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THE RELATIONSHIP BETWEEN DEFENSE EXPENDITURES AND ECONOMIC GROWTH: ROLLING-WINDOWS CAUSALITY TEST

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ABSTRACT

Defense expenditures have an essential place in the growth of countries. Defense expenditures and economic growth are frequently linked in the literature. The relationship between these variables may alter according to time and country-specific characteristics. This study examines the causality relationship between defense expenditures and economic growth with the rolling-windows causality. For all panels, the study found bidirectional causality only in China and unidirectional causality in S. Korea and the UK. On the other hand, the rolling-windows causality test detected bidirectional causality between the variables in all countries except the USA. Economic growth and defense expenditures have a unidirectional causality in the USA.

Keywords: *Defense Expenditures, Economic Growth, Rolling-Windows Causality.*

JEL Codes: *C33, H56, O40.*

1. INTRODUCTION

Defense expenditures are essential to economic growth and development. Researchers, academicians, and others have studied the relations. Benoit (1973) firstly discussed the relationship between these variables. Benoit (1978) noted that, despite expectations, countries with high defense expenditures tend to have the highest growth rates, while countries with the lowest tend to have the lowest growth rates. Moreover, these variables are not only positively correlated, but essential explanatory of each other (Benoit, 1978: 272).

Despite claims that the growth and defense expenditures are positively correlated, the relationship has complex characteristics. Chang et al. (2014) emphasized that there may be four different relation forms between defense expenditures and growth. Firstly, Benoit (1978) emphasized the defense expenditures–growth hypothesis, from defense expenditures to economic growth. Resources may not be used effectively if defense expenditures are financed through taxes or borrowing. This situation is explained by the military spending–growth detriment hypothesis. Second, Defense expenditures and economic growth are bidirectional. The third situation is no causality, and the neutrality hypothesis expresses the fourth situation (Chang et al., 2014: 178). For decision-makers, knowing the direction and

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degree of the relationship between these variables is very important because they direct the economy by looking at these results. While examining the relationship, it is necessary to consider the country-specific characteristics because countries are at different development levels. The negative impact of defense expenditures on economic growth is based on the opportunity cost or the crowding out effect on other types of spending, such as investments in physical and human capital (Hatemi-J ve diğerleri, 2018: 1194).

Studies explain the relationship between defense expenditures and economic growth from different perspectives in the literature. It is argued that defense expenditures affect economic growth through total demand. In case the aggregate demand is insufficient, defense investments create additional demand and provide resource optimization. It also provides additional workforce employment. These expenditures have long-term rather than short-term effects on growth. As a result, it leads to more efficient capacity use, resulting in increased profit rates and growth (Deger, 1986: 182).

This study examines the relationship between defense expenditures and growth for eight countries with the highest defense expenditures. It is stated in the literature that there are four different types of relationships between these two variables. However, this relationship may differ over time. Although there seems to be no causality in this period, there may be a causal relationship over time. This study explores the rolling-windows causality relationship. The Kónya Bootstrap Panel Causality Test found bidirectional causality for all panels only in China. While there was positive causality from defense expenditures to growth in China, negative causality was found vice versa. At the same time, defence expenditures have a positive relationship to growth in S. Korea and the United Kingdom. The Benoit hypothesis is confirmed in China, S. Korea, and the United Kingdom.

The study consists of four parts. First, there is an introduction, followed by the literature review. In the third, the empirical model is introduced and analyzed. The final section is the conclusion and discussion.

2. LITERATURE REVIEW

Benoit (1978) explained a positive correlation between defense expenditures and growth in forty-four LDCs. Chowdhury (1991) examined fifty-five developing countries using the causality analysis method. The study found a causal link between defense and growth. Chowdhury (1991) emphasized that causality may vary according to country and time. LaCivita and Frederiksen (1991) found causality between growth to defense in five countries, defense to growth in three countries, and a bidirectional relationship in two countries. No causality was found in eleven countries.

Dakurah et al. (2001) examined the relationship between defense and growth in developing countries using cointegration and causality analysis. There is bidirectional causality between twenty-three countries, with a positive relationship in sixteen countries and a negative one in seven. At the same time, while there was bidirectional causality in seven countries, causality was not found in eighteen countries.

