Time-Varying Association between Military Spending and Economic Growth in Nepal: Evidence From Wavelet Analysis

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Abstract

National defense is a public good, accounting for heavy public spending, and its effects on economic growth are multifaceted. The study is intended to examine the relationship between military spending and economic growth at different times and scales. The study employed wavelet coherence and partial wavelet coherence for its robustness—keeping the effects of investment and government spending aside—covering the data from 1975 to 2021 which was interpolated in quarterly form to address the frequency issues in the study. The overall findings revealed a significant negative leading association between military spending and economic growth in Nepal, except for the special context of 1976/77 and 2007 to 2009 during which it was positive. The findings indicated a stronger—and highly correlated—short-run time-frequency relationship than long-run within anti-phase and had different degrees of relationship across the frequencies or scales, excluding the special context in Nepal. This sort of time-varying and scale estimate was robust and was evident from partial wavelet coherence analysis, removing the effect of investment and government expenses from the original estimation. The study thus provides some insights to stakeholders and policymakers that they should be cautious about military spending, the institutionalization of the labor forces as a military, and the tremendous resource gap experienced in the economy of Nepal in a time-varying perspective.

Keywords: defense, economic development, investment, wavelet coherence, Nepal

JEL Classification: H56, O11, E22

Introduction

National defense, a non-rival and non-excludable public good, is the prime function of government rather than intervening in the other economic activities performed by private sectors (Smith, 1776). Economic growth is the pivotal aim of the economic policies. Due to the scarcity of resources, therefore, the gun-butter tradeoff is always faced (Mankiw, 1998; Nelson et al., 2009). To accelerate and achieve higher growth in the economy, the resources should be allocated and reallocated efficiently and effectively. More spending on defense means fewer resources are available for channeling the growth. The impact of military spending is thus a growing concern in the economic development of the nations. Military expenditure therefore can have positive economic effects beyond just ensuring sociopolitical and economic stability;

however, it is challenging to pinpoint and categorize these benefits accurately, leading to discrepancies in fiscal accounting, where certain expenditures, like military infrastructure benefiting the private sector, are deemed productive capital assets despite potential inefficiencies (Hemmin & Hewitt, 1991). Military personnel are considered institutionalized and excluded from the labor force (Booth & Segal, 2005), the basic factor of economic growth or output. Nepal's military spending is trending upward (Figure 1), and there is intense debate over its impact on economic growth, motivating policymakers, politicians, and academics in the aftermath of the republic movement in Nepal.

From the very beginning, a seminal work by Benoit (1973) attempted to analyze the growth-defense nexus with the evidence of 44 least-developed countries from 1950 to 1965 and found a positive correlation between military expenses and economic growth. In line with this, Kennedy (1974) found the positive impact of military spending on economic growth. It was also supported by the evidence from 12 SAARC and ASEAN countries that there was a positive impact of defense expenses on economic growth (Dangal & Gajurel, 2022). Recent empirical studies endeavored on military economics and found positive impacts (Atesoglu, 2002; Dimitraki & Win, 2021; Farzanegan, 2014; Lobont et al., 2019) and negative impacts (Azam, 2020; Chang et al., 2011; d'Agostino et al., 2017; Desli & Gkoulgkoutsika, 2021; Khalid & Habimana, 2019) of military or defense expenses on economic growth at several spatial and methodological contexts. Furthermore, conducting a meta-analysis, Alptekin and Levine (2012) and Awaworyi Churchill & Yew (2018) found a net positive effect of military expenses on economic growth. Moreover, insignificant relationships were also found in some studies (Ajmair et al., 2018; Maher & Zhao, 2022). These studies had a piece of evidence that military economics attracted academia. These studies showed a mixed impact and no proper idea of the conclusive impact of military spending on economic growth.

Nepal faces higher defense expenditure and at the same time, military administrators as well as lobbyists on their behalf tend to promote military entrepreneurship. Ministry of Finance (MOF, 2022) reported that the total value addition of the public administration, defense, and compulsory social security sectors was expected to rise from 3.38% in the fiscal year 2020/21 to 4.05%, in the fiscal year 2021/22 due to increased defense and administrative spending by the federal government and three tiers of government. Furthermore, despite a slight decrease in its contribution to total value addition from 7.85% to 7.73% in the current fiscal year, the sector has maintained an average contribution of 6.57% over the past decade with an average growth rate of 5.17% (MOF, 2022). In the aftermath of dictatorships, newly established regimes often struggle to secure political legitimacy, exhibiting inherent weaknesses and fragility (Khadka, 1993), thereby increasing Nepal's domestic and foreign threats (Brown, 2002; Thapa & Sharma, 2009). Increasing military spending, many political movements, and civil wars have severely influenced the investment and economic growth of Nepal (Pradhan, 2009). The lack of empirical studies on military spending and its size and degree of effects on different regimes became a motivating factor to contribute to the literature on this field. This paper thus attempts to fill the gap in the literature, contributing to the military literature as time and scale causality of military expenses on the economic growth of Nepal.

Military spending did not impact economic growth in the same manner in all regimes experienced in Nepal from 1975 to 2021. A huge amount of water was flown from the river.

