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Re-examination of the Convergence in Military Expenditures across NATO Countries: Do Different Approximations in Modeling Structural Breaks Matter?

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Abstract

The goal of this paper is to investigate whether the ratio of military expenditures to GDP converged across 27 NATO countries for the period 1993–2018 within the scope of stochastic convergence analysis. For this purpose, paying attention to the modeling of structural breaks, the paper employs unit root tests with and without sharp breaks and a unit root test with gradual breaks. The empirical findings imply that using different approximations in modeling structural breaks results in different outputs. The findings indicate weak evidence for the presence of convergence as well. The theoretical and practical implications of these findings are discussed.

Keywords: military expenditures, NATO countries, burden-sharing, convergence, unit root tests
JEL Classification: C22, H56, N40

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1. Introduction

Depending on geopolitical and geographical characteristics, economic and social structures, and political instability, the volume of defense expenditures varies across countries. However, some factors, such as the risk of war, democracy level, political instability, proximity to unstable regions, and technological developments in defense industries, are among the most important factors in determining the volume of defense expenditures.

With the disintegration of the Union of Soviet Socialist Republics (USSR) in 1991 and the end of the Cold War, defense expenditures began to decrease all over the world. Defense expenditures, which had followed a declining trend until the 2000s, started to increase again as a result of the terrorist attack on the USA in 2001. Although the global financial crisis and the sovereign debt crisis led defense expenditures to decrease in Europe, the amount of defense spending has increased globally. According to data from the Stockholm International Peace Research Institute (2019, hereafter SIPRI), in 2018, defense spending in the world rose to 1.82 trillion USD, which was the highest level since the Cold War. Besides, defense spending per capita reached 239 USD in 2018, while this figure was 230 USD in 2017. Defense spending accounted for approximately 2.1% of the global GDP in 2018. The top five countries with the highest level of defense spending in 2018 were the USA, China, Saudi Arabia, India, and France, respectively. The defense expenditures of these countries constituted 60% of the global military expenditures in 2018.

One of the most discussed issues within the North Atlantic Treaty Organization (hereafter NATO) in recent years has been burden sharing. Burden sharing can be defined as “the relative weight of the distribution of costs and risks across allies in pursuit of common goals” (Mesterhazy, 2018). Within this scope, the decision taken by NATO in 2014 with the aim of ensuring equal burden sharing among the member states regulates the share of defense expenditures in the GDP for the 29 member states. NATO, which was established by 12 countries to take precautions against the danger of the expansionist policies of the USSR after World War II, adopted new principles due to the dissolution of the Eastern Bloc. Today, the fact that countries prefer indirect war methods is leading to a change in defense and security strategies. For this reason, NATO’s activities and the burden sharing of the member countries are frequently discussed issues within the alliance. During the Cold War, a great part of NATO’s military expenditures was met by the USA. However, in the post-Cold War period, uncertainty about the equal responsibility and the burden of the member states within the alliance caused some problems (Bagbaslioglu, 2016). The defense spending of the European allies in recent years is disproportionate to the defense spending of the USA. According to the SIPRI (2019) data, while the defense spending of European allies accounted for about 34% of NATO's total defense spending in 1991, this ratio was nearly 21% in 2018. Additionally, in 2018, while NATO's total budget was 963 billion USD, the USA met almost 67% of the organization's budget alone with 649 billion USD. Countries with a larger share of military spending have a relatively higher defense burden. For this reason, the decision taken at the NATO summit in 2014 indicated that the member states should allocate 2% of their GDP to defense spending. Hence, equal burden sharing means that the share of defense expenditures in countries' GDP should be 2% for all the allies in the organization. The SIPRI (2019) data show that only five allied countries, namely Estonia, France, Greece, Turkey, and the USA, achieved this goal by 2018. It can be observed that the share of defense expenditures in the budget of the member countries gradually decreased, especially after 1990. After 2008, the share of defense spending diminished further as European allies focused on the banking sector, the sovereign debt crisis, and policies to reduce the budget deficits. It is noteworthy that the shares of defense expenditures in the budgets for some considerable and ascendant countries of the alliance, namely Canada, Germany, Italy, and Spain, are considerably below 2% (see Appendix 1).

