Is geopolitical risk a reason or excuse for bigger military expenditures?

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Abstract

This study aims to investigate the relationship between military expenditures and geopolitical risk using the Panel Fourier Toda-Yamamoto Causality test over the 1993-2020 period. Considering structural changes, the findings reveal that geopolitical risk fluctuations in Colombia, India, South Korea, Russia, Saudi Arabia, Ukraine, and the USA affect military expenditures. Conversely, the results point out that for Chile, Israel, Russia, Taiwan, and the UK, military expenditures appear to cause geopolitical risk. This highlights that changes in military spending across nations trigger an arms race due to the perception of increased threat by neighbours and/or interest groups. In a nutshell, the results show a complex interplay between military expenditures and geopolitical risk, where changes in one can affect the other. Based upon this, policymakers must prioritize diplomacy, utilize international mediation/peacekeeping initiatives, develop military alliances, and commit to non-threatening military expenditures for regional stability.

Keywords: military expenditures; geopolitical risk; Panel Fourier Toda-Yamamoto causality; arms race; Keynesian theory

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1. Introduction

Geopolitical risk *(hereafter GPR)* is commonly used for national and/or international terrorist attacks/threats/conflicts, security problems, political stability, and geopolitical positioning (Caldara and Iacoviello 2022). The rapid growth of globalization affects geopolitical risk (Aziz 2017; Das 2019; Sweidan 2023). In recent decades, it has intensified, as evidenced by incidents such as the Russia-Ukraine War, Russia-USA tensions over Ukraine, China-USA tensions over Taiwan, the Cold War, 9/11, the Iraq War, the Mavi Marmara (2010), the Syrian Civil War, Arap Spring, etc (Sandler and George 2016; Kyriazis and Economou 2021; Caldara and Iacoviello 2022). These have led to the inference that countries allocate more financial resources for military power to safeguard their national and international security (Aizenman and Glick 2006; Feridun and Shahbaz 2010; Zhong et al. 2017; Khan, Su, and Rizvi 2020). The Stockholm International Peace Research Institute *(hereafter SIPRI)* report (2023) indicates that the total military expenditures *(hereafter MILEX)* of countries increased rapidly, especially after 2019, and exceeded the highest level of $2 trillion. However, GPR has not decreased as expected. Conversely, it has increased in some countries. Identifying this complex relationship between MILEX and the GPR is essential for policymakers to make more effective decisions to ensure the efficient usage of public resources and to sustain safeguarding (Fraser and Carbonnier 2020; Khan, Su, and Rizvi 2020).

MILEX is made to protect national security and avoid potential territorial threats (Bilgin, Gozgor, and Karabulut 2018; Dudzevčiūtė, Česnuitytė, and Prakapienė 2021). However, if a country enhances its military capacities and allocates more resources, neighbours might consider it a potential threat, resulting in an arms race. So, countries embark on competing to build stronger military forces and acquire more weapons, ultimately increasing MILEX (Kollias et al. 2018; Clement, Gupta, and Khamidova 2019). This could lead to a vicious cycle that increases GPR. On the other hand, according to Keynesian theory, an increase in MILEX will accelerate the development of defence-related sectors, and accordingly, the improvement in total demand and employment reduces income inequality (Zhong et al. 2017; Carter and Fay 2019; Fraser and Carbonnier 2020; Hanson and Jeon 2024). However, the shift of government expenditures to MILEX might cause a decrease in social expenditures and a crowd-out effect *(guns and butter arguments)*. Thus, GPR might heighten depending on national tension (Yakovlev 2007; Coutts et al. 2019; Balestra, Caruso and Di Domizio 2024). Based on the arms race and Keynesian theory, *we conjecture a positive relationship between MILEX and GPR, and vice versa.*

In contrast to the proposed hypothesis, a powerful military system mitigates the likelihood of conflict by deterring national or international interest groups. Such groups show reluctance to engage in conflicts as they perceive a low probability of success. It contributes to national and international stability through diplomatic channels, reducing GPR (Carter and Fay 2019; Das 2019; Khan, Su, and Rizvi 2020). For instance, international treaties banning certain weapons and reducing military operations promote national and international stability and security by minimizing GPR (Odehnal and Neubauer 2020). Conversely, a country's substantial investment in its military doesn't guarantee effective GPR management (Kuokštytė, Kuokštis, and Miklaševskaja 2020). Poor governance and corruption can result in MILEX that does not align with the efforts to mitigate geopolitical risk (Fraser and Carbonnier 2020). Instead, a country might

establish strong diplomatic relations and engage in cultural exchange to address it (Asongu, Le Roux, and Singh 2021).

This study aims to examine the complex relationship between MILEX and GPR using causality tests. It has several contributions to the literature. Firstly, to our knowledge, the relationship between MILEX and GPR was researched by Khan, Su, and Rizvi (2020) and Sweidan (2023) for Brazil, China, India, Israel, South Korea, Russia, Saudi Arabia, Turkey, and the USA. However, the authors did not consider the variables' structural changes. In cases where structural changes are not taken into consideration, null hypotheses are inclined to be rejected even in the case there is no causality between variables (Ender and Lee, 2012; Nazlioglu, Gormus, and Soytas 2016). Henceforth, the examination of causality between the variables was undertaken through an exhaustive analysis of structural changes, representing an important contribution to the literature. The second contribution is the countries that are examined in this study. The North Atlantic Treaty Organization (NATO) states that the share of military spending in national revenue should not exceed 2% (SIPRI, 2021). Nevertheless, many other countries, including NATO members, spend more than that. These countries consist of those that have realized the highest military expenditures for the last 30 years after the Cold War *(Chile, Colombia, France, India, Israel, South Korea, Russia, Saudi Arabia, Taiwan, Turkey, the United Kingdom, Ukraine, and the United States)* and have experienced various national and international tensions through the history. Hence, examining these countries is crucial to obtaining information on military expenditures. The study provides an opportunity to discuss obtained results under differentiated circumstances by filling the gap in the literature. The last contribution is about the period that began in 1993, due to the dissolution of Soviet Russia in 1992. In addition, MILEX was expected to decrease after the Cold War. However, contrary to expectations, this decline was short-lived and MILEX started to increase rapidly afterward (Dunne 1996; Aziz and Asadullah 2017; Khan, Su, and Rizvi 2020). Similarly, GPR has increased swiftly since 2000. For this reason, the period discussed contributes to the literature in determining the relationship between them.

