption by military equipment and infrastructure expenditures, but these effects are not well supported by the data.

Therefore, based on model estimation using two methods, it can be concluded that military expenditures in CEE countries led to a slow-down of GDP growth in the 1999-2021 period. In connection with the planned increase of military expenditures in 2023 and later on, policy-makers and forecasters may expect a lower rate of economic growth in these countries. Providing security after rise in geopolitical instability in the region need handling higher opportunity costs related to higher military burden. It seems that one of the most important factors having a negative impact on economic growth is the outflow of workers from non-military sectors to the military sector due to compulsory military service (forcing employees to work below their potential productivity on the civil labour market) and professional army. Since it is possible to substitute capital and labour to some degree in the military (e.g. Bove i Cavatorta 2012), it may be worth considering increasing capital expenditures and purchasing more advanced weapons instead of conscripting more recruits.

The effect of military expenditures on economic growth is definitely a very complex and complicated issue. The literature lacks a consensus on the topic; that is why it is worth conducting further research in this regard. Researchers should also remember that data from SIPRI and NATO databases is recorded on a cash basis, while data on the GDP in the EU and OECD methodologies are recorded on an accrual basis. This may lead to inconsistencies, since in the EU and OECD methodologies data may be recorded with delays, whereby using regressions with no lags or with only one lag may provide biased results resulting from the methodology of collecting data in national accounts. Another interesting stream of research are studies over individual channels of influence of military-related activities on economic growth, in particular supply-side effects and the labour market channel.

Graphs 3-12. Impulse response functions after structural decompositions





References

d'Agostino, G., Dunne, J. P. & Pieroni, L. (2017). Does military spending matter for long-run growth? *Defence and Peace Economics*, 28(4), 429–436.

Aizenman, J. & Glick, R. (2006). Military expenditure, threats, and growth. The Journal of International Trade & Economic Development, 15(2), 129–155.

Alptekin, A. & Levine, P. (2012). Military expenditure and economic growth: A meta-analysis. *European Journal of Political Economy*, 28(4), 636–650.

Antonakis, N. (1997). Military expenditure and economic growth in Greece, 1960-90. J*ournal of Peace Research*, 34(1), 89–100.

Barro, R. J. (1990). Government Spending in a Simple Model of Endogeneous Growth. *Journal of Political Economy*, 98(5), 103–125.

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

Barro, R. & Sala-i-Matin, X. (2003). Economic Growth (2nd ed.). MIT Press.

Becker, J. (2021). Rusty guns and buttery soldiers: Unemployment and the domestic origins of defense spending. *European Political Science Review*, 13(3), 307–330.

Becker, J. & Dunne, J. P. (2021). Military spending composition and economic growth. *Defence and Peace Economics*, 1–13.

Benoit, E. (1973). *Defense and economic growth in developing countries*. Lexington Books.

Benoit, E. (1978). Growth and defense in developing countries. *Economic Development and Cultural Change*, 26(2), 271–280.

Biolsi, C. (2019). Local effects of a military spending shock: Evidence from shipbuilding in the 1930s. *Review of Economic Dynamics*, 32, 227–248.

Biswas, B. & Ram, R. (1986). Military expenditures and economic growth in less developed countries: An augmented model and further evidence. *Economic Development and Cultural Change*, 34(2), 361–372.

Blackburne, E. F. & Frank, M. W. (2007). Estimation of nonstationary heterogeneous panels. *The Stata Journal: Promoting Communications on Statistics and Stata*, 7(2), 197–208.

Blanchard, O. & Perotti, R. (2002). An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output. *The Quarterly Journal of Economics*, 117(4), 1329–1368.

Bleaney, M., Gemmell, N. & Kneller, R. (2001). Testing the endogenous growth model: Public expenditure, taxation, and growth over the Long Run. *Canadian Journal of Economics*, 34(1), 36–57.

Bove, V. & Cavatorta, E. (2012). From conscription to volunteers: Budget shares in NATO Defence Spending. *Defence and Peace Economics*, 23(3), 273–288.

Burriel, P., De Castro, F., Garrote, D., Gordo, E., Paredes, J. & Pérez, J. J. (2010). Fiscal policy shocks in the euro area and the US: An empirical assessment. *Fiscal Studies*, 31(2), 251–285.