Military spending includes recurrent and capital expenses, and it has different levels of effect on the economy in the short, middle, and long run. The paper employed wavelet coherence and partial wavelet coherence (PWC) to analyze the time-varying nexus between military spending and growth. Xu et al. (2020) stated that the characteristics inherent in wavelet analysis make it well-suited for the examination of economic data, particularly in situations involving nonstationary variables and complex signals with rapid regime shifts which is quite consistent with the studying military spending-growth nexus in Nepal.

Some panel studies including Nepal and some political science literature were found in the the context of Nepal (Dangal & Gajurel, 2022; Pradhan, 2009; Vadlamannati & Pathmalal, 2010; Wijeweera & Webb, 2011). To the best of our knowledge, no studies were conducted in the Nepalese context with the time horizon effects of military spending on growth. The study is therefore attempted to study the time and scale effect of military spending on economic growth, employing wavelet techniques. It analyses the positive and negative comovement between military spending and economic growth with different time frequencies.

The study aims to evaluate the nexus between military spending and economic growth in Nepal, applying wavelet techniques, and evaluating the co-movement and causality between variables. This paper makes these contributions: firstly, to fill the literature gap; secondly, to explore the time horizon effects of military spending on economic growth across the different political regimes; thirdly, to plug the methodological gap in time series analysis in Nepalese context; and finally to help the academics for their robust novel contributions. Wavelet analysis, which divides the series into single time horizons and scale to confirm the result's robustness, is also helpful for the time series data having nonstationary properties and structural breaks (Hacker et al., 2014; Khalid & Habimana, 2019; Ramsey & Lampart, 1998). Wavelet analysis provides the chronological time-variant relationship between military spending and growth with different socio-political and economic development under the study periods. Moreover, the paper provides insights for the policymakers and stakeholders to formulate future policies on the size and scale effects of military spending in the economy of Nepal. The study thus broadly organizes into the following sections: introduction, literature review, data and method, results and discussion, and conclusion.

Literature Review

A seminal study by Benoit (1973) revealed a positive link between military spending and economic growth. Likewise, an extensive cross-sectional study by Landau (1994) found no substantial evidence of the negative impact of military expenditures on economic growth. Corroborating these findings, research on the relationship between military spending and economic growth in South Asian countries, including Nepal, using panel co-integration with data from 1988 to 2007, identified a slight positive effect of military spending on GDP growth (Wijeweera & Webb, 2011). Analyzing time series data from 1991 to 2016 with the Granger causality test, Lobont et al. (2019) discovered a two-way relationship between military spending and GDP in Romania, indicating that military expenditures can positively affect resource mobilization for economic growth. Similarly, Furuoka et al. (2016) found military spending not only spurred economic growth but also maintained a long-term connection with it in China.

Conversely, Khalid and Habimana (2019) investigated the link between military spending and economic growth in Turkey using wavelet analysis on data from 1961 to 2014. Their study found that military expenditures negatively impacted per capita GDP growth through timescale regression. Furthermore, timescale Granger causality indicated that economic growth drove military spending in the long run, while wavelet coherence demonstrated a long-term negative co-movement between military spending and growth. In a similar vein, Azam (2020) conducted a panel study encompassing 35 non-OECD countries from 1988 to 2019 to examine the impact of military spending on economic growth. The findings demonstrated a negative relationship between military expenses and economic growth. However, the study also identified a bidirectional causality between military spending and economic growth. Previous research, utilizing panel causality tests across various countries and economic contexts, has yielded mixed results, including unidirectional, bidirectional, and inconclusive causality between military spending or burden and economic growth (Chen et al., 2014; Pan et al., 2015).

Using two-state Markov-switching specifications, with Chinese experience, a study found that changes in military spending impact economic growth differently depending on economic conditions, with negative effects during slower growth and positive effects during faster growth, indicating that military spending shifts can predict changes in growth probabilities (Menla Ali & Dimitraki, 2014). Conversely, in the long run, Maher and Zhao (2022) found that military spending did not affect economic growth in Egypt significantly. Thus, there was no evidence of the externality and productive effects of military spending on economic growth (Huang & Mintz, 1991).

Dunne et al. (2005) emphasized the supply effects (neoclassical analysis), demand effects (Keynesian analysis), and security effects (national interest and coping with foreign threats) of military spending-growth nexus. Demand effects are based on the Keynesian multiplier and found that an increase in defense expenses increased the aggregate demand thereby economic growth (Dunne et al. 2001; Dunne et al., 2005; Khalid & Habimana, 2019). Moreover, the supply effect of military spending is to improve technology, administration, and human capital which produced a feedback effect on economic growth (Dunne & Nikolaidou, 2001; Khalid & Habimana, 2019). Eventually, security effect implies the military spending ensuring the security for everything else and producing confident investing environment which accelerates the growth to some extent (Dunne et al., 2005; Maizels & Nissanke, 1987).

