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ORIGINAL RESEARCH ARTICLE

Exploring the dynamic interplay of export, energy imports, capital formation and renewable energy use in Nepal

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ABSTRACT

This study attempts to explore the determinants of Nepal's export performance with focus on the energy variable. The major aim of the study is to find the impact of rising use of renewable energy and growing energy import on export trade of landlocked country Nepal in the context of growing trade deficit after 1990 to till date. Auto Regressive Distributed Lag Model (ARDL) for the time series data from 1990 to 2021 reveal the positive contribution of renewable energy consumption, gross fixed capital formation and energy imports. However, exchange rate did not show the significant result. The findings further reveal the fact that Nepalese export industries are still highly vulnerable to energy shocks besides having high potential for the generation of renewable energy. Thus, increasing the speed of generation of renewable energy and transfer it for industrial use could help to minimize energy import shock, reduce energy cost and increase export competitiveness. The findings suggest that national trade strategies should be linked up with renewable energy use and policymakers should rethink about restructuring trade based exchange rate system in Nepal.

Keywords: energy import; export trade; renewable energy; capital formation; ARDL

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1. Introduction

Trade is widely recognized as a key driver of economic growth and inclusion. Global trends, especially globalization and liberalization, have shaped trade by easing export barriers. The ease of export barriers led countries to gain benefits through the export trade, supporting economic development by increasing production, employment opportunities as well as improving the balance of payments.

Growing connectivity has increased the world trade volume and value. Since the establishment of the World Trade Organization in 1995, world trade volume and value have grown at average annual rates of 4% and 5% respectively, as of 2024[1]. But the global market concentration is found among few nations during these years creating vulnerability to the small countries like Nepal who are facing chronic trade deficit. So, export performance of a country is analyzed from different perspective and keeping close eyes on several socio-economic factors.

Export performance of a country mainly depends on firm-specific factors, export strategy factors, and external environmental factors[2]. Reliable and affordable energy supply is an important determinant of industrial competitiveness and export performance. Nations having

substantial energy resources typically attain higher export volumes in energy-intensive sectors[3]. The use of renewable energy sources can increase manufacturer's competitiveness by reducing their reliance on unstable fossil fuel markets[4]. However, the transition to renewables requires careful management, since an abrupt decline in fossil fuel consumption may adversely affect international trade and constrain economic growth[5,6]. Hence generation and use of renewable energy as well as level of energy import are the highly influencing variable for external trade.

Beyond the foundational role of energy, export performance is significantly shaped by two key macroeconomic factors: Gross fixed capital formation (GFCF) and the exchange rate. GFCF, representing capital investment in a country is critical for long-term development as it facilitates the diversification of the export base, generates positive spillovers to related industries[7], and ultimately reinforces GDP growth[8]. Furthermore, the exchange rate acts as a potent tool for influencing trade competitiveness, with numerous studies in developing nations like Nepal confirming that a depreciated domestic currency enhances exports[9-11].

Over the years, Nepal has taken a series of initiatives to promote exports in order to achieve sustainable and inclusive economic growth, poverty reduction, and improvement in the living standards of the Nepalese people[13]. With the introduction of a liberal trade policy in 1992 and succeeding trade policies of 2010 and 2015, trade integration strategies (2010, 2016, and 2023), as well as being a member of the WTO, BIMSTEC, SAFTA, etc. Nepal is expanding the scope of its trade[14]. However, the increased integration of Nepal with the world economy since the 1990s has led to a prolonged trade deficit for Nepal. Annual percentage growth of export of goods and services of the last two decades is not at a satisfactory level, as shown in **Figure 1**. Export growth is almost negative except for a few years. It has not reached the export growth rate of 2012 in consecutive years. It demands the enhancement of export competitiveness. Strengthening a country's energy situation could help to increase its export competitiveness. Geographical location and reliance on imported energy from India have created instability in the Nepalese goods market, leading to a price rise[15]. This dependence is responsible for higher production costs, damaging the competitive strength of Nepali goods[16]. Therefore, there is a need to study various variables that could enhance export competitiveness, and this study primarily focuses on energy-related variables as prior studies have shown hope for decreasing production cost by the use of renewable energy resources.

