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# Testing behavior of defense expenditures in the NATO Countries: evidence from Fourier quantile unit root test

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**Abstract.** *The defense expenditure is an essential part of government expenditures due to political preferences, geopolitical conditions, and level of economic development of a country. If one of them makes war risk for the country, governments tend to increase defense expenditures and the share of it in the budget will rise. In the literature, behavior of government expenditures is tried to explain via Peacock and Wiseman's "displacement effect" hypothesis. The hypothesis claims that ratio of government expenditures to gross domestic product increases permanently when policy makers increase it once. So, if Peacock and Wiseman's "displacement effect" hypothesis is valid, that would share of defense expenditures in the central government budget will rise and share of other expenditure items will decrease. Its socio-economic outcomes will be different.*
*In this study, we aim to test behavior of defense expenditures of government in the NATO member countries to better understand how government manage expenditures. We modify "displacement effect" hypothesis by proportioning defense expenditures to gross domestic product. If it is not stationary, displacement effect hypothesis is valid, vice versa. Results imply that in most of the member countries displacement hypothesis for ratio of defense expenditures to GDP is valid, except Hungarian economy.*

**Keywords:** defense expenditures, Fourier quantile unit root test.

**JEL Classification:** H56, E62.

## 1. Introduction

Expenditures made for the security of a country are called defense expenditures. These expenditures may consist of many different items such as military training, military facilities, equipment, weapons, and personnel salaries. It is a kind of investment to increase military capability of the economy.

Defense expenditures are politically important as well as economically influential. They affect country's foreign policy and political relations. A country with high defense expenditures may adopt a harsher attitude in its relations with other countries. This is among the factors determining the country's foreign policy and plays a key role in the country's international relations (Dunne, 1990). Besides its impact on power on political relations of a country, it is vital to the country's economic structure. While defense capability of an economy ensures its protection against its enemies, size of defense industry may have significant effects on the economy.

According to Peacock and Wiseman (1961), "displacement hypothesis" is valid for government expenditures. Hypothesis claims that an increase in government expenditures due to socio-economic crisis such as war, natural disaster and etc., does not tend to recede to former level.

This might be valid for also military expenditures. In this case, if defense expenditures are stationary, they would recede to initial level. On the other hand, if it is non-stationary, "displacement hypothesis" is valid.

As a result of non-stationary defense expenditures in a country, permanent effects on economic growth will also reveal pass-through effects on other factors such as physical capital, trade, domestic and foreign debt stock, and human capital development. Therefore, it is very important for policy makers to determine whether the fluctuations in military spending are permanent or temporary (Alper and Alper, 2018: p. 20).

In this study, we aim to analyze stationarity of defense expenditures in NATO countries to better understand whether hypothesis is validity of "displacement hypothesis". To do so, we employ Fourier quantile unit root test methods and give permission to test for econometric methods. The contribution of the study is twofold. First, econometric method employed allows to put countries those have different time periods available. Secondly, increasing danger of Russian attacks after annexation of Crimea by Russian military power has made defense power of NATO member countries important. Increasing defense expenditures of member countries to prevent potential Russian attacks would also affect economies of member countries. By investigating behavior of defense expenditures, we will be able to predict future actions of fiscal policies.

In the following section, theoretical background related to defense expenditures will be summarized. In the third section, literature is presented. In the fourth section, econometric findings are summarized and in the light of findings, policy implications are made.

## 2. Theoretical Background

Theoretically defense expenditure is a part of government expenditures. In this regard, an increase in defense expenditures would also mean an increase in government expenditure. At first glance, it is rational to think that would affect economy positive. But, according to DeRouen (1994), effect might be positive and/or negative.

One of the positive effects of defense expenditures on the economy is about employment and economic growth. Increasing military expenditures also increase job opportunity due to investments made in the sector. As a result of investments economy grows.

Besides its positive effects, there might be negative effects of defense industry expenditures on the economy. one of them is about budget balance. According to Rooney et al. (2021), when defense expenditures is seen as a priority in the economy, it might induce budget imbalances. Increased defense expenditures may lead to increased tax burden and cuts in public services. Moreover, defense expenditures might make it difficult to allocate sufficient resources to other sectors. These expenditures may limit the potential for economic growth by constraining the financing of other sectors.