The rest of the research is structured as follows: Section 2 explores the literature, Section 3 explains the research methodology, Section 4 introduces the dataset, Section 5 presents empirical results, Section 6 conducts an in-depth discussion, and the final section synthesizes the findings while providing political recommendations.

2. Literature Review

After the Cold War ended, the MILEX research started to expand. This is attributed to specific factors such as economic development, the risk of national/international terrorist attacks/threats/conflicts, political stability, and geopolitical position. Studies regarding MILEX and economic growth typically reveal that MILEX affects economic growth negatively (Dunne and Tian 2015; Wang, Hou, and Chen 2022; Saeed 2023; Dimitraki and Emmanouilidis 2024; Dimitraki, Emmanouilidis, and Asllani 2024; Dada et al. 2024). However, economic growth, by its nature, also increases MILEX, and vice versa (Zhong et al. 2017; Dimitraki and Win 2020; Dimitriou et al. 2024; Hanson and Jeon 2024). Dunne (1996) classified countries based on their conflict status, revealing that the presence of conflict triggers increased MILEX, which indirectly decreases economic growth. Building on this, Aizenman and Glick (2006) revealed that external threats led to increased MILEX, which in turn

negatively had an impact on economic growth. Considering the threats, while Nordhaus, Oneal, and Russett (2009) concluded that international threats were the primary driver of increased MILEX, Aziz and Asadullah (2017) determined that domestic threats had a more significant impact on MILEX. Conversely, Kollias et al. (2018) suggested that both internal and external threats affect MILEX, with neighbouring countries playing a pivotal role. This is echoed in various research in the literature (Yakovlev 2007; Waszkiewicz 2016; Clement, Gupta, and Khamidova 2019), highlighting how political factors form MILEX. Further research by Kuokštytė, Kuokštis, and Miklaševskaja (2020) and Asongu, Le Roux, and Singh (2021) reveals the impact of political stability on MILEX fluctuations. Additionally, Feridun and Shahbaz (2010), Carter and Fay (2019), Fraser and Carbonnier (2020) emphasize the positive correlation between MILEX and terrorism, however, noting the occasionally inverse incidents.

Existing studies explore how various security problems including national and/or international terrorist attacks/threats/conflicts, political stability, and geopolitical position relate to MILEX. Nations typically face multiple security issues simultaneously. It complicates the assessment of their overall risk level. The GPR Index, developed by Caldara and Iacoviello (2022) offers a comprehensive measurement. It incorporates military and political factors alongside security concerns, providing a common consensus. It has gained traction among researchers as it provides a standardized approach to measuring and evaluating geopolitical risk (Balli, Uddin, and Hussain 2019; Demiralay and Kilincarslan 2019). To date, Khan, Su, and Rizvi (2020), Sweidan (2023), Tran and Vo (2024), Song and Chen (2024) have specifically examined the relationship between MILEX and GPR. Khan, Su, and Rizvi (2020) conducted a causality test for Brazil, China, India, Israel, South Korea, Russia, Saudi Arabia, and Turkey. They revealed that in China, India, and Saudi Arabia, GPR was found to influence MILEX, while in South Korea and Turkey, MILEX appeared to affect GPR. Sweidan (2023) investigated the relationship in the USA context, concluding that increased MILEX led to a higher level of GPR. In a separate study. Tran and Vo (2024) examined the association between local/global GPR and MILEX. They found that local GPR, rather than global, significantly affects MILEX. Song and Chen (2024) suggested that arm race doesn't affect China's MILEX aligning with its defensive national policy and that GPR's effect on it is unstable.

These studies failed to account for *structural changes,* leading to the inaccurate identification of causality between variables, where none exists. Given that many macroeconomic indicators such as tourism, financial and economic development, environmental policies, trade openness, etc. are influenced by geopolitical threats. As such, misinterpreting these relationships hinders policymakers' ability to make informed decisions. Furthermore, changes in MILEX can affect public spending, resulting in a misallocation of resources through flawed transfer mechanisms. To address it, the study employs the Panel Fourier Causality test, which incorporates Fourier terms to account for smooth structural breaks, as identified by Enders and Lee (2012) in macroeconomic variables. Besides, this test, based on the bootstrap method, allows for cross-sectional dependency and provides country-specific causality results. Additionally, the analysis includes countries with above-average MILEX, selected in line with NATO's target of allocating 2% of national income to military expenditures, as per SIPRI (2021).

3. Methodology

The testing procedure illustrated in Figure 1 is utilized to investigate the bidirectional relationship between MILEX and GPR. It indicates the sequence of statistical tests and decision points employed to evaluate causality and reveal the nature of the relationship between the variables.

[Figure 1]

Panel Fourier unit root test

Lee, Wu, and Yang (2016) introduced a new unit root test to the literature by using the Fourier approach[2] proposed by Enders and Lee (2012) instead of dummy variables to determine the structural change. It allows for examining the unit root process by adding the Fourier function to the Cross-Sectionally Augmented Panel Unit Root (CIPS) test developed by Pesaran, Smith and Yamagata (2013). Lee, Wu, and Yang (2016) call this process Break Augmented CIPS (BCIPS) statistics. The BCIPS statistic is primarily based on the extension of the Cross-Sectionally Augmented Dickey-Fuller Statistic (CADF) statistic to the Break and Cross-Sectional Dependence ADF Statistic (BCADF) statistic proposed in Equation 1.

$$\Delta y_{it} = c_{i,0} + c_{i,1}\, sin\left(\frac{2\pi kt}{T}\right) + c_{i,2}\, cos\left(\frac{2\pi kt}{T}\right) + c'_{1,3}\bar{z}_{t-1} + c'_{1,4}\Delta\bar{z}_t + \sum_{j=1}^{p} c'_{1,5}\Delta\bar{z}_{t-1} + \sum_{j=1}^{p} c_{i,6}\Delta y_{i,t-1} + b_{,}y_{i,t-1} + e_{it} \quad (1)$$

where p and t respectively show optimal lag length and trend, k denotes the Fourier frequency, and $z_{it} = (y_{it}, x'_{it})'$, x'_{it} vector of common factor. The unit root test is calculated as follows according to the BCIPS test statistics developed by Lee, Wu, and Yang (2016), under the Pesaran (2007) and Pesaran, Smith, and Yamagata (2013), considering the breaks and cross-section dependence augmented version.

$$BCIPS\ (N,T) = \frac{1}{N}\sum_{i=1}^{N} t_i(N,T) \quad (2)$$

where t_i represents each unit of calculated test statistic. In addition, the test's null hypothesis expresses the unit root process.