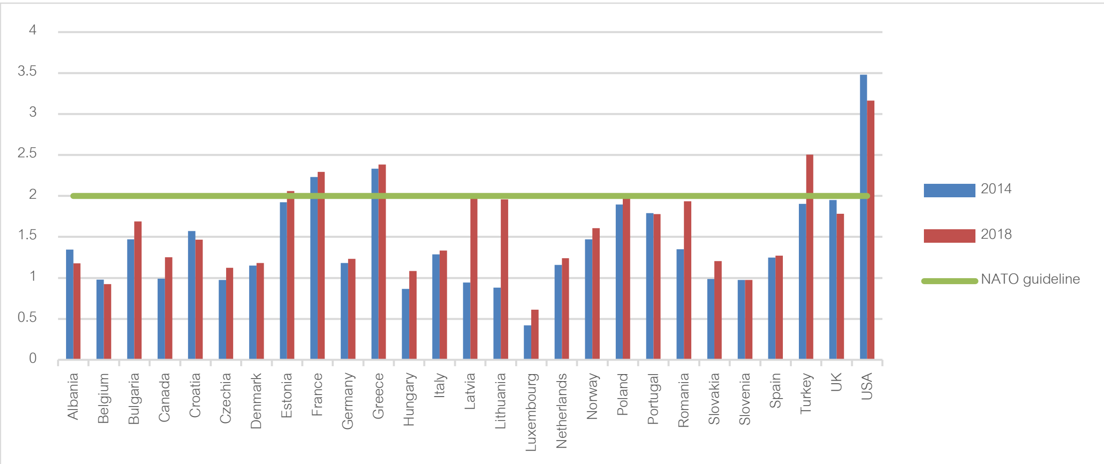

Figure 1: Defense expenditures as a share of countries' GDP (%)

Source: SIPRI (2019)

Figure 1 depicts the shares of defense expenditures in the GDP for some of the member countries in 2014 and 2018. Accordingly, while the shares of defense expenditures in the GDP were above 2% for only three countries (France, Greece, and the USA) in 2014, this ratio was over 2% for five countries (Estonia, France, Greece, Turkey, and the USA) in 2018. Therefore, other member countries failed to meet this criterion. From this point of view, the course of the military expenditures of the member countries and whether they converge in the long term have become crucial within the frame of burden sharing.

Even though convergence analysis has been discussed primarily in the growth literature since the seminal papers of Barro and Sala-i-Martin (1991, 1992), it is not limited to economic growth and is utilized in many different fields. Within this scope, some recent papers have begun to pay regard to this issue in defense economics and have examined convergence in military expenditures. For instance, while some papers have examined convergence in NATO countries (Guris, Guris, & Tirasoglu, 2017; Yazgan, Ceylan, & Mollavelioglu, 2018), others have investigated convergence in different country groups (Apergis, Christou, & Hassapis, 2013; Arvanitidis & Kollias, 2018; Arvaniditties, Kollias, & Anastasopoulos, 2014; Clements, Gupta, & Khamidova, 2019; Das, Dinda, & Martin, 2018; Lau, Demir, & Bilgin, 2016). On one hand, only Guris et al. (2017) considered structural breaks in series while testing the stochastic convergence propounded by Carlino and Mills (1993). On the other hand, they regarded only sharp breaks in series and ignored the presence of possible gradual breaks.

This paper re-examines the question of whether the shares of defense expenditures in the GDP are converging in the long term for 27 NATO countries using annual data from 1993 to 2018 within the frame of stochastic convergence analysis. The present paper employs not only unit root tests with and without sharp breaks but also a unit root test with gradual breaks. Accordingly, it first performs the Dickey and Fuller (1981, hereafter ADF) unit root test without breaks. Then, it relaxes the assumption of no breaks and carries out the Zivot and Andrews (1992, hereafter Z&A) and Narayan and Popp (2010, hereafter N&P) unit root tests with sharp breaks. Finally, it employs the Enders and Lee (2012, hereafter E&L) unit root test with both sharp and gradual breaks. Put differently, the present paper exploits unit root tests with different approximations in modeling structural breaks. Therefore, the distinguishing feature of the present paper is that it is the first paper to employ a unit root test with gradual breaks to test stochastic convergence. Hence, a critical gap in the empirical literature is addressed in the paper.

The rest of the paper is structured as follows. The following section presents the background of convergence analysis. Section 3 provides a literature review. Section 4 introduces the data and methodology. The empirical findings are reported in section 5. The last section concludes the paper with a summary of the main findings and some implications.

2. Background of convergence analysis

In the empirical literature on economic growth, many studies have considered whether economies with a lower GDP per capita tend to grow faster than economies with a higher GDP per capita and thus whether poorer countries can catch up with richer ones. Put differently, they have investigated whether there will be convergence across economies in terms of income levels (Barro & Sala-i-Martin, 2004). The hypothesis that posits that poor economies tend to grow faster than rich ones and that incomes per capita converge to a common steady-state level irrespective of their characteristics, such as institutions, policies, technology levels, and investments, is referred to as absolute/unconditional convergence (Acemoglu, 2009; Barro & Sala-i-Martin, 2004; Durusu-Ciftci & Nazlioglu, 2019). On the other hand, the conditional convergence hypothesis postulates that income per capita convergence can prevail only in countries with similar institutions, policies, initial conditions, and so on (Acemoglu, 2009; Durusu-Ciftci & Nazlioglu, 2019). Some seminal studies in the empirical literature have provided evidence that conditional convergence prevails for countries while finding no evidence for unconditional convergence (Acemoglu, 2009; Barro & Sala-i-Martin, 1991; Mankiw, Romer, & Weil, 1992).