Cappelen et al. (1984) emphasizes negative effects of defense industry on investment costs. Defense expenditures include investments in the development and renewal of military technology. These investments can lead to high costs for the defense industry, and, in the long run, it may limit the economic growth of the country.

Töngür and Elveren (2012) summarizes defense expenditures on income inequality. According to Keynesian theory, military expenditures increase income via aggregate demand. On the other hand, expenditures special to a sector would increase income inequality.

We can investigate effects of defense expenditures in the name of current account balance. By increasing the military power of the country, defense expenditures increase military competition with other countries. This competition may increase the exports of enterprises in the defense industry, which in turn may affect the country's position in foreign trade. However, increased defense expenditures may cause other countries to act in a similar way, which may increase competition in the overall international trade. At the end, trade relations can be complicated.

When we investigate movement of defense expenditures in an economy, it is essential to speak about displacement hypothesis. The displacement effect developed by Peacock and Wiseman (1961) indicates that growth of government expenditures because of an upheaval does not go back to initial level. Governments take it as a chance to expand its spendings which it can use ordinary times. On the other hand, possible behavior of defense expenditures would affect government’s role on the economy. Original study of Peacock and Wiseman (1961) takes ratio of government expenditures to GDP into account. When we modify it, it is possible to measure the validity of hypothesis by using defense expenditures directly. By doing so, it will be easier to understand possible effects of upheaval such as Russian – Ukraine tension and Russian attack risks.

## 3. Empirical Results

In this study, it is investigated whether defense expenditures of NATO member countries are stationary or not. By measuring stationarity, we will better understand validity of "displacement hypothesis" in the context of ratio of defense expenditures to GDP. Different from existing literature and original study of Peacock and Wiseman (1961), we test stationarity of defense expenditures instead of government expenditures.

The data belonging to ratio of defense expenditure to gross domestic product was obtained from the World Bank database. While the empirical analysis is performed, the analysis period of each country is different, but the end date of the analysis period is 2020 for all countries. In the empirical analysis, descriptive statistics are presented first, then Fourier quantile unit root test developed by Bahmani-Oskooee et al. (2017) is implemented.