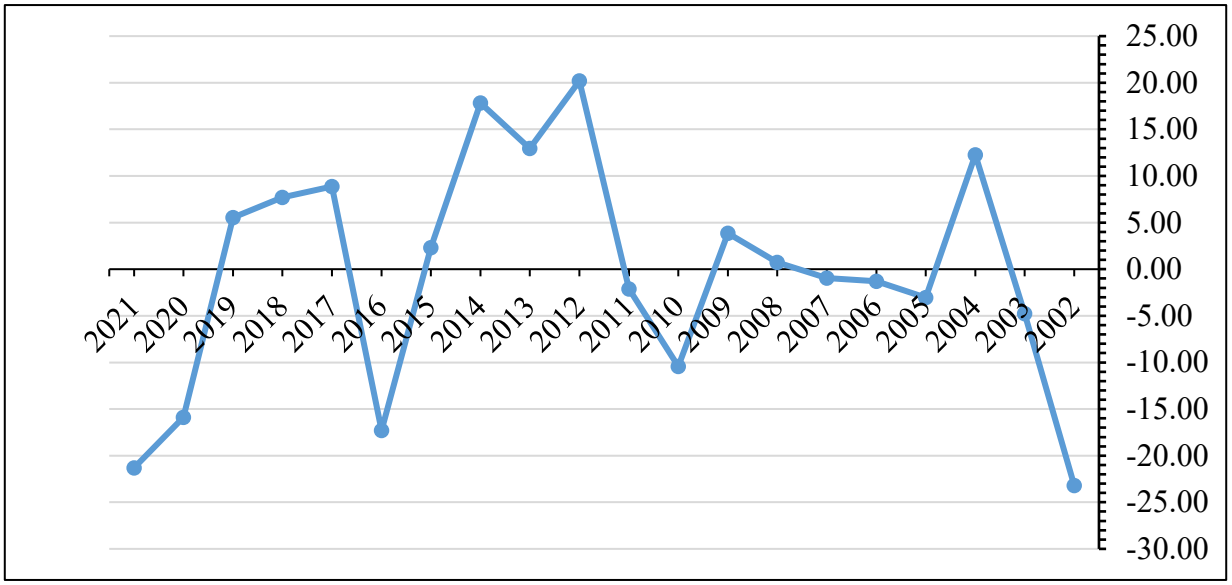

Figure 1. Exports of goods and services (annual % growth).

Source: *World Bank [12]*

Since 1991, when Nepal established its first 500 kW hydropower plant in Pharping, to the initiation of electricity exports to India in 2021, key milestones have shaped the renewable sector in Nepal, except for the period of load shedding from 2005 to 2018[17]. These developments have created positive momentum that can be harnessed for industrial and trade growth. In this context, this study offers a comprehensive analysis of how Nepal's energy choices influence its export performance, highlighting the interplay between energy imports and renewable energy consumption. Past research studies have mainly analyzed the effect of electricity consumption on exports[16,18]; however, this study examines the impact of energy imports and renewable energy sources to clarify their strategic importance. By addressing these relationships, the research directly informs policy to leverage Nepal's energy assets for reduced import dependence and robust export-led growth. Likewise, the study attempts to expose the influence of growing electricity generation and other renewable energy resources to the export trade of Nepal.

Remaining sections of the study are organized as follows: second section highlights the relevant literature reviews focusing determinants of export trade. Third section includes methodology used in the study followed by Results in Fourth section. Finally, last section presents the conclusion of the study and policy implications.