Several studies found a positive linkage between military spending and economic growth (Atesoglu & Mueller, 1990; Dangal & Gajurel, 2022; Pacific et al., 2017; Yildirim et al., 2005; Yildirim & Öcal, 2016); some other found negative effects (Abu-Bader & Abu-Qarn, 2003; Dunne & Nikolaidou, 2001; Dunne & Tian, 2016; Klein*, 2004; Manamperi, 2016; Shaaba Saba & Ngepah, 2019); and some studies showed the inconclusive and non-significant impact (Maher & Zhao, 2022; Manamperi 2016) of military spending on economic growth.

The prior studies revealed mixed outcomes of military spending in economic development. Positive and causal connection results support that the Keynesian approach about increasing defense spending may accelerate the aggregate demand, infrastructure, trade, employment, and so forth, thereby enhancing economic growth. On the contrary, some studies reported a negative impact due to crowding out of private investment and an increase in unproductive finance that adversely affected the economic development. Moreover, some

studies found inclusive results and an insignificant relationship between military spending and economic growth. This paper thus attempts to examine the relationship between military spending and the economic growth of Nepal and to bridge the literature gap in the Nepali context.

Materials and Method

Data and Its Sources

This study is intended to analyze the military expenses and economic growth nexus of Nepal by employing wavelet analysis techniques that allow us to evaluate the time-variant movement between the military spending and economic growth of Nepal. This study, a quantitative analysis, applied time series data from 1975 to 2021. Military spending was obtained from the Stockholm International Peace Research Institute (SIPRI) military expenditure database, and economic growth was obtained from Penn World Table (PWT) 10.1 published by the Federal Reserve Bank of St. Louis, USA. Furthermore, the descriptions of the variables of interest are presented in Table 1. Moreover, this study employed partial wavelet coherence (PWC) with control variables—investment and government expenditure—to analyze the robust relationship between military expenses and economic growth.

Table 1

Description of Variables

Variables	Proxies	Description	Measurement	Source
military	Military spending	Current and capital expenditures on the armed forces	% of GDP	SIPRI
growth	Economic growth	Growth in output-side per capita real GDP (in 2017 US$)	% change in the ratio of RGDP to population	PWT 10.1
investment	Capital formation	Gross capital formation at current PPPs	Share of GDP	PWT 10.1
gexp	Government expenses	Government consumption expenses at current PPPs	Share of GDP	PWT 10.1

Note. GDP = Gross domestic product, RGDP = Real GDP, PPP = Purchasing power parity, SIPRI = Stockholm International Peace Research Institute, PWT = Penn World Table

Method and Model Specification

In the midway between 1975 and 2021, Nepal became a political guinea pig as a multiparty democratic movement, Maoist insurgency, republic, and federalism movement. These episodes of frequent changes in the regime in Nepal show the different degrees of defense spending. The rising institutionalized, economically active population and increasing defense spending due to political turmoil cause a different degree of impact on the economic growth of Nepal. To study the time horizon and scale effects of military spending on economic growth, this paper employed the wavelet mechanism. Wavelet techniques originated with a geophysics background which was attempted by Morlet et al. (1982). Thereafter, it gained popularity for the time and scale effects between time series. The paper employed wavelet coherence and partial wavelet coherence to infer the time and scale effect of military expenses on the economic growth of Nepal. To perform the wavelet analysis, the data were interpolated into quarterly series by quadratic sum method (Adebayo et al., 2022; Aziz et al., 2020; Shahbaz

et al., 2018; Shahbaz et al., 2013) in Eviews 10, and then it was analyzed in R4.3.3 programming language. Finally, ChatGPT 3.5 was used to correct the grammar and English language in the paper.

Wavelet Coherence

Wavelets, a modern advancement in signal processing, examine local characteristics of complex signals across various time scales and signal nonstationary regions (Misiti et al., 2013). Following Misiti et al. (2013), the study estimated the wavelet system, assuming that ψ is a sufficiently smooth, regular, and well-localized function. This function, denoted as $\psi \in L^1 \cap L^2$, is termed as a wavelet if it satisfies the following acceptability condition in the frequency domain (Misiti et al., 2013):

$$\int_{\mathbb{R}^+} \frac{|\hat{\psi}(\omega)|^2}{|\omega|} d\omega = \int_{\mathbb{R}^-} \frac{|\hat{\psi}(\omega)|^2}{|\omega|} d\omega < +\infty$$

where $\hat{\psi}$ refers to the Fourier transform of ψ. This condition specifically requires that the wavelet function integrates to zero. This fundamental prerequisite is frequently strengthened by stipulating that the wavelet possesses vanishing moments, verifying $\psi, \psi \in L^1 \cap L^2, t\psi \in L^1$ and $\int_{\mathbb{R}} \psi(t) dt = 0$ (Misiti et al., 2013).