**Table 1.** *Descriptive Statistics*

| Countries | Start Date | Mean | Max. | Min. | Std. Dev. | Coeff. Var | Jarque-Bera |
|---|---|---|---|---|---|---|---|
| Albania | 1980 | 2.82 | 6.11 [1984] | 1.10 [2016] | 1.99 | 0.70 | 6.68 (0.03)[b] |
| Belgium | 1972 | 1.92 | 3.36 [1981] | 0.88 [2017] | 0.90 | 0.46 | 6.06 (0.04)[b] |
| Bulgaria | 1989 | 2.27 | 4.39 [1989] | 1.22 [2017] | 0.76 | 0.33 | 1.84 (0.39) |
| Canada | 1972 | 1.53 | 2.11 [1984] | 0.98 [2014] | 0.37 | 0.24 | 5.05 (0.07)[c] |
| Croatia | 1992 | 3.68 | 11.14 [1994] | 1.57 [2018] | 3.16 | 0.85 | 8.17 (0.01)[b] |
| Czech Republic | 1993 | 1.49 | 2.33 [1993] | 0.94 [2015] | 0.41 | 0.27 | 1.50 (0.47) |
| Denmark | 1972 | 1.74 | 2.43 [1981] | 1.11 [2015] | 0.41 | 0.23 | 4.13 (0.12) |
| Estonia | 1993 | 1.59 | 2.30 [2020] | 0.76 [1993] | 0.40 | 0.25 | 1.67 (0.43) |
| France | 1972 | 2.51 | 3.24 [1981] | 1.84 [2013] | 0.54 | 0.21 | 6.02 (0.04)[b] |
| Germany | 1972 | 1.96 | 3.28 [1975] | 1.06 [2005] | 0.82 | 0.41 | 6.84 (0.03)[b] |
| Greece | 1972 | 3.67 | 5.91 [1977] | 2.35 [2014] | 1.08 | 0.29 | 5.21 (0.07)[a] |
| Hungary | 1972 | 2.09 | 4.97 [1995] | 0.85 [2014] | 1.01 | 0.78 | 3.84 (0.14) |
| Italy | 1972 | 1.71 | 2.39 [1972] | 1.20 [2015] | 0.26 | 0.15 | 0.74 (0.68) |
| Latvia | 1993 | 1.24 | 2.30 [2020] | 0.58 [1997] | 0.47 | 0.37 | 1.63 (0.44) |
| Lithuania | 1993 | 1.12 | 2.12 [2020] | 0.45 [1995] | 0.43 | 0.38 | 2.22 (0.32) |
| Luxembourg | 1972 | 0.76 | 1.21 [1981] | 0.42 [2012] | 0.22 | 0.28 | 2.41 (0.29) |
| Netherlands | 1972 | 1.97 | 3.14 [1982] | 1.13 [2015] | 0.68 | 0.34 | 5.92 (0.05)[c] |
| Norway | 1972 | 2.27 | 3.29 [1972] | 1.37 [2008] | 0.62 | 0.27 | 4.81 (0.08)[c] |
| Poland | 1980 | 2.82 | 3.24 [1982] | 1.75 [2008] | 0.43 | 0.15 | 7.51 (0.02)[b] |
| Portugal | 1972 | 2.42 | 5.74 [1974] | 1.68 [2017] | 0.85 | 0.35 | 132.23 (0.00)[a] |
| Romania | 1980 | 2.47 | 4.79 [1979] | 1.23 [2012] | 1.09 | 0.44 | 5.62 (0.05)[c] |
| Slovak Republic | 1993 | 1.62 | 3.15 [1995] | 0.97 [2013] | 0.52 | 0.32 | 10.77 (0.00)[a] |
| Slovenia | 1992 | 1.34 | 2.24 [1992] | 0.93 [2015] | 0.29 | 0.21 | 4.34 (0.11) |
| Spain | 1972 | 1.89 | 2.96 [1994] | 1.13 [2016] | 0.54 | 0.28 | 3.61 (0.16) |
| Turkey | 1972 | 3.25 | 5.11 [1975] | 1.81 [2015] | 0.85 | 0.26 | 1.38 (0.49) |
| United Kingdom | 1972 | 3.47 | 5.50 [1984] | 1.94 [2017] | 1.26 | 0.36 | 6.00 (0.04)[b] |
| United States | 1972 | 4.67 | 6.81 [1982] | 3.08 [1999] | 1.12 | 0.23 | 3.447 (0.17) |

**Note:** [] related dates, () shows probability value. a, b, c means 1 %, 5 % and 10 % significance levels, respectively.

USA has the highest defense expenditures volume and Luxembourg has the lowest defense expenditure average among NATO countries. Albania, Canada, United Kingdom in 1984, Belgium, Denmark, France and Luxembourg in 1981, Bulgaria in 1989, Croatia and Spain in 1994, Czech Republic in 1993, Estonia, Latvia and Lithuania in 2020, Germany and Turkey in 1975, Greece in 1977, Hungary in 1995, Italy and Norway in 1972, Netherlands, Poland and United States in 1982, Portugal in 1974, Romania in 1979, Slovak Republic in 1995 and Slovenia reached the highest level of defense expenditures ratio in 1992.

Albania and Spain reached the lowest defense expenditures in 2016. Moreover, Belgium, Bulgaria, Portugal and United Kingdom in 2017, Canada, Greece and Hungary in 2014, Croatia in 2018, Czech Republic, Denmark, Italy, Netherlands, Slovenia and Turkey in 2015, Estonia in 1993, France and Slovak Republic in 2013, Germany in 2005, Latvia in 1997, Lithuania in 1995, Luxembourg in 2012, Norway and Poland in 2008, Romania in 2012 and United States of America in 1999, reached their lowest rate of defense industry expenditures, respectively.

It is seen that variation coefficient is high in Balkan countries such as Albania, Croatia and Hungary. Series belonging to Albania, Belgium, Bulgaria, Canada, Croatia, France, Germany, Greece, Netherlands, Norway, Poland, Portugal, Romania and United Kingdom do not show normal distribution.