2. Literature review

Around the world, many studies show that switching to renewable energy can help a country compete better in exports by lowering production costs, making countries less dependent on unpredictable fossil fuel markets, and giving them an edge over others[4]. In energy dependent country like Nepal use of renewable energy could help to lower trade deficit as well as help to tackle climate change by reducing dependence of fossil fuels[19]. As per the nature of the study literature review is organized under following sub-headings:

2.1. Renewable energy use and export

Trade and energy are two sides of the same coin. After growing concern regarding environmental issues, the green trade is in priority these days. So, researchers have been exploring new facts about trade and renewable energy use. A study on Nepal found a strong positive long-run relationship between electricity consumption and export performance, suggesting that increased energy access, whether from renewable or conventional sources, is vital for boosting exports[16]. Bidirectional Granger causality between electricity consumption and exports in Vietnam[18] and between energy use and exports in 25 OECD countries[20], positive relation between renewable energy consumption and international trade in Nordic countries Khan et al.[21] indicates the significance of energy consumption on export trade. Renewable energy consumption significantly reduced energy import in 16 emerging market economies indicating that countries can reduce energy import dependency by developing renewable resources[22].

In South Asia, cheap power is a big challenge for industry, so renewables could help exports by making sure there is a steady and affordable supply of electricity. Specifically, energy-abundant high-income countries were found to have significantly higher employment and net exports in energy-intensive sectors compared to energy-scarce countries, supporting the theory that factor endowments shape international trade patterns[3]. However, shift from fossil fuel consumption to renewable energy is still challenging. Based on the study of energy-exporting countries Canada, Norway, Ecuador and South Africa, Fei and Rasiah[5] suggested that developing economies should not hastily reduce their consumption of fossil fuel-powered electricity without considering other factors. Unexpected shortage in energy supply could hinder trade and consequently impede GDP growth[6].

2.2. Energy import and export

Global energy politics significantly impact international trade. So, energy import is very sensitively observed and analyzed these days. Energy politics may affect energy import as well as export by influencing various factors such as energy demand, energy resource distribution as well as energy prices[23]. Such practices

can create trade barriers through creating hindrances in optimal resource allocation and economic benefits[24]. A study by Hu et al.[25] reveals the causal relationship between imported energy and trade and suggest for securing energy supplies for the betterment of the trade. Geopolitical tensions affect not only energy import and trade, but also creates disturbance in renewable energy production. A study by Attílio[26] showed that U.S.-China geopolitical tension reduced renewable energy production for at least four months during the period 1999 to 2022. Such two country based tensions had affected Asian countries also. Similarly, past studies have justified the energy led economic growth and trade growth. However, growing energy import is found to have negative impact on sustainable development both in the short run and long run. This fact was explored by the study of Meng et al.[27] based on 127 countries over the period 1990 to 2019.

Petroleum dependence is a critical national issue[28] in Nepal. It is making foreign trade highly vulnerable. However, potentiality of renewable energy generation and recent speed up electricity generation and trade with India could help to boost export trade in the future. Continuous increase in renewable energy use significantly has reduced Turkey's high-energy import dependency, a problem that had reached approximately 74% foreign dependence[29]. Now a days energy-trade discussions include environmental and social concerns[30]. So, promoting export trade through less import of non-renewable energy sources is an issue of concern these days.

2.3. Capital formation and export

Both theoretically and empirically, it has been proven that capital formation is a primary condition for economic growth and export promotion. Higher levels of gross fixed capital formation precede and positively correlate with an increase in export volume and value [31]. It can create diversified export base through positive spillovers to the industries[7] which could play a role of key driver of sustainable development. Gross fixed capital formation helps in boosting GDP, reinforcing the significance of capital investment for long-term development[8] which can create a strong base of export trade. In South Africa, Adekunle[32] found a positive relation between export and gross capital formation. Financial development through capital formation also supports for the growth of green trade by increasing renewable energy consumption[33].