To test whether convergence exists, researchers have developed some methodological approaches. For instance, β-convergence exists if a relatively poor economy grows faster than a rich economy and thus the poor economy catches up with the rich economy in terms of income per capita (Barro & Sala-i-Martin, 1991, 1992, 2004; Sala-i-Martin, 1996). In the literature, β-convergence is sometimes defined as the regression towards the mean. The second concept for convergence is associated with cross-sectional dispersion. Accordingly, σ-convergence happens if the standard deviation of the logarithm of income per capita across a group of countries decreases over time (Barro & Sala-i-Martin, 1991, 1992, 2004; Sala-i-Martin, 1996). As Barro and Sala-i-Martin (2004), Sala-i-Martin (1996), and Young, Higgins, and Levy (2008) pointed out, β-convergence and σ-convergence are related to each other. Accordingly, the presence of β-convergence tends to generate σ-convergence while an essential condition for the presence of σ-convergence is the existence of β-convergence.

In the growth economics literature, β-convergence and σ-convergence have been criticized in many respects. For instance, Quah (1993) argued that β-convergence, which is based on a cross-sectional analysis, can yield inefficient output as it ignores the dynamic behavior of the data. Bernard and Durlauf (1995) contended that β-convergence is only able to test the hypothesis that the incomes of all the countries under consideration converge. Binder and Pesaran (1999) focused on β-convergence and revealed that stochastic technological progress led to differences in steady-state capital–output ratios for the 72 countries under consideration. Pesaran (2007) argued that β-convergence is basically related to convergence within an economy rather than convergence across countries. Last but not least, Quah (1996) asserted that, when the standard deviation of the logarithm of income per capita across countries is constant over time, indicating no convergence or divergence, economies might be moving within an invariant distribution, implying a stochastic steady-state output level.

With a stochastic definition of convergence, Carlino and Mills (1993) propounded a convergence test that is based on the possibility that income per capita differences among countries follow a stationary process. Put differently, their test posits that shocks to relative incomes per capita should be temporary when convergence exists. Within this scope, unit root tests are employed to determine whether the income per capita of one country $(y_{i,t})$ converges to the sample average $(\bar{y}_t)$. While $y_{i,t}$ is the income per capita for the ith country in period t, $\bar{y}_t$ is the average income per capita in period t. If the results of the unit root tests for $x_t = \ln(y_{i,t}/\bar{y}_{i,t})$ yield that the log difference in these two series is stationary, then one can conclude that convergence exists.

3. Literature review

Convergence analysis is not limited to economic growth and has been utilized in many different fields. Within this scope, some recent papers have begun to consider this issue in defense economics and investigate convergence in military expenditures. This paper categorizes these papers into three groups with regard to the methodologies that they used.

The first group of studies has investigated convergence in military expenditures through β- and σ-convergence methodologies. For instance, Arvanitidis et al. (2014), using data over the period 1988–2008 for 128 countries, examined the possibility of convergence in military expenditures. They found evidence in favor of convergence for the countries in the sample. They also provided evidence that the military expenditures of developing countries converge more rapidly than those of less developed countries. Arvanitidis and Kollias (2018) examined the convergence relationship for the same 128 countries using data over the period 1950–2015. Their findings implied that convergence prevails for countries with relatively low military expenditure to GDP ratios. Das et al. (2018), utilizing data over the period 1988–2013 for 23 developed and 22 developing countries, investigated whether convergence occurs in military expenditures. The empirical findings of the study indicate the presence of β-convergence but a lack of σ-convergence.

The second group of studies has used the nonlinear time-varying factor model to test convergence in military expenditures. For example, Apergis et al. (2013) investigated whether military expenditures converged for 17 European Union countries using data for the period 1990–2012. The findings of the study indicated the presence of three convergence groups. While Cyprus, Estonia, Greece, Finland, France, Italy, Portugal, and Slovenia constitute the first group, the second group consists of Austria, Belgium, Germany, Malta, the Netherlands, Slovakia, and Spain. Finally, the last group contains Ireland and Luxembourg. Clements et al. (2019) considered whether there was convergence between the military expenditures of 140 countries in the post-Cold War period using data for the period 1990–2017. They found strong evidence in favor of convergence.