Panel Fourier Toda-Yamamoto causality

The causality test, which was introduced to the literature by Granger (1969), tests the relationship between variables at the level where the variables are stationary. This leads to the difference of non-stationary series at the state level and thus to the loss of information (Toda and Yamamoto 1995; Dolado and Lütkepohl 1996). Toda and

[2] Fourier functions have several advantages. First, it produces fairly good results for the types of breaks often used in economic analysis. Second, it provides a good approximation for breaks of an unknown form. Lastly, it removes complex steps such as figuring out outbreak dates, break numbers, and break shapes and only requires choosing an appropriate model component (Lee, Wu, and Yang 2016). Enders and Lee (2012) show that their proposed test is robust against various possible breakings in the deterministic trend function of unknown forms and numbers.

Yamamoto (1995) have developed a causality test based on the VAR $(k + d_{max})$ model, which allows the variables to be included in the model at level values, to prevent the loss of information caused by the inclusion of the variables in the model by taking the difference.

The VAR model, which is formed by adding the optimal lag length (k) to the level values of the variables, as well as the maximum order of integration $(k + d_{max})$, has a χ^2 distribution. Emirmahmutoglu and Kose (2011) propose a panel causality test by using the Toda-Yamamoto causality test and the equation proposed by Fisher (1932). The null hypothesis of this test suggests that there is no causality between the variables. However, these causality tests do not consider structural change. Enders and Jones (2016) determined that the null hypothesis of the Granger causality test provides misleading results if the structural changes are not considered in the VAR $(k + d_{max})$ model. Afterward, they propose a new causality test based on the VAR model, considering the structural change with Fourier functions. On the other hand, Nazlioglu, Gormus, and Soytas (2016) extended the Toda-Yamamoto causality test for time series with the help of Fourier functions. Yilanci and Gorus (2020) developed the Panel Fourier Causality test proposed by Nazlioglu, Gormus, and Soytas (2016), and the Panel Fourier Causality test by using the equation proposed by Fisher (1932)[3]. The causality between two variables, MILEX, and GPR, is expressed in Equations 3 and 4 using the Panel Fourier Causality test:

$$MILEX_{i,t} = \mu_i + \sum_{j=1}^{\left(k_i + d_{max_i}\right)} A_{11} MILEX_{i,t-j} + \sum_{j=1}^{\left(k_i + d_{max_i}\right)} A_{12} GPR_{i,t-j} + A_{13} sin\left(\frac{2\pi t k_i}{T}\right) + A_{14} cos\left(\frac{2\pi t k_i}{T}\right) + u_{i,t} \quad (3)$$

$$GPR_{i,t} = \mu_i + \sum_{j=1}^{\left(k_i + d_{max_i}\right)} A_{21} MILEX_{i,t-j} + \sum_{j=1}^{\left(k_i + d_{max_i}\right)} A_{22} GPR_{i,t-j} + A_{23} sin\left(\frac{2\pi t k_i}{T}\right) + A_{24} cos\left(\frac{2\pi t k_i}{T}\right) + u_{i,t} \quad (4)$$

where k and d_{max_i} respectively show optimal lag length and maximum order of integration. Also, t and T respectively show trend and number of observations, and k_i represents the frequency value in the range of one-five where the residual sum of squares of the i. unit is minimum. In this test, the probability values of Wald statistics are calculated using the bootstrap technique. The statistical significance of the coefficients in Equations 3 and 4 respectively presents unidirectional causality GPR→MILEX and MILEX→GPR. Therefore, the series allows for cross-sectional dependence. It can also be used in heterogeneous panels, as it allows the Fourier Toda-Yamamoto causality test to be calculated for each unit.

[3] Fisher test statistic $= -2\sum_{i=1}^{N} ln\,(p_i)$; p_i shows probability value of Wald statistic calculated for the i. unit; N is the number of units.

4. Data

In this study, the relationship between MILEX and GPR was examined by utilizing an annual data set spanning from 1993 to 2020. The research encompasses 13 countries: Chile, Colombia, France, India, Israel, South Korea, Russia, Saudi Arabia, Taiwan, Turkey, the UK, Ukraine, and the USA. The sample selection is motivated by their consistently high military spending over the past three decades post-Cold War, often exceeding NATO's 2% guideline (SIPRI, 2021). Besides, their history of national and international tensions provides a rich context for evaluating the dynamics of MILEX.

MILEX as a share of Gross Domestic Product (GDP)[4] is calculated by SIPRI. Countries with an MILEX of over 2% approximately were included as samples. The GPR data set is obtained from Caldara and Iacoviello (2022), who developed a text search algorithm[5], considering the political tensions, geopolitical, nuclear, war, and terrorist threats, and actions in national and international relations in the electronic archives of 11 newspapers. The Index is available on their website (www.matteoiacoviello.com/gpr.htm). Figure 1 illustrates selected countries' GPR and MILEX.

[Figure 2]

Figure 2 highlights that most countries, except Ukraine, experienced a short-term decrease in MILEX post-Cold War, followed by an upward trend. Saudi Arabia, Israel, and the USA lead in military spending, although countries like Chile, France, Israel, Taiwan, and the UK have shown a general decrease in MILEX. GPR has typically fluctuated, with significant peaks triggered by events such as the Russia-Ukraine War, Russia-USA tensions over Ukraine, China-USA tensions over Taiwan, 9/11, the Iraq War, the Mavi Marmara, the Syrian Civil War, Arap Spring, Israel-Palestine conflict (Sandler and George 2016; Kyriazis and Economou 2021; Caldara and Iacoviello 2022). These findings underscore the complex link between GPR and MILEX, reflecting the influence of national and international incidents on these dynamics. The diagnostic statistics of the countries are shown in Table 1.