2.4. Exchange rate and export

Exchange rate is also a major influencing macroeconomic variable on export trade. Various studies in Nepal indicate that weaker domestic currency can enhance Nepal's export competitiveness. Adhikari[9] found that a one percentage depreciation of the Nepalese Rupee (NPR) against the US Dollar results in a 0.75 percentage point decline in the trade deficit. The study by Nepali[11] also confirms that a depreciation of the Nepalese Rupee (NPR) against key trading currencies positively and significantly affects export growth and concludes that depreciated currency is an effective tool for enhancing the nation's export competitiveness. Similarly, Joshi et al.[10] confirm a significant relationship between the exchange rate and Nepal's export performance across both the short and long run. A depreciation of the Vietnamese Dong (VND) was also found effective in promoting export growth, but its expected effect on reducing imports was limited[34]. Traditional and value-added exchange rates on exports across 33 industries in Nepal from 2007 to 2021 showed that traditional exchange rate appreciation reduces exports, while value-added exchange rate appreciation increases exports[35].

Past empirical studies provide evidence of positive influence of capital formation, renewable energy use, energy import, and exchange rate on export trade. However, there is limited research on export trade linking renewable energy use and energy import. Overall, international trade has been mainly analyzed in the context of use of renewable resources. Inside this, electricity use has been mainly used as the major trade influencing variable. Hence, this study aims to fill this research gap mainly in the context of Nepal, where renewable energy use is getting priority.

3. Materials and methods

This study explores the dynamic interplay between export and energy variables. In Nepal, economic transformation primarily began during the 1990s, when privatization, financial liberalization, and significant changes in political institutions (the introduction of a multiparty democratic system) commenced. Therefore, data from 1990 were selected to find the nexus between export and other selected variables. Variable description is shown in **Table 1**, and summary statistics of the chosen variables are shown in **Table 2**.

Table 1. Variable description.

Variable	Notation with log transformation	Data Source
Renewable energy consumption (% of total final energy consumption)	REUSE	[12]
Energy imports, net (% of energy use)	ENIMP	[12]
Gross fixed capital formation (current US$)	GFCF	[12]
Official exchange rate (Local Currency Unit per US$, period average)	EXCH	[12]
Exports of goods and services (current US$)	EXPORT	[12]

Data Source: [12]

Based on the past studied following model is developed.

$$EXPORT = f(REUSE, ENIMP, GFCF, EXCH) \quad (1)$$

$$EXPORT_t = \alpha_0 + \alpha_1 REUSE_t + \alpha_2 ENIMP_t + \alpha_3 GFCF + \alpha_4 EXCH + \varepsilon_t \quad (2)$$

$$\ln EXPORT_t = \alpha_0 + \alpha_1 \ln REUSE_t + \alpha_2 \ln ENIMP_t + \alpha_3 \ln GFCF + \alpha_4 \ln EXCH + \varepsilon_t \quad (3)$$

Equation (1) indicates the simple economic model, which indicates that the volume of exports depends on the use of renewable energy, the level of imported energy, gross fixed capital formation, and the exchange rate. Energy price[36] and industrial productivity also affect export performance of a country. Due to lack of reliable time series data these variables have been omitted in the model. Around 64% of total energy source[37] comes from traditional source (firewood, cow dung cake and agriculture residue) and there is not the availability of reliable data on price of such energy sources in Nepal. Though Nepal has started to formulate and publish manufacturing production index, it does not represent productivity and there is lack of reliable macroeconomic data related to productivity. Trade openness has not been found effective variable for export trade though it has contributed for economic growth[38]. Along with trade liberalization trade deficit has surged in Nepal. So, trade openness variable also has not been included in the model.

Equation (2) indicates the econometric model where α_0 denotes the intercept and $\alpha_{1\ to}\ \alpha_4$ denote coefficient of respective independent variables. Finally, equation (3) represents the log transformed model which is tested by using E-views software.

Equation (3) is tested by using the Autoregressive Distributed Lag (ARDL) Model. This model is widely used to find the long run relationship among the variables having mixed order of integration[15,39,40]. The ARDL method is a cointegration technique used in econometrics to determine the long-run equilibrium relationship among time series variables[41]. It is highly significant as a robust remedy for spurious regression in non-stationary time series[42]. It does this by including past values (lag values) of both the dependent and independent variables, which helps cover any missing changes from earlier periods. This makes it especially helpful in economics when studying long-term relationships with a small sample size[42].