The third group of studies has examined convergence in military expenditures using the stochastic convergence approach. Accordingly, Lau et al. (2016) analyzed the possible presence of stochastic convergence for 37 countries using data from 1988 to 2012 through a nonlinear panel unit root test. According to the empirical findings of the study, the military expenditures of about 53% of the countries in the sample converged to the world average. Guris et al. (2017), using data over the period 1953–2014, investigated whether stochastic convergence exists in the military expenditures of NATO countries via a linear unit root test with structural breaks and a nonlinear unit root test. They reported that the military expenditures of Germany, Greece, Portugal, the UK, and Luxembourg converged to the average. Yazgan et al. (2018) studied the stochastic convergence of military expenditures for 14 NATO countries over the period 1960–2014 with nonlinear unit root tests. The findings of the study revealed that the military expenditures of the countries converged to those of the USA.

Table 1: Brief literature

Author(s)	Sample	Methodology	Findings
Apergis et al. (2013)	17 EU countries 1990–2012	Nonlinear time-varying factor model	Convergence
Arvanitidis et al. (2014)	128 countries 1988–2008	β- and σ- convergence	Convergence
Lau et al. (2016)	37 countries 1988–2012	Stochastic convergence (nonlinear panel unit root test)	Mixed findings
Guris et al. (2017)	NATO countries 1953–2014	Stochastic convergence (linear and nonlinear unit root tests)	Mixed findings
Arvanitidis and Kollias (2018)	128 countries 1950–2015	β- and σ- convergence	Mixed findings
Das et al. (2018)	45 countries 1988–2013	β- and σ- convergence	Mixed findings
Yazgan et al. (2018)	NATO countries 1960–2014	Stochastic convergence (nonlinear unit root tests)	Convergence
Clements et al. (2019)	140 countries 1990–2017	Nonlinear time-varying factor model	Convergence

Table 1 presents the papers that have investigated convergence in military expenditures in the literature on defense economics. As it can be observed from the table, the previous papers on convergence in military expenditures have not provided clear-cut evidence. Hence, more papers focusing on convergence in military expenditures through advanced statistical and/or econometric methods can enrich the extant literature.

4. Data and methodology

4.1. Data

This paper investigates whether stochastic convergence exists in the ratio of military expenditures to GDP for the NATO countries. While there are no military expenditure data for Iceland, military expenditure data for Montenegro have been announced since 2005. Therefore, the data set excludes Iceland and Montenegro. Data are sourced from SIPRI (2019) and belong to

27 NATO countries (Albania, Belgium, Bulgaria, Canada, Croatia, Czechia, Denmark, Estonia, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Turkey, the UK, and the USA).

Before employing the approach of Carlino and Mills (1993) to test stochastic convergence, the paper reports some graphical observations for the examination of σ-convergence. The plot of the cross-sectional standard deviation of the logarithm of the ratio of military expenditures to GDP is presented in Appendix 2. As the cross-sectional standard deviation does not have an explicit downward trend, the analysis indicates that σ-convergence does not exist for military expenditures.

As indicated above, the paper principally follows the methodology of Carlino and Mills (1993) and describes stochastic convergence as the stationarity of $x_t = \ln\left(ME_{I,t}/\overline{ME}_t\right)$, where $ME_{i,t}$ is the military expenditure to GDP ratio for the ith country in period t and $\overline{ME}_t$ is the average of the military expenditure to GDP ratio in period t.

4.2. Unit root tests

The paper starts with the ADF test without structural breaks. A main shortcoming of this test is that it does not take structural breaks in a series into account. However, as Perron (1989) reported, time series can be exposed to breaks due to considerable events in an economy, such as economic crises, wars, natural disasters, and great changes in economic policies. Narayan and Popp (2010) and Zivot and Andrews (1992) relaxed the strong assumption of no breaks and respectively produced one-break and two-break unit root tests. The main advantage of these tests is that they consider endogenous structural breaks rather than a predetermined break date. Besides, both tests exploit dummy variables to capture breaks in a series. In other words, these tests posit that a certain number of breaks occur instantaneously. Therefore, these tests can be defined as unit root tests with sharp breaks. However, the number of breaks and the break dates may be unknown. Additionally, the breaks can be gradual. To overcome these problems, Ender and Lee (2012) suggested a unit root test based on Fourier approximation. Therefore, their test is able to produce efficient results about the stationarity levels of a series regardless of the form, namely sharp or gradual, and the number of structural breaks.

4.2.1. ADF test without structural breaks

In the applied economics literature, the ADF unit root test suggested by Dickey and Fuller (1981) is commonly performed. The model for the ADF test is shown below:

$$\Delta x_t = \beta + \delta x_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta x_{t-i} + \varepsilon_t \quad (1)$$

where Δ denotes the first-difference operator and ε is the error term. The null hypothesis of a unit root defined as $\delta = 0$ is tested against the alternative hypothesis of stationarity. When the test statistic is greater than the critical values, the null hypothesis of a unit root is rejected, meaning that the series is stationary.