[Table 1]

Table 1 indicates Saudi Arabia had the highest variability in MILEX, while France had the lowest. In terms of GPR, the USA showed the highest variability, and Chile the lowest. In addition, it was determined that while the skewness of all countries was positive, only Chile's MILEX value was skewness-negative to the left (the average of the observation values was smaller than the mode value). On the other hand, when the kurtosis of the variables belonging to the countries are examined, it is calculated that the values have a platykurtic distribution since the value of Chile, India, Turkey, and the USA's MILEX and Russia, Saudi Arabia, Taiwan, and Turkey's GPR are less than three

[4] Sköns et al. (2005) stated that countries' MILEX varies according to their GDP. For this reason, the % of MILEX in GDP should be used for comparative analysis.
[5] The GPR index consists of 8 subheadings: war threats, peace threats, military buildups, nuclear threats, terror threats, beginning of war, escalation of war, and terror acts.

and the others have a leptokurtic distribution. Finally, the Jarque-Bera (JB) test statistic was used to determine the normal distribution of the variables. This test statistic is calculated by considering the mean, standard deviation, skewness, and kurtosis values of the series. JB test statistics revealed that the MILEX showed a normal distribution for France, Israel, South Korea, Russia, Taiwan, and the UK, and the GPR for Chile, Colombia, France, India, Israel, South Korea, the UK, Ukraine, and the USA. Concluding that the MILEX and GPR values of other countries do not have a normal distribution.

5. Empirical results

The Panel Toda-Yamamoto Causality test is based on the VAR model and is to use the length ($k + d_{max}$) to determine the lag length. For this reason, it is necessary to determine the stationarity level of the variables first. The results are shown in Table 2. According to the Panel Fourier Unit Root test, the MILEX is stationary at level, the GPR is stationary at the first difference. In this case, it has been determined that the d_{max} length to be applied in the VAR model is 1, which is the maximum stationarity level.

[Table 2]

The Panel Fourier Toda Yamamoto Causality test considers cross-sectional dependence and heterogeneity. The results of the cross-section and homogeneity tests investigated as MILEX→GPR and GPR→MILEX are given in Table 3. As a result of the findings, while the null hypothesis was rejected, it was determined that the shock that occurred in one country also affected other countries, and the model was heterogeneous.

[Table 3]

The results of the Panel Fourier Toda Yamamoto Causality test are shown in Table 4 and Table 5. The results in Table 4, which express this situation, give information about the countries in the study and whether their GPR is the reason for MILEX or not. In Chile, France, Israel, Taiwan, Turkey, and the UK, where the null hypothesis could not be rejected, it has been determined that *the GPR is not the reason for MILEX*. Since the null hypothesis was rejected at a statistical significance level of at least 10% in other countries, causality was found from GPR to MILEX. Thus, it has been determined that the GPR is important in the military expenditures of the country, and is valid for Colombia, India, South Korea, Russia, Saudi Arabia, Ukraine, and the USA. In addition, the results for India, Saudi Arabia, and the USA support Khan, Su, and Rizvi (2020) and Sweidan (2023), respectively.

[Table 4]

The effect of GPR on MILEX is investigated in the literature, a few studies show that increasing MILEX affects the GPR (or national and/or international terrorist attacks/threat/conflict, security problem, political stability, and geopolitical position) of countries (Sandler 2005; Feridun and Shahbaz 2010). In this context, MILEX was researched by the causality test on geopolitical risks, and the results are given in Table 5. According to the results of the Panel Fourier Toda Yamamoto Causality test, the null hypothesis is rejected for Chile, Israel, Russia, Taiwan, and the UK. In these countries,

there is a one-way causality running from MILEX to GPR. Thus, it can be stated that national and international interest/terror groups perceive the developments in the military structure of the country as a threat and create geopolitical risks. Moreover, there was no statistically significant causality from MILEX to GPR in Colombia, France, India, South Korea, Saudi Arabia, Turkey, Ukraine, and the USA. This suggests that military measures alone are not sufficient to hinder GPR.

[Table 5]

There are several approaches to the panel Fourier Toda Yamamoto causality test in the literature, but the results are debatable. To support the results obtained considering this situation, the variables were tested with the Panel Fourier Granger Causality test. The empirical results are shown in Appendix 1.

6. Discussion

The relationship between MILEX and GPR varies, due to the brief decline in MILEX post-Cold War (Dunne 1996) and changes in power centers after the collapse of Soviet Russia in 1991 (Sandler 2005; Dunne and Tian 2015). This relationship was examined bidirectionally, and the findings are shown in Tables 4 and 5. Upon examining the results of the GPR→MILEX in Table 4, no significant relationship was found for developed countries with the exception of the USA. Research by Nikolaidou (2008) and Beckley (2010) reveals that advanced economies typically allocate more resources to their defence systems. This is specifically attributed to the robust economic growth achieved by Western democracies (Beckley 2010). Therefore, in developed countries, MILEX is more closely tied to economic prosperity than GPR. However, findings suggest a significant relationship for the USA, contrasting with Sweidan (2023). Especially after the 9/11, 2001 terrorist attacks, its MILEX and GPR have increased rapidly. According to SIPRI (2023), USA MILEX increased due to escalated international tensions.

Chile stands out among the nations showing no relationship with the lowest MILEX and GPR. Chile's MILEX has been decreasing over the period (SIPRI 2023). Turkey and Taiwan encounter several security issues and conflicts with neighbouring countries. They require robust military power to safeguard borders, protect interests, and improve economies, regardless of GPR. In such cases, GPR does not directly affect MILEX. Table 4 shows a significant relationship for Colombia, India, South Korea, Russia, Saudi Arabia, Ukraine, and the USA. The results for India and Saudi Arabia support Khan, Su, and Rizvi's (2020) research. As noted by Keling, Shuib, and Ajis (2009), and Jacob (2018), India has struggled with interest groups and international tensions especially with China and Pakistan, due to its geopolitical location. Keling, Shuib, and Ajis (2009) suggest that this circumstance requires having a powerful army and increased MILEX. Saudi Arabia has been experiencing a sharp rise in GPR and MILEX following the Arab Spring in 2011. Khan, Su, and Rizvi (2020) point out that Iran's growing political ambitions and military power are pivotal factors driving Saudi Arabia's military reinforcement.

Post-Cold War, Russia and Ukraine have been in persistent conflict. Ukraine particularly began increasing its MILEX after escalated tension in 2014 (SIPRI 2023). Colombia differs from these countries as its GPR mainly reflects national problems. For

instance, they confronted 24 armed attacks over a decade in ten years and ongoing civil wars due to the international drug trade. According to Dube and Naidu (2015), this forces the country to have a stronger military presence. Lastly, South Korea's military reinforcement initiatives have been shaped by its ongoing conflicts with North Korea (Friedman and Logan 2012; Furuoka 2016). Besides, the long-term dominance of military power in South Korea's government has increased MILEX, being closely linked to GPR (Bove, Rivera, and Ruffa 2020).