It is suggested to use Zivot and Andrews (1992) and Lee and Strazicich (2003) unit root tests in the case of structural breaks in the empirical analysis period. But unit root test with structural breaks contains a sharp break because of dummy variable. For this reason, Koenker and Ziao (2004) suggest using stationarity test for each sub – samples in different quantiles. It is possible to present possible effects of shocks via under an unknown number of smooth breaks. In fourier unit root test developed by Bahmani – Oskooee et al. (2017), $Y_t$ is stochastic variable, k is number of frequency and T is number of samples.

$$Y_t = \psi_0 + \psi_1 \sin(\frac{2\pi kt}{T}) + \psi_2 \cos(\frac{2\pi kt}{T}) + \varepsilon_t$$

In the model presented in equation 1, $h_0$ hypothesis which claims the existence of unit root in variable is as follows:

$$\varepsilon_t = \varepsilon_{t-1} + \nu_t$$

It is assumed that $\nu_t$ is distributed independent identically distributed. At the end optimal $k^*$ frequency number which minimizes the sum of residual squares is chosen and OLS is implemented.

$$\varepsilon_t = Y_t - \psi_0 - \psi_1 \sin\left(\frac{2\pi k^* t}{T}\right) - \psi_2 \cos\left(\frac{2\pi k^* t}{T}\right)$$

In model above, unit root is tested in $\tau$ conditional quantile.

$$\gamma_t(\tau|\varepsilon_{t-1}) = \beta_0(\tau) + \theta_1(\tau)\varepsilon_{t-1} + \sum_{p=1}^{p} \theta_{1+p}(\tau)\, \Delta\varepsilon_{t-p} + e_t$$

$\beta_0(\tau)$ value estimated captures size of shock which affects defense expenditures in each quantile. Koenker and Xiao (2004) calculate Kolmogorov-Smirnov (QKS) statistics related to quantile regression as follows:

$$QKS = sup_{\tau_i \in [min,max]} |t_n(\tau)|$$

**Table 2.** *Fourier Quantile Unit Root Test Results*

| Countries | Fourier QKS | 10% | 5% | 1% | k* | F Statistics |
|---|---|---|---|---|---|---|
| Albania | 14.985 | 58.214 | 104.727 | 206.672 | 0.6 | 121.583[a] |
| Belgium | 6.281 | 19.950 | 40.158 | 260.864 | 0.7 | 510.371[a] |
| Bulgaria | 7.953 | 12.969 | 21.667 | 38.350 | 1.2 | 0.484 |
| Canada | 4.166 | 30.092 | 52.304 | 4004.747 | 0.9 | 146.279[a] |
| Croatia | 13.286 | 21.060 | 26.687 | 60.794 | 0.1 | 89.930[a] |
| Czech Republic | 6.495 | 35.061 | 138.394 | 592.982 | 0.7 | 75.127[a] |
| Denmark | 15.169 | 23.197 | 57.644 | 318.282 | 0.7 | 460.14[a] |
| Estonia | 6.575 | 13.412 | 21.149 | 71.332 | 0.1 | 116.416[a] |
| France | 14.018 | 15.285 | 47.439 | 126.383 | 0.7 | 1183.924[a] |
| Germany | 3.415 | 5.539 | 6.267 | 16.658 | 0.7 | 603.65[a] |
| Greece | 4.742 | 50.233 | 188.592 | 21893.359 | 0.7 | 109.146[a] |
| Hungary | 6.618[c] | 6.382 | 8.960 | 14.398 | 0.8 | 136.202[a] |
| Italy | 6.461 | 32.522 | 50.707 | 2240.957 | 0.2 | 87.886[a] |
| Latvia | 4.287 | 6.000 | 8.548 | 12.275 | 1.8 | 40.522[a] |
| Lithuania | 5.832 | 27.334 | 56.474 | 112.434 | 1.8 | 23.825[a] |
| Luxembourg | 17.635 | 63.459 | 416.328 | 6181.435 | 0.9 | 137.918[a] |
| Netherlands | 6.666 | 17.256 | 24.431 | 41.876 | 0.7 | 718.791[a] |
| Norway | 9.231 | 137.093 | 1600.583 | 8279.839 | 0.7 | 189.452[a] |
| Poland | 4.741 | 44.457 | 640.817 | 7320.362 | 0.5 | 91.455[a] |
| Portugal | 5.141 | 10.628 | 15.903 | 59.081 | 0.1 | 70.112[a] |
| Romania | 28.564 | 96.368 | 1031.558 | 45205.589 | 1 | 57.338[a] |
| Slovak Republic | 31.185 | 16.843 | 21.079 | 51.534 | 0.7 | 25.029[a] |
| Slovenia | 4.17 | 23.274 | 60.587 | 729.354 | 1.8 | 18.534[a] |
| Spain | 9.201 | 79.244 | 1497.205 | 7191.956 | 0.8 | 256.022[a] |
| Turkey | 12.580 | 41.155 | 1004.257 | 86901.265 | 0.6 | 42.993[a] |
| United Kingdom | 25.947 | 125.76 | 614.664 | 25263.07 | 0.7 | 285.584[a] |
| United States | 7.544 | 18.937 | 29.205 | 580.122 | 0.7 | 32.807[a] |