Gallegati et al. (2014) stated that wavelet coherence, calculated by normalizing the wavelet cross-spectrum to individual wavelet spectra, identifies time and frequency intervals with significant interactions between two phenomena. It reflects local correlation in time-frequency space, and its statistical significance is determined through Monte Carlo methods. Following several studies (Adebayo et al., 2021; Çepni et al., 2020; Khalid & Habimana, 2019; Ng & Chan, 2012; Tiwari et al., 2020; Torrence & Compo, 1998), this study applied the wavelet time-scale coherency between two time-series, $military_t$ and $growth_t$, as cross-wavelet transform (CWT) forms accounts as

$$W_{\text{military-growth}}(k,f) = W_{\text{military}}(k,f)\, W_{\text{growth}}(k,f)$$

Where, W_{military} (k,f) implies the CWT of series, $military_t$ and W_{growth} (k,f) refers to the CWT of series, $growth_t$. Wavelet coherence thus can be estimated as the covariance for time and frequency of CWT of both series:

$$R^2(k,f) = \frac{\left|C[f^1 W_{\text{military-growth}}(k,f)]\right|^2}{C\left[f^1 W_{\text{military}}(k,f)^2\right] \times C\left[f^1 W_{\text{growth}}(k,f)^2\right]}$$

The parameter *C* encapsulates the smoothing process and period, with R^2(k, f) ranging between 0 and 1 ($0 \leq R^2(k, f) \leq 1$), where a value of R^2(k, f) closer to 1 suggests correlation among time series at a specific scale represented by a red color, while the value closer to 0 indicates no association represented by a blue color.

Partial Wavelet Coherence (PWC)

PWC allows the wavelet coherence between two series while controlling the third series to determine the comovement between these two series. The transfiguration method is applied to analyze the PWC. This paper estimated the wavelet coherence (WC) between military expenses and growth, controlling investment and government expenditure (*gexp*). Following the studies by Adebayo et al. (2021), Mihanović et al. (2009), and Ng & Chan (2012), the estimated PWC in this paper is expressed in the following equations.

PWC System 1:

$$R^2\ (military,\ growth) = \left(\frac{S[W(military,growth)]}{\sqrt{S[W(military)],S[W(growth)]}}\right)^2$$

$$R^2\ (military,\ investment) = \left(\frac{S[W(military,investment)]}{\sqrt{S[W(military)],S[W(investment)]}}\right)^2$$

$$R^2\ (growth,\ investment) = \left(\frac{S[W(growth,investment)]}{\sqrt{S[W(growth)],S[W(investment)]}}\right)^2$$

PWC System 2:

$$R^2\ (military,\ growth) = \left(\frac{S[W(military,growth)]}{\sqrt{S[W(military)],S[W(growth)]}}\right)^2$$

$$R^2\ (military,gexp) = \left(\frac{S[W(military,gexp)]}{\sqrt{S[W(military)],S[W(gexp)]}}\right)^2$$

$$R^2\ (growth,\ gexp) = \left(\frac{S[W(growth,gexp)]}{\sqrt{S[W(growth)],S[W(gexp)]}}\right)^2$$

Here, *S*, the smoothing operator, is used for balancing between significance and resolution. Partial wavelet coherence can be squared as an extension of linear simple correlation to partial correlation, aiming to mitigate the influence of a third variable on the relationship between two variables in PWC (Mihanović et al., 2009).

PWC (*military spending and growth*|*investment*) following system (1):

$$RP^2\ (military,\ growth,\ investment) = \frac{|R(military,growth) - R(military,investment)\cdot R(growth,investment)^*|^2}{[1-R(military,investment)]^2[1-(investment,growth)]^2}$$

PWC (*military spending and growth*|*government expenses*) following system (2):

$$RP^2\ (military,\ growth,\ gexp) = \frac{|R(military,growth) - R(military,gexp)\cdot R(growth,gexp)^*|^2}{[1-R(military,gexp)]^2[1-(gexp,growth)]^2}$$

Results and Discussion

Statistical Summary and Trend of Variables of Interest

The study evaluates the relationship between military spending and economic growth in Nepal. Table 2 shows that the 47 years of annually collected time series were used to estimate this relationship. Military spending (*military*) is expressed as a percentage of *GDP* and it was averaged at 1.2% with a standard deviation of 0.27%. The military spending was 0.98% in the 25th percentile and 1.4 % in the 75th percentile—1.9% of GDP, the maximum in Nepal. Table 2 also reveals that the average *GDP* per capita growth (*gdpp*) was 2.5% with a maximum of 7.7% and a minimum of -5.3%. However, there was a positive 25th and 75th percentile value of *GDP* per capita growth. Similarly, average government expenditure (*gexp*) and investment as a share of *GDP* was 8.6% and 25% respectively.