Table 5 findings show that the null hypothesis *(no causality from MILEX to GPR)* is rejected for Chile, Israel, Russia, Taiwan, and the UK. Governments attempt to minimize their GPR by increasing MILEX (Khan, Su, and Rizvi 2020). As noted by Shlapentokh (2021), the Russian government officially announced an increase in MILEX in 2019 to be advantageous in the arms race. As one of the world's largest arms exporters with nuclear resources (SIPRI 2023), Russia causes problems with NATO countries, notably the USA, escalating conflicts and disimproving diplomatic relations. Similarly, The UK is among the top three countries with the largest nuclear power, prioritizing military modernization. The USA Bureau of Counterterrorism (2019) report suggests that the change in MILEX is perceived as a potential threat, particularly by Islamic terrorist organizations. According to Yildirim, Sezgin, and Öcal (2005), Israel continues to develop its military modernization activities despite the end of the Gulf War. This creates constant tension with Arab countries and results in an arms race. Similarly to Israel, Taiwan, which had the highest GPR in the early 2000s and 2017-2020, is engaged in an arms race with China (Tsai and Liu 2023). The increased MILEX is perceived as a potential threat by others and provokes reactions from both national and international groups (Lin, Wu, and Chou 2012; Carter and Fay 2019; Asongu, Le Roux, and Singh 2021). Chile, the other participant in the arm race dynamic, experiencing tensions with its Latin American neighbours throughout its history (Caldara and Iacoviello 2022).

The political, economic, and social policies play a substantial role in mitigating GPR (Feridun and Shahbaz 2010). Besides, socioeconomic factors such as democracy level, inequality, and education eliminate such risks (Carter and Fay 2019). For instance, South Korea shows no MILEX→GPR causality. Despite its swift industrialization and economic growth, South Korea has experienced increased inequality due to decreased social support programs (World Inequality Report 2022). India ranks low among 189 nations in Human Development Reports' Multidimensional Poverty Index (2020), with over 50% of its population struggling with poverty. Considering political and civil rights, Turkey and Saudi Arabia are shown as countries without freedom (Freedom House 2022). Arab Spring impacted these countries due to their geopolitical position (Coutts et al. 2019). Ukraine's GPR stems more from its geopolitical position —the ongoing tensions with Russia— than its MILEX. Despite no overall increase in MILEX, Colombia's GPR is rising (SIPRI 2023). It is more influenced by national interest groups and tensions than by MILEX (Caldara and Iacoviello 2022). Especially, the National Liberation Army's actions threaten the country's security (Zapata 2012). Unlike other countries, the USA and France are among the developed nations. Their GPR largely fluctuates due to the relations with the Middle East and North Africa. For instance, after the 9/11 terrorist attacks, GPR rapidly increased, however, has not turned back to pre-attack levels. The Arab Spring showed its effect after this process, especially the influence of the USA, and France's Françafrique movement played a significant role in GPR (Caldara and Iacoviello 2022; Sweidan 2023).

7. Conclusion

This study investigated the causality relationship between MILEX and GPR with the Panel Fourier Toda Yamamoto Causality test. It focuses on 13 countries with above-average MILEX, selected in line with NATO's target of allocating 2% of national income to military spending, over the 1993-2020 period. The results for Colombia, India, South Korea, Russia, Saudi Arabia, Ukraine, and the USA show that GPR significantly affects MILEX. The findings suggest that GPR is primarily driven by international threats rather than national threats, which in turn affects MILEX. Countries allocate resources towards MILEX to enhance their development levels. These align with previous research by Nordhaus, Oneal, and Russett (2009), Feridun and Shahbaz (2010), Kollias et al. (2018), Carter and Fay (2019). On the other hand, examining the reverse relationship reveals that MILEX influences GPR for Chile, Israel, Russia, Taiwan, and the UK. These countries typically experience various tensions with their neighbours. As these countries and/or interest groups are perceived as a potential threat, MILEX fluctuates, and arms race. Notably, the UK and Russia's military reinforcement constitutes a potential risk to other nations. Consequently, MILEX demonstrates a statistically significant effect on GPR, aligning with research by Aziz and Asadullah (2017), Fraser and Carbonnier (2020), and Asongu, Le Roux, and Singh (2021).

The findings offer valuable insights for policymakers. They should consider a nuanced approach to MILEX and GPR by prioritizing dialogue and diplomatic channels of peace, engaging in international mediation/peacekeeping initiatives, and avoiding interference in other's internal conflicts. The strategic approach plays a pivotal role in mitigating GPR. For instance, fostering regional peace through agreements, diplomatic corps, military alliances, and forums leads to addressing shared security concerns. Additionally, policymakers need to adopt a multi-faceted strategy regarding MILEX. For example, they should develop comprehensive risk assessment tools to analyze GPR, invest in dual-use technologies and infrastructures for civilian and military purposes, implement regular MILEX monitoring, promote transparency through strong governance, uphold the rule of law, and expand civil liberties. So that, they might be able to balance MILEX with national priorities considering GPR. The study has a limitation in revealing MILEX and GPR's long-term relationships. To do so, both variables must be stationary in their first difference. However, the results did not meet this requirement, therefore, the relationship was examined for short-term using causality tests. Future research might focus on emerging military technologies' impact and MILEX offensive/defensive strategies on GPR.

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Appendix 1. Robustness test

The Panel Fourier Toda-Yamamoto Causality Test was used to investigate the relationship between MILEX and the GPR Panel. The robustness test results are analyzed to see if they will change when subjected to further analysis using different techniques. For this reason, the Panel Fourier-Granger Causality test was used. In this test, the cross-section dependency is considered and analyzed with the bootstrap technique. According to Table 6, there is a one-way causal relationship between GPR and MILEX in South Korea, Saudi Arabia, Ukraine, and the USA. Table 7 demonstrates that there is in Taiwan a one-way causal relationship between MILEX and GPR. According to the Panel Fourier Toda-Yamamoto causality test findings, although a causal relationship was detected in similar countries, it was determined that the causality relationship occurred in fewer countries. The Panel Fourier Granger Causality test is conducted at the level where the variables are stationary in this case, which is the most significant factor. Information is lost when variables are analyzed, and their differences are used (Toda and Yamamoto 1995).

