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Militarization, investment, and economic growth 1995–2019

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Abstract

The economic effects of defense spending have attracted considerable attention in the literature. Invariably, the defense burden, i.e., the military spending to GDP (gross domestic product) ratio, is the variable through which these effects are empirically traced. In this article, an alternative measure that captures the burden on the economy and society from allocating resources to the defense sector is used—the Global Militarization Index (GMI), constructed by the Bonn International Centre for Conflict Studies (BICC). The empirical investigation covers a total of 116 countries and spans the period 1995–2019. The results reported herein do not reveal any systematic and statistically significant relation between a country's militarization levels and two main macroeconomic variables (growth rate of GDP and gross fixed capital formation as a share of GDP).

The literature on the economic effects of military spending has systematically grown over the years. Recent representative examples of this steadily expanding body of literature are Agostino *et al.* (2017), Desli and Gkoulgkoutsika (2021), Emmanouilidis and Karpetis (2021), Cevik and Ricco (2018), and Dunne and Tian (2015). In brief, the potential effects of such expenditures include both demand and supply side as well as security related externalities.[1] A comprehensive and in-depth critical discussion of the issues associated with the impact of defense spending on the economy can be found in Dunne and Tian (2013, 2016) and in Churchill and Yew (2018). In addition, Alptekin and Levine (2012), Yesilyurt and Yesilyurt (2019), and Emmanouilidis and Karpetis (2020) offer a comprehensive review and meta-analysis of the accumulated empirical findings and methodologies used to probe into this issue. Consequently, for reasons of brevity, we refrain from engaging in a fundamentally similar discussion and review.

Invariably, all empirical studies that address the nexus between this budgetary item and countries' economic performance employ the defense burden, i.e., military spending as a share of GDP, to examine its impact on macroeconomic variables such as GDP growth rates, investment, savings, and unemployment. This article builds on this literature and extends the empirical analysis by employing an alternative index that encapsulates the economic burden of the defense sector. The Global Militarization Index (GMI) is an annual index estimated and published by the Bonn International Centre for Conflict Studies (BICC)[2]. As pointed out by Mutschler and Bales (2020), "[it] presents the relative weight and importance of a country's military apparatus in relation to its society as a whole"[3]. Hence, it can be construed as an alternative measure of a country's defense burden. To the best of our knowledge, this is the first time that BICC's GMI has been used in this context[4]. The index is presented in more detail in the next

1 *Inter alia,* Desli *et al*. (2017); Heo and Ye (2016); Malizard (2016).
2 https://www.bicc.de/about/about-us/.
3 https://www.bicc.de/publications/publicationpage/publication/global-militarisation-index-2020-1024/.
4 The index is available at https://gmi.bicc.de/ranking-table.

section; this is followed by the presentation and discussion of the empirical methods and findings.

This article uses the Global Militarization Index constructed by BIC to examine the effects that the allocation of resources to defense sector exerts on two key macroeconomic variables. The results do not show any systematic and significant effect of the levels of militarization on growth and investment. This rather surprising result may suggest that this more general measure of military burden reflects a more complex set of interactions that are not captured in the existing literature

The data: a bird's eye view

BICC's militarization index, GMI, is a composite index of annual frequency that takes values on a scale ranging from 0 to 1,000 with higher values reflecting higher militarization[5]. It is constructed using data grouped in three broad categories: expenditures, personnel and weapons. The first category comprises two indicators: military expenditure as percentage of GDP and military expenditure relative to health spending. The second group includes three indices: First military and paramilitary personnel as a share of the total population, second military reserves as a share of population and of the core military, and third paramilitary personnel relative to the number of physicians. The third category is the number of heavy weapons in relation to population, including all types of armored vehicles, artillery, fighter aircrafts, and naval assets (such as submarines and surface vessels above corvette size). In calculating the annual value of the final composite index, all the indicators are normalized and assigned different weights with which they contribute towards the estimation of the GMI[6] (Mutschler and Bales, 2020). While data is available from 1990 onwards, missing values meant that 1995 was taken as the starting year.