**Notes:** a, b and c show the null hypothesis of unit root is rejected at 10%, 5% and 1%, respectively. k* is the number of optimal frequency number. In order to test significance of trigonometric terms F-stat is used. Critical values of F-stat are 4.668, 3.022 and 2.318 for 1%, 5% and 10%, respectively. Critical values of Fourier QKS statistics are calculated via 1000 bootstrap.

The fact that defense expenditures carry a unit root in the level value indicates that the effect of internal and external shocks on the variable is permanent, while the absence of a unit root indicates that the effect of shocks is temporary.

According to FQKS (2018) unit root test results, defense expenditures are stationary in only Hungary. That means shocks to defense expenditures are not permanent only in Hungary. Defense expenditure series are not stationary in level for other countries. Moreover, response to shocks is higher in Latvia, Lithuania, Romania and Slovenia. Between 2010 and 2016, Fourier function turns into increasing trend in Belgium, Canada, Croatia, Czech Rep., Denmark, France, Germany, Greece, Hungary, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Slovak Rep., Slovenia, Spain, United Kingdom and United States of America. This result means that internal and external shocks affect defense expenditures of related countries in an increasing way.

## Conclusion

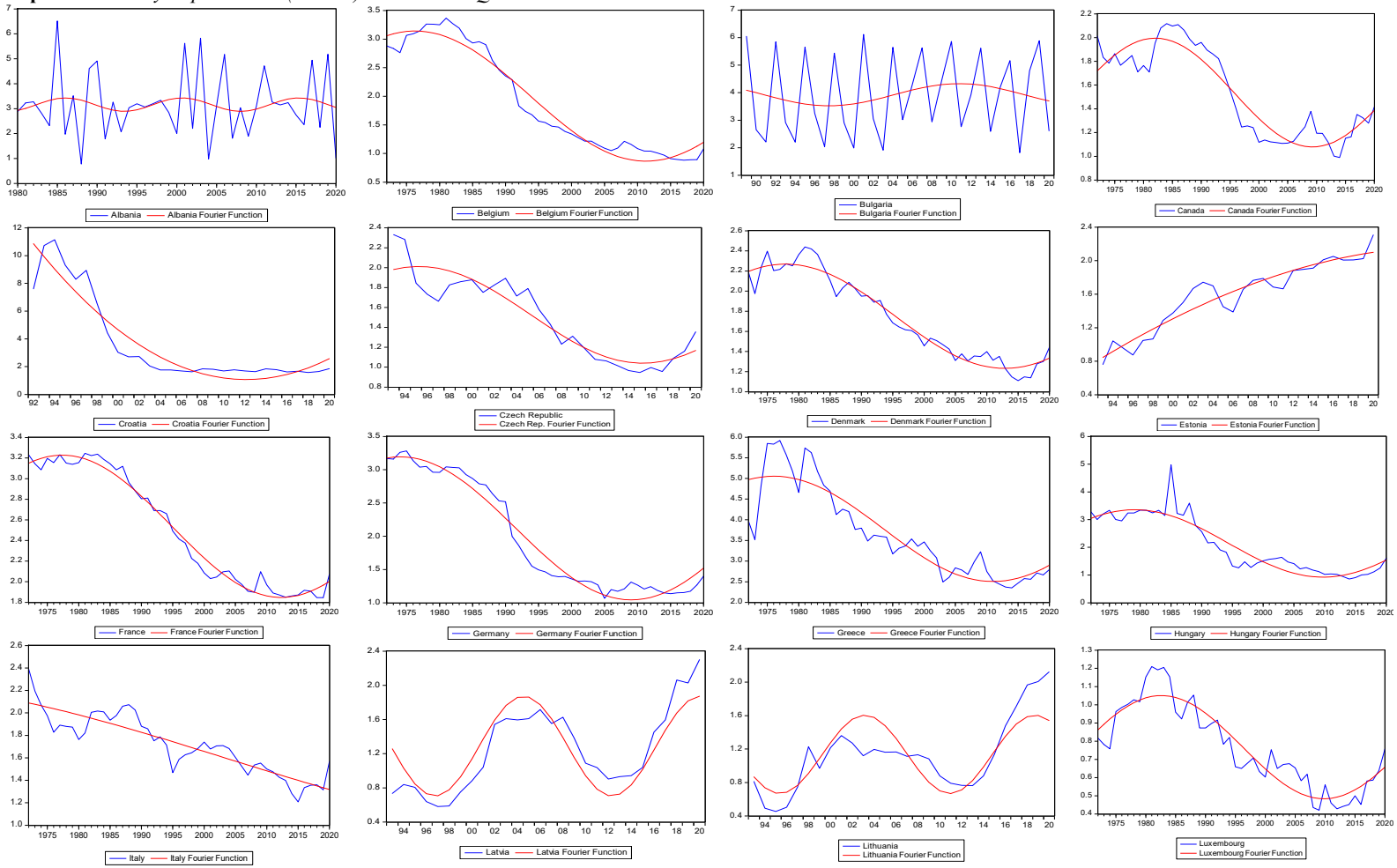
Defense expenditures is important not only because of its crucial role in the security of country, because of economic effects. Increasing size of defense expenditures can induce higher economic performance and faster economic growth. On the other hand, increasing defense expenditures might reduce other type of government expenditures. For example, reducing education expenditures to increase defense expenditures might be reason of human capital reduction in near future. That might reduce high – tech export volume in the following twenty years. For this reason, size of implementation method of defense expenditures is crucial for economy.