4.2.2. Z&A test with one break

Zivot and Andrews (1992) produced a unit root test with one endogenous structural break. The null hypothesis of a unit root is tested for this model. The model for the Z&A test can be described as the following:

$$x_t = \alpha + \beta DU_t(\lambda) + \delta t + \vartheta x_{t-1} + \sum_{j=1}^{k} \gamma_j \Delta x_{t-j} + \varepsilon_t \quad (2)$$

where t = 1,2,3,…,T stands for the observed period, TB shows the break date, and λ = TB/T indicates the break point. The dummy variable in the model, namely $DU_t(\lambda)$, indicates the break. In the model, $DU_t(\lambda)$ is 1 if $t > T\lambda$ and 0 otherwise. When the test statistic is greater than the critical values, the null hypothesis of a unit root is rejected, indicating that the series is stationary.

4.2.3. N&P unit root test with two breaks

Narayan and Popp (2010) extended the Z&A test and suggested a two-break unit root test. They defined the data-generating process as $x_t = d_t + u_t$. While d_t shows the deterministic component, u_t indicates the stochastic component. The model for the N&P test can be specified as follows:

$$d_t = \alpha + \beta t + \delta^*(L)\left(\gamma_1 DU_{1,t} + \gamma_2 DU_{2,t}\right) \quad (3)$$

where $DU_{i,t} = 1$ if $t > T_{B,i}$ and 0 otherwise. Besides, $T_{B,i}$, i = 1,2 denotes the break dates. The test regression is considered to be the reduced from of the corresponding model. The test equation can be shown as below:

$$x_t = \rho x_{t-1} + \alpha + \beta t + \gamma_1 D(T_B)_{1,t} + \gamma_2 D(T_B)_{2,t} + \lambda_1 DU_{1,t-1} + \lambda_2 DU_{2,t-1} + \sum_{j=1}^{k} \beta_j \Delta x_{t-j} + \varepsilon_t \quad (4)$$

The null hypothesis of a unit root is tested against the alternative hypothesis of stationarity for this test. When the test statistic is greater than the critical values, the null hypothesis of a unit root is rejected, implying that the series is stationary.

4.2.4. E&L unit root test

To produce a unit root test that considers both sharp and gradual breaks in a series, Enders and Lee (2012) first considered the following model:

$$x_t = \alpha(t) + \rho x_{t-1} + \varepsilon_t \quad (5)$$

where ε and α(t) are the stationary error term and the deterministic function of t, respectively. E&L considered the following Fourier expansion when the form of α(t) is unknown:

$$\alpha(t) = \alpha_0 + \sum_{k=1}^{n} \alpha_k \sin(2\pi kt/T) + \sum_{k=1}^{n} \beta_k \cos(2\pi kt/T), \qquad n \leq T/2 \quad (6)$$

In the above equation, n, k, and T, respectively, are the number of frequencies, the particular frequency, and the number of observations. Enders and Lee (2012) used a single frequency k in their paper and dealt with the following equation:

$$\Delta x_t = \rho x_{t-1} + c_1 + c_2 \sin(2\pi kt/T) + c_3 \cos(2\pi kt/T) + \varepsilon_t \quad (7)$$

The null hypothesis of a unit root described as $\rho = 0$ is tested against the alternative hypothesis of stationarity. When the test statistic is greater than the critical values, the null hypothesis of a unit root is rejected, meaning that the series is stationary.

5. Results

The results for stochastic convergence are reported in Table 2. The rejection of the null hypothesis of a unit root implies that convergence exists since the null hypothesis of a unit root means divergence. Accordingly, the output of the ADF test exhibits that the null hypothesis of divergence is rejected only for Estonia and Greece, indicating that the military expenditures of these countries converged to the sample average. To consider structural breaks, the paper performs the Z&A and N&P unit root tests with sharp breaks. The findings of the Z&A unit root test with one sharp break show that the null hypothesis of divergence is rejected for five countries, namely Albania, Denmark, Slovakia, Turkey, and the UK. Put differently, the military expenditures of these countries converged to the average. In addition, the findings obtained from the N&P unit root test with two sharp breaks present evidence in favor of convergence for eight countries in the data set, specifically Canada, Croatia, Latvia, Lithuania, Norway, Slovakia, Turkey, and the UK. Finally, the outcome of the E&L unit root test with gradual breaks implies the rejection of the null hypothesis of divergence for six countries, namely Bulgaria, Denmark, Greece, Hungary, Luxembourg, and the USA.

