LONG-TERM WAR IN AFGHANISTAN: ITS IMPACTS ON THE ECONOMY, ENVIRONMENT, AND HUMAN RESOURCE DEVELOPMENT

A Thesis submitted by

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ABSTRACT

War is a devastating phenomenon that destroys the economic, social, and technological infrastructure of a country, causing civilians to suffer from lost social and economic development opportunities, lost human capital development opportunities, forced migration, hunger, high mortality rates, and massive destruction. Moreover, war causes significant governance vulnerabilities and imposes substantial costs for the reconstruction and rehabilitation of damaged infrastructure. The principal objective of the present thesis is to examine the symmetric and asymmetric effects of long-term war on three key socioeconomic indicators, the economy, environment, and human resource development in the context of Afghanistan. It also aims to produce statistical evidence on the nature, size, and magnitude of the effects of long-term war on the predictors in order to generate specific policy recommendations to national policymakers and the international community who are engaged in the process of nation-building, peace-building, and market-building in Afghanistan.

To accomplish the objectives, five research articles focusing on the key themes of the thesis were produced to investigate the effects of war on economic growth, unemployment rate, environmental quality, human resource development, and public healthcare services over the period from 2002 to 2020. This thesis employed time-series datasets collected from reliable sources, such as the WDI (World Development Indicators), ADB (Asian Development Bank), IMF (International Monetary Fund), and the United States Defense Budget. To test the newly developed hypotheses (H_1–H_{15}) relevant to the research questions informed by the research objectives, complex econometric methods such as the NARDL (non-linear autoregressive distributed lags), MVAR (modified vector autoregressive), and a series of multivariate regression models that have been augmented with sets of well-known predictors were used. In addition to testing the effects, both symmetric and asymmetric causality techniques were also used to determine the link and the direction of the causality from war to the variables of interest and vice versa.

The findings of the thesis are critical and produce important insights into the effects of war on the variables of interest. On the economic front, the results confirm a long-run asymmetric relationship between war and economic growth. It is also

indicated that a positive asymmetric shock from war reduces economic growth, while a negative asymmetric shock from war increases growth in the short and long runs.

Moreover, the findings highlight the non-monotonic effects of war on economic growth, both in size and magnitude. Statistical evidence concludes that there is a significant bidirectional causality between economic growth and the war. On the unemployment front, the findings reveal that the positive asymmetric shocks from war decrease the unemployment rate, while their negative asymmetric shocks increase it in the short and long runs. It also demonstrates that enhancing the outreach of financial services plays an important intermediating role in reducing the unemployment rate during wartime in Afghanistan. The findings show that an asymmetric causality runs from both the positive and negative components of war to the unemployment rate, confirming a bidirectional nexus among them. On the environment front, the findings support a long-run relationship between war and environmental degradation. It also reveals bidirectional causal links between environmental degradation and war, while confirming multidimensionality and interdependencies among predictors. Moreover, the findings confirm the existence of an inverted U-shaped relationship, supporting the validity of the EKC hypothesis in Afghanistan. On the human resource front, the findings support a long-run asymmetric relationship between war and human resource development, while the magnitude of the relationship has been confirmed to be asymmetrically negative. It further reveals that the school enrolment rate—a proxy for human resource development—is highly sensitive to and swiftly reacts against the intensity of war. Furthermore, the findings show that both the positive and negative aspects of war have a significant impact on the school enrolment rate. Finally, on the public healthcare front, aging results support a significant long-run relationship between war and public health, showing that war positively impacts health expenditures, whereas child mortality rate and crude death rate have negative impacts. The findings also indicate a statistically significant bidirectional causal nexus between health expenditure and war, while supporting the existence of strong and significant interconnectivity and multidimensionality between war and health expenditure, with a significantly strong feedback response from the control variables.
Considering the statistical evidence, the results of this thesis conclude that the long-term war in Afghanistan had significantly devastating effects on socioeconomic indicators, most specifically on the economy, environment, and human resource development during the period of the study. It concludes that war significantly

suppresses economic growth, imposing serious consequences on the well-being of the nation through increased unemployment rates, diminished human resource development processes, and degraded environmental quality, all of which impact both the nation's lives and its development. The critical findings of the thesis shed light on important policy implications and offer a set of policy recommendations to policymakers.

CERTIFICATION OF THESIS

I Mohammad Ajmal Hameed declare that the PhD Thesis entitled "Long-term war in Afghanistan: its impacts on the economy, environment, and human resource development" is not more than 100,000 words in length including quotes and exclusive of tables, figures, appendices, bibliography, references, and footnotes.

This Thesis is the work of Mohammad Ajmal Hameed except where otherwise acknowledged, with the majority of the contribution to the papers presented as a Thesis by Publication undertaken by the student. The work is original and has not previously been submitted for any other award, except where acknowledged.

Date: 27.05.2023

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Associate Prof. Mafiz Rahman
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Student and supervisors' signatures of endorsement are held at the University.

STATEMENT OF CONTRIBUTIONS

This thesis is by publication and the articles produced from this study have been a joint contribution of three researchers. The details of the scientific contributions of each researcher are provided below:

Paper 1:

Hameed MA, Rahman MM, Khanam R (2022). Assessing the asymmetric war-growth nexus: A case of Afghanistan. PLOS ONE 17(8): e0272670. DOI: https://doi.org/10.1371/journal.pone.0272670.

The overall contribution of Mohammad Ajmal Hameed (the first *author*) has been 75% to the conceptualization, data collection, methodology, data analysis, results and discussion, and the completion, revision, and submission of the final draft of the paper. Mafiz Rahman and Rasheda Khanam each contributed 15% and 10%, respectively, to the development of the theoretical background and literature review, as well as technical inputs and editing.

Paper 2:

Hameed MA, Rahman MM, Khanam R (2022). The health consequences of civil wars: Evidence from Afghanistan. BMC Public Health. DOI: https://doi.org/10.1186/s12889-022-14720-6

Mohammad Ajmal Hameed is the first author and has contributed 70% to the conceptualization of the paper, data collection, methodology, data analysis, results and discussion, and the completion, revision, and submission of the final draft of the paper. Mafiz Rahman and Rasheda Khanam each contributed 20% and 10%, respectively, to the development of the theoretical background and literature review, as well as technical inputs and editing.

Paper 3:

Hameed MA, Rahman MM, Khanam R (2022). Asymmetric effects of long-term war on human resource development in Afghanistan: Evidence from NARDL approach. Submitted to the Journal of Quality and Quantity.

The overall contribution of Mohammad Ajmal Hameed (the first *author*) has been 80% to the conceptualization, data collection, selection of methodology, data analysis, results and discussion, and the completion, revision, and submission of the final draft of the paper. Mafiz Rahman and Rasheda Khanam each contributed 10%, to the development of the theoretical background and literature review, as well as technical inputs and editing.

Paper 4:
Hameed MA, Rahman MM, Khanam R (2022). The validity of the Environmental Kuznets Curve in the presence of long-run civil wars: A case of Afghanistan. Submitted to Heliyon.

Mohammad Ajmal Hameed is the first author and major contributor. He has contributed 75% to the conceptualization of the paper, data collection, methodology, data analysis, results and discussion, and the completion, revision, and submission of the final draft of the paper. Mafiz Rahman and Rasheda Khanam each contributed 15% and 10%, respectively, to the development of the theoretical background and literature review, as well as technical inputs and editing.

Paper 5:
Hameed MA, Rahman MM, Khanam R (2022). Analyzing the consequences of long-run civil war on unemployment rate: Empirical evidence from Afghanistan. Sustainability, Volume 15, Issue 8. DOI: https://doi.org/10.3390/su15087012

The overall contribution of Mohammad Ajmal Hameed (the first *author*) has been 70% to the conceptualization, data collection, selection of methodology, data analysis, results and discussion, and the completion, revision, and submission of the final draft of the paper. Mafiz Rahman and Rasheda Khanam each contributed 20% and 10%, respectively, to the development of the theoretical background and literature review, as well as technical inputs and editing.

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A special thanks goes to my great, kind, and supportive mother, who sacrificed her life to give me the best support and opportunities to make my future. I was 5 years old when my father passed away, and my mother has played a key role in my life. The sacrifices she made throughout the years have made me the person I am today. It's not easy for a five-year-old orphan to have such a big and important achievement, so I would like to dedicate this thesis to my mother, who is the only supporter in my life. She sacrificed her life to make my future. Though I wish my dad was alive to celebrate this lifetime of happiness and achievements with us, I am sure he would feel proud to see his son at such a great stage of life.

I have faced lots of problems and challenges in my life, but I never gave up. I gave priority to my education and have worked hard to achieve my goals. On August 15, 2021, while the Islamic Republic of Afghanistan collapsed and the Taliban took control of Afghanistan, many Afghan families left their homeland and migrated to different countries. On August 24, 2021, my family and I also left our beloved country for Dubai, and on August 28, 2021, we travelled from Dubai to Australia. It was not an easy journey, we left everything and our destiny was not clear. There was much stress in starting a new life from zero but we never gave up, we always believed in replacing the challenges of life with opportunities. Though it was a struggle to achieve my goals for each single problem and challenge, I thank the Almighty Allah for the successful end of this tough journey. Finally, thank you to the Almighty, the most merciful and graceful, for being able to complete this thesis and achieve my lifetime goal.

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CHAPTER 1: INTRODUCTION

1.1. Introduction

The principal objective of the present thesis is to examine the varying effects (short and long term) of civil wars in Afghanistan on the economy, environment, and human resource development using five specific socio-economic indicators (key variables of interest). These variables are economic growth, environmental quality, public health services, unemployment rate, and human resource development. The extent, nature, and magnitude of the effects of civil wars on the stated macroeconomic indicators will be measured to provide contextualized, specific, and accurate policy recommendations and build a solid quantitative foundation in the existing literature. As this thesis is by publication, the scope of its study has been expanded to produce five empirical articles using purely quantitative approaches. This thesis consists of three chapters. The first chapter introduces the background and purpose of the study, research objectives, questions and newly developed hypotheses, the rationale and importance of the study, the research design leading to the extraction of the articles and the achievement of the objectives, the types, nature, and sources of the data used, variables of the study, and the methodologies applied to analyze the data. The second chapter presents the conceptual framework, the theories underpinning the study, reviews of recent empirical studies, and the existing literature gaps in the literature. Chapters three to seven presents the published and under-review articles that have been collaboratively produced as part of the present thesis. Chapter eight presents the overall conclusion of the thesis, led by the key understanding of the concept of civil wars in connection with socio-economic predictors, the key statistical findings from chapter three to seven (the statistical findings obtained from the articles), the practical contribution of the present thesis, specific policy recommendations based on the findings and statistical evidence, limitations of the study, and avenues for future studies. A structured organization of the thesis is provided in more detail in Section “1.10. Thesis Organization”.

1.2. Background and purpose

War is a devastating phenomenon, destroying the economic, social, and technological infrastructure of a country, but its impact is further reaching than expected. Studies show that there is a direct and strong causal link between civil wars and the negative impact on civilians from various factors, such as a higher mortality rate, extreme hunger, lost social and economic development opportunities, lost human capital development opportunities, forced migration, and massive destruction (Kreif et al., 2022). War permanently damages the social, political, economic, and technological institutions, leaving the war-hosting nation with a substantial cost of reconstruction and a long period for rehabilitation, even if meritocracy and sufficient resources are made available. Thus, the consequences of civil wars are profound for social, economic, and technological development. Undoubtedly, war kills, but its negative impacts extend far beyond direct deaths and injuries (Huth, 2010). There is a large body of studies showing that civil wars have significant negative effects on macroeconomic indicators, such as GDP (gross domestic product) and trade balance (see, for instance, Abadie and Gardeazabal, 2003; Collier et al., 2004, Heger and Neumayer, 2021). Resulting from this latest disruption, further statistical proof has surfaced—for example, civil wars increase the economic cost of labor, worsen the productivity of human capital, and increase imports of goods and services relative to exports. As a result, if production facilities are lost due to perpetrated wars, the war-hosting country's economy becomes import-dependent.

Studies also indicate that most civil wars occur in relatively poorer societies. Early contributions to studies of armed conflicts within poor societies focused on economic deprivation, political exclusivity, and grievances as key motives, highlighting significant inequality and how groups may resort to revolt if they are dissatisfied with their current economic and political status relative to their ambitions (Mincheva and Gurr, 2013). Therefore, opportunities become greater for the insurgent groups when partakers can prosper, through stealing or by gaining power and control over the resources. Moreover, perhaps by scope, civil wars can start and develop as a result of factors that are external to certain nations. The participants in numerous civil wars are not usually limited to the nations where the majority of the fighting occurs. Insurgent groups routinely cross international borders, and relatives from different countries frequently take part in or support uprisings in other countries (Suder, 2006). For governments and the rebel groups, the position of international borders generates varied limits and opportunities. Technically, borders are only the lines in the sand, and from a strictly military standpoint, they are frequently and easily crossed by insurgent groups (Elayah and Verkoren, 2020). However, the legal demarcation of state sovereignty by boundaries makes it more challenging for governments to suppress insurgencies by rebel groups located in neighboring countries. Poor relations between countries may motivate governments to support insurgencies in rival countries, and civil wars may in turn promote military operations between them, for example, as a result of border violations or alleged insurgent support.

Afghanistan is a true representation of the longest civil war in the world, surpassing the civil wars in Vietnam (1955–1975) by more than twenty years (Gehrmann, 2019). Afghanistan is one of the few nations in the world that, despite political reconciliation following the terrorist attacks of September 11, 2001, and four decades of continuous war, is still impacted by unrest and under constant threat from bombings, assassinations, night raids into suspected insurgent homes, and other forms of violence. Furthermore, following the collapse of Afghanistan on August 15, 2021 and the resurgence of the Taliban with the reinstatement of the "Islamic Emirate" by overthrowing the "Republic of Afghanistan," after twenty years of international collaboration with direct engagement of the U.S. troops, it will continue to face critical political instability, economic growth challenges with increased insecurity, a growing number of civilian casualties, displacement of people from provinces to capital and major regional cities due to conflict and drought, forced capital flight, rapid brain drain and increasing reduction of human resources (Lambert et al., 2012). On the other hand, the long-term war had also created an open war economy, affecting Afghanistan and its surrounding neighboring countries and even the world. As a result, it has become not only the world's largest opium producer and a center for arms dealing but also supports a multibillion-dollar trade in goods smuggled from Dubai to Pakistan (Rubin, 2000), facilitating a criminalized economy that was financially supporting both anti-government insurgents and their adversaries and forming a significant threat to the economic and political sustainability of the country. From 2002 to 2021, based on the announcement of George W. Bush (the former US president) for the reconstruction of Afghanistan (Council of Foreign Relations, 2020), substantial development and reconstruction programs have been employed not only as a mechanism for post-war reconstruction, economic development, and political stability but also as a tool for counterinsurgency in Afghanistan (Beath et al., 2012). Although the total cost of the U.S. wars in Afghanistan against the insurgent groups amounts to $2.313 trillion (see Figure 2) to stabilize Afghanistan's security, the total number of Afghans killed was 176,000, out of which 46,319 civilians (see Figure 1), 69,095 military and police personnel, and at least 52,893 opposition fighters were killed. The death toll is possibly higher due to unaccounted deaths from disease, loss of access to food, drinking water, basic infrastructure, and other indirect consequences of the civil wars in Afghanistan. According to Pettersson et al. (2021), the death toll from civil wars in Afghanistan is higher than what is regularly reported with the exclusion of stated-based and non-state-based violence. The closest number indicates that 278,783 people were killed, while 263,681 deaths were caused by state-based violence and 4,146 deaths were caused by non-state violence in Afghanistan. It also notes that local and international organizations have recorded an additional 162,000 people who have been seriously injured in the fighting, adding that war violence, the resulting displacement of individuals from their homes, and destruction of the environment and public services have also contributed to an untold number of indirect deaths from malnutrition, disease, and lack of access to health care services in Afghanistan (Crawford, 2015). Afghanistan is one of the least developed countries, whose young, expert, and productive human capital migrates to different parts of the world every year. Unfortunately, this movement has taken an upward trend due to civil war, political unrest, economic downturn, social instability, and the loss of opportunities. The statistics show that about 2.6 million Afghans were immigrants in different countries around the world at the end of 2020 (Crawford, 2015). The trend of brain drains and forced migration of Afghans in 2021 has been on the rise due to the fall of the "Republic of Afghanistan" and the re-establishment of the interim government of the "Islamic Emirate" by the Taliban. In the first six weeks after the fall of the former regime in August 15, 2021, more than 124,000 people left Afghanistan during the evacuation operation, the majority of whom were experts and educated people; after that, tens of thousands of people left Afghanistan gradually to different parts of the world. The Afghan economy is also on the brink of failure due to the political isolation and the non-recognized government of the Taliban by the world community. The World Bank and IMF have ceased banking relations with Afghanistan, as a result of which the banking sector of the country is under extreme pressure and is close to failure (UNDP, 2021), while trade endeavors are limited to few neighboring countries.

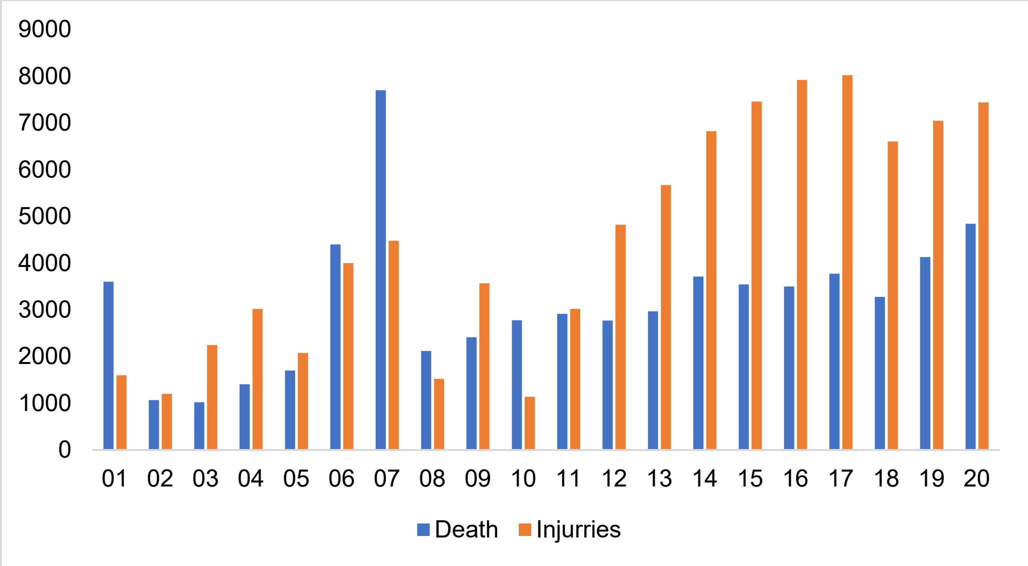

Figure 1 Number of civilians deaths and injuries from 2001–2020.

Source: Watson Institute, International and Public Affairs, Brwon University (2022).

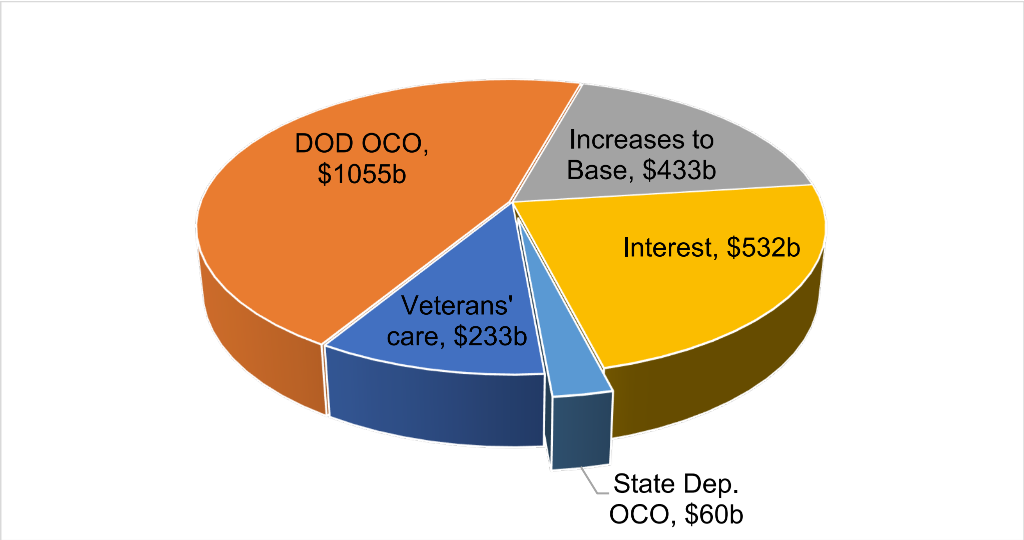

Figure 2 U.S. cost of war in Afghanistan from 2001–2021.

Source: Watson Institute, International and Public Affairs, Brwon University (2022).

Notes: DOD = Department of Defense, OCO = Overseas Contingency Operations, Dept. = Department. All costs are presented in billions of US dollars.

Furthermore, 97% of the Afghan population could plunge into poverty by the end of 2022, bringing it to the brink of universal poverty. The World Bank report indicates that the poverty rate has been 70.33% at the end of 2020 (see Figure 3 for more illustration). The unemployment rate has been significantly correlated with the slope of the civil war intensity in Afghanistan (see Figure 4). Theories also expect the civil wars to deploy specific resources relevant to military operations, increase consumption, and thus increase employment opportunities for a specific sector. The World Bank report shows that the unemployment rate has been standing at 11.68% since 2002, with insignificant volatility throughout the period from 2002 to 2020, standing at 11.73%.

This is the case for three different reasons. Labor-intensive industries include food and education. When spending the same amount, more money is spent on employing labor and less on purchasing tools and supplies. Additionally, more money is spent domestically on items like health care, military operations, and reconstruction projects, which led to more jobs in Afghanistan during the period of civil wars. Military personnel spend a greater percentage of their income within the country for personal security. Last but not least, the same amount of money employs more people in those non-military sectors because wages and benefits there are generally cheaper than for military contractors and troops (Abadie and Gardeazabal, 2003; Farrell, 2013; Hoeffler, 1998).

The deteriorating situation in Afghanistan as a result of the compressed economic performance, political isolation, and the ban on girls' schools and universities will necessitate additional capital outflows and human resources drain in the coming years. Poverty may reach its peak and unemployment rate will shift upward. Pursuant to that, due to low income, environmental quality will significantly diminish and the access to healthcare services will be limited to those who can afford it. As a result, a substantial and broad-based study is required to investigate the effects of such long-term and devastating civil wars on various socioeconomic indicators in order to determine the size and magnitude of effects and to facilitate appropriate policy interventions.

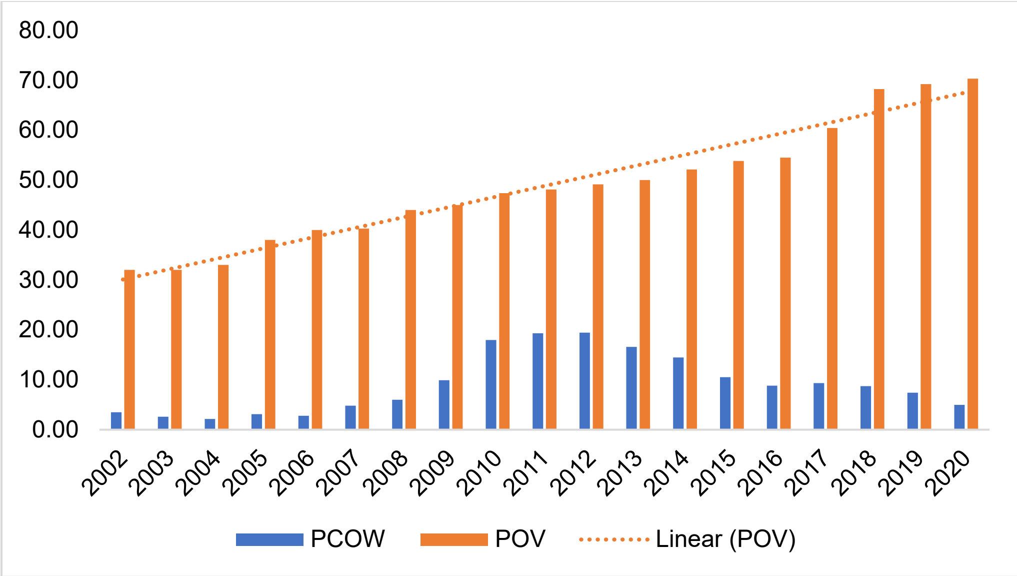

Figure 3 Poverty rate and per capita cost of war in Afghanistan from 2001–2020.

Source: World Development Indicators, World Bank Data.

Notes: PCOW = Per capita cost of war in millions of US dollars, UMPR = Unemployment rate in %.

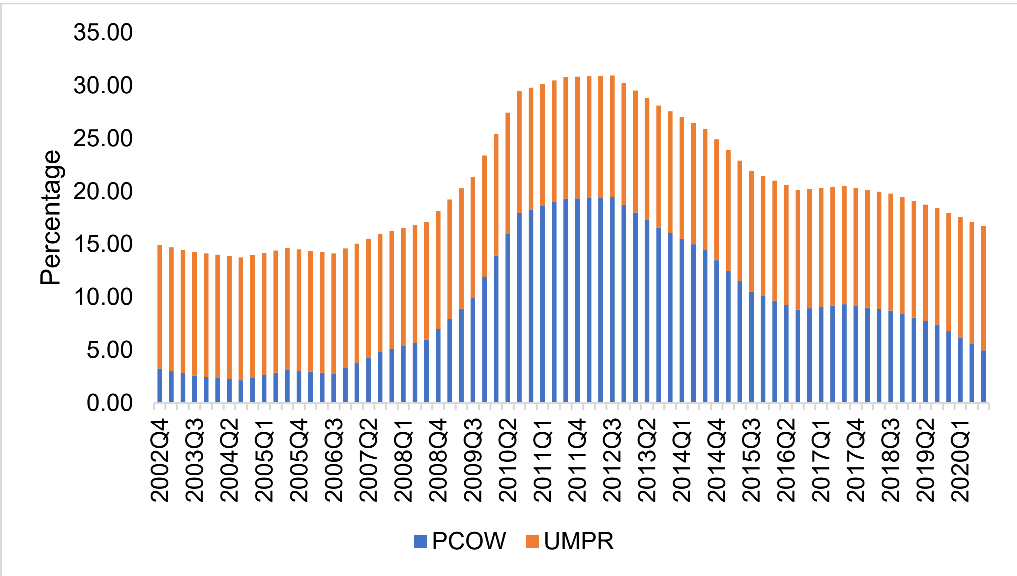

Figure 4 Unemployment rate and per capita cost of war in Afghanistan from 2002–2020.

Source: World Development Indicators, World Bank Data.

Notes: PCOW = Per capita cost of war, UMPR = Unemployment rate.

1.3. Problem statement

As discussed earlier, since 1989, Afghanistan has experienced multiple layers of complex effects due to the ongoing civil war. As a result, there have been unwanted effects on the economy, environment, and overall development of human resources, resulting in the loss of its infrastructure, economy, and human capital that were built during the first half of the 20th century. After the fall of the first round of the Taliban's regime, Afghanistan has been able to swiftly revive its growth with the direct contributions of the international community. Unfortunately, the prolonged and uninterrupted series of armed conflicts, violence, and political instability driven by civil wars have had detrimental effects on the reconstruction efforts, though billions of US dollars were inflexed both through on-the-budget and off-the-budget monetary assistance. Among all other sectors, public health, trade, banking, education, and the environment have been highly affected, while the measure of the extent and behavior of the effects require a comprehensive examination. Moreover, the resurgence of the rebel group (the Taliban) in 2005 and their newly modelled attacks on social infrastructure, schools, and colleges, along with an upward rise in the rate of civilian deaths, exposed Afghanistan to a higher risk of state failure with millions of people re-immigrating, a large outflow of capital, increased deaths through self-bombing and armed attacks both on militants and civilians, a larger number of injuries, and a rise in poverty. Such an unending human tragedy has drawn the attention of the media and reports reflecting the ongoing situation in Afghanistan, whereas academic debates have not engaged in such an important discussion. Thus, despite all the qualitative reports, papers, and articles written and published on the effect of war on different variables, there is no research underpinning the impact of long-term war in the country on different determinants using a quantitative approach in estimating and analyzing the relevant coefficients that can facilitate a literature foundation for a rational policy discussion in Afghanistan.

1.4. Objectives of the study

Considering the importance of the study, the key objective of the present review is to determine the effects of long-term war on three principal themes including the economy, environment, and human resources in Afghanistan during the period of resurgent civil wars from 2002 to 2020. To be more specific, Figure 5 illustrates the formulation of the objectives of the study. Considering the flow of objectives as shown in Figure 5, this study establishes a new foundation in the existing literature of war-socioeconomic indicators through the use of quantitative approaches for Afghanistan and other conflict zones with similar characteristics. Furthermore, upon the achievement of the objectives, it also extracts and presents specific policy recommendations to relevant policymakers.

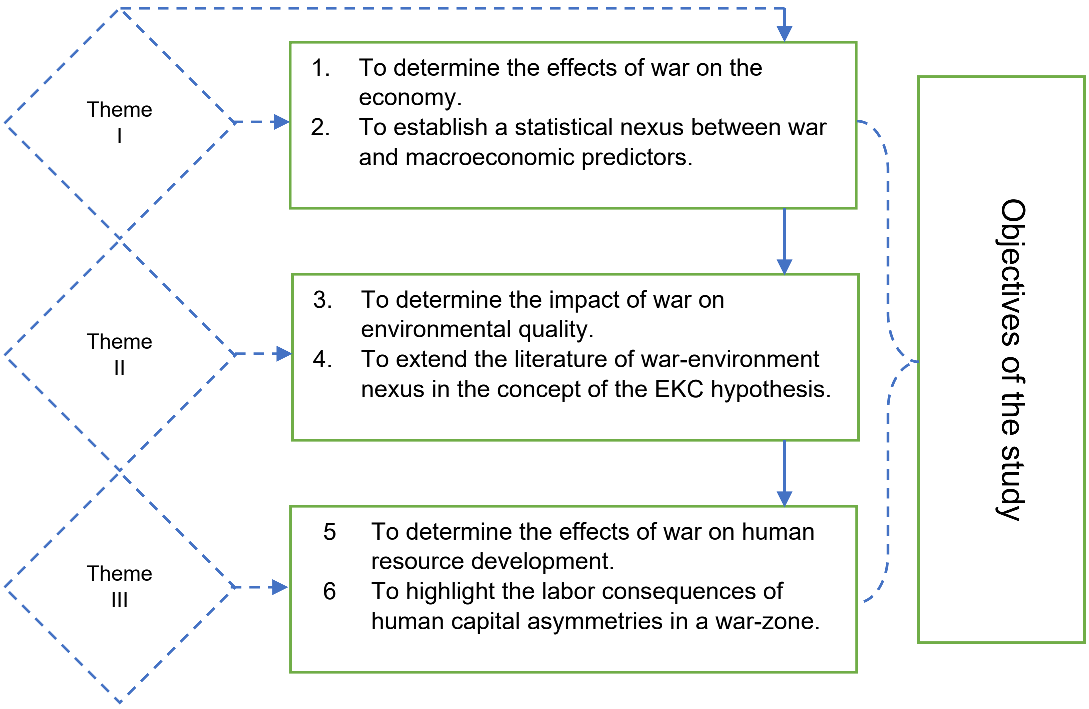

Figure 5 Objective formulation flow.

1.5. Questions and hypotheses

Methodically, it is important to instruct the study by formulating relevant questions followed by appropriate research hypotheses. As a result, the study formulates fifteen key questions in relation to the objectives. Questions one to three, with corresponding hypotheses H_1–H_3, are related to theme I, that is, the effects of long-term war on the economy. Questions four to six correspond with hypotheses H_4–H_6 and are developed to test the impact of a long-term war on unemployment rate, focusing on Theme I. Questions seven to fifteen, with corresponding hypotheses H_7–H_9, are relevant to theme II, developed to test the effects of long-term war on environmental quality. Questions ten to fifteen correspond with hypotheses H_{10}–H_{15} testing the effects of war on human resource development, and the public healthcare services in Afghanistan relevant to theme III. Figure 6 illustrates the formulated research questions and the relevant research hypotheses.

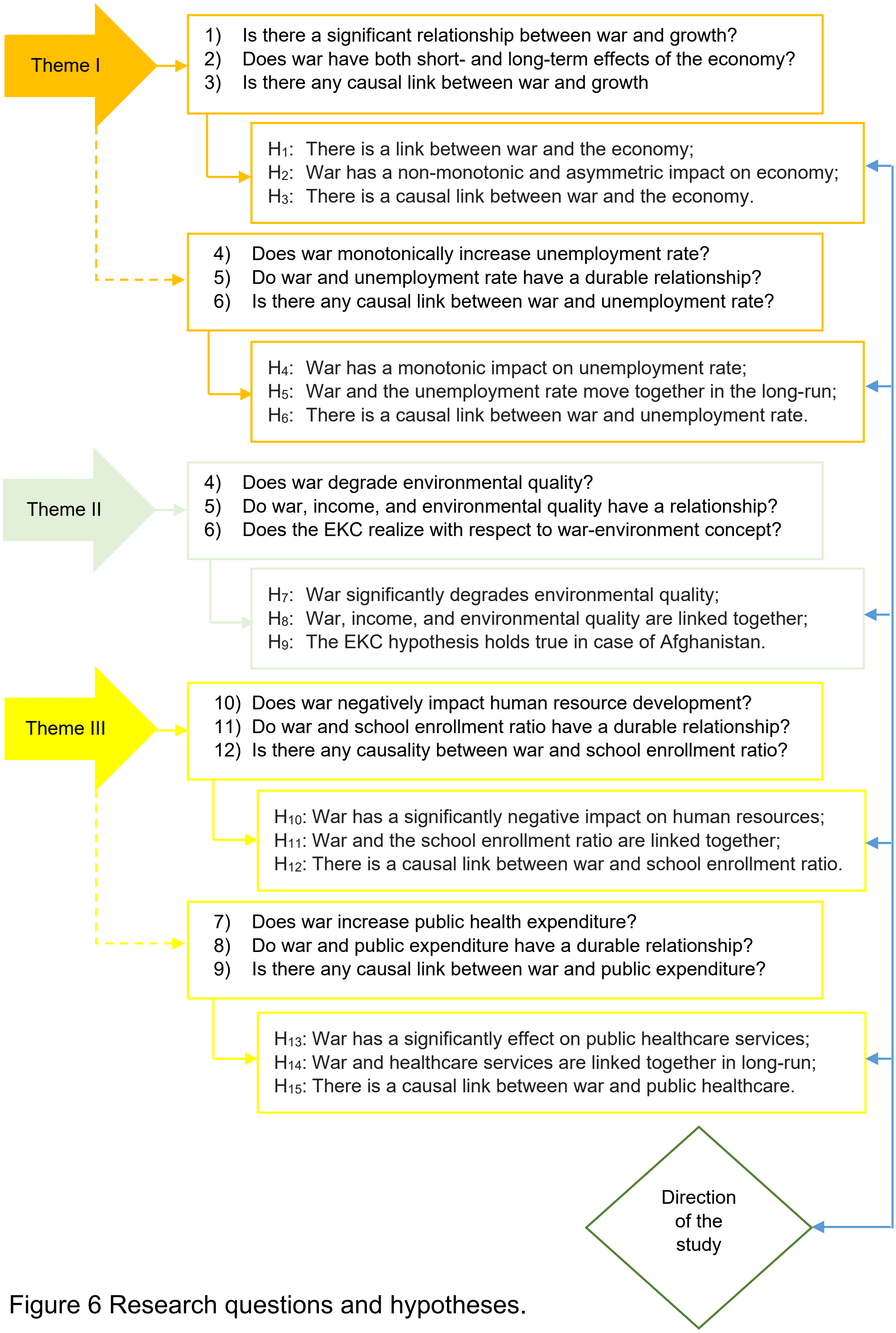

Figure 6 Research questions and hypotheses.

1.6. Rationale and importance of the study

War-driven consequences of socio-economic burden need critical discussion led by consistent and accurate results that can generate measurable policy implications. This study is one of its kind by nature, scope, and methodology, delving into the durable effects of civil wars in Afghanistan using a quantitative approach to support statistical findings upon which specific policy recommendations can be generated. It also controls for various macroeconomic indicators that may provoke the dependent variables employed as the input factors for the specific context of the war-driven effects, such as economic growth, public healthcare, human resource development, unemployment rate, and environmental degradation. Thus, this study is important from various aspects. First, it instructs policymakers on how to reduce the effects of long-term civil wars on specific socioeconomic indicators, as discussed previously. It offers appropriate and specific policy recommendations containing both macro- and micro-level interventions for both current and post-conflict environments in Afghanistan. Secondly, it takes a new step in the existing literature of civil wars by proffering quantitative modeling to estimate, measure, and determine the effects' size and behavior on economic and social development, though recent studies have only presented subjective judgments. Thirdly, almost all social and economic dimensions of war are addressed and considered by this study. The study of war may be a daunting task however its analysis is of importance because it allows the study to understand this phenomenon's historical impact in the context of Afghanistan, while the results can be generalized to other conflict-zones that share common nature. For critical economic and social science scholars, the study of war opens up a space for analytical reflection on it, an intellectual space to formulate strategies for avoiding, limiting, and countering the negative effects of war by viewing it through the various theoretical and empirical lenses provided by this study. Finally, the immediate effects of civil wars are terrible, including the devastation of infrastructure, the deterioration of economic and financial institutions, and the glaring loss of human life. Although the catastrophic short-term effects of war are obvious and brought by a general consensus, there is a clear disagreement over the war's long-term effects on social and economic development. War radically and irreversibly disrupts societal cohesion and economic growth. Wars are referred to as "development in reverse". Their legacy is the continuation of underdevelopment through the deterioration of regional and national institutions, the tearing apart of the social fabric, and the splintering of populations as a result of the removal of the interpersonal and communal trust that underpins norms and values and promotes interpersonal cooperation. This study adds to this phenomenon and statistically clarifies that civil wars have long-term effects and simultaneously move along with the degradation of social and economic inclusion.

1.7. Research design

This study has mainly focused on the achievement of the formulated objectives, led by the significant gaps in the existing literature about the impacts of long-term war on different macroeconomic indicators and the evolving discussions around them. The extracted studies—five research papers—are all designed in a sophisticated way to produce consistent and accurate results to generate specific policy recommendations. Each paper discussed a particular socioeconomic predictor and the effects of long-term war on it in the context of Afghanistan, a true sample of the longest war, using reliable datasets that are publicly available for reproduction and reuse by future scholars (Figure 7 illustrates the employed research design). Since purely quantitative techniques have been applied, it has required the study to develop at least fifteen new hypotheses to be tested in order to produce rational answers to the research questions. As a result, the research design focuses on hypotheses rather than research questions.

1.7.1. Paper 1

The article explores the asymmetric short-run and long-term effects of wars on the economic growth of Afghanistan using a non-linear assumption of the effects followed by the non-monotonic behavior of the intensity of the war and its effects on economic growth during the last two decades. Failing to reject Hyp_1 to Hyp_3 indicates that the long-term war in Afghanistan has both short-run and long-term effects, imposing a non-monotonic impact on the economy in the runs. Moreover, the determination of the direction of causality between war and the economy also highlights the greater force of the relationships between war and economic growth in Afghanistan.

1.7.2. Paper 2

The article has been designed to test hypotheses 4–6 to provide statistical insights into the war's asymmetries on the unemployment rate in Afghanistan. Again, it is of great interest to investigate the varying short- and long-term effects of Afghanistan's long-term war on the trend of the unemployment rate over the last two decades.

1.7.3. Paper 3

This article uses the conceptual framework of the EKC (Environmental Kuznets Curve) assumption to explore the environmental consequences of long-term war associated with the increase in per capita real income mainly caused by the injection of funds by the international community into different sectors of the economy during the war in Afghanistan. Thus, the non-rejection of Hyp_7 to Hyp_9 reveals the statistical facts on the effects of long-term impacts on the environmental quality in Afghanistan during the last twenty years. It also highlights whether a triangular nexus has been formed between long-term war, an increase in per capita real income, and environmental degradation.

1.7.4. Paper 4

This article is centered around the effects of long-term war on the human capital development in Afghanistan. Pursuant to that, Hyp_{10} to Hyp_{12} are developed and tested to highlight the scale and magnitude of the effects of war on human resource development both in the short-run and long-run. Two key assumptions have been made with respect to the effects of war on human resource development in Afghanistan during war time. First, based on the theoretical models, the human resource development begins with the schooling period and thus, this article will only focus on the enrolment ratio to schools as the base of the human resource development. Second, the trend of the data exhibits significant asymmetries. Therefore, it seeks to explore the non-linear effects of war on human resource development in Afghanistan.

1.7.5. Paper 5

The Grossman (1972) concept has been used to delve into the effects of long-term war on the public healthcare services in Afghanistan, though the linearity assumption fits in with the trend of the acquired datasets. Again, it seeks to provide clear insights into the behavior, direction—that is, the statistical causation and magnitude of the long-term war's effects on public healthcare services in order to generate specific and consistent policy recommendations with broad generalizability.

Finally, all five studies are interconnected in a way to contribute to the overall achievement of the objectives of the present thesis. Table 1 offers further details about the extraction of the themes, development of the objectives, formulation of key questions Hyp_1 to Hyp_{15}, and methods.

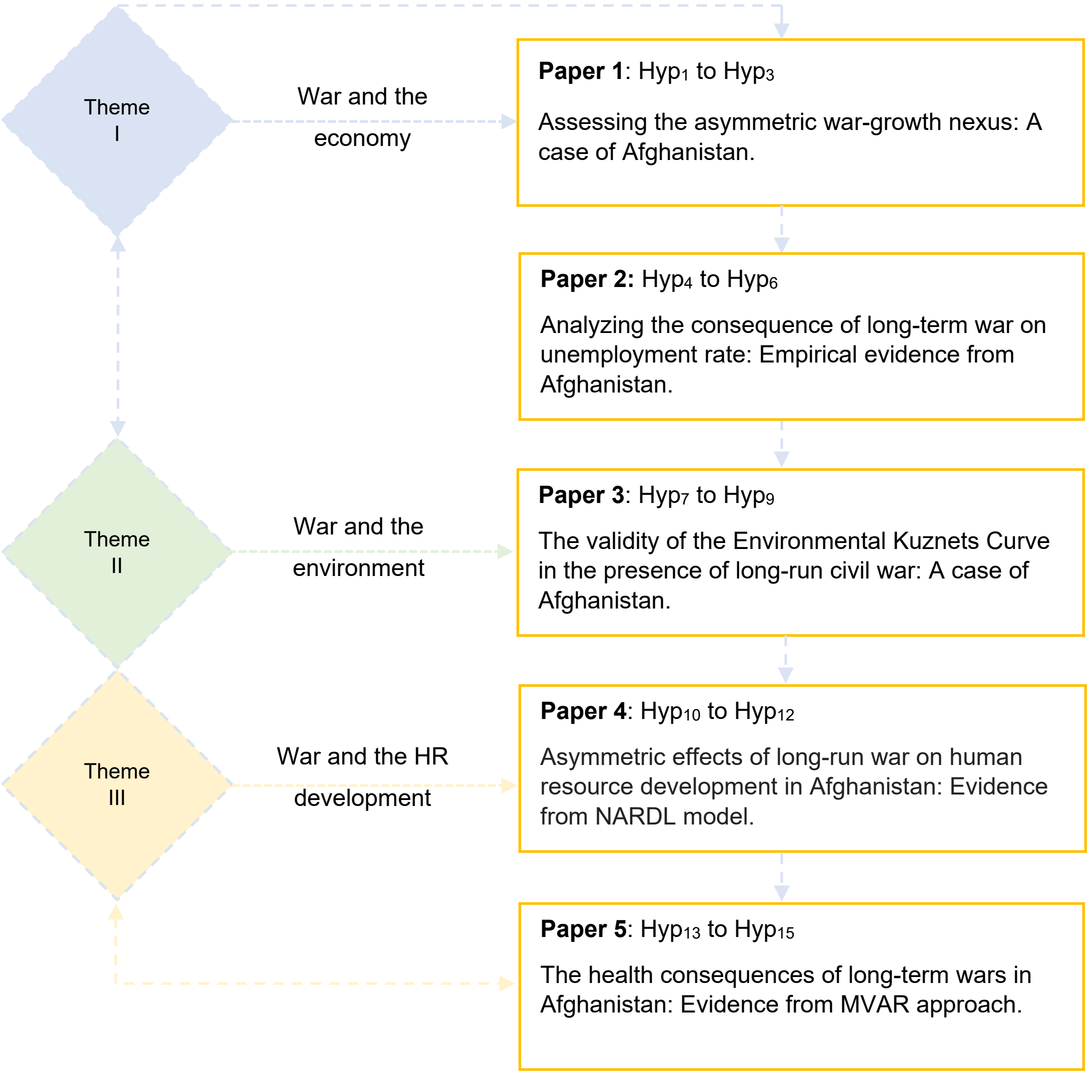

Figure 7 Research design; interconnectivity of the studies.

Table 1 The direction of studies towards the achievements of the thesis's objectives.

Themes (scope)	Articles	Objectives of the studies	Questions	Sources of Data	Method	Outcomes of the studies
Economy	I	RO1: To determine the effects of war on the economy. RO2: To establish a statistical nexus between war and macroeconomic predictors.	RQ1: Is there a significant relationship between war and growth? RQ2: Does war have both short- and long-term effects on the economy? RQ3: Is there any causal link between war and growth?	WDI and USDB	NARDL	1) Lon-run non-linear relationships exist between war and the economic growth. 2) War has both short- and long-term effects on economic growth. 3) There are bidirectional causality and multidimensionality nexus between indicators.
	II	RQ1: To determine the short-run and long-run effects of long-term war on the unemployment trend in Afghanistan. RQ2: To establish the causal links between war and the unemployment rate in Afghanistan.	RQ1: Does war monotonically increase unemployment rate? RQ2: Do war and unemployment rate have a durable relationship? RQ3: Is there any causal link between war and unemployment rate?	WDI and USDB	NARDL	1) Lon-run asymmetric association between war and unemployment. 2) War has both short- and long-term effects on unemployment rate. 3) There are bidirectional causality and multidimensionality nexus between indicators.
Environment	III	RO1: To determine the impact of war on environmental quality. RO2: To extend the literature of war-environment nexus in the concept of the EKC hypothesis.	RQ1: Does war degrade environmental quality? RQ2: Do war, income, and environmental quality have a relationship? RQ3: Does the EKC realize with respect to war-environment concept?	WDI and USDB	VECM	1) Cointegration exists between war and pollutant predictors. 2) The EKC assumptions have been realized. 3) There is unidirectional causality from war to environmental degradation.
Human Resource Development	IV	RQ1: To establish statistical nexus between war and the healthcare services.	RQ1: Does war increase public health expenditure?	WDI and USDB	MVAR	1) Long-run relationship between war and healthcare predictors.

		RQ2: To determine the quantitative effects of war on healthcare services. RQ3: To highlight the direction of causation between war and healthcare services.	RQ2: Do war and public expenditure have a durable relationship? RQ3: Is there any causal link between war and public expenditure?			2) War positively impacts per capita health expenditures. 3) Bidirectional causality nexus between per capita health expenditure and war.
	V	RO1: To determine the effects of war on human resource development. RO2: To highlight the labor consequences of human capital asymmetries in a war-zone.	RQ1: Does war negatively impact human resource development? RQ2: Do war and school enrolment ratios have a durable relationship? RQ3: Is there any causality between war and school enrollment ratio?	WDI and USDB	NARDL	1) Long-run asymmetric bound amid war and HRD. 2) Positive and negative shocks from war decrease and increase the school enrollment rate in the short and long runs. 3) The school enrolment swiftly reacts against the rise and fall in war. 4) Unidirectional causality nexus running from war to school enrolment rate.

Notes: WDI = World Development Indicators of the World Bank, USDB = United States Defense Budget, NARDL = Non=linear autoregressive distributed lags, MVAR = Modified vector autoregressive, RQ = Research questions, RO = Research objectives, EKC = Environmental Kuznets Curve, VECM = Vector error-correction model.

1.8. Data and variables

In terms of the study's population, Afghanistan was chosen for a number of reasons, two of which are critical. First, Afghanistan's war has outlasted Vietnam's by more than two decades, requiring two superpowers (Russia and America) and their allies to fight fundamentalism and extremism in order to avoid spillover effects on the rest of the world. This took more than four decades, though absolute victory is still in doubt. This war is the longest armed conflict in history, leaving behind substantial negative consequences in almost all sectors. Thus, the context is rational for a study that guides through a wide spectrum, although this study only focuses on three main themes. Second, gaps in the literature show that, despite the fact that Afghanistan's war has made headlines, very little attention has been given to delving into the effects of war on the nation in order to highlight policy implications and instruct informed policy formulation and adaptation.

In terms of the specification, this thesis has augmented all possible variables when modeling its statistical estimations for each of the themes (see Section 1.12 of Chapter One and Chapter Two). The datasets were specified as required by the nature, scope, and hypotheses developed for each study. The present thesis employed secondary datasets that are publicly available for reproduction and reuse by scholars. The main sources of data used were the World Development Indicators (WDI) sources that are relevant to the World Bank Group and are available at (https://data.world/worldbank/world-development-indicators), datasets from the International Monetary Fund (IMF) available at (https://www.imf.org/en/data), the United States Department of Defense Budget available at (https://www.defense.gov/), and the Asian Development Bank (ADB) available at (https://data.adb.org/).

The range of the time-series datasets spans from 2002 to 2020. This study used the techniques proposed by Azimi and Shafiq (2020) and Asogu (1997) or the linear interpolation of the annual series conversion into the quarterly series to obtain a larger number of observations for our statistical analysis because the statistical estimation of the studies required datasets with a high number of observations and the original source only provided annual data frequencies. This method is consistent with the empirical econometric literature found in Chipman (1964), Chow and Lin (1971), and Friedman (1962). The linear interpolation of time series data is a commonly known and widely used technique to convert the low-frequency observations into higher-frequency observations. This method is efficient and does not change the magnitude of the original data points (see also: Chipman and Lapham, 1995).