[Table 6]

[Table 7]

Table 1. Descriptive statistics

Countries		Mean	Maximum	Minimum	SD	Skewness	Kurtosis	JB
Chile	MILEX	0.023	0.027	0.018	0.003	-0.345	1.547	3.018
	GPR	0.016	0.057	0.004	0.01	2.193	9.517	71.989
Colombia	MILEX	0.033	0.044	0.025	0.004	0.571	4.342	3.622
	GPR	0.041	0.107	0.014	0.021	1.305	4.303	9.937
France	MILEX	0.021	0.027	0.018	0.003	1.235	3.574	7.503
	GPR	0.514	0.966	0.275	0.174	1.047	3.928	6.12
India	MILEX	0.027	0.031	0.024	0.002	0.543	2.387	1.816
	GPR	0.202	0.397	0.072	0.071	0.929	3.756	4.698
Israel	MILEX	0.065	0.115	0.052	0.014	2.23	7.902	51.243
	GPR	0.368	0.814	0.16	0.156	1.083	3.781	6.184
Korea, South	MILEX	0.026	0.034	0.023	0.003	1.836	6.169	27.454
	GPR	0.279	0.877	0.093	0.186	1.685	5.585	21.048
Russia	MILEX	0.038	0.054	0.027	0.006	0.861	4.072	4.802
	GPR	0.653	1.142	0.339	0.218	0.619	2.429	2.1674
Saudi Arabia	MILEX	0.096	0.143	0.072	0.018	0.838	3.13	3.299
	GPR	0.197	0.396	0.057	0.11	0.487	1.863	2.615
Taiwan	MILEX	0.025	0.049	0.017	0.009	1.335	3.557	8.684
	GPR	0.047	0.097	0.012	0.026	0.637	2.271	2.509
Turkey	MILEX	0.028	0.041	0.018	0.008	0.349	1.55	3.02
	GPR	0.214	0.497	0.048	0.122	0.689	2.284	2.817
The UK	MILEX	0.025	0.036	0.019	0.003	1.289	5.354	14.225
	GPR	1.017	2.287	0.598	0.384	1.8	6.044	25.937
Ukraine	MILEX	0.022	0.041	0.003	0.007	0.469	4.112	2.469
	GPR	0.109	0.917	0.014	0.178	3.606	16.591	276.179
The USA	MILEX	0.038	0.049	0.031	0.006	0.471	2.132	1.913
	GPR	2.215	4.349	1.054	0.803	1.316	4.388	10.324

Table 2. Panel Fourier unit root test results

	p	k	t statistic
MILEX	4	2	-1.7446
GPR	1	1	-3.7488***

Note: Table critical values in Lee et al. (2016). ***, $p<0.01$.

Table 3. Cross-sectional dependency and homogeneity test results

Tests	MILEX→GPR	GPR→MILEX
Breusch and Pagan (1980) – LM	343.54***	410.784***
Pesaran (2004) – scaled LM	21.26***	26.644***
Pesaran (2004) – CD	14.303***	8.02***
Pesaran, Ullah, and Yamagata (2008) – LM_{adj}	26.15***	26.811***
Pesaran and Yamagata (2008) – $\widetilde{\Delta}$	3.013***	3.507***
Pesaran and Yamagata (2008) – $\tilde{\Delta}_{adj}$	3.182***	3.704***

Note: ***, *p<0.01*.

Table 4. Geopolitical risk (GPR) granger cause military expenditures (MILEX)

Countries	*p*	*k*	Wald Statistic	Bootstrap Critical Value		
				10%	5%	1%
Chile	1	1	0.073	3.279	4.682	9.086
Colombia	*3*	*2*	*10.048***	*7.006*	*9.348*	*14.466*
France	1	2	0.918	3	4.303	7.307
India	*1*	*3*	*3.753**	*3.029*	*4.315*	*7.765*
Israel	3	1	2.093	7.298	9.55	17.716
Korea, South	*2*	*2*	*6.374**	*5.915*	*7.613*	*12.586*
Russia	*1*	*2*	*5.893**	*2.532*	*3.788*	*6.209*
Saudi Arabia	*1*	*2*	*4.591***	*2.84*	*4.154*	*7.761*
Taiwan	1	1	0.53	3.209	4.636	8.059
Turkey	1	1	1.441	2.572	3.954	6.981
The UK	2	2	0.49	5.49	7.495	12.585
Ukraine	*1*	*1*	*6.088***	*2.599*	*4.655*	*8.994*
The USA	*2*	*2*	*5.441**	*5.327*	*7.069*	*12.406*
Panel Fisher Test Statistic			*45.592***			

Note: The maximum lag length is determined to be 3, and p is the optimal lag length. The optimal frequency number is k, and the *, **, and *** *p<0.10*, *p<0.05*, and *p<0.01*, respectively.

Table 5. Military expenditures (MILEX) granger cause geopolitical risk (GPR)

Countries	*p*	*k*	Wald Statistic	Bootstrap Critical Value		
				10%	5%	1%
Chile	*1*	*1*	*3.848**	*3.248*	*4.824*	*11.926*
Colombia	1	1	0.287	3.067	4.829	9.427
France	1	2	0.146	3.129	4.204	9.329
India	1	3	0.819	2.758	4.232	7.198
Israel	*3*	*1*	*10.762***	*7.338*	*9.561*	*14.209*
Korea, South	2	2	0.056	5.171	7.154	11.766
Russia	*2*	*2*	*6.869**	*4.951*	*6.921*	*10.942*
Saudi Arabia	1	2	1.328	2.772	3.98	7.252
Taiwan	*1*	*1*	*3.916**	*3.056*	*4.663*	*9.09*
Turkey	1	1	0.087	2.769	4.009	8.386
The UK	*2*	*2*	*13.293****	*5.37*	*7.739*	*13.157*
Ukraine	1	1	0.458	3.08	4.397	7.227
The USA	2	2	2.923	5.012	6.844	9.922
Panel Fisher Test Statistic			*39.481***			

Note: The maximum lag length is determined to be 3, and p is the optimal lag length. The optimal frequency number is k, and the *, **, and *** *p<0.10, p<0.05,* and *p<0.01*, respectively.