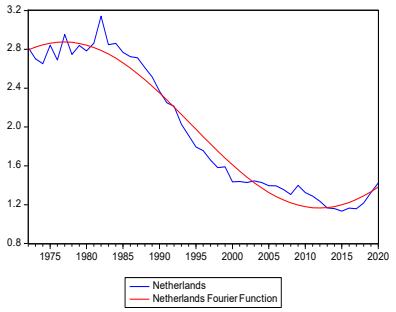
Another question is to answer is that what is the driver of defense expenditures. Internal and/or external shocks such as war thread, terrorist activities and geopolitical position might be reason of increasing defense expenditures. A change in conditions would fluctuate expenditures. On the other hand, an economy might spend the budget for defense industry in a planned way and does not change trend of expenditures.

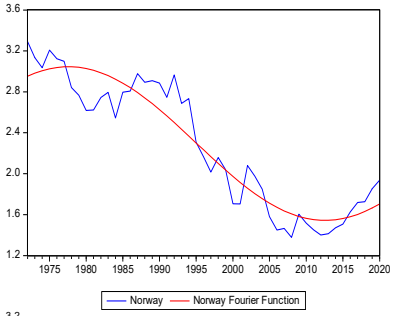
In this study, we aim to investigate the behavior of NATO countries in the name of defense expenditures. While investigating the relation we modify "displacement hypothesis" by taking defense expenditures into account. By employing advanced unit root tests, we try to better understand whether NATO countries change defense expenditures due to external shocks listed above. Results show that NATO member countries react to shocks expect Hungary. On the other hand, reactions of Latvia, Lithuania, Romania, and Slovenia are stronger than others. In 17 of 29 countries, reaction to shocks is getting to increase than before between years 2010 and 2016. In the light of these findings, NATO member countries' defense expenditures are sensitive to shocks.