Kollias et al. (2004) tested the cointegration analysis, they found that the variables in the twelve EU countries are cointegrated in the long run. There is bidirectional causality in Australia, Denmark, and Luxembourg, but no causality in France, Finland, and Portugal. They found unidirectional causality from economic growth to defense expenditures in the other six countries. Malizard (2010) found bidirectional causality between France's growth and defense. According to Impulse-response analyses, growth negatively impacts defense spending for the first period, but then the negative impact disappears.

Chang et al. (2011) performed a dynamic panel causality for ninety countries. The study found that the relationship between defense and growth varies according to the country's income. It has a positive effect in high- and middle-income countries and a negative in low-income countries.

Chang et al. (2014) conducted a causality test for the G-7 and China, the top defense spenders. The study found a bidirectional link between defense and growth in Japan and the USA. While there is a negative bidirectional relationship in Japan, there is a negative relationship from defense to growth in the USA; on the contrary, it is positive. Negative causality was found between defense and growth in Canada and the UK. There is only positive causality in China from economic growth to defense expenditures.

Chen et al. (2014) analyzed the causal link between defense and GDP for one hundred and thirty-seven countries. While defense expenditures affect GDP positively, GDP affects defense expenditures negatively in all countries. Yılgör et al. (2014) tested cointegration analysis and found that defence and growth act together in the long run. The causality analysis confirmed the same situation.

Zhong et al. (2017) determined that military expenditures in Russia affect economic growth negatively, and growth affects defense expenditures positively. In the USA, defense expenditures negatively affect growth, while economic growth positively affects military spending in Brazil and India. The causality was not found in China and South Africa.

Hatemi-J et al. (2018) analyzed asymmetric causality for the relationship between defense expenditures and growth in the top six countries with the highest military spending. As a result of symmetrical causality, while defense expenditures affect growth positively in China, it negatively affects Russia. At the same time, as a result of asymmetric causality, the positive shock in defense expenditures in China affects economic growth positively. The negative shock in Japan's defense expenditures negatively impacts economic growth.

Su et al. (2020) detected bidirectional causality between variables in China. At the same time, the study examined whether causality changed over time. The study found that causality changed over the years and disappeared in some years in China.

According to the literature, the relationship between these two variables varies by country, region, level of development, and time. This study retests the relationship between two variables with rolling-windows causality analysis. There may be a causal relationship in different periods in terms of countries.

3. DATA AND ANALYSIS

3.1. Data

The study used annual data for 1992-2020 and analyzed eight countries with the high defense expenditures (China, France, Germany, Japan, S. Korea, Russia, the United Kingdom, and the USA). The study used military expenditures (% GDP) as the proxy for defense expenditures and annual GDP growth for economic growth. These data were obtained from Worldbank World Development Indicators (WorldBank, 2022). ME represents defense spending and GDP economic growth.

3.2. Empirical Methodology

3.2.1. Cross-Sectional Dependence Tests

The cross-section dependency (CD) test examines whether all units are affected similarly by shocks to panel units or whether a shock from one unit affects other panel units. In other words, the test searches whether the error terms of the same period are related. This method is decisive for the reliability of the estimations or the selection of estimation methods (Ün, 2018: 90).

In order to test the CD in panel data analysis, there are alternative tests of the "*Spatial Correlation Test*" developed by Moran (1948) and the "*Lagrange Multiplier Approach*" by Breusch and Pagan (1980). The study used Breusch and Pagan (1980) LM test, which gives more relevant results when N is constant and T→ ∞. The LM test and the null hypothesis are shown as follows (Pesaran, 2021: 17-18):

$$CD_{LM} = T\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{p}_{ij}^{2} \qquad (1)$$

In this formula $\hat{p}_{ij}^{2}$ is the correlation coefficient of the residual. $\hat{p}_{ij}^{2}$ is represented by the formula (Pesaran, 2021:18):

$$\hat{p}_{ij} = \hat{p}_{ji} = \frac{\sum_{t=1}^{T} e_{it}e_{jt}}{(\sum_{t=1}^{T} e_{it}^{2})^{1/2}(\sum_{t=1}^{T} e_{jt}^{2})^{1/2}} \qquad (2)$$

e_{it} is the OLS estimate of u_{it}.

The null hypothesis of the LM test is expressed as H_0= cov(u_{it}, u_{jt})=p_{ij}=0 (i≠j for all t). The LM has N(N-1)/2 degrees of freedom and a chi-square distribution.