Table 2

Statistical Summary of Variables of Interest

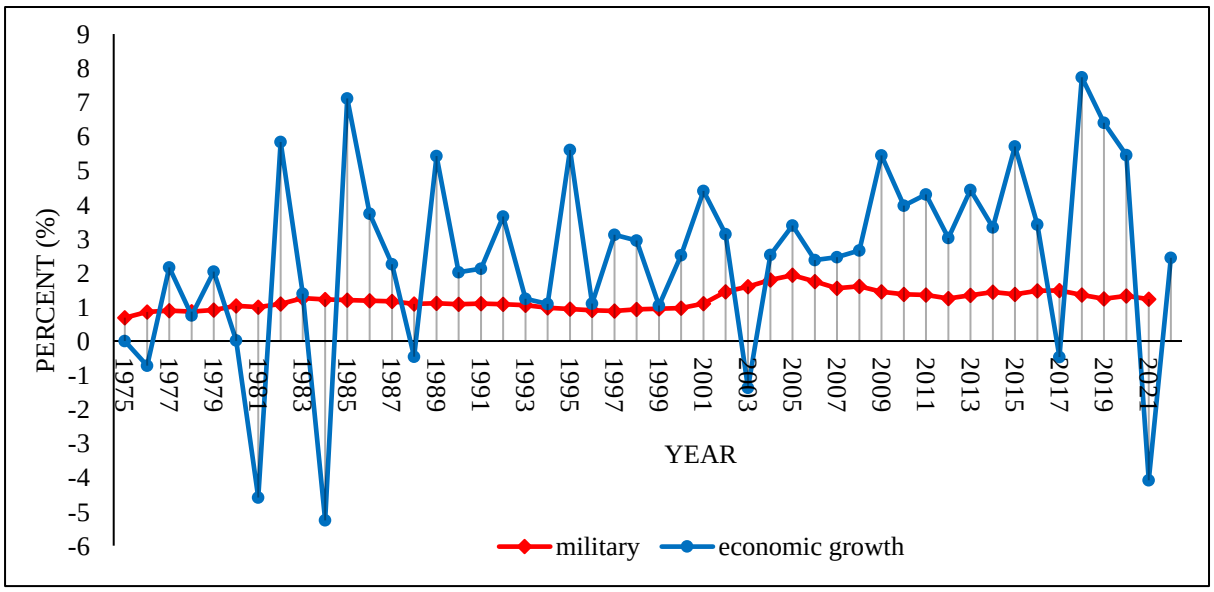
Variable	N	Mean	σ	Min	Pctl. 25	Pctl. 75	Max
military	47	1.2	0.27	0.68	0.98	1.4	1.9
gexp	47	8.6	0.84	6.7	8	9.1	11
gdpp	47	2.5	2.8	-5.3	1.2	4.1	7.7
investment	47	25	6.7	14	20	29	41

Note. N = Number of observations, σ = standard deviation, Min = Minimum, Pctl. 25 = 25th percentile, Pctl.75 = 75th percentile, Max = Maximum

The military spending was observed to be more or less stable, being highest between 2002 to 2007, and ranging between 0.68% to 1.9% across all sample periods as indicated in Figure 1. Similarly, Figure 1 revealed fluctuating trends of economic growth (*gdpp*) across the sample periods, ranging between negative 5.3 % to positive 7.7%.

Figure 1

Trend of Military Spending and Economic Growth (GDP Per Capita)



Note. Plot based on data obtained from SIPRI and PWT 10.1.

Wavelet Coherence: Bi-Wavelet Analysis

Wavelet coherence is employed to determine the local correlation between two series, indicating the series' co-varying effect in time and space. It measures the correlation and comovement as well as causality between series across the time and scales. Gallegati et al. (2014) showed that a bold black outline indicates the 5% significance level against the null hypothesis of red noise, whereas a thin black line marks the cone of influence (COI), cautioning against interpreting values beyond it due to potential significant zero padding at the beginning and end of the time series. Figure 2 shows the plot of the wavelet coherence between military spending and the economic growth of Nepal. The X-axis represents the time dimensions or periods and the short, middle, and long-term frequency bands or scales are along with the Y-axis—that every lower frequency shows the higher scale and vice versa. Color in the wavelet coherence plot shows the degree of coherence between military spending and economic growth. Color ranges from blue—low coherence or association to red—high coherence or association, indicating the correlation between 0 and 1. Black contours encircled the different colors show the 95% confidence intervals to test the null hypothesis of coherency is zero.

Similarly, in Figure 2, COI is shown as a lighter shade marked by gray lines that show the boundary conditions and edge effects. The area outside a cold one of COI shows no correlations between the series. Moreover, arrows in the Figure 2 indicate the lead and lag phase difference between military spending and the economic growth of Nepal; the arrow pointing right shows the time series in phase (series move same direction), indicating positive correlation and anti-phase when the arrow points left (series move reverse direction), indicating negative correlation. The arrow points downward, leading the first series over the second series

by π/2; on the other hand, pointing upwards refers to the second series' dominance over the first series by π/2.