Table 2: Empirical results for stochastic convergence

Country	ADF	Z&A	N&P	E&L
Albania	-2.619	-4.994**	-0.747	-3.263
Belgium	-0.683	-3.457	-1.809	-2.012
Bulgaria	-1.115	-3.739	-3.400	-4.075**
Canada	-1.498	-3.053	-4.643**	-2.770
Croatia	-1.769	-4.371	-4.761**	-2.485
Czechia	-1.031	-3.627	-4.094	-3.337
Denmark	-2.110	-4.587***	-2.599	-4.724*
Estonia	-3.229**	-3.855	0.821	-3.252
France	-1.368	-3.088	-1.154	-3.218
Germany	-1.624	-3.369	-2.513	-2.037
Greece	-2.849***	-4.414	-3.455	-3.546***
Hungary	-2.217	-4.387	-3.153	-3.808***
Italy	-2.202	-2.687	-2.172	-2.194
Latvia	-1.004	-4.317	-5.059**	-2.958
Lithuania	-0.732	-2.328	-6.113*	-2.729
Luxembourg	-2.476	-3.991	2.060	-3.508***
Netherlands	-1.978	-4.277	-2.738	-2.927
Norway	-2.146	-2.822	-4.568**	-3.147
Poland	-1.188	-4.441	-2.687	-2.236
Portugal	-1.649	-2.059	-3.380	-3.243
Romania	-1.101	-2.237	-1.469	-1.902
Slovakia	-1.754	-8.956*	-5.638*	-3.344
Slovenia	-0.944	-2.123	-1.382	-2.171
Spain	-1.804	-3.709	-2.770	-2.687
Turkey	-1.380	-5.274**	-4.398***	-2.823
UK	-1.800	-4.585***	-6.088*	-0.207
USA	-2.024	-2.140	-1.442	-3.744***

Notes: *, **, and *** show the 1%, 5%, and 10% levels of significance, respectively. The break dates are available on request.

One can observe from Table 2 that (i) none of the unit root tests present evidence in favor of convergence for Belgium, Czechia, France, Germany, Italy, the Netherlands, Poland, Portugal, Romania, Slovenia, and Spain, (ii) one out of four unit root tests signifies convergence for Albania, Bulgaria, Canada, Croatia, Estonia, Hungary, Latvia, Lithuania, Luxembourg, Norway, and the USA, and (iii) two out of four unit root tests imply convergence for Denmark, Greece, Slovakia, Turkey, and the UK. Hence, the paper appears to provide weak evidence of stochastic convergence in NATO countries.

This paper also classifies the countries into two groups in terms of the years of participation in NATO by the members to check the robustness of the baseline findings. Accordingly, the first group includes countries that joined NATO before 1999 while the second group contains countries that joined NATO after 1999. The reason for selecting the year 1999 is that many huge political developments occurred in the 1990s, such as the reunification of East Germany and West Germany in 1990, the dissolution of Yugoslavia in the 1990s, the end of the Cold War in 1991, and the dissolution of Czechoslovakia in 1993. Hence, 15 countries are included in the first group while the second group contains 12 countries. Panel A and panel B of Table 3, respectively, report the results of the convergence analysis for the countries that joined NATO before 1999 and those that joined NATO after 1999.

As can be seen in panel A of Table 3, the output of the ADF test indicates that the null hypothesis of divergence is rejected for Denmark, Greece, the UK, and the USA, meaning that the military expenditures of these countries converged to the average. The findings obtained from the Z&A unit root test present evidence in favor of convergence for France, Greece, and Spain. The findings of the N&P unit root test show that the null hypothesis of divergence is rejected for four countries, namely Denmark, France, Germany, and Greece. The outcome of the E&L unit root test implies that the null hypothesis of divergence is rejected for Denmark, Greece, Italy, Portugal, and the USA. Besides, according to the results in panel B of the table, the outcome of the ADF unit root test suggests that the null hypothesis of divergence is rejected only for Estonia. The output of the Z&A unit root test indicates that the null hypothesis of divergence is rejected for Lithuania and Slovakia. The findings obtained from the N&P unit root test present evidence in favor of convergence for Bulgaria, Croatia, Hungary, Latvia, Lithuania, and Slovakia. The findings of the E&L unit root test show that the null hypothesis of divergence is rejected for Estonia and Hungary.