1.9. Methodology

The present thesis is composed of three main themes (studies), such as the effects of long-term war on the economy, the effects of long-term war on environmental quality, and the effects of long-term war on human resource development, resulting in the production and publication of five research articles. Using purely quantitative techniques, appropriate econometric theoretical frameworks are defined for each of the studies that are discussed in brief as follows:

Paper 1: The effects of long-term war on the economy

The statistical estimation of the first study, resulting in the publication of the first article, "Assessing the asymmetric war-growth nexus: A case of Afghanistan," used the exogeneous growth model of Solow (1956) as the initial base model:

$$\begin{aligned} EGC_t = \alpha + \eta_1 WAR_t + \eta_2 CAP_t + \eta_3 GE_t + \eta_4 FDI_t \\ + \eta_5 CPR_t + \eta_6 EC_t + \eta_7 INF_t + u_t, \end{aligned} \tag{1}$$

where *EGC*, *WAR*, *CAP*, *GE*, *FDI*, *CPR*, *EC*, and *INF* represent the economic growth, war, capital investment, government expenditure, foreign direct investment, credit to the private sector, energy consumption, and the inflation rate, respectively. Since the non-linearity assumption of the nexus between war and macroeconomic predictors is justified, it led the study to extend equation (1) and employ the following non-linear model to form the base model:

$$\begin{aligned} EGC_t = \alpha &+ \eta_1^+ WAR_t^+ + \eta_2^- WAR_t^- + \eta_3^+ CAP_t^+ + \eta_4^- CAP_t^- + \eta_5^+ GE_t^+ + \eta_6^- GE_t^- \\ &+ \eta_7^+ FDI_t^+ + \eta_8^- FDI_t^- + \eta_9^+ CPR_t^+ + \eta_{10}^- CPR_t^- + \eta_{11}^+ CE_t^+ + \eta_{12}^- CE_t^- \\ &+ \eta_{13}^+ INF_t^+ + \eta_{14}^- INF_t^- + u_t \end{aligned} \tag{2}$$

Here, all the variables are explained before, $\eta_t^+ (\eta_t^-)$ are the asymmetric shocks of the variables decomposed by positive (negative) non-linear effects of war and other predictors on economic growth in Afghanistan. The technical decomposition approach follows the asymmetric model proposed by Shin et al. (2014). Extracted from the first study, the effects of long-term war on the unemployment rate have been assessed. As a result, the second article "Analyzing the consequences of long-run civil war on unemployment rate: Empirical evidence from Afghanistan," has been developed. Continuing with the non-linearity assumption, drawing on the symmetries introduced by the existing literature (Urdal, 2004; DeFina, 2004; Azeng and Yogo, 2015; Park and Mercado 2016), if follows the concept of Honohan (2008), Cramer (2010), Jabir et al. (2017), and Janifar et al. (2020) to develop the base model to test the effects of long-term war on the unemployment rate as follows:

$$\begin{aligned} UMR_t = \alpha &+ \lambda_1^+ WAR_t^+ + \lambda_2^- WAR_t^- + \lambda_3^+ CFI_t^+ + \lambda_4^- CFI_t^- + \lambda_5^+ GDPG_t^+ + \lambda_6^- GDPG_t^- \\ &+ \lambda_7^+ PGR_t^+ + \lambda_8^- PGR_t^- + \lambda_9^+ FGE_t^+ + \lambda_{10}^- FGE_t^- + \lambda_{11}^+ INF_t^+ + \lambda_{12}^- INF_t^- \\ &+ \lambda_{13}^+ SER_t^+ + \lambda_{14}^- SER_t^- + \lambda_{15}^+ ROL_t^+ + \lambda_{16}^- ROL_t^- + \lambda_{17}^+ FDI_t^+ + \lambda_{18}^- FDI_t^- + u_t \end{aligned} \quad (3)$$

where all other variables are explained before, UMR is the unemployment rate, CFI is the composite financial index, GDPG is the gross domestic product growth rate, PGR is the population growth rate, FGE is the final government expenditure, SER is the secondary school enrollment rate, and ROL is the rule of law.

Paper 2: The effects of long-term war on environment

The conceptual framework of the third article under the second theme "The validity of the Environmental Kuznets Curve in the presence of long-run civil wars: A case of Afghanistan," employed the EKC (Environmental Kuznets Curve) assumption. It builds the base model with the initial concept of Dinda (2004) and extends it by incorporating the proposed modification of Apergis and Ozturk (2015), Lean and Smyth (2010), Hassan *et al*. (2019), Yilanci and Pata (2020), and Kyara *et al*. (2022). Therefore, the base model for estimating the effects of long-term war on environmental quality takes the following form:

$$\ln CO_{2t} = \varphi + \eta_1 \ln(Y_t) + \eta_2 \ln(Y_t^2) + \eta_3 \ln(EN_t) + \eta_4 \ln(TO_t) + \eta_5 \ln(POP_t) + \eta_6 \ln(INF_t) + \eta_7 \ln(WAR_t) + \eta_8 \ln(FDI_t) + u_t \quad (4)$$

where all other variables are described before, the environmental quality is presented by the CO_2 emission which is assumed to be positively influenced by per capita real income (*Y*) up to a certain limit, negatively influenced by squared per capita real income (Y^2) after a certain level (turning point), energy use (*EN*), trade openness (*TO*), and the population growth (*POP*).

Paper 3: The effects of war on human resource development

Study III led to the extraction of two research articles, "Asymmetric effects of long-term war on human resource development in Afghanistan: Evidence from the NARDL approach" and "The health consequences of civil wars: Evidence from Afghanistan." For the first article of the third study—that is, the effects of war on human resource development—it follows the conceptual model of Pesaran et al. (2001), extended with the non-linearity assumption of the series by Shin et al. (2014), while it also considers the stylized facts of the predictors' trend developed by Kisswani (2017) and Bist and Bista (2018) as follow:

$$SER_t = \alpha + \lambda_1^+ WAR_t^+ + \lambda_2^- WAR_t^- + \lambda_3^+ GDP_t^+ + \lambda_4^- GDP_t^- + \lambda_5^+ GEE_t^+ + \lambda_6^- GEE_t^- + \lambda_7^+ PGR_t^+ + \lambda_8^- PGR_t^- + \lambda_9^+ CMR_t^+ + \lambda_{10}^- CMR_t^- + u_t \quad (5)$$

For the second article of the third study, that is, the effects of war on public healthcare services, it adopts the conceptual model proposed by Grossman (1972) with an extension by war predictor as follows:

$$PHE_t = \phi + \varphi_1 WAR_t + \varphi_2 Y_t + \varphi_3 CHM_t + \varphi_4 CDR_t + \varphi_5 AGD_t + \varepsilon_t \quad (6)$$

where all other variables have been explained before, GEE and CMR are the government expenditure on education, respectively, in equation (5), while CHM is the child mortality rate, CDR is the crude death rate, and AGD is the age dependency ratio in equation (6). All employed models are tested against endogeneity issue, and their summaries are presented in “Notes, Table A1” on p. 201. The results indicate that our models do not suffer from the endogeneity problem. Since purely econometric techniques have been employed, the technical specifications are outlined in each of the articles (see Chapter Two for more details). Moreover, the choice of variables for each of the studies are based on the relevant theoretical frameworks, the developed hypotheses, and the existing literature. Figure 8 describes the flow of the thesis organization.

1.10. Thesis Organization

The present thesis has been organized into three main chapters. Chapter one is composed of fourteen sub-sections, presenting the purpose and background of the study, the problem statement, objectives, questions and hypotheses, rationale and importance of the study, conceptual framework, a review of the state of the art, gaps in the literature, research design, data and variables, and the methodologies employed. The second chapter contains five extracted research articles related to the thesis's three main themes, which are as follows:

- **Paper 1: (Published)**
  Hameed MA, Rahman MM, Khanam R (2022). Assessing the asymmetric war-growth nexus: A case of Afghanistan. PLOS ONE 17(8): e0272670. DOI: https://doi.org/10.1371/journal.pone.0272670.

- **Paper 2: (Published)**
  Hameed MA, Rahman MM, Khanam R (2022). Analyzing the consequences of long-run civil war on unemployment rate: Empirical evidence from Afghanistan. Sustainability, Volume 15, Issue 8. DOI: https://doi.org/10.3390/su15087012.

- **Paper 3: (Under review)**
  Hameed MA, Rahman MM, Khanam R (2022). The validity of the Environmental Kuznets Curve in the presence of long-run civil wars: A case of Afghanistan. Heliyon.

- **Paper 4: (Under review)**

Hameed MA, Rahman MM, Khanam R (2022). Asymmetric effects of long-term war on human resource development in Afghanistan: Evidence from NARDL approach. Quality and Quantity.

- **Paper 5: (Published)**
  Hameed MA, Rahman MM, Khanam R (2022). The health consequences of civil wars: Evidence from Afghanistan. BMC Public Health, Volume 23, Issue 154. DOI: https://doi.org/10.1186/s12889-022-14720-6

The third chapter contains an overview of the key findings extracted from the second chapter, suggestions, policy recommendations, limitations of the study, a practical contribution of the thesis to the body of existing knowledge, an avenue for future studies on the effects of war on the current and other macroeconomic predictors, and a comprehensive conclusion.

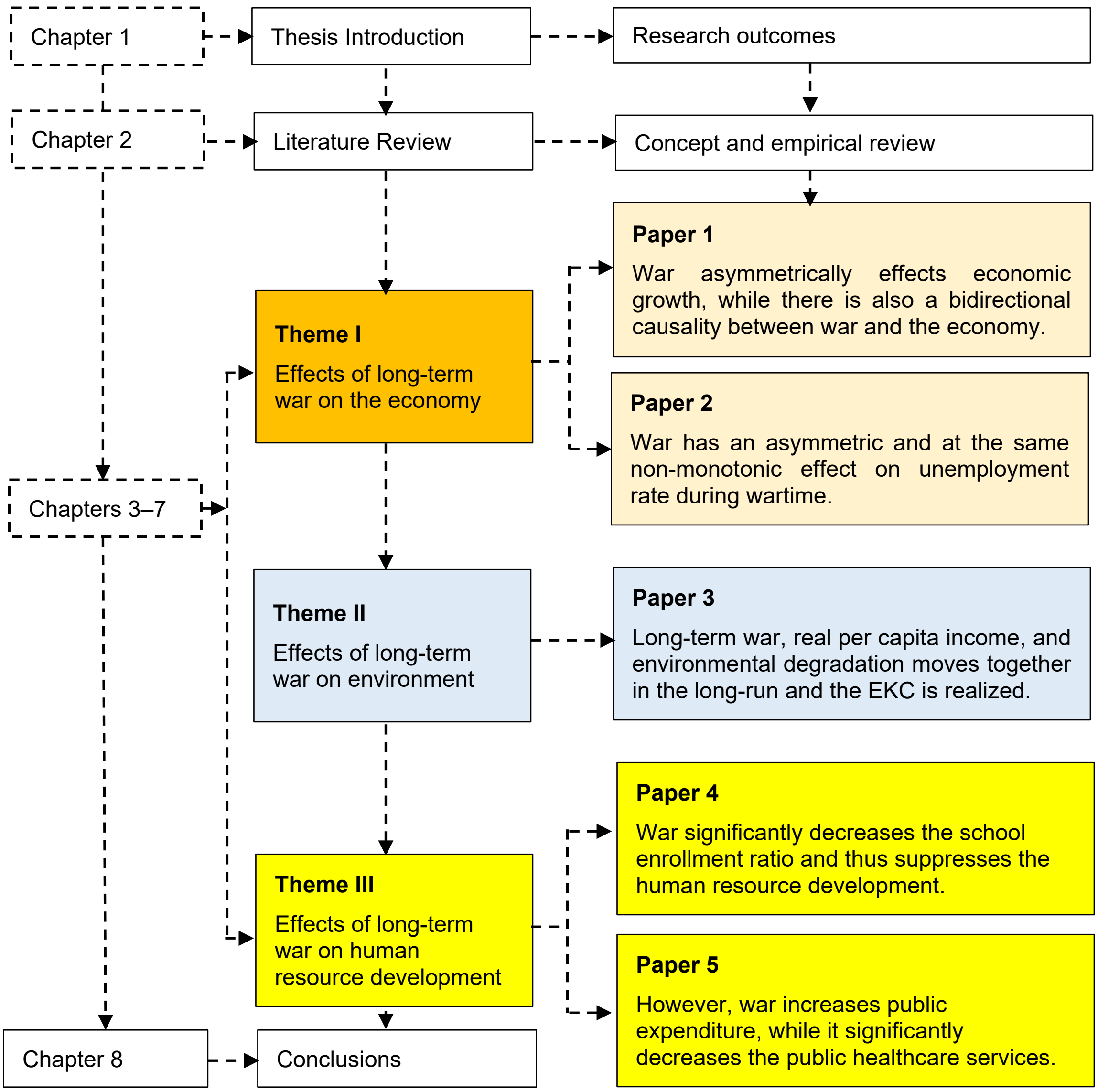

Figure 8 Flow-chart of the thesis organization.

CHAPTER 2: LITERATURE REVIEW

2.1. Conceptual framework

Any philosophical approach to the concept of war generally raises four ontological questions: what is war, what causes war, what is the relationship between war and human nature, and can war be morally justifiable? (Kersnovski, 2021) Conceptually, war is defined as a state of armed conflict between groups of people or governments that are seeking either political, economic, or other hegemonic benefits (Moosa, 2019), linked by aggressions of extensive duration and magnitude across a wide spectrum, resulting in a social and economic catastrophe in a war-hosting state (McNeill and Mueller, 1990; Yetim et al., 2021; Kersnovski, 2021). Among all other definitions, Arreguín-Toft (2001) offered a comprehensive definition, causes, and consequences of civil wars that occur between a government (the "on-power-side") and a rebel group (the "off-power-side"). It states that while the on-power-side defends its hegemonic power (political and economic power) and the off-power-side struggles to pursue dominance over the existing government in power. From the last two centuries, several theories have been developed to define war and explain its impacts on the nation. On the causation front, it exceptionally depends on the philosophical view on the determinism and free will. The cause of war is unimportant and unavoidable if a person's actions are out of their control. If, on the other hand, war is the result of human decision, there are three broad categories of causes to consider: biological, cultural, and rational (Hoeffler, 1998). This study only delves into the causes of war and the connection between human nature and warfare.

Though advances in technology have changed the mechanics of war from those of 1945, the concept of war has remained unchanged. Theories predict that the process of economic and social development begins with nurturing human capital, advancing and promoting financial institutions, supporting investments from both the public and private sectors, enhancing production capacity, and enhancing linkages of global trade endeavors through acts of policy and well-established connections (Chamarbagwala and Morán, 2011a; O'Brien, 2020; Sohn, 2014). Interstate wars significantly impact the development process both at macro and micro levels via several conduits, such as the destruction of economic, social, and technological infrastructures; death; internal displacement; and human capital flight, which are the common negative impacts of war on a war-bearing nation. According to Shank (2012), "negative unintended consequences occur either concurrently with the war or develop as residual effects afterwards, thereby impeding the economy over the longer term." According to classical growth theory, economic growth depends on capital, labor, land, and entrepreneurs. Economic growth will decrease or end due to an increase in population and the existence of finite resources, but modern progress has proven the classical growth theory wrong. Neoclassical growth theory says that economic growth is the result of three driving forces: labor, capital, and technology. Growth and social inclusiveness depend on driving forces; some argue that innovation and new technology do not occur simply by random chance. Rather, it depends on the number of people seeking out new innovations or technological advancements and how hard they are looking for them.

Furthermore, there is no general consensus on the duration of the effects of war on social and economic development, though there is general agreement on the slow economic outcomes. According to neoclassical growth theory with respect to economic outcome—factors of production—an economy swiftly recovers and returns to its steady state. Alternative models suggest that the return to a steady economic state in a post-conflict economy takes a long time because of the slow recovery of the production factors (Acemoglu, 2012; Surya et al., 2021), or that countries can get stuck in a low-level equilibrium where war and the loss of economic, financial, and social capital coexist (Shemyakina, 2011). Therefore, at minimum, three key factors may establish this contradiction. First, the duration of wartime in an economy and the leftover social and economic infrastructures; second, the size and scale of the impacts of war on social and economic institutions; and third, the nexus between the intensity and duration of war.

In a general theoretical sense, using plausible assumptions, a longer period of war causes higher negative impacts on economic and social institutions, with great negative moral effects on human capital. Sometimes the duration of war is shorter than expected, but the scale of its intensity imposes the same effects as in the first instance (Hall, 1979). However, these assumptions become invalid in an economy facing steady and low-scale war because, though war negatively effects economic and social institutions, swift recovery to a steady economic state is simultaneously facilitated. Contrary to this, the present study develops the fourth assumption—that is, the most volatile intensity and long-term war effects on social and economic development in a war zone such as Afghanistan. Thus, the fourth assumption, inspired by the general concept of war, informs the theoretical direction of this study.

2.2. Review of the state of art

Having described the theoretical background and determined the conceptual direction of this review, this section explores the empirical studies existing in the literature and reviews the state of the art. Specifically, it reviews the studies on the nexus between war and the economy, war and the environment, war and public healthcare, war and human resource development, and war and the unemployment rate. Lastly, it highlights the existing gaps in the literature to instruct further steps in the thesis.

Moreover, on the review front, it only focuses on the published articles and working papers published by reputable journals, while ordinary reports and analyses reflected by unreliable sources are not reviewed. The empirical literature widely documents the effects of long-term armed conflicts on various macroeconomic indicators. It shows the customary measurement of war effects in terms of money, cost of war, effects of war on economy, lost productivity, psychological effects of war, and the number of people killed, wounded, and displaced, while on the other hand, it rarely reports complex methodological studies to measure the effects of war on the economic performance, public healthcare, human resource development, environmental quality, and the unemployment rate. Although the trend of global war has been gradually declining in the past two centuries, the trend of civil war shows a rapid upward shift in the last four decades (Yum and Schenck-Hamlin, 2005; Gleditsch, 2004). The following sub-sections will review the empirical effects of armed conflicts on the specific macroeconomic dimensions forming the scope of the present thesis.

2.2.1. War and the economy

The existing empirical literature indicates that civil wars have initial and short-term effects on the economic performance of a nation, while there is no general consensus on the long-term empirical effects of war on the economy, though the residual effects of war have not been denied. For instance, Abadie and Gardeazabal (2003) investigated the effects of the terrorism outbreak on per capita GDP (gross domestic product) in Bosque in the 1960s. The authors found that significant terrorism outbreaks caused the per capita GDP to decline by ten percent compared to synthetic control regions without any terrorist attacks or violence. They also discovered that the cease-fire had a relatively positive impact on the stock performance of companies doing business in the Basque region.

Gupta et al. (2004) examined the fiscal effects of civil wars and terrorist attacks on economic growth and government spending using a panel of low- and middle-income countries from the World Development Indicators (WDI) sources of the World Bank Group. They analyzed 22 war episodes, showing that war is significantly associated with higher inflation and lower economic growth and has negative effects on tax revenues and investment, leading to higher government spending on defence. They also discovered that war has a significantly negative impact on economic growth through changes in the composition of government spending. The author provided statistical evidence that civil war has direct, significant effects on growth, independent of its impact on government spending.

Kang and Meernik (2005) employed a two-stage OLS (ordinary least squares) technique to test the effects of civil wars on economic growth for a panel dataset over the period from 1960–2002. The author discovered that although civil wars interrupt the process of technological innovation and human resource development in a nation, they also pose a significantly negative effect on economic performance, leading to a reduction in economic growth. Similarly, Lopez and Wodon (2005) discovered that in Rwanda, war and genocides have caused substantial losses in human lives while posing a remarkable decline in per capita GDP between 25 and 30 percent during wartime.

Gaibulloev and Sandler (2009) examined the effects of terrorism and armed conflicts on per capita income growth in some selected Asian countries for the period from 1970 to 2004. The authors indicate that transnational terrorist attacks have a significant growth-limiting effect. An additional terrorist incident per million people reduces per capita GDP growth by 1.5 percent in the region. Moreover, they show that in populous countries, additional attacks are needed to achieve such a large impact. Terrorist attacks reduce economic growth by crowding out government spending in defense sector. The authors argue that, unlike developing countries, developed economies can absorb terrorism without displaying adverse economic effects in the short-term.

Gates et al. (2012) investigated the impact of war on economic growth using quantitative approaches. The authors found that armed conflict increases the rate of poverty and hunger, negatively effects the education system both in terms of quantity and quality, increases the child mortality rate, and limits access to drinkable water in war-zone areas. They also found that a medium-sized war with at least 2500 battle deaths increases malnutrition by 3.3 percent, decreases life expectancy by almost 1 year, increases child mortality by 10 percent, and divest 1.8 percent of the population access to clean water.

Moreover, Camacho and Rodriguez (2013), Ali (2013), Kasidi and Mwakanemela (2013), Ganegodage and Rambaldi (2014), Ezeoha and Ugwu (2015), Serneels and Verpoorten (2015), Kutan and Yaya (2016), Aziz and Asadullah (2017), Bove et al. (2017), Torres-Garcia et al. (2019), and Hodler (2019), examined the economic consequences of armed conflicts in different war-zones, excluding Afghanistan. The review of these studies indicates that there is a general consensus on the negative effects of war on the economic performance of the war-hosting country, while they also add that armed conflicts have significantly negative effects on per capita real income, household consumption expenditure due to limited income, FDIs (foreign direct investments), local investments, capital and money market performance, the banking system, remittances, and the agriculture sector of the country.

Consistently, the latest findings in the literature show that Frolov and Bosenko (2020), Bataeva et al. (2020), Kešeljević and Spruk (2021), Heger and Neumayer (2021), and Bluszcz and Valente (2022) analyzed the effects of armed conflicts, financial, and legal resistance of the economy and enterprises during wartime, providing contextual examples from the Gaza Strip, Syria, Yugoslav, Latin America, African countries, Iraq, Syria, Donbass, and Ukraine, respectively. However, although the authors have employed different analytical methods and time periods, they all found that armed conflicts negatively affected the gross domestic product of the nations, leaving behind a residual negative impact on the economy and slowing a recovery. They also found that countries with lower conflict intensities had swifter growth than those with higher war intensities, arguing that the effects of armed conflict have been short-term with no statistical evidence of their long-term impact.

2.2.2 War and the unemployment

The establishment of relationships between war and the unemployment rate has been extensively discussed at macroeconomic policy levels, while empirical studies have not been sufficiently focused to delve into the matter. The available literature reports a few noteworthy studies like Rabiile's (2010), which focused on examining how civil wars affected the unemployment rate in Mogadishu, Somalia, in order to gauge how well the efforts of the Somalian government to boost job creation in a war-damaged economy worked. Descriptive statistics and correlation analysis were utilized to gather primary data from 171 out of 300 respondents using a self-administered questionnaire. The author came to the conclusion that there was a strong correlation between the unemployment rate and civil conflict, highlighting the significance of policy changes to attract foreign investment and reliable international initiatives to lower unemployment.

Moreover, Hooker and Knetter (1994) for a panel of states, Anyanwu (2002) for African countries, Abadie and Gardeazabal (2003) for the Bosque, Hamilton (2010) for 184 countries, Cramer (2010) for a large panel of developing economies, Miguel and Roland (2011) for Vietnam, Kecmanovic (2013) for Croatia, Galdo (2013) for Peru, Korkmaz (2015) for Mediterranean countries, Shemyakina (2015) for Tajikistan, and Vincent de Paul et al. (2020) for Sierra Leone investigated the effects of violence, armed conflicts, and civil wars—as relevant to their contexts—on the labor market and the unemployment rate. They used both qualitative and quantitative approaches and found that although war and armed conflicts create job opportunities for a specific target group (war participants), they have a significantly negative impact on the labor market and increase the unemployment rate. They also claim that younger women in conflict zones were more affected by the conflict than men and were 10% more likely to be employed than older women in less affected areas. These results show a changing pattern in the employment of women induced by civil war (see, also, Barceló, 2021).

The literature also indicates that Berman et al. (2011) advanced the concept of the opportunity cost in relation to government spending to restore social and political order, assuming that gainful employment of young men reduces their inclination to participate in war. They used Afghanistan, Iran, and the Philippines as the context of their study and employed a set of survey data for unemployment, attacks against governments and their allies, and civilian deaths. They conclude that there is no significantly positive link between the predictors. Specifically, no evidence was found to support the relationship between unemployment and the number of attacks killing civilians in all three countries. On the other hand, Mansoor (2021) has also examined the effects of war on the unemployment rate in the context of Afghanistan, using secondary datasets collected from a nationally representative household survey and a logistic regression model for analysis. The author employed cross-sectional datasets augmented with various socio-economic variables and found that the high unemployment rate is not statistically significant in impacting the war and the insecurity in Afghanistan on the one hand, while on the other hand, the rapidly rising unemployment rate in Afghanistan is not necessarily caused by the prolonged war. It implied that there were no relationships between war and the unemployment rate, while age, gender, education, marital status, geographical constraints, and sector-wise employment are statistically significant enough to impact the unemployment rate in Afghanistan.

2.2.3. War and the environment

Armed conflicts have been shown to worsen environmental degradation due to the use of military equipment and weaponry, resulting in the release of massive CO_2 emissions, the destruction of forests, and the harming of natural resources (Verwey, 1995). However, there are many other reasons affecting the environmental quality discussed in the existing empirical literature. For example, Perman and Stern (2003) for 74 countries over 31 years, Nasir and Ur-Rehman (2011) for Pakistan over the period from 1972–2008, Arouri *et al*. (2012) for Middle-Eastern and North African economies from 1981–2015, Kengni (2013) for Somalia, Shahbaz *et al*. (2013) for Romania from 1980–2010, Parlow (2014) for Myanmar over several years, Vita et al. (2015) for Turkey over 15 years, Khed (2016) for India from 1991–2014, Ozturk *et al*. (2016) for 144 countries from 1988–2008 for a panel of 144 countries, Alvarado et al. (2018) for 151 countries from 1980–2016, Liu et al. (2019) for China over the period of 1996–2015, Shahbaz et al. (2019) for high-income, middle-income, and low-income economies from 1970–2015, Saleem et al. (2020) for Asian economies from 1980–2015, Nutakor *et al*. (2020) for Rwanda from 1960–2014, İçen (2021) for D8 countries from 1972–2014, Rahman and Vu (2021) for China from 1971-2018, investigated the impact of various indicators, such as economic growth, armed conflicts, population density, energy consumption, and the use of disposable material on environmental degradation. Of interest is that armed conflicts, among all other predictors, have been shown to have significantly negative effects on environmental quality, increasing CO_2 emissions, damaging natural forests, and worsening public health conditions. It is also found that the effects of war on the environment continue long after the actual hostilities have ended. For instance, the hazardous by-products of explosives can cause long-lasting land and water damage.

Lijnzaad and Tania (1993) examined the effects of war on environmental quality during the Iraq-Kuwait war. The authors discovered that civil wars have a negative impact on environmental quality and thus the environment. Among all others, Qayyum *et al*. (2021) is an exceptional study, which has employed a set of data from 1984–2019 for South Asian economies, such as Afghanistan, Bangladesh, Bhutan, India, Nepal, Maldives, Pakistan, and Sri Lanka, to examine the consequences of armed conflicts and aggression between India and Pakistan. Though their dataset suffered from missing data for four out of eight countries, they found that the hostility left India and Pakistan with relatively higher growth in defence and military operations that were found significantly deteriorative to environmental quality. Finally, Hellen (2022) discovered that the war in Ukraine, an industrialized economy, is having a devastating effect on the country's environment. Considering the full-scale invasion of Russia, the war has caused incalculable human suffering. As a result of the bombardment of industrial infrastructure and chemical plants, leading to toxic gas leakage, the environment has been significantly damaged.

2.2.4. War and human resource development

Theories predict that civil wars have direct and swift impacts on human capital, while numerous empirical studies have also documented the negative effects of war on human resource management. For instance, Iden (1971) for Vietnam, Adeola (1996) in third world countries, Sunder (2004–2006) for developed and developing countries, Lai and Thyne (2007) for a panel of countries facing interstate wars, Gentry (2008) for developing countries, Catani et al. (2008) for Sri Lanka, Panter-Brick et al. (2009) for Afghanistan, Merrouche (2011) for Cambodia, Chamarbagwala and Morán (2011b) for Guatemala, Dabalen and Paul (2014) for Côte d'Ivoire, Buvinić et al. (2014) for war-effected zones, Diwakar (2015) for Iraq, Swee (2015) for Bosnia and Herzegovina, Gurses (2015) for war-effected zones, Gat (2015) for a general panel, Johnson (2017), Ouili (2017) for the Ivory Coast, Weldeegzie (2017) for Ethiopia, and (Maqbool, 2017) for Kashmir investigated the effects of war on human resource management using different proxies for human capital such as the primary school enrolment ratio, the secondary school enrolment ratio, public expenditure on education, and the higher education enrolment ratio. All these studies provided evidence that the primary effects of armed conflicts are on the education system of a country, causing a significant disruption to the teaching and learning processes in that country. They also discovered that armed conflicts have a negative impact on the enrolment ratio in education, with girls being more affected than boys. Armed attacks on schools and educational centers have also been shown to have negative moral effects on school enrolment ratio.

Furthermore, the most recent literature on the effects of war on human resource development shows the same findings as discussed earlier, forming a general agreement on the negativity of war on human capital. For example, Safranchuk et al. (2020) examined the perceptions of high-ranking participants and witnesses of the war in Afghanistan between years 1979 and 1989, using historical descriptive data. The authors present a holistic view, which they define as a patriotic perception and its elements, indicating the key peculiarity of the formation and support the use of interpretations of current international events to rationalize a positive valuation of the long-run war in Afghanistan.

Juárez et al. (2020) employed a far different concept in assessing the effects of war on human resources. They argued that lowering government expenditure on education due to budget reallocation from education to defence is significant for diminishing the process of human resource development in a war-hosting country. They also note that the flight of human capital is the most expensive cost of war in terms of both money and time in a country. Education, which is fundamental to human resource development, requires simultaneous investments in time and money, while the occurrence of war forces the reallocation of budget from education to military operations. Consistently, Moosa (2019) and Keji (2021) shows that post-war environments critically need human resources for swift reconstruction and boosting economic growth to help the state recover from the negative consequences of war (see, also, Dar and Deb, 2021).

Mayai (2022) used regional variation in exposure to violence to estimate the causal impact of the war on school enrolment as a proxy for gauging human capital in Sudan. Using the difference-in-differences method, the author found a statistically significant link between school enrolment rate and war. According to the author, schools in South Sudan's combat zones lost 18.5% of their entire enrolment. The decline in girls' enrolment is unconnected to the war, which is not surprising given the sociocultural constraints that have historically hampered female educational opportunities in South Sudan, such as gendered domestic responsibilities, early marriage, and out-of-wedlock pregnancies.

Abdulghani et al. (2022) examined the effects of war on education in Yemen using a structured interview for a narrative inquiry from schools' teachers and a semi-structured interview with four female and six male school teachers and leaders to answer the study questions. The authors found that displacement and discrimination, the use of children as war participants, the conflict of identities among children, destruction of children's physical and mental health, exploitation of education for financial benefits, the normalization of negative behaviors, and the destruction of teachers' dignity were the significant effects of war on education. Moreover, O'Brien (2022) has also investigated the effects of armed conflicts on the enforced human capital flight in Tajikistan using a series of logistic regressions. The author found that that war mortalities have insignificant impact on successive human capital flight, while the relationship between development and conflict is significant and negative.

2.2.5. War and the public healthcare

The existing literature on the relationship between war and public healthcare reports a large number of studies for various war contexts around the world. It shows that Ugalde et al. (2000) for El Salvador, Roberts et al. (2004) for Iraq, Giacaman et al. (2005) for Palestine, Betsi et al. (2006) for the Côte d'Ivoire, Devkota and Teijlingen (2010) for Nepal, Spiegel et al. (2010) for Rwanda, Urdal and Che (2013) for a world panel, Adegboye and Kotze (2014) for Afghanistan, Abbara et al. (2015) for Syria, Levy and Sidel (2016) for Iraq, Namasivayam et al. (2017) for Uganda, Daw (2017) for Libya, Kadir et al. (2018) for a world panel, Chukwuma and Ekhator-Mobayode (2019) for Nigeria, Liese (2020) for Afghanistan, and Bendavid et al. (2021) for a world panel, investigated the effects of armed conflicts on healthcare systems and outputs using both quantitative and qualitative approaches. The above cited studies provide significantly strong evidence on the negative effects of war on the healthcare system, emphasizing that armed conflicts not only destroy healthcare systems but also increase the mortality rate due to the limited access of war-effected people to basic healthcare services in war-torn societies. Some of the above studies have also found that armed conflicts reduce the number of health staff both in the private and public health sectors, which leads to the collapse of the healthcare system, public health infrastructure, reduction of private sector's interest in investing in healthcare services, and a lack of antiretrovirals.

Kotsadam and Østby (2019) and Lafta and Al-Nuaimi (2019) assessed the impact of war on healthcare services in Sub-Saharan African countries and Iraq, respectively. They found that local exposure to the intensity of armed conflict has a significantly negative impact on the mortality rate, giving rise to the risk of maternal deaths, whereas there were significant differences in the mortality rate in rural areas with an adverse report from educated areas. They emphasize that civil wars have severe effects on healthcare systems, increasing the numbers of morbidity, injuries, disabilities, mortality rates, and mental problems. Moreover, using the World

Development Indicators (WDI) sources of the World Bank Group datasets for 181 countries covering the years 2002–2019, Jawad et al. (2021) examined the direct and indirect effects of armed conflicts and violence on healthcare systems. Panel data regression analysis with fixed effect estimators was used to analyze the data. According to their findings, armed conflict and violence are strongly associated with ongoing global excesses in maternal and child fatalities, as well as declines in vital indicators showing a severe reduction in access to organized healthcare systems. Their findings also emphasize how crucial it is to safeguard women and children from the indirect negative effects of war, such as the deterioration of health systems and worsening economic consequences. On the other hand, using data that was routinely gathered from 597,675 medical consultations and 11,396 events, Ekzayez et al. (2021) used an observational method to test the effects of armed conflicts on the accessibility and availability of healthcare services in Syria from October 2014 to June 2017. The data was analyzed by the authors using panel data methodologies and fixed effects estimators, and they discovered that bombardments in Syria have a significant negative influence on both consultations and prenatal care visits. Additionally, they discovered that patients' access to healthcare services in Syria's war-torn regions was severely constrained, and conflict-related incidents had a detrimental impact on how often people used basic healthcare services. Last but not least, Meagher et al. (2021) conducted a thorough literature review on the effects of armed conflicts and physical violence on a variety of indicators, such as gender-specific barriers to accessing basic healthcare services, drinkable water, sanitation, education, and some other macroeconomic indicators, such as poverty rates, debt loads, and the unemployment rates. They found that armed conflicts and physical violence seriously affect healthcare services and socioeconomic indicators in war-affected areas, but gender-specific effects—the negative effects of war on women and children—were found to be relatively greater. The authors used multidisciplinary narrative reviews of the relevant literature to reach this conclusion.

2.3. Gaps in the literature

An in-depth review of the state-of-the-art reveals that despite numerous studies exploring the effects of civil wars and armed conflicts on various socioeconomic indicators (ignoring the massification of web reports on the war's devastating effects), there is still significant gaps in the literature about Afghanistan's long-term war and its impact on the variables of interest. The literature also indicates that most of the existing studies have relied on subjective judgments inspired by the common definition of war, emphasizing the short-term effects of war on the economy, environment, public health, poverty, unemployment, and other related predictors, whereas the examination of the long-term negative associations of war with the stated variables has been overlooked. However, some of the cited studies argue for the residual effects of civil wars on the growth and development of a war-hosting country. Furthermore, some of the sensitive societal dimensions attracted less attention from the scholars, such as the effects of civil wars on the environment, while an exception is given to the work of Qayyum *et al*. (2021), who overlooked Afghanistan's battle and examined the effects of armed conflicts on environmental quality, focusing on the war between India and Pakistan with a claim of its generalizability for South Asian countries. Although Mansoor (2021), Berman *et al.* (2011), Liese (2020), Adegboye and Kotze (2014), and Panter-Brick et al. (2009) have provided research into the effects of armed conflicts on some of the variables of interest, other variables, such as economy, unemployment rate, and environment are complete off-shoots of their studies.

On the other hand, despite noticing this gap, their methodology in highlighting accurate insights into the effects of war on the variables of their interest is also confounded because they have mostly employed descriptive methods. On the trend analysis of the effects of the war's intensity on macroeconomic indicators, almost all existing studies ignored this dimensional analysis that could have led to more accurate and consistent results. Finally, it also reveals that few of the studies have focused on extracting policy-oriented recommendations. This might be due to two reasons. First, the subjectivity of the judgements directed by the confounded analysis and the conclusions reached by recent studies. Second, the incomprehension of the scope of their studies, lacking generalizability and thus lacking rational policy recommendations (see, for instance, Liese, 2020 and Qayyum *et al.* 2021).

CHAPTER 3: PAPER 1 – ASSESSING THE ASYMMETRIC WAR-GROWTH NEXUS: A CASE OF AFGHANISTAN

3.1. Introduction

The first study of the present thesis examined the asymmetric impact of long-term civil wars on the economic performance of Afghanistan. Theoretically, civil wars have direct impacts on the economic growth of the war-hosting country, but literally, it is little known whether their impacts are significant, symmetric, or asymmetric. The results of such a study make it imperative for policymakers to take prompt decisions in order to either eliminate the war (a peace-building approach) if possible or minimize the effects of war on the economy. Thus, it led the study to produce the first article of the present thesis.

Article one's overarching objective was to investigate the effects of long-term civil wars on Afghanistan's economy, determining the scale and magnitude of the effects, and establishing a strong quantitative foundation of the war-growth nexus in the existing literature. As a result, three new hypotheses were developed. H_1: There is a long-run link between war and the economy; H_2: Long-run war has a non-monotonic and asymmetric impact on the economy in the short and long run; and H_3: In Afghanistan, there is an asymmetric causal link between long-run war and the economy. The overall results confirmed by complex statistical methods provided evidence of a long-run relationship between war and economic deterioration, while short-run effects were also evident. More interestingly, the results that instruct significant policy implications were the empirical confirmation of the asymmetric effects of war on growth and their causality relationships in Afghanistan.

3.2. Published paper

PLOS ONE

RESEARCH ARTICLE

Assessing the asymmetric war-growth nexus: A case of Afghanistan

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Abstract

This study explores the war-growth nexus in Afghanistan, a country where war-torn acts inform resource allocation. Employing the asymmetric ARDL, dynamic multipliers, and asymmetric causality techniques, the initial results confirm the existence of a long-run asymmetric nexus amid predictors. The asymmetric ARDL results indicate that a positive asymmetric shock from the per capita cost of war reduces per capita GDP—that is, economic growth—while a negative asymmetric shock from the per capita cost of war increases growth in the short and long run. Moreover, the findings reveal that per capita capital investment, per capita energy consumption, per capita household consumption, per capita remittance, per capita foreign direct investment, population growth, and inflation rate have significantly asymmetric effects on growth, highlighting non-monotonic impacts in scale and magnitude. The results of the asymmetric causality technique by bootstrap confirm that there is an asymmetric bidirectional causality between growth, per capita cost of war, per capita household consumption, per capita capital investment, and per capita foreign direct investment, while expanding only unidirectional causality with per capita remittance, population growth, and inflation rate. Based on the findings, the study concludes by offering relevant policy recommendations.

1 Introduction

Assessing the impact of war on the macroeconomic variables of a nation that has experienced a long-run armed conflict is a critical research topic that has recently gained popularity among academics, scholars, and policymakers. Undoubtedly, many nations have witnessed civil wars that resulted in the destruction of economies, infrastructures, and social development backwardness. Though understanding the effects of civil war is central to the developmental policies of post-conflict environments, little is known about their scale and magnitude [1]. The negative impacts of war occur either concurrently during the period of war or develop as enduring effects after it ends—thereby hampering the economy over the long term. On the one hand, statistical evidence shows that as a result of civil war, budgetary reallocation from physical and technological development to military operations swiftly impacts the economy in the short-run [2], while on the other hand, the destruction of infrastructure and human capital flight are the enduring negative impacts of war on an economy. In the context of Afghanistan, rising military spending is an opportunity cost, diverting funds that could otherwise be spent

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Abbreviations: ADF, Augmented Dickey-Fuller; AIC, Akaike information criterion; ARDL, Autoregressive distributed lags; GDP, Gross domestic product; GFCE, Per capita final household consumption expenditure; HQIC, Hannan-Quinn information criterion; INR, Inflation rate; NARDL, Non-linear autoregressive distributed lags; PCCE, Per capita capital investment; PCEC, Per capita energy consumption; PCOW, Per capita cost of war; PFDI, Per capita FDI; PGDP, Per capita gross domestic product; PGR, Population growth rate; PP, Phillips-Perron; QLD, Queensland; SIC, Schwarz information criterion; WB, World Bank; WDI, World development indicators.

on essential public services, such as state-building, education, health care, private sector development and promotion, and the development of infrastructure for its citizens and businesses to ease economic growth. Because fewer fiscal revenues limit the Afghan government's ability to offer these fundamental public services to its citizens, financial losses add to the conflicts of humanitarian consequences. This loss appeared to be significant in Afghanistan and resulted in greater economic depression and a steady state failure [3]. According to the International Monetary Fund [4], the long-run war in Afghanistan lowered yearly national income by roughly 50% in 2016. This amounts to nearly 70 billion Afghanis (1 billion US dollars) and is based on the level of violence in 2005.

Moreover, in a war-state economy, governments are hesitant to restrict monetary policies such as tax rises or subsidies on commodities since such regulations will indeed bring home the instantaneous wars; as a result of the government's unwillingness or inability to interrogate its politics straight with current war costs, price pressures are likely to increase. Djankov and Reynal-Querol [5] argue that poverty has a causal relationship with public support for insurgent groups and therefore with the feasibility of this form of spending. Most aid spending by governments aiming to restore the balance of power is predicated on the opportunity-cost notion of diverting prospective employees, they claim. The theory goes that unemployed young people are much less likely to engage in political violence, establishing a link between unemployment and war in areas where insurgent groups are active. Therefore, its continuity entails several negative consequences for the overall economic performance in several ways. First, in most respects, the government declines spending in all sectors except military operations. Second, household entitlements decline, resulting in a downward shift both in aggregate demand and aggregate supply. Third, the economy conforms to a war-torn society [6]. From an economic theory point of view, there is no general consensus on the duration of the effects of war on the economy. The neoclassical growth theory—factors of production—says an economy swiftly recovers and returns to its steady state after the war ends. Alternative models suggest that the return takes a long time because of the slow recovery of the economy [7] and [8], or that countries can be stuck in a low-level equilibrium where war and loss of production factors coexist [9]. At minimum, two key factors may establish this contradiction. First, the duration of wartime in an economy and the leftover social and economic infrastructures; second, the nature of the data and variables augmented in the analytical models. Empirical studies found that slow economic growth and low per capita incomes are robustly connected to civil war in an economy (see, for instance, [1]). Again, there is no general consensus on the most effective policies to avoid conflicts or endorse postwar repossession. The present study, which is based on country-specific data—Afghanistan, assesses both the concurrent and enduring effects of war on the economy, following the fundamental concept of war effects on economic performance. Therefore, this triggers the formulation of three key questions, among all others. First, do economic performance and the war effects—both concurrent and residual effects—move together? Second, what would be the scale and magnitude of the war effects on the economy, i.e., monotonic or non-monotonic? Third, is there any causality relationship between war and the economy? Providing consistent and evidence-based answers to these questions will not only help policymakers to consider the asymmetries of the war's effects on the economy when developing and implementing relevant policies; they will also assist future studies to build upon the literature.

Although there are numerous studies concerning the effects of war on various socioeconomic indicators in other countries, such as Libya [10–12]; Syria [13, 14]; Croatia [15, 16]; Sri Lanka [17–19]; Rwanda [2]; and Ukraine [20, 21]; yet studies are rare or even non-existent to articulate the scale and magnitude of the effects of war on the Afghan economy. This significant gap in the literature has caused two key shortcomings. First, the analytical reports and studies (see, for instance, [22–24]) have been qualitative, producing descriptive information on the status of war and its presumable impacts on the economy, leading to perplexing results and confounded conclusions. Second, the non-existence of comprehensive and complexed modeling empirical works, resulted in knowing little about the scale and magnitude of the effects of long-run war on the economic performance in Afghanistan. Thus, the existing gap—linked to the key questions—directs the study to develop and test three key hypotheses. H_1: There is a long-run link between war and the economy; H_2: Long-run war has a non-monotonic and asymmetric impact on the economy in the short and long run; and H_3: In Afghanistan, there is an asymmetric causal link between long-run war and the economy.

The present study is unique in context, method, and generalizability. It contributes to the existing literature on the war-growth nexus in four ways. First, to the best of the authors' knowledge, this is the first study in the context of a long-running war in Afghanistan, allowing quantitative analysis to determine the scale and magnitude of the effects of war on the Afghan economy. Second, it employs a set of well-known predictors of war and control variables selected by the PCA (principal component analysis) method to provide consistent and accurate estimation. Third, the asymmetric ARDL model is used in this article to test the effects of the predictors on the economy and compares their asymmetric significance with respect to the short- and long-run responses of growth to war. Fourth, it uses asymmetric causality techniques to delve into the causality nexus between predictors to find out any multidimensionality and interdependence between war and the economy over the period of this study. The critical findings of the study are also fourfold. First, it notes that the effects of war are asymmetrically bound with the economy in the long-run. Second, the findings confirm the asymmetric effects of war on the economy both in the short and long runs, while criticality suggests that effects are non-monotonic by scale in the runs. Third, corresponding with the theoretical concept, the non-monotonic impact of war describes higher intensity in the long-run than short-run effects. Fourth, during the period under study, the findings confirm bidirectional causality among the predictors.

The remaining parts of the study are structured as follows. Section two presents a brief literature review both on the theoretical background and the empirical impact of war on the economy. Section three presents the data and describes the variables used in the study. Section four explains the methodology used to analyze the data. Section five presents the results and discusses the findings. Section six concludes the study. Finally, the concluding paragraphs will discuss the policy implications of the findings on the impact of the long-run war on the Afghan economy and provide some relevant policy recommendations.

2 Literature review

The existing literature vastly defines war as an intense armed conflict between governments, states, nations, and groups of people who try to achieve certain economic, military, and political benefits that are not available through peaceful discourse [25]. The successful conclusion of an armed conflict may satisfy the desires of a party or a group of insurgents, but it leaves the war-effected nation with severe negative consequences, either concurrently or as residuals after the war ends [26]. According to Serneels and Verpoorten [2], critical gaps will remain in the academic literature to understand the clear and well-supported evidence on the economic consequences of war; what is clear is the substantial economic cost of rehabilitation and reconstruction in a post-conflict environment, along with other psychologically negative consequences that take a long time to recover. It is well-evident that war, terrorism, and organized crimes are interconnected with each other, implying the impact of war on enabling illicit enterprises. For instance, the long-run war in Afghanistan created an open war economy, affecting both the economic and political stability of Afghanistan and the surrounding regions. As a result, it has become not only the world's largest opium producer and a center for arms dealing but also supports a multibillion-dollar trade in goods smuggled from Dubai to Pakistan [27]. It further facilitated a criminalized economy that financially supports both anti-government insurgents and their adversaries, posing a significant threat to the economic and political sustainability of a country that is already unstable [28]. An extensive empirical literature indicates that the effects of war and armed conflicts on socioeconomic indicators have been critically analyzed in other economies. For instance, in the context of Sri Lanka, Arunatilake et al. [29] examined the effects of war on the economy and found that since 1983, the cost of war was approximately equivalent to Sri Lanka's GDP in 1996.

In a study of the economic repercussions of armed conflicts in the Basque country, Abadie and Gardeazabal [30] discovered that with the outbreak of terrorism in the 1960s, per capita GDP declined by 10% compared to synthetic control regions without violence. Furthermore, the authors discovered that stocks of companies doing business in the Basque region had a positive relative performance when the cease-fire became credible and a negative relative performance after the cease-fire ended. Kang and Meernik [31] examined the effects of war on economic growth using the two-stage ordinary least square method and a set of panel data from 1960–2002. They found that civil war has a significantly negative impact on economic growth and that it reduces the power of special interests, disrupts technological innovation, and human capital accumulation (see also, [32]).

Gates et al. [33] assessed the effects of war on economic growth and discovered that conflict has clear damaging effects on poverty and hunger, education, child mortality, and access to drinkable water. They further found that a medium-sized armed conflict of 2500 battle deaths would increase malnutrition by 3.3%, decrease life expectancy by almost 1 year, increase child mortality by 10%, and divest 1.8% of the population from access to clean water. Moreover, Camacho and Rodriguez [34] employed two panel data sets to test the causal effects of the armed conflict on the firms' exit in Colombia, using the fixed effect model for estimation. The authors found that one standard deviation shock would increase the number of insurgent and guerrilla attacks in a municipality and the probability of plant exit by 5.5 percentage points. The effect is robust for new manufacturing plants, with a smaller number of workers and low levels of capital. Similarly, Ali [35] examined the economic cost of the Darfur conflict and discovered that the cost of war has been equivalent to 171% of Sudan's 2003 GDP in Darfur, implying a clear cut of spending from other macroeconomic sectors. In addition to a substantial number of deaths and injuries, the war had a significantly negative impact on the country's economy during wartime.

Ganegodage and Rambaldi [36] employed the neoclassical endogenous theoretical framework to test the impact of civil war on Sri Lanka's economic growth and found that war has significantly adverse effects on the economy, proxied by GDP both in the short and long runs. They further show that high returns from investment in technological and physical capital do not explain sizable positive outwardness. Only short-term significant effects of economic openness on growth are found to be significant. Furthermore, Serneels and Verpoorten [2] examined the impact of civil war in Rwanda using a set of micro-data for the early 1960s and considered the endogeneity effects of the violence. The authors found that the households and localities that experienced the most intense armed conflict are lagging behind in terms of consumption six years after the armed conflict. The authors also discovered that returns from land and labor were significantly different between localities experiencing low and high intensities of armed conflict.

Kutan and Yaya [37] analyzed the effects of war on financial and economic risk in Colombia using a set of data spanning from 2002–2012. In the presence of a large-scale terrorist attack, the authors examined the abnormal returns in the stock market and found that abnormal returns in the stock market significantly responded to the terrorist attacks in Colombia. Their findings also show that such attacks increase the volatility of the abnormal returns while the overall economic performance suffers statistically.

Aziz and Asadullah [38] investigated the causality relationships and the impact of military expenditure on economic growth for the period 1990–2013 using a large panel dataset for 70 developing economies. The authors employed the generalized method of moments, fixed effects, and random effects models by regression. Considering the non-linearity assumptions, their findings indicate a significant effect of military expenditure on economic growth. While controlling for conflict, the effect of military expenditure conditional upon conflict exposure was also positive and statistically significant. Importantly, the authors found a joint effect of armed conflict and military expenditure on economic growth. Moreover, Bove et al. [39] explored the heterogenous effects of a civil war on the economy, proxied by GDP, using a case study of large panel data and a synthetic control method. The authors provide statistical evidence that civil war, on average, has a significantly negative effect on the economy, while little evidence was found to show its enduring effects. The authors also provide a counter-example of some economies that highlight positive reactions towards armed conflicts.