At the same time, a CD test was developed by Pesaran (2004), which can be used in the case of N>T. This test asymptotically shows the standard distribution feature. The null hypothesis is established as "*No correlation between the residuals*". Pesaran CD test is shown as follows (Pesaran, 2004: 5);

$$CD = \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{p}_{ij}\right) \tag{3}$$

When the group means differ from zero and the individual means differ from zero, the power of LM and CD tests weakens. Pesaran et al. (2008) recommend using the deviation-corrected LM test to overcome this problem. The null hypothesis is formed as "*No cross-section dependence*" in this test. The bias-adjusted LM test is asymptotically standard-normally distributed in the case of T→∞ and N→∞ (Pesaran et al., 2008: 108);

$$LM_{adj} = \sqrt{\frac{2}{N(N-1)}}\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\frac{(T-k)\hat{p}_{ij}^2-\mu_{Tij}}{v_{Tij}} \tag{4}$$

3.2.2. Homogeneity Test

Pesaran and Yamagata (2008) developed Delta ($\tilde{\Delta}$) tests to test the slope coefficients of the models established in panel data analysis. Two delta ($\tilde{\Delta}$) test with the null hypothesis of "*Slope coefficients are homogeneous*" while T and N → ∞ are √N/T →∞. It is recommended that the deviation corrected delta ($\tilde{\Delta}_{adj}$) test be used in a small sample from these tests (Pesaran & Yamagata, 2008:62);

$$\tilde{\Delta} = \sqrt{N}\left(\frac{N^{-1}\tilde{S}-1}{\sqrt{2k}}\right) \tag{5}$$

$$\tilde{\Delta}_{adj} = \sqrt{N}\left(\frac{N^{-1}\tilde{S}-k}{\sqrt{\mathrm{var}(\tilde{z}_{it})}}\right) \tag{6}$$

It is expressed by $k = E(\tilde{z}_{it})$ and $\mathrm{var}(\tilde{z}_{it}) = \frac{2k(T-k-1)}{(T+1)}$ in this formula.

4.3. Kónya Bootstrap Panel Causality Test

In the case of both CD and heterogeneity in panel data, it is appropriate to use the Kónya Bootstrap Causality Test. In the Kónya model, SUR (seemingly unrelated regression) estimation is used, not VAR estimation. For this reason, separate Wald statistics are calculated for each unit. At the same time, this model does not require any preliminary testing for unit root and cointegration since the time series properties of the data are not taken into account. Therefore, the level values of the variables are used

(Kónya, 2006: 981). Using the variables' level values in the empirical analysis is very important. Making the variables stationary by taking their differences causes the trend dynamics of the series to be eliminated. (Menyah et al., 2014: 391).

The Kónya causality requires estimating the following equations (Menyah et al., 2014: 391):

$$GDP_{1,t} = \alpha_{1,1} + \sum_{l=1}^{lGDP_1} \beta_{1,1,l} GDP_{1,t-1} + \sum_{l=1}^{lME_1} \gamma_{1,1,l} ME_{1,t-1} + \varepsilon_{1,1,t} \quad (7)$$

$$GDP_{2,t} = \alpha_{1,2} + \sum_{l=1}^{lGDP_1} \beta_{1,2,l} GDP_{2,t-1} + \sum_{l=1}^{lME_1} \gamma_{1,2,l} ME_{2,t-1} + \varepsilon_{1,2,t}$$

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$$GDP_{N,t} = \alpha_{1,N} + \sum_{l=1}^{lGDP_1} \beta_{1,N,l} GDP_{N,t-1} + \sum_{l=1}^{lME_1} \gamma_{1,N,l} ME_{N,t-1} + \varepsilon_{1,N,t}$$

and

$$ME_{1,t} = \alpha_{2,1} + \sum_{l=1}^{lGDP_1} \beta_{2,1,l} GDP_{1,t-1} + \sum_{l=1}^{lME_1} \gamma_{2,1,l} ME_{1,t-1} + \varepsilon_{2,1,t} \quad (8)$$

$$ME_{2,t} = \alpha_{2,2} + \sum_{l=1}^{lGDP_1} \beta_{2,2,l} GDP_{2,t-1} + \sum_{l=1}^{lME_1} \gamma_{2,2,l} ME_{2,t-1} + \varepsilon_{2,2,t}$$