Caldara, D. & Kamps, C. (2017). The analytics of SVARs: A unified framework to measure fiscal multipliers. The Review of Economic Studies, 84(3), 1015–1040.

Chang, H.-C., Huang, B.-N. & Yang, C. W. (2011). Military expenditure and economic growth across different groups: A dynamic panel granger-causality approach. *Economic Modelling*, 28(6), 2416–2423.

Christiano, L., Eichenbaum, M. & Rebelo, S. (2011). When is the government spending multiplier large? *Journal of Political Economy*, 119(1), 78–121.

Daněk, Tomáš. (2015). Military Expenditures and Economic Growth: The Case of EU Countries. *Ekonomický časopis.* 63. 853-868.

Dunne, J. P. (2012). Military spending, growth, development and conflict. *Defence and Peace Economics*, 23(6), 549–557.

Dunne, J. P. & Nikolaidou, E. (2012). Defence spending and economic growth in the EU15. *Defence and Peace Economics*, 23(6), 537–548.

Dunne, J. P. & Tian, N. (2013a). Military expenditure and economic growth: A survey. *The Economics of Peace and Security Journal*, 8(1).

Dunne, J. P. & Tian, N. (2013b). Military expenditure, economic growth and heterogeneity. *Defence and Peace Economics*, 26(1), 15–31.

Dunne, J. P., Perlo-Freeman, S. & Smith, R. P. (2009). Determining military expenditures: arms races and spill-over effects in cross-section and panel data. *Working Papers 0901*, University of the West of England.

Dunne, J. P. & Sköns, E. (2014). The Military Industrial Complex. *The Global Arms Trade*, 281–292.

Dunne, J. P., Smith, R. P. & Willenbockel, D. (2005). Models of military expenditure and growth: A critical review. *Defence and Peace Economics*, 16(6), 449–461.

Dunne, J. P. & Uye, M. (2014). Defence spending and development. *The Global Arms Trade*, 293–305.

Dupor, B. & Guerrero, R. (2017). Local and aggregate fiscal policy multipliers. *Journal of Monetary Economics*, 92, 16–30.

Eurostat (2019). *Manual on government deficit and debt implementation of ESA 2010*. Luxembourg: Publications Office of the European Union, 2019

Fatás, A. & Mihov, I. (2001). The Effects of Fiscal Policy on Consumption and Employment: Theory and Evidence, *CEPR Discussion Papers 2760*

Galí, J., López-Salido, J. D. & Vallés, J. (2007). Understanding the effects of government spending on consumption. *Journal of the European Economic Association*, 5(1), 227–270.

Gechert, S. & Rannenberg, A. (2018). Which fiscal multipliers are regime-dependent? A meta-regression analysis. *Journal of Economic Surveys*, 32(4), 1160–1182.

Gechert, S. & Will, H. (2012) Fiscal multipliers: a meta regression analysis. *IMK working paper (No. 97)*

Hall, R. (2009). By How Much Does GDP Rise If the Government Buys More Output? *Brookings Papers on Economic Activity*, 2009(2), 183–249.

Heo, U. & Bohte, J. (2011). Who pays for national defense? Financing defense programs in the United States, 1947–2007. *Journal of Conflict Resolution*, 56(3), 413–438.

Ilzetzki, E., Mendoza, E. G. & Végh, C. A. (2013). How big (small?) are fiscal multipliers? *Journal of Monetary Economics*, 60(2), 239–254.

Jordà, Ò. (2005). Estimation and inference of impulse responses by local projections. *American Economic Review*, 95(1), 161–182.

Keller, K., Poutvaara, P. & Wagener, A. (2009). Military draft and economic growth in OECD countries. *Defence and Peace Economics*, 20(5), 373–393.

Knight, M., Loayza, N. & Villanueva, D. (1996). The peace dividend: Military spending cuts and economic growth. *Staff Papers - International Monetary Fund*, 43(1).

Kollias, C., Mylonidis, N. & Paleologou, S. M. (2007). A panel data analysis of the nexus between defence spending and growth in the European Union. *Defence and Peace Economics*, 18(1), 75–85.