Torres-Garcia et al. [40] analyzed a set of panel data from 1980 to 2015 comprising 55 countries to test the nexus between aggregate savings rates and war intensity during the armed conflict period. Their results reveal that economies that have suffered some type of conflict show a 2.7% decline in the saving rate on average compared to those that have not suffered such conflicts. The authors show that if there is a higher intensity of conflict, the saving rates would decrease by 2.5% in war-torn economies compared with those having a lower intensity of armed conflict. They also highlight that a nonlinear nexus exists between saving rates and conflict duration, signifying that the effects of armed conflict on savings decrease with the laps of time. Similarly, Hodler [41] examined the effects of war and genocides on the economic development in Rwanda using the synthetic control method. Controlling for other predictors, the author found that the GDP in Rwanda declined by 58% in 1994, corresponding to a sharp decline in the per capita GDP by 31% considering the death of approximately eight hundred thousand people. The counterfactual results of the study show that Rwanda had a quick recovery, experiencing only short-run war effects, with evidence indicating that the agriculture sector of the country was less severely hit by the genocide than those of industry and service sectors.

Frolov and Bosenko [42] analyzed the financial and legal resistance of enterprises during wartime, providing contextual examples from the Gaza Strip and Syria. The authors discovered that, while war has a significant impact on economic performance, which declines during the war and thereafter until the economy recovers, enterprises have learned to exist in unstable conditions, forming new strategies and reactions to events. Moreover, in a comparative study by Bataeva et al. [43], who assessed the effects of war on investment attractiveness, the authors highlight that the effects of civil wars in Latin America, African countries, Iraq, and Syria significantly differ at macro and microeconomic levels. Throughout, the authors argue, conflict-zone economies substantially relinquish their investment attractiveness, resulting in the economy showing a sharp decline in capital investments.

Heger and Neumayer [44] evaluated the legacy effects of violence on the gross domestic product of the province of Aceh in Indonesia using subnational district-level data. They found that armed conflict had a residual negative impact on the economy, though a general peace dividend existed. They also provide evidence that districts with lower conflict intensity had swifter growth during 2005 than those with higher intensity. The authors argue that the effects of conflict have been short-term, with no statistical evidence of their long-term impact. Finally, Bluszcz and Valente [45] examined the causal impact of the Donbass war on the economy of

Ukraine using cross-country data spanning from 1995–2017. The authors employed a synthetic control method and found that the per capita GDP of Ukraine that has foregone due to the war rounded to 15.1% during the period from 2013 to 2017, while during the period from 2013 to 2016, the war-effected regions, such as Donetsk and Luhansk, show a causal effect of 47%.

The existing literature on the effects of war on economic growth is rarely straightforward, and anyone is likely to be overwhelmed by the number of pertinent studies that have been completed to date. This limitation is more highlighted by the fact that the analysis of the effects of war has only undergone qualitative and descriptive analysis by the publication of various reports referenced to international debates, while little attention is paid to this phenomenon as scholarly published documents in Afghanistan. A review of the existing literature offers some sense of what is known as war effects, but one of the consequences of armed conflict that is equally revealing is how little is known about the scale and magnitude of its effects on the socioeconomic predictors with any degree of certainty. Therefore, the scarcity of scholarly studies concerning the scale and magnitude of the war effects on the economy in Afghanistan and the war-torn countries sharing the same nature makes the present study important and relevant to fill the existing gaps in the literature.

3 Data and variables

As per the availability of data, this study uses a set of quarterly time-series data spanning from 2002Q3–2020Q4 relevant to Afghanistan's war and economic predictors. Based on two key motives, Afghanistan is selected as the context of this study. First, it is a true representation of history's longest war and an example of multiple state failures, much of which is the outcome of ideological battles. Second, there is a scarcity of comprehensive and quantitative studies that provide empirical insights into the scope and magnitude of the effects of war on the Afghan economy. The datasets have been collected from WDI (World Development Indicators), sources relevant to the World Bank and the US Department of Defense Budget FY2002–FY2020. The variables used in the study are consistent with the theoretical foundation and recent empirical studies and include (i) per capita GDP, (ii) per capita energy consumption, (iii) per capita final household consumption expenditure, (iv) per capita remittance, (v) per capita cost of war, (vi) per capita capital investment proxied by gross fixed capital formation, (vii) per capita foreign direct investments, (viii) population growth rate, and (ix) inflation rate. Variable (i) is expressed in hundreds of US dollars, variables (ii–iv) are expressed in thousands of 2015 constant US dollars, variables (v–vii) are expressed in millions of 2015 constant US dollars, and variables (viii and ix) are expressed as annual percentages. Table 1 provides complete information on the variables' descriptions, symbols, measurement, and sources from which they are collected.

Per capita GDP is used as the dependent variable to measure the variability of economic performance and growth, as well as inflation, to assess the extent of macroeconomic instability in the country due to the impact of war components [46]. For instance, theory predicts that war clutches the production factors and thus the aggregate output of an economy declines [47], so the economy may be squeezed during wartime. The cost of war is used to measure the amount of money spent by the United States in Afghanistan from 2002 to 2020. Due to lack of availability of the data, the cost of war presents aggregate data for Afghanistan and is not disaggregated by province and sector, although the war intensity has been higher in some provinces than in others during the period of this study. Furthermore, this proxy has two more features than other proxies used by recent studies. First, it allows a more accurate estimation than the number of people killed and injured. Second, it provides actual data on the amount of money spent on operating pure military operations.

Table 1. Description of variables.

Full name	Symbols	Measurement	Sources
Dependent variable			
Per capita GDP	PGDP	Thousands of 2015 constant US dollars	WDI, the World Bank Group
War variable			
Per capita cost of war	PCOW	Millions of US dollar	The US Department of Defense Budget FY02–FY18
Control variables			
Per capita final household consumption expenditure	PFCE	Millions of US dollars	WDI, the World Bank Group
Per capital energy consumption	PCEC	Thousands of US dollars	World Data (Energy consumption)
Per capita remittance	PCR	Thousands of US dollars	WDI, the World Bank Group
Per capita capital investment	PCCI	Millions of US dollars	WDI, the World Bank Group
Per capita foreign direct investment	PFDI	Millions of US dollars	WDI, the World Bank Group
Population growth rate	PGR	Annual (%)	WDI, the World Bank Group
Inflation rate	INR	Annual (%)	WDI, the World Bank Group

Notes: WDI: World Development Indicators, FY: Financial Year, US: United States. Sample size adjusted from 2002Q3–2020Q4.

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For the control variables, capital investment proxied by gross fixed capital formation measures the overall investment of an economy in the acquisition of assets and production infrastructure [48]. Since armed conflicts force governments to reallocate budgets, capital investment is assumed to swiftly react to the reallocation during wartime and thus affect the overall economic performance in a conflict environment. Both economic theories and empirical studies show that there exists a direct link between household consumption expenditures and economic growth [49] and it is used to control its effects on economic growth. Moreover, studies by Dogan and Turkekul [50], Magazzino [51], and Ma and Fu [52] suggest employing the energy consumption when testing the effects of other predictors on economic growth to avoid any potential specification bias. Based on the inflation-targeting regime of the central bank of Afghanistan, it seriously attempted to control the inflationary impact on economic growth during wartime. Therefore, along with the war predictors, it is important to capture the inflationary effects on economic growth (see, for instance, [53]. Finally, population growth rate is used to measure the annual change in the population and is employed to capture its effect on growth. Literature shows that population growth has significant effects on economic growth either directly or indirectly [54]. In sum, the variables have been thoroughly selected to provide consistent results and avoid omitted variable bias, though some recent studies employed different control variables, such as climate changes, CO_2 emissions, and financial crises. To validate the predictors, the present study computes the PCA (principal component analysis) to test the explanatory power of the variables and reports the results in Table 2.

Table 2 reports the specific computation by PCA, demonstrating that the first to nine components have explanatory powers ranging from 66 percent to 0.01 percent. This means that the first component accounts for 66 percent of the variation in the predictors, while the last component accounts for less than 1 percent. It concludes that the first component has the greatest explanatory power to translate the variations when compared to the other variables. It is important to note that the estimates in the fifth column are used to weight the war and control indicator fed into the subsequent regressions.

4 Methods

Based on the key objectives of this study, this section explains the methods used to assess the asymmetric effects of the long-run war on economic growth in Afghanistan, using the

Table 2. War-growth aggregation index.

Components	Eigen-values	Variance (%)	Cumulative Proportion (%)	First principal component
1	4.855	0.662	0.662	-0.175 [INR]
2	1.642	0.105	0.767	0.400 [PCCI]
3	1.055	0.093	0.860	-0.393 [PCEC]
4	0.741	0.074	0.934	0.306 [PCOW]
5	0.527	0.033	0.967	0.324 [PCR]
6	0.479	0.021	0.988	-0.018 [PFDI]
7	0.421	0.007	0.995	0.438 [PGDP]
8	0.408	0.004	0.999	-0.269 [PGR]
9	0.334	0.001	1.000	0.438 [PHFC]

Notes: Eigenvalues: (sum = 9, average = 1). Sample size adjusted from 2002Q3–2020Q4. [] presents the predictors' weigh. INR = Inflation rate, PCCI = Per capita capital investment, PCEC = Per capita energy consumption, PCOW = Per capita cost of war, PCR = Per capita remittance, PFDI = Per capita foreign direct investment, PGDP = Per capita GDP, PGR = population growth rate, PHFC = Per capita household final consumption expenditure.

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proposed model by Shin et al. [55], that is—the non-linear autoregressive distributed lags method. However, following certain econometric literature, the specification begins with prerequisite tests of stationarity, cointegration, and test of symmetries to facilitate appropriate model selection. Therefore, the following sub-sections explain the series of sequential tests:

4.1 Unit root tests

In time-series analysis, it is important to begin the analysis with determining the integrating order of the predictors to avoid any potential misspecification and fabricated results. In this faith, the Augmented Dickey and Fuller [56], Phillips and Perron [57], and Kwiatkowski et al. [58] methods are used. Augmented Dickey and Fuller (ADF) and Phillips and Perron (PP) methods are employed to test the null of H_O: $\delta = 0$ (non-stationarity) vs. H_A: $\delta \neq 0$ (stationarity), where the KPSS tests the null of $H_O : \sigma_\varepsilon^2 = 0$ vs. $H_A : \sigma_\varepsilon^2 > 0$. The ADF, PP, and the KPSS equations used in the study take the following forms, respectively:

$$\Delta x_t = \varphi + \eta T + \lambda x_{t-1} + \sum_{i=1}^{q-1} \delta_1 \Delta x_{t-1} + \varepsilon_t \tag{1}$$

$$\Delta x_t = \varphi + \eta t + \delta x_{t-1} + \varepsilon_t \tag{2}$$

$$x_t = \varphi + \delta(r_t) + \eta t + \varepsilon_t \sim WN(0, \sigma_\varepsilon^2) \tag{3}$$

where the change sign Δ is the first difference operator, φ presents the intercept, μ is the time trend coefficient, δ is the coefficient of the variable being tested for unit root, and ε presents the error term of the models 1–3. In Eq (3), (r_t) is the random walk process. To compute Eqs (1)–(3), the optimal lag length is automatically selected using the AIC (Akaike information criterion), SIC (Schwarz information criterion), and HQIC (Hannan-Quinn information criterion) frameworks.

4.2 Cointegration test

Considering the formulated hypotheses and to establish the long-run nexus amid war and growth predictors, this study employs the ARDL bound test of Pesaran et al. [59]. For brevity, let y_t, x_t, and z_t be a set of variables presenting economic growth, war predictor, and the control variables, respectively, the ARDL bound test to cointegration can be expressed as:

$$\begin{aligned}\Delta y_t &= \varphi + \xi_1 y_{t-1} + \xi_2 x_{t-1} + \xi_3 z_{t-1} + \vartheta k_t \\ &+ \sum_{i=1}^{p} \lambda_{1i} \Delta y_{t-1} + \sum_{i=0}^{q} \lambda_{2i} \Delta x_{t-1} + \sum_{i=0}^{q} \lambda_{3i} \Delta z_{t-1} + \varepsilon_t\end{aligned} \quad (4)$$

where all the variables are described before, φ is the intercept, $\lambda(\xi)$ presents the short-run (long-run) coefficients, ϑ is the trend regressor, and ε is the stochastic error term of the model. Eq (4) is cointegrated if it rejects the null hypothesis of $\xi_1 = \xi_2 = \xi_3 = 0$ in the favor of $\xi_1 \neq \xi_2 \neq \xi_3 \neq 0$ jointly or separately as $\xi_1 = 0$, $\xi_2 = 0$, and $\xi_3 = 0$, using F-statistics [60]. If the F-statistics are greater than the upper bound I(1) critical value of a desired level, the null is rejected, while it fails to reject the null if the F-statistics are less than the lower bound I(0) critical value. In case the F-statistics fall between the lower bound and the upper bound critical values, the test is inconclusive about the null hypothesis [61]. The use of ARDL bound test has various advantages over other common cointegration methods. First, it allows the predictors to follow mixed integrating orders. Second, it provides consistent and accurate results even in small samples [62]. Third, it allows the dependent and independent variables to augment different lags in computation.

4.3 Non-linear ARDL model

Assuming that all the indicators follow mixed integrating orders of I(0) and I(1) without any I (2) series, the study proceeds to estimate the asymmetric ARDL model to test the short and long-run effects of the war and other control variables on economic growth, using the non-linear ARDL model of Shin et al. [63]. The asymmetric ARDL model allows the decomposition of the partial sums of both the positive and negative squares to explore the non-linearities in the short and long-run effects. To initiate the asymmetric ARDL modeling, the present study modifies Eq (4) and represents it as:

$$y_t = \lambda_{1t}^{+} x_t^{+} + \lambda_{2t}^{-} x_t^{-} + \lambda_{3t}^{+} z_t^{+} + \lambda_{4t}^{-} z_t^{-} + \mu_t \quad (5)$$

where the variables hold the same meaning as defined in Eq (4), λ_t^{+} and λ_t^{-} present the positive and negative changes in x_t and z_t, respectively (see, for instance, [63]). The positive and negative changes are incorporated into the model by the function $x_t = x_t + x_t^{-} + x_t^{-}$ and $z_t = z_t + z_t^{+} + z_t^{-}$ utilizing the following process as:

$$\begin{aligned} x_t^{+} &= \sum_{j=1}^{t} \Delta x_j^{+} = \sum_{j=1}^{t} \max(\Delta x_{t,} 0), \quad x_t^{-} = \sum_{j=1}^{t} \Delta x_j^{-} = \sum_{j=1}^{t} \min(\Delta x_{t,} 0) \\ z_t^{+} &= \sum_{j=1}^{t} \Delta z_j^{+} = \sum_{j=1}^{t} \max(\Delta z_{t,} 0), \quad z_t^{-} = \sum_{j=1}^{t} \Delta z_j^{-} = \sum_{j=1}^{t} \min(\Delta z_{t,} 0) \end{aligned} \quad (6)$$

The linear I(0) combination in Eq (5) and non-linear partial sum of squares are as:

$$d_t = k + \vartheta_{1t}^{+} y_t^{+} + \vartheta_{2t}^{-} y_t^{-} + \omega_{2t}^{+} x_t^{+} + \omega_{2t}^{-} x_t^{-} + \omega_{3t}^{+} z_t^{+} + \omega_{4t}^{-} z_t^{-} + e_t \quad (7)$$

Thus, Eq (7) would be stationary if $d_t = I(0)$ and with asymmetric long-run cointegration rejecting the null of $\vartheta_t^{+} = \vartheta_t^{-} = \lambda_t^{+} = \lambda_t^{-} = 0$ in favor of its alternative $\vartheta_t^{+} \neq \vartheta_t^{-} \neq \lambda_t^{+} \neq \lambda_t^{-} \neq 0$. Eqs (5) and (7) may assume endogeneity and multicollinearity problems and that can be fixed by integrating the dynamic forms of the equations as:

$$y_t = \sum_{i=1}^{p} \eta un_{t-1} + \sum_{i=0}^{q} \left(\gamma_1^{+} x_{t-i}^{+} + \gamma_2^{-} x_{t-i}^{-} + \gamma_3^{+} z_{t-i}^{+} + \gamma_4^{-} z_{t-i}^{-}\right) + u_t \quad (8)$$

where η presents the autoregressive parameter, γ is the dynamic parameter of the model adjusting the dynamic format of cointegration. Thus, considering this, the asymmetric ARDL model used in the present study takes the following form:

$$\begin{aligned}\Delta y_t &= \rho y_{t-i} + \xi_1^+ x_{t-i}^+ + \xi_2^- x_{t-i}^- + \xi_3^+ z_{t-i}^+ + \xi_4^- z_{t-i}^- + \sum_{i-1}^{p} \phi_i \Delta y_{t-i} + \sum_{i-0}^{q} \lambda_{1i}^+ \Delta x_{t-i}^+ \\ &+ \sum_{i=0}^{q} \lambda_{2i}^- \Delta x_{t-i}^- + \sum_{i=0}^{q} \lambda_{3i}^+ \Delta z_{t-i}^+ + \sum_{i=0}^{q} \lambda_{4i}^- \Delta z_{t-i}^- + e_t\end{aligned} \tag{9}$$

where all the variables are defined before, $\xi_t^+(\xi_t^-)$ are the long-run non-linear, say, positive (negative) coefficients, $\lambda_t^+(\lambda_t^-)$ short-run positive (negative) coefficients. Moreover, the present study investigates that how in the long-run, the per capita GDP, therefore, economic growth responds to a dynamic asymmetric shock by the war and other control variables, using the dynamic multipliers approach. The dynamic multiplier is used to expedite the sequential growth element as it changes from milieus of the previous short-run dynamism and the early non-stabilities into a new equilibrium after a standard shock. The equation used is expressed as:

$$\begin{aligned}mh^+ &= \sum_{i-0}^{h} \frac{\partial(y_t)}{\partial(x_t^+)} = \sum_{i-0}^{h} \varphi_i^+,\ mh^- = \sum_{i-0}^{h} \frac{\partial(y_t)}{\partial(x_t^-)} = \sum_{i-0}^{h} \varphi_i^-, \\ mh^+ &= \sum_{i-0}^{h} \frac{\partial(y_t)}{\partial(z_t^+)} = \sum_{i-0}^{h} \varphi_i^+,\ mh^- = \sum_{i-0}^{h} \frac{\partial(y_t)}{\partial(z_t^-)} = \sum_{i-0}^{h} \varphi_i^-,\end{aligned} \tag{10}$$

where $mh^+(mh^-)$ are the asymmetric long-run coefficients and are empirically consistent when m tends to infinity and they are important to preserve the vital evidence responsible for the macroeconomic volatilities.

4.4 Asymmetric causality test

Finally, this study investigates the causal relationships among indicators. In this faith, it applies the asymmetric causality tests of Hatemi-J [64], which is based on Toda-Yamamoto's [65] approach. The study initiates building the modified vector autoregressive ($K + d_{\max}$) approach based on the optimal lag selected using the AIC, SIC, and HQIC frameworks and specifies the Toda-Yamamoto pairwise equations that can take the following forms:

$$\begin{aligned}y_t &= \varphi + \left(\sum_{i=1}^{k} \vartheta_{1t} x_{t-1} + \sum_{i=k+1}^{d_{\max}} \vartheta_{2t} x_{t-2}\right) + \left(\sum_{i=1}^{k} \phi_{1t} x_{t-1} + \sum_{i=k+1}^{d_{\max}} \phi_{2t} x_{t-2}\right) + e_t \\ x_t &= \delta + \left(\sum_{i=1}^{k} \omega_{1t} x_{t-1} + \sum_{i=k+1}^{d_{\max}} \omega_{2t} x_{t-2}\right) + \left(\sum_{i=1}^{k} \eta_{1t} x_{t-1} + \sum_{i=k-1}^{d_{\max}} \eta_{2t} x_{t-2}\right) + e_t\end{aligned} \tag{11}$$

where φ and δ are the intercepts, k is the lag length automatically selected via AIC, SIC, and HQIC methods, and ($K + d_{\max}$) is the number of cointegrating orders of the predictors. Thus, let the positive and negative shocks of each predictor in a cumulative form be $y_{1t}^+ = \sum_{i-1}^{t} \varepsilon_{1t}^+$ and $y_{1t}^- = \sum_{i=1}^{t} \varepsilon_{1t}^-$, $y_{2t}^+ = \sum_{i=1}^{t} \varepsilon_{2t}^+$ and $y_{2t}^- = \sum_{i=1}^{t} \varepsilon_{2t}^-$ with a permanent effect on the underlying indicator. Thus, $y_t^+ = (y_1^+, y_2^+)$ and $y_t^- = (y_1^-, y_2^-)$ vectors are employed to test for the asymmetric causality nexus in the following vector autoregressive model:

$$y_t^+ = v + A_1 y_{t-1}^- + \ldots + A_p y_{t-p}^+ + u_t^+ \tag{12}$$

where v, y_t^+, u_t^+, and A present the 2×1 vector of the intercept, 2×1 vector of the predictors, 2×1 vector of the error term, and the 2×2 matrix of parameters for k (k = 1, 2, 3, . . ., p) lag orders, respectively. Based on the Toda and Yamamoto [65] approach, the Wald test following asymptotic chi-squared distribution is applied to test the null of no asymmetric causal relationship between the variables. Moreover, to control for the abnormal and ARCH (autoregressive conditional heteroskedasticity) effects in the residual, the present study employs bootstrap simulation with 1,000 replications to find the critical values. Eq (12) is capable to capture the upside and downside causality nexus between economic growth and the war predictors, assuming that the economic growth is asymmetrically affected by the predictors and that it reacts more to both positive and negative shocks from the war. In such a context, common methods fail to capture the in-depth causal nexus between the indicators, while an asymmetric causality test accounts for different positive and negative asymmetrical causal effects of the predictors on the outcome variable—that is, economic growth [65]. Finally, the study computes some important post-estimation diagnostic tests to ensure the results are robust and accurate.

5 Results and discussions

5.1 Unit root analysis

The analysis begins with the unit root tests of the ADF, PP, and KPSS methods, using both constant and trend regressors. The estimation is based on the optimal lag length selection via AIC and SIC approaches. The results are reported in Table 3 and indicate that PCEC (per capita energy consumption) and PCCI (per capita capital investment) are level-stationary variables, implying that their *p-values* are significant for the rejected null of non-stationarity at 1% level by all three methods. The test statistics for the other variables, such as PGDP, PCOW, PFCE, PCR, PFDI, PGR, and INR, are insignificant to reject the null at the level; instead, all three methods reject it at the first difference. Therefore, the results reveal that PCEC and PCCI follow the I(0) series while the remaining predictors follow the I(1) series, leading the study to proceed with the estimation of the bound test to examine any long-run nexus among them. Moreover, the unit root results support the model specification discussed earlier, and thus, it computes both symmetric and asymmetric ARDL models, that are appropriate for mixed integrating orders of I(0) and I(1) without any I(2) series [66] and [67].

5.2 Cointegration analysis results

Next, to examine the long-run nexus amid growth, war, and control predictors, both symmetric and asymmetric ARDL bound tests are applied. The bound test estimation includes

Table 3. Unit root test results.

Variables	Augmented Dickey-Fuller		Phillips-Perron		KPSS	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
PGDP	-2.152	-4.486***	-2.018	-4.247***	0.969***	0.327
PCOW	-2.138	-5.852***	-1.998	-4.854***	0.931***	0.118
PFCE	-2.095	-3.634***	-1.871	-4.021***	0.874***	0.289
PCEC	-4.062***	-4.997***	-3.974***	-4.282***	0.344	0.801***
PCR	-0.266	-4.313***	-1.122	-3.898***	1.011***	0.302
PCCI	-3.840***	-4.991***	-4.011***	-4.447***	0.289	0.899***
PFDI	-1.465	-3.982***	-1.377	-4.099***	0.884***	0.149
PGR	-0.993	-3.849***	-0.826	-3.689***	1.128***	0.129
INR	-1.044	-4.038***	-1.031	-4.011***	0.861***	0.133

Notes:

***, **, and * present significance at 1%, 5%, and 10%, respectively.

PGDP = Per capita GDP, PCOW = Per capita cost of war, PFCE = Per capita final household consumption expenditures, PCEC = Per capita energy consumption, PCR = Per capita remittance, PCCI = Per capita capital investment, PFDI = Per capita foreign direct investment, PGR = Population growth rate, INR = Inflation rate, KPSS = Kwiatkowski, Phillips, Schmidt, and Shin. Critical values for KPSS at 1% and 5% are 0.739 and 0.463, respectively.

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Table 4. Bound test results.

Statistics	Symmetric ARDL bound test			Asymmetric ARDL bound test		
	Values	Critical values (1%)		Values	Critical values (1%)	
		I(0)	I(1)		(0)	I(1)
F-statistics	1.544	2.62	3.77	18.339***	2.73	3.90
t-statistics	-1.015	-3.39	-3.97	-21.044***	-3.31	-3.97

Notes:

***, **, and * present significance at 1%, 5%, and 10%, respectively.

K = 8 and implies the number of regressors augmented in the models.

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automatic lag selection of (p = 2, q = 2) for dependent and independent variables via AIC, SIC, and HQIC methods. The results are reported in Table 4 demonstrate that economic growth is only asymmetrically bounded with the war and control variables in the long-run (F = 18.339, t = -21.044) being greater than the critical values rejecting the null of $\rho = \xi_1^+ = \xi_2^- = \xi_3^+ = \xi_4^- = 0$ at the 1% significant level, while the results of the symmetric ARDL bound (F = 1.544, t = -1.055) are insignificant to reject the null of no cointegration, say, H_O: $\xi_1 = \xi_2 = \xi_3 = 0$ at either of the significant levels. This implies that the war-growth nexus is only asymmetrically bound in the long-run, which triggers further insights into their short and long run asymmetries (see, Table 5). The findings are related to the fact that it is reasonable to assume that long-run war and the relevant predictors are linked to economic growth and the tendency to move together in the long run. According to the theoretical foundation, long-term wars, such as those in Afghanistan that lasted more than four decades, imply two types of tie-ups, such as concurrent impact and residual effects, which move in tandem with socioeconomic indicators.

Based on the critical result of the asymmetric ARDL bound test reported in Table 4, this study computed the Wald statistics to test the null hypothesis of short-run and long-run symmetries. The results reported in Table 5 confirm that the non-linear relationships between economic growth, war, and control predictors by rejecting the null of short and long run symmetries, say, $H_O : \xi_t^+ = \xi_t^- \sim \chi^2$ and $H_O : \lambda_t^+ = \lambda_t^- \sim \chi^2$ at the 1% significant levels. The finding reveals that the war and other control variables' positive and negative partial sums of squares differently impact the per capita GDP—the economic growth in the short and long runs, while it also suggests exploring the scale and sign of the effects.

5.3 Asymmetric ARDL estimates

Considering the specified methodology and based on the outcome of the asymmetric long-run nexus and the rejected null of both short and long-run symmetries (see Tables 4 and 5), the study proceeds to estimate the asymmetric ARDL model using Eq (9). It further computes and presents the results of the dynamic multipliers using Eq (10) to delve into the asymmetric

Table 5. Wald test for symmetries.

Wald test statistics	Chi-squared statistics	*p-values*
Short-run symmetries, $\sum_{j=0}^{p-1} n_j^+ = \sum_{j=0}^{p-1} n_j^-$ test statistics	1309.478***	0.000
Long-run symmetries, $-\xi^+/\varphi = -\xi^-/\theta$ test statistics	18294.005***	0.000

Notes:

***, **, and * present significance at 1%, 5%, and 10%, respectively.

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Table 6. Asymmetric ARDL estimates.

Statistics	Model estimated: NARDL							
	$PCOW_t^+$	$PCOW_t^-$	$PFCE_t^+$	$PFCE_t^-$	$PCEC_t^+$	$PCEC_t^-$	PCR_t^+	PCR_t^-
Coefficients	-30.65***	10.37***	56.75***	-60.98***	-8.11***	2.66***	-0.72***	6.67***
t-statistics	-8.254	3.719	6.339	-4.841	-5.011	9.141	-4.155	4.833
p-values	0.000	0.009	0.000	0.000	0.000	0.000	0.000	0.004
	$PCCI_t^+$	$PCCI_t^-$	$PFDI_t^+$	$PFDI_t^-$	PGR_t^+	PGR_t^-	INR_t^-	INR_t^-
Coefficients	19.88***	-11.95***	0.88***	-2.87***	-21.42*	7.04***	-14.25***	4.07***
t-statistics	5.312	-6.011	4.901	-3.991	-3.452	8.133	-5.862	5.097
p-values	0.000	0.000	0.001	0.009	0.051	0.000	0.000	0.000

Notes:

***, **, and * present significance at 1%, 5%, and 10%, respectively.

PGDP = Per capita GDP, PCOW = Per capita cost of war, PFCE = Per capita final household consumption expenditures, PCEC = Per capita energy consumption, PCR = Per capita remittance, PCCI = Per capita capital investment, PFDI = Per capita foreign direct investment, PGR = Population growth rate, INR = Inflation rate, ECT = Error-correcting term. [+] and [−] present positive and negative partial sum of squares, respectively.

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effects of the per capita cost of war and other explanatory variables on the per capita GDP—that is, the economic growth in Afghanistan. The estimation of Eq (9) is based on the optimal lag length using the AIC, SIC, and HQIC frameworks, using the "varsoc" command. Table 6 reports the standard asymmetric ARDL estimates of both positive and negative partial sum effects, while Table 7 reports the short and long-run estimates of the asymmetric ARDL model. The results of post-estimate diagnostic tests relevant to the computation of Eq 9 are provided in the rare parts of Table 7.

The results reported in Table 6 provide important and interesting highlights. They indicate that a positive change in the per capita cost of war decreases the per capita GDP by $30.65 and a negative partial sum change in the per capita cost of war increases the per capita GDP by $10.37. In an empirical sense, as found by estimations, a positive change (negative impact) of war on the economy is higher than its negative change (positive impact), giving rise to an opportunity cost of $10.37 per capita foregone in the case of continued war in Afghanistan. In a theoretical sense, the result is consistent with the concept of the effects of armed conflict and violence on economic growth in a conflict environment (see, for instance, [68, 69]). In line with the practical survey conducted by Catani et al. [70] on the war in Afghanistan, the results confirm that the intensity of war significantly decreases economic and societal performance, while a decline in the intensity of war creates a temporal relaxation, allowing the nation to produce higher output. With respect to the control variables, the results indicate that all predictors asymmetrically effect economic growth. A positive partial change in per capita household consumption expenditure spurs economic growth by $56.75, while its negative partial change reduces the growth by $8.11. Intuitively, household consumption is widely regarded as one of the ultimate goals of economic activity, and the level of per capita consumption is frequently observed as a key indicator of an economy's productive success [71]. In comparison to theoretical expectations, the results confirm that a positive partial sum change in per capita capital investment and per capita FDI raises per capita GDP, while negative partial sum changes lower economic growth. This is also linked with the fact that economic growth swiftly responds to the advancement in technological, physical, and human capital accumulation. Neoclassical theory considers that economic growth and FDI are correlated, implying that increased FDI inflows inject different technologies, expertise, and foreign investment while

Table 7. Short-run and long-run asymmetric estimates.

Variables	Short-run effects			Long-run effects		
	Coefficients	**t-statistics**	***p-values***	**Coefficients**	**t-statistics**	***p-values***
$PCOW_t^+$	-10.099***	-6.371	0.000	-15.149***	-4.061	0.001
$PCOW_t^-$	23.436***	5.993	0.000	56.438***	6.229	0.000
$PFCE_t^+$	16.274***	11.450	0.000	23.275***	5.761	0.000
$PFCE_t^-$	-4.475***	-5.811	0.000	-24.771***	-8.001	0.000
$PCEC_t^+$	-10.937***	-4.755	0.000	-3.327***	-4.027	0.009
$PCEC_t^-$	2.142***	6.449	0.000	10.924***	7.111	0.000
PCR_t^+	-1.754***	-10.338	0.000	-2.971***	-7.854	0.000
PCR_t^-	4.833***	5.999	0.000	2.972***	6.997	0.000
$PCCI_t^+$	15.333***	4.559	0.000	49.017***	7.873	0.000
$PCCI_t^-$	-27.667***	-6.712	0.000	-81.533**	-12.081	0.000
$PFDI_t^+$	44.853***	6.683	0.000	35.551***	5.381	0.000
$PFDI_t^-$	-9.541***	-5.367	0.000	-11.891***	-4.644	0.003
PGR_t^+	-23.411	0.921	0.645	-20.318***	-5.881	0.000
PGR_t^-	16.984	1.834	0.553	11.842***	4.825	0.008
INR_t^+	-10.851***	-11.951	0.000	-16.023***	-4.784	0.000
INR_t^-	5.773***	6.671	0.000	10.988***	9.556	0.000
Diagnostic checks						
Adjusted r-squared	0.849				CUSUM	Stable
F-statistics [20, 50]	23.448***				CUSUMSQ	Stable
Portmanteau [chi^2]	0.861					
Breusch-Pagan heteroskedasticity test [chi^2]	1.009					
Ramsey RESET [F]	2.101					
Jarque-Bera [chi^2]	1.412					

Notes:

***, **, and * present significance at 1%, 5%, and 10%, respectively.

PGDP = Per capita GDP, PCOW = Per capita cost of war, PFCE = Per capita final household consumption expenditures, PCEC = Per capita energy consumption, PCR = Per capita remittance, PCCI = Per capita capital investment, PFDI = Per capita foreign direct investment, PGR = Population growth rate, INR = Inflation rate, ECT = Error-correcting term. [+] and [−] present positive and negative partial sum of squares, respectively.

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also bolstering economic activity and infrastructural developments, generating employment opportunities, and positively impacting living standards [72].

Moreover, the population growth rate and the inflation rate are found to have adverse asymmetric effects on per capita GDP, consistent with the findings of Ngoc [73], who also found that the inflation rate has an asymmetrically negative impact on economic growth in Vietnam, a post-conflict environment. Population growth also postulates adverse effects on economic growth of diverting resources from productivity-enhancing technologies and industries toward economic growth, which are assumed to have lower rates of return. Since substantial costs are required to offer certain services to citizens, rapid growth in the population posits a discouraging task for a war-torn society [74] and [75]. To provide more insights, the findings suggest delving into the short-run and long-run effects. Table 7 reports the results of the short- and long-run asymmetric ARDL model using Eq (9).

The results shown in Table 7 are consistent with the theoretical concept of the effects of war on the economy. The findings indicate that the war had a significant impact on the Afghan economy in both the short and long run. It shows that positive partial sum changes in the per capita cost of war, say, an injection of one million dollars into the per capita cost of war, decreases per capita GDP by $10.099 and $15.149 in the short and long run, respectively. It further reveals that negative partial sum changes in the per capita cost of war have positive effects on the economy. It implies that lowering the per capita cost of war by a million dollars raises per capita GDP by $23.436 and $56.438 in the short and long run, respectively. The results are consistent with most economic models predicting that military spending on armed conflicts diverts economic resources from productive uses such as consumption and investment, ultimately reducing economic growth and employment opportunities. Again, the empirical findings are consistent with those presented by Gupta et al. [76], Gaibulloev and Sandler [77], Gates et al. [33], and Ezeoha and Ugwu [78] on five key significant impacts of war on the economy, among all others. First, it is found that war is linked to lower economic growth and higher inflation rates, impeding the overall economic performance. This effect causes a double impact on the economy, such as rises in general prices of goods and a substantial loss in per capita income. Second, it has a negative impact on investment and taxation (see also, [79]), suppressing the economy by limiting the public revenue conduits and distortion in the process of the formal economy. Third, it leads to increased government spending on defense. Fourth, the war brings changes in the composition of government spending, causing a significant negative impact on growth due to substantial reallocation. This also implies that smaller investment shares in infrastructure, health, education, and technology and increased government spending on war cause the higher crowding-in of government spending to be the dominant influence.

For the control predictors, the results indicate that except for population growth, which does not pose short-run effects on the per capita GDP, all other predictors have a significant negative impact on the economy both in the short and long run. Specifically, the partial sum of squares of per capita final household consumption expenditure increases per capita GDP, while its negative partial sum of squares has an adverse effect in the short and long run. The results concur with the findings of Al Gahtani et al. [80] who also highlighted the rising importance of household consumption expenditure to growth-targeting strategies in developing economies. Moreover, the positive (negative) partial sum of squares of per capita energy consumption is found to decrease (increase) per capita GDP by $10.937 ($2.142) in the short-run and by $3.327 ($10.942) in the long-run, respectively. The results are consistent with those of Zhang et al. [81], Dar et al. [82], Sek [83], and Osobajo et al. [84], who statistically found the negative impact of energy consumption on growth for China and a panel of 77 economies.

Furthermore, the findings reveal that the positive partial sum of squares of per capita remittance adversely affects the economy while its negative partial sum of squares increases the per capita GDP in the short and long runs. The results are contrary to the expected sign of the coefficients. The positive effect of remittances on growth can be empirically achieved in secured economies (see, for instance, Adjei et al. [85]), while it may respond adversely to the effects of remittances in war-torn societies, as the results presented by Ahmed [86] for some African countries. The findings show that population growth's partial sum of squares reduces per capita GDP and that its negative partial sum of squares increases growth only in the long run. The findings contrast with Thornton's [87] findings and are consistent with Peterson's [88] study, in which the former found no evidence of a long-run relationship between the economy and population growth rate and the latter found evidence that population growth reduces economic growth. Moreover, the results presented in Table 7 demonstrate that the positive (negative) partial changes in per capita capital investment and per capita FDI increase (decrease) per capita GDP both in the short and long runs.

This implies that FDI promotes technology spillovers, human capital development, and a more competitive business environment. All of these factors foster economic growth, which is critical for alleviating poverty and raising living standards. The results are consistent with the findings of Hayat [89], Muse and Mohd [90], and An and Yeh [91], who also provided statistical evidence on the significant effects of FDI and capital investments on economic growth. Lastly, the results confirm the asymmetric effects of the inflation rate on the economy both in the short and long runs. It shows that in the short-run, a positive partial change in the inflation rate causes per capita GDP to reduce by $10.851, while its negative partial change increases per capita GDP by $5.773, noting that the long-run asymmetric effects are higher than the short-run.

The results of the asymmetric short and long-run effects of war and control predictors on per capita GDP are in line with the theoretical expectations, while they also indicate some important highlights that require further insights into the asymmetric effects of the predictors on growth. In this faith, the present study computes the dynamic multipliers, using Eq (10) to test the response of per capita GDP towards the temporal dynamics behavior of the per capita cost of war and other augmented predictors, considering the backgrounds invented by the short-run dynamics and the initial disequilibrium due to the shocks to growth confirmed by the results shown in Tables 4 and 5. The results of the dynamic multipliers are depicted in Fig 1 and demonstrate that the cumulative effect of the per capita cost of war on per capita GDP shows that the positive asymmetric shock from the per capita cost of war causes the per capita GDP to increase, while its negative asymmetric shock reduces the per capita GDP. The results are in line with the argument of Luca [92] on the wider spectrum of effects of war on the economy, but closely confirm the latest findings of Getzner and Moroz [93] relevant to the swift response of the economy to war in Ukraine. The results of the cumulative effect of per capita final household consumption expenditure indicate a counter-example, showing that growth does not significantly respond to the positive asymmetric shock of per capita final household consumption expenditure, while it positively responds to the negative shock. Moreover, the per capita GDP slightly responds to both the positive and negative asymmetric shocks from the per capita remittance, while it strongly responds to the per capita FDI. It reveals that the positive asymmetric shock from per capita FDI causes the growth to increase, whereas the growth decreases by an asymmetric negative shock from per capita FDI. The finding concurs with those of Asunka et al. [94] and Hobbs et al. [95], who also found the significant response of economic growth to FDI asymmetries. Despite the fact that the response of growth remains null to the asymmetric positive partial shock from population growth, it significantly reacts to the positive asymmetric shock from per capita capital investment. On the other hand, the significance of the growth response to the negative shock of population growth is short-term, while it becomes null and shows a decline in the long-run.

The results are statistically robust and valid, upon which the present study draws conclusions. The rare part of Table 7 reports the relevant diagnostic checks and demonstrates that the estimation does not suffer from serial correlation and heteroskedasticity problems, while it also indicates that the model is appropriately fit for purpose and the residuals are normally distributed. Moreover, the stability of the coefficients and the asymmetric ARDL model is tested by the use of the CUSUM and CUSUMSQ methods shown in Fig 2, indicating that the residuals are within the 5% bound and confirming the stability of the coefficients and the model.

5.4 Asymmetric causality test results

This section concludes the statistical analysis and presents the asymmetric causality analysis among the predictors, using Hatemi-J's [64] method based on the modified VAR model of Toda and Yamamoto's [65] approach. The motivation to delve into the asymmetric causality nexus is based on the critical results presented in Tables 4–7 on the one hand, while on the

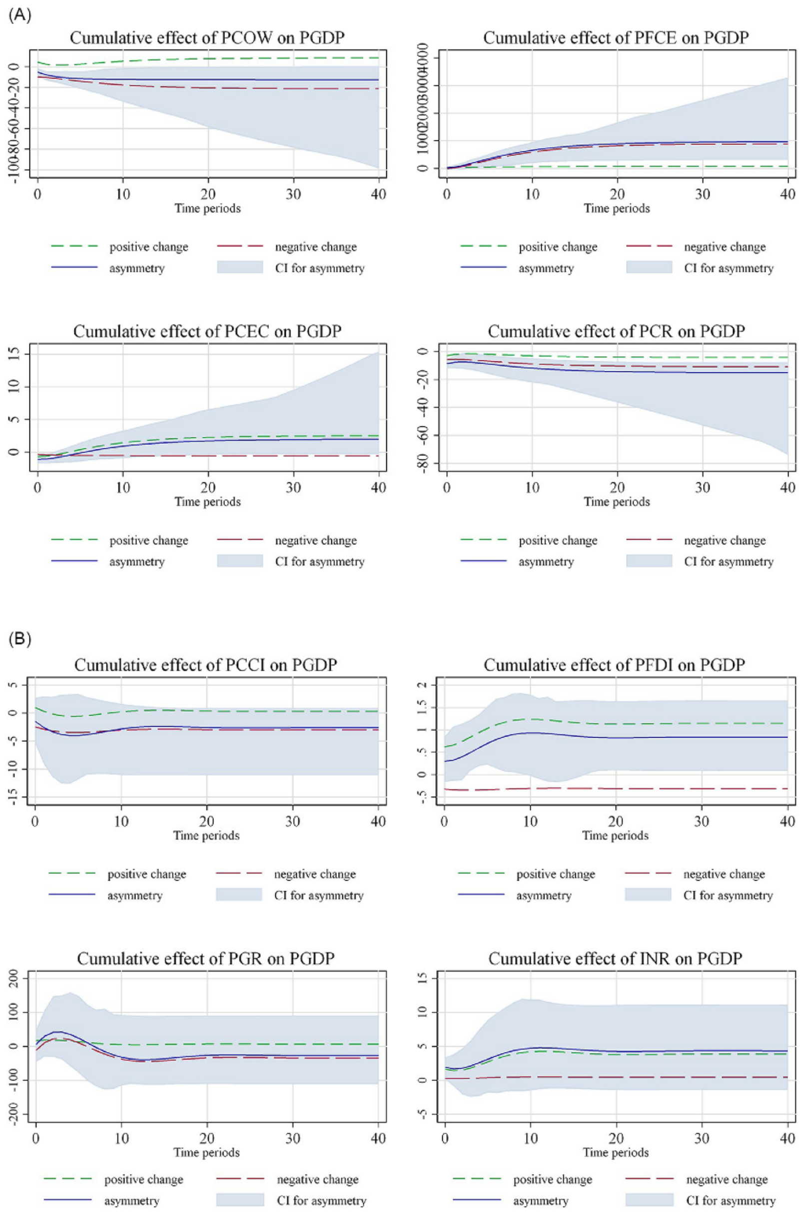

Fig 1. Asymmetric ARDL; dynamic multipliers. Note: 95% confidence interval bootstrap is based on 100 replications.

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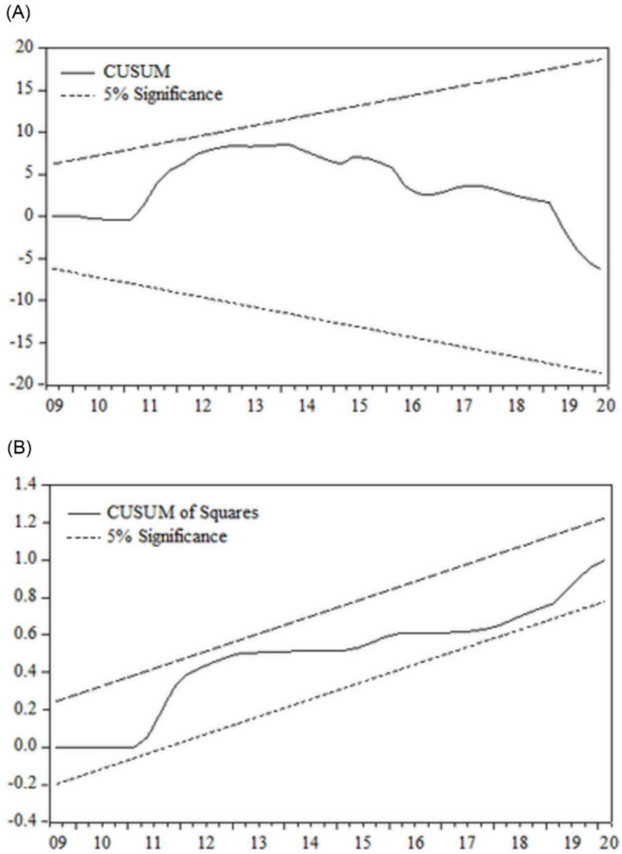

Fig 2. Asymmetric ARDL CUSUM and CUSUMSQ tests.

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other hand, it is one of the benchmarks of the study to explore the war-growth interdependence. The estimation uses optimal lag length selected by the AIC, SIC, and HQIC frameworks with (dmax = 2 + 8) in the modified unrestricted vector autoregressive order and the bootstrap of 1,000 replications based on the asymptotic chi-squared distribution for the Wald test. The results are reported in Table 8 and provide interesting findings. They show that positive (negative) shocks from the per capita cost of war have a significant causal relationship with the per capita GDP, while the flip-side results confirm a significant bidirectional causality among them at 1% significant level. Furthermore, the results show that both positive and negative asymmetric shocks from per capita final household consumption expenditure, per capita capital investment, and per capita FDI have significant bidirectional causality relationships with per capita GDP and vice versa. The estimation reveals that both positive and negative asymmetric shocks of population growth are insignificant to reject the null of no asymmetric causality both for unidirectional and bidirectional nexus, while unidirectional causality is confirmed from per capita remittance and inflation rate with the per capita GDP.

Table 8. Asymmetric causality results.

Causality direction	$d_{\max}$	Test statistics	Causality direction	$d_{\max}$	Test statistics	Critical values	
						1%	5%
$PCOW^{+}_{t-i} \rightarrow PGDP^{+}_{t-i}$	2+8	18.332***	$PCCI^{+}_{t-i} \rightarrow PGDP^{+}_{t-i}$	2+8	10.063***	6.781	3.331
$PCOW^{-}_{t-i} \rightarrow PGDP^{-}_{t-i}$	2+8	33.061***	$PCCI^{-}_{t-i} \rightarrow PGDP^{-}_{t-i}$	2+8	11.937***	6.781	3.331
$PFCE^{+}_{t-i} \rightarrow PGDP^{+}_{t-i}$	2+8	15.239***	$PFDI^{+}_{t-i} \rightarrow PGDP^{+}_{t-1}$	2+8	7.710***	6.781	3.331
$PFCE^{-}_{t-i} \rightarrow PGDP^{-}_{t-i}$	2+8	12.737***	$PFDI^{-}_{t-i} \rightarrow PGDP^{-}_{t-i}$	2+8	7.082***	6.781	3.331
$PCEC^{+}_{t-i} \rightarrow PGDP^{+}_{t-i}$	2+8	14.162***	$PGR^{+}_{t-i} \rightarrow PGDP^{+}_{t-1}$	2+8	3.011	6.781	3.331
$PCEC^{-}_{t-i} \rightarrow PGDP^{-}_{t-i}$	2+8	17.917***	$PGR^{-}_{t-i} \rightarrow PGDP^{-}_{t-i}$	2+8	2.889	6.781	3.331
$PCR^{+}_{t-i} \rightarrow PGDP^{+}_{t-i}$	2+8	6.371**	$INR^{+}_{t-i} \rightarrow PGDP^{-}_{t-i}$	2+8	9.485***	6.781	3.331
$PCR^{-}_{t-i} \rightarrow PGDP^{-}_{t-i}$	2+8	5.628**	$INR^{-}_{t-i} \rightarrow PGDP^{-}_{t-i}$	2+8	12.337***	6.781	3.331
Reveres causality							
$PGDP^{+}_{t-i} \rightarrow PCOW^{+}_{t-i}$	2+8	33.145***	$PGDP^{+}_{t-i} \rightarrow PCCI^{+}_{t-i}$	2+8	8.536***	6.781	3.331
$PGDP^{-}_{t-i} \rightarrow PCOW^{-}_{t-i}$	2+8	26.044***	$PGDP^{-}_{t-i} \rightarrow PCCI^{-}_{t-i}$	2+8	8.099***	6.781	3.331
$PGDP^{+}_{t-i} \rightarrow PFCE^{+}_{t-i}$	2+8	11.773***	$PGDP^{+}_{t-1} \rightarrow PFDI^{+}_{t-i}$	2+8	10.101***	6.781	3.331
$PGDP^{-}_{t-i} \rightarrow PFCE^{-}_{t-i}$	2+8	10.494***	$PGDP^{-}_{t-i} \rightarrow PFDI^{-}_{t-i}$	2+8	13.682***	6.781	3.331

Notes:

***, **, and * present significance at 1%, 5%, and 10%, respectively.

PGDP = Per capita GDP, PCOW = Per capita cost of war, PFCE = Per capita final household consumption expenditures, PCEC = Per capita energy consumption, PCR = Per capita remittance, PCCI = Per capita capital investment, PFDI = Per capita foreign direct investment, PGR = Population growth rate, INR = Inflation rate. [+] and [−] present positive and negative partial sum of squares, respectively. → presents direction of the causality.