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$$ME_{N,t} = \alpha_{2,N} + \sum_{l=1}^{lGDP_1} \beta_{2,N,l} GDP_{N,t-1} + \sum_{l=1}^{lME_1} \gamma_{2,N,l} ME_{N,t-1} + \varepsilon_{2,N,t}$$

In these equations, GDP is dependent, ME is the independent variable, N is the number of countries (i: 1.2…N), t is the time, and *l* is the lag length. The lag length was determined according to the AIC. In the study, all countries are evaluated simultaneously to allow for simultaneous correlation between countries, and the causality from X to Y and from Y to X is tested while calculating the country-specific critical Wald statistics (Kónya, 2006: 984).

Kónya Bootstrap Panel Causality test gives results only for the panel as a whole. However, this study re-examined the relationship between defense expenditures and economic growth, based on Yılancı & Özgür's (2019) study, using a rolling-windows causality test. In the rolling-windows causality test $t = \tau - 1 + l, \tau - 1, \ \tau = l, \ l + 1 \ldots\ldots T$ sub-sampling windows is determined. The fixed size of subsamples is shown l in this formula (Yılancı and Özgür, 2019: 24800).

3.3. Empirical Analysis

Before the causality tests, CD and homogeneity tests were examined in the paper. CD and homogeneity test results are reported in Table 1.

Table 1. The Results of CD and Homogeneity Tests

Test	Statistic	p-value
LM	203.662***	0.000
CD_{LM}	23.474***	0.000
CD	12.071***	0.000
LM_{adj}	27.826**	0.000
$\tilde{\Delta}$	3.334***	0.000
$\tilde{\Delta}_{adj}$	3.514***	0.000

Note: * 10 %, ** 5 % and ***1 % are significant.

CD and homogeneity tests reject the H_0 hypotheses of "*no cross-sectional dependence*", and "*slope coefficients are homogenous*". Tests confirmed that the series was both cross-sections dependent and heterogeneous. In the CD test, the shock that occurs in one country spreads to other countries. Therefore, the shock that occurs in the defense expenditures of any country spreads to other countries. At the same time, the homogeneity test implies that there are country-specific characteristics. Series are appropriate for Panel Bootstrap Granger Causality tests. Table 2 reports Kónya Bootstrap Panel Granger Causality test results.

Table 2. Results of Kónya Bootstrap Panel Granger Causality

H_0: ME does not Granger-cause GDP						
					Critical Values	
Countries	**Coefficient**	**Wald Statistics**	**Boot-p-value**	**1 %**	**5 %**	**10 %**
China	4.097	14.188**	0.019	16.068	10.407	7.842
France	0.867	1.247	0.349	9.323	5.398	3.928
Germany	-0.747	0.269	0.711	12.698	7.422	4.910
Japan	19.356	3.554	0.206	17.121	8.386	6.164
S. Korea	5.723	14.198**	0.020	17.172	9.170	6.140
Russia	-1.160	1.110	0.862	22.773	15.262	10.857
United Kingdom	1.163	5.471*	0.070	10.800	6.704	4.307
USA	0.132	0.191	0.749	17.101	8.289	5.663
H_0: GDP does not Granger-cause ME						
					Critical Values	