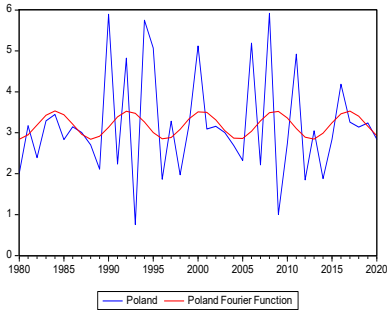
When we take main reason for establishment of NATO into account, it is possible to make of results. Especially reaction of Latvia, Lithuania and Slovenia to a shock is rational when violations such as Russia's aggressive military movements and violation of Crimea. Also increasing trend in most of NATO member countries can be interpreted as in the same behavior concept. It is seen that countries neighbor to Baltic Sea react more aggressively to external threats compare to other countries. Results mean that hypothesis is valid for NATO countries in general.

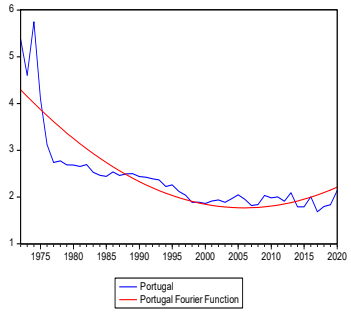
**Graphic 1.** *Military Expenditures (%GDP) and Fourier Quantile Function*

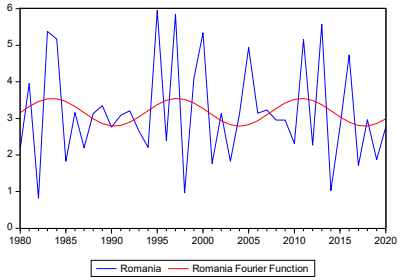


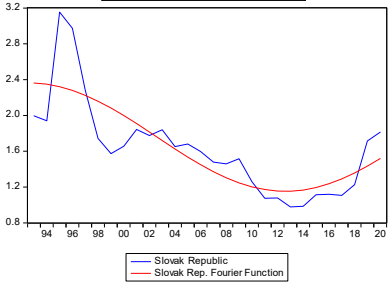

Netherlands
Netherlands Fourier Function

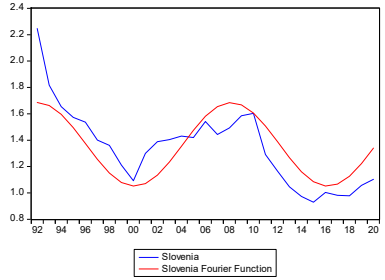

Norway
Norway Fourier Function

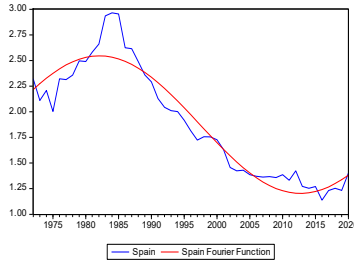

Poland
Poland Fourier Function

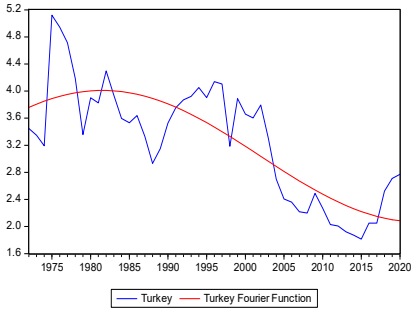

Portugal
Portugal Fourier Function

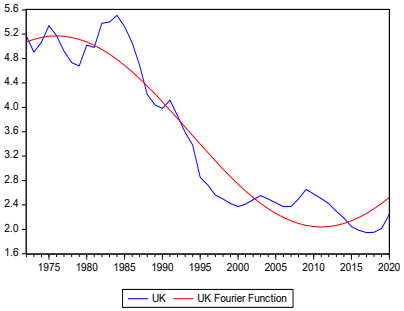

Romania
Romania Fourier Function

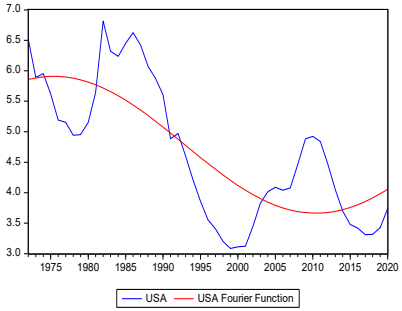

Slovak Republic
Slovak Rep. Fourier Function


Slovenia
Slovenia Fourier Function


Spain
Spain Fourier Function


Turkey
Turkey Fourier Function


UK
UK Fourier Function


USA
USA Fourier Function

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