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6 Conclusions

The economic cost of Afghanistan's protracted war has been astounding. Life's losses cannot be overturned, and the psychological effects of the conflict will take a very long time to recover. This study hypothesized the asymmetric effects of long-run war and other well-known control predictors on economic growth in Afghanistan for the period ranging from 2002Q3–2020Q4. Employing datasets collected from WDI (World Development Indicators) and the Department of Defense Budget of the United States and using non-linear autoregressive distributed lags, dynamic multipliers, and asymmetric causality techniques to test the competing hypotheses, the initial results indicate that the predictors exhibit mixed integrating orders [I(0) and I(1) without any I(2)] and long-run asymmetric nexus. Using the asymmetric ARDL model, interesting results were highlighted by statistical evidence. It shows that a positive partial sum shock from the per capita cost of war decreases per capita GDP, while its negative partial sum shock increases it both in the short and long runs. This implies that an increase in the cost of war causes the growth to decline and vice versa. Moreover, the results indicate the partial sum of squares of per capita final household consumption expenditure increases per capita GDP, while its negative partial sum of squares has an adverse effect in the short and long run, with a counter-evidence for per capita energy consumption and per capita remittance. The findings also reveal that the positive (negative) partial changes in per capita capital investment and per capita FDI increase (decrease) per capita GDP both in the short and long runs, while the asymmetric effects of the inflation rate on the economy were found to be adverse in the runs. Employing the dynamic multipliers demonstrates that growth swiftly responds to the positive and negative asymmetric shocks from the per capita cost of war and the control predictors. Finally, an asymmetric causality model is applied to delve into the asymmetric causality nexus amid predictors. The results disclose that there is a significant bidirectional causality nexus between per capita cost of war, per capita GDP, per capita final household consumption expenditure, per capita capital investment, and per capita FDI, while statistical evidence only confirms a unidirectional causality between per capita GDP and the remaining variables. In sum, the results conclude that war overwhelms the economy and poses severe consequences to the well-being of the Afghan nation, the leftover social and techno structures. Based on the findings, two important and yet specific policy recommendations are provided as follows:

1. As the findings show, war has a negative impact on the economy in both the short and long run. The positive asymmetries are consistent with the real outcome of the war in Afghanistan. The new chapter of international inclusion in the war of the country brought in billions of US dollars and supported the GDP to grow, though it was unrealistic growth during the past two decades. Therefore, it is recommended that policymakers switch to higher government spending on economic infrastructure development to take the pressure off long-term economic growth.
2. In relation to the negative impacts of the war on the economy, it is also found that a shock of the positive partial sum of the war decreases economic growth in the short and long runs. Thus, it is a complex challenge that calls for international lobbying to bring peace and sustain security in the country so the long-run negative impact of the war can be controlled. This recommendation includes four proposals: (i) international community engagement to lobby for and facilitate peace and security; (ii) internal political solidarity to facilitate an internal environment conducive to peace; (iii) community awareness of the impact of the war; and (iv) emphasizing the rule of law and corruption control in the country.

6.1 Limitations of the study

Due to the unavailability of disaggregated datasets at sectoral and state levels, the present study used aggregated datasets, which has led the study to fail in testing the sensitivity of sectoral-growth and state-based growth against the long-war in Afghanistan. Upon its availability, future studies may use disaggregated datasets to overcome this limitation.

Author Contributions

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CHAPTER 4: PAPER 2 – THE HEALTH CONSEQUENCES OF CIVIL WARS: EVIDENCE FROM AFGHANISTAN

4.1. Introduction

The second study of the present thesis examined the impact of long-term civil wars on healthcare outcomes in Afghanistan. Theoretically, armed conflicts have both concurrent and long-term impacts on people's health, measured either by mortality, maternity, or life expectancy. Afghanistan is one of the domains of the longest civil wars in the world that has little been attended to by scholars to investigate the effects of wars on different aspects of socioeconomics either during or post-war periods. However, there are numerous qualitative reports, but none significantly contributes to enhancing the current level of understanding of the magnitude and scale of the effects of wars on healthcare outcomes in Afghanistan.

The primary objectives of the second study were to investigate the effects of long-term civil wars on Afghanistan's healthcare outcomes, determining the scale and magnitude of the effects, and establishing a strong quantitative foundation of the war-health nexus in the existing literature. As a result, three new hypotheses were developed. H_1: War has a significantly effect on public healthcare services; H_2: War and healthcare services are linked together in long-run; and H_3: There is a causal link between war and public healthcare. The overall results confirmed by complex statistical methods provided evidence of a long-run relationship between war and per capita health expenditures, and it has been found that long-term war is a significant predictor that causes a long-term negative impact on healthcare. Given the loss of budgetary commitment to advance public healthcare outcomes, war redirects contemporary healthcare budgets to cure the injuries caused by wars and pay incentives to the families of war victims. Furthermore, causal links were identified, indicating that civil wars were the main cause of increasing current health expenditures in Afghanistan.

4.2. Published paper

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The health consequences of civil wars: evidence from Afghanistan

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Abstract

This study examines the effects of long-run civil wars on healthcare, which is an important component of human capital development and their causality nexus in Afghanistan using the MVAR (modified vector autoregressive) approach and the Granger non-causality model covering data period 2002Q3-2020Q4. The primary results support a significant long-run relationship between variables, while the results of the MVAR model indicate the per capita cost of war, per capita GDP, and age dependency ratio have significantly positive impacts on per capita health expenditures, whereas child mortality rate and crude death rate have negative impacts. The results of the Granger non-causality approach demonstrate that there is a statistically significant bidirectional causality nexus between per capita health expenditure, per capita cost of war, per capita GDP, child mortality rate, crude death rate, and age dependency ratio, while it also supports the existence of strong and significant interconnectivity and multidimensionality between per capita cost of war and per capita health expenditure, with a significantly strong feedback response from the control variables. Important policy implications sourced from the key findings are also discussed.

Keywords Civil wars, Causality, MVAR, GDP, Afghanistan

JEL Classification I11, B23, C32

Introduction

The long-run civil wars in Afghanistan have been astonishing. It devastated the economic, social, and technological infrastructure. This social upheaval resulted in significant outbreaks in both the public and private sectors. The prevalence of mortality rate has decreased by approximately 51 percent in Afghanistan, from 1,240 deaths per 100,000 live births in 2003 to 638 deaths per 100,000 live births in 2017 [1]. Although the long-run effects of war comprise wide dimensionality and it is essential to address each of them separately, the present study specifically attempts to analyze the effects of long-run civil wars on the healthcare systems of Afghanistan as the most contested battlefield worldwide. As a macro-level strand, health, education, and employment are the essential components of nurturing the human capital of a nation to bring welfare and prosperity, yet they have been proven to be vulnerable sectors that have received substantial assaults during wartime [2, 3]. Moreover, health spendings mainly aim to result in the efficient provision of health prospects, strengthening human capital to improve overall productivity, thus contributing to welfare and efficient economic performance [4]. It is therefore important to understand the pattern of healthcare spending in a conflict zone during wartime. Afghanistan's healthcare system, which was dependent upon the international community's financial assistance during the last two decades [5], and its rapidly deteriorating healthcare system under the Taliban have raised another alarming concern for a major portion of the population in Afghanistan [6]. War is an ominous phenomenon that not only limits people's access to health services but also destroys

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the health infrastructure of the war-effected country [7]. It is also well-evident that armed conflicts cause significant underfunding and redirection of the financial resources to combat war-driven expenses [7, 8], resulting in substantial barriers to the provision of sufficient healthcare services [9, 10].

The effects of civil wars on various socioeconomic indicators can be traced from the available literature (see, for instance, [11–19]), but it suggests thorough analysis to determine the effects of civil wars on various health indicators to assist intra-policy reconciliation between the resources directed by local governments and the interference of international funding agencies supporting parallel healthcare systems. Therefore, it is important to formulate three key questions, among all others. First, do long-run civil wars in Afghanistan constitute an extra cost burden to the local government other than that which has been directly covered by the United States and its alliance during wartime? Second, do protracted (prolonged) civil wars have the same devastating magnitude and effects on Afghanistan's overall public healthcare system as in other war-effected zones? Do long-run civil wars have causality relationships with other healthcare indicators, and can this causality nexus be traced out as a feedback response as well?

There are several studies analyzing the impact of armed conflicts on various healthcare indicators in different war-effected environments, such as Sudan [20–22], El Salvador [23], Nigeria [23–25], Kurdistan [26], Syria [26–28], and Iraq [29, 30]. Though an exception is given to the work of Walker [31] for an extensive review of health consequences of war on various health indicators in Afghanistan; other relevant studies [31, 32] have been descriptive by nature, which raise empirical debates on the confounded results presented by them. Despite the scarcity of sophisticated analysis of the effects of civil wars on healthcare in Afghanistan and answers to the formulated research questions, the present study takes a new step in the literature to fill the missing gaps and invites further empirical discussions on the health consequences of armed conflicts shifting from descriptive to advanced analytical approaches.

This article is a distinctive work in the existing literature quantifying the effects of long-run civil wars on public healthcare in Afghanistan, which is a true representation of a long-run battlefield in the world. To be specific, the contribution of the present study can be outlined as follows. First, it is the first of its kind in the existing literature for Afghanistan, which fills the missing gaps. Second, the authors employ sophisticated econometric models to estimate the effects of civil wars on health predictors proxied by per capita health expenditure to provide consistent and efficient results, though most recent studies relied upon descriptive analysis that might have led to perplexing conclusions. Third, to inform evidence-based conclusions, the study controls for relevant societal and macroeconomic variables and provides appropriate policy recommendations.

The remaining parts of the study are structured as follows. Literature review presents a brief theoretical background and reviews recent empirical literature assessing the effects of armed conflicts on healthcare indicators. Data describes the data, sources of data collection, variables, and key measurements. Methods presents the empirical and econometric methods used to analyze the data. Results presents the results of data analysis. Discussion provides a brief discussion. Conclusion concludes the study and offers some relevant policy recommendations.

Literature review

The literature widely defines war as a state of armed conflict between group of people or states seeking either economic, political, or other hegemonic benefits [33] linked by aggressions of extensive duration and magnitude across a wide spectrum, resulting in a societal catastrophe [33, 34]. Moreover, the empirical literature also widely documents the various impacts of civil wars and armed conflicts on healthcare indicators. It reports the customary measurement of war effects on mortality rates, maternity rates, healthcare systems, and gender-specific health services during wartime and afterwards, though many of them to date are descriptive by analytical method and require reconfirmation of the type, scale, and magnitude of the effects of armed conflicts on healthcare indicators. For instance, Roberts et al. [35] conducted a survey to compare the mortality rate due to inefficiency of healthcare services before and after the war period in Iraq using monthly data and a cluster sampling approach—that is, 33 clusters consisting of household interviews. Examining the inefficiencies of the healthcare systems caused by civil wars, the authors found, though descriptively explained, that civil wars led by the invaders in Iraq had significantly devastated the healthcare systems and resulted in an increase in the mortality rate by 2.5 times higher than pre-war conditions. They confirm that civil wars had seriously negative effects on healthcare systems in Iraq (see also [36]).

Betsi et al. [37] attempted to quantify the impact of civil wars and armed conflicts on healthcare systems and human resources through an administered questionnaire and review of the records of the ministry of health in Côte d'Ivoire. Using descriptive statistics, the authors found that due to armed conflicts, there was a significant reduction in the number of health staff both in the private and public health sectors, which led to the collapse of the healthcare system, public health infrastructure, interruption of condom distribution, and lack of antiretrovirals. The authors also report a significant increase in the number of non-governmental organizations supporting healthcare centers and a substantial decrease in the number of private health clinics.

Devkota and Teijlingen [38] argue that, in contrast with an abundance of literature on the negative impact of armed conflicts on healthcare systems, they show an improvement in a number of healthcare indicators in Nepal during wartime from 1996–2006. The authors employed data from the Nepal Demographic and Health Survey and found that 16 out of 19 healthcare indicators have improved during wartime, suggesting that such improvements in healthcare systems are driven by both conflict and non-conflict factors in Nepal. However, their results might be confounded due to the statistical methods used by the author; they report a counter-example of the effects of war on healthcare systems. Elamein et al. [39] evaluated the effects of war on healthcare systems in Syria through a participative data method using data collected from Turkey's healthcare centers in Syria and local Syrian health employees. Since November 2015, the datasets have been collected from the monitoring violence against healthcare alert network. Using descriptive data analysis techniques, the authors found a significant impact of armed conflicts on the healthcare indicators, implying that from November 2015 to December 2016, more than 938 people have been directly harmed in 402 incidents of violence against healthcare. That consists of 72% injuries and 28% deaths in Syria. The authors argue that since health centers have been attacked more than other public organizations, the negativity of their effects has been substantially higher in distracting the healthcare centers, thus affecting public health in Syria.

Kotsadam and Østby [40] examined the effects of armed conflicts on healthcare proxied by maternal mortality rate in thirty Sub-Saharan African countries, using combined geo-coded data on a number of different types of violent events from the Uppsala Conflict Data Program with geo-referenced survey data from the Demographic and Health Surveys and a sister-fixed effects model to analyze the data. The authors clustered the respondents aging from 12–45 years old into gender-specific categories. They found that local exposure to the intensity of armed conflict has a significantly negative impact on the mortality rate, giving rise to the risk of maternal deaths, whereas there were significant differences in the mortality rate in rural areas with an adverse report from educated areas. On the other hand, Lafta and Al-Nuaimi [41] descriptively explained the effects of long-term war, terrorism acts, and organized crimes on healthcare systems in Iraq during the last 40 years. The authors emphasize that civil wars have severe effects on healthcare systems, increasing the numbers of morbidity, injuries, disabilities, mortality rates, and mental problems.

Jawad et al. [42] examined the direct and indirect effects of armed conflicts and violence on healthcare systems using datasets from the World Development Indicators in 181 countries for the period spanning from 2002–2019 and panel data regression analysis with fixed effects estimators to analyze their data. According to their findings, armed conflict and violence are significantly linked with persistent excess maternal and child deaths across the world, as well as reductions in key measures indicating high reduction of availability to organized healthcare systems. Their findings also highlight the importance of protecting women and children from the indirect harms of conflict, such as the degradation of health systems and exacerbating economic outcomes. Furthermore, Ekzayez et al. [43] employed an observational method to test the effects of armed conflicts on the availability and accessibility of healthcare services in Syria from October 2014 to June 2017 using datasets that were routinely collected from 597,675 medical consultations and 11,396 events. The authors used panel data techniques with fixed effects estimators to analyze the data and found that bombardments have strong negative impacts on both consultations and antenatal care visits in Syria. They also found that access to healthcare services in war-affected areas in Syria was significantly limited for patients, while conflict incidents were found to negatively affect the utilization of routine health services. Table 1 provides some more insights into recent studies relevant to the context of this study.

Meagher et al. [49] reviewed a comprehensive literature covering the ripple impact of armed conflicts and violence on a wide range of indicators, including gender-specific barriers to accessing essential healthcare services, water, sanitation, education, and some macroeconomic indicators, such as poverty rates, debt burdens, and unemployment rate. The authors employed multidisciplinary narrative reviews of the existing literature relevant to the political economy of health in conflict zones and conclude that armed conflicts and violence seriously affect healthcare and socioeconomic indicators in war-effected areas, while gender-specific effects—negative effects of war on women and children—were found to be relatively greater.

The review of existing literature clearly indicates two critical missing gaps about the analysis of the effects of civil wars and armed conflicts on public healthcare services. First, it reports that empirical studies are scarce analyzing the effects of long-run civil wars and armed conflicts on the healthcare services in Afghanistan during

Table 1 Some relevant studies

Author	Context	Method	Findings
Spiegel et al. [20]	Rwanda	Descriptive analysis	The healthcare needs of war-affected people show an expansion in morbidity and mortality. Armed conflicts impose negative effects on the provision of curative health services
Urdal and Che [44]	Global perspective from 1970–2005	Cross-sectional data analysis	Armed conflicts cause higher fertility, and maternal mortality rates. In neighboring countries, it causes lower maternal mortality rates, possibly indicating that health interventions among refugee and host populations are relatively successful
Abbara et al. [29]	Syria	Descriptive analysis	The long-term conflict has led to significant destruction of the health infrastructure and has increased both communicable and non-communicable diseases and raised morbidity and mortality rates
Levy and Sidel [15]	Iraq	Descriptive analysis	Armed conflicts seriously affect public health. It also effects on inadequate healthcare system, social breakdown, forced migration, internal displacement, and reporting biases
Namasivayam et al. [45]	Uganda	Logistic regression analysis	Armed conflicts have direct effects on the reduction of healthcare services in Uganda vis-à-vis the rest of the regions. However, skilled assistance at birth among women has been found significantly higher
Kadir et al. [46]	Global perspective	Descriptive analysis	Armed conflicts have both direct and indirect effects on the mortality, mentality, and psychology of people, with most pressure on children, while internal displacement and family separation are also evident as the long-run consequences of civil wars
Chukwuma and Ekhator-Mobayode [47]	Nigeria	Difference-in-difference analysis	Armed conflicts like the Boko Haram Insurgency (HBI) have a high effect on the maternal mortality rates in Nigeria. Furthermore, the BHI decreased the frequency of care visits, delivery at health centers, and delivery by skilled health professionals
Bendavid et al. [48]	Global perspective	Descriptive analysis	Besides, armed conflicts have negative effects on healthcare, more than 265 million women and 368 million children have been displaced both internally and across borders

Source: Authors' collection

the war period. Second, the literature, however, covers other war-effected zones, such as Syria, Libya, Iraq, and African countries, but the results might be confounded due to the use of non-sophisticated and non-comprehensive statistical methods to analyze relevant data. Thus, these two significant missing gaps in the literature justify the present study and spark its importance to fill the gaps.

Data

As per the availability of data, this study employs datasets containing observations from 2002Q3–2020Q4 for Afghanistan. The variables used in the study are consistent with the theoretical concept and recent studies and includes per capita health expenditure (as a proxy for public healthcare) as the dependent variable. Per capita cost of war as a proxy for long-run civil wars; per capita GDP as a proxy for per capita income; child mortality rate expressed as the number of the death of children under 5 years old; the crude death rate, and the age dependency ratio are used as explanatory variables. The dataset for the cost of war is collected from the U.S. Department of Defense Budget, whereas all other datasets come from the WDI (World Development Indicators) World Bank. Table 2 reflects more details about variables, symbols, descriptions, and sources of data, while it also highlights some important summary statistics.

The main variable of interest, the cost of war, represents the total amount of US dollars spent by the US on military operations in Afghanistan over the period. The choice of this proxy is based on the accuracy of its data, whereas some other studies employed the number of deaths and casualties to proxy the civil war variable (see, for instance, [50–52]). Furthermore, the study controls for two additional variables, such as the child mortality rate and the crude death rate, which are proxies for the rate of death due to causes other than the consequences of Afghanistan's civil wars. Per capita GDP is used to assess the effects of per capita income on health expenditure and, as a result, the nation's healthcare services. From a theoretical viewpoint, per capita income is linked with the quantification of healthcare from three major aspects, such as better nutrition; enhancement of public health infrastructure; and the advancement of medical technology used to offer healthcare services [53]. Besides, age dependency ratio is also employed as a control variable. It is used to control the extra burden other than the consequences of civil wars on health expenditure in Afghanistan. A lower age dependency ratio facilitates better healthcare services, while a higher ratio of dependence indicates greater financial stress on the working population [54].

Table 2 Variables' description and summary statistics

Description of variables				Summary statistics				
Name	Symbol	Description	Sources	Mean	Max	Min	Std. Dev	Obs
Per capita health expenditure	PHE	PHE is expressed in constant 2015 US dollar and includes healthcare goods and services consumed during each year	WDI	45.57	69.99	15.80	17.24	73
Per cost of war	PCW	PCW is expressed in millions of US dollar	USDB	9.27	19.43	2.14	5.69	73
Per capita GDP	PGDP	PGDP is expressed in thousands of constant 2015 US dollar	WDI	487.77	587.56	330.30	96.55	73
Child mortality rate	CHM	CHM is expressed as the number of children deaths under 5 years old	WDI	4.90	6.20	3.10	1.11	73
Crude death rate	CDR	CDR is expressed as the number of deaths per 1000 population during the year	WDI	8.19	11.04	6.15	1.51	73
Age dependency ratio	AGD	AGD is expressed as a percentage of working-age population, younger than 15 and older than 64 years old	WDI	95.59	103.67	80.08	7.51	73

Source: Authors compilation

Max Maximum, *Min* Minimum, *Std. Dev* Standard deviation, *Obs* Number of observations, *USDB* US Department of Defense Budget FY2020

Table 2 indicates some important descriptive highlights in addition to describing the variables. It shows that during the period under study, the average per capita health expenditure is only $45.57 with a maximum of $69.99, whilst the average per capita cost of war stands at $9.27 million with a maximum of $19.43 million. On the other hand, the per capita GDP stands at an average of $487.77 with a maximum of $587.56. The child mortality rate and the crude death rate are averaged at 4.9% and 8.19%, respectively, indicating that the crude death rate is higher than the child mortality rate. More deepening insights show that due to a long-run war and a lack of basic healthcare and malnutrition, Afghanistan is the second country to have the highest crude death rate [55, 56]. Moreover, the age dependency ratio stands at an average of 95.59 which is relatively high in comparison with other economies. In real life, a major proportion of children and elderly are part of the labor force in Afghanistan, while the data indicates the dependency ratio as the composition of the population. All these preliminary insights require further statistical analysis that are discussed the Results of the present study.

Methods

This section explains the econometric methods used to explore the impact of civil wars and other control variables on per capita health expenditure, presenting an integrated human capital dimension from health perspectives in Afghanistan. The study follows the empirical model of Grossman [57], which expresses the demand for good health vis-à-vis other relevant predictors, thereby, the civil wars as a key variable of interest in the present study. Thus, we initiate with the following function:

$$PHE_t = \phi + \varphi_1 PCW_t + \varphi_2 Y_t + \varphi_3 CHM_t + \varphi_4 CDR_t + \varphi_5 AGD_t + \varepsilon_t \quad (1)$$

where *PHE, PCW, Y, CHM, CDR, AGD* are per capita health expenditures, per capita GDP, child mortality rate, the crude death rate, and the age dependency ratio, respectively. ϕ presents the intercept and φ is the long-run coefficient. Equation (1) explicitly considers a lifetime view and is well-defined to explore the link between health-oriented decisions and the outcomes at the aggregate level. This insight is useful to understand the likely implications of civil wars and an aging population on the level of health systems and overall healthcare expenditure over the period of time [58]. The expected coefficient signs are $\varphi_1 < 0$, $\varphi_2 > 0$, $\varphi_3 < 0$, $\varphi_4 < 0$, and $\varphi_5 < 0$. The estimation of Eq. (1) begins with the test of unit root, which is important to determine the integration order of the variables to avoid misspecification and fabricated results. To that end, the Augmented model of Dickey and Fuller (ADF) [59] and Phillips and Perron (PP) [60] are employed. Assuming that the variables follow a mixed order of integration and if we let the maximum integration to be $= m$, then in our case, $m = 2$. In such circumstances, common cointegration methods do not provide consistent results, while in Johansen's [61–63] cointegration method, any I(2) series is defined as a submodel of the basic vector autoregressive (VAR) model through two reduced rank conditions [64] using the Π matrix comprising trace-statistics and max-eigenvalues to establish a long-run nexus between the predictors, accounting for any I(2) series in a sample of variables [61]. The optimal lag length both for unit root and Johansen's cointegration equations are selected using the AIC (Akaike Information Criterion), SIC (Schwarz Information Criterion), and HQIC (Hanan-Quinn Information Criterion) in the unrestricted VAR model.

Instructed by the unit root results (see Table 3) by having mixed integrating order with maximum $m = 2$ series and based on an extensive empirical literature (see, for instance, [61, 62]), the study employs the Toda and Yamamoto's [65] modified VAR model, which is an appropriate estimation method for the case of this study. The modification is built upon the augmented VAR model—that is, the $k + d_{\max}$ augmented with the optimal lags selected via information criteria plus allowing for lags to the number of variables plugged into the unrestricted VAR model expressed as:

$$y_t = \alpha + \sum_{i=1}^{k} \beta_i y_{t-i} + \sum_{j=1}^{k} \phi_j x_{1t-j} + \sum_{m=1}^{k} \varphi_m x_{2t-m} + u_t, \quad (2)$$

where for brevity, y_t presents per capita health expenditure, which is the dependent variable; x_1 is the per capita cost of war; x_2 presents the set of control variables, such as per capita GDP, child mortality rate, age dependency ratio, and crude death rate; k is the number of optimal lag length; α is the intercept; β_i, ϕ_j, and φ_m are the short-run dynamic coefficients of the equations' adjustment for long-run equilibrium; and u_t is the error term. Now, we build upon Eq. (2) using the $k + d_{\max}$ approach to test the Granger non-causality null by modified Wald statistics using Toda and Yamamoto's [65] modified VAR model as:

$$y_{1t} = \theta_1 + \left(\sum_{i=1}^{k} \lambda_{1t} x_{t-1} + \sum_{i=k+1}^{d_{\max}} \lambda_{2t} x_{t-2}\right) + \left(\sum_{i=1}^{k} \varphi_{1t} x_{t-1} + \sum_{i=k+1}^{d_{\max}} \varphi_{2t} x_{t-2}\right) + \varepsilon_{t1}, \quad (3)$$

$$x_{1t} = \theta_2 + \left(\sum_{i=1}^{k} \eta_{1t} x_{t-1} + \sum_{i=k+1}^{d_{\max}} \eta_{2t} x_{t-2}\right) + \left(\sum_{i=1}^{k} \vartheta_{1t} x_{t-1} + \sum_{i=k+1}^{d_{\max}} \vartheta_{2t} x_{t-2}\right) + \varepsilon_{t2}, \quad (4)$$

where θ is the intercept, λ_1, λ_2, φ_1, φ_2, η_1, η_2, ϑ_1, and ϑ_2 present the short-run dynamic coefficients of the model, k is the number lag, and $k + d_{\max}$ is the number of cointegrating vectors of the predictors augmented into the model. Equation (3) and (4) follow asymptotic chi-squared distribution using degree of freedom based on $k + d_{\max}$ to test the null of Granger non-causality between the variables [66]. The modified VAR approach of the Toda and Yamamoto [65] to Granger non-causality has several advantages over other cointegrating vector regressions. First, it produces both adjusted VAR coefficients and Granger non-causality results simultaneously by one estimation. Second, it allows I(2) series estimation, while using other regression models may produce inconsistent and inaccurate results [67]. Finally, the study computes and reports relevant diagnostic tests to ensure the statistical validity of the results upon which the conclusions are drawn.

Results

Stationarity results

The analysis begins with the unit root analysis using the ADF and PP methods and reports the results in Table 3. Although the results of both ADF and PP are consistent and indicate the same findings, they show that the per capita cost of war is the only variable that is stationary at

Table 3 Results of stationarity test

Variables	Augmented Dickey-Fuller				Phillips-Perron			
	W/trend		Trend		W/trend		Trend	
	t-statistics	*p*-value	t-statistics	*p*-value	t-statistics	*p*-value	t-statistics	*p*-value
At level								
PCW	-4.41[a]	0.000	-4.38[a]	0.000	-3.84[a]	0.003	-3.91[a]	0.001
At first difference								
CDR	-4.13[a]	0.000	-4.85[a]	0.000	-4.01[a]	0.000	-4.38[a]	0.000
CHM	-3.99[a]	0.001	-3.81[a]	0.001	-3.70[a]	0.009	-4.19[a]	0.000
PGDP	-5.31[a]	0.000	-5.10[a]	0.000	-4.60[a]	0.000	-4.81[a]	0.000
At second different								
PHE	-6.24[a]	0.000	-6.44[a]	0.000	-5.32[a]	0.000	-5.14[a]	0.000
AGD	-8.26[a]	0.000	-8.21[a]	0.000	-8.01[a]	0.000	-7.94[a]	0.000

Source: Authors' computations

PCW Per capita cost of war, *CDR* Crude death rate, *CHM* Child mortality rate, *PGDP* Per capita GDP, *PHE* Per capita health expenditure, *AGD* Age dependency ratio. Optimal lag length is based on SIC

[a] indicates significance at 1% level

level. The crude death rate, child mortality rate, and per capita GDP are strongly significant to reject the null of non-stationarity after the first difference. Moreover, the results of both the ADF and PP methods reveal that per capita health expenditure and age dependency ratio are integrated of order two, meaning that their t-statistics are insignificant to reject the null both at level and first difference, whilst the null is rejected after their second differences at a 1% level. The results show that the variables have mixed integrating orders, such as [I(0), level stationary], [I(1), first differenced stationary], and [I(2), second differenced stationary], informing the appropriate model specification discussed in the preceding section. Since the t-statistics for both trend and without trend vector models are similar, the study concludes that there are no structural breaks in the data and proceeds with further analysis.

Cointegration results

Using Eqs. (3) and (4), that is, Johansen's cointegration test with considering the second difference order of integration (see, for instance, [64]), we estimate the long-run relationships between per capita health expenditure, per capita cost of war, and other control variables and report the results in Table 4. The results indicate that there are four cointegration ranks among the variables, each exhibiting significant *p*-values at 1%, 5%, and 10% levels.

Toda-Yamamoto modified VAR results

For two obvious reasons, this study employs the Today-Yamamoto modified VAR model to test both the effects of variables on per capita health expenditures and their causality relationships. First, the use of other common regressions, such as standard and restricted VAR models and the ARDL method, are not appropriate for variables that follow higher degrees of integration than I(1), as in our case. Second, standard and restricted VAR models may produce spurious results due to the existence of cointegrating ranks among variables showing I(2) series. Thus, this study estimates the Toda-Yamamoto's [65] model to overcome these empirical shortcomings and reports the results in Tables 5 and 6. The optimal lag length of two has been selected using AIC, SIC, and HQIC criteria in standard VAR environment with maximum six lags estimation. Thus, it only reports the results of lag two estimates.

Table 4 Cointegration test results

Cointegration ranks	Eigenvalues	Trace statistics		Max statistics	
		Trace values	*p*-values	Max values	*p*-values
1	0.44	138.57[a]	0.000	80.98[a]	0.000
2	0.39	97.58[a]	0.000	68.24[a]	0.000
3	0.32	61.87[a]	0.001	55.90[a]	0.003
4	0.24	34.27[b]	0.014	40.98[b]	0.039
5	0.18	14.58[c]	0.068	27.59[c]	0.049
6	0.00	0.19	0.658	0.00	0.658

Source: Authors' computations

[a,b,c] indicate significance at 1%, 5%, and 10%, respectively. Null hypothesis $H_{null} : r = 0$ vs. $H_{alt.} : r \geq 1$

Table 5 Modified VAR estimates

Variables	PHE_{t-i}	PCW_{j-t}	$PGDP_{m-t}$	CHM_{n-t}	CDR_{v-t}	AGD_{u-t}
Coefficients	16.84[b]	10.16[b]	1.99[b]	-0.74[b]	-21.33	1.58[a]
t-statistics	4.31	6.01	4.86	-8.11	-1.60	2.71
p-values	0.000	0.000	0.000	0.000	0.425	0.023
Diagnostic checks						
Adjusted r-squared	0.92					
Residual heteroskedasticity	2.75	[0.355]				
F-statistics serial correlation	0.47	[0.991]				
Jarque–Bera normality of residuals	1.36	[0.625]				

Source: Authors' computations

PHE Per capita health expenditure, *PCW* Per capita cost of war, *PGDP* Per capita GDP, *CHM* Child mortality rate, *CDR* Crude death rate, *AGD* Age dependency ratio

[a,b] indicate significance at 5% and 10% levels, respectively

Table 6 Granger non-causality estimates

Causality direction	$k + d_{max}$	$\chi^2 - stat.$	*p*-values	Causality direction	$k + d_{max}$	$\chi^2 - stat.$	*p*-values
DV=PHE				DV=PCW			
PCW ≠ >PHE	2+5	28.38[a]	0.000	PHE ≠ >PCW	2+5	17.08[a]	0.000
PGDP ≠ >PHE	2+5	15.09[a]	0.000	PGDP ≠ >PCW	2+5	21.71[a]	0.000
CHM ≠ >PHE	2+5	21.45[a]	0.000	CHM ≠ >PCW	2+5	12.35[a]	0.000
CDR ≠ >PHE	2+5	16.17[a]	0.000	CDR ≠ >PCW	2+5	4.40	0.110
AGD ≠ >PHE	2+5	27.34[a]	0.000	AGD ≠ >PCW	2+5	3.95	0.113
DV=PGDP				DV=CHM			
PHE ≠ >PGDP	2+5	20.01[a]	0.000	PHE ≠ >CHM	2+5	14.33[a]	0.000
PCW ≠ >PGDP	2+5	17.14[a]	0.000	PCW ≠ >CHM	2+5	5.75[c]	0.71
CHM ≠ >PGDP	2+5	28.65[a]	0.000	PGDP ≠ >CHM	2+5	9.88[a]	0.007
CDR ≠ >PGDP	2+5	15.99[a]	0.000	CDR ≠ >CHM	2+5	9.51[a]	0.009
AGD ≠ >PGDP	2+5	18.04[a]	0.000	AGD ≠ >CHM	2+5	7.73[b]	0.019
DV=CDR				DV=AGD			
PHE ≠ >CDR	2+5	15.71[a]	0.000	PHE ≠ >AGD	2+5	14.02[a]	0.000
PCW ≠ >CDR	2+5	14.23[a]	0.000	PCW ≠ >AGD	2+5	3.36	0.194
PGDP ≠ >CDR	2+5	6.16[b]	0.046	PGDP ≠ >AGD	2+5	15.26[a]	0.000
CHM ≠ >CDR	2+5	7.10[b]	0.042	CHM ≠ >AGD	2+5	2.17	0.324
AGD ≠ >CDR	2+5	7.39[b]	0.024	CDR ≠ >AGD	2+5	6.87[b]	0.032

Source: Authors' computations

[a,b,c] indicate significance at 1%, 5%, and 10% levels, respectively. $k + d_{max}$ = optimal lag length plus lag of parameters. ≠ > indicates non-causality direction. *DV* Dependent variable of different vector model

Table 5 presents the results of the modified VAR estimates using $k + d_{max}$ approach. The results are interesting and demonstrate that the per capita cost of war has a significant impact on per capita health expenditures, implying that a million US dollar increase in the per capita cost of war causes an increase in per capita health expenditure by $10.161 per quarter. It reveals that, other than those costs that have been covered by the US Department of Defense Budget for military operations, the civil war has also had its general effect on per capita health expenditure. Therefore, the incremental cost of the per capita health expenditures vis-à-vis the average per capita health expenditures as a result of the civil wars can be estimated as $10.161/$45.57 = 0.2229 or 22.29%. Moreover, the results show that per capita GDP significantly increases per capita health expenditures by $1.99. It shows that a one hundred US dollar increase in per capita GDP contributes to increasing the per capita health expenditure by $1.99. Incorporating the child mortality rate into the model, the results show that it has negative effects on per capita health expenditures in Afghanistan. The result for the crude death rate on per capita health expenditure is insignificant, although it requires more insights into their causality nexus that come in the next section. Furthermore, the findings reveal that the age dependency ratio is positively associated with per capita health expenditure. It shows that one percent increase in age dependency ratio increase the per capita health expenditure by $1.589. Finally, the robustness of the modified VAR model is estimated and reported underneath the Table 5. They indicate that the results are statistically robust and do not suffer from heteroskedasticity and serial correlation, while their residuals are also normally distributed.

Granger non-causality results

The key test of interest is the Granger non-causality amid predictors that is estimated using the modified VAR model of Today and Yamamoto's [65] approach. Regardless of the empirical criticism leveled at the presentation of modified VAR estimates and the preference for the Granger non-causality results, this study reported the estimates of the modified VAR model in the preceding section and continues to present the study's main findings extracted from the Granger non-causality test. Table 6 reports the results of the Granger non-causality estimates for all vector models estimated on the Today-Yamamoto's modified VAR model. The reason for estimating all vector models is based on the assumption of interconnectivity among variables and the extraction of multidimensional causality between them. For the per capita health expenditure vector model, there are bidirectional causality relationships between per capita health expenditure, per capita cost of war, per capita

GDP, child mortality rate, crude death rate, and the age dependency ratio, rejecting the null of Granger non-causality at 1% significant level. For the per capita cost of war vector model, there is bidirectional causality between per capita GDP, per capita cost of war, per capita health expenditure, and child mortality rate, while there is unidirectional causality running from crude death rate and age dependency ratio to per capita cost of war. For the age dependency ratio vector model, the results show that there is a bidirectional causality relationship between per capita health expenditure, per capita GDP, age dependency ratio, and crude death rate. For per capita GDP vector model, the results demonstrate that per capita GDP is bidirectionally caused by per capita cost of war, child mortality rate, age dependency ratio, and the crude death rate, supporting the rejection of null hypothesis of Granger non-causality at 1% and 5% significant levels. Moreover, the findings reveal that except for child mortality rate and age dependency ratio, all other vector models exhibit significant interdependencies and multi-dimensionality between the variables.

Discussion

This study hypothesized the effects of civil wars on healthcare in Afghanistan during wartime. The statistical analysis began with the test of stationarity and revealed that the predictors follow mixed and complex integrating orders (see Table 3). This led the study to examine the long-run relationship between per capita cost of war, per capita health expenditure, and the control variables and to inform appropriate model specification. The rejected null of no cointegration ranks (see Table 4) reveals that the variables have a long-run nexus, implying that per capita health expenditure moves together with the per capita cost of war, child mortality rate, the crude death rate, per capita GDP, and the age dependency ratio in the long run. Furthermore, the results indicated that per capita cost of war, the key variable of interest, has a significantly positive impact on per capita health expenditure (see Table 5). Intuitively, the incremental effects of the civil war predictor on health expenditure do not necessarily imply an improvement in the healthcare system and its coverage, but rather an additional burden of costs being paid by the government to cover the negative health consequences of Afghanistan's armed conflicts. Per capita GDP is also found to have positive effects on per capita health expenditure. The results are consistent with the findings of Fedeli [68], Erçelik [69], and Bayar et al. [70], who also found that an increase in GDP significantly causes the per capita health expenditures to increase over time. Moreover, the results also correspond with the findings of Rahman et al. [71], who revealed that an increase in GDP improves population's health status in SAARC-ASEAN region. These findings reflect the fact that Afghanistan's civil war had severe impacts on a variety of socioeconomic and healthcare indicators, including per capita health expenditures. The results lend statistical support to the findings of Mirzazada et al. [72], who found that the armed conflicts in Afghanistan have a long-run relationship with the health predictors, indicating that the increase in child mortality rate is due to several factors—an important of which is the redirection of resources to defense and military operations, rather than the advancement of healthcare services. Moreover, Malik and Akhtar [73], Hu and Mendoza [74], Jaba et al. [75], Rahman et al. [76], Ray and Linden [77], and Malik et al. [78] discovered a long-run relationship between health expenditure and child mortality rates in different geographical contexts. In contrast to our results, they found that an increase in per capita health expenditure causes the child mortality rate to decrease due to providing more healthcare services to the citizens. The findings also revealed that the age dependency ratio has a positive effect on per capita health expenditure consistent with those of Boz and Ozsarı [79], who also discovered the significance of the age dependency ratio on health expenditure. Considering the significant impact of the per capita cost of war on health expenditure, it suggests to delve into their causality directions. The Granger non-causality results shown in Table 6 highlighted two key findings. First, the results indicate that there are bidirectional causality relationships between per capita health expenditure, per capita cost of war, per capita GDP, child mortality rate, crude death rate, and age dependency ratio. Second, there exists a multidimensional and complex interdependence between the explanatory variables, indicating serious policy implications for Afghanistan when developing relevant policies. The results are consistent with those of Mehrara et al. [80], Sghari [81], Lago-Peñas et al. [82], Marta and Noelia [83], Ashiabi et al. [84], Owusu et al. [85], Lakshmana [86], Linden and Ray [87], Akif and Torusdağ [88], Lopreite and Zhu [89], Yetim et al. [34], Rahman and Alam [90], Doğan et al. [91], Dhrifi [92], Abbas and Awan [93], Bilgili et al. [94], and Yang et al. [95], who also provided statistical evidence on the significant relationships between health spending, gross domestic product, child mortality rate, and the age dependency ratio in different geographical contexts. the present study, in addition to extending the findings for Afghanistan, adds to the existing literature and provides evidence on the bidirectional causality nexus between health spending and long-run civil war proxied by the per capita cost of war in Afghanistan.

Conclusion

Recognizing the importance of the healthcare system and its effectiveness in a war-torn society such as Afghanistan that has experienced more than four decades of consecutive civil wars, this article examines the effects of civil wars on healthcare in Afghanistan over the period from 2002Q3 to 2020Q04. To test the developed hypotheses, this study uses datasets collected from WDI (World Development Indicators) and the US Department of Defense Budget sources, and based on the time-series properties of the data—that is, the combination of I(0), I(1), and I(2) integrating orders—it employs the modified vector autoregressive (MVAR) of Today and Yamamoto [65], and expands its analysis by using the Granger non-causality method. For the rejected null of no cointegration, the results of the Johansen test confirm the existence of a significant long-run relationship between predictors. Using the MVAR technique, the results indicate that the per capita cost of war has a significantly positive impact on per capita health expenditures, which is not necessarily an indication of improvement in health systems, but rather, an additional cost burden to offset the health consequences of the civil wars. Furthermore, the findings show that per capita GDP and age dependency ratio have a significant positive impact on per capita health expenditures, whereas child mortality rate and crude death rate have a negative impact. Far more interesting results are achieved from the Granger non-causality method, which is the key test of interest in this study. It demonstrates that there is a statistically significant bidirectional causality relationship between per capita health expenditure, per capita cost of war, per capita GDP, child mortality rate, crude death rate, and age dependency ratio, while it also supports the existence of strong and significant interconnectivity and multidimensionality between civil war, per capita health expenditure, and other augmented predictors in the study. The findings have an important policy implication. It clearly indicates that civil wars create additional health expenditure without impacting the improvement of the quality of healthcare systems in Afghanistan during wartime, resulting in a significant reallocation and redirection of the healthcare budget. Thus, the government should focus on the dual effects of the civil wars and reformulate relevant policies to increase efficiency both for the advancement of the healthcare system in the long-run and the accessibility of the citizens to healthcare services, in addition to covering the proportional cost of the health consequences of the civil wars.

Limitations of the study

Although the findings are consistent and cannot be doubted in any way; this study is confronted with one major limitation—the unavailability of the disaggregated civil war dataset by state. However, because the intensity of civil war in different states of Afghanistan has significantly varied throughout the period, this study mainly relied on aggregated civil war datasets. Future studies may account for this limitation as long as the required datasets are made available for analysis.

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Authors' contributions
MAH: Major writing, data collection and analysis, methodology selection and regression analysis; MMR: Conceptualization, variable and methodology selection, minor writing, supervision and editing; RK: minor writing, editing and supervision. The author(s) read and approved the final manuscript.

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Availability of data and materials
Datasets relevant to PHE, PGDP, AGD, CDR, CHM, and population are collected from the World Development Indicators (WDI) sources available at (https://databank.worldbank.org/source/world-development-indicators) and dataset relevant to cost of war is collected from the Department of Defense Budget of the United States available at (https://www.state.gov/countries-areas/afghanistan/).

Declarations

Ethics approval and consent to participate
This study has used secondary dataset of the World Banks' World Development Indicators and Department of Defense Budget of the United States' dataset that are publicly available at (https://databank.worldbank.org/source/world-development-indicators) and (https://www.state.gov/countries-areas/afghanistan/). Therefore, ethical approval and consent are not required for the use of secondary datasets. Thus, we confirm that all methods were performed in accordance with the relevant guidelines and regulations.

Consent for publication
Not applicable.

Competing interests
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Publisher's Note

CHAPTER 5: PAPER 3 – ASYMMETRIC EFFECTS OF LONG-TERM WAR ON HUMAN RESOURCE DEVELOPMENT IN AFGHANISTAN: EVIDENCE FROM NARDL APPROACH

5.1. Introduction

The third study of this thesis explored the asymmetric impact of long-term civil wars on the human resource development of Afghanistan. The concept of the study was based on the various negative consequences of civil wars on human capital, which include forced migration of human capital, death, injuries, disability, and, more importantly, the direct effects of civil wars on school enrolment in Afghanistan during the period of armed conflicts. The results of this study not only assist policymakers, but also determine how negative policy implications can be addressed through alternative recommendations if civil wars presumably continue. Thus, it led the study to produce the third article of the present thesis.

This study had three main goals to achieve. First, determine whether civil wars move asymmetrically with human resource development and whether the effects of civil wars differ in the short and long run. Second, to provide statistical evidence supporting the hypothesized concurrent negative long-run effects of civil wars on human resource development in Afghanistan. Third, to find whether both the positive and negative components of civil wars significantly deteriorate human resource development in Afghanistan. The overall results of the study confirmed that long-run civil wars and human resource development have an asymmetric relationship, while short-run effects were also evident. Moreover, the results derived from statistical techniques informed significant policy implications and recommended further studies.

5.2. Under review paper

The asymmetric effects of long-term war on human resource development in Afghanistan: Evidence from NARDL approach

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Abstract

This study explores the effects of the long-term war on human resource development in Afghanistan using non-linear autoregressive distributed lags (NARDL) and asymmetric causality techniques. The results of the NARDL bound test support the long-run asymmetric relationship between predictors. The results of the NARDL model reveal that positive and negative shocks from the per capita cost of war, child mortality rate, and population growth rate asymmetrically decrease and increase the school enrolment rate in the short and long run, respectively. It further reveals that in both runs, positive shocks from per capita GDP and per capita government expenditure on education raise the school enrolment rate, while their negative shocks posit adverse effects, implying that the school enrolment is highly sensitive to and swiftly reacts against the rise and fall in the per capita cost of war. Moreover, the results reveal that while there is significant causality from both the positive and negative components of the per capita cost of war, per capita GDP, per capita government expenditure on education, and population growth to both the positive and negative components of the school enrolment rate, there is only a causal nexus from the negative component of the child mortality rate to the school enrolment rate. Based on findings, relevant policy implications are discussed.

Keywords: Asymmetric, Afghanistan, NARDL, war, human resource development.
JEL codes: A2, B23, I25.

1 Introduction

While the world's major powers have been relatively peaceful since the end of World War II, the developing world frequently experienced violence and high insecurity

(Kang and Meernik, 2005). The peace achieved from certain past battles in some parts of the world deserves high credit, while the price paid for it was also high (Gentry, 2008). It reports that, based on the criteria of 1,000 casualties per year, there have been 213 interstate wars from 1816 to 1997, of which 104 happened from 1944 to 1997 (Licklider, 2006), estimating that more than 90 civil wars have occurred from 1945 to 2007, while 20 are ongoing. Whatever the case, war is a devastating phenomenon that destroys the social and economic infrastructure of an economy (Djankov and Reynal-Querol, 2010) and forces both governments and civilians to pay a high price for it. Afghanistan is a true representation of the long-term war and a real example of massive social and economic destruction in the last four decades. In addition to the destruction of physical capital, millions of deaths and injuries, internal displacements, and the loss of substantial private investments during the war, thousands of people, both educated and investors, have fled Afghanistan due to the insecurity caused by protracted civil wars (Ritchie, 2021). From 2015 to 2019, more than 1,000 armed attacks occurred on teachers, students, and educational institutions in Afghanistan, making it one of the worst war-affected nations in the world (Barr, 2022). Since education is a key indicator of enhancing knowledge and skills in human capital (Khan et al., 2020), it has been the primary target for proliferation and war attacks in Afghanistan. As a result, the school enrolment ratio has been significantly impacted, leading to the ban on secondary education for female students—a large proportion of potential human capital in Afghanistan. It also resulted in the loss of a high percentage of professors and teachers and the collapse of a high number of private schools and higher education institutions that were on the brink of failure due to substantial losses in human capital and financial investments.

Thus, it is important to provide empirical insight into the magnitude and effects of the long-term war on human capital development in Afghanistan. The existing literature reports a large number of empirical studies analyzing the impact of war on different socioeconomic indicators in countries. For instance, Karimi and Shafaee (2018) and Waterbury (2019) for Syria; Capasso (2020), Nyere (2020), and Zoubir (2020) for Libya; Elayah and Verkoren (2020), Ruggiero (2019), and Sharp (2020) for Yemen; Šlaus et al. (2007) and Susić et al. (2014) for Croatia; Liyanag and Jayawardena (2013), Wakkumbura and Wijegoonawardana (2017), and Yusoff and

Sarjoon (2017) for Sri Lanka; Hovorun (2020) and Stukalo and Simakhova (2018) for Ukraine; and Serneels and Verpoorten (2015) for Rwanda; but studies are scarce and even non-existent for the context of Afghanistan. This gap has caused two key shortcomings. First, the analytical reports that have produced descriptive information about the status and impacts of war on socioeconomic indicators have led to unclear conclusions in Afghanistan (see, for instance, Skovdal et al., 2014; O'Leary et al., 2018; Panter-Brick et al., 2009a). Second, the non-existence of comprehensive studies has resulted in knowing little about the scale and magnitude of the effects of the long-term war on human resource development in Afghanistan.

Therefore, considering the gap, the study formulates four key questions, among all others. Firstly, is the long-term war associated with human resource development in the long-run? Secondly, does the long-term war have an asymmetrical short-run and long-run effects on human resource development? Thirdly, does human resource development respond to the background invented by the short-run dynamics and the initial disequilibrium? Finally, does long-term war asymmetrically cause human resource development limitations in Afghanistan? Providing rational and evidence-based answers to these questions will not only assist policymakers but will also build a solid foundation in the literature on Afghanistan's war-human resource development nexus.

This study is one of its kind in the existing literature of effects of war on human resource development in Afghanistan, and its contributions are threefold. Firstly, distinctively and unlike almost all the recent studies in the literature, this study delves into quantitative analysis, allowing to determine accurate effects of war on human resource development in Afghanistan. Secondly, the study innovatively employs the asymmetric ARDL model to explore the short-run and long-run asymmetric effects of the war predictors on human resource development to determine both the scale and magnitude of the asymmetries, allowing the presentation of consistent and accurate results. Thirdly, it builds on foundational literature in assessing the concurrent and residual effects of the war on socioeconomic predictors in Afghanistan during the period of war and after it ends.

Among all others, three findings stand out as significant. Firstly, it is found that war asymmetrically moves together with human resource development and differently affects it in the short and long runs. Secondly, statistical evidence supports the hypothesis that war has both concurrent and long-run effects on human resource development in Afghanistan, thus supporting the theoretical expectation of wars negative impact on socioeconomic indicators. The third and most interesting finding is that both positive and negative components of war significantly cause human resource development in Afghanistan.

The remaining parts of this article are structured as follows: Section two presents a brief literature review on the effects of war human resource development. Section three describes the data and variables used in the study. Section four explains the methodology employed to analyze the data. Section five presents the results and provides appropriate discussion. Section six presents the practical contribution of the study. Section seven concludes the article and offers general and specific policy recommendations.