Table 6: Geopolitical risk (GPR) granger cause military expenditures (MILEX)

Countries	p	k	Wald Stat.	p-value
Chile	1	1	0.922	0.337
Colombia	3	1	5.154	0.161
France	2	2	1.714	0.424
India	1	5	0.005	0.944
Israel	2	4	0.696	0.706
Korea, South	*2*	*2*	*9.669*	*0.008*
Russia	1	2	0.075	0.784
Saudi Arabia	*1*	*2*	*2.636*	*0.09*
Taiwan	1	1	1.391	0.238
Turkey	1	1	0.472	0.492
The UK	2	2	0.159	0.923
Ukraine	*1*	*3*	*7.755*	*0.005*
The USA	*2*	*2*	*4.837*	*0.089*
Panel Test Statistic			2.729**	

Note: The maximum lag length is determined to be 3, and p is the optimal lag length.

Table 7: Military expenditures (MILEX) granger cause geopolitical risk (GPR)

Countries	*p*	*k*	Wald Stat.	p-value
Chile	1	1	1.944	0.163
Colombia	3	1	0.993	0.803
France	2	2	1.381	0.501
India	1	5	1.121	0.289
Israel	2	4	0.622	0.733
Korea, South	2	2	0.109	0.946
Russia	1	2	0.018	0.895
Saudi Arabia	1	2	0.008	0.928
Taiwan	*1*	*1*	*4.371*	*0.037*
Turkey	1	1	0.017	0.897
The UK	2	2	0.476	0.788
Ukraine	1	3	0.109	0.741
The USA	2	2	1.846	0.397
Panel Test Statistic			1.001	

Note: The maximum lag length is determined to be 3, and p is the optimal lag length.

Figure 1. Methodological flowchart

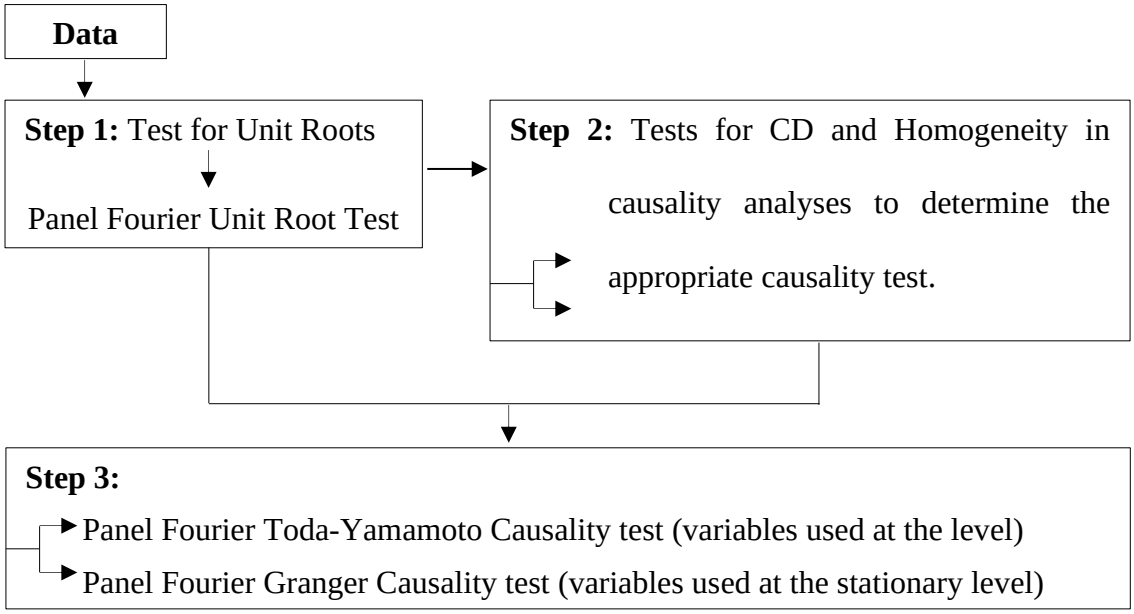
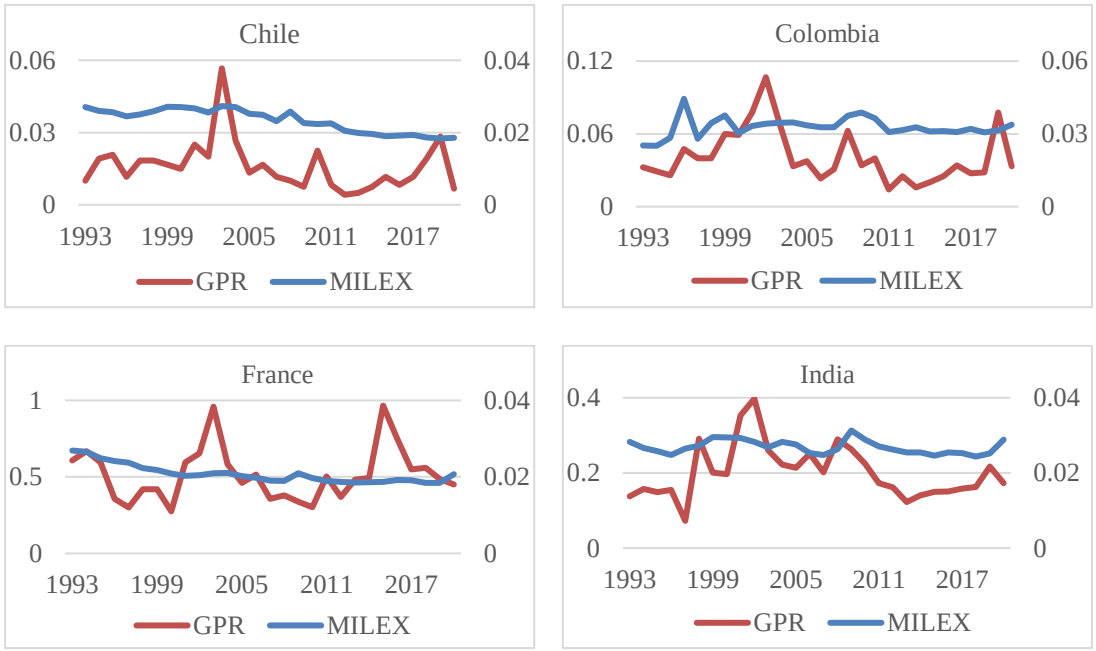
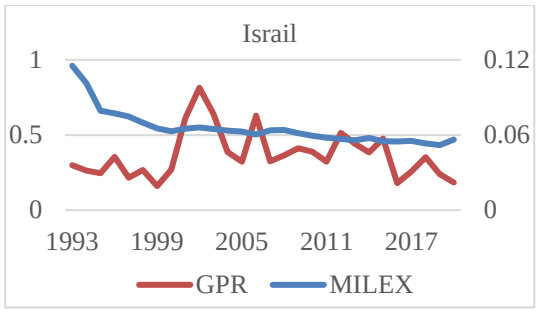