To confirm the order of integration unit root test (**Table 3**) is performed. For this, Phillips Perron (PP) test and Augmented Dickey Fuller (ADF) test is used. ADF test is the most popular test to identify the

stationarity of the variable under study which uses lagged differences to the error term. The PP test is more robust to heteroscedasticity in the error term and it does not require specifying a lag length for the regression[43].

Table 2. Summary statistics.

Variables	lnENIMP	lnEXCH	lnEXPORT	lnGFCF	lnREUSE
Mean	2.554994	4.28073	21.00327	21.56218	4.465345
Std. Dev.	0.460592	0.337309	0.493415	0.976263	0.073372
Minimum	1.661815	3.379945	19.76063	20.18674	4.291828
Maximum	3.376263	4.773606	21.70147	23.17083	4.554929

Source: *Author's computation*

After confirmation of mix order of integration, F-Bound test is performed. By comparing the F bound test value with critical values long run relationship is confirmed. After this, long run coefficients are derived. Reliability and stability of the selected model and its output are further confirmed by the help of Jarque-Bera normality test, Breusch-Godfrey serial correlation LM test, Breusch-Pagan-Godfrey heteroscedasticity test, and Cumulative Sum of Recursive Residuals (CUSUM) test. The Jarque-Bera normality test is used to determine whether the model residuals are normally distributed. Similarly, the Breusch-Pagan-Godfrey heteroscedasticity test is used to check serial correlation. The p-value of all the tests should be greater than 0.05 for the reliability of the model. The CUSUM test is used to assess the model's stability, and it is indicated by the CUSUM line falling within the specified boundaries. All of the above-mentioned procedures are applied through the E-Views software.

4. Results

This section includes findings during the test of the selected model (3). It starts with the test of order of integration and ends with the reliability test of the model.

The Phillips-Perron test and the Dickey-Fuller test address the issue of unit roots using distinct methodologies. When both tests produce almost consistent outcomes, the reliability of the inference regarding the stationarity of the series is strengthened. The unit root test result (**Table 3**) indicates that lnEXCH and lnEXPORT have integration order I (0) and remaining variables lnENIMP, lnGFCF and lnREUSE have integration order I (1). Such mix order of integration allowed to test ARDL bound test.

Table 3. Unit root test.

Dicky Fuller Test	lnENIMP	lnEXCH	lnEXPORT	lnGFCF	lnREUSE
Level					
Constant	0.7723	0.0143	0.0439	0.9631	0.9998
Constant and trend	0.6717	0.338	0.3446	0.7446	0.9351
First Difference					
Constant	0.0000	0.0005	0.0331	0.0002	0.484
Constant and trend	0.0002	0.0031	0.0443	0.0008	0.0117
Phillips-Perron Test	**lnENIMP**	**lnEXCH**	**lnEXPORT**	**lnGFCF**	**lnREUSE**
Level					
Constant	0.766	0.041	0.0337	0.9626	0.9943
Constant and trend	0.6717	0.0331	0.3969	0.7446	0.8832
First Difference					
Constant	0	0.0004	0.0006	0.0002	0
Constant and trend	0.0002	0.003	0.0009	0.0008	0

Source: *Author's computation*

Table 4. ARDL F-Bound test Null Hypothesis: No levels relationship.

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	6.7933	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.50%	2.88	3.87
		1%	3.29	4.37

The F-bound test shown in **Table 4** indicates that there exists cointegration among the selected time-series variables. Computed F-statistics (6.79) is greater than the lower bound [I(0)] and upper bound [I(1)]. It justifies the existence of long run relationship between the selected variables and allowed to find the long run coefficients of the variables (**Table 5**).

Table 5. Long run relation.