2 Literature review

2.1 Theoretical framework

The existing literature offers various definitions for war. It defines war as a state of armed conflict among different groups of people within or between two or more countries seeking political, economic, and/or other beneficial hegemonies (McNeill and Mueller, 1990). Among all others, Arreguín-Toft (2001) provided a comprehensive definition, causes, and consequences of civil wars that occur between a government (the “on-power-side”) and a rebel group (the “off-power-side”), while the former defends its hegemonic power and the latter pursues dominance. From the last two centuries, several theories have been developed to define war and explain its impacts on the nation. War is a tragedy and a societal catastrophe, whether it is perpetrated by one country against another or imagined to be waged by humanity as a whole (Moosa, 2019). The concept of war is not uncommon to the nations; it is stated that, if not all, almost a large proportion of the nations have witnessed either intense or trifling conflicts. In the common sense, an armed conflict between political groups is linked by aggressions of extensive duration and magnitude (Kersnovski, 2021). Though advances in technology have changed the mechanics of war from those of 1945, the concept has remained unchanged. From the point of view of human resource development, theories predict that the development process of human resources begins with schooling and continues through technical and higher education (Chamarbagwala and Morán, 2011a; O'Brien, 2020; Sohn, 2014), while interstate wars significantly impact the human resource development process both at macro and micro levels via several conduits, such as the destruction of economic, social, and technological infrastructures; death; internal displacement; and human capital flights are the common negative impacts of war on a war-bearing nation, while industrial advancement and business profitability are its positive effects for others. Furthermore, from an economic theory standpoint, there is no general consensus on the duration of the effects of war on human capital. According to neoclassical growth theory with respect to human capital—a factor of production—an economy swiftly recovers and returns to its steady state. Alternative models suggest that the return takes a long time because of the slow recovery of human capital (Acemoglu, 2012; Surya et al., 2021), or that countries can be stuck in a low-level equilibrium where war and loss of human capital coexist (Shemyakina, 2011). At minimum, two key factors may establish this contradiction. First, the duration of wartime in an economy and the leftover social and economic infrastructures; second, the nature of the data and variables augmented in the analytical models.

2.1 Empirical studies

One the one hand, the empirical literature widely documents the effects of long-term war on socioeconomic indicators. It reports the customary measurement of war effects in terms of money, cost of war, effects of war on economy, lost productivity, psychological effects of war, and the number of people killed, wounded, and displaced, while on the other hand, it rarely reports complex methodological studies to measure the effects of war on human resource development. Although the trend of global war has been gradually declining in the past two centuries, the trend of civil war shows a rapid upward shift in the last four decades (Yum and Schenck-Hamlin, 2005). It shows that civil war is most likely to impact the working population and therefore the human resources development process in an affected economy (Gleditsch, 2004). Iden (1971) evaluated the war implications for the human capital in Vietnam. The author argued that war epitomizes the disinvestment of human capital that results not only in the individual and social cost of the citizens and military, but also in the unescapable investments in human resources such as education, health, training, and lucid geographical deployment. The costs in terms of the human capital of the citizen economy are especially severe when war takes place in a country. According to Sunder (2004–2006) armed conflicts significantly suppress the overall strategies concerning human capital development in developing economies. These strategies are mostly based on the national agenda of an economy for growth and development that are adversely influenced by civil war.

Lai and Thyne (2007) examined the negative effects of war on education expenditure and enrolment rates. They consider two causal mechanisms which are the destructive effects of war on the education system through loss of human capital and infrastructure and an increase in the funds to cover military expenditures. The authors employed a UNESCO dataset ranging from 1980–1997 and found that war has a negative effect on the education system and enrolment rate, while no statistical evidence was provided to indicate the adverse effects of budget reallocation from education to military operations. Merrouche (2011) used district-level data in Cambodia to evaluate the long-term effects of civil war on human capital. The authors employed the difference-in-differences and instrumental variable estimators' methods to analyze the data. They found that the overall effects of war are weak on the human capital proxied by school students, though the results were made unclear by specification and measurement bias. Diwakar (2015) employed a set of data relevant to Iraq's household socioeconomic indicators to assess the impact of the long-term war on the education process. The author found that war is strongly correlated with the education of both boys and girls, while the negative impact of the war has been significantly higher on boys, who are more exposed to war proliferation. Similarly, Dabalen and Paul (2014) examined the effects of war on years of schooling in Côte d'Ivoire, using the difference-in-difference method to analyze their data relevant to all cohorts of aging. The authors found a drop in average years of education ranging from 0.2–0.9 fewer years, while they further documented that the effects of war have been extensive on males between 19 and 22 years of age. Furthermore, Swee (2015) investigated the effects of war on educational achievement in Bosnia between 1992 and 1995, looking into probable mechanisms of influence. The author used regional variation in conflict intensity and birth cohort variation to find that cohorts that experienced more war intensity were less likely to complete secondary schooling but not primary schooling. These impacts are far more pronounced in males than in females, and draftee male cohorts had worse physical and mental health than female and non-draftee cohorts. Studies by Gat (2015) and Johnson (2017) revealed that armed conflicts impose serious limitations on accessing education and force the affected government to attempt to defeat poverty rather than facilitating technicalities to develop human resource capacities in producing high quality economic goods and to render the required services for the welfare of human beings. Furthermore, Gurses (2015) state that human resource development plays a significant role in the nation-building process in a war affected country that includes basic, secondary, and higher education, trainings, capacity building, and cultural advancement. Ouili (2017) investigated the effects of war and political instability in Ivory Coast, using a nationally representative household dataset. The author used temporal and geographic variations in Ivorian political instability from 1999 to 2011 to determine its causal effect on children's schooling and death. The author found that individuals who lived in conflict zones and reached the formal age to enroll in school during the era of instability had a 10% reduced chance of enrolling in school and students who attended school during the conflict and resided in an impacted area faced a year-long gap in their educational attainment. Weldeegzie (2017) examined the long-run effects of war on childhood well-being and schooling outcomes in Ethiopia, using child-level panel data and the difference-in-difference method. The author found that children exposed to war have a one-third standard deviation lower height and a 12% higher incidence of childhood impedance. The author further explained that exposed children are less likely to be enrolled in school, complete fewer grades, and are more likely to show reading complications. Safranchuk et al. (2020) evaluated the perceptions of high-ranking participants and witnesses of the war in Afghanistan between 1979 and 1989, using historical descriptive data. The authors present a holistic view, which they define as a patriotic perception and its elements, indicating the key peculiarity of the formation and support the use of interpretations of current international events to rationalize a positive valuation of the long-run war in Afghanistan. Moreover, Juárez et al. (2020) note in their study that flight of human capital is the most expensive cost of war in terms of both money and time in a country. Education which is fundamental to human resource development requires simultaneous investments in time and money, while the occurrence of war enforces the reallocation of budget from education to military operations. Mayai (2022) estimated the causal impact of the war on school enrolment as a proxy for gauging human capital in Sudan using regional variance in exposure to violence. Using the difference-in-differences method, the author found a statistically significant link between school enrolment rate and war. According to the author, schools in South Sudan's combat zones lost 18.5 percent of their entire enrolment. The decline in girls' enrolment is unconnected to the war, which is not surprising given the sociocultural constraints that have historically hampered female educational chances in South Sudan, such as gendered domestic responsibilities, early marriage, and out-of-wedlock pregnancies. Lastly, an in-depth review of the empirical literature shows that O'Brien (2022) assessed the residual effects of armed conflicts on the human capital flight, using a series of logistic regressions and Tajikistan's 2007 living standards dataset. The author found that that war mortalities are insignificant to impact on successive human capital flight, while the relationship between development and conflict is significant and negative. Table 1 presents some more highlights on the recent empirical literature about the war effects on the human capital.

2.3 Insights from empirical studies

The review of the state of the art shows a general consensus on the empirical effects of civil wars on the school enrolment rate, human capital flight, diminishing opportunities for human capital development, and the loss of resources, all of which, individually or in aggregate, cause an economy to bear substantial costs and maintain a steady state for recovery over a longer period than expectations. In terms of direction, the existing literature is chiefly based on country-specific analysis—that is, war-affected countries, given the importance of the consequences of civil wars on economic growth, factors of production, gender, schooling, and capital flight (see, inter alia, Shemyakina, 2011; Gat, 2015; Johnson, 2017; Ouili, 2017; Juárez et al., 2020; and O'Brien, 2022). In terms of analysis, although informative-based studies make up a major proportion of the literature, empirical analysis have significantly increased throughout the last decade. In terms of model input, different studies have used subject-specific proxies for war, noticing a deviation from a general consensus for war proxies. Lastly and more importantly, the state of the art indicates that despite the longest civil war in Afghanistan being unhidden, one can hardly find relevant empirical studies to analyze the effects of war on human capital development in Afghanistan.

Table 1 Summary of relevant literature.

Authors' name and year of publication	Context of the study	Analytical models applied	Key findings of the studies
Miguel et al. (2004)	Panel of African countries	Instrumental variables regression model	The authors found that civil armed conflicts have a significant negative impact on the macroeconomic indicators, especially on growth.
Shemyakina (2011)	Tajikistan	Survey-based analysis	War has a significant impact on female student's enrollment rate.
Chamarbagwala and Morán (2011)	Guatemala	Difference in difference model	The authors found strong negative effects of war on the education of the two most disadvantaged groups, namely rural Mayan males and female.
Miguel and Roland (2011)	Vietnam	Cross-sectional regression analysis	The authors argue that heavy armed conflict, such as bombing, did not generate local poverty traps in Vietnam.
León (2012)	Perú	Regression analysis	The authors exploited the variation in conflict location and birth cohorts to identify the short and long-run effects of war on educational attainment. They found that in the short term, the effects are stronger than in the long run.
Serneels and Verpoorten (2015)	Rwanda	Micro-data analysis	The authors found that by distinguishing between war and genocide, the returns to a steady state, and by implication, correlate with the intensity of war and violence.
O'Leary et al. (2018)	Afghanistan	Descriptive analysis	The authors provided descriptive analysis on the negative effects of long-run war on the middle age children of primary schools.
Capasso (2020)	Libya	Descriptive analysis	The author observes that war has a significant negative impact on socioeconomic indicators, following Libya's slow shift from a progressive revolutionary state to a comprador state and a staging ground for global class warfare.

3 Data and variables

Based on the availability of data for Afghanistan, this study uses a set of time-series data ranging from 2002Q3 to 2020Q1 collected from World Development Indicators sources relevant to the World Bank Group and the Department of Defense Budget of the U.S.A. The variables used are consistent with the theoretical framework and recent studies (Ali, 2004; Umeh, 2008; Maqbool, 2017; Hassan et al., 2019). They are (i) the school enrolment rate expressed as an annual percentage, (ii) the per capita cost of war expressed in millions of US dollars, (iii) the per capita GDP expressed in hundreds of thousands of US dollars, (iv) the per capita government expenditure on education expressed as a percentage of total government expenditure, (v) the population growth rate expressed as an annual percentage, and (vi) child mortality rate of death for the age 5 to 9 years expressed per 1,000 children. Variable (i) is used as the dependent variable, while variables (ii–iv) are used as the independent variables, and (v–vi) are employed as the control variables. Table 2 presents complete information about the variables. The function of the school enrolment rate is to measure the gross enrolment of children in primary schools across a country. This shows the variability of the fundamental attempts at human resource development in post-conflict countries where social development—an integral part of the nation-building process—begins from scratch, such as Afghanistan, though some recent studies (Oketch, 2006; Mohamed, 2020; Harry and Emeh, 2021) employed other proxies for human resource development, such as budget allocation for education, training, capacity building, and enrolment in secondary and higher education. The cost of the war measures the amount of money the United States spent in Afghanistan from 2002 to 2020. Due to a lack of data availability, the cost of war presents aggregate data for Afghanistan and is not disaggregated by provinces, although the intensity of war has been higher in some provinces than in others during the period of this study. Furthermore, this proxy has two more features than previous works' proxies. First, it allows a more accurate estimation than the number of people killed and injured. Second, it provides actual data on the amount of money spent on operating pure military operations. Moreover, GDP measures the overall changes in the total costs, investments, and expenditures during the period and allows for control of the rise and fall of the GDP's effects on human resource development. Theoretically, it is assumed that human capital is correlated with aggregate production—that is, education, training, and capacity-building of a nation (see, for instance, Keji, 2021; Matousek and Tzeremes, 2021; Oketch, 2006).

Table 2 Variables and summary statistics.

			Summary statistics				
Variable	Symbol	Measurement	Mean	Std. Dev.	Min.	Max.	Obs.
School enrollment rate	SER	Annual (%)	44.07	13.89	13.00	57.00	73
Per capita cost of war	COW	USD	9.27	5.69	2.14	19.43	73
Per capita GDP	PGDP	Constant USD	487.77	96.55	330.30	587.56	73
Per capita government expenditure on education	GEE	total GEE (%)	3.81	1.17	1.05	5.23	73
Child mortality rate	CMR	Per 1000 children	4.90	1.12	3.10	6.20	73
Population growth rate	PGR	Annual (%)	3.02	0.64	2.30	4.70	73

Notes: Sample size adjusted from 2002Q3–2020Q1. Std. Dev.: Standard deviation, Min.: Minimum, Max.: Maximum, Obs.: Number of observations, USD: United States dollars, GEE: Government expenditure on education.

The government expenditure on education is also an aggregate used to measure the national expenditure on education. Although a large proportion of Afghanistan's national budget was funded by the United States and its allies, some of these expenditures were funded from the national income of the country and need to be considered as a separate variable in the analysis to avoid any omitted variable bias. Finally, the population growth rate measures the annual change in the population and is employed to capture its effect on human resources. Literature shows that population growth has a significant effect on human resource development both directly and indirectly (Adeosun and Popogbe, 2021).

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Table 3 Correlation analysis.

Variables	SER	COW	PGDP	GEE	CMR	PGR
SER	1.00					
COW	0.45	1.00				
PGDP	0.26	0.29	1.00			
GEE	0.59	0.54	0.20	1.00		
CMR	0.14	-0.22	0.27	-0.28	1.00	
PGR	0.11	-0.11	-0.40	-0.48	0.38	1.00

Notes: Sample size adjusted from 2002Q3–2020Q1. SER: School enrollment rate, COW: Per capita cost of war, PGDP: Per capita GDP, GEE: Government expenditure on education, CMR: Child mortality rate, PGR: Population growth rate.

Table 2 shows some important highlights of the variables. In addition to the variables descriptions, it shows that the average school enrolment rate stands at 44.07%, with a maximum of 57% in the first quarter of 2020. The per capita cost of war stands at 9.27 million US dollars, with a minimum of 4.14 million US dollars and a maximum of 19.43 million US dollars, while in the same period, the per capita GDP rose from $330 to $587. The summary statistics show that population growth and child mortality rates have had an upward trend, whereas per capita government expenditure on education has also grown proportionately from 1.05% to 5.23%. Since the initial descriptive statistics indicate a similar trend among the predictors, it is empirically important to examine their correlation before diving into model specification (O’Brien, 2007). Therefore, the results of the correlation matrix are reported in Table 3. The results indicate both positive and negative weak correlation among the predictors, implying that there exists no perfect and extreme correlation between the variables, which leads the study to continue with model specification (see, for instance, Farrar and Glauber, 1967).

4 Methods

This section explains the econometric methods used to test the asymmetric effects of the long-run war on human resource development in Afghanistan. In order to capture the asymmetric effects of the predictors and to provide consistent and accurate results, the following sub-sections explain the sequential econometric test models used to test the competing hypotheses.

4.1 Unit root test

In time-series analysis, it is important to begin the estimation with the unit root analysis (Smeekes and Wijler, 2020), because determining the integrating order of the predictors avoids model misspecification. More importantly, for the rejected null of symmetries (see Table 8), common unit root tests that assume linearity may produce biased results. Therefore, the study employs Kapetanios and Shin's (2008) unit root test using the technique proposed by Otero and Smith (2017). It is a superior method among all others and accounts for the non-linearity of the series when testing for the null of the non-stationarity of a variable (Olaniyi et al., 2022).

4.2 Cointegration test

To test for a long-run nexus amid predictors, this study uses the ARDL (autoregressive distributed lags) bound test to cointegration model proposed by Pesaran et al. (2001), which is an appropriate method in the presence of structural breaks in the data (Bist and Bista, 2018). Thus, the ARDL bound test equation can be expressed as:

$$\begin{aligned}\Delta SER_t &= \phi_{SER} SER_{t-1} + \phi_{COW} COW_{t-1} + \phi_{RGDP} RGDP_{t-1} + \phi_{GEE} GEE_{t-1} + \phi_{CMR} CMR_{t-1} + \phi_{PGR} PGR_{t-1} + \varpi k_t \\ &+ \sum_{i=1}^{u-1} \vartheta_{iSER} \Delta SER_{t-i} + \sum_{i=0}^{v-1} \vartheta_{iCOW} \Delta COW_{t-1} + \sum_{i=0}^{v-1} \vartheta_{iRGDP} \Delta RGDP_{t-1} + \sum_{i=0}^{v-1} \vartheta_{iGEE} \Delta RGEE_{t-1} \\ &+ \sum_{i=0}^{v-1} \vartheta_{iCMR} \Delta CMR_{t-1} + \sum_{i=0}^{v-1} \vartheta_{iPGR} \Delta PGR_{t-1} + \varepsilon_t \end{aligned} \quad (1)$$

where the change sign Δ is the first difference operator, ϕ is the long-run coefficient, ϑ_i is the short-run coefficient, ϖ presents the trend coefficient, ε is the error term of the model, and all other variables hold the same meaning as described before. The optimal lag length is selected in the AIC, SIC, and HQIC frameworks. Equation (1) is cointegrated if it rejects the null hypothesis of $\phi_{SER} = \phi_{COW} = \phi_{RGDP} = \phi_{GEE} = \phi_{CMR} = \phi_{PGR} = 0$ jointly or separately as $\phi_{SER} = 0$ and $\phi_{COW} = 0, \phi_{RGDP} = 0, \phi_{GEE} = 0, \phi_{CMR} = 0,$ and $\phi_{PGR} = 0$, using the F-statistics. The null is rejected if the F-statistics are greater than the upper bound I(1) desired critical value, while it cannot be rejected if it is less than the lower bound I(0) critical value. The test would be inconclusive about the null if the F-statistics fall between the lower and the upper bounds critical values. The ARDL bound test has two key advantages, among all other common cointegration methods. First, it does not require all the predictors to follow the same integrating order. Second, it produces efficient and accurate results in small samples.

4.3 NARDL model

Based on the objective of the study, a non-linear approach is used to capture the parametric nexus of both the short- and long-run asymmetries of the effects on human resource development due to lengthy periods of war. To this end, assuming that the predictors follow mixed integrating orders of I(0) and I(1) without any I(2) series (Kisswani, 2017), this study uses the non-linear ARDL (NARDL) model proposed by Shin et al. (2014) to capture the potential asymmetric effects of negative and positive changes in the predictors. Moreover, the NARDL model is applied to examine non-linear shifts from short-run to long-run effects, supported by the theoretical assumption of civil wars' asymmetries developed by Arreguín-Toft (2001). Therefore, equation (1) can be adjusted to incorporate the long-run asymmetric components as follows:

$$\begin{aligned} SER_t = \phi^+ COW_t^+ + \phi^- COW_t^- + \phi^+ RGDP_t^+ + \phi^- RGDP_t^- + \phi^+ GEE_t^+ \\ + \phi^- GEE_t^- + \phi^+ CMR_t^+ + \phi^- CMR_t^- + \phi^+ PGR_t^+ + \phi^- PGR_t^- + u_t \end{aligned} \quad (2)$$

where ϕ^+ and ϕ^- are the partial sum of positive and negative changes in the explanatory variables. ϕ^+ and ϕ^- are augmented in the model by the function, say, for instance, $COW_t = COW_t + COW_t^+ + COW_t^-$ using the following framework:

$$COW_t^+ = \sum_{j=1}^{t} \Delta COW_j^+ = \sum_{j=1}^{t} \max(\Delta COW_j, 0),\ COW_t^- = \sum_{j=1}^{t} \Delta COW_j^- = \sum_{j=1}^{t} \min(\Delta COW_j, 0) \quad (3)$$

where linear stationarity, say, I(0) combination (ω_i) of equation (2) and the asymmetric partial sum of squares would be expressed as:

$$\begin{aligned}\omega_i = k = \varphi_1^+ SER_t^+ + \varphi_2^- SER_t^- + \phi_1^+ COW_t^+ + \phi_2^- COW_t^- + \phi_3^+ RGDP_t^+ + \phi_4^- RGDP_t^- \\ + \phi_5^+ GEE_t^+ + \phi_6^- GEE_t^- + \phi_7^+ CMR_t^+ + \phi_8^- CMR_t^- + \phi_9^+ PGR_t^+ + \phi_{10}^- PGR_t^- + u_t\end{aligned} \quad (4)$$

and stationarity is achieved if $\omega_i = I(0)$ with a long-run asymmetric cointegration for the rejected null hypothesis of $\varphi_1^+ = \varphi_2^- = \phi_1^+ = \phi_2^- = \phi_3^+ = \phi_4^- = ... = 0$. Moreover, to overcome the potential multicollinearity issues in equations (2) and (4), their dynamic forms are rationale to address them before analysis. Therefore, equations (2) and (4) can be adjusted as:

$$SER_t = \sum_{i=1}^{p} \eta un_{t-i} + \sum_{i=1}^{q} \begin{pmatrix} \varphi_1^+ COW_t + \varphi_2^- COW_t + \varphi_3^+ RGDP_t + \varphi_4^- RGDP_t + \varphi_5^+ GEE_t \\ +\varphi_6^- GEE_t + \varphi_7^+ CMR_t + \varphi_8^- CMR_t + \varphi_9^+ PGR_t + \varphi_{10}^- PGR_t \end{pmatrix} + u_t \quad (5)$$

where η and $(\varphi_1 - \varphi_{10})$ are the autoregressive and dynamic adjusting parameters, which incorporate the cointegration dynamics. Therefore, based on the above and in line with the context of this study, the NARDL model of Shin et al. (2014) can be written as:

$$\begin{aligned}\Delta SER_t = \rho SER_{t-1} + \phi_1^+ COW_t^+ + \phi_2^- COW_t^- + \phi_3^+ RGDP_t^+ + \phi_4^- RGDP_t^- + \phi_5^+ GEE_t^+ + \phi_6^- GEE_t^- \\ + \phi_7^+ CMR_t^+ + \phi_8^- CMR_t^- + \phi_9^+ PGR_t^+ + \phi_{10}^- PGR_t^- + \sum_{i=1}^{p} \delta_i SER_{t-1} + \sum_{i=0}^{q} \vartheta_{i,1}^+ \Delta COW_{t-i}^+ \\ + \sum_{i=1}^{q} \vartheta_{i,2}^- \Delta COW_{t-i}^- + \sum_{i=1}^{q} \vartheta_{i,3}^+ \Delta RGDP_{t-i}^+ + \sum_{i=1}^{q} \vartheta_{i,4}^- \Delta RGDP_{t-i}^- + \sum_{i=1}^{q} \vartheta_{i,5}^+ \Delta GEE_{t-i}^+ \\ + \sum_{i=1}^{q} \vartheta_{i,6}^- \Delta GEE_{t-i}^- + \sum_{i=1}^{q} \vartheta_{i,7}^+ \Delta CMR_{t-i}^+ + \sum_{i=1}^{q} \vartheta_{i,8}^- \Delta CMR_{t-i}^- + \sum_{i=1}^{q} \vartheta_{i,9}^+ \Delta PGR_{t-i}^+ + \sum_{i=1}^{q} \vartheta_{i,10}^- \Delta PGR_{t-i}^- + u_t\end{aligned} \quad (6)$$

where all the variables are explained before, $\phi^+(\phi^-)$ are the long-run coefficients, $\vartheta^+(\vartheta^-)$ are the short-run coefficients, and u is the error term of the model. Equation (6) is capable of estimating both short-term and long-run asymmetric effects and fulfills the objectives. The present study investigates how human resource development responds long term to a dynamic asymmetric shock by the war, using the dynamic multiplier approach. The dynamic multiplier is used to expedite the sequential growth element as it changes from milieus of the previous short-run dynamism and the early non-stabilities into a new equilibrium after a standard shock. The equation used is expressed as:

$$mh^{+} = \sum_{i=0}^{h} \frac{\partial(SER_t)}{\partial(x_t^{+})} = \sum_{i=0}^{h} \varphi_i^{+},\ mh^{-} = \sum_{i=0}^{h} \frac{\partial(SER_t)}{\partial(x_t^{-})} = \sum_{i=0}^{h} \varphi_i^{-} \quad (7)$$

where SER is the dependent variable; $x_t^{+}(x_t^{-})$ are the positive (negative) partial sum of the explanatory variables; such as COW, RGDP, GEE, CMR, and PGR; and $mh^{+}(mh^{-})$ are the asymmetric long-run coefficients and are empirically consistent when *m* tends to infinity.

4.4 Asymmetric causality test

Finally, this study also investigates the causal relationships among indicators. To this end, the asymmetric causality test of Hatemi-J (2012) is employed. This test determines the upside and downside causality nexus between human resource development and the war predictors, assuming that the school enrolment rate is asymmetrically affected by the predictors and that it reacts more to both positive and negative shocks from the war. In such a context, common methods fail to capture the in-depth causal nexus between the indicators, while an asymmetric causality test accounts for different positive and negative asymmetrical causal effects of the predictors on the outcome variable—that is, human resource development (Toda and Yamamoto, 1995). It also has a preference over other common causality methods, that account for the potential structural breaks in data. This study does not aim to discuss the statistical properties of the Hatemi-J (2012) asymmetric causality test (for this, see, Cevik et al., 2017), rather it dives into its specification relevant to the context of this study. Therefore, let the positive and negative shocks of each predictor in a cumulative form be $y_{1t}^{+} = \sum_{i=1}^{t} \varepsilon_{1t}^{+}$ and $y_{1t}^{-} = \sum_{i=1}^{t} \varepsilon_{1t}^{-}$, $y_{2t}^{+} = \sum_{i=1}^{t} \varepsilon_{2t}^{+}$ and $y_{2t}^{-} = \sum_{i=1}^{t} \varepsilon_{2t}^{-}$ with a permanent effect on the underlying indicator. Thus, $y_t^{+} = (y_1^{+}, y_2^{+})$ and $y_t^{-} = (y_1^{-}, y_2^{-})$ vectors are employed to test for the asymmetric causality nexus in the following vector autoregressive (VAR p-q) model:

$$y_t^{+} = v + A_1 y_{t-1}^{+} + \ldots + A_p y_{t-p}^{+} + u_t^{+} \quad (8)$$

where v, y_t^{+}, u_t^{+}, and A present the 2×1 vector of the intercept, 2×1 vector of the predictors, 2×1 vector of the error term, and the 2×2 matrix of parameters for k $(k = 1,2,3,\ldots,p)$ lag orders, respectively. Based on the Toda and Yamamoto (1995) approach, three step computation is performed to test the asymmetric causality nexus among predictors, such as unit root test to determine the integrating order of the variables, optimal lag length selection, and the estimation of modified VAR model with $k + d_{\max}$. Finally, the Wald test following asymptotic chi-squared distribution is applied to test the null of no asymmetric causal relationship between the variables. Moreover, to control for the abnormal and ARCH (autoregressive conditional heteroskedasticity) effects in the residual, the present study employs bootstrap simulation with 1,000 replications to find the critical values.

5 Results and discussions

5.1 Unit root analysis

This section begins with the unit root analysis of the predictors using Kapetanios and Shin's (2008) method with an automatically optimal lag length selected by the AIC and SIC frameworks. The results are presented in Table 4. They indicate that the corresponding p-values for SER, CMR, and PGR are significant for the rejected null hypothesis of non-stationarity at level at 1%, whereas the remaining variables are insignificant to reject the null at level; rather, they reject the null after taking their first difference. Therefore, it can be concluded that the predictors are either I(0), such as SER, CMR, and PGR, or I(1), such as COW, RGDP, and GEE, without any I(2) series.

5.2 Cointegration analysis

Considering the formulated hypotheses, this study uses the ARDL bound test approach of Pesaran et al. (2001) to test for the long-run nexus amid predictors. The AIC, SIC, and HIC frameworks with the maximum six lags criterion have been used to select the optimal lag length, of which, $(p = 1,\ q = 1,0,1,0,1)$ has been determined by all the stated criteria, using the "varsoc" command in Stata 17. The results are reported in Table 5. The findings reveal that school enrolment rate and regressed predictors such as per capita cost of war, per capita GDP, per capita government expenditure on education, child mortality rate, and population growth rate have a long-run relationship. This implies that, intuitively, it is reasonable to assume that long-run war and the relevant predictors are tied together with human resource development and they move together in the long-run. Corresponding to the theoretical background, a long-term war, as in Afghanistan, that lasted for more than four decades posits two types of tie-ups, such as concurrent impact and residual effects, which move together with the socioeconomic variables. The assumption of the concurrent relationship between them requires a deeper analysis, for which equation (6) is also employed to test for the asymmetric bound test. It derives the Wald statistics to examine the short- and long-run asymmetries of the per capita cost of war, per capita GDP, per capita government expenditure on education, child mortality, and population growth rate on human resource development. The results of the asymmetric ARDL bound test and the Wald statistics are reported in Table 5. The upper part of the table presents the asymmetric ARDL bound test, while its lower part reports the Wald statistics.

Table 4 Non-linear unit root test results.

Variables	Kapetanios and Shin (2008) I(0)	Kapetanios and Shin (2008) I(1)
SER	-4.367***	-7.018***
COW	-0.912	-3.605***
PGDP	-1.666	-4.238***
GEE	-1.208	-3.962***
CMR	-3.451***	-7.420***
PGR	-3.927***	-7.812***

Notes: *** significant if (p<0.01), ** if (p<0.05), and * if (p<0.10). Sample size adjusted from 2002Q1 to 2020Q1. SER: School enrollment rate, COW: Per capita cost of war, PGDP: Per capita GDP, GEE: Per capita government expenditure on education, CMR: Child mortality rate, PGR: Population growth rate. Adjusted observations: 59.

Table 5 ARDL bound test results.

Test statistics	Values	Significance	Critical values I(0)	Critical values I(1)
F-statistics (k=5)	22.134***	1%	3.15	4.43
t-statistics	-10.168***	1%	-3.43	-4.99

Notes: *** significant if (p<0.01), ** if (p<0.05), and * if (p<0.10). The null hypothesis indicates a long-run cointegration among the indicators. k=5 (number of regressors fit in the regression), Critical values come from Pesaran et al (2001). Adjusted observations: 59.

Table 6 Asymmetric cointegration and Wald test results.

Model estimates	Values	1% critical values I(0)	1% critical values I(1)
Asymmetric ARDL bound test			
F-statistics	18.871***	3.15	4.43
t-statistics	-14.088***	-3.43	-4.99
Wald test			
Short-run asymmetries, $\sum_{j=0}^{p-1} n_j^+ = \sum_{j=0}^{p-1} n_j^-$ test statistics	933.481***		[0.000]
Long-run asymmetries, $-\xi^+ / \varphi = -\xi^- / \theta$ test statistics	1246.003***		[0.000]

Notes: *** significant if (p<0.01), ** if (p<0.05), and * if (p<0.10). Critical values come from Pesaran et al (2001). [ ] presents the p-values for the Wald test statistics. Adjusted observations: 59.

The asymmetric ARDL bound and Wald test results reported in Table 6 provide deeper insights into the cointegration between predictors (see, for instance, Bernstein and Nielsen, 2019). The statistics reveal that the school enrolments per capita cost of war, and other augmented predictors exhibit a long-run asymmetric nexus, where the same results are confirmed by a symmetric ARDL bound test in Table 5. Thus, it necessitates to test the null hypothesis of $H_0: \phi_1^+ = \phi_2^- + \vartheta_3^+ = \vartheta_4^- = ... = 0$ (symmetries) against its alternative $H_A: \phi_1^+ \neq \phi_2^- + \vartheta_3^+ \neq \vartheta_4^- \neq ... \neq 0$ (asymmetries), using the Wald test.

The results of the Wald test (short-run asymmetries = 933.418 and long-run asymmetries = 1246.003) are significant for the rejected null hypothesis of both the short and long-run symmetries, which implies that the per capita cost of war, per capita GDP, per capita government expenditure on education, child mortality rate, and population growth rate have different asymmetrical effects on the school enrollment rate. In sum, the Wald test results affirmatively indicate the significant impact of the predictors on human resource development, leading the study to check for the scale and magnitude of the asymmetric effects of the cost of war on human resource development. In this faith, it proceeds to estimate the asymmetric ARDL model and discusses the findings.

5.3 Non-linear ARDL results

In this section, the NARDL model is computed using equation (6) and presents the results of the dynamic multipliers based on the computation of equation (7) to delve into the asymmetric effects of the per capita cost of war and other explanatory variables on the school enrolment rate—that is, the human resource development in Afghanistan. The estimation of equations (6–7) is based on the optimal lag length using the AIC, SIC, and HQIC frameworks—$(p = 1,\ q = 1,0,1,0,1)$. The results are reported in Tables 7 and 8. Table 8 reports the standard asymmetric ARDL estimates of both positive and negative partial sum effects, while Table 8 reports the short and long run estimates of the NARDL model. The results of some important post-estimate diagnostic tests relevant to the computation of equation (6) are provided at the rare part of Table 10.

Table 7 Asymmetric ARDL estimates.

	Model estimates: NARDL					
Estimates	COW^{+}_{t-i}	COW^{-}_{t-i}	$PGDP^{+}_{t-i}$	$PGDP^{-}_{t-i}$	GEE^{+}_{t-i}	GEE^{-}_{t-i}
Coefficients	-0.547***	0.564***	0.190***	-0.119*	8.012***	-3.186***
t-statistics	-4.321	9.124	6.635	-3.016	5.642	-10.331
p-values	0.002	0.000	0.000	0.091	0.000	0.000
			CMR^{+}_{t-i}	CMR^{-}_{t-i}	PGR^{+}_{t-i}	PGR^{-}_{t-i}
Coefficients			1.888	-1.935***	-1.514***	1.971***
t-statistics			1.081	-22.100	-6.115	8.004
p-values			0.319	0.000	0.002	0.000

Notes: *** significant if (p<0.01), ** if (p<0.05), and * if (p<0.10). Sample size adjusted from 2002Q1 to 2020Q1. SER: School enrollment rate, COW: Per capita cost of war, PGDP: Per capita GDP, GEE: Per capita government expenditure on education, CMR: Child mortality rate, PGR: Population growth rate. [+] and [–] present positive and negative partial sum of squares, respectively. Adjusted observations: 59.

The results in Table 7 indicate that a positive partial sum change in the per capita cost of war causes the SER to decrease by 0.547% and that a negative partial sum change in the per capita cost of war causes the SER to increase by 0.564%. In addition to confirming the asymmetric effects of the per capita cost of war on the SER, the result is consistent with the theoretical concept of the effects of armed conflict and violence on human resource development in a conflict environment (see, for instance, Poirier, 2012; Buvinić et al., 2014). In line with the practical survey conducted by Catani et al. (2009) on the war in Afghanistan, the results confirm that the intensity of the war significantly decreases the school enrolment rate, while a decline in the intensity of the war creates a temporal relaxation, causing a higher SER. Furthermore, the results show that as the per capita GDP increases, the school enrolment rate increases by 0.19%, while its negative partial sum causes the school enrolment rate to decrease by 11.9%. The per capita government expenditure on education has the same positive and negative partial sum effects on the school enrolment rate as the per capita GDP by magnitude but by a difference scale of 8.012% and 3.186%, respectively. Moreover, the results indicate that positive partial sum changes in child mortality rate increase the school enrolment rate by 1.88%, while its negative partial sum decreases the school enrolment rate by 1.935%. Considering the theoretical expectations, the results confirm that a positive partial sum change in the population growth rate decreases the school enrolment rate, while its negative partial sum change increases the SER. This is also linked with the fact that swift population growth postulates adverse effects on economic growth of diverting resources from productivity-enhancing technologies and industries toward human capital and education, which are assumed to have lower rates of return. Since substantial schooling costs are required to maintain educational standards, expanding the coverage and levels of education posits a discouraging task for a post-conflict environment (Kelley, 1996; Meeks, 1982). The results presented in Table 7 show that, except for the positive partial sum of the child mortality rate, all predictors are significant at the 1% level.

Table 8 reports the short-run and long-run asymmetric effects of the predictors on the school enrolment rate—that is, the human resource development in Afghanistan. It demonstrates that COW^{+}_{t-i} decreases the school enrolment rate both in the short and long runs by 1.382% and 0.189, respectively. But as expected, COW^{-}_{t-i} increases the SER in the runs by 3.1% and 0.195%, respectively. This implies that a positive partial sum change in the per capita cost of war has a negative impact, while its negative partial sum shock imposes an incremental effect on the school enrolment rate in Afghanistan. This is related to the fact that war has a significant negative impact on socioeconomic indicators and human resource development both in the short and long runs. For instance, war-effected societies suffer from declining production and increased poverty; education plummets due to proliferation and human capital flight; and an intense displacement both at internal and international levels (Musisi and Kinyanda, 2020). $PGDP^{+}_{t-i}$ and $PGDP^{-}_{t-i}$ show a counterevidence. They indicate that a positive partial sum change in the per capita GDP spurs the school enrolment rate, whereas its negative shock reduces the SER both in the short and long runs. In fact, per capita GDP has been augmented to represent the economic size and to exhibit the overall variability of economic activity during the period of armed conflict in the country. Therefore, a rise in GDP—economic activity—positively affects the overall sector, including education. This is linked with the theoretical concept of the growth-education nexus as in Dahliah and Nirwana (2021), where a rise in GDP is expected to expand the coverage and schooling standards in Third World countries (see, for example, Buvinić et al., 2014; Keji, 2021; Maqbool, 2017). For the per capita government expenditure on education, the results show that GEE^{+}_{t-i} has an adverse effect on the SER in the short and long runs, implying that a positive shock from the per capita government expenditure on education reduces the SER while its negative shock, say, GEE^{-}_{t-i} increases the outcome variable.

Table 8 Short and long run asymmetric effects.

Variables	Short-run effects Coefficients	t-statistics	p-values	Long-run effects Coefficients	t-statistics	p-values
COW^{+}_{t-i}	-1.382***	-6.45	0.000	-0.189***	-4.72	0.000
COW^{-}_{t-i}	3.099***	4.93	0.000	0.195***	5.28	0.000
$PGDP^{+}_{t-i}$	0.021***	5.65	0.000	0.066**	2.27	0.029
$PGDP^{-}_{t-i}$	-1.365***	-9.41	0.000	-0.022***	-4.89	0.000
GEE^{+}_{t-i}	0.998***	10.33	0.000	0.414***	4.98	0.000
GEE^{-}_{t-i}	-0.701**	-2.88	0.022	-0.779***	-11.36	0.000
CMR^{+}_{t-i}	-1.228*	-1.88	0.068	-1.027**	-2.25	0.024
CMR^{-}_{t-i}	0.641***	3.91	0.000	1.858	1.09	0.465
PGR^{+}_{t-i}	-1.674***	-3.31	0.001	-1.858***	-3.871	0.001
PGR^{-}_{t-i}	1.989***	3.89	0.000	1.099***	4.74	0.000
Diagnostic checks						
Adjusted r-squared	0.871				CUSUM	Stable
F-statistics [20, 50]	9.59*** (0.000)				CUSUMSQ	Stable
Portmanteau [chi^2]	41.97 (0.142)					
Breusch-Pagan heteroskedasticity test [chi^2]	1.38 (0.325)					
Ramsey RESET [F]	0.64 (0.740)					
Jarque-Bera [chi^2]	1.32 (0.552)					

Notes: *** significant if (p<0.01), ** if (p<0.05), and * if (p<0.10). Sample size adjusted from 2002Q1 to 2020Q1. SER: School enrollment rate, COW: Per capita cost of war, PGDP: Per capita GDP, GEE: Per capita government expenditure on education, CMR: Child mortality rate, PGR: Population growth rate. [+] and [–] present positive and negative partial sum of squares, respectively. ( ) indicates p-values. Adjusted observations: 59.

This result reflects the real-life example of Afghanistan's situation during the period of study where a large proportion of the public expenditure was incurred on the military operation and little was allocated to other remaining sectors of the economy. On the control variables' front, the results reveal that CMR^{+}_{t-i} accompanied by negative coefficients, say, a positive partial sum change in the child mortality rate increases the rate of school enrolment by 1.228% and 1.027% in the short and long run, respectively, and vice-versa. Lastly, the population growth rate has been augmented in the model to control for its effects on the school enrolment rate. The results indicate that PGR has adverse effects on the school enrolment rate. A positive partial sum shock from PGR decreases the SER, while its negative partial sum shock increases the SER both in the short and long-runs. It is an obvious fact that rapid growth in the population rate expands the schooling cost and requires a comparative enlargement in the level of schooling coverage, which would seem difficult for countries facing long-term war, such as Afghanistan. Liu and Yamauchi (2014) also found rapid population growth raises household consumption, which has a negative impact on food security in developing economies—thereby reducing the potential for investing in human capital.

For model validity, some important diagnostic tests are computed and presented underneath Table 8. The Portmanteau, Breusch-Pegan, and Jarque-Bera results are not significant to reject the null of no autocorrelation, homoskedasticity, and normal distribution of the residuals, while the adjusted r-squared, CUSUM, and CUSUMSQ results demonstrate the high fitness of the model, its coefficient, and model stability, respectively. The results of the CUSUM and CUSUMSQ tests are also depicted in Figure 1. Both CUSUM and CUSUMSQ results indicate the residuals are within the 5% bound of significance, showing stable coefficients and model.

Finally, the present study examines the dynamic multiplier behavior of the temporal dynamics of the per capita cost of war and other augmented predictors to consider the backgrounds invented by the short-run dynamics and the initial disequilibrium due to the shocks to human resource development proxied by SER. The rejected null hypothesis shown in the upper part of Table 5 indicates that there exists an initial equilibrium, say, a long-run nexus amid predictors. Thus, employing the dynamic multipliers provides deeper insights into the statistical validity of the asymmetric results presented in Tables 7 and 8. Figure 2 shows that the standard shock of both the positive and negative partial sum of the predictors' effects on human resource development in the runs. It indicates that a nose-dive in the per capita cost of war positively increases the school enrolment rate (see, cumulative effects of COW on SER) shown by the red line, while an increase in the per capita cost of war has an adverse effect on the SER shown by the green line. The results show a counter-example to PGDP's effects on SER. That is, a standard positive partial sum shock from PGDP decreases the SER, whereas a negative shock increases the SER. On the GEE front, the results indicate that a positive shock from GEE increases the SER, while its negative shock distorts the SER. Although the PGR effects on SER provide the same results as the GEE effects, the result for CMR is the vice versa. It shows that a positive partial shock to the child mortality rate has a negative effect, while a negative partial shock increases the SER. This is clearly linked with the fact that the intensity of war and armed conflicts has caused a large number of children's deaths and physical disabilities on one hand, while on the other hand, one particularly devasting fact, often ignored, is the proliferation of armed attacks on schools, leading to increased fear among parents to prevent their children from attending schools in Afghanistan (Catani et al., 2008). The results are consistent with the findings of Cameron et al. (2021), who discovered the effects of violence against Afghan children at the community level during the period of armed conflict (see also, Panter-Brick et al., 2009).

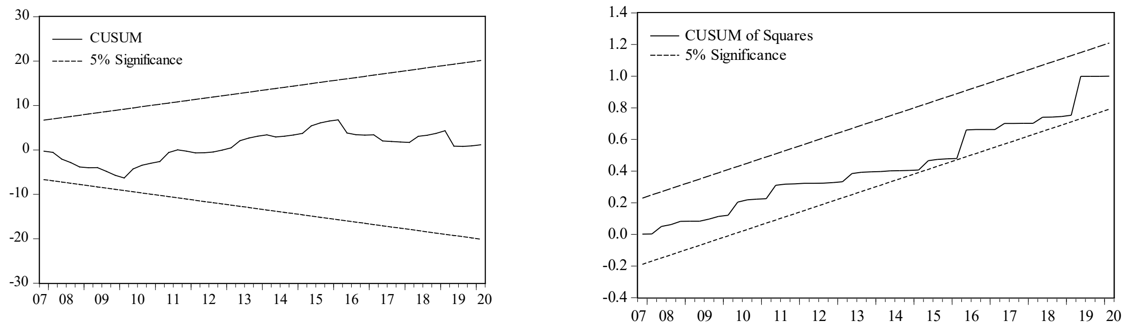

Figure 1 NARDL CUSUM and CUSUMSQ test results.

Note: CUSUM: Cumulative sum, CUSUMSQ: Cumulative sum of squares.

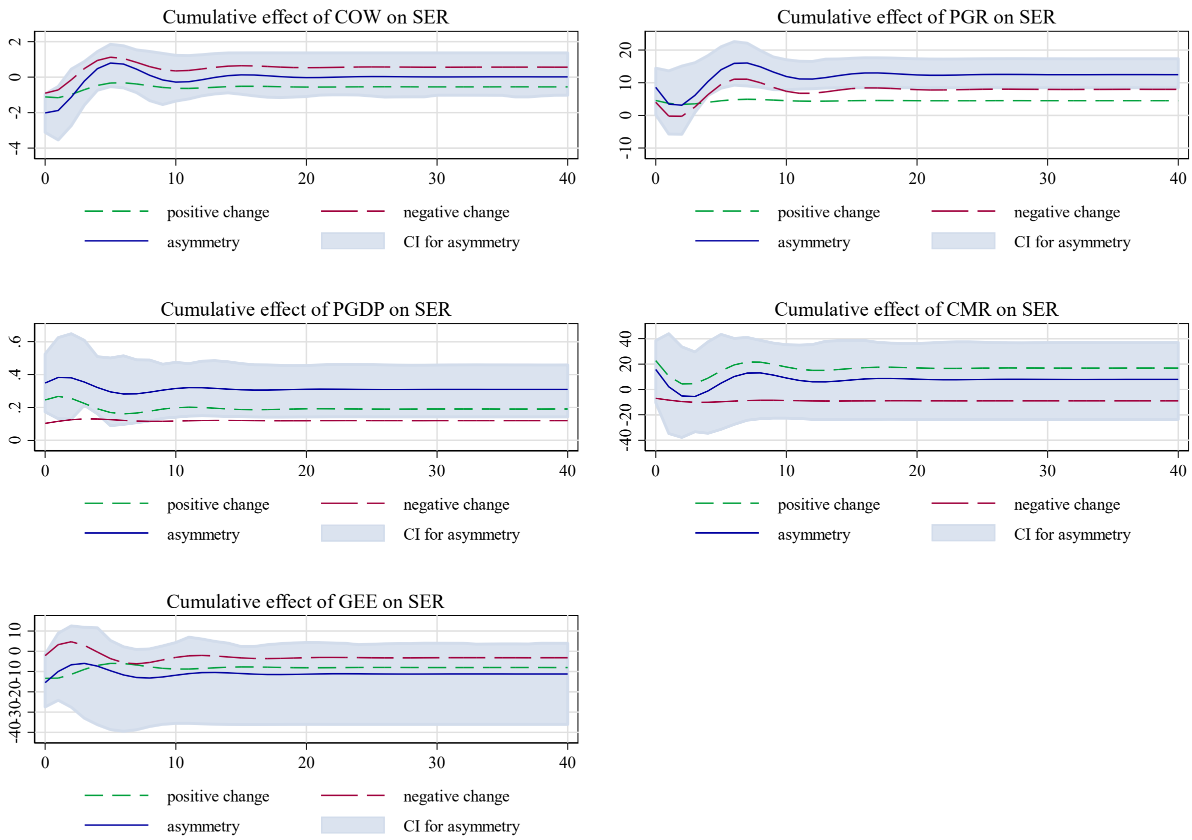

Figure 2 Dynamic multipliers.

Note: 95% confidence interval bootstrap is based on 100 replications.

5.4 Asymmetric causality test results

As a last step in the analysis, this study estimates the asymmetric causality nexus between school enrolment rate, per capita cost of war, per capita GDP, per capita government expenditure on education, child mortality rate, and population growth rate, using Hatemi-J's (2012) method based on the modified VAR model of Toda and Yamamoto's (1995) approach. The results are reported in Table 10. Optimal lag length of (2) is selected using the AIC, SIC, and HQIC frameworks with $d_{\max} = 2+5$ modified VAR order for estimation. Employing the bootstrap technique with 1,000 replications based on the asymptotic chi-squared distribution for the Wald test, the critical values are derived to test the null hypothesis of no asymmetric causality amid predictors. The results clearly indicate that there is a significant asymmetric causal relationship between the predictors at a 1% significance level. The results indicate that both positive and negative shocks from the per capita cost of war strongly cause school enrolment rates and reject the null at 1% significant level. Moreover, both positive and negative shocks from per capita GDP, per capita government expenditure on education, and population growth rate have bidirectional significant asymmetric causal relationships with the school enrolment rate. The negative shock from the child mortality rate is significant to cause the school enrolment rate, while its positive shock is insignificant. The findings only show a bidirectional asymmetric causality from predictors to the school enrolment rate, with a flip-side causality being insignificant and thus not reported. Conceptually, the benchmark of this study is to find out the asymmetric causal nexus between the human resource development and the war predictors. The results presented in Tables 6 and 7 are strongly supported by the results reported in Table 9, confirming the existence of both asymmetric effects of the war on human resource development and the asymmetric causality nexus among them. These results highlight that the long-run war in Afghanistan moves together with the deterioration of human capital in the country at a slow speed of convergence. The results support the findings of Serneels and Verpoorten (2015) in the context of wartime effects in Rwanda in the early 1990s. The empirical evidence shows that regardless of the geography and size of the economy, war and armed conflicts cause human resource development to decline concurrently with the war period and after it ends, with an unspecified time for the community to return to its pre-war condition (see also, Alade et al., 2021; Carbonnier and Wagner, 2015).

Table 9 Asymmetric causality results.

Causality direction	$d_{\max}$	Test statistics	Critical values 1%	5%	Result
$COW^{+}_{t-i} \rightarrow SER^{+}_{t-i}$	2+5	12.443***	7.106	3.934	Reject *Ho*
$COW^{-}_{t-i} \rightarrow SER^{-}_{t-i}$	2+5	22.016***	7.106	3.934	Reject *Ho*
$PGDP^{+}_{t-i} \rightarrow SER^{+}_{t-i}$	2+5	34.001***	7.106	3.934	Reject *Ho*
$PGDP^{-}_{t-i} \rightarrow SER^{-}_{t-i}$	2+5	18.189***	7.106	3.934	Reject *Ho*
$GEE^{+}_{t-i} \rightarrow SER^{+}_{t-i}$	2+5	10.336***	7.106	3.934	Reject *Ho*
$GEE^{-}_{t-i} \rightarrow SER^{-}_{t-i}$	2+5	16.762***	7.106	3.934	Reject *Ho*
$CMR^{+}_{t-i} \rightarrow SER^{+}_{t-i}$	2+5	3.841	7.106	3.934	Do not reject *Ho*
$CMR^{-}_{t-i} \rightarrow SER^{-}_{t-i}$	2+5	4.212**	7.106	3.934	Reject *Ho*
$PGR^{+}_{t-i} \rightarrow SER^{+}_{t-i}$	2+5	27.449***	7.106	3.934	Reject *Ho*
$PGR^{-}_{t-i} \rightarrow SER^{-}_{t-i}$	2+5	19.389***	7.106	3.934	Reject *Ho*

Notes: *** significant if (p<0.01), ** if (p<0.05), and * if (p<0.10). Sample size adjusted from 2002Q1 to 2020Q1. SER: School enrollment rate, COW: Per capita cost of war, PGDP: Per capita GDP, GEE: Per capita government expenditure on education, CMR: Child mortality rate, PGR: Population growth rate. [+] and [–] present positive and negative partial sum of squares, respectively. Adjusted observations: 59.