Figure 2

Wavelet Coherence between Military Spending and Economic Growth of Nepal

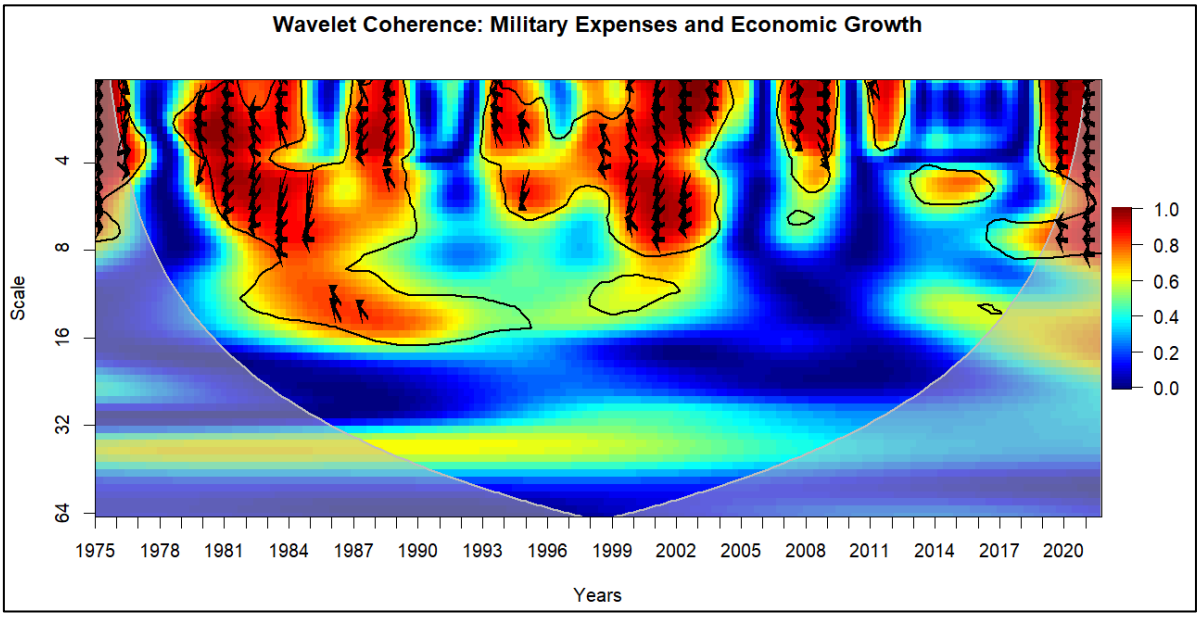


Figure 2 demonstrates the wavelet coherence between military spending and economic growth that analyses how military spending moves in tandem with the economic growth of Nepal. The correlation and directions of comovement between these two variables are indicated by the different range of colors and colors scale, concerning R^2(k,f). In Figure 2, frequency ranges from 0 to 64 shows the various levels of scale effects from short-run (0 to 8) to medium-run (8-32) and long-run (32 to 64). In Figure 2, military spending and economic growth were highly and significantly associated in the short run. From year 1976 to 1977, wavelet coherence, in Figure 2, indicates a positive correlation between military spending and economic growth, implying that military spending had positive causal effects on growth and these two series had in phase as indicated by the arrow pointing to the right. At that time, the domestic reconciliation process began and Palace took some democratic initiatives to improve the cooperation with political parties (Scholz, 1978) that may be caused to the short-run positive impact on economic growth by military spending in Nepal. Security and defense might improve economic activities and provide greater space for private investment, thereby leading to the country's economic growth.

Moreover, the WC plot revealed several periods in the short-run—1979 to 1984, 1987 to 1990, 1993 to 2004, 2011 to 2012, and 2019 to 202—had a negative correlation at 5% level of significance; it was also observed that military spending had negative causal linkage with the growth of Nepal; and as arrows were pointing to the left, these two variables were moving in anti-cycle manner or anti-phase. The results of short-run negative coherency between military spending and economic growth are consistent with the empirical findings of Khalid & Habimana (2019). Military spending may misallocate resources on one hand; on the flip side, it can improve the economic inertial to accelerate economic growth if there are more suitable other political and legal situations. Thus, merely military spending cannot cause economic

growth, it diverts the resources from productive channels. It seems effective only when the other political, social, and legal environments are sufficient to cultivate the economic endeavors in the country.

However, it was observed that during the period 2007 to 2009, military spending and economic growth were positively correlated and these two were moving in the same direction. The primary reason for the positive association may be that the optimism arising among the Nepalese, following the political shift of 2006 and the cessation of a decade-long violent insurgency, has significantly evaporated (Sangroula, 2009). In this period, the peace process in Nepal began and the Maoist insurgency was to be settled down. The increasing military spending in the new context in Nepal helped to inject more confidence in investors, thereby showing the movement in the same direction as feedback effects of security. On the other hand, the medium-run scale effects (frequency 8 to 16) showed a moderate level of significant negative correlation between military spending and economic growth from 1983 to 1991. Similarly, in the medium run, there was a significant association between military spending and economic growth between 1998 and 2001 and 2016 and 2017. In this period, these two variables moved in anti-phase. Eventually, in the long run, a significant association was found between military spending and economic growth. As Xu et al. (2020) observed, there was a negative coherency between military spending and economic growth: the more the military spending, the less the inflation, thereby ultimately increasing consumption with employment and aggregate demand promoting economic growth.

Thus, an overall study revealed that the short-run effect was stronger than the medium-run, and long-run in the coherence between military spending and economic growth in Nepal. Excluding the special contextual periods of the study, military spending and economic growth in Nepal were anti-cycle across frequencies in the short run and medium run.