Variable	Coefficient	Std. Error	t-Statistic	Probability
lnGFCF	0.254165	0.088229	2.880752	0.0087***
lnREUSE	6.68575	1.809036	3.695753	0.0013***
lnEXCH	-0.32588	0.48099	-0.67752	0.5051
lnENIMP	1.539307	0.447272	3.441545	0.0023***
C	-16.7748	8.52039	-1.96878	0.0617*

***Note:** *, ** & *** indicate 10%, 5% and 1% level of significance*

The analysis specifically focuses on the context of Nepal's export energy nexus and the role of the exchange rate. The findings present a mixed picture of Nepal's export dynamics. The coefficient for lnGFCF is positive and statistically significant ($p<0.01$). The results suggest that a 1% increase in GFCF is associated with approximately a 0.25% increase in export growth, highlighting the crucial role of domestic investment in Nepal's export sector. The most striking finding is the large, positive, and highly significant coefficient for lnREUSE ($p<0.01$). This suggests that a 1% increase in renewable energy consumption is associated with a remarkable 6.69% increase in export growth. The coefficient for lnEXCH is negative, but not statistically significant ($p>0.05$). The coefficient for lnENIM is positive and statistically significant ($p<0.01$). This implies a 1% increase in energy imports is associated with a 1.54% increase in export growth.

Post Estimation Diagnostic Tests

Model's validity, reliability and stability is tested through Heteroskedasticity test, serial correlation LM test, Normality test (**Table 6**) and CUSUM test (**Figure 2**).

Table 6. Reliability test.

Test	P-Value
Breusch-Pagan-Godfrey Heteroskedasticity Test	0.5845
Breusch-Godfrey Serial Correlation LM Test	0.405
Jarque-Bera Normality Test	0.535

Probability value of Jarque-Bera normality test (P>0.5%: 0.535) indicates the goodness of fit of the tested model. P-value greater than 5 % significance level of Breusch-Godfrey Serial Correlation LM Test indicates that there is no serial correlation. Similarly, there is no evidence of heteroscedasticity, as the P-value of the Breusch-Pagan-Godfrey Heteroscedasticity Test is also greater than the 5% significance level **(Table 6)**.

Similarly, CUSUM and CUSUM of Squares test findings (**Figure 2**) indicate the stability of the model. CUSUM lines lie between the upper and lower dashed lines (5 % significance boundaries). Hence, the model's findings are reliable, as it passes both stability and reliability tests.

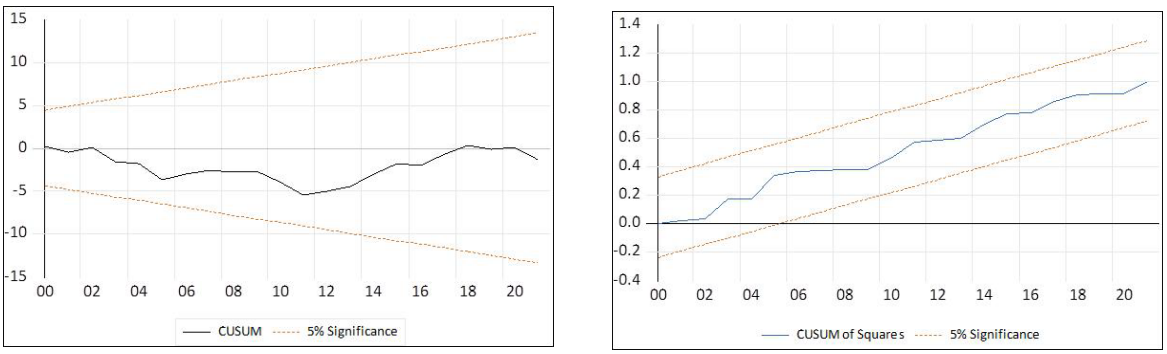

Figure 2. CUSUM Test.

5. Discussion

Macroeconomic variables are interconnected to each other. A major macro variable, export trade is also highly influenced by production, production cost, investment and resources available in the economy. In this preview, the study exposed the influence of renewable energy use in Nepal, gross fixed capital formation, exchange rate, and energy import on export trade of Nepal.