6 Practical contributions

This study raised arguments about the consequences of long-term civil wars on human resource development in Afghanistan, prompted by a significant gap in the existing literature. Pursuant to our little understanding of war's impact on socioeconomic indicators, the present study attempted to fill the gap and enhance the empirical knowledge of the war's consequences on human resource development on a battlefield that hosted a civil war for more than four decades. To that end, it draws on the asymmetric theorem of civil wars developed by Arreguín-Toft (2001) with those of the evident and practical armed conflicts that occurred between the government (resourceful) and the rebel groups in Afghanistan, supported by the rejected null of hypothesis the symmetries of long-term war to human resource development (see Table 6). Furthermore, the findings (see Tables 7 and 8) lend statistical support that both increases (positive shocks) and decreases (negative shocks) in the intensity of civil wars critically explain their impacts on human resource development, keeping other variables constant. The key difference between previously mentioned studies and the present one is that, despite evidencing significant asymmetries in civil war occurrences, they emphasized the static and dynamic contemporaneous link between different socioeconomic indicators and the armed conflicts in the context of their studies (see, for instance, Miguel et al., 2004; Miguel and Roland, 2011; Merrouche, 2011; León, 2012; Dabalen and Paul, 2014; Moosa, 2019; Alade et al., 2021). Moreover, it also reveals that assuming a contemporaneous nexus amid war and human resource development not only deviates from the theoretical prediction, but also leads to perplexing conclusions.

7 Conclusions

Unlike most of the recent studies considering a stable and secured economy to discuss the effects of predictors on human resource development either at micro or macro levels, this study hypothesized the asymmetric effects of long-run war and other well-known predictors on human resource development in Afghanistan during the period spanning from 2002Q1–2020Q1, which is one of its kind in the existing literature. Employing datasets collected from WDI (World Development Indicators) and the Department of Defense Budget of the United States and using non-linear autoregressive distributed lags, dynamic multipliers, and asymmetric causality techniques to test the competing hypotheses, the initial results indicate that the predictors exhibit mixed integrating orders and long-run symmetric and asymmetric relationships. Employing the asymmetric ARDL model, interesting results were highlighted by statistical evidence. It shows that positive partial sum shocks from the per capita cost of war, child mortality rate, and population growth exert negative asymmetric impacts on the school enrolment rate, while their negative partial sum shocks increase the rate of school enrolment. The results further indicate that the per capita GDP and the per capita government expenditure on education have counter-effects on the school enrolment rate, meaning that their positive partial sum shocks have a positive effect, whereas their negative partial sum shocks, such as a decrease in per capita GDP and per capita government expenditure on education, have a negative effect on school enrolment. Based on the critical results from the non-linear ARDL model, the study explored the temporal dynamics of the per capita cost of war and other augmented predictors to consider the backgrounds invented by the short-run dynamics and the initial disequilibrium due to the shocks to human resource development using dynamic multipliers. The results demonstrate that asymmetric shocks of both the positive and negative partial sums of the predictors' significantly impact human resource development, while a downtrend in the per capita cost of war positively increases the school enrolment rate, accompanied by periods of correction. Furthermore, an asymmetric causality technique is employed to explore the asymmetric causality nexus among the predictors. Using the asymmetric causality test, the results show that there is significant causal nexus running from the positive and negative components of the per capita cost of war, per capita GDP, per capita government expenditure on education, and population growth to both the positive and negative components of the school enrolment rate. It also shows that there is only a causal nexus from the negative component of the child mortality rate to the school enrolment rate. In sum, it is found that war devastates the school enrolment rate and, thereby, the education sector, in which human capital is nurtured. One general recommendation is that, if at all possible, war must be avoided; if it fails to yield peace in Afghanistan and the war continues, the loss to human capital should be minimized. Based on the findings, three important and yet specific recommendations are also provided, as follows:

[i]. Human capital flight and brain drain must be minimized to an acceptable low level by means of an incentive-based approach, especially for the teachers and instructors, to keep the schools. Schools are the places where future human capital signals the potential for post-conflict reconstruction.

[ii]. The government should provide consistent and sufficient safeguarding tools and equipment to schools during wartime and sufficient financial attention to them afterward.

[iii]. Government organizations, social activists, and the media must try to make families an institution of dedication, strength, and pride in order to increase school enrolment.

6.1 Limitations of the study

Although we tried to minimize the limitations of the study in terms of scope and applicability, the study has some limitations. Firstly, disaggregated data is not available at the state-level to test the sensitivity of rural and urban school enrolment rates to war. Secondly, despite employing complex modeling to capture the effects of war on human resource development, this study does not account for the theological reasons that caused several interventional wars in Afghanistan. Future studies may use an instrumental variable approach to test this predictor as well.

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Conflict of interest

The authors do not have any competing interests to declare.

Data and materials

Datasets relevant to school enrolment ratio, GDP, population, and government final expenditure on education are collected from the World Development Indicators sources available at (https://databank.worldbank.org/source/world-development-indicators) and dataset relevant to cost of war is collected from the Department of Defense Budget of the United States available at (https://www.state.gov/countries-areas/afghanistan/).

Contribution

All authors have equal contribution in writing, editing, and completing this study.

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CHAPTER 6: PAPER 4 – THE VALIDITY OF THE ENVIRONMENTAL KUZNETS CURVE IN THE PRESENCE OF LONG-RUN CIVIL WARS: A CASE OF AFGHANISTAN

6.1. Introduction

The fourth study of the present thesis explored the environmental consequences of long-term civil wars in Afghanistan. Using the EKC (Environmental Kuznets Curve) hypothesis, the study investigated whether civil wars worsen environmental quality and environmental degradation, and whether they have a relationship with other macroeconomic predictors such as child mortality rate, disposable income, crude death rate, energy consumption, population growth rate, and trade openness. The results of this research were important from several perspectives. For example, from a community point of view, it is important to increase the level of community awareness in order to control and reduce the effects of war on the quality of the environment and reduce the impact of environmental degradation on socio-economic indicators. From a policy point of view, the results could influence policymakers and provide the basis for effective measures to eliminate or reduce the effects of civil war on the environment. Thus, it led the study to produce the fourth article of the present thesis.

Although the present study is a new step in the existing literature on the EKC hypothesis for war-torn zones, it aimed to achieve specific objectives. First, to innovatively extend the common EKC model with civil war predictors to test whether, in the presence of war, an inverted U-shaped link exists between per capita real income and pollutant predictors. Second, in the short and long run, to see if there is a causal link between the EKC predictors in a conflict zone. Third, in the presence of long-term civil wars, to test the EKC hypothesis for a specific war zone, say, Afghanistan, rather than panel analysis, and to provide accurate and consistent results to offer specific policy measures.

6.2. Under review paper

The validity of the Environmental Kuznets Curve in the presence of long-run civil wars: A case of Afghanistan

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Abstract

This study aims to explore the long-run impact of civil wars on environmental degradation in a war-torn society such as Afghanistan using the conceptual framework of the Environmental Kuznets Curve (EKC) and models augmented with pollutants, civil wars, comprehensive financial development index, and macroeconomic predictors on a set of data from 2002Q1–2020Q1. However, while the results confirm long-run relationships amid indicators by the ARDL (autoregressive distributed lags) bound test, the results of the vector error-correcting model to Granger causality reveal bidirectional causality links between CO_2 emissions, per capita real GDP, civil wars, the financial development index, energy consumption, trade openness, and the inflation rate in the long-run, while the findings extend to confirm multidimensionality and interdependencies among predictors in the short-run. Moreover, the ARDL results indicate dual findings. First, it confirms that civil wars—a key variable of interest—the financial development index, per capita real GDP, population growth, and the inflation rate significantly increase CO_2 emissions, while the squared per capita real GDP, energy consumption, and trade openness reduce CO_2 emissions both in the short and long runs. Second, the results confirm an inverted U-shaped relationship, supporting the validity of the EKC hypothesis in Afghanistan. Based on the findings, appropriate policy measures are recommended.

Keywords: EKC, Afghanistan, ARDL, environmental quality, VECM

JEL codes: C12, D74, F64

1 Introduction

Since the 1990s, the initial idea of the Environmental Kuznets Curve (EKC) has been put forward by Grossman and Krueger (1991) and empirically described by Kuznets (1995), it has gained prominence in the empirical literature to delve into the co-movement of environmental degradation and economic growth, forming a consensus amongst environmental economists that environmental quality deteriorates in the early stage of economic development up to a certain level—a turning point—while it descends afterward. Given this background, higher economic performance requires higher inputs of materials, resulting in the production of large amounts of carbon emissions; whilst equally, higher employability and a rise in per capita real income make it easy to ignore the long-term environmental consequences (Dasgupta *et al*., 2001). At a later stage of development, people with a higher per capita income are sensitive and give more value to controlling and reducing environmental pollution (Dinda, 2004). This is where the changing pattern of the nexus between economic development and environmental degradation forms the EKC, that is, an inverted U-shaped nexus between them (Rahman and Alam, 2022a).

Regardless, recent studies on the EKC hypothesis have mainly taken five directions. The first group (see, *inter alia*, Rahman and Alam, 2022b; Shafiei and Salim, 2014; Kasman and Duman, 2015; Al-Mulali *et al*., 2015; Dogan and Seker, 2016; Churchill *et al*., 2018; Weber and Sciubba, 2019; Huang *et al*., 2021; Thangaiyarkarasi and Vanitha, 2021), examined the EKC hypothesis in developed economies and presented mixed results. The second group of studies, such as Lean and Smyth (2010); Apergis and Ozturk (2015); Abdouli and Hammami (2017); Khoshnevis and Dariani (2019); Nkalu *et al*. (2020); Sultana *et al*., 2022; and Khalid *et al*. (2021), explored the validity of the EKC in developing economies and provided controversial results due to the use of different predictors and estimation models. The third group of studies examined the EKC from global perspectives (see, *inter alia*, Sharma, 2011; Nasreen and Anwar, 2015; Azam and Khan, 2016; Balado-Naves *et al*., 2018; Danish *et al*., 2018; Jiang and Ma, 2019). The fourth group of studies, such as Chen *et al*. (2007), Shahbaz *et al*. (2014), Can and Gozgor (2017), Moghadam and Dehbashi (2018), Salahuddin and Gow (2019), Gokmenoglu *et al*. (2019), Hassan *et al*. (2019), focused on individual economies to test the EKC. The fifth group of studies, like Kengni (2013), Parlow

(2014), Bildirici and Gokmenoglu (2020), and Qayyum *et al*. (2021), tested the EKC hypothesis in post-conflict environments and presented implicit results by ignoring the effects of civil wars in their analysis. However, war-torn societies bear frequent and heavy military operations and are assumed to suffer dual effects, the first of which is the same as the general assumptions, but the second is the use of heavy military equipment that produces an extensive amount of carbon emissions and greenhouse gases, resulting in higher pollution that significantly degrades the environmental quality. Although recent studies have not tested the intermediating effects of civil wars in the EKC hypothesis for the countries that have been battlefields, with an exception to the implicit work of Qayyum *et al*. (2021), the present study fills the existing gap and explicitly uncovers the validity of the EKC hypothesis in the presence of civil wars in Afghanistan, which is a true representation of the longest civil war in history. Figure 1 depicts how carbon emissions (CO_2), and thus environmental degradation, move in lockstep with the intensity of civil wars in Afghanistan, demonstrating a potential coexistence between civil wars and environmental degradation.

Thus, this study is a new step in the existing literature of the EKC hypothesis for the war-torn zones, and its contribution can be outlined as follows: First, the authors innovatively extend the common EKC model with civil war predictors to test whether, in the presence of war, an inverted U-shaped link exists between per capita real income and pollutant predictors. Second, learning from missing gaps, the study extends the analysis and tests the short- and long-run causal nexus between the EKC predictors in a conflict zone. Third, since in the presence of war, it tests the EKC hypothesis for a specific war zone, say, Afghanistan, rather than panel analysis, it provides accurate and consistent results on which specific policy measures are recommended.

The purview of results highlights four key findings, among all others. First, the findings show that civil wars have a significant impact on environmental degradation in both the short and long run. Second, the results provide statistical evidence for the existence of an inverted U-shaped relationship between per capita real income and CO_2 emissions—thereby confirming the EKC hypothesis. Third, there exist bidirectional causality links between CO_2 emissions, per capita real GDP, civil wars, the financial development index, energy consumption, trade openness, and the inflation rate. Fourth, interestingly, the findings reveal multidimensionality and interdependencies among predictors.

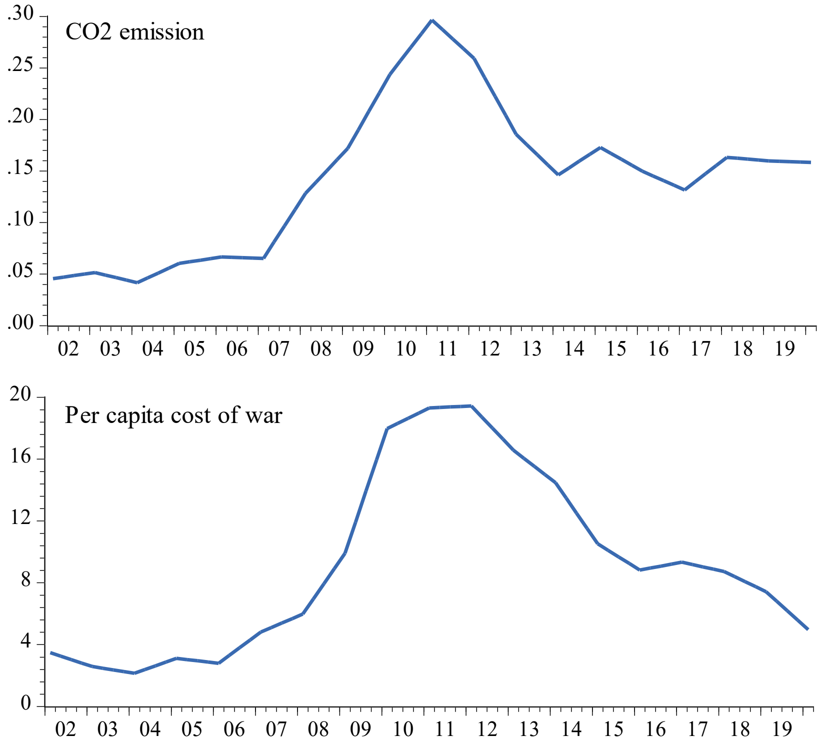

Fig. 1 CO_2 emissions and per capita cost of war; time-trend plot.

The remaining parts of the study are organized as follows. Section two, "Literature Review," reviews relevant empirical studies. Section three, "Methodology," explains the data, variables, key measurements, empirical, and econometric models. Section four, "Results and discussions," presents the empirical results and discusses the findings. Section five, "Analysis of results," presents a brief analysis on the main findings and compares the results with recent studies. Section six, "Conclusions," concludes the study.

2 Literature review

The existing literature widely documents a vast number of statistical arguments for the validity of the EKC hypothesis in both developed and developing economies—capturing the coexistence of an economic movement through different stages of development, vis-à-vis environmental quality. An EKC emerges when environmental degradation increases as a consequence of economic development at an early stage while it begins to improve at a later stage of economic development (Rahman *et al.*, 2021; Anderson and Cavendish, 2001; Dinda, 2004), which forms an inverted U-shaped pattern between environmental pollutants and economic development. The realization of this trend can be traced out through three key stages of economic development, such as a pre-industrialized economy that leads to decreased environmental quality—implying that an increase in per capita real income causes an increase in environmental degradation; an industrialized economy that reaches a certain level of growth and, therefore, a turning point; and a post-industrialized or service-based economy that leads to increased environmental quality—an increase in per capita real income causes a decrease in environmental degradation (Purcel, 2020). Empirically, the inverted U-shaped pattern does not only hold true with regard to the nexus between pollutants and real income predictors; rather, it is significantly influenced by a variety of other determinants, such as growth in population, free trade agreements, globalization, and economic variability (Lacheheb *et al*., 2015). According to Galeotti *et al*. (2009), incorporating different control predictors into EKC modeling results in the emergence of new EKCs, making it more fragile and complicated than the initial concept sparked in the early 1990s. However, the literature owes to Grossman and Krueger (1991), who claimed the coexistence of growth and environmental degradation, Shafik and Bandyopadhyay (1992) confirmed the validity of the EKC hypothesis by testing the transformation of environmental quality at different income levels across various economies.

Perman and Stern (2003) investigated the long-run relationship between sulfur emissions and economic growth for 74 countries over 31 years using cointegration analysis. Though the authors found a long-run relationship between the variables of growth and environmental pollutants supporting a concave pattern, they argue that due to the stochastic trend of time-series dimension over time, a concave pattern is not necessarily true in all economies to confirm the validity of the EKC hypothesis. Nasir and Ur-Rehman (2011) explored the link between income, CO_2 emissions, foreign trade, and energy consumption in Pakistan from 1972–2008 and used cointegration analysis. They found a long-run relationship between income, CO_2 emissions, foreign trade, and energy consumption, supporting the existence of the EKC hypothesis, while their results failed to support the EKC in the short-run.

Arouri *et al*. (2012) used bootstrapping panel unit root tests and cointegration techniques to examine the inverted U-shaped curve for Middle-Eastern and North African economies from 1981 to 2015. The authors discovered a long-run positive relationship between CO_2 emissions and energy consumption, as well as quadratic relationships across the entire panel. As a result, their findings support the existence of the EKC hypothesis for the economies of the Middle East and North Africa. Shahbaz *et al*. (2013) investigated the EKC hypothesis in Romania using data from 1980 to 2010. Using the ARDL bound test, the authors discovered a long-run relationship between economic growth, energy consumption, and energy pollutants, implying the existence of the EKC hypothesis both in the short and long run. In addition, Vita et al. (2015) found that the income earned from the sector of tourism has a significant impact on explaining the EKC realization in Turkey. The authors discovered that foreign tourists visiting Turkey, as well as other economic and pollutant indicators like energy consumption, income, and squared income, exhibit significant cointegration with CO_2 emissions, implying that the EKC hypothesis exists in Turkey.

Khed (2016) investigated the EKC hypothesis in India and employed a set of time-series data spanning from 1991–2014. However, the author found a statistical relationship between CO_2 emissions and per capita GDP, but the EKC hypothesis did not hold in the context of India. Ozturk *et al*. (2016) used an ecological footprint as a predictor of environmental quality and tourism to GDP ratio to test the existence of the EKC hypothesis. The authors used a GMM-based environmental degradation model with a dataset from 1988 to 2008 for a panel of 144 countries. Their findings indicate that the number of countries with a negative relationship between ecological footprint and its determinants was higher in upper-middle and high-income economies. Furthermore, they provided statistical evidence supporting the EKC hypothesis in upper-middle and high-income countries. Rahman (2017) also found the existence of EKC for the Philippines. Alvarado et al. (2018) used a set of data from 1980–2016 to test the EKC in 151 countries, focusing on global and countries categorized by income level. The authors discovered a statistical link between real per capita output and CO_2 emissions and supported the U-shaped curve between economic growth and pollutant predictors in middle-income, high-income, and low-income economies. They also discovered that urbanization has a positive impact on CO_2 emissions in middle-high and middle-low-income economies, while energy consumption and manufacturing have a positive impact on CO_2 emissions in all groups of countries.

Liu et al. (2019) used provincial level data in China over the period of 1996–2015 and used a panel fixed effects model to examine the association between economic growth CO_2 emissions. The authors found an inverted U-shaped relationship between CO_2 emissions and economic growth, while an inverted N-shaped nexus was also evident between CO_2 emissions and foreign direct investment. Moreover, the authors showed that energy consumption has a positive effect on the production pace of CO_2 emissions. Shahbaz et al. (2019) explored the relationships between energy demand and globalization predictors in high-income, middle-income, and low-income economies, consisting of 84 countries from 1970–2015. The authors applied the cross-correlation method, which was a simple approach to investigate the EKC's existence and to analyze their datasets. They found that for 64 out of the 86 economies, the EKC hypothesis was supported, while the majority of these countries have been effective in reducing their energy consumption in the long-run.

Saleem et al. (2020) examined the policy schemes of Asian economies' effectiveness in achieving sustainable environmental practices with respect to green growth, green financing, and CO_2 emission reduction mechanisms. The authors used a set of data over the period of 1980–2015 and employed a fully modified ordinary least squares method to test their hypotheses. They found that the EKC exists in Asian countries, while GDP growth and its square have positive and negative effects on CO_2 emissions, respectively. They also add that the EKC hypothesis is not supported in the context of lower income economies. However, their results show that the EKC is supported in high-income and upper middle-income countries. Nutakor *et al*. (2020) used a vector autoregression model and a bootstrap Granger causality test to examine the causality nexus between economic growth and CO_2 emissions in Rwanda over the period from 1960–2014. The authors discovered that GDP has a negative influence on CO_2 emissions, and their results show that the EKC shows a decreasing trend. They add that the downward slope of the EKC is explained by the transition of the Rwandan economy from an industrial-based economy to a service-based economy. Comparatively, İçen (2021) examined the EKC hypothesis in D8 countries over the period of 1972–2014. The author found an inverted N and N-shaped pattern and supported the EKC hypothesis. On the other hand, Rahman and Vu (2021) found the validity of the EKC for China for the period of 1971-2018.

Ajanaku and Collins (2021) examined the effects of deforestation and the existence of EKC in Africa using a set of panel data from 1990–2016. The authors applied a generalized method of moment to account for any endogeneity issues in the panel and found that the EKC hypothesis is valid in the context of deforestation in Africa. The authors also found that the turning point was $3,000. Based on the heterogenous panel non-causality test, the authors added that Africa deters and reverses deforestation through forest product trade policies that would not impact their economic growth. Comparatively, in another study by Adu and Denkyirah (2019) in the context of West African countries with the same level of per capita income over the period of 1970–2013, the authors found that economic growth positively affects CO_2 emissions, while the insignificant nexus between CO_2 emissions and the pollutant predictors confirms the invalidity of the EKC hypothesis in the West African economies. In exploring the literature, it shows that Murshed *et al*. (2021) examined the EKC hypothesis in the context of Bangladesh, using deforestation propensities as environmental predictors and energy consumption, population growth, and agricultural land coverage over the period from 1972–2018. The authors employed an ECM-based autoregressive distributed lag model to test the hypothesis and found a nonlinear inverted-U-shaped trend between deforestation and economic growth in Bangladesh. Moreover, they also found that the deforestation-induced EKC was a valid hypothesis in Bangladesh.

Relevant to the context of the present study, among all others, Qayyum *et al*. (2021) is an exceptional study, which has employed a set of data from 1984–2019 for South Asian economies, such as Afghanistan, Bangladesh, Bhutan, India, Nepal, Maldives, Pakistan, and Sri Lanka, to test the EKC hypothesis in the presence of armed conflicts and aggression between India and Pakistan. Though their dataset suffered from missing data for four out of eight countries, they found that the EKC hypothesis is valid in the context of South Asian economies. Furthermore, the authors showed that the hostility left India and Pakistan with relatively higher growth in defense and military operations that were found significantly deteriorative to environmental quality. The review of literature clearly indicates two key missing gaps. First, the non-existence of an explicit study of the EKC realization in the presence of civil wars, which is a significant indicator of environmental pollution in war-torn societies, and second, the scarcity of a specific empirical study in the context of Afghanistan, which is a true representation of the longest civil war in history. Thus, to fill the missing gaps, three new hypotheses have been developed. H_1: Civil wars have significantly positive effects on environmental degradation. H_2: Civil wars, economics, and pollutant predictors form both short-run and long-run relationships. H_3: The validity of the EKC hypothesis can be confirmed in the presence of civil wars in Afghanistan.

3 Methodology

3.1 Data and variables

Based on the availability of data, the empirical analysis of this study employs a dataset containing observations ranging from 2002Q1–2020Q1 for Afghanistan. Due to the objectives, except for the civil wars and financial development variables that are innovatively used in the study, the choice of other variables is based on theoretical assumptions and recent EKC studies (see, *inter alia*, Pao and Tsai, 2010; Kasman and Duman, 2015; Boontome, Therdyothin and Chontanawat, 2017; Khoshnevis and Dariani, 2019; Nilüfer *et al.*, 2022). The variables are measured by different units and include CO_2 emission expressed in metric tons per capita, real GDP derived as the nominal GDP (constant 2015 US$) over the GDP deflator, energy consumption expressed in kilos of oil equivalent per capita, trade openness expressed as the sum of imports of goods and services to GDP (%) plus the sum of exports of goods and services to GDP (%), per capita cost of war expressed in millions of US$ spent by the United States in supporting the military operations in Afghanistan, population growth expressed as an annual (%), inflation rate based on GDP deflator (%), and the financial development index expressed as GDP (%). The financial development index comprises three key indicators, such as domestic credit to the private sector to GDP (%), liquid liabilities to GDP (%), and gross fixed capital formation to GDP (%). The construction of the financial development index follows a similar methodology used by the UNDP (United Nations Development Programs) for constructing the HDI (human development index), GDI (gender development index), and HPI (human poverty index), using dimensional average indices (see, Anand and Sen, 1994, for detailed construction methodology). The per capita cost of war, which is a key variable of interest, measures the monetary value of military operations in Afghanistan as an aggregate index. This proxy has two features, vis-a-vis proxies used in recent studies. First, it allows more accurate estimations than the number of people killed and injured. Second, it provides actual data on the amount of money spent on operating pure military operations—thus reflecting the real economic cost of war and its impact on the outcome variable. The datasets for CO_2, nominal GDP, GDP deflator, trade openness, energy consumption, domestic credit to the private sector, liquid liabilities, inflation rate, population growth, and gross fixed capital formation are collected from the WDI (World Development Indicators), sources that are relevant to the World Bank, and the data for cost of war is collected from the United States Department of Defense Budget.

3.2 Model specification

This study aims to test the effects of long-run civil wars on the environmental quality in Afghanistan by using the conceptual framework of the EKC hypothesis to take a new step in the existing literature on the war-environment nexus. To obtain a specification fit for the purpose, we begin with the common empirical approach used for the EKC specification (see, Dinda, 2004 for an excellent and comprehensive EKC survey), which is as:

$$co_{2t} = \sigma + \beta_1 y_t + \beta_2 y_t^2 + \beta_3 en_t + \beta_4 to_t + \beta_5 pop_t + u_t \qquad (1)$$

where the environmental quality—that is, the CO_2 emission is assumed to be positively influenced by per capita real GDP (y) up to a certain limit (Apergis and Ozturk, 2015), negatively influenced by squared per capita real GDP (y^2) after a level (turning point) (Lean and Smyth, 2010; Rahman, 2020), energy use (*en*), trade openness (*to*), and population growth (*pop*). However, some studies, such as Hassan *et al*. (2019), Yilanci and Pata (2020), and Kyara *et al*. (2022), have employed ecological footprint as a proxy for environmental degradation. For two reasons, this study uses CO_2 emission instead. First, CO_2 emission is a better proxy for the environmental quality in war-torn societies to measure the environmental damage. Second, the required data for ecological footprint during the relevant period—that is, the most intense period of civil war—is not available. Moreover, in recent studies, among all others, Kong and Khan (2019) included the inflation rate and arms imports and exports indicators in testing the EKC hypothesis, assuming that real GDP shows the overall real economic function of a country, while the inflation rate controls for the economic variability in the EKC studies. Most recent empirical studies have used credit to the private sector as a proxy to measure the effects of financial markets on environmental quality (see, *inter alia*, Can and Gozgor, 2017; Gokmenoglu *et al*., 2019; Chen *et al*., 2019; Bilgili *et al*., 2020), which is not a comprehensive predictor of financial market progressions; rather, it only indicates the supply-side of credit to private borrowers. Therefore, the present study draws on the existing EKC literature and innovatively extend the analysis by fitting a model augmented with common EKC predictors, long-run civil war indicator, and comprehensive financial development index as:

$$co_{2t} = \sigma + \beta_1 y_t + \beta_2 y_t^2 + \beta_3 en_t + \beta_4 to_t + \beta_5 pop_t + \beta_6 inf_t + \beta_7 cw_t + \beta_8 fd_t + u_t \qquad (2)$$

where *cw* = per capita cost of war—the key variable of interest used to capture the effects of long-run civil war on the environmental quality in war-torn society, *inf* = inflation rate is employed to control for economic variability, and *fd* = financial development index, comprising domestic credit to the private sector, liquid liabilities, and gross fixed capital formation, is used to capture the effects of financial market progression on the outcome variable. For the purpose of empirical analysis, the variables are transformed into their natural logarithmic form with a long-run linear function as:

$$\ln co_{2t} = \varphi + \beta_1 \ln y_t + \beta_2 \ln y_t^2 + \beta_3 \ln en_t + \beta_4 \ln to_t + \beta_5 \ln pop_t + \beta_6 \ln inf_t + \beta_7 \ln cw_t + \beta_8 \ln fd_t + \varepsilon_t \qquad (3)$$

where ln = the natural log of the predictors, $\varphi =$ the intercept, β_1 to $\beta_8 =$ long-run coefficients of the explanatory variables, and $\varepsilon_t =$ the error term of the model. All other variables hold the same meaning as described before. Due to the EKC—that is, the inverted U-Shaped curve hypothesis, we expect that $\beta_1 > 0$ implying that an increase in CO_2 emission is associated with an increase in per capita real GDP up to a certain limit and then it begins falling $\beta_2 < 0$, squared per capita real GDP. The coefficient signs for energy consumption, trade openness, population growth, and inflation rate are expected to be positive (see, for instance, Dou *et al*., 2021). For the financial development index, its coefficient sign is also expected to be positive. It is because the progression in financial development that eases capital-intensive projects in an economy contributes to increased CO_2 emission and, therefore, reduces environmental quality (Al-Mulali *et al*., 2015; Jiang and Ma, 2019; Shoaib *et al*., 2020; Thangaiyarkarasi and Vanitha, 2021). Since civil wars strongly contribute to the rise in CO_2 emission, the expected sign for $\beta_7 > 0$, that is, the increase in civil wars is positively associated with an increase in environmental degradation. Moreover, the turning point arising from the representing values is calculated as $\tau = \exp[-\beta_1 / (2\beta_2)]$ (see, *inter alia*, Balado-Naves *et al*., 2018; Churchill *et al*., 2018).

3.3 Econometric methods

The estimation begins with the test of unit root, which is important to determine the integrating order of the variables in time-series analysis. In this faith, Augmented Dickey and Fuller (ADF) (1979), Phillips and Perron (PP) (1988), and Ng and Perron (2001) methods are employed. Assuming that all the predictors follow mixed integrating orders of I(0) and I(1) without any I(2) series, the study proceeds to test the long-run relationship between them using the autoregressive distributed lags (ARDL) bound test to cointegration of Pesaran *et al*. (2001). The use of ARDL test with an optimal lag length addresses the issues of serial correlation and endogeneity, provides consistent coefficients for small sample sizes, allows the dependent and independent variables to follow mixed integration, permits the dependent and independent predictors to use different lags, and estimates both short and long run coefficients simultaneously (Pesaran and Shin, 2012). We fit the error-correcting ARDL test as:

$$\begin{aligned}\Delta \ln co_{2t} &= \theta_i + \lambda_1 \ln co_{2t-1} + \lambda_2 \ln y_{t-1} + \lambda_3 \ln y_{t-1}^2 + \lambda_4 \ln cw_{t-1} + \lambda_5 \ln fd_{t-1} + \lambda_6 \ln pop_{t-1} \\ &+ \lambda_7 \ln en_{t-1} + \lambda_8 \ln to_{t-1} + \lambda_9 \ln inf_{t-1} + \sum\nolimits_{i=1}^{p} \varphi_1 \ln co_{2t-i} + \sum\nolimits_{i=1}^{q} \varphi_2 \ln y_{t-i} \\ &+ \sum\nolimits_{i=1}^{q} \varphi_3 \ln_{t-i}^2 + \sum\nolimits_{i=1}^{q} \varphi_4 \ln cw_{t-i} + \sum\nolimits_{i=1}^{q} \varphi_5 \ln fd_{t-i} + \sum\nolimits_{i=1}^{q} \varphi_6 \ln pop_{t-i} \\ &+ \sum\nolimits_{i=1}^{q} \varphi_7 \ln en_{t-i} + \sum\nolimits_{i=1}^{q} \varphi_8 \ln to_{t-i} + \sum\nolimits_{i=1}^{q} \varphi_9 \ln inf_{t-i} + \eta ECT_{t-1} + u_t\end{aligned} \tag{6}$$

where $\theta =$ intercept, $\lambda_1 - \lambda_9 (\varphi_1 - \varphi_9) =$ long-run (short-run) coefficients, $p =$ lag operator of the dependent variables, $q =$ lag operator of the explanatory variables, and all other variables hold the same meaning as described before. Equation (6) tests the joint null of $\mathrm{H_{null}} : \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 =,...,= \lambda_9 = 0$ vs. $\mathrm{H_{alt.}} : \lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq,...,\neq \lambda_9 \neq 0$ using F-statistics vis-a-vis the critical values for the lower bound I(0) and upper bound I(1) for a desired significant level. The null is rejected if the F-statistics is greater than the upper bound, and it is not if the F-statistics is otherwise (Banerjee *et al.*, 1998). Once the cointegration is established among the predictors, the study employs the vector error-correcting model (VECM) to granger causality among them. This method is superior in showing causality, long-run, and short-run variables, which is imperative to highlight different policy implications. Consistent with Wang *et al*. (2018), the following VECM-Granger causality equation is used:

$$\begin{bmatrix} \ln co_2 \\ \ln y \\ \ln y^2 \\ \ln cw \\ \ln fd \\ \ln pop \\ \ln to \\ \ln en \\ \ln inf \end{bmatrix} = \begin{bmatrix} \vartheta_1 \\ \vartheta_2 \\ \vartheta_3 \\ \vartheta_4 \\ \vartheta_5 \\ \vartheta_6 \\ \vartheta_7 \\ \vartheta_8 \\ \vartheta_9 \end{bmatrix} = \begin{bmatrix} \vartheta_{11k}\vartheta_{12k}\vartheta_{13k}\vartheta_{14k}\vartheta_{15k}\vartheta_{16k}\vartheta_{17k}\vartheta_{18k}\vartheta_{19k} \\ \vartheta_{21k}\vartheta_{22k}\vartheta_{23k}\vartheta_{24k}\vartheta_{25k}\vartheta_{26k}\vartheta_{27k}\vartheta_{28k}\vartheta_{29k} \\ \vartheta_{31k}\vartheta_{32k}\vartheta_{33k}\vartheta_{34k}\vartheta_{35k}\vartheta_{36k}\vartheta_{37k}\vartheta_{38k}\vartheta_{39k} \\ \vartheta_{41k}\vartheta_{42k}\vartheta_{43k}\vartheta_{44k}\vartheta_{45k}\vartheta_{46k}\vartheta_{47k}\vartheta_{48k}\vartheta_{49k} \\ \vartheta_{51k}\vartheta_{52k}\vartheta_{53k}\vartheta_{54k}\vartheta_{55k}\vartheta_{56k}\vartheta_{57k}\vartheta_{58k}\vartheta_{59k} \\ \vartheta_{61k}\vartheta_{62k}\vartheta_{63k}\vartheta_{64k}\vartheta_{65k}\vartheta_{66k}\vartheta_{67k}\vartheta_{68k}\vartheta_{69k} \\ \vartheta_{71k}\vartheta_{72k}\vartheta_{73k}\vartheta_{74k}\vartheta_{75k}\vartheta_{76k}\vartheta_{77k}\vartheta_{78k}\vartheta_{79k} \\ \vartheta_{81k}\vartheta_{82k}\vartheta_{83k}\vartheta_{84k}\vartheta_{85k}\vartheta_{86k}\vartheta_{87k}\vartheta_{88k}\vartheta_{89k} \\ \vartheta_{91k}\vartheta_{92k}\vartheta_{93k}\vartheta_{94k}\vartheta_{95k}\vartheta_{96k}\vartheta_{97k}\vartheta_{98k}\vartheta_{99k} \end{bmatrix} = \begin{bmatrix} \Delta \ln co_{2t} \\ \Delta \ln y_t \\ \Delta \ln y_t^2 \\ \Delta \ln cw_t \\ \Delta \ln fd_t \\ \Delta \ln pop_t \\ \Delta \ln to_t \\ \Delta \ln en_t \\ \Delta \ln inf_t \end{bmatrix} = \begin{bmatrix} n_1 \\ n_2 \\ n_3 \\ n_4 \\ n_5 \\ n_6 \\ n_7 \\ n_8 \\ n_9 \end{bmatrix} = ECT_{t-1} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \\ \varepsilon_{5t} \\ \varepsilon_{6t} \\ \varepsilon_{7t} \\ \varepsilon_{8t} \\ \varepsilon_{9t} \end{bmatrix} \quad (7)$$

where all variables are explained before, $\vartheta_{12},...,\vartheta_{99}$ = coefficients, $t = 2002, 2003, ..., 2020$, and -1 presents the lag of the error correction, where its negative sign implies long-run causality nexus and the disturbance term of the model. The significant result of the error term, the statistical significance of $t-stat.$, and significant nexus imply the causality direction of the short-run association in the first difference order of the predictors—that is, $\vartheta_{12k} \neq 0 \forall i$ indicates that natural log of per capita real GDP granger causes the natural log of CO_2 emission and $\vartheta_{21k} \neq 0 \forall i$ shows a flip-side causality from natural log of CO_2 to the natural log of per capita real GDP (see, for instance, Engle and Granger, 1987). Finally, the study confirms the robustness and accuracy of the estimates using various diagnostic tests that are consistently reported with the results.

4 Results and discussion

4.1 Descriptive statistics

The study begins the analysis with some important descriptive statistics reported in Table 2. During the study period, the *lnco2*—simplified, CO_2 stands at 0.12 metric tons per capita with a maximum of 0.30 metric tons per capita, while the average per capita cost of war rounds up to 7.19$m with a maximum of 19.43$m, both showing growth over time. Moreover, the mean of per capita real GDP (*lny*) is $474.38 with a maximum of $587.57, whereas the average financial development index (*lnfd*) rounds up to 15.63% to GDP with a maximum of 21.63% to GDP in Afghanistan. Although one can read through the summary statistics, the rear part of Table 2 reports the correlation analysis between the predictors, indicating no significant correlation between them, except for the association between per capita real GDP (*lny*) and its squared values (*lny2*), which is as expected.

Table 2 Descriptive statistics.

Summary statistics	$lnco_2$	Lncw	lnen	Lnfd	lninf	lnpop	lnto	lny	lny^2
Mean	-2.120	1.972	3.144	2.749	1.594	1.093	3.181	6.162	37.97
Maximum	-1.216	2.967	3.909	3.074	3.273	1.548	3.493	6.376	40.65
Minimum	-3.178	0.763	2.441	1.741	-0.553	0.833	2.412	5.800	33.64
Std. Dev.	0.589	0.710	0.428	0.389	0.805	0.205	0.279	0.219	0.047
Correlation matrix	$lnco_2$	Lncw	lnen	Lnfd	lninf	lnpop	lnto	lny	lny^2
$lnco_2$	1								
Lncw	0.489	1							
Lnen	-0.499	-0.244	1						
Lnfd	0.308	0.197	-0.502	1					
Lninf	0.214	0.566	0.199	-0.162	1				
Lnpop	0.400	0.255	0.408	0.389	0.204	1			
Lnto	0.543	0.502	-0.537	0.119	-0.054	-0.530	1		
Lny	0.448	0.384	-0.388	0.304	-0.496	-0.485	0.260	1	
lny^2	-0.367	0.499	-0.266	0.421	-0.429	-0.405	0.453	0.689	1

Notes: Std. Dev. = Standard deviation, lnco2 = natural log of CO2, lncw = natural log of per capita cost of war, lnen = natural log of energy consumption, lnfd = natural log of financial development index, lninf = natural log of inflation rate, lnpop = natural log population growth, lnto = natural log of trade openness, lny = natural log of per capita real GDP, lny2 = natural log of square of per capita real GDP.

4.2 Stationarity analysis

In time-series analysis, ascertaining the integrating orders of the variables leads to appropriate specification. To that end, the results of three methods testing the null of non-stationarity, such as Augmented Dickey and Fuller (1979), Phillips and Perron (1988), and Ng and Perron (2001), are reported in Table 3. The results demonstrate that *lnfd*, *lnpop*, *lnto*, *lny*, and *lny2* are significant at 1% and 5% levels to reject the null of non-stationarity, while other remaining variables, such as *lnco2*, *lncw*, *lnen*, and *lninf*, can only reject the null after the first difference by all three methods. The mixed integration orders of I(0) and I(1) without any I(2) series supports the estimation of the ARDL bound test model to establish the cointegration, if any, between the predictors (see, *inter alia*, Pesaran *et al*., 2001; Narayan, 2005), covered in the following section.

4.3 Cointegration analysis

Considering the results of the predictors' integration shown in Table 3, the study proceeds to estimate the ARDL bound test model to establish the long-run relationship between the variables and reports its results in Table 4. Before estimation, the optimal lag length selection using the Akaike information criterion (AIC), Schwarz information criterion (SIC), and Hannan-Quinn information criterion (HQIC) was estimated in the VAR environment. All three criteria suggested two lags. The ARDL bound test results indicate that the F-statistics (F = 13.940 > CV = 3.77) is greater than the critical value of I(1) bound at 1% level of significance and thus rejects the null of $\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 =,...,= \lambda_9 = 0$ (no cointegration). The rejected null implies that there exists a long-run relationship between the variables, and therefore, they move together in the long-run. However, the results provide a clear indication of significant nexus and important long-run properties of the variables, we proceed to estimate the short and long run coefficients to determine the size and magnitude of the effects using equation (6).

Table 3 Stationarity tests.

	ADF test		PP test		Ng and Perron	
Variables	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
$lnco_2$	-1.818	-3.991***	-1.681	-4.100***	-1.681	-14.266***
Lncw	-1.786	-4.206***	-1.190	-4.231***	-4.212	-17.126***
Lnen	-1.851	-4.598***	-1.552	-4.722***	-2.192	-14.552***
Lnfd	-3.127***	-4.836***	-3.511***	-4.264***	-11.564**	-14.898***
Lninf	-1.669	-3.994***	-1.794	-3.590***	-2.011	-15.977***
lnpop	-3.579***	-5.835***	-3.736***	-5.136***	-13.429***	-19.253***
Lnto	-3.801***	-4.349***	-2.953**	-3.306***	-12.512***	-16.200***
Lny	-2.341**	-4.469***	-2.512**	-3.016***	-9.227**	-13.920***
lny^2	-2.353**	-4.410***	-2.908**	-4.958***	-9.004**	-14.034***

Notes: *** and ** indicate 1% and 5% respectively. ADF = Augmented Dickey-Fuller, PP = Phillips-Perron. Critical values of Ng-Perron for 1%, 5%, and 10% are -13.80, -8.10, and -5.70, respectively. Critical values come from Ng and Perron (2001) table. Adjusted observations: 64.

Table 4 ARDL bound test results.

Model estimated	F-statistics	1% CV		Robustness checks		
		1(0)	I(1)	ARCH	LM	RAMSEY
$\ln co_2 \mid \ln y, \ln y^2, \ln cw, \ln fd, \ln pop, \ln to, \ln en, \ln inf$	13.940***	2.62	3.77	0.961 [0.326]	3.689 [0.158]	0.040 [0.960]

Notes: *** indicates significance at 1% level. [ ] indicates *p-values*. Adjusted observations: 64.

4.4 Short and long run estimates

Next, the present study estimates the ECT-based ARDL model to test the effects of long-run civil wars on the environmental quality using the conceptual framework of EKC, presented by equation (6). The results of the ECT-based ARDL model are reported in Table 5. Interestingly, the results indicate that the natural log of per capita real GDP (*lny*)—simplified for ease of reading, the per capita real GDP has significantly positive effects on the *lnco2* emissions, implying that an increase in the per capita real GDP increases the carbon emissions by a log of 3.344 and 3.681 in the short and long runs, respectively, whereas the *lnco2* decreases by a unit decrease led by the squared per capita real GDP by 0.305 and 0.281 in the short and long runs, respectively. Therefore, it confirms the validity of the EKC hypothesis with a turning point of $699.120 in Afghanistan. However, the results must be used with serious caution in conflict zones such as Afghanistan. They demonstrate that, based on the size of the economy proxied by per capita real GDP, environmental quality deteriorates up to a certain limit—hence, the $699.12 turning point—and then it improves afterward—where the EKC emerges in the context of Afghanistan. Like most of recent studies, such as Kasman and Duman (2015), Jebli *et al*. (2016), Dogan and Seker (2016), and Beşe and Kalayci (2019), who also verified the existence of the EKC hypothesis, our results are much similar to those of Apergis and Ozturk (2015) for Asian economies, and Nasreen and Anwar (2015) for low-income economies with a turning point of $652.47 in aggregate.

Table 5 Short-run and long-run estimates.

	Short-run effects			Long-run effects		
Variables	Coefficients	t-statistics	*p-values*	Coefficients	t-statistics	*p-values*
Lny	3.344***	4.681	0.000	3.681***	3.656	0.000
lny2	-0.305*	-1.758	0.089	-0.281***	-3.855	0.000
lncw	0.119***	4.212	0.001	1.091***	3.312	0.000
lnfd	0.323**	2.278	0.027	0.277**	2.318	0.028
lnen	-1.192***	-7.383	0.000	-0.471***	-3.947	0.000
lnpop	0.104*	1.815	0.075	0.362**	2.018	0.049
lnto	-0.110*	-1.844	0.071	-0.384*	-1.959	0.089
lninf	0.023***	3.497	0.000	0.080**	2.623	0.011
Constant	-11.996***	-4.143	0.000			
ECT	-0.281***	-6.851	0.000			
Turning point $= \exp[-3.681/(2\times 0.281)]$				$699.120		
Per capita real GDP 2020				$502.481		
EKC results				Inverted U-shaped		
Sensitivity checks						
Adjusted r-squared	0.968					
F-statistics	62.334***					
F-probability	0.000					
Durbin Watson	1.802					
Diagnostic checks						
Breusch-Pegan Godfrey	1.187	[0.101]				
Breusch Godfrey LM	2.689	[0.258]				
Jarque-Bera	0.611	[0.728]				
CUSUM	Stable					
CUSUMSQ	Stable					

Notes: ***, **, and * indicate significance at 1%, 5%, and 10%, respectively. Values in [ ] present the *p-values*. CUSUM = Cumulative sum, CUSUMSQ = Cumulative sum of squares. Adjusted observations: 61.

Moreover, the results reveal that civil war, the key variable of interest, proxied by the per capita cost of war significantly impacts CO_2 emissions both in the short and long runs. It indicates that the natural log of the per capita cost of war (*lncw*) increases the natural log of CO2 (*lnco2*) by 0.119% and 1.091% in the short and long runs, respectively. In a theoretical sense, the utilization of massive weapons and the continuity of military operations negatively affect environmental quality, where in an empirical sense, studies also show that war is a damaging factor to environmental quality (Kengni, 2013). Unlike most countries, Afghanistan is a country that has hosted more than four decades of war and has experienced almost all types of massive damage due to civil war. The findings are consistent with the fact that war degrades environmental quality, increasing CO_2 emissions both in the short and long term. The natural log of the financial development index (*lnfd*) is found to have positive association with the *lnco2*. It implies that in the short and long runs, *lnfd* increases *lnco2* by 0.323% and 0.277%, respectively. The results are consistent with the findings of Shahbaz *et al*. (2016) in the context of Pakistan; Esmaeilpour and Dehbashi (2018) in the context of Iran; Acheampong (2019) in the context of Sub-Saharan African countries; and Khalid *et al*. (2021) in the context of South Asian countries, who also provided evidence of positive effects of financial development progressions on environmental degradation. The results are in contrast with those of Charfeddine and Ben Khediri (2016) and Aluko and Obalade (2020), who argued that financial development improves environmental quality in the contexts of the United Arab Emirates and Sub-Saharan African countries, respectively.

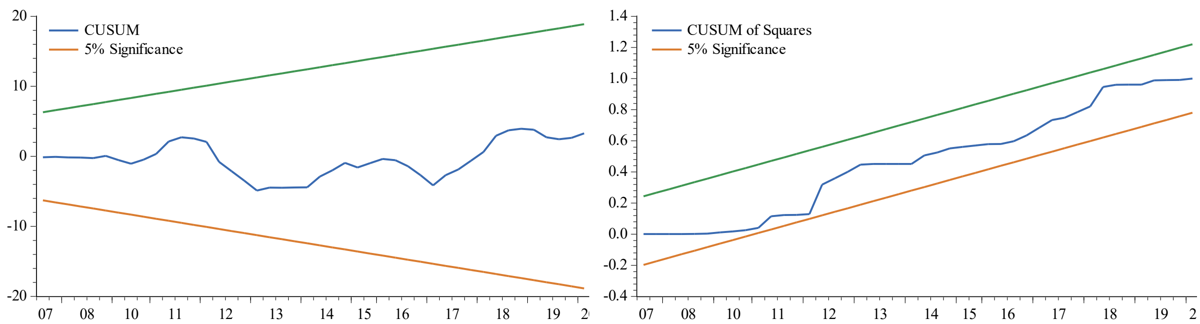

Fig. 2 CUSUM and CUSUMSQ results.

The results also indicate that the natural log of energy consumption (ln*en*) and trade openness (*lnto*) negatively impact *lnco2* in the short and long runs. This implies that an increase in *lnen* decreases the lnco2 by 1.119 and 0.471 units in the short and long runs, respectively. The results are linked to the facts in Afghanistan, though they are in contrast with the findings of Salahuddin and Gow (2019), Purnama *et al*. (2020), and Nathaniel (2021). It shows that the use of energy improves environmental quality, reflecting the fact that the majority of people living under the poverty line consume non-standard warming materials that strongly contribute to environmental degradation, while energy as a standard substitute decreases environmental degradation. Some other studies, such as Nasreen and Anwar (2015) and Vasichenko *et al*. (2020) demonstrate that energy consumption that encourage higher capital-intensive projects increase environmental degradation in low and middle-income economies. In both the short and long run, population growth (lnpop) is found to be a significant factor in increasing lnco2. The results indicate that *lnpop* increases *lnco2* by 0.104% and 0.362% in the short and long runs, respectively. The results correspond with the findings of Wang *et al*. (2015) and Weber and Sciubba (2019), who also found that the incremental effects of population growth on CO_2 emissions are negligible. Furthermore, the inflation rate (*lninf*) is a significant factor in increasing *lnco2*. The results demonstrate that lninf increases *lnco2* by 0.023% in the short run and by 0.08% in the long run. The results are consistent with those of Kong and Khan (2019), who also incorporated the inflation rate into the EKC model and found that the fluctuational inflation rate negatively impacts environmental quality. Finally, the effects of trade openness are tested on the *lnco2*. The results show that increasing trade openness reduces LNCO2 levels in both the short and long runs, implying that increasing trade openness improves environmental quality in Afghanistan. The results are consistent with the findings of Managi *et al*. (2009), Shahbaz *et al*. (2014), and Dou *et al*. (2021), who found that trade openness improves environmental quality, but in contrast with those of Mahmood *et al*. (2019).