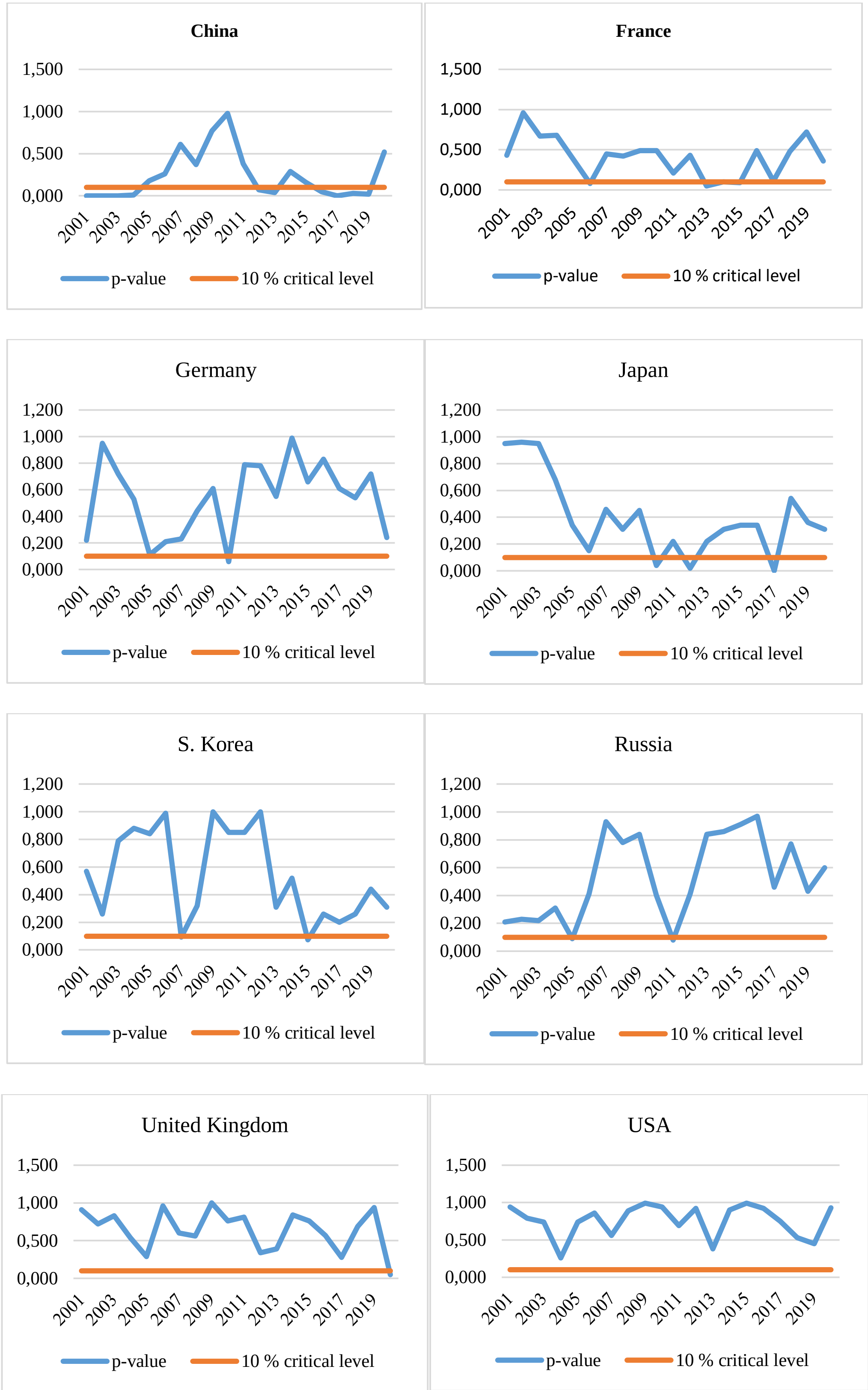
Countries	**Coefficient**	**Wald Statistics**	**Boot p-value**	**1 %**	**5 %**	**10 %**
China	-0.018	12.929***	0.005	9.817	5.199	3.630
France	-0.011	2.984	0.775	26.140	18.128	15.216
Germany	-0.002	0.076	0.827	13.789	6.625	4.597
Japan	0.000	0.006	0.989	34.238	18.968	14.703
S. Korea	0.003	0.656	0.874	29.928	19.908	15.419
Russia	-0.007	0.283	0.765	19.095	9.309	6.839
United Kingdom	-0.021	6.312	0.141	15.691	9.884	7.540
USA	-0.082	14.476	0.100	23.909	18.013	14.471

Note: * 10 %, ** 5 % and ***1 % are significant. The bootstrap critical values are calculated from 10,000 replications.

The Kónya Boostrap Panel Causality test determined causality from defense expenditures to economic growth in China, S. Korea, and the United Kingdom in the upper part of the table. An increase of 1% in defense expenditures caused the economic growth of 4.09% in China, 5.72% in S. Korea, and 1.16% in the United Kingdom. At the same time, when looking at the causality from economic growth to defense expenditures, China is the only country with causality in the table's lower part.

Political, structural, social, and innovative changes also affect the relationship over time in the countries (Yılancı and Özgür, 2019: 24800). For this reason, the Panel Rolling-windows Causality Test, which considers the causality over the years, was used, in addition to the Kónya Bootstrap Panel Granger Causality Test in this paper. Graph 1 demonstrates the results of the Rolling-Windows Causality Tests.