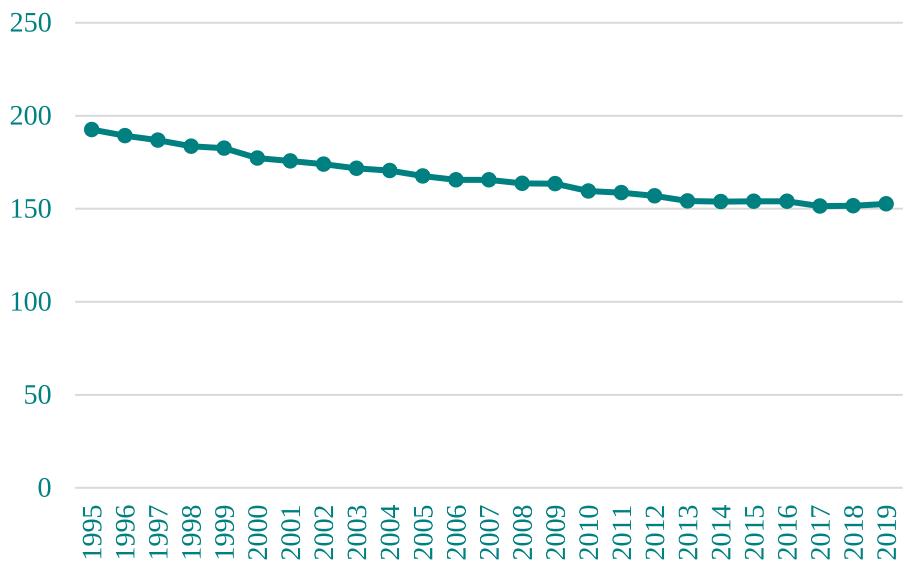

Figure 1: Sample's annual average GMI 1995–2019

In line with Dunne and Smith (2020) and Kollias and Paleologou (2016, 2019) the two macroeconomic variables used to probe the issue are the growth rate of GDP and gross fixed capital formation as a share of GDP—drawn from the IMF and the World Bank's World Development Indicators databases[7]. The rate of economic growth is used by the vast majority of empirical studies[8] and a strong positive relationship between investment and the long-run growth performance of an economy is a robust and well-established finding (Bond *et al.* 2010). The allocation of resources to the defense sector can crowd-out investment since, as it has been shown in the extant literature, they compete for financing from the same sources (Dunne *et al*. 2005; Dunne and Smith, 2020; Kollias and Paleologou, 2010; 2019).

5 Apart from BICC's own data, other sources of data are the Stockholm Peace Research Institute (SIPRI), the International Monetary Fund (IMF), the World Health Organization (WHO), and the International Institute for Strategic Studies (IISS).
6 A detailed presentation of the methodology used to estimate the GMI and the sources of the data used can be found here: https://gmi.bicc.de/.
7 https://data.imf.org/regular.aspx?key=63122827 and https://databank.worldbank.org/reports.aspx?source=world-development-indicators.
8 *Inter alia,* Chen *et al*. (2014); Malizard (2016); Desli *et al*. (2017); Desli and Gkoulgkoutsika (2021).

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Drawing on the sample of 116 countries, four summary variables were key: GMI, GDP, INV (the gross fixed capital formation as a share of GDP), and MILEX (the military burden).[9]

Figure 1 shows the average value of GMI for the entire period (i.e., 1995–2019[10]). As can be seen, it follows a mild downward trend. From an average value of 192.6 in 1995 to 152.6 in 2019. However, as one would expect, the countries in our sample exhibit great heterogeneity in terms of their respective GMI scores (as well as GDP and INV). A summary snapshot picture of GMI and GDP is offered in Tables 1 and 2.

Table 1 presents the sample's top and bottom ten average GMI scores. Israel emerges as the country with the highest GMI average score of 417.5, followed by Singapore (388.9) and Bahrain (354). Iceland, Costa Rica and Panama have the lowest average GMI scores (3.2, 15.9 and 38.2 respectively).