While the results are statistically robust and do not suffer from heteroskedasticity, serial correlation, and abnormal residuals' distribution issues, they verify the EKC hypothesis in Afghanistan—that is, the inverted U-shaped nexus. The turning point has been calculated using the long-run effects, which represents $699.120. Notwithstanding, for the stability of parameters, the present study computes the CUSUM (cumulative sum) and CUSUMSQ (cumulative sum of squares) tests that are depicted in Fig. 2—showing that the residuals are within 5% critical bounds, implying that the estimated model and coefficients are stable.

4.5 VECM Granger causality analysis

Finally, this article tests the Granger causality nexus between the *lnco2* and the augmented predictors using the VECM Granger causality approach (see, equation 7), which is appropriate for the case of this study. The results of the short-run and long-run causality are reported in Table 6. First and foremost, the results clearly indicate a significant long-run causality link between *lnco2*, *lny*, *lny2*, *lncw*, *lnfd*, *lnen*, *lnpop*, *lnto*, and *lninf* at a 1% level. Rejecting the null $\vartheta_{12,...,nk} \neq 0 \forall i$ implies that all the predictors significantly Granger cause *lnco2*. Extending the analysis to the short-run causality links, the results indicate that *lny*, *lny2*, *lncw*, *lnfd*, and *lnpop* postulate significant bidirectional causality with *lnco2*, while *lnen*, *lnto*, and *lninf* indicate only unidirectional causality with *lnco2*. The results also highlight some multidimensionality and interdependencies between the variables. For instance, there is a bidirectional causality between *lny*, *lny2*, and *lninf*, and *lnen* and *lnto* with *lnfd* in the short-run. The results are robust and consistent as reported by the diagnostic checks reported at the rear part of Table 6. Though contexts are different, the results are similar to those of Azam and Khan (2016), Zhang *et al*. (2017), Boontome *et al*. (2017), and Kong and Khan (2019), who also found causality nexus between the environmental quality and their predictors explaining the pollutant, macroeconomic, and energy predictors.

5 Analysis of results

Despite filling the missing gaps in the literature of war-environment nexus, the key findings of this study are worth further discussion. Firstly, the results empirically support the significant effects of civil wars on environmental degradation—that is, civil wars increase CO_2 emissions both in the short and long runs. Intuitively, this implies that civil wars are not only environmentally destructive but also emit large amounts of carbon emissions and contribute to the depletion of resources, among all other possible impacts. Secondly, using the conceptual framework of the EKC, the results confirm the existence of an inverted U-shaped nexus between per capita real income appreciated by per capita real GDP and CO_2 emissions, thereby supporting the EKC hypothesis in Afghanistan. Thirdly, the empirical findings support bidirectional causality relationships between CO_2 emissions, per capita real GDP, civil wars, the financial development index, energy consumption, trade openness, and the inflation rate. Fourth, the purview of findings also indicates multidimensionality and interdependencies among predictors. It is also worth comparing the results of this article with some leading recent studies in war-torn societies. Parlow (2014) examined the EKC hypothesis in Myanmar, a conflict zone, and found that the EKC hypothesis exists by identifying two different regimes. Although Mehmood and Tariq (2020) did not capture the effects of armed conflicts on the environmental quality, they did confirm the existence of the EKC hypothesis in South Asian countries from 1972–2013.

Table 6 Short and long run causality results.

Predictors	*t-stat.* long-run causality (ECT_{t-1})	Wald statistics for short-run causality								
		$lnco_2$	lny	lny^2	lncw	lnfd	lnen	lnpop	lnto	lninf
$lnco_2$	-0.247***	–	3.128***	-0.238**	0.122***	0.298***	-1.010*	0.118**	-0.099**	0.104*
lny	-0.623***	4.212***	–	1.023*	-0.723***	0.616***	0.019	-0.449	-0.026	-0.122
lny^2	-0.502***	-0.338***	0.881***	–	-0.028**	0.009*	-0.022	-0.016	-0.004	-0.013
lncw	-0.618***	0.281***	-0.273**	-0.012*	–	0.437	0.288	1.019	0.721	0.491
lnfd	-0.395***	0.845**	0.441***	0.016**	0.105	–	0.166***	0.367	0.273***	-0.111
lnen	-0.426***	-0.126	0.087	0.008	0.174	0.449	–	0.244	0.093	0.404
lnpop	-0.747***	0.377***	-0.184**	-0.028*	0.005	0.019	0.080	–	0.383	0.128
lnto	-0.189***	-0.107	0.019*	-0.017	0.634	0.441	0.413	0.165	–	0.449
lninf	-0.318***	0.225	-0.181***	-0.022***	0.115	-1.010	0.220	0.066	-0.301	–
Diagnostic checks										
Hetero-chi^2	715.24	[0.459]								
SC-LM	1.284	[0.193]								
NT-JB	1.270	[0.428]								

Notes: ***, **, and * indicate significance at 1%, 5%, and 10%, respectively. SC-LM = Serial correlation Lagrange Multiplier test, NT-JB = Joint normality test of Jarque-Bera. Values in [ ] indicate *p-values*. Adjusted observations: 64.

Bildirici and Gokmenoglu (2020) found significant effects of terrorism, energy consumption, economic growth, and foreign direct investments on environmental pollution for Afghanistan, Pakistan, Iraq, Syria, Nigeria, Philippines, Yemen, and Thailand using panel analysis for data spanning from 1975–2017 and bidirectional long-run causality between their variables of concern. Qayyum *et al*. (2021) also confirm the existence of the EKC hypothesis in South Asian economies, two of which, such as Pakistan and Afghanistan, were conflict zones. However, our findings are consistent with recent studies and they significantly add to the existing literature on the incremental effects of civil wars on environmental pollutants, providing robust results from Afghanistan, a real-example of an extensively war-torn society.

6 Conclusion

This article hypothesized the effects of long-run civil wars on environmental degradation in Afghanistan, a war-torn society with a long history of war. To test the competing hypothesis, this study uses the conceptual framework of the Environmental Kuznets Curve (EKC) hypothesis and econometric models augmented with civil wars, pollutants, financial development, and macroeconomic predictors on a set of data ranging from 2002Q1–2020Q1. The primary results from unit root analysis indicate that all predictors follow a combination of I(0) and I(1) integration, while the results of the autoregressive distributed lags (ARDL) bound test affirm the long-run relationship between pollutants, civil wars, financial development, and macroeconomic indicators. Using the EKC framework and employing the ARDL model, the dual findings present interesting results and indicate that civil wars—a key variable of interest—financial development index, per capita real GDP, population growth, and the inflation rate have incremental effects on CO_2 emissions, whereas the squared per capita real GDP, energy consumption, and trade openness reduce CO_2 emissions both in the short and long runs. The results confirm an inverted U-shaped relationship—that is, the EKC hypothesis in Afghanistan with a turning point of $699.52. Moreover, the results obtained from the VECM (vector error-correcting model) Granger causality reveal that there exist bidirectional causality relationships between CO_2 emissions, per capita real GDP, civil wars, the financial development index, energy consumption, trade openness, and the inflation rate in the long-run, while the analysis extends to confirm multidimensionality and interdependencies among predictors in the short-run. The critical findings entail three key policy implications, among all others. First, the government needs to engage the international community in bridging the gaps in the process of peace negotiation with the insurgent groups to eradicate the civil wars or even minimize them to low levels as they not only result in the loss of human capital, loss of economic infrastructure, and economic nose-dive, but also seriously harm the environmental quality. Second, inspired by the effects of energy consumption in the short and long runs and learning from the practical consumption of substitute materials for warming, public baths, and industrial production, the government needs to attempt to replace them with energy consumption by enhancing energy production capacity, while in the long run, energy consumption should also be controlled to reduce CO_2

emissions. Third, an overall consumption behavior campaign seems necessary to promote natural resource protection, appropriate consumption, and reduce exploitation of pasture lands in Afghanistan.

Data and materials

Datasets relevant to nominal GDP, GDP deflator, population growth, imports of goods and services, imports of goods and services, inflation rate, credit to the private sector, gross fixed capita formation, and liquid liabilities are collected from the World Development Indicators sources available at (https://databank.worldbank.org/source/world-development-indicators) and dataset relevant to cost of war is collected from the Department of Defense Budget of the United States available at (https://www.state.gov/countries-areas/afghanistan/).

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Competing interest

The authors do not have any conflict of interest for declare.

Contribution

MAH: Major writing, data collection and analysis, methodology selection and regression analysis; MMR: Conceptualization, variable and methodology selection, minor writing, supervision and editing; RK: minor writing, editing and supervision.

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CHAPTER 7: PAPER 5 – ANALYZING THE CONSEQUENCES OF LONG-RUN CIVIL WARS ON UNEMPLOYMENT RATE: EMPIRICAL EVIDENCE FROM AFGHANISTAN

7.1. Introduction

The fifth study of the present thesis explored the asymmetric long-run effects of civil wars on unemployment rate from the third quarter of 2004 to the fourth quarter of 2020 in Afghanistan. The results disclose that the cost of war, GDP growth, final government expenditure, foreign direct investment, and the rule of law significantly decrease the unemployment rate. The study also controlled for some market variables. The results demonstrate that enhancing the outreach of financial services plays an important role in reducing the unemployment rate during wartime in Afghanistan, while its exclusion is found to increase the unemployment rate both in the short and long runs. The fifth paper has several serious policy implications that has been discussed and has made a great contribution to the overall objective of the present thesis.

Although the present study is a new step in the existing literature of the war-unemployment hypothesis in Afghanistan, it aimed to achieve specific objectives. First, to determine the extent to which long-run war can impact the unemployment rate in a war-torn zone during the wartime. Second, it revealed both short and long run consequences of civil wars on the labor market of Afghanistan that led to several policy recommendations. Third, in the presence of long-term civil wars, marker variables such as financial inclusion, inflation rate, GDP growth, and foreign direct investment have also been tested and their results also emphasized on the policy adjustment for Afghanistan.

7.2. Published paper

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Analyzing the Consequences of Long-Run Civil War on Unemployment Rate: Empirical Evidence from Afghanistan

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Abstract: This article aims to uncover the asymmetric labor-market consequences of the long-run civil war in Afghanistan by employing a non-linear autoregressive distributed lags (NARDL) model and an asymmetric causality technique over the period from 2004Q3 to 2020Q4. The findings from the NARDL model reveal that the positive asymmetric shocks from the cost of war, GDP growth, final government expenditure, foreign direct investment, and the rule of law significantly decrease the unemployment rate, while their negative asymmetric shocks increase the unemployment rate in the short and long runs. Innovatively, the composite financial inclusion index has been incorporated into the model, which provides interesting results. It demonstrates that enhancing the outreach of financial services plays an important role in reducing the unemployment rate during wartime in Afghanistan, while its exclusion is found to increase the unemployment rate both in the short and long runs. Moreover, the results of the asymmetric causality test reveal that an asymmetric causality runs from both the positive and negative components of the cost of war, the composite financial inclusion index, GDP growth, foreign direct investment, inflation rate, population growth, and the rule of law to the unemployment rate, while no evidence is found to support a causality nexus between the unemployment rate, final government expenditure, and the secondary school enrollment rate. The results entail several policy implications that are discussed.

Keywords: cost of war; unemployment rate; Afghanistan; GDP; NARDL

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1. Introduction

From 1992 to 2021, Afghanistan's longest war, which resulted in the overthrow of several political regimes and governments, had severe impacts on socioeconomic indicators. Extreme poverty, the highest unemployment rate, extreme income disparities, forced migration, loss of millions of people, physical and mental disabilities, loss of social and economic infrastructure, human capital flight, and trillions of dollars of outcome-free expenditure are the ultimate results of the civil wars in Afghanistan [1,2]. It is well documented by the existing literature (see, inter alia, [3–5]) that civil wars destroy economic and social institutions, plunge a country into poverty, foster extremism, erode social norms, and increase unemployment rate, all of which return as a cyclical effect to war intensification. Nonetheless, there is no general agreement on the speed of a nation's post-conflict recovery, but it is literally obvious that it takes longer than expected due to the prevalence of social exclusion, extreme poverty, and reconstruction of devasted infrastructure in war-torn societies—Afghanistan being at the top of the list of such societies, assuming that long-run civil wars have concurrent and long-term negative effects, specifically on the high unemployment rate. Thus, this study turns its focus to analyzing one of the sensitive strands of the socioeconomic predictors—that is, the labor market effects of the long-run war on the unemployment rate, which is assumed to have significant causality in intensifying the war in Afghanistan.

From an economic point of view, civil wars disrupt the balance of demand and supply of manpower in an economy, causing the supply (demand) curves to shift upward (downward), resulting in an excess of manpower supply, which significantly heightens the unemployment rate [6,7]. The short-run consequences of war-driven unemployment may simultaneously swallow per capita savings and decrease per capita real income and aggregate consumption, which can be adjusted by effective interference [8], while the long-run consequences of war-driven unemployment have far more serious social impacts on the economy, inflicting severe negativity and inconceivable human suffering [9], which will take an unexpectedly long time to recover to its pre-war state. Moreover, it is also well evident that war-driven unemployment is a significant driver of plunging nations into severe poverty and unemployment, further enhancing the propensity for prolonged civil wars. Therefore, the emerging term "war-driven unemployment" should still be used with caution because several empirical studies show an inverse trend—that is, unemployment-driven civil wars [5,10]. Such claims are plausible but are likely to provide only half an explanation. Therefore, one way or another, each war-torn society will, perhaps, require a context-specific analysis to gain a wider and deeper insight into the causes, effects, and causality direction of the civil wars with the socioeconomic indicators. The principal conclusions of recent studies have also urged empirical works to focus on context-specific questions, sophisticated empirical models, and a wide range of predictors to offer comprehensive results on the social and economic consequences of civil wars (see, inter alia, [11,12]). From a sustainability viewpoint, only when output growth exceeds the economy's aggregate productivity of human capital can it decrease the unemployment rate. As a result, growth moves closer to sustainability if the gradual economic growth promotes a rapid decline in unemployment [13]. Again, such a theoretical expectation is disrupted by the consequences of prolonged civil wars in a country.

Even though a vast body of literature exists on the legacies of civil wars and their effects on different indicators, such as mental health, human displacement, growth, poverty, and income disparities, the missing gaps in the literature can be highlighted in two key areas. *First*, the scarcity of empirical studies to analyze the effects of long-run civil war on the unemployment rate—that is, one of the sensitive labor-market strands and an important component of the sustainable development goals (SDGs) for developing and post-conflict economies, using sophisticated models to offer consistent, accurate, and comprehensive results. *Second*, the non-existence of such studies examining the effects of the longest civil war on the unemployment rate in Afghanistan, which has been a war-torn society for the last four decades, provides ample room and significant justification for the present study to fill the gaps. To that end, it is important to direct the study by formulating three key questions, among all others. *First*, does the long-run civil war have positive (negative) asymmetric effects that increase (decrease) the unemployment rate? *Second*, as aimed by the United Nations, does financial inclusion effectively intermediate to squeeze the asymmetries of civil war on the unemployment rate? *Third*, do the negative (positive) components of the civil war cause any negativity (positivity) in the unemployment rate?

The key objective of this study is to provide statistical evidence on the effects of the long-run civil war on the unemployment rate in Afghanistan by taking a new step in the existing literature and using non-linear autoregressive distributed lags (NARDL) and asymmetric causality techniques to uncover the effects and establish a foundational literature. Though the study focuses on Afghanistan, its outcome can be generalized to all war-torn societies that share a common nature. Thus, this paper is a novel study in the literature of war-driven unemployment analysis in Afghanistan and, therefore, its contribution can be outlined as follows: *First and foremost*, to the best of the authors' knowledge, this is the first ever study in the existing literature for Afghanistan examining the effects of long-run civil war on the unemployment rate. *Second*, this paper builds a comprehensive composite financial inclusion index for Afghanistan, using widely accepted predictors that explain financial inclusion outreach and are incorporated into the model to explain its intermediating role in reducing unemployability during wartime. *Third*, unlike most recent studies, this paper employs sophisticated models that allow asymmetric characteristics of the predictors in assessing the effects of civil war on the unemployment rate, using the most recent and updated datasets from 2004Q3 to 2020Q4 to reflect new statistical evidence. *Fourth*, it enables a broad range of control predictors in the modeling process to provide deeper analysis by considering the intermediating effects of relevant macroeconomic indicators on the unemployment rate.

The remaining sections of the study are structured as follows. Section 2 reviews the relevant literature about the concept of civil war and its effects on various socioeconomic indicators, specifically the unemployment rate. Section 3 presents the methodology, explaining the empirical models, estimation strategy, data, and variables used in the study to test the competing hypotheses. Section 4 presents the results of the estimations and discussion about the findings. Section 5 provides the concluding remarks and some relevant policy recommendations.

2. Literature Review

There are various definitions of war in the existing literature, but all definitions give the impression of similar content. McNeill and Mueller [14] define war as a state of armed conflict within or between two or more nations seeking political, economic, and/or other beneficial hegemonies. Gersovitz and Kriger [15] define civil wars as politically organized, sustained, large-scale, and armed conflicts within or between important groups of a country's inhabitants over the monopoly of political and economic powers. Kalyvas [16] and Farrell [17] define war as instances of organized and sustained conflicts between political parties, groups of inhabitants, two or more nations, or countries that are subject to a common authority at the onset of aggression. Although various definitions and theories have been developed to define civil war and its destructive effects on nations, it is evident that war is a great tragedy and a societal catastrophe [18], whether it is executed by one country against another or imagined to be waged by humanity as a whole [19].

The basic concept of war is not uncommon to the nations; it is stated that, if not all, almost a large proportion of all nations have witnessed either intense or trifling conflicts. In the common sense, an armed conflict between political groups is linked by aggressions of extensive duration and magnitude [20]. Though advances in technology have changed the mechanics of war from those of 1945, the concept has remained unchanged. On the one hand, the empirical literature widely documents the effects of long-term war on socioeconomic indicators, reporting the customary measurement of war effects in terms of money, cost of war, effects of war on the economy, lost productivity, psychological effects of war, and the number of people killed, wounded, and displaced; while on the other hand, it does not report a standard measurement method to ascertain the scale and magnitude of the effects of war on specific socioeconomic indicators. Moreover, the trend of global war has been gradually declining in the past two centuries, but the trend of civil war shows a rapid upward shift in the last four decades [21]. It shows that civil war is most likely to impact the working population; therefore, the human capital and their active engagement in an affected economy [22]. In a general theoretical sense, using plausible assumptions, unemployment is based on the excessive supply of manpower viz-a-viz demand for labor in an economy. A supply that is higher than the numbers demanded or does not match the skills, knowledge, and technicalities is likely to influence the rate of unemployment [23]. However, these assumptions become invalid in an economy bearing the brunt of massive destruction due to prolonged civil wars, where war is assumed to be the main cause of the unemployment onset and unemployment is the outset cause of the intensified civil wars. Though the existing literature mainly documents the civil wars that are outright linked to unemployment, this study proceeds to review the available ones.

For instance, Raphael and Winter-Ebmer [24] investigated the empirical relationship between the unemployment rate and the level of crime, using datasets for US states. The authors employed a wide range of control variables for state-level demographic and economic factors, prime defense contracts, state-effects, time-trend, and year-effects in their estimations. They found that there was a significant link between the decline in crime and the unemployment rate during the 1990s, implying that the decline in the unemployment rate was associated with a reduction in the crime rate. This requires testing the following hypothesis in the context of the long-term war in Afghanistan:

H1. *There is an asymmetric relationship between civil war and unemployment in Afghanistan*.

Rabiile [25] examined the effects of civil wars on the unemployment rate in Mogadishu, Somalia, aiming to test the effectiveness of the Somalian government's policies to increase job creation in an affected war economy. The author used a self-administered questionnaire and collected primary data from 171 out of 300 respondents and employed descriptive statistics and correlation analysis. The author concluded that there was a significant link between civil war and unemployment, emphasizing the importance of policy changes to encourage foreign investment and sound international projects to reduce unemployment in Mogadishu, Somalia. Hamilton [26] examined the impact of unemployment on civil conflict in 184 countries based on the North Ireland case. The author used both social and economic factors, with a specific focus on civil conflict in ethnically heterogeneous nations. Using logit regression models, the author found that rising unemployment rates are linked with the onset of civil wars.

Miguel and Roland [27] investigated the impact of US bombing on the persistence of local poverty and unemployability in Vietnam, using a set of unique data relevant to the US military, comprising bombing intensity at district levels, which bears a massive humanitarian cost. The estimation was based on comparative analysis of the districts bombed with other districts, while the authors controlled for demographic and geographic characteristics. The authors conclude that there were no significant effects of bombing on the outcome variables, though it has been the most intensified bombing in the history of Vietnam (see, also, [28]).

Berman et al. [29] argued for the notion of the opportunity cost, relevant to government spending to bring social and political order, assuming that gainful employment of young men reduces their propensity to participate in armed conflicts. The authors used their assumptions in Afghanistan, Iran, and the Philippines, employing a set of survey data comprising unemployment, attacks against governments and their allied forces, and civilian deaths. The estimation results of their study conclude that there is no significantly positive link between the predictors. Specifically, no evidence was found to support the relationship between unemployment and the number of attacks killing civilians in all three countries. Furthermore, the authors found potential explanations, presenting the notion that insurgent meticulousness to arbitrate between the potentials of predation on one hand and security measures and information costs on the other would be the negative association between the unemployment rate and civil wars.

Kecmanovic [30] evaluated the effects of war in Croatia on unemployment, education, and earnings lines of men born in 1971, using the Croatian and Slovenian Labor Force Survey datasets and the Difference in Difference (DiD) method to analyze their data in comparison with Slovenia, a neighboring country that experienced no war. The authors found that the war is negatively associated with education and positively associated with the unemployment rate and earning outcomes of men born in 1971. The author argues that Croatia's victory explains the observed preferential treatment of draftees in the labor market. Moreover, Galdo [12] investigated the effects of armed conflicts on the labor market in Peru, using datasets spanning from 1980 to 1995. The author discovered that the first 36 months of life are the most vulnerable period of early life exposure to civil war, and that one standard deviation increase in war causes a 5% decrease in adult monthly earnings, a significant decrease in the recruitment of female job seekers, and a 6% decrease in the possibility of men working in large companies. Thus, the author emphasizes the positive association of unemployment with the civil war in Peru. This leads this study to develop the following hypothesis:

H2. *Civil war has non-monotonic negative effects on the rapidly rising unemployment rate in both the short and long runs.*

Shemyakina [31] explored the effects of armed conflicts on the outcomes of the labor market in Tajikistan, focusing on school-age cohorts during wartime, from 1992 to 1998. The author controlled for district-level exposures to civil war and employed regression analysis. The author found that younger women who lived in war-effected regions were more affected by conflict than men and were 10% more likely to be employed compared to older women from less affected districts. These results show a changing pattern in the employment of women induced by civil war.

Vincent de Paul et al. [32] evaluated the long-run effects of conflict exposure throughout various stages of life on the outcomes of the labor market in Sierra Leone using datasets from the Sierra Leone Integrated Household Survey (2011) and other sources on human-rights violations and loss of assets during war. The authors found negative effects of conflict exposures throughout primary schooling time and long-run labor market involvement and employment, implying that long-run effects of war reduce labor market participation, e.g., employment, by 3% in Sierra Leone.

Mansoor [33], which is a leading study of the war-unemployment rate nexus in Afghanistan, attempted to explain the principal reasons for unemployment in Afghanistan. The author employed secondary datasets collected from a nationally representative household survey and augmented the variables of his study with age, gender, marital status, the level of education, educational attainment, sector-wise employment, and insecurity perception. The author employed logit regression models to test the effects of the war and the youth protuberance on total labor market failure in Afghanistan and found that the high unemployment rate is not statistically significant enough to impact the war and the insecurity in Afghanistan and concluded that the rapidly rising unemployment rate is not necessarily the cause of the prolonged war in the country, while age, gender, education, marital status, geographical constraints, and sector-wise employment are statistically significant enough to impact the unemployment in Afghanistan. Assuming the feedback effects, it is important to develop and test the following two competing hypotheses:

H3. *In a country-specific context—for example, in Afghanistan—asymmetric causality runs from civil war to unemployment rate with no feedback response.*

H4. *The current study assumes that the expansion of financial inclusion outreach intertwines with the civil war and reduces the direct effects of the civil war on the unemployment rate.*

Although the existing literature is limited in reporting empirical studies focusing on testing the effects of civil wars on unemployment rate or using sophisticated models to provide accurate and consistent results, the literature reports no study analyzing the effects of long-term civil wars on the unemployment rate in Afghanistan, a country where most of the population lives below the poverty line with an extremely high unemployment rate. Thus, it encourages the present study to overcome these empirical shortcomings.

3. Methodology

Based on the developed hypotheses and the overarching objectives of the study, this section specifies the econometric methods used to examine the effects of the civil war on the unemployment rate in Afghanistan—a country that has been a war-torn society for more than four decades. It then explains key measurements, data collection from various reliable sources, and the variables employed in the study. Recognizing the importance of the SDGs (Sustainable Development Goals) of the United Nations, this paper innovatively employs the composite financial inclusion index as a comprehensive proxy to capture the effects of emerging financial services on the unemployment rate during wartime. The study also describes the methodology used to construct the composite financial inclusion index.

3.1. Model Specification

To obtain a specification, the present study draws on linear methods used by recent studies (see, inter alia, [33–35]) and argues that the linearity assumption does not fully uncover the effects of civil war and the control predictors on the dependent variables used in this paper—thereby, the effects of civil war on the unemployment rate. Except for the cost of war, which is used as a key variable of interest and the composite financial inclusion index, the choice of other explanatory variables augmented in the subsequent models follow recent studies in the literature (see, for instance, [36–40]). To that end, assuming that all the predictors are either I(0), I(1), or a combination of both, without any higher degree of integration, this study begins the specification with the long-run non-linear model of Shin et al. [41] as follows:

$$\begin{aligned} uer_t = {} & \lambda_1^+ cow_t^+ + \lambda_2^- cow_t^- + \lambda_3^+ cfi_t^+ + \lambda_4^- cfi_t^- + \lambda_5^+ gdpg_t^+ + \lambda_6^- gdpg_t^- \\ & + \lambda_7^+ pgr_t^+ + \lambda_8^- pgr_t^- + \lambda_9^+ fge_t^+ + \lambda_{10}^- fge_t^- + \lambda_{11}^+ inf_t^+ + \lambda_{12}^- inf_t^- \\ & + \lambda_{13}^+ ser_t^+ + \lambda_{14}^- ser_t^- + \lambda_{15}^+ rol_t^+ + \lambda_{16}^- rol_t^- + \lambda_{17}^+ fdi_t^+ + \lambda_{18}^- fdi_t^- + u_t \end{aligned} \tag{1}$$

Here, $uer =$ the unemployment rate, $cow =$ cost of war, $cfi =$ composite financial index, $gdpg =$ gross domestic product growth rate, $pgr =$ population growth rate, $fge =$ final government expenditure, $inf =$ inflation rate, $ser =$ secondary school enrollment rate, $rol =$ the rule of law, and $fdi =$ foreign direct investment rate. Moreover, $\lambda_t^+ (\lambda_t^-)$ are the long-run positive (negative) partial sum changes in the variables [41]. The positive and negative partial sum changes of the explanatory variables $x_t = x_t + x_t^+ + x_t^-$ use $x_t^+ = \sum_{j=1}^{t} \Delta x_t^+ = \sum_{j=1}^{t} \max(\Delta x_j, 0)$ and $x_t^- = \sum_{j=1}^{t} \Delta x_t^- = \sum_{j=1}^{t} \min(\Delta x_j, 0)$ functions to be integrated in the model (1). The linear I(0) combination, that is, (z_t) of Equation (1) and its asymmetric partial sum of squares, can be expressed as:

$$\begin{aligned} z_t = {} & \pi + \vartheta_1^+ uer_t^+ + \vartheta_2^- uer_t^- + \gamma_1^+ cow_t^+ + \gamma_2^- cow_t^- + \gamma_3^+ cfi_t^+ + \gamma_4^- cfi_t^- + \gamma_5^+ gdpg_t^+ \\ & + \gamma_6^- gdpgi_t^- + \gamma_7^+ pgr_t^+ + \gamma_8^- pgr_t^- + \gamma_9^+ fge_t^+ + \gamma_{10}^- fge_t^- + \gamma_{11}^+ inf_t^+ + \gamma_{12}^- inf_t^- \\ & + \gamma_{13}^+ ser_t^+ + \gamma_{14}^- ser_t^- + \gamma_{15}^+ rol_t^+ + \gamma_{16}^- rol_t^- + \gamma_{17}^+ fdi_t^+ + \gamma_{18}^- fdi_t^- + e_t \end{aligned} \tag{2}$$

where all the variables are explained before, the conditioned [I(0; stationarity at the level)] property of the series can be achieved in Equation (2) if (z_t) is significant to reject the null hypothesis of non-stationarity at the level. Moreover, the cointegration between the predictors can be established if (z_t) is significant to reject the null of no cointegration between the predictors $H_O : \vartheta_1^+ = \vartheta_2^- = \lambda_1^+ = \lambda_2^- = 0$ at either of 10%, 5%, or 1% significant levels. It is very probable that Equation (2) may exhibit endogeneity and multicollinearity problems that needs to be adjusted before empirical estimation [42]. Thus, we adjust the endogeneity and multicollinearity issues by incorporating the autoregressive (AR) and parameter and the dynamic form into Equation (2) as:

$$y_t = \sum_{i=1}^{p} \theta un_{t-i} + \sum_{i=0}^{q} \left(\lambda_1^+ cow_t^+ + \lambda_2^- cow_t^- + \lambda_3^+ con_t^+ + \lambda_1^- con_t^- \right) + e_t \tag{3}$$

where θ is the AR parameter, λ presents the coefficient that brings in the dynamic adjustment in the equation [43], and for simplicity purposes, $con_t^+ (con_t^-)$ presents the positive (negative) partial sum of all the other control variables. Now the present study specifies the non-linear autoregressive distributed lags model of Shin et al. [41] as follows:

$$\Delta uer_t = \rho y_{t-i} + \lambda_1^+ cow_t^+ + \lambda_2^- cow_t^- + \lambda_3^+ con_t^+ + \lambda_4^- con_t^- + \sum_{i=1}^{p} \delta_i \Delta uer_{t-i} + \sum_{i=0}^{q} \Delta\omega_{i1}^+ cow_t^+ + \sum_{i=0}^{q} \Delta\omega_{i2}^- cow_t^- + \sum_{i=0}^{q} \Delta\omega_{i3}^+ con_t^+ + \sum_{i=0}^{q} \Delta\omega_{i4}^- con_t^- + e_t \quad (4)$$

where the change sign Δ is the difference operator, $\lambda^+(\lambda^-)$ are the long-run positive (negative) partial sum changes, and $\omega^+(\omega^-)$ are the short-run positive (negative) asymmetric coefficients augmented in the model. All other specifications are similar to Equation (1). The use of the non-linear ARDL model has several distinctive advantages over other common estimation methods, such as linear ARDL, ordinary least squares, vector autoregressive, and vector error-correction. First, its superiority is clear in decomposing the positive and negative partial sum of the predictors in both the short- and long-run to capture the asymmetric effects of the explanatory variables on the outcome variable. Second, it incorporates the cointegration bound test into the long-run and instantaneously estimates it with the short-run coefficients while it conserves the data-generation processes, yielding robust and consistent estimates (see, for instance, [41]). Third, the coefficients of the asymmetric ARDL model are robust in the presence of any structural break in the series [44].

Consistent with the asymmetric assumption and in-line with the above specification, the present study investigates causality relationships between the variables using an asymmetric approach. The need for an asymmetric causality model comes from the reality that macroeconomic predictors respond more to negative shocks than positive ones. Therefore, this study employs the proposed asymmetric causality model of Hatemi-J [45] to examine the asymmetric causality nexus between the unemployment rate (y) and the described explanatory variables (x), defining each of them as a random walk process as:

$$y_t = y_{t-1} + u_{1t} = y_0 + \sum_{i=1}^{t} u_{1i} = y_0 + \sum_{i=1}^{t} u_{1i}^+ + \sum_{i=1}^{t} u_{1i}^-$$
$$x_t = x_{t-1} + u_{2t} = x_0 + \sum_{i=1}^{t} u_{2i} = x_0 + \sum_{i=1}^{t} u_{2i}^+ + \sum_{i=1}^{t} u_{2i}^- \quad (5)$$

where u_{1i} and u_{2i} are the stochastic error terms and are defined as:

$$u_{1i} = u_{1i}^+ + u_{1i}^-,\ u_{1i}^+ = \max(u_{1i}, 0), u_{1i}^- = \min(u_{1i}, 0), \quad (6)$$

$$u_{2i} = u_{2i}^+ + u_{2i}^-,\ u_{2i}^+ = \max(u_{2i}, 0), u_{2i}^- = \min(u_{2i}, 0), \quad (7)$$

Equations (6) and (7) represent the sum of the positive and negative shocks [46]. Therefore, the positive and negative shocks of the dependent and independent variables can be $y^+ = \sum_{i=1}^{t} u_{1i}^+,\ y^- = \sum_{i=1}^{t} u_{1i}^-,\ x^+ = \sum_{i=1}^{t} u_{2i}^+,\ x^+ = \sum_{i=1}^{t} u_{2i}^+$. The non-linear causality of negative shocks is estimated using the following vector autoregressive (VAR) model:

$$x_t^- = \varphi + A_1 x_{t-1}^- + \ldots + A_p x_{t-1}^- + e_t^- \quad (8)$$

where x_t^-, φ, A_r, and e_t^- present the vector of variables being tested, the constant, the matrix of lagged variables as such $r = 1, 2, \ldots, p$, and the error terms, respectively. Testing the null hypothesis of no granger causality of positive and negative shocks between the variables, the following Wald test is used:

$$W_L = (Cvec(D))'[C((Z'Z)^{-1} \otimes V_s)C'](Cvec(D)) \quad (9)$$

where C presents the matrix of ones for restricted and zeros for all other parameters, $D = v, A_1, \ldots, A_p$ and $vec(.)$ presents the column of stacking operators. $V_s = \hat{\xi}_s{}'\hat{\xi} \div T - q$ the variance covariance of the VAR model. Optimal lag length is selected via the HJC (Hatemi-J Information Criterion), while the critical values are derived using bootstrap iterations [46]. The null hypothesis of no asymmetric causality nexus between the positive and negative components of the predictors is rejected if the Wald statistics are greater than the critical values at a desired significant level.

3.2. Measurement and Data Sources

This paper uses a set of time-series data containing annual observations spanning from 2004 to 2020 for Afghanistan, which is the context of interest for the analysis of the effects of civil war on the unemployment rate. Following Shahbaz et al. [47], Hameed et al. [48], and Azimi and Shafiq [49], the study transformed the annual observations into quarterly series, using the linear interpolation methodology proposed by Asogu [50]. This method is rational because it accurately transforms the data into a higher number of observations without affecting the stationarity properties or trends of the variables. Moreover, it increases the sample size (N = 17 to N = 66) and offers more observations, helping to obtain consistent results. Thus, the dataset presents quarterly observations from the third quarter of 2004 to the fourth quarter of 2020. As defined before, the variables include unemployment rate; cost of war to Afghanistan's GDP (%); GDP growth rate; secondary school enrollment rate; the rule of law; final government expenditure to GDP (%); composite financial inclusion index; inflation rate; population growth rate; and foreign direct investment to GDP (%). The data comes from the World Development Indicators (WDI), Worldwide Governance Indicators (WGI), the International Monetary Fund's Financial Access Survey (FAS-IMF), and the United States Department of Defense Budget. Table 1 provides complete information about the description, symbols, measurements, and sources of the data obtained for the variables.

Table 1. Variables' description and data sources.

Full Name	Symbol	Measurement	Sources	Summary Statistics		
				Mean	Max.	Min.
Unemployment rate	*uer*	This variable measures the number of people actively looking for job as a percentage of total labor force.	WDI	11.396	11.730	10.980
Cost of war	*cow*	Cost of war is in millions of US dollars and originated from the US Department of Defense Budget, and then it is divided by GDP that is sourced from WDI. Therefore, it is expressed as a percentage of GDP.	USDS Budget	28.389	37.221	19.473
School enrollment rate	*ser*	School enrollment rate presents the secondary school enrollment ratio expressed as a gross percentage of the total enrollment in Afghanistan.	WDI	39.411	58.340	12.325
Final government expenditure	*fge*	Final government expenditure is expressed as a percentage of GDP.	WDI	3.817	5.236	1.049
Composite financial inclusion index	*cfi*	Composite financial inclusion index is estimated using the methodology proposed by Sarma [51] to reflect a comprehensive measure of financial inclusion in Afghanistan. It is expressed as numbers; 0 = perfect financial exclusion, and 1 = perfect financial inclusion.	FAS	0.415	0.442	0.218
The rule of law	*rol*	The rule of law is expressed as a percentile rank [0 = no rule of law; 100 = perfect rule of law]. Therefore, the higher the percentile rank, the higher the institutional quality is.	WGI	2.467	5.769	0.469
Official inflation rate	*inf*	Inflation rate is measured by the consumer price index and reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services.	IFS/IMF	5.836	26.400	−6.800
Foreign direct investment	*fdi*	It is the net inflow of investment to acquire a lasting management interest in an enterprise operating in an economy. It is expressed as a percentage of GDP.	WDI	1.157	4.400	0.100
Population growth rate	*pgr*	This variable is expressed as a percentage of change in the population.	WDI	17.226	17.477	16.933
GDP growth rate	*gdpg*	GDP growth is expressed as a percentage of growth in gross domestic product.	WDI	6.246	21.400	−2.400

Source: Authors' collection. Notes: FAS = Financial Access Survey, IMF = International Monetary Fund, WDI = World Development Indicators, WGI = Worldwide Governance Indicators, IFS = International Financial Statistics, USDS = United States Department of Defense Budget, Max. = Maximum, Min. = Minimum.

Unemployment rate is employed as the dependent variable. It reflects the percentage change in the unemployment rate during the civil war in Afghanistan. General theory postulates that civil wars and unemployment rate strongly covariate during wartime and aftermath, affecting the overall social inclusion and economic well-being of a nation [52], [53]. The cost of war measures the amount of money the United States spent in Afghanistan from 2004 to 2020. Due to a lack of availability of the data, the cost of war presents aggregate data for Afghanistan and is not disaggregated by provinces, although the war intensity has been higher in some provinces than in others during the period of this study. Furthermore, this proxy has two more features than the proxies used in recent studies. First, it allows more accurate estimations than the number of people killed and injured. Second, it provides actual data on the amount of money spent on operating pure military operations—thus reflecting the real economic cost of war. The secondary school enrollment rate is used as an explanatory variable to measure the gross enrollment in secondary schools and to reflect the variability of the fundamental attempts at advancing skills and knowledge to reduce the unemployment rate. Furthermore, the rule of law is employed to capture the effects of institutional quality on reducing unemployment rate. It is widely documented that the rule of law is an appropriate proxy for institutional quality when analyzing the effects of civil war on the mentioned outcome variables (see, inter alia, [54], [55]). Studies by Bala and Bala [56], Janifar et al. [57], Mubarak [58], and Hjazeen et al. [59] suggest the incorporation of population growth, GDP growth, foreign direct investment, and the inflation rate when investigating the effects of other socioeconomic predictors on unemployment rate in developing economies. Finally, recognizing the importance of financial inclusion in combating unemployment, this paper innovatively constructs and employs the composite financial inclusion index as a control variable to ascertain its impact on the unemployment rate during wartime.

3.3. Construction of (*cfi*)

The *cfi* comprises three key dimensions, such as banking penetration, availability, and usage of financial services by the bankable adults. The construction is based on the methodology proposed by Sarma [51] and begins with the specification of key indicators for each dimension. Table 2 describes the indicators and weights.

Table 2. The *cfi* indicators.

Dimensions	Indicators		Assigned Weights
Banking penetration	i.	Number of deposit accounts per 1000 people	0.50
	ii.	Number of depositors per 1000 adults	0.50
Availability of financial services	i.	Number of banks per 100,000 people	0.70
	ii.	Number of ATMs per 100,000 adults	0.30
Usage of financial services	i.	Number of loan accounts in banks per 1000 people	0.50
	ii.	Number of borrowers from banks per 1000 people	0.50

Source: Authors' calculations. Notes: The average number of deposit accounts per 1000 people is estimated to be 1.5. Therefore, the assigned weight for it would be 1.5/3 = 0.50, and so on.

Then, the construction continues to determine an appropriate index for each of the dimensions by observing the minimum and maximum integers using the following equation:

$$"d_i = w_i \frac{A_i - m_i}{M_i - m_i}" \quad (10)$$

Here, d_i, w_i, A_i, m_i, and M_i are the normalized value of the particular dimension, weight of the dimension, actual value, lower limit, and upper limit of the dimension *i*, respectively [60]. It is worth mentioning that the lower limit is fixed by assigning 0 value, while the upper limit is fixed by the 90th percentile rank. Next, the composite financial inclusion index is estimated employing Equations (9)–(11), using the notions of distance (d) achievements of points $(d_1, d_2, d_3, \ldots, d_n)$ from $(O = 0,0,0,\ldots,0)$ being the worst and from $(W = w_1, w_2, w_3, \ldots, w_n)$ being the ideal situation:

$$x_1 = \frac{\sqrt{d_1^2 + d_2^2 + d_3^2 + \ldots + d_n^2}}{\sqrt{w_1^2 + w_2^2 + w_3^2 + \ldots + w_n^2}} \tag{11}$$

$$x_2 = 1 - \frac{\sqrt{(w_1 - d_1)^2 + \ldots + (w_n - d_n)^2}}{\sqrt{(w_1^2 + \ldots + w_n^2}} \tag{12}$$

$$\widehat{cfi}_i = \frac{1}{2}(x_1 + x_2) \tag{13}$$

where Equation (11) estimates the normalized Euclidian distance between the achievement point (x) and worst position (O) on the n*th* space, Equation (12) estimates the normalized inverse distance between (x) and ideal position (W) on the n*th* space, and Equation (13) computes the composite financial inclusion index by taking the average of Equations (11) and (12). This method of construction is widely accepted as a standardized predictor of composite financial inclusion index (see, inter alia, [39,40,61]). Having described the methodology, dependent and independent variables, and the data collection sources used in the study, the next section explains the results and discusses on the findings.

4. Results and Discussions

4.1. Stationarity Result

We start our analysis with a correlation analysis among the variables to detect any multicollinearity between them. The results of the correlation analysis are presented in Table 3. They indicate, however, that the cost of war is negatively associated with school enrollment ratio and positively associated with final government expenditures; they are significant at a 10% level, implying no extreme collinearity. Other variables are discovered to have a negligible correlation with one another. Thus, the results support the specification and estimation of the NARDL model to determine the effects of cost of war on the unemployment rate. Moreover, we test the unit root of the variables, which is important in time-series estimations to ascertain their integrating orders to avoid any misspecifications. To that end, this study employs the Augmented Dickey and Fuller (ADF) [62] and Phillips and Perron (PP) [63] methods. For estimation purposes, the study has selected the optimal lag length via the AIC, SIC, and HIC frameworks in the standard vector autoregressive environment with a maximum five-lag order. The results are reported in Table 4, and all three methods suggest using two lags. Thus, the study employs two lags and maintains them throughout the subsequent estimations.

Table 3. Correlation matrix.

	uer	*cow*	*ser*	*fge*	*cfi*	*rol*	*inf*	*fdi*	*Pgr*	*gdpg*
uer	1.000	0.489	−0.206	0.444	−0.467	−0.273	0.487	0.420	0.500	−0.336
cow		1.000	−0.519 *	0.504 *	0.229	0.082	0.338	−0.182	0.202	0.217
ser			1.000	0.421 *	0.388	0.517 *	−0.076	0.367	−0.490	0.540 *
fge				1.000	−0.111	−0.409	−0.264	0.319	−0.254	0.462
cfi					1.000	0.255	−0.311	0.442	−0.099	0.337
rol						1.000	−0.402	−0.402	−0.017	0.125
Inf							1.000	−0.199	0.287	−0.441
fdi								1.000	0.188	0.503
pgr									1.000	−0.390
gdpg										1.000

Source: Authors' estimation. Notes: * indicates significance at 10% level.

Table 4. Optimal lag length.

Lags	LogL	AIC	SIC	HIC
0	−110.429	−8.339	−8.391	−8.322
1	122.071	−8.595	−8.389	−8.511
2	139.448	−8.600 ***	−8.461 ***	−8.541 ***
3	146.222	−8.558	−7.492	−8.428
4	161.331	−8.508	−7.889	−8.349
5	201.418	−8.520	−7.665	−8.106

Source: Authors' estimation. Notes: *** indicates the optimal lags selected by criterion. AIC = Akaike Information Criterion, SIC = Schwarz Information Criterion, HIC = Hannan–Quinn Information Criterion. Total observations included = 66.

Both the ADF and PP tests are widely used in the literature and provide consistent results in testing the null of non-stationarity, unless the data exhibit structural breaks. To account for any structural breaks in the data, the Zivot and Andrew (ZA) [64] method is also deployed with one structural break to test the null of non-stationarity in the presence of structural break. The results of the ADF and PP tests that include intercept and trend regressors are reported in Table 5, while the results of the ZA are presented in Table 3. For the rejected null of non-stationarity at the level, the ADF and PP results indicate that the unemployment rate and inflation rate are significant at 5% and 1% levels, while they indicate that composite financial inclusion index, school enrollment ratio, the rule of law, final government expenditure, foreign direct investment, cost of war, and population growth rate are insignificant to reject the null at the level, but they become significant at 1% level to reject the null after taking their first difference. The results demonstrate that the variables follow mixed integration of I(0) and I(1) without any higher degree of integration.

Table 5. Unit root test results.

Tests Estimated	*uer*	*cfi*	*gdpg*	*ser*	*inf*
ADF at level	−3.083 **	−1.087	−2.661 **	−1.521	−4.285 ***
PP at level	−3.611 **	−0.963	−2.153 *	−1.426	−2.847 *
	rol	*fge*	*fdi*	*cow*	*pgr*
ADF at level	−1.654	−1.973	−2.153	−2.084	−0.217
PP at level	−1.235	−1.429	−1.029	−0.959	−0.925
	Δ*uer*	Δ*cfi*	Δ*gdpg*	Δ*ser*	Δ*inf*
ADF at first difference	−4.353 ***	−3.850 ***	−5.887 ***	−3.332 **	−5.324 ***
PP at first difference	−4.169 ***	−3.340 **	−4.468 ***	−3.150 **	−4.299 ***
	Δ*rol*	Δ*fge*	Δ*fdi*	Δ*cow*	Δ*pgr*
ADF at first difference	−4.412 ***	−4.356 ***	−3.866 ***	−3.921 ***	−3.591 ***
PP at first difference	−3.683 ***	−3.718 ***	−3.801 ***	−3.942 ***	−3.373 **

Source: Authors' estimation. Notes: ***, **, and * indicate 1%, 5%, and 10% significant levels, respectively. Δ denotes first difference operator. uer = unemployment rate, gdpg = gross domestic product growth, ser = school enrollment ratio, inf = inflation rate, rol = rule of law, fge = final government expenditure, fdi = foreign direct investment, cow = cost of war, pgr = population growth.

Moreover, the study computed the ZA test to capture any break in the data, allowing breaks both in the intercept and trend. The results indicate that the unemployment rate, GDP growth, inflation rate, the rule of law, and final government expenditure are significant for the rejected null of non-stationarity in the presence of break at 1% level. Though the results are consistent with those of the ADF and PP shown in Table 5, ZA provides more insights into the data trend. The results reflect the fact that due to several major events in Afghanistan, such as the US troop withdrawal inception in 2014 and their retainment as Afghan military supporting units, a sharp downward shift in government expenditure [65], aggregate consumption, aggregate demand and supply, the rise and fall in on-the-budget contributions of the US and its alliance to support military operations, a sudden shift in employment and placements, and the higher intensity of civil war from 2014 onward, various macroeconomic strands have witnessed significant shifts and caused breaks. Considering the results obtained from ADF, PP, and ZA tests, the study concludes that the variables follow mixed integrating orders of I(0) and I(1), while there is no evidence to support any higher degree of integration. Therefore, based on the specifications, the study proceeds to estimate and interpret the long-run nexus, e.g., cointegration between the variables.

4.2. Cointegration Analysis

The study confirms the mixed integrating order of the predictors and the presence of breaks in the data, as shown in Tables 5 and 6. Next, the study computes the symmetric ARDL bound test for the cointegration augmented with a dummy variable for break date [1 = break, 0 = no break] and optimal lag length automatically selected via the AIC, SIC, and HQIC methods. The results are reported in Table 7 and demonstrate that the test statistics (F = 39.196 > 3.97, t = −10.651 > −5.54) are greater than the critical values at a 1% significant level and support the rejection of the null hypothesis of no cointegration between the variables. This implies that the variables are cointegrated and move together in the long run.

Table 6. Zivot and Andrew unit root test results.

Tests estimated	*uer*	*cfi*	*gdpg*	*ser*	*inf*
Test statistics	−7.104 ***	−0.734	−4.461 ***	−0.899	−7.318 ***
Break date	2014:Q3		2018:Q6		2004:Q9
Result	Stationary	Non-stationary	Stationary	Non-stationary	Stationary
	rol	*fge*	*fdi*	*cow*	*pgr*
Test statistics	−6.399 ***	−4.927 ***	−1.099	−1.581	−1.374
Break date	2009:Q2	2015:Q3			
Result	Stationary	Stationary	Non-stationary	Non-stationary	Non-stationary

Source: Authors' estimation. Notes: *** indicates 1% significant level. uer = unemployment rate, gdpg = gross domestic product growth, ser = school enrollment ratio, inf = inflation rate, rol = rule of law, fge = final government expenditure, fdi = foreign direct investment, cow = cost of war, pgr = population growth.

Table 7. Bound test cointegration results.

DV: *uer* **Test Statistics**	**Values**	**CV at 1%**		**Null: No Cointegration**
		I(0)	**I(1)**	
F-statistics	39.196 ***	2.65	3.97	Reject the null.
t-statistics	−10.651 ***	−3.42	−5.54	Reject the null.

Source: Authors' estimation. Notes: *** indicates significance at 1% level. DV = Dependent variable, uer = unemployment rate.