Graph 1. The results of the Rolling-Windows Causality Test from ME to GDP



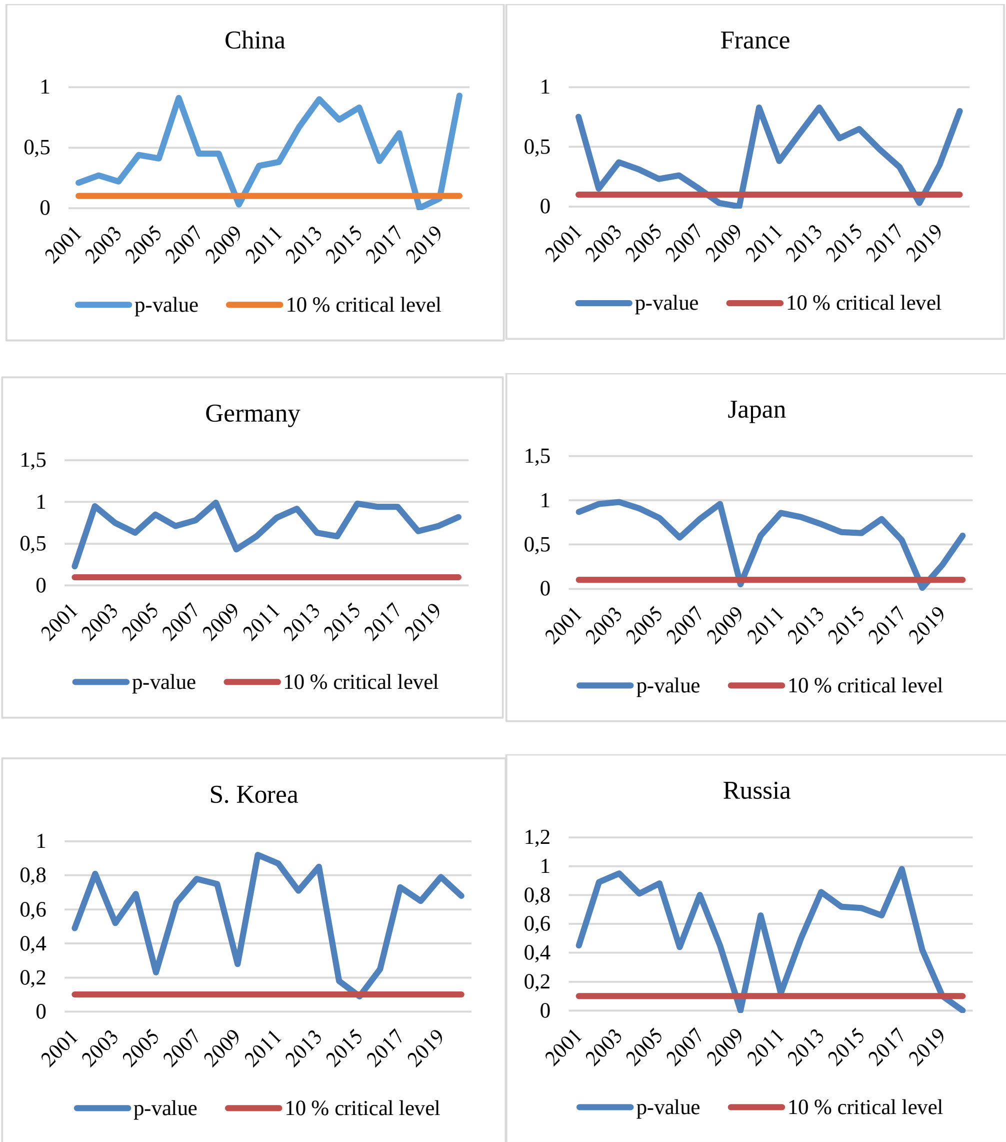
Note: The sub-sample size was selected as ten years. AIC was used for sub-sample optimal lag length.