Table 3: Empirical results for stochastic convergence for the groups

Country	ADF	Z&A	N&P	E&L
Panel A: Countries joining NATO before 1999				
Belgium	-0.975	-4.052	-3.557	-1.636
Canada	-1.377	-2.785	-0.015	-3.390
Denmark	-3.082**	-3.699	-5.652*	-3.993*
France	-1.406	-5.856*	-5.403*	-0.796
Germany	-2.074	-4.406	-4.176***	-2.785
Greece	-4.432*	-6.926*	-4.346***	-3.110**
Italy	-2.119	-3.892	-3.585	-3.090**
Luxembourg	-2.091	-4.045	-3.525	-2.684
Netherlands	-2.345	-4.101	-3.161	-2.658
Norway	-2.138	-3.378	-2.181	-3.158
Portugal	-1.858	-3.213	-3.568	-3.724***
Spain	-2.287	-5.109**	-3.975	-2.186
Turkey	-1.344	-4.454	-4.064	-3.460
UK	-2.645***	-2.919	-3.787	-1.803
USA	-3.082**	-3.221	-3.436	-5.025*
Panel B: Countries joining NATO after 1999				
Albania	-2.452	-4.169	-1.912	-2.823
Bulgaria	-1.098	-3.623	-4.979**	-3.138
Croatia	-1.701	-4.308	-4.237***	-2.442
Czechia	-1.018	-4.417	-3.895	-2.423
Estonia	-3.328**	-3.336	2.256	-3.304**
Hungary	-2.570	-4.399	-4.498**	-3.762***
Latvia	-0.942	-3.981	-4.854**	-2.741
Lithuania	-0.760	-4.759***	-6.151*	-2.539
Poland	-1.244	-3.616	-2.581	-2.670
Romania	-1.109	-2.407	-1.698	-2.017
Slovakia	-1.719	-4.997**	-8.029*	-3.184
Slovenia	-0.890	-1.993	-0.330	-2.504

Notes: *, **, and *** show the 1%, 5%, and 10% levels of significance, respectively. The break dates are available on request.

One can notice from panel A of the table that (i) none of the unit root tests signify convergence for Belgium, Canada, Luxembourg, the Netherlands, Norway, and Turkey, (ii) one out of four unit root tests implies convergence for Germany, Italy, Portugal, Spain, and the UK, (iii) two out of four unit root tests present evidence in favor of convergence for France and the USA, (iv) three out of four unit root tests indicate that convergence exists for Denmark, and (v) all the unit root tests report convergence for Greece. Additionally, one can observe from panel B of the table that (i) none of the unit root tests indicate evidence in favor of convergence for Albania, Czechia, Poland, Romania, and Slovenia, (ii) one out of four unit root tests signifies convergence for Bulgaria, Croatia, and Latvia, and (iii) two out of four unit root tests imply the presence of convergence for Estonia, Hungary, Lithuania, and Slovakia. Hence, even though the results of the unit root tests for some countries change, the baseline findings seem to be robust in terms of providing weak evidence for stochastic convergence in the military expenditures of NATO countries.

6. Conclusion

This paper investigates whether the ratio of military expenditures to GDP converged among 27 NATO countries over the period 1993–2018 within the frame of stochastic convergence analysis. The paper performs four unit root tests with different approximations in modeling structural breaks to test whether the military expenditures of NATO countries have converged to the sample average. It first uses the conventional ADF unit root test, which does not take structural breaks into account. Second, it exploits the Z&A and N&P unit root tests with sharp breaks. Finally, it employs the E&L unit root test based on Fourier approximation to capture both sharp and gradual breaks in the series. The paper first examines the stochastic convergence for all the countries in the sample and finds weak evidence for the existence of convergence. The baseline findings also reveal that considering structural breaks and modeling breaks using different approaches result in highly different findings when testing stochastic convergence. Then, to check the robustness of the baseline findings, the paper classifies the countries into two groups in terms of the years of participation in NATO by the members. The baseline empirical findings are robust in terms of exploring weak evidence for stochastic convergence, though the findings obtained from the unit root tests for some countries change. Hence, the paper ultimately explores whether (i) different approximations in modeling structural breaks to test stochastic convergence can lead to different findings and (ii) weak evidence exists in favor of stochastic convergence for the ratio of military expenditures to GDP among NATO countries.

The trend of the global defense spending supports the empirical findings of the present paper. Accordingly, although global defense expenditures have increased since 1960, the share of defense expenditures in countries' GDP has been gradually decreasing, especially since the Cold War period. While the September 11, 2001 terrorist attack in the United States led to a significant increase in the US defense spending, the stagnation induced by the 2008 global financial crisis led to a reduction in the defense spending of European countries. The 2001 terrorist incidents and the 2008 crisis significantly affected the trends and the regional distribution of defense expenditures along with the burden sharing within NATO. After 2008, defense spending gradually decreased as European governments focused their efforts on the banking sector, the Euro crisis, and the economic recovery process. Hence, only three allies (Greece, the UK, and the USA) achieved the 2% target in 2014. In 2018, the number of countries that achieved this target increased to five (Estonia, France, Greece, Turkey, and the USA). Although there has been an increase in the defense expenditures of Estonia, Lithuania, and Poland within the scope of NATO's Baltic Plan in recent years, the shares of defense expenditures in the budgets are still very limited. However, especially in recent years, defense spending has increased significantly in the Middle East, North Africa, East Asia, and Pacific regions. In line with the economic and security interests of the Western allies, there is an increasing need to enhance defense spending to increase their strengths and influences in these unstable regions. Moreover, Russia's recent desire for further enlargement by taking over some territory from Ukraine is a serious concern for the NATO countries. For this reason, the United States has recently criticized Germany and many other NATO countries for reconsidering their defense burdens, which decreased particularly after the 2008 global crisis, as the USA generally undertakes approximately 60% of the alliance budget alone. In particular, the member states that joined the union in the 1999 enlargement period (Bulgaria, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia) have undertaken only 2.4% of the NATO's military spending since 2000 (NATO, 2019).