Recalling the assumption of the non-linear combination of the predictors, the present study continues to test the asymmetric cointegration between them. Though establishing non-linear cointegration among the variables of mixed integrating orders is relatively complicated, it provides deeper insights into the long-run nexus among them [66]. To that end, the asymmetric ARDL bound test is computed and the results are reported in the upper part of Table 7. It shows that for the rejected null hypothesis of no asymmetric cointegration between the variables, both F-statistics and t-statistics are significant at a 1% level; that is, they are greater than the upper bound I(1) critical values at 1%, confirming the long-run asymmetric bound between variables. This simply shows that the variables incorporated in the model asymmetrically move together in the long run, and the results are linked to both the theoretical concept and real-life example of the effects of civil war on socio-economic indicators—that is, civil wars bring in serious shifts in employment in the host country, heighten poverty, and increase government expenditure through intense economic fragility, forced population displacement, and loss of economic infrastructure. Furthermore, the Wald test is applied to examine the null of short- and long-run symmetries using $SR_W = \sum_{j=0}^{p-1} n_j^+ = \sum_{j=0}^{p-1} n_j^-$ and $LR_W = -\omega^+ / \lambda = -\omega^- / \theta$, respectively. The results of the Wald test that are presented in the rear part of Table 8 are statistically significant to reject the null of short-run and long-run symmetries $H_{null}: \lambda_1^+ = \lambda_2^- + \omega_1^+ = \omega_2^- = 0$ and support the notion of non-linearity among the predictors both in the short and long runs. From these results, several important findings can be noted. First, it implies that the cost of war, which is the key variable of interest, and other control variables together significantly impact the unemployment rate in the short and long run. Second, the rejected null of symmetries indicates that the cost of war and the control variables differently affect the unemployment rate both in the short and long run—thereby, supporting the non-monotonic effects of war and the control variables on the dependent one. Third, the results direct the study to investigate and determine the size and magnitude of the short and long-run asymmetric effects of war and the control variables on the unemployment rate. To that end, the study estimates the non-linear ARDL model.

Table 8. Asymmetric cointegration and Wald test results.

DV: *uer*	**Values**	**CV at 1%**		**Results**
Test Statistics		**I(0)**	**I(1)**	
NARDL bound test				
F-statistics	6.371 ***	3.43	5.68	Reject the null.
t-statistics	−7.544 ***	−3.13	−5.18	Reject the null.
Wald test				
Short-run asymmetries	128.044 ***	[0.000]		Reject the null.
Long-run asymmetries	389.227 ***	[0.000]		Reject the null.

Source: Authors' estimation. Notes: *** indicates significance at 1% level. DV = Dependent variable, uer = unemployment rate.

4.3. Non-Linear ARDL Results

Next, the study computes the non-linear ARDL model to investigate the effects of the cost of war and the relevant control variables on the unemployment rate in Afghanistan, using Equation (4). The estimation is conducted by selecting the optimal lag length via the AIC, SIC, and HIC frameworks using the "varsoc" command, e.g., in the unrestricted vector autoregressive environment (Table 3). First and foremost, Table 9 reports the results of the NARDL estimates for model 1—that is, the nonlinear effects of civil war on the unemployment rate. The results are very clear-cut and reflect the real-life example of a war-torn community like Afghanistan. They demonstrate that the cost of war to GDP (%), as a proxy for civil war, has a significant impact on the unemployment rate in both the short and long run. The results indicate that a positive change in the cost of war increases the unemployment rate by 0.218% and 0.405% in the short and long runs, respectively. A negative partial sum change in the cost of war has a negative effect on the unemployment rate, demonstrating that a negative change in the cost of war—thus, a decrease in the intensity of war—causes the unemployment rate to fall by 0.221% and 0.387% in the short and long runs, respectively, providing a relaxation to higher job opportunities and higher employment in different sectors of the economy. The results are somehow consistent with the findings of Humphreys and Weinstein [67], who found weak effects of civil wars on employability. Comparatively, Justino and Verwimp [68] did not find sufficient evidence to link the consequences of civil wars with employability, poverty, and economy in Rwanda. In a flip-side effect analysis, though it might be confounded for all developing countries irrespective of homogeneity issues, Cramer [37] argued that there is a meaningful nexus between civil wars and unemployability, showing that unemployed youth are the key cause of civil wars in developing economies. The findings of this study indicate that, considering the homogeneous property of Afghanistan's case, civil armed conflicts have significant effects on the rising unemployment rate in the short and long runs.

Moreover, this study innovatively measures the impact of financial inclusion on the unemployment rate during wartime in Afghanistan. Coincidentally, the topic of financial inclusion emerged in the 2001s, as Afghanistan entered a new political era and new civil wars erupted. Therefore, the composite financial inclusion has been added into the model to control for the effects of financial inclusion, which is assumed to be an effective tool for reducing unemployability. The results indicate that a positive shock from the composite financial inclusion reduces the unemployment rate by 0.17% and 0.049% in the short and long runs, respectively. A negative shock from the composite financial inclusion increases the unemployment rate by 0.066% and 0.057% in the short and long runs, respectively. This implies that even though the civil armed conflicts in Afghanistan reduced the employability from one side, while on the other, the emergence of banking system, outreach of financial inclusion to potentially bankable population have raised the employability in Afghanistan. The results are consistent with those of Kim et al. [69], Mehry et al. [70], Azimi [42], Akanbi et al. [71], and Alshyab et al. [72], who also found that financial inclusion significantly reduces the unemployment rate, while there is a large proportion of the world population that is still financially excluded.

The results for the effects of GDP growth on the unemployment rate indicate that a positive partial sum change in growth causes the unemployment rate to reduce by 0.290% and 0.019% in the short and long runs, respectively. This is linked to the general theory that growth in GDP accelerates labor productivity, enhances the labor force cycle, and increases employment. On the other hand, the results demonstrate that a negative partial sum shock from GDP growth increases the unemployment rate by 0.110% and 0.020% in the short and long runs, respectively. This implies that the short-run negative effects are higher than the long run, giving rise to the rapid growth in the labor force than the economic growth causes the unemployment rate to increase in the short run, while it slows down by 0.020% in the long run. Studies by Banda et al. [73], Soylu et al. [74], Chand et al. [75], Shaaibith et al. [76], and Hjazeen et al. [59] also found a significantly negative impact of economic growth on the unemployment rate in different economic contexts, while Tenzin [77] and Chuttoo [78] found no significance to link the unemployment rate with economic growth. In sum, these results correspond with Okun's law, assuming that a rise in GDP is associated with a rise in employment—thus, GDP growth reduces the unemployment rate.

Table 9. Results of non-linear ARDL estimates.

Dependent Variables: Unemployment	**Short-Run Estimates**			**Long-Run Estimates**		
Rate	**Coefficients**	**t-Statistics**	***p*-Values**	**Coefficients**	**t-Statistics**	***p*-Values**
cow_t^+	0.218 ***	3.94	0.000	0.405 ***	8.25	0.000
cow_t^-	−0.221 **	−2.22	0.019	−0.387 **	−2.50	0.038
cfi_t^+	−0.170 ***	−4.00	0.000	−0.049 ***	−4.66	0.000
cfi_t^-	0.066 ***	3.07	0.000	0.057 ***	3.21	0.000
$gdpg_t^+$	−0.290 ***	−3.81	0.000	−0.019 ***	−3.98	0.000
$gdpg_t^-$	0.110 ***	4.19	0.000	0.020 ***	−3.85	0.000
fge_t^+	−0.016 ***	−4.03	0.000	−0.013 ***	−4.57	0.000
fge_t^-	0.007 ***	7.94	0.000	0.097 ***	4.02	0.000

fdi_t^+	−0.108 ***	−8.10	0.000	−0.063 ***	−4.04	0.000
fdi_t^-	0.267 ***	8.60	0.000	0.024 ***	−3.56	0.000
inf_t^+	−0.101 ***	3.75	0.000	−0.067 ***	4.83	0.000
inf_t^-	0.126 ***	3.81	0.000	0.041 ***	−4.12	0.000
ser_t^+	0.117 ***	5.20	0.000	0.021 ***	4.33	0.000
ser_t^-	−0.055 ***	−3.99	0.000	−0.133 ***	−3.47	0.000
pgr_t^+	0.098 ***	3.69	0.000	0.047 ***	4.91	0.000
pgr_t^-	−0.346 ***	−4.02	0.000	−0.140 ***	−5.16	0.000
rol_t^+	−0.283 ***	−5.12	0.000	−0.146 ***	−3.74	0.000
rol_t^-	0.004 ***	4.18	0.000	0.017 ***	4.44	0.000
Constant	−1.032 ***	−7.81	0.000			
Diagnostic tests						
Adjusted r-squared	0.951			Ramsey RESET test (F)		[0.635]
F-statistics	37.32 ***	[0.000]		JB test on normality (chi2)		[0.308]
Port. test for SC (chi2)	1.32	[0.472]		CUSUM		Stable
BP for hetero test (chi2)	0.13	[0.736]		CUSUMSQ		Stable

Source: Authors' estimations. Notes: *** and ** indicate significance at 1% and 5% levels. Optimal lag length is selected via "varsoc" command (p = 1 and q = 1). cow = cost of war, cfi = composite financial inclusion index, gdpg = GDP growth, fge = final government expenditure, fdi = foreign direct investment, inf = inflation ration, Port. = Portmanteau test up to lag (33), SC = serial correlation, BP = Breusch–Pegan, JB = Jarque–Bera.

For the effects of government expenditure on the unemployment rate, the results report significant short and long run coefficients both for positive and negative changes. It shows that a positive shock reduces unemployment by 0.016% while a negative shock increases unemployment by 0.007% in the short run. A positive change in government expenditure decreases unemployment by 0.013%, whereas its negative shock increases unemployment by 0.097% in the long run. Furthermore, foreign direct investment is also found to have a significant impact on the unemployment rate in Afghanistan. The results indicate that positive (negative) partial sum changes decrease (increase) the unemployment rate by 0.108% (0.267%) in the short run, while in the long run, positive (negative) partial sum changes in foreign direct investment decrease (increase) unemployment by 0.063% (0.024%). The inflation rate is also tested against the unemployment rate. The results indicate that a positive partial sum shock from the inflation rate decreases the unemployment rate, while a negative partial sum shock increases the unemployment rate in the short and long runs. The results correspond with the Phillips-curve concept, implying that a percentage rise in the inflation rate causes the unemployment rate to reduce proportionately. These are also consistent with the findings of Attia et al. [79] but are in contrast with those of Azimi [80], who found that the inflation rate increases the unemployment rate in transitional economies.

Notwithstanding, the secondary school enrollment rate has been employed in the model to test its effects viz-a-viz the unemployment rate during wartime in Afghanistan. It reveals that positive (negative) changes in the secondary school enrollment rate significantly increase (decrease) the unemployment rate both in the short and long runs by 0.117% (0.055%) and 0.021% (0.133%), respectively. Though in a theoretical sense, it is commonly assumed that increased human capital knowledge and skills increase creativity and job creation, the findings of this study suggest otherwise in a war-torn economy, therefore, Afghanistan. This might be due to three key reasons. First, the results are linked to the fact that during the war, the number of ghost schools in rural areas and students increased, while in reality it did not contribute to reduce the unemployment rate but rather showed an incremental effect. Second, the Afghan economy did not grow simultaneously with the growth in the labor force, causing graduates and human capital to remain unemployed. Third, the higher proportion of employment is sourced from the agriculture sector. War has seriously shifted the agricultural lands to be used as battle grounds—so it may have caused the unemployment rate to increase in Afghanistan. In an empirical sense, our results are in contrast with the findings of Erdem and Tugcu [81], Aden [82], and Hindun [83], who found that education, thereby, school enrollment, is negatively associated with the unemployment rate. Furthermore, the results reveal that the population growth rate is significant enough to explain the unemployment rate in Afghanistan during wartime. It shows that a positive partial sum change in the population growth rate causes the unemployment rate to increase by 0.098% and 0.047% in the short and long runs, respectively. It also indicates that a negative shock from the population growth rate decreases the unemployment rate by 0.346% and 0.140% in the short and long runs, respectively. Yelwa et al. [84], Gideon [85], and Manuhuttu and Kimirop [86] also found that population growth is positively associated with the unemployment rate, implying that an increase in the population rate causes unemployment to increase. Finally, the asymmetric effects of the rule of law, which is used as a proxy for institutional quality, are tested on the unemployment rate. The results demonstrate that a positive shock from institutional quality reduces the unemployment rate by 0.283% and 0.146% in the short and long runs, respectively, whereas a negative shock from institutional quality increases the unemployment rate in the short and long runs. The results are consistent with the findings of Ragmoun [87], who also found that institutional quality negatively impacts the unemployment rate.

The results of the non-linear ARDL model are robust and consistent. The rear part of Table 6 provides the relevant diagnostic checks. They indicate that the model is highly fit and that all the explanatory variables jointly affect the unemployment rate at a 1% level. Moreover, the residuals of the estimated model are homoscedastic, normally distributed, and do not suffer from serial correlation. For parameter stability, the study computed the CUSUM (cumulative sum) and CUSUMSQ (cumulative sum of squares) tests (see Figure 1), and they indicate that the parameters are significantly stable.

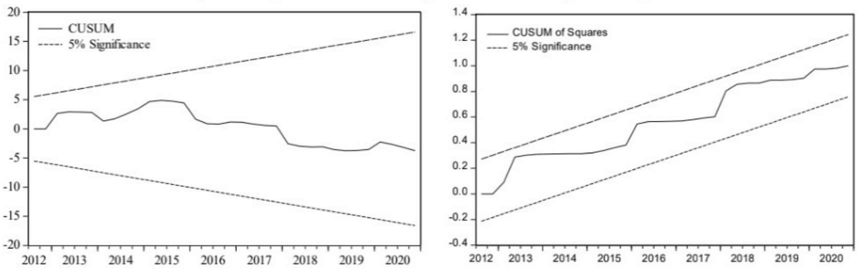

Figure 1. CUSUM and CUSUMSQ results. Note: CUSUM = Cumulative sum, CUSUMSQ = Cumulative sum of squares.

4.4. Non-Linear Causality Analysis

Table 10 reports the results of the asymmetric causality test of Hatemi-J [45]. The optimal lag length is based on the HJC (Hatemi-J Information Criterion) framework, and the critical values for 1%, 5%, and 10% are generated using the bootstrap iteration method. The results are interesting and indicate that the null hypothesis of both positive and negative shocks of the cost of war causing unemployment is rejected at a 1% level. It also indicates that the test statistics of both positive and negative shocks of the composite financial inclusion index to cause positive and negative unemployment rates are rejected at a 1% level. The positive shock of GDP growth to positive unemployment rates is only significant at a 10% level, while its negative null is rejected at a 5% level. Furthermore, unless no evidence is found to reject the null hypothesis of both positive and negative shocks to final government expenditure and school enrollment rate causing positive and negative unemployment rates, all other predictors were found to be statistically significant to reject the null hypothesis. The results are consistent with the findings of Kenny [88], Sahoo and Sahoo [89], Mehry et al. [70], and Purwiyanta and Rini [90], who also found statistically significant causality relationships between unemployment rate, economic growth, and financial inclusion.

Table 10. Asymmetric causality test of Hatemi-J.

Null Hypothesis	Lag Length	Test Statistics	Null Hypothesis	Lag Length	Test Statistics	Bootstrap CV at 1%	Bootstrap CV at 5%	Bootstrap CV at 10%
$cow^+_{t-i} \nRightarrow uer^+_{t-i}$	1 + 9	10.16 **	$fdi^-_{t-i} \nRightarrow uer^-_{t-i}$	1 + 9	20.21 ***	14.58	9.70	7.87
$cow^-_{t-i} \nRightarrow uer^-_{t-i}$	1 + 9	23.44 ***	$inf^+_{t-i} \nRightarrow uer^+_{t-i}$	1 + 9	18.52 ***	14.58	9.70	7.87
$cfi^+_{t-i} \nRightarrow uer^+_{t-i}$	1 + 9	21.98 ***	$inf^-_{t-i} \nRightarrow uer^-_{t-i}$	1 + 9	15.74 ***	14.58	9.70	7.87
$cfi^-_{t-i} \nRightarrow uer^-_{t-i}$	1 + 9	28.04 ***	$ser^+_{t-i} \nRightarrow uer^+_{t-i}$	1 + 9	1.99	14.58	9.70	7.87
$gdpg^+_{t-i} \nRightarrow uer^+_{t-i}$	1 + 9	9.18 *	$ser^-_{t-i} \nRightarrow uer^-_{t-i}$	1 + 9	1.17	14.58	9.70	7.87
$gdpg^-_{t-i} \nRightarrow uer^-_{t-i}$	1 + 9	10.67 **	$pgr^+_{t-i} \nRightarrow uer^+_{t-i}$	1 + 9	13.65 **	14.58	9.70	7.87
$fge^+_{t-i} \nRightarrow uer^+_{t-i}$	1 + 9	7.44	$pgr^-_{t-i} \nRightarrow uer^-_{t-i}$	1 + 9	19.48 ***	14.58	9.70	7.87
$fge^-_{t-i} \nRightarrow uer^-_{t-i}$	1 + 9	5.38	$rol^+_{t-i} \nRightarrow uer^+_{t-i}$	1 + 9	29.64 ***	14.58	9.70	7.87
$fdi^+_{t-i} \nRightarrow uer^+_{t-i}$	1 + 9	13.40 ***	$rol^-_{t-i} \nRightarrow uer^-_{t-i}$	1 + 9	18.07 ***	14.58	9.70	7.87

Source: Authors' estimation. Notes: ***, **, and * indicate significance at 1%, 5%, and 10% levels. VC = critical values, cow = cost of war, cfi = composite financial inclusion index, gdpg = GDP growth, fge = final government expenditure, fdi = foreign direct investment, inf = inflation ration, ser = secondary school enrollment rate, pgr = population growth, rol = rule of law.

5. Conclusions

It is assumed that civil war not only destroys a country's infrastructure but also has serious negative effects on the socioeconomic indicators of an economy, both during wartime and as residual effects afterward. The results of the empirical analysis using an asymmetric approach to test the effects of civil war and relevant control predictors on the unemployment rate in Afghanistan suggest that both the positive and negative asymmetric shocks from civil war, which is the key variable of interest in this study, significantly increase and decrease the unemployment rate in the short and long runs, respectively. The results clearly reflect that an increase in the cost of war causes the unemployment rate to increase, while a percentage decrease in the cost of war causes the unemployment rate to decrease in the runs. This implies that the occurrence of war allocates specific employments for the military sector, while it causes a massive unemployability in Afghanistan. Innovatively, this article incorporated the composite financial inclusion index into the model. The results demonstrate that enhancing the outreach of financial services intermediately reduces the unemployment rate during wartime in Afghanistan, while the exclusion of financial services increases the unemployment rate both in the short and long runs. Consistent with Okun's law, the findings support that an asymmetric positive change in the GDP growth rate increases employability, whereas its negative asymmetric change reduces employability in the short and long runs. Moreover, the findings provide significant evidence that positive (negative) partial changes in government expenditure, foreign direct investment, and the rule of law decrease (increase) the unemployment rate in the short and long runs. The findings show that an asymmetric positive change in the inflation rate reduces the unemployment rate, while a negative partial sum change in the inflation rate reduces the unemployment rate. The population growth rate is also found to have significantly asymmetric effects on the unemployment rate both in the short and long runs, implying that positive (negative) changes in the population growth rate increase (decrease) the unemployment rate in Afghanistan. Finally, as the results suggested, the study examined the asymmetric causality relationship between the unemployment rate, the cost of war, and the control variables. The results indicate that except for the final government expenditure and the secondary school enrollment rate, asymmetric causality runs from both the positive and negative asymmetric components of the cost of war, the composite financial inclusion index, GDP growth, foreign direct investment, inflation rate, population growth, and the rule of law to the unemployment rate.

These results highlight several important policy implications. First, the government needs to bring in significant orders in the relevant policies concerning the labor market to adjust to the excessive supply of unskilled and deficient labor that has emerged as a direct and indirect consequence of the long-running war in Afghanistan. Second, improving regional and provincial occupational mobility would be an effective policy tool to reduce the unemployment rate, with a specific focus on the regions most affected by war. Third, as an act of post-war economic recovery, though it takes longer, the government needs to support the engagement of private sector actors to generate jobs. Fourth, improvement of policies that attract innovative and technological projects to create new job opportunities. Fifth, it is found that financial inclusion is an effective tool to reduce the long-run effects of war on unemployability. As a result, assisting financial institutions in extending the outreach of financial inclusion would engage newly banked people in the creation of new job opportunities.

Limitations of the Study

The present study suffers from one major limitation, which is the unavailability of datasets for the cost of war in Afghanistan for a longer period. Since there has been war in Afghanistan for more than four decades, the datasets are only available from 2004 to 2020. Upon availability, future studies may augment higher-frequency datasets to explore additional insights into the effects of war on the unemployment rate in Afghanistan.

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Abbreviations

AIC	Akaike information criterion
ARDL	autoregressive distributed lags
CUSUM	cumulative sum
CUSUMSQ	cumulative sum of squares
CV	critical values
cow	cost of war,

cfi	composite financial inclusion index
gdpg	GDP growth
FAS	Financial Access Survey
fge	final government expenditure
fdi	foreign direct investment
HQIC	Hannan–Quinn information criterion
IMF	International Monetary Fund
inf	inflation ration
Port.	Portmanteau test
SC	serial correlation
SIC	Schwarz information criterion
BP	Breusch–Pegan
JB	Jarque–Bera
ser	secondary school enrollment rate
pgr	population growth
rol	rule of law
uer	unemployment rate
WDI	World Development Indicators
WGI	Worldwide Governance Indicators

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CHAPTER 8: CONCLUSIONS

8.1. Introduction

In this chapter, the key findings that led to the determination and analysis of the scales, sizes, and magnitudes of the long-term effects of war on the economy, environment, and human resources in Afghanistan from 2002–2020 are presented. The findings that are discussed below have been extracted from the research articles (1–5) and are supported by statistical evidence, leading to specific policy recommendations. Moreover, each of the sub-sections of the proceeding part (3.2.1 to 3.2.5) will return the newly developed research hypotheses (Figure 6 of Chapter One) and continue discussion of the new findings.

8.2. Discussion on the findings

8.2.1. Key findings of paper 1

In this part, the study proceeds to present and discuss the key findings supported by statistical evidence obtained from Article I, that is, the effects of war on the economy. For clarity, it uses the key arguments developed in the form of three key alternative hypotheses (see Figure 6 of Chapter One) as follows:

H_1: There is a long-term link between war and the economy;

H_2: War has a non-monotonic and asymmetric impact on the economy;

H_3: There is an asymmetric causal link between war and the economy.

Firstly, using an asymmetric ARDL (autoregressive distributed lags) bound test, the findings lend support to confirm the existence of an asymmetric long-term relationship between war, economic growth, and other augmented variables by failing to reject the alternative hypothesis (H_1) at 1% level. The asymmetric long-run nexus among predictors has been statistically supported by rejecting the null of $H_O : \xi_t^+ = \xi_t^- \sim \chi^2$ (short-run symmetries) and $H_O : \lambda_t^+ = \lambda_t^- \sim \chi^2$ (long-run symmetries) at the 1% significant level, using the Wald test. These results imply that both the positive and negative partial sum of squares of war differently impact economic growth, suggesting to explore the scale and sign of the effects by non-linear models.

Secondly, the findings indicate that a positive partial sum of squares of the per capita cost of war decreases the per capita GDP by $30.65 and its negative partial sum change increases the per capita GDP by $10.37. In an empirical sense, a positive change (negative impact) of war on the economy is higher than its negative change (positive impact), giving rise to an opportunity cost of $10.37 per capita foregone in the case of continued war in Afghanistan. In a theoretical sense, the result is consistent with the concept of the effects of armed conflict and violence on economic growth in a conflict environment (see, for instance, Poirier, 2012; Buvinić et al., 2014). In line with the practical survey conducted by Catani et al. (2009) on the war in Afghanistan, the results confirm that the intensity of war significantly decreases economic and societal performance, while a decline in the intensity of war creates a temporal relaxation, allowing the nation to produce higher output. Therefore, considering the results, it fails to reject the alternative hypothesis (H_2) and lends support to confirm that war has an asymmetric impact on Afghanistan's economy during the period of war.

Third, inspired by asymmetric effects, the study also explored the short and long run effects. The findings indicate that positive partial sum changes in the per capita cost of war, say, an injection of one million dollars into the per capita cost of war, decreases per capita GDP by $10.099 and $15.149 in the short and long run, respectively. It further reveals that negative partial sum changes in the per capita cost of war have positive effects on the economy. It implies that lowering the per capita cost of war by a million dollars raises per capita GDP by $23.436 and $56.438 in the short and long run, respectively. They are consistent with most economic models predicting that military spending on armed conflicts diverts economic resources from productive uses such as consumption and investment, ultimately reducing economic growth and employment opportunities. These findings are consistent with those of Gupta et al. (2004), Gaibulloev and Sandler (2009), Gates et al. (2012), and Ezeoha and Ugwu (2015) on four key significant impacts of war on the economy as follows:

1) It is found that war is linked to lower economic growth and higher inflation rates, impeding the overall economic performance. This effect causes a double impact on the economy, including increases in general prices of goods and a substantial loss in per capita income.

2) It has a negative impact on investment and taxation (see also, Aziz and Khalid, 2019), suppressing the economy by limiting the public revenue conduits and distortion in the process of the formal economy.
3) It leads to increased government spending on defense, rather than economic development.
4) The war brings changes in the composition of government spending, causing a significant negative impact on growth due to substantial reallocation. This also implies that smaller investment shares in infrastructure, health, education, and technology and increased government spending on war cause the higher crowding-in of government spending to be the dominant influence.

With respect to test (H_3), the study employed Hatemi-J's (2012) causality technique using Toda and Yamamoto's (1995) approach. The findings show that positive (negative) shocks from the per capita cost of war have a significant causal relationship with the per capita GDP, while the flip-side results confirm a significant bidirectional causality among them at 1% significant level. Thus, the findings fail to reject the alternative hypothesis (H_3) and support that there is only a causality running from war to economic growth during the period from 2002–2020.

8.2.2. Key findings of paper 2

In this part, the study continues to present and discuss the key findings supported by statistical evidence obtained from Article II, that is, the effects of war on unemployment rate in Afghanistan. Again, for clarity, it uses the key arguments developed in the form of three key alternative hypotheses (see Figure 6 of Chapter One) as follows:

H_4: War has a monotonic impact on unemployment rate;
H_5: War and the unemployment rate move together in the long-run;
H_6: There is a causal link between war and unemployment rate.

To explore the long-term relationship between war and the unemployment rate, that is, the alternative hypothesis (H_5), the study applied both the symmetric ARDL and asymmetric bound tests for cointegration augmented with a dummy variable for break date [1 = break, 0 = no break]. The results can be summarized as follows:

1) For linear ARDL vector model, the findings indicate that the test statistics (F = 39.196 > 3.97, t =-10.651 > -5.54) are greater than the critical values at a 1% significant level and support the rejection of the null hypothesis of no cointegration between war and the unemployment rate.
2) For the asymmetric ARDL vector model, the results support the rejection of the null hypothesis of no asymmetric cointegration between war and the unemployment rate in Afghanistan.

This shows that war and the unemployment rate move together asymmetrically in the long run, and the results are linked to both the theoretical concept and real-life example of the effects of civil war on socio-economic indicators—that is, civil wars bring in serious shifts in employment in the host country, heighten poverty, and increase government expenditure through intense economic fragility, forced population displacement, and loss of economic infrastructure. Therefore, the statistical findings both from the linear and non-linear ARDL vector models fail to reject the alternative (H_5) and conclude that war and the unemployment rate have a long-run nexus. Next, since war has been assumed to follow an asymmetric pattern, the study used the Wald test to $SR_W = \sum_{j=0}^{p-1} n_j^+ = \sum_{j=0}^{p-1} n_j^-$ (short-run symmetries) and $LR_W = -\omega^+ / \lambda = -\omega^- / \theta$ (long-run symmetries), respectively. The results of the Wald test are statistically significant to reject the null of short-run and long-run symmetries $\mathrm{H}_{\mathrm{null}} : \lambda_1^+ = \lambda_2^- + \omega_1^+ = \omega_2^- = 0$ and support the notion of non-linearity between war and the unemployment rate. From these results, three important findings can be noted as follows:

1) It implies that war, which is the key variable of interest, and other control variables together significantly impact the unemployment rate in the short and long run.
2) The rejected null of symmetric relationships indicates that war and the control variables differently affect the unemployment rate both in the short and long run—thereby, supporting the non-monotonic effects of war and the control variables on the dependent one.

3) The results direct the study to investigate and determine the size and magnitude of the short and long-run asymmetric effects of war and the control variables on the unemployment rate. To that end, the study estimates the non-linear ARDL model.

With respect to the determination of the size and direction of the effects of war on the unemployment rate and to test the (H_4), the study computed the non-linear ARDL model. The results reflect the real-life example of the war in Afghanistan supported by statistical evidence. The key findings can be summarized as follows:

1) The findings show that the cost of war to GDP (%), as a proxy for war, has a significant impact on the unemployment rate in both the short and long run.
2) It indicates that a positive change in the cost of war increases the unemployment rate by 0.218% and 0.405% in the short and long runs, respectively.
3) A negative partial sum change in the cost of war has a negative effect on the unemployment rate, demonstrating that a negative change in the cost of war—thus, a decrease in the intensity of war—causes the unemployment rate to fall by 0.221% and 0.387% in the short and long runs, respectively, providing a relaxation to higher job opportunities and higher employment in different sectors of the economy.
4) The varying and asymmetric effects of war on unemployment rate both in the short and long runs fail to reject the alternative hypothesis (H_4), supporting that the positive change in war (higher intensity) has a greater effect on unemployment rate in the short run, while its negative change (lower intensity) also has a greater short-run effect on unemployment rate comparative to the long-run effects.

In a comparative sense, Humphreys and Weinstein (2007) found statistically weak effects of civil wars on the unemployment rate. Justino and Verwimp (2013) and Cramer (2010) found meaningful nexus between civil wars and unemployability, showing that unemployed youth are the key cause of civil wars in developing economies.

Finally, to test the causality nexus between war and unemployment rate, the study employed the asymmetric causality test of Hatemi-J (2012) with an optimal lag selected by the HJC (Hatemi-J Information Criterion) framework, and the critical values for 1%, 5%, and 10% generated using the bootstrap iteration method. The results are interesting and indicate that the null hypothesis of both positive and negative components of the war causing unemployment is rejected at a 1% level. Thus, based on the statistical evidence, the results fail to reject the alternative hypothesis (H_6)—that is, the causal relationship between war and the unemployment rate in Afghanistan.

8.2.3. Key findings of paper 3

The discussion on findings and providing statistical support to the results obtained from Article III, that is, the effects of war on environmental quality, can be presented using the key arguments developed in the form of three key alternative hypotheses (see Figure 6 of Chapter One) as follows:

H_7: War significantly degrades environmental quality;
H_8: War, income, and environmental quality are linked together;
H_9: The EKC hypothesis holds true in case of Afghanistan.

The first finding lends support to the existence of a long-term linear relationship between war and environmental quality as proxied by CO_2 emissions in Afghanistan by rejecting the null hypothesis of $\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 =, ..., = \lambda_9 = 0$ (no cointegration, see Figure 6, H_8-war and environmental quality are linked in the long-run) at 1% significant level. This finding indicates that in the long run, CO_2 emissions and civil wars move together, although further statistical interference has been required to determine the size and behavior of the effects.

The second findings show that civil wars have an extensive impact on environmental deterioration, with both short- and long-term increases in CO2 emissions during the period from 2002 to 2020. Furthermore, the results demonstrate that civil war, as measured by the per capita cost of war (figures in US$), has a considerable short- and long-term influence on CO_2 emissions. It shows that in the short and long runs, respectively, CO_2 grows by 0.119% and 1.091%, depending on the per capita cost of war. Recalling H_7 (Figure 6 of Chapter One), the results fail to reject the alternative hypothesis (long-term war has significant impact on environmental degradation) at 1% level. It implies that the use of large-scale weapons and the continuation of military operations have a negative impact on environmental quality in a theoretical sense, while, empirical studies also support these findings (see, for instance, Kengni, 2013). Afghanistan, unlike most nations, has hosted war for more than 40 years and has seen nearly every form of significant devastation as a result of civil wars. The findings support the idea that war reduces environmental quality and raises CO_2 emissions over the short and long terms. Intuitively, this also implies that civil wars are not only environmentally destructive but also emit large amounts of carbon emissions and contribute to the depletion of resources, among all other possible impacts.

Third, the findings support the existence of an inverted U-shaped curve led by the relationship between per capita real income proxied by per capita real GDP and CO_2 emissions, thereby supporting the EKC (Environmental Kuznets Curve) hypothesis in Afghanistan. These findings fail to reject the alternative hypothesis of the EKC realization (H_9) with respect to the war-environmental quality in the context of Afghanistan. It also indicates that the environmental quality degrades up to a certain level (the turning point of $699.120) of the per capita real income before it begins improving afterwards. Since the stability of security and political situations is in doubt, the improvement point may be somehow biased as the results support the economic notion of ceteris-paribus.

Fourth, the empirical findings support bidirectional causality relationships between CO_2 emissions, per capita real income, civil wars, the financial development index, energy consumption, trade openness, and the inflation rate. The findings extend to support the existence of multidimensionality and interdependencies among vector models. It is also worth comparing the results with some leading recent studies in war-torn societies. Parlow (2014) examined the EKC hypothesis in Myanmar, that is, a conflict zone, and found that the EKC hypothesis exists by identifying two different regimes. Although Mehmood and Tariq (2020) did not capture the effects of armed conflicts on the environmental quality, they did confirm the existence of the EKC hypothesis in South Asian countries from 1972–2013. Bildirici and Gokmenoglu (2020) found significant effects of terrorism, energy consumption, economic growth, and foreign direct investments on environmental pollution for Afghanistan, Pakistan, Iraq, Syria, Nigeria, Philippines, Yemen, and Thailand using panel analysis for data spanning from 1975–2017 and bidirectional long-run causality between their variables of concern. Qayyum *et al*. (2021) also confirm the existence of the EKC hypothesis in South Asian economies, two of which, such as Pakistan and Afghanistan, were conflict zones. However, our findings are consistent with recent studies; they significantly add to the existing literature on the incremental effects of civil wars on environmental pollutants, providing robust results from a real-example of a long-term war-torn society.

8.2.4. Key findings of paper 4

The discussion on findings and providing statistical support to the results obtained from Article IV, that is, the effects of war on human resource development, can be presented using the key arguments developed in the form of three key alternative hypotheses (see Figure 6 of Chapter One) as follows:

H_{10}: War has a significantly negative impact on human resources;

H_{11}: War and the school enrollment ratio are linked together;

H_{12}: There is a causal link between war and school enrolment ratio.

Considering the formulated hypotheses, the results obtained from statistical analysis reveal significant evidence in favor of the (H_{11}) and confirm that long-term war has a long-run relationship with human resource development in Afghanistan. This is also linked to the theoretical background: a long-term war, as in Afghanistan, that lasted for more than four decades posits two types of tie-ups, such as concurrent impact and residual effects, which move together with the socioeconomic variables. To test the effects of long-term war on human resource development, the results obtained from the asymmetric ARDL model indicate that a positive partial sum change in the per capita cost of war causes the SER to decrease by 0.547% and that a negative partial sum change in the per capita cost of war causes the SER to increase by 0.564%. In addition to confirming the asymmetric effects of the per capita cost of war on the SER, the results show that as the per capita GDP increases, the school enrolment rate increases by 0.19%, while its negative partial sum causes the school enrolment rate to decrease by 11.9%. The per capita government expenditure on education has the same positive and negative partial sum effects on the school enrolment rate as the per capita GDP by magnitude but by a difference scale of 8.012% and 3.186%, respectively. With these findings, the study fails to reject the (H_{10}) and extend that the incremental trend of war has a negative impact on human resource development in Afghanistan, while a decrease in the intensity of war raises human resource development. Furthermore, the estimated asymmetric causality technique shows that both positive and negative shocks from the per capita cost of war strongly cause school enrolment rates and reject the null at the 1% significant level. Moreover, both positive and negative shocks from per capita GDP, per capita government expenditure on education, and population growth rate have significant bidirectional asymmetric causal relationships with the school enrolment rate. The negative shock from the child mortality rate is significant to cause the school enrolment rate, while the positive shock is insignificant. Thus, the developed hypothesis (H_{12}) cannot be rejected.

8.2.5. Key findings of paper 5

The fifth and final article titled "The health consequences of civil wars: Evidence from Afghanistan," published in BMC Public Health, has devoted several key findings to inform important policy recommendations to the policymakers. In particular, this study has been designed to test the developed hypotheses (H_{13} to H_{15}) of the main thesis as follows:

H_{13}: War has a significantly effect on public healthcare services;
H_{14}: War and healthcare services are linked together in long-run;
H_{15}: There is a causal link between war and public healthcare.

Recognizing the importance of the healthcare system and its effectiveness in Afghanistan the fifth article examined the impact of long-term wars on healthcare from 2002Q3 to 2020Q04. To test the above-mentioned hypotheses, this study uses datasets collected from World Development Indicators and the US Department of Defense Budget sources and employs the modified vector autoregressive (MVAR) model, and expanded its analysis by using the Granger non-causality method. The results confirm the existence of a significant long-run relationship between long-term war and healthcare services in Afghanistan during the period under review and thus, it supported to accept (H_{14}). Moreover, the results indicated that the per capita cost of war has a significantly positive impact on per capita health expenditures, which is not necessarily an indication of improvement in health systems, but rather, an additional cost burden to offset the health consequences of the civil wars. This finding supported to accept the (H_{13}) and conclude that civil wars have a negative impact on the overall health expenditure, increasing unmercenary cost without improving the healthcare output in Afghanistan. Far more interesting results are achieved from the Granger non-causality method, which is the key test of interest in this study. It demonstrates that there is a statistically significant bidirectional causality relationship between per capita health expenditure, per capita cost of war, per capita GDP, child mortality rate, crude death rate, and age dependency ratio, while it also supports the existence of strong and significant interconnectivity and multidimensionality between civil war, per capita health expenditure, and other augmented predictors in the study. While these findings concluded the study, they provided statistical evidence to accept (H_{15}).

8.3. Practical contributions

This study is the first of its kind in the existing literature on civil wars from several perspectives. Firstly, the literature concerning the impact of war on socioeconomic indicators in Afghanistan has lacked quantitative analysis to determine the scale and magnitude of the effects of the long-term war on economics, health, the environment, and human capital development. This study has filled the existing gaps. Secondly, policy-oriented implications were quite rare in supporting policymakers at the macroeconomic level to formulate or adjust policies during the period of war to minimize the impact of war on society. This study provides numerous recommendations on various aspects of society to assist policymakers in Afghanistan. Thirdly, this study has employed several sophisticated econometric methods to test the effects of war on different macroeconomic variables in Afghanistan, extending the analysis to extract accurate results and contribute to the stock of knowledge for societies experiencing war and sharing a common nature with Afghanistan.

8.4. Conclusions

This study has attempted to investigate the effects of long-term war on various indicators such as economic growth, public healthcare, human resource management, the unemployment rate, and environmental quality in Afghanistan. The average period that the study has covered ranges from 2002 to 2020. All the datasets have been collected from reliable sources such as the World Development Indicators (WDI), the International Monetary Fund (IMF), and the US Defense Budgets. War is assumed and witnessed to have devastating effects on the economic, social, and technological infrastructure of a country. This unrest causes civilians to suffer from lost social and economic development opportunities, lost human capital development opportunities, forced migration, hunger, a higher mortality rate, and massive destruction. Following the key objective of the thesis, which was to assess the effects of long-term war on three key socioeconomic indicators, it formed research themes of the economy, environment, and human resource development. The context of the study has been selected to be Afghanistan, which has been involved in the longest war in the world. It aims to produce statistical evidence on the nature, size, and magnitude of the long-term effects to produce specific policy recommendations to national policymakers and the international community who are engaged in the process of nation-building, peace-building, and market-building in Afghanistan. To achieve the objectives, five research articles have been produced out of which, three are published in Q1 journals and two of them are under review at present. As an empirical approach to achieve the objectives, new hypotheses (H_1–H_{15}) have been developed that are relevant to the research questions informed by the research objectives and complex econometric methods such as the NARDL (non-linear autoregressive distributed lags), MVAR (modified vector autoregressive), and a series of multivariate regression models that have been augmented with sets of well-known predictors were used. Nonetheless, in addition to determine the effects of the long-term war on the outcome variables, the study also attempted to establish the causal links between them so appropriate policy recommendations can be drawn.

The key findings of the study can be outlined as follows: on the war-economic nexus, the results confirm a long-run asymmetric relationship. It also indicates that a positive asymmetric shock from war reduces economic growth, while a negative asymmetric shock from war increases growth in the short and long runs. Moreover, the findings highlight the non-monotonic effects of war on economic growth, both in size and magnitude. Statistical evidence concludes that there is a significant bidirectional causality between economic growth and the war. On the unemployment front, the findings reveal that the positive asymmetric shocks from war decrease the unemployment rate, while their negative asymmetric shocks it in the short and long runs. It is demonstrated that enhancing the outreach of financial services plays an important intermediating role in reducing the unemployment rate during wartime in Afghanistan. The findings show that an asymmetric causality runs from both the positive and negative components of war to the unemployment rate, confirming a bidirectional nexus among them. On the environment front, the findings support a long-run relationship between war and environmental degradation. It also reveals bidirectional causal links between environmental degradation and war, while confirming multidimensionality and interdependencies among predictors. The findings confirm the existence of an inverted U-shaped relationship, supporting the validity of the EKC hypothesis in Afghanistan. On the human resource front, the findings support a long-run asymmetric relationship between war and human resource development, while the magnitude of the relationship has been confirmed to be asymmetrically negative. It further reveals that the school enrolment rate—a proxy for human resource development—is highly sensitive to and swiftly reacts against the intensity of war. Furthermore, the findings show that both the positive and negative aspects of war have a significant impact on the school enrolment rate. Finally, regarding public healthcare, aging results support a significant long-run relationship between war and public health, showing that war positively impacts health expenditures, whereas child mortality rate and crude death rate have negative impacts. The findings also indicate a statistically significant bidirectional causal nexus between health expenditure and war, while supporting the existence of strong and significant interconnectivity and multidimensionality between war and health expenditure, with a significantly strong feedback response from the control variables.

Considering the statistical evidence, the results conclude that the long-term war in Afghanistan had significantly devastating effects on socioeconomic indicators, most specifically, and as covered by the scope of the present thesis, on the economy, environment, and human resource development during the period of the study. It concludes that war significantly suppresses economic growth, imposing serious consequences on the well-being of the nation by increasing unemployment rates, diminishing the process of human resource development, and degrading environmental quality. These aspects impact both the nation's lives and its development and the critical findings of this thesis shed light on important policy implications and offer a set of policy recommendations to policymakers.

8.5. Policy recommendations

Using the findings of the studies extracted from Articles 1–5 and focusing on one of the important objectives, the following policy recommendations are presented with respect to each of the socioeconomic indicators employed in the thesis. Initially, one general recommendation is that, if possible, war must be avoided. If there is a failure to yield peace in Afghanistan and the war continues, the degree and size of the devastation should be minimized.

8.5.1. Economic growth

With respect to the findings about the effects of long-term war on economic growth (Article I), three important and yet specific policy recommendations are provided as follows:

1) War has negative impacts on the economy both in the short and long runs. The positive asymmetries are consistent with the real outcome of the war in Afghanistan during wartime. The new chapter of international inclusion in the war of the country brought in billions of US dollars and supported the GDP to grow, though it was unrealistic growth during the past two decades. Therefore, it is recommended that policymakers switch to higher government spending on economic infrastructure development to take the pressure off long-term economic growth.
2) Social inclusion, which has been highly affected by the long-term war in Afghanistan, must resume bringing social and financial capital to boost economic growth in the long term. One possible solution is the establishment of the NRA (None Resident Afghans) organization to swiftly attract financial capital and investment from the Afghans residing outside the country through a properly

formed mechanism. This can boost job opportunities, encourage investment in production, and ease quick economic growth.

3) In relation to the negative impacts of the war on the economy, it is also found that a shock of the positive partial sum of the war decreases economic growth in the short and long runs. Thus, it is a complex challenge that calls for international lobbying to bring peace and sustain security in the country so the long-run negative impact of the war can be controlled. This recommendation includes four proposals:
   a. international community engagement to lobby for and facilitate peace and security;
   b. internal political solidarity to facilitate an internal environment conducive to peace;
   c. community awareness of the impact of the war; and
   d. emphasizing the rule of law and corruption control in the country.

8.5.2. Unemployability

In terms of the effects of war on unemployment rate in Afghanistan that have been highlighted by the results obtained (Article II), the following key policy recommendations are offered:

1) The government needs to produce significant orders in the relevant policies concerning the labor market to adjust to the excessive supply of unskilled and deficient labor that has emerged as a direct and indirect consequence of the long-running war in Afghanistan.
2) Improving regional and provincial occupational mobility would be an effective policy tool to reduce the unemployment rate, with a specific focus on the most affected regions by war.
3) As an act of post-war economic recovery, the government needs to support the engagement of private sector actors to generate jobs. It is acknowledged that this can require extended periods of time.
4) Improvement of policies that attract innovative and technological projects to create new job opportunities.
5) It is found that financial inclusion is an effective tool to reduce the long-run effects of war on unemployability. As a result, assisting financial institutions in extending

the outreach of financial inclusion would engage newly banked people in the creation of new job opportunities.

8.5.3. Environmental quality

In terms of the effects of the long-term war on environmental quality in Afghanistan during the wartime (Article III), the critical findings extracted from the results of the analysis entail the following three key policy recommendations:

1) The government needs to engage the international community in bridging the gaps in the process of peace negotiation with the insurgent groups to eradicate the civil wars or even minimize them to low levels as they result in the loss of human capital, loss of economic infrastructure, and economic downturn, and seriously harm the quality of the environment.
2) Inspired by the effects of energy consumption in the short and long runs and learning from the practical consumption of substitute materials for warming, public baths, and industrial production, the government needs to attempt to replace them with energy consumption by enhancing energy production capacity, while in the long run, energy consumption should also be controlled to reduce CO_2 emissions.
3) An overall consumption behavior campaign is necessary to promote natural resource protection, appropriate consumption, and reduce exploitation of pasture lands in Afghanistan.

8.5.4. Human resource management

With respect to human resource management in Afghanistan and highlighting negative consequences of the long-term war on school enrolment ratio (Article IV), the following policy recommendations are offered to the relevant policymakers:

1) The government should provide consistent and sufficient resources to safeguard schools, education centers, and higher education institutions during wartime. Current security measurements are insufficient both in terms of financial and securities resources. Recent frequent attacks on education centers have caused both losses of students and infrastructure, while moral effects have been highly felt among families.

2) Government organizations, social activists, and the media must try to make families an institution of dedication, strength, and pride in order to increase school enrolment in Afghanistan. These campaigns may have greater effects on the families residing in rural areas. Rural residents are less aware of the benefits of education for social advancement, and yet the majority of them prevent their children from enrolling in school for insufficient and logical reasons.
3) As the result of the effects of war, many children have been forced to beg on the streets and perform difficult tasks in order to feed their families. The government must pay serious attention to these children, using basic financial incentive packages to support both families and the school enrolment ratio.
4) The wave of large-scale human capital flight must be minimized to an acceptable low level by means of both financial and security incentive schemes, especially for the teachers and instructors, to keep the schools operating. Schools are the locations where future human capital signals the potential for post-conflict reconstruction.

8.5.5. Public healthcare

As shown in the findings, public healthcare sector is one the most sensitive sectors of an economy that significantly suffers from the negative effects of war. Thus, considering the facts and findings (Article V), the following policy recommendations are offered:

1) It is indicated that civil wars create additional health expenditure without impacting the improvement of the quality of healthcare systems in Afghanistan during wartime, resulting in a significant reallocation and redirection of the healthcare budget. Thus, the government should focus on the dual effects of the civil wars and reformulate relevant policies to increase efficiency both for the advancement of the healthcare system in the long-run and the accessibility of the citizens to healthcare services, in addition to covering the proportional cost of the health consequences of the civil wars.
2) The government must reduce the number of people affected by national movements during wartime in order to gain access to public healthcare services. It needs to increase the number of health clinics and centers in remote areas and

allocate both financial and human capital to serve those areas. The access to basic healthcare services in remote areas must be effective to reduce the number casualties, though it may proportionally increase the healthcare expenditure.

8.6. Limitations and direction for future studies

In a general perspective, although the present study's outcome has significantly contributed to the existing body of knowledge and offered new statistical evidence on the association between long-term war and specific socioeconomic indicators, it suffers from several limitations. Firstly, the scarcity of disaggregated datasets at the state level has caused the study to focus on aggregate datasets for the whole country during the period of war. Because of this limitation, the study was forced to ignore the effects of the war's intensity and only measure the aggregate indices. Secondly, the unavailability of relevant datasets for the accurate number of deaths, injuries, and cost of destruction during the period of war has also caused the study to fail in establishing the link between them and estimating the proportional effects of war on each of the stated variables. Thirdly, it suffers from the low frequency of the available datasets relevant to war and the required variables that have been augmented in the regressions. Though the findings can be statistically challenged, the availability of a large number of observations would have facilitated controlling for the effects of more variables.

Specifically, in article I (war-growth), due to the unavailability of disaggregated sectoral and state level datasets, the study used aggregated datasets, causing the study to fail in testing the sensitivity of sectoral-growth and state-based growth against the long-term war in Afghanistan. Understanding the level of sensitivity of economic growth to the rise and fall of the war provides full insights into the policy implications. In article III, (war-environment), using lagged variables' models required higher number of observations, but due to limited scope of the period led by the availability of data, it only relied on data for 2002–2020. In article IV (war-human resource development), there are also some limitations, though the researcher tried to minimize the limitations in terms of scope and applicability. First, disaggregated data is not available at the state-level to test the sensitivity of rural and urban school enrolment rates to war. Second, despite employing complex modeling to capture the effects of war on human resource development, the study does not account for the theological reasons that caused several interventional wars in Afghanistan. In Article V (war-public healthcare), although the findings are consistent and cannot be doubted in any way; the study is confronted with one major limitation—again, the unavailability of the disaggregated civil war dataset by state. However, because the intensity of civil war in different states of Afghanistan has significantly varied throughout the period, this study mainly relied on aggregated civil war datasets.

Future studies may employ the same methods, designs, and approaches to explore the quantitative effects of war on the same and different social, economic, and technological indicators by overcoming the stated shortfalls. It also directs future studies to take a more detailed perspective by employing longitudinal datasets to offer more comparative results in order to provide more comparative policy recommendations. The present study has augmented one political dimension in the modeling process; future studies may account for further political indicators using either dummy or actual variables to control for the effects of political dimensions on the level of war's intensity and its devastating effects on socioeconomics.

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Notes

Table 1A Results of endogeneity tests.

Estimated models	Page	Dependent variable	Reverse causality Statistics	p-values	Results
Model 1	18	Economic growth	1.337	0.425	Do not reject H0.
Model 3	18	Unemployment rate	0.408	0.538	Do not reject H0.
Model 4	19	Natural log of CO_2 emissions	1.220	0.450	Do not reject H0.
Model 5	20	School enrollment ratio	1.017	0.455	Do not reject H0.
Model 6	20	Per capita health expenditures	1.567	0.120	Do not reject H0.

Notes: H0: DV does not cause Xs.