In Table 2, the best growth performers are China with an average annual rate of 9% followed by Rwanda (8.7%) and Cambodia (7.5%). The three lowest average annual GDP growth rates are Jamaica (0.6%), Italy (0.7%) and Zimbabwe (0.7%).

Both tables illustrate that there is no apparent consistent pattern between the two variables.

Table 1: Sample's top ten average GMI scores and ten lowest 1995–2019

Ten highest GMI			*Ten lowest GMI*		
	GMI	*GDP Growth %*		*GMI*	*GDP Growth %*
Israel	417.5	4.2	Nigeria	70.0	5.3
Singapore	388.9	5.2	Mexico	62.5	2.3
Bahrain	354.0	6.0	Gambia	61.8	3.4
Oman	349.6	3.3	Ghana	60.9	5.8
Saudi Arabia	331.9	2.9	Jamaica	59.8	0.6
Jordan	323.3	4.3	Malta	55.0	4.0
Brunei	318.2	0.9	Mauritius	53.1	4.2
Russia	314.6	2.8	Panama	38.2	5.8
Armenia	299.5	6.4	Costa Rica	15.9	4.1
Lebanon	298.8	3.4	Iceland	3.2	3.4

Table 2: Sample's ten highest and ten lowest GDP growth rates (%) 1995–2019

Ten highest GDP growth rates			*Ten lowest GDP growth rates*		
	GMI	*GDP Growth %*		*GMI*	*GDP Growth %*
China	134.5	9.0	France	171.5	1.7
Rwanda	162.6	8.7	Portugal	177.8	1.5
Cambodia	216.0	7.5	Germany	137.4	1.4
Azerbaijan	247.0	7.3	Ukraine	214.2	1.0
Mozambique	116.3	7.1	Greece	285.7	0.9
India	137.6	6.9	Japan	95.8	0.9
Uganda	135.6	6.6	Brunei	318.2	0.9
Armenia	299.5	6.4	Zimbabwe	183.2	0.7
Mongolia	235.0	6.1	Italy	155.4	0.7
Tanzania	121.4	6.1	Jamaica	59.8	0.6

9 Descriptive statistics for the GDP, GMI and INV series of the complete sample can be found at https://mycloud.econ.uth.gr/s/o9bFo5ci5BKaSC7.
10 Downloaded in November 2021

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Method and findings

For the empirical analysis an extended version of the Panel VAR model with fixed effects from Sigmund and Ferstl (2021) is used:

$$(1) \quad \pi_{i,t} = \left(T_\zeta - \sum_{l=1}^{\zeta} K_l\right)\delta_i + \sum_{l=1}^{\zeta} K_l \pi_{i,t-1} + B\pi_{i,t} + M\rho_{i,t} + \omega_{i,t}$$

where $\pi_{i,t}$ are the endogenous covariates, t is the period, and $\pi_{i,t-1}$ the lagged of endogenous covariates. An identity matrix $(\delta * \delta)$ is displayed by T_ζ , while the homogeneity parameters are $K, B\ and\ M$. Sigmund and Ferstl (2021) follow Binder *et al*. (2005) to determine the GMM conditions and establish the first difference GMM estimator:

$$(2) \quad \Delta\pi_{i,t} = \sum_{l=1}^{\zeta} K_l \Delta\pi_{i,t-1} + B\Delta\pi_{i,t} + M\Delta\rho_{i,t} + \Delta\omega_{i,t}$$

where Δ is the first difference or the forward orthogonal transformation, π the lagged endogenous variables, in our case military burden (MILEX), GMI, GDP, and investment (INV). We use the moment selection criteria-Hannan-Quinn information criterion (MMSC-HQIC) and one proposed by Andrews and Lu (2001), based on the Bayesian information criterion (MMSC-BIC). We also use the orthogonal impulse response function (OIRF) introduced by Luetkepohl (2005) to check the response between the three endogenous covariates. The OIRF model can be obtained as follows:

$$(3) \quad OIRF(\zeta,\theta) = \frac{\partial\pi_{i,t+\zeta}}{\partial(\omega_{i,t})_\theta}$$

Turning to the empirical investigation, before the estimation of the panel VAR we begin by applying preliminary tests. Panel unit root tests are applied using the Im *et al*. (2003) and Pesaran (2007) tests. The results reported in Table 3 indicate that all four variables (GMI, GDP, INV and MILEX) are stationary in levels, that is $I(0)$.