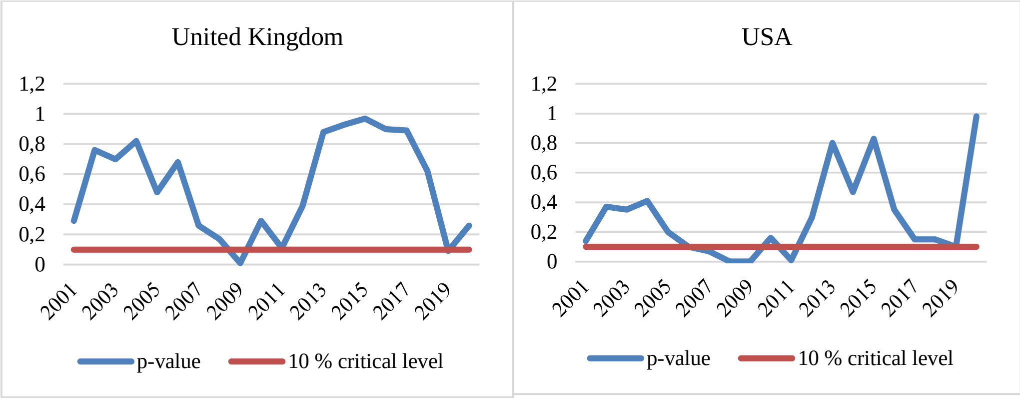
The Upper of Table 2 shows a panel bootstrap causality from ME to GDP only for China, S. Korea, and the United Kingdom. There is no causality in other countries. However, the rolling-windows causality test shows no causal relationship in the USA. The panel bootstrap causality analysis supports this result. However, there is causality in some periods in China, France, Germany, Japan, S. Korea, Russia, and United Kingdom. The rolling-windows bootstrap causality test captures causality at different periods. This feature of this test shows the advantage of the test.

Graph 1 proves causality from ME to GDP in China 2001-2004, 2012, 2013, 2016-2019, France in 2006, 2013, and 2015, Germany in 2010, Japan in 2010, 2012, and 2017, S. Korea in 2007 and 2015, Russia 2005 and 2011 and the United Kingdom in 2020 years.

In Table 2, there is only causality from GDP to ME in China and no causality in other countries. The causality results differ from GDP to ME in the rolling-windows causality test. Graph 2 shows rolling-windows causality results from GDP to ME.

Graph 2. Results of Panel Rolling-Windows Causality from GDP to ME





The test shows a causality from GDP to ME; in China in 2009, 2018, and 2019, in France in 2008, 2009, and 2018, in Japan in 2009 and 2018, in S. Korea in 2015, in Russia in 2009, 2019, and 2020, in the United Kingdom in 2009, and 2019, and in the USA 2007-2009, 2011, and 2019. According to the rolling-windows panel causality test, the existence of bidirectional causality, excluding the USA, is consistent with the findings of Malizard (2010), Chang et al. (2014), and Su et al. (2020).

4. CONCLUSION AND DISCUSSION

Defense expenditures have a significant impact on economic growth and development. Defense expenditures affect the economy in terms of demand and supply. However, the direction and degree of influence differ depending on the level of development of the countries. While allocating resources to defense positively affects growth in developed countries, it may negatively affect the least developed and developing countries. In addition, causality differs from defense expenditures to economic growth or vice versa. At the same time, this relationship may change over time. For this reason, the relationship between the two variables should be examined in detail from different aspects. This study examines the causality relationship between defense expenditures and economic growth with the rolling-windows causality test. For this purpose, the study evaluated eight countries with the highest defense expenditures. Kónya Bootstrap Panel Causality test results found bidirectional causality in China, unidirectional causality in S. Korea and the UK, and no causality in other countries for all panels. In the Kónya Bootstrap Panel Causality test, defense expenditures positively affect economic growth in China, S. Korea, and the UK. These results support the Benoit hypothesis. In these countries, defense expenditures are important for economic growth. However, the causality relationship changes over time in countries. As a result of the rolling-windows causality, it is understood that there is causality in other countries except the USA. In the USA, on the other hand, there is causality from economic growth to defense expenditures. However, causality in countries may vary from year to year. In general, it is known that there is causality between two variables in all countries. In the policies developed for defense expenditures in countries, the countries' time effect and characteristics should be considered. This study can be retested for different country groups, periods, and datasets because the causality relationship that occurs over time is important.

In conclusion, there is a causal relationship between defense expenditures and economic growth. Therefore, developed and developing countries should pay special attention to defense expenditures for economic growth and resource distribution. Because as a result of the deterioration of resource distribution, defense expenditures have a negative effect on growth.

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