Partial Wavelet Coherence (PWC)

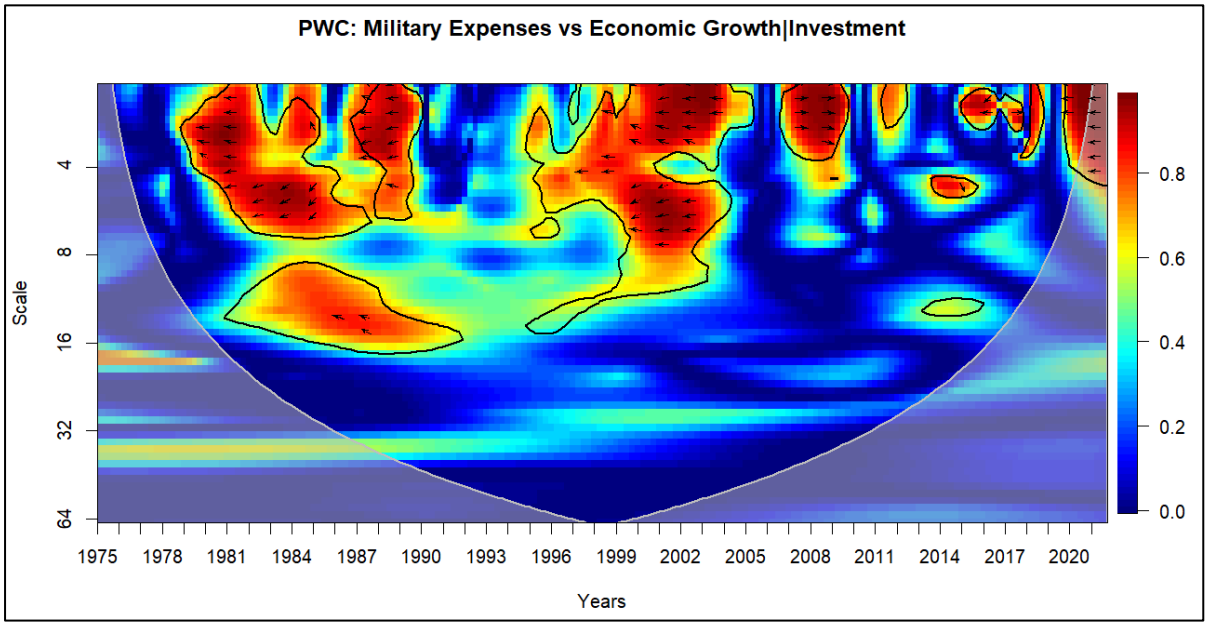
Partial wavelet coherence is a similar technique to partial correlation analysis, employing wavelet coherence between two series after controlling or removing the effect of the other series (Ng & Chan (2012). It could also infer evidence of the robustness of the wavelet coherence. In this study, the influence of investment (Figure 3) and government consumption expenses (Figure 4) were removed from the wavelet coherence between military spending and economic growth in Nepal.

Figure 3 shows the PWC between military spending and economic growth in Nepal keeping the effect of investment aside. The coherence between military spending and economic growth in Nepal was quite similar to the results of wavelet coherence between them without eliminating the effects of investment (Figure 2). The short-run causal connection between military spending and economic growth was more powerful in Nepal. The PWC also confirmed that with the short and medium period of scales, there was significant coherence between military spending and economic growth with the effect of inflation canceled. Figure 3 also revealed a high degree of negative coherence between military spending and economic growth with anti-phase comovement in the short run (up to the 8 period of scales), spanning the period between 1978 to 1990 while eliminating the effect of investment. Furthermore, a piece of similar evidence was found between the period 1994 to 2005. The military spending and

economic growth in Nepal during these periods moved in an anti-cycle manner as shown by the leftward pointing arrow with the effect of investment annulled.

Figure 3

Partial Wavelet Coherence Military versus Growth Eliminating the Effect of Investment



In contrast, there was a high degree of positive coherence within the phase between military spending and economic growth in Nepal between 2007 and 2009 in a short period, removing the effect of investment. Besides, PWC revealed a significant correlation between military spending and economic growth in a very short period from 2011 to 2012. PWC confirmed a negative association between military spending and growth between 2015 and 2017 in a very short period; then it was positively significant from 2017 to 2018. Moreover, there was a high degree of coherence between military spending and economic growth in Nepal between 2018 and 2019 in the short run. It was an anti-phase and negative coherence between military spending and economic growth from 2020 to the end of the study period. In the medium scale, however, there was a coherence between military spending during periods of 1995 to 2003 and 2013 to 2016; while in the medium-run, as indicated by color scale contours, there was a moderate level of negative causal linkage between military spending and economic growth from 1981 to 1992. In the long run (after period 16), keeping investment aside, however, there was no evidence of coherence between military spending and economic growth in Nepal.

The overall findings of PWC with investment were similar to the results of wavelet coherence (Figure 2) between military spending and the economic growth of Nepal. If the effect of investment on economic growth was eliminated, strong short-frequency coherence appeared. The PWC confirmed strong short to medium-scale effects and anti-phase coherence between military spending and economic growth. Thus, PWC confirmed negative coherence and anti-cycle movement between military spending and economic growth, and results were robust as shown in Figure 2.