Before proceeding with the estimation of the GMM-PVAR model, we probe into the associations governing the four variables using two standard techniques that produce reliable and comparable results—the Pooled OLS and Fixed Effects (FE) estimators[11]. The results of the panel data estimations are reported in Table 4. Three different models were

Table 3: Panel unit root tests

Level		*GMI*	*GDP*	*INV*	*MILEX*
Pesaran (2007)	t-bar	-1.736	-2.19	-1.709	-2.160
	p-value	0.00	0.00	0.00	0.00
Im *et al*. (2003)	t-bar	-2.895	-3.539	-2.763	-3.451
	p-value	0.00	0.00	0.00	0.00
First difference					
Pesaran (2007)	t-bar	-8.643	-4.843	-4.065	-5.260
	p-value	0.00	0.00	0.00	0.00
Im *et al*. (2003)	t-bar	-11.913	-12.446	-12.334	11.656
	p-value	0.00	0.00	0.00	0.00

11 To decide between Fixed or Random effects we implemented a Hausman test.

estimated[12]. Model 1 shows the association of MILEX with the militarization index (GMI), while Models 2 and 3 show the effect of MILEX and GMI on growth (GDP) and gross fixed capital formation (INV), respectively.

Given the construction of the composite militarization index, the results of both the Pooled OLS and Fixed effects in the case of Model 1 are as expected—since they reveal a strong positive association between the two variables. The results of Models 2 and 3 in Table 4 show that MILEX has a significant negative influence on growth, but only for the fixed effects estimates, while investment is positively influenced by GMI but only for the pooled OLS estimation results. It is likely that these results reflect the potential endogeneity problem that is a common characteristic among the variables, such as bidirectional causality.

Table 4: Results of Pooled OLS and Fixed Effects

	Model 1 - GMI		*Model 2 - GDP*		*Model 3 - INV*	
Dependent variables	*Pooled OLS*	*Fixed effects*	*Pooled OLS*	*Fixed effects*	*Pooled OLS*	*Fixed effects*
MILEX	0.249*** (0.058)	0.113*** (0.041)	-0.037 (0.058)	-0.179** (0.091)	-0.001 (0.049)	-0.003 (0.007)
GMI	-	-	-0.064 (0.146)	0.252 (0.261)	0.046*** (0.122)	-0.004 (0.025)
Constant	4.480*** (0.147)	4.745*** (0.457)	4.115*** (0.665)	2.817** (1.220)	2.834*** (0.556)	3.089*** (0.122)
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	116	116	116	116	116	116
R^2	0.386	0.203	0.153	0.205	0.264	0.229

Notes: ***, **, and * depict significance at a 1%, 5% and 10% level, respectively. Robust standard errors are depicted in parentheses.

Using the GMM-PVAR method ought to overcome this potential endogeneity, so two models are constructed. The first model includes the variables GMI, growth and investment while the second model encompasses the variables GMI, MILEX, growth and investment. The results of Model 1 are presented in Table 5 and point to a statistically significant relationship only in the case of the GDP growth rates and gross fixed capital formation as a share of GDP (INV) with a positive effect from GDP to INV. No statistically significant nexus is established between the militarization index (GMI) and the other two macroeconomic variables. These findings are in line with those reported by Dunne and Smith (2020), as their findings do not suggest any strong relations between military expenditure and either investment or growth. Nonetheless, it should be pointed out that the results reported here constitute initial evidence. More robust inferences can be drawn through a formal modelling procedure.