Figure 2. MILEX and GPR




Israil
1
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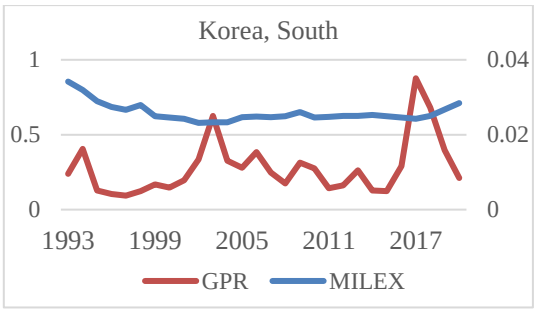
0
0.12
0.06
0
1993
1999
2005
2011
2017
GPR
MILEX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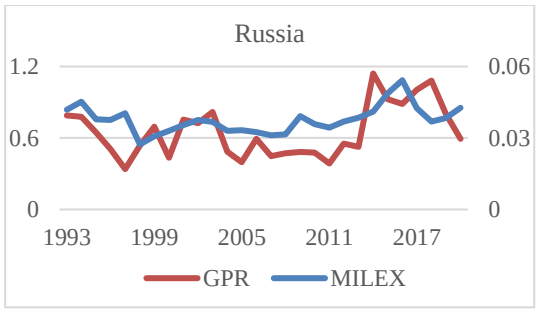
1993
1999
2005
2011
2017
GPR
MILEX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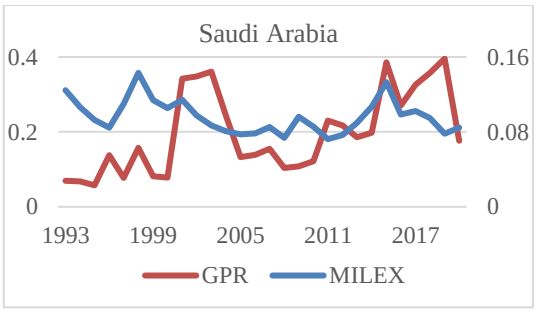
0.03
0
1993
1999
2005
2011
2017
GPR
MILEX


Saudi Arabia
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0.16
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1993
1999
2005
2011
2017
GPR
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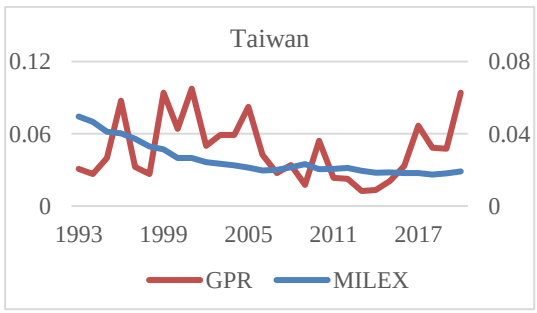
Taiwan
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0.08
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0
1993
1999
2005
2011
2017
GPR
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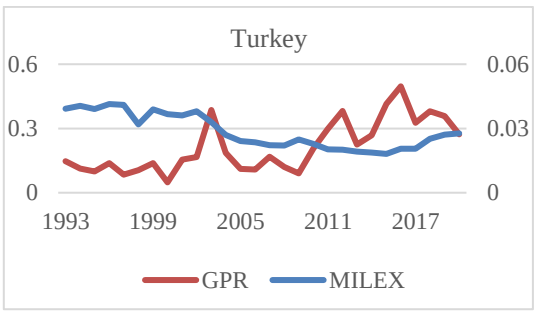
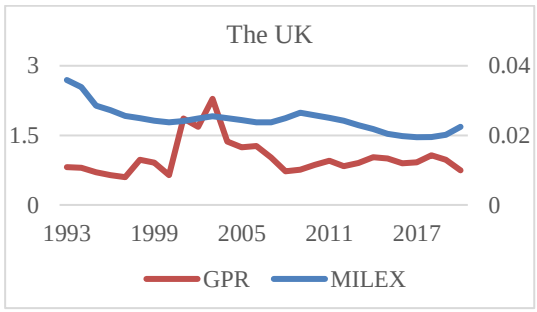

Turkey
0.6
0.3
0
0.06
0.03
0
1993
1999
2005
2011
2017
GPR
MILEX


The UK
3
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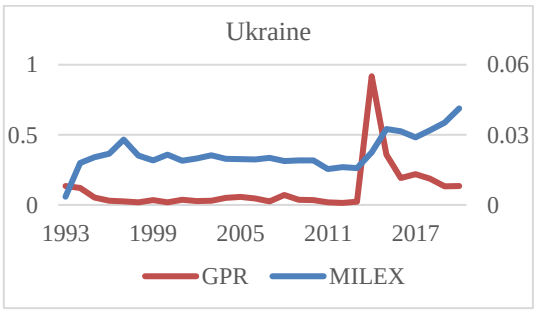
0.02
0
1993
1999
2005
2011
2017
GPR
MILEX


Ukraine
1
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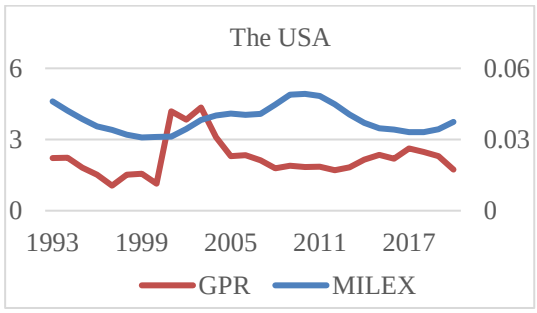
0
0.06
0.03
0
1993
1999
2005
2011
2017
GPR
MILEX


The USA
6
3
0
0.06
0.03
0
1993
1999
2005
2011
2017
GPR
MILEX