Gross fixed capital formation has significantly influenced the Nepalese export trade. The finding is consistent with standard economic theory, which explains that an increase in investment in tangible assets like machinery, buildings, and infrastructure leads to enhanced production capacity and, consequently boosts in export capabilities[8]. Such positive relation of GFCF with export trade is similar to the findings of Adekunle[32] in case of South Africa. Investment by Government of Nepal on Motihari Amlekhgunj petroleum pipeline project, Nepal's first cross border pipeline and other Indo- Nepal planned projects like Amlekhgunj to Chitwan Pipeline Project, Silguri to Charali (Jhapa) Pipeline project has raised hope for reduction on petroleum transportation cost in Nepal. Initiation taken by the government to connect Nepalese roads to Asian Highway has further created good environment for export trade to Nepal. Likewise, investment on electricity transmission line in recent year will have positive impact in export trade in the coming year.

Facts indicate that Nepal has a massive hydropower potential (43000 MW feasible capacity). Electricity generation capacity has reached to 3,157 MW in 2022/23[44]. Share of hydropower energy, solar and others have reached to 92.60%, 3.25 % and 4.15% respectively in 2024[37]. In such a scenario, increased use of renewable energy may improve the productivity and competitiveness of export-oriented Nepalese industries through higher energy availability[45]. The findings showed that renewable energy use is helping to boost the export trade in Nepal. It could also indicate that export sectors are shifting towards a more sustainable and efficient energy mix, reducing operational costs and appealing to environmentally conscious international markets. Nepal can also be the good example like that of Turkey who significantly had reduced energy-import dependency by enhancing renewable energy use[29]. The findings have shown the possibility of reducing energy import dependency of Nepal, similar to the findings of Yadav and Mahalik[22] in the case of 16 emerging market economies.

By increasing the use of domestic renewable energy, particularly hydropower, Nepal can reduce costs, enhance energy security, and provide a more reliable power supply[15]. This shift from imported fossil fuels to local clean energy supports industrial productivity and enhances export competitiveness, thereby improving the trade balance. Growing cross-border electricity trade with India and development of energy infrastructure also has raised hope for stable energy supply in Nepal which could have positive impact on trade balance[46]. From the point of view of employment and export trade, energy abundant countries have been achieving success operating energy intensive sectors[3]. However, still there is lack of sound and confident environment to promote energy intensive sectors due to uncertainty of stable energy supply sustainability of growth of foreign trade is questionable one. In the context of falling in the category of top 10 highly polluted country in

the world, the priority given for the use of renewable energy could have spillover effect on minimizing adverse impact of climate change[47].

The positive and significant relationship of imported energy with export is logical, as imported energy, such as petroleum products and coal, is a vital input for industrial and transportation sectors that support export activities. This finding highlights Nepal's dependence on imported energy to fuel its export sector, which could be a source of vulnerability to global energy price shocks and geopolitical influence[23-25]. Nepal has already faced blockades that had hampered economic activities. Such dependency on energy import could only be reduced by harnessing potential hydropower generation.

Insignificant impact of exchange rate on export trade contradicts to the study of Adhikari[9], Nepali[11], Joshi et al.[10], Nga et al.[34]. This is a key finding that challenges the conventional economic view that a depreciating currency (higher exchange rate) makes exports cheaper and more competitive, thereby boosting export volume. A high p-value of 0.5051 suggests this relationship may be due to random chance. This is particularly interesting for Nepal, which has a long-standing currency peg with the Indian Rupee, i.e., NPR 160 is equal to INR 100. The fixed exchange rate system limits the ability of the Nepalese rupee to depreciate to boost exports to third countries, and its peg to a major trading partner (India) can lead to a real exchange rate appreciation, which negatively impacts export competitiveness[9]. Such an insignificant impact could be due to the fixed exchange rate regime, where other non-price factors, such as trade policies and production capacity, play a more dominant role[9]. Researchers have supported for fixed exchange rate of Nepalese currency with India[48] due to relatively inelastic nature of Nepalese exports and low export diversification besides the implementation three Trade Integration Strategies (2010, 2016 and 2023) in Nepal.

The reliability of energy supply is a major concern that has direct economic and social implications, especially for low-income