12 We thank the two anonymous reviewers for this suggestion.

Similarly, the results of the extended Model 2 in Table 6 show that GMI has a significantly positive effect on growth but not on the other variables. Figures 2 and 3 illustrates the stability condition of the models, as all variables (the dots in Figures 2 and 3) are inside the unit circle.

The orthogonalized impulse response functions, in Figures 4 and 5, show the response of one variable to shocks of the other covariates. These shocks have short-run dynamics, eight quarters (two years) with the blue areas illustrating the confidence bands. A positive shock in GDP leads to an increase in INV and GMI, but this shock is very small and short-lived. Moreover, a positive shock in GMI leads to a stable response on GDP and INV. A positive shock in the gross fixed capital formation variable (INV) yields a stable response of GDP but a negative response of GMI (albeit

Table 5: Results for the GMM-PVAR Model 1

Variables	*GMI(t)*	*GDP(t)*	*INV(t)*
GMI(t-1)	0.890 (0.00)	0.007 (0.198)	0.005 (0.263)
GDP(t-1)	0.180 (0.143)	0.326 (0.00)	0.095 (0.01)
INV(t-1)	-0.159 (0.174)	0.035 (0.301)	0.781 (0.00)

Notes: p values in parenthesis

Table 6: Results for the GMM-PVAR Model 2

Variables	*GMI(t)*	*GDP(t)*	*INV(t)*	*MILEX(t)*
GMI(t-1)	0.874(0.00)	0.014(0.01)	0.004(0.321)	0.002(0.457)
GDP(t-1)	0.199(0.114)	0.308(0.00)	0.089(0.01)	0.010(0.207)
INV(t-1)	-0.112(0.142)	0.020(0.718)	0.774(0.00)	0.003(0.279)
MILEX(t-1)	0.135(0.565)	-0.545(0.475)	-0.339(0.360)	0.678(0.00)

Notes: p values in parenthesis

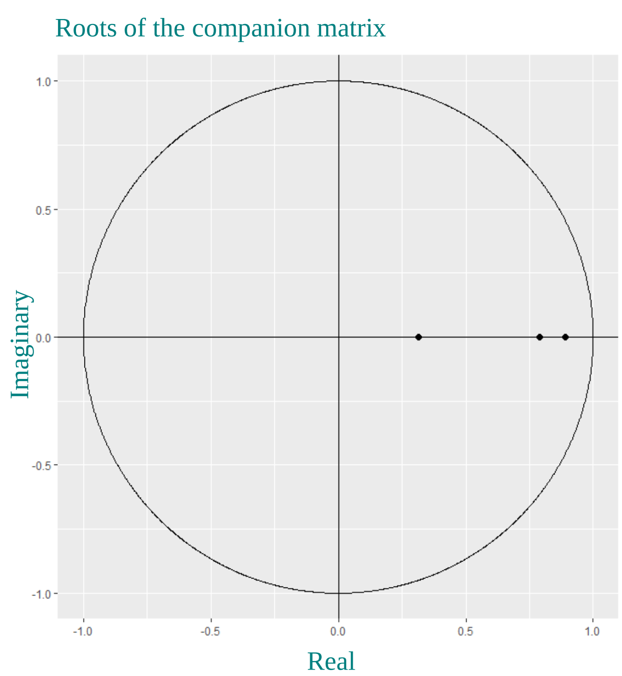

Figure 2: Stability test for Model 1

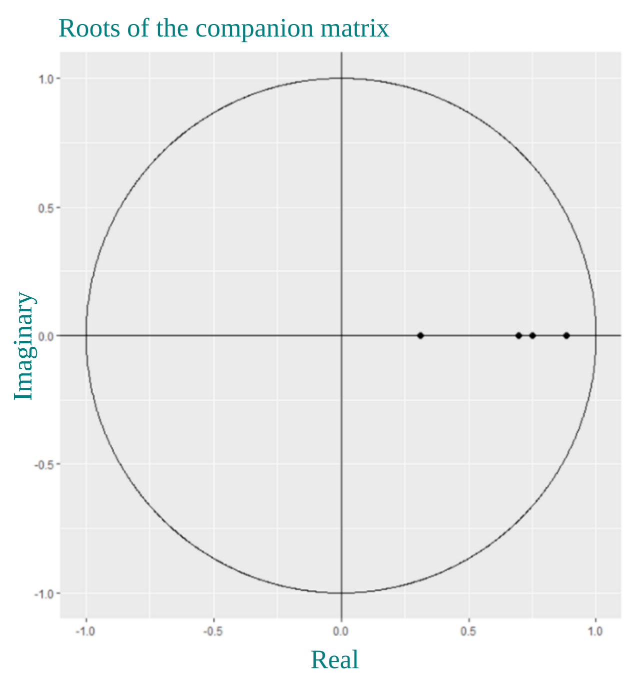

Figure 3: Stability test for Model 2

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very small). Finally, Tables 7 and 8 report the forecast error variance decompositions (FEVD), the percent of the fluctuation in one variable that is brought about by the shock to other covariates for the two models. Since, the FEVD calculation stems from the OIRF the outcomes are the intuitively expected ones. None of the variables can be explained by the dependent variables since the percentage response is very small (less than one percent).

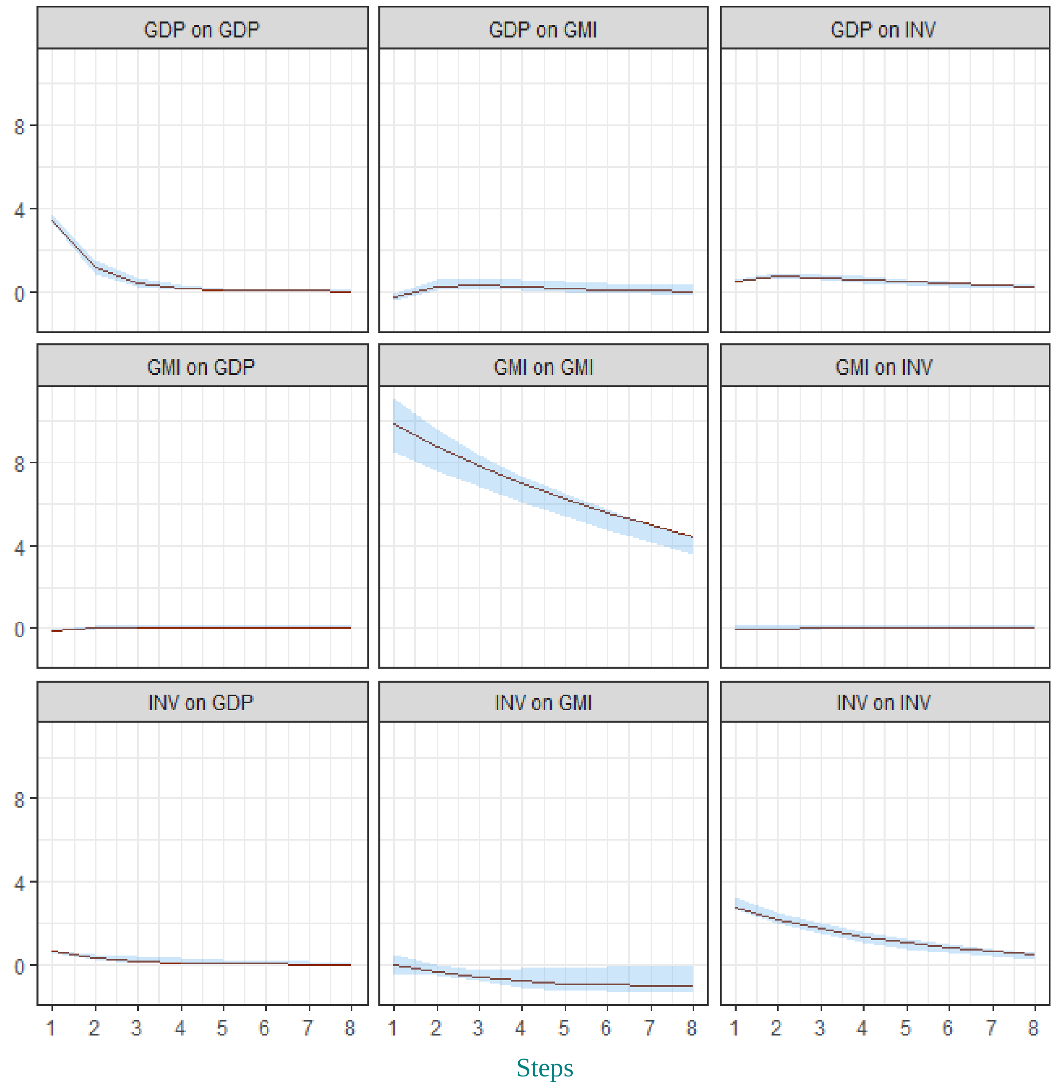

Figure 4: OIRF for model 1 — Generalized impulse response function.
Notes: GIRF and 95% confidence bands.

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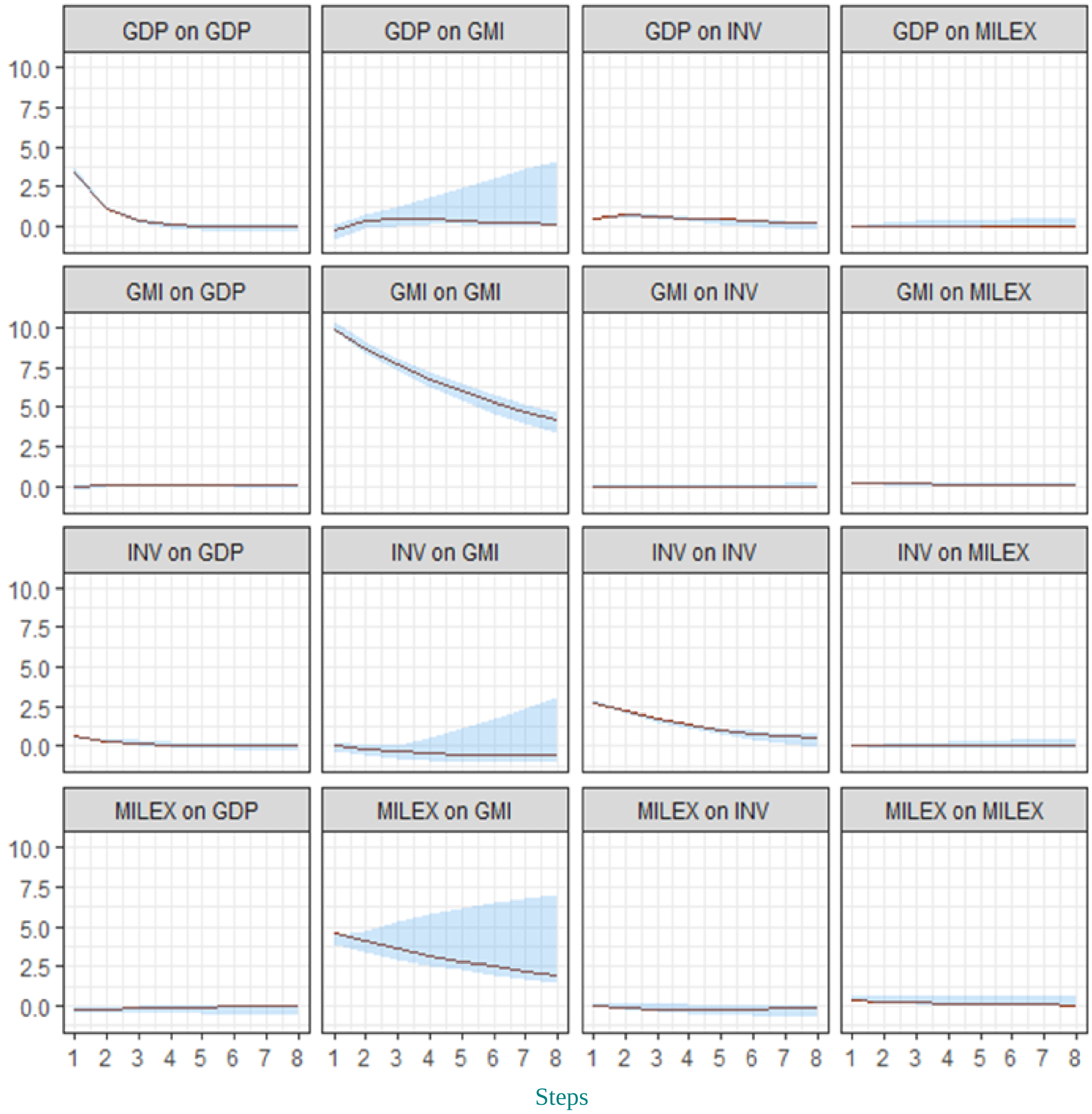

Figure 5: OIRF for model 2 — Generalized impulse response function.
Notes: GIRF and 95% confidence bands.

Table 7: Results for forecast error variance decomposition for Model 1

Dependent variable GMI

Period	*GMI*	*GDP*	*INV*
1	1.000	0.000	0.000
3	0.994	0.002	0.002
5	0.989	0.002	0.007
10	0.980	0.002	0.016

Dependent variable GDP

Period	*GMI*	*GDP*	*INV*
1	0.000	0.999	0.000
3	0.001	0.997	0.001
5	0.002	0.995	0.002
10	0.003	0.993	0.002

Dependent variable INV

Period	*GMI*	*GDP*	*INV*
1	0.000	0.999	0.000
3	0.001	0.997	0.001
5	0.002	0.995	0.002
10	0.003	0.993	0.002

Table 8: Results for forecast error variance decomposition for Model 2

Dependent variable GMI

Period	*GMI*	*GDP*	*INV*	*MILEX*
1	1.000	0.000	0.000	0.000
3	0.994	0.003	0.001	0.000
5	0.991	0.004	0.003	0.000
10	0.987	0.004	0.007	0.000

Dependent variable GDP

Period	*GMI*	*GDP*	*INV*	*MILEX*
1	0.000	0.999	0.000	0.000
3	0.000	0.992	0.000	0.006
5	0.001	0.989	0.000	0.009
10	0.001	0.987	0.000	0.009

Dependent variable INV

Period	*GMI*	*GDP*	*INV*	*MILEX*
1	0.000	0.034	0.965	0.000
3	0.000	0.076	0.919	0.003
5	0.000	0.087	0.903	0.008
10	0.000	0.091	0.893	0.014

Dependent variable MILEX

Period	*GMI*	*GDP*	*INV*	*MILEX*
1	0.219	0.002	0.000	0.777
3	0.257	0.006	0.002	0.734
5	0.284	0.009	0.003	0.703
10	0.314	0.010	0.003	0.670

Conclusion

The economic effects of military spending have attracted considerable attention in the literature in both single and multi-country empirical studies (*inter alia*: Emmanouilidis and Karpetis, 2021; Agostino *et al.* 2017; Desli and Gkoulgkoutsika, 2021; Dunne and Tian, 2015). Invariably, defense burden (military spending as a share of GDP) is the variable used to probe into the potential economic effects of allocating resources to defense. Building on this literature, this article considered an alternative measure that better captures the burden on the economy and society—the Global Militarization Index (GMI). To the best of our knowledge, BICC's GMI has never been used before in an empirical investigation. Considering 116 countries for the period 1995–2019, the results did not reveal any systematic and statistically significant relation between the militarization index (GMI) and two main macroeconomic variables—namely the growth rate of GDP and gross fixed capital formation as a share of GDP. Given the common finding that military burden has a significant impact on growth, this is a rather surprising result. It may suggest that this more general measure of military burden reflects a more complex set of interactions that are not captured in the existing literature. The findings should be treated with caution as a more formal modelling procedure is probably required in order to draw more robust inferences. It certainly suggests that further research using the GMI measure would be of value.

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