Kollias, C. & Paleologou, S.-M. (2017). Military spending, economic growth and investment: A disaggregated analysis by income group. *Empirical Economics*, 56(3), 935–958.

Lobont, O. R., Glont, O. R., Badea, L. & Vatavu, S. (2019). Correlation of military expenditures and economic growth: Lessons for Romania. *Quality & Quantity*, 53(6), 2957–2968.

Lorusso, M. & Pieroni, L. (2017). The effects of military and non-military government expenditures on private consumption. *Journal of Peace Research*, 54(3), 442–456.

Lütkepohl, H. (2005). *New introduction to multiple time series analysis*. Springer.

Malizard, J. (2015). Does military expenditure crowd out private investment? A disaggregated perspective for the case of France. *Economic Modelling*, 46, 44–52.

Mankiw, N. G., Romer, D., & Weil, D. N. (1992). A contribution to the empirics of economic growth. *The Quarterly Journal of Economics*, 107(2), 407–437.

Mylonidis, N. (2008). Revisiting the nexus between military spending and growth in the European Union. *Defence and Peace Economics*, 19(4), 265–272.

Nakamura, E. & Steinsson, J. (2014). Fiscal stimulus in a monetary union: Evidence from US regions. *American Economic Review*, 104(3), 753–792.

OECD, Lequiller, F. & Blades, D. W. (2014). *Understanding national accounts*. OECD.

Pamp, O. & Thurner, P. W. (2017). Trading arms and the demand for military expenditures: Empirical explorations using new SIPRI-Data. *Defence and Peace Economics*, 28(4), 457–472.

Perotti, R. (2014). Defense government spending is contractionary, civilian government spending is expansionary. *NBER Working Paper 20179*

Pesaran, M. H. & Smith, R. (1995). Estimating long-run relationships from dynamic heterogeneous panels. *Journal of Econometrics*, 68(1), 79–113.

Pesaran, M. H. & Shin, Y. (1996). Cointegration and speed of convergence to equilibrium. *Journal of Econometrics*, 71(1-2), 117–143.

Pesaran, M. H. Shin, Y., & Smith, R. P. (1999). Pooled mean group estimation of dynamic heterogeneous panels. *Journal of the American Statistical Association*, 94(446), 621–634.

Pieroni, L. (2009). Military expenditure and economic growth. *Defence and Peace Economics*, 20(4), 327–339.

Poutvaara, P. & Wagener, A. (2007). Conscription: Economic costs and political allure. *The Economics of Peace and Security Journal*, 2(1).

Ramey, V. A. (2011). Identifying government spending shocks: It's all in the timing. *The Quarterly Journal of Economics*, 126(1), 1–50.

Ramey, V. A. & Shapiro, M. D. (1998). Costly capital reallocation and the effects of government spending. *Carnegie-Rochester Conference Series on Public Policy*, 48, 145–194.

Ramey, V. A. & Zubairy, S. (2018). Government spending multipliers in good times and in bad: Evidence from US Historical Data. *Journal of Political Economy*, 126(2), 850–901.

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

Shieh, J., Lai, C. & Chang, W. (2002). The impact of military burden on long-run growth and Welfare. *Journal of Development Economics*, 68(2), 443–454.

Smaldone, J. P. (2006). African military spending: Defence Versus Development? *African Security Review*, 15(4), 17–32.

Tao, R., Glonț, O. R., Li, Z.-Z., Lobonț, O. R. & Guzun, A. A. (2020). New evidence for Romania regarding dynamic causality between military expenditure and sustainable economic growth. *Sustainability*, 12(12), 5053.

Topcu, M. & Aras, I. (2013). Defense spending and economic growth: Extended Empirical Analysis for the European Union. *Defence and Peace Economics*, 26(2), 233–246.

Uhlig, H. (2005). What are the effects of monetary policy on output? Results from an agnostic identification procedure. *Journal of Monetary Economics*, 52(2), 381–419.

Waszkiewicz, G. (2020). Defence spending and economic growth in the Visegrad countries. *Panoeconomicus*, 67(4), 539–556.

Yakovlev, P. (2007). Arms trade, military spending, and economic growth. *Defence and Peace Economics*, 18(4), 317–338.