Figure 4

Partial Wavelet Coherence Military versus Growth Removing the Effect of Government Expenditure

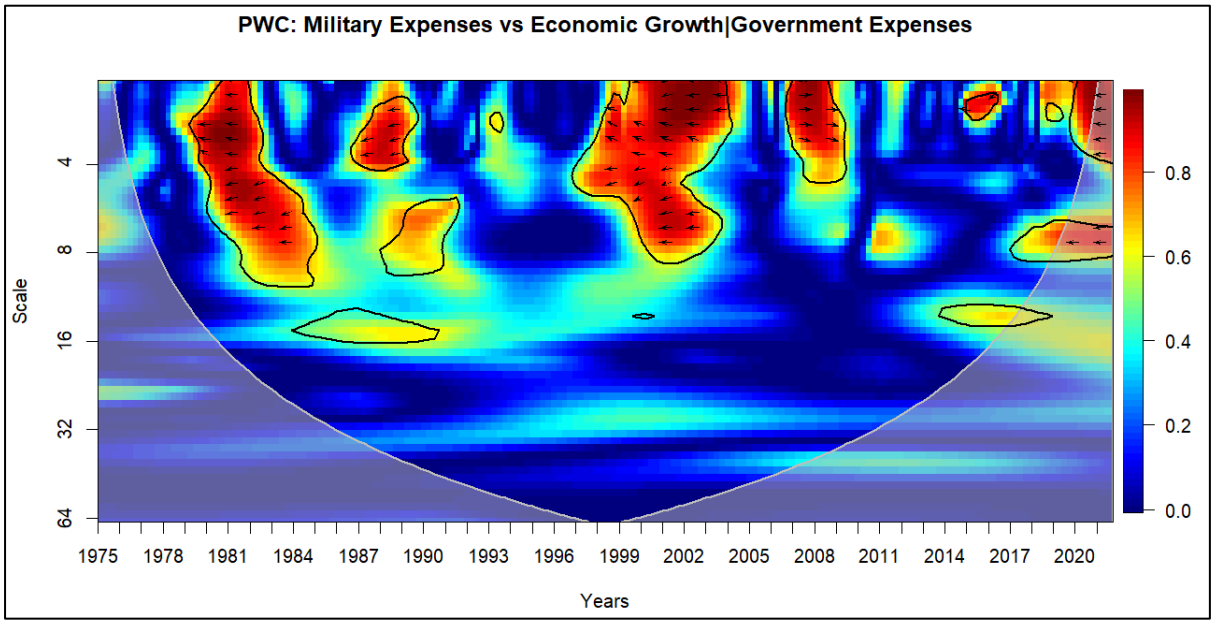


Figure 4 demonstrates the PWC between military spending and economic growth with government consumption expenses effect annulled. The plot is approximately similar to the previously estimated PWC and wavelet coherence. The coherence between military spending and economic growth was quite similar after removing the effect of government expenses. The wavelet coherence plot in Figure 4 showed highly negative coherence between military spending and economic growth on short frequencies between 1979 to 1985, 1997 to 2004, 2015 to 2016, and 2020 to 2021. The military spending and economic growth were moving in an anti-cycle manner as shown by the arrow pointing to the left. As earlier estimated wavelet coherence (Figure 2), there was a positive high degree of coherence between military spending and economic growth between 2007 and 2009 in the short run. The arrows pointing to the right imply their movement in the same direction and within a phase. The plot showed a correlation between military spending and economic growth in a medium run between 1984 and 1991 and 2014 to 2019. The long run, however, saw a significant coherence between military spending and economic growth. The results of PWC were consistent and robust with previous estimations of wavelet coherence (Figure 2).

Conclusion and Implication

Military spending is the largest general public expenditure of the countries. Past studies showed mixed (positive, negative, or not significant) relationships between military spending and economic growth. Nepal experienced several political turmoil in the past. Thus, the effect of military spending on growth is assumed to be nonlinear and has no single scale. This paper employed wavelet analysis techniques to examine the time and frequency association between military spending and economic growth in Nepal. The overall findings revealed different degrees of relationship between military spending and growth across different periods and frequencies or scales. The findings also demonstrated that the short-run scale effect was more powerful than the medium-run and long-run. The results indicated that there was no significant

effect in the long run. The results, however, also confined some evidence of a significant effect of military spending on economic growth in the medium-run frequencies. This study observed a significant negative coherence and lead-lag relationship—with anti-phase comovement—between military spending and economic growth in Nepal up to the middle term, except in two time periods spanning from 1976 to 1977 and from 2007 to 2009, the periods that were two different contexts of national integration in Nepal. The result implies that military spending had negative lag-leading properties and could help predict the growth in Nepal across the different frequencies. Furthermore, these results were supported by partial wavelet coherence analysis, eliminating the effect of investment and government expenditure. Military spending is a debatable issue in Nepal. Thus, this study may help those stakeholders formulate an appropriate spending policy, and balance the trade-off between defense-growth nexus. As evident from the results, military spending adversely affects growth in the short run and does not significantly affect growth in the long run. In this scenario, policymakers should be cautious about military spending, stemming from the size of the institutionalized labor force and the tremendous resource gap experienced in the economy of Nepal, across time and frequencies.

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