To sum up, as shown in Appendix 1, the ratio of defense expenditures to GDP in many member states showed high volatility during the period 1993–2018 and was below 2% by 2018. This evidence leads to two considerable implications for the defense expenditures within the NATO countries. First, regional and global factors are causing a continuous fluctuation in the defense expenditures of the NATO countries. Second, the critiques of the USA toward other member countries about burden sharing appear to be reasonable in terms of the status of the USA in burden sharing.

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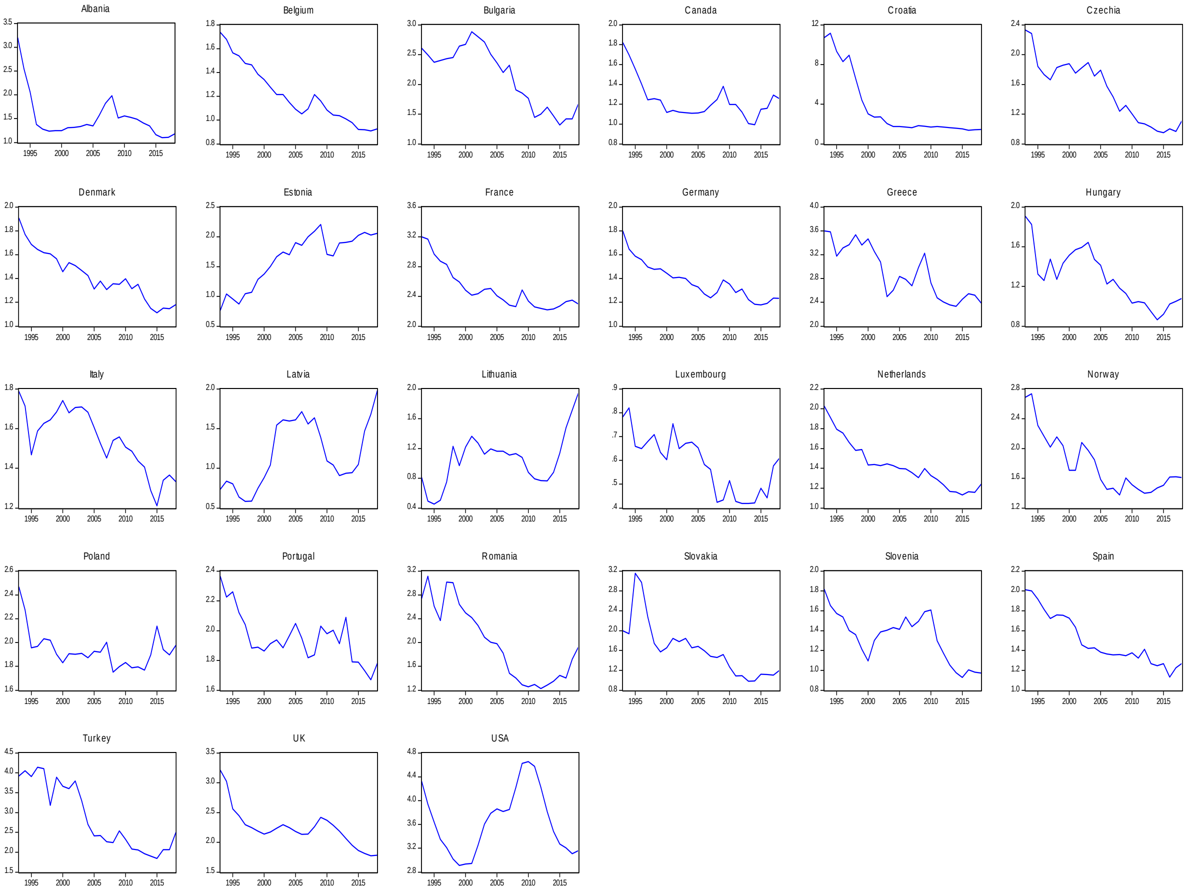
Appendix 1: Ratio of military expenditures to GDP for 27 NATO countries (%)



Appendix 2: Evidence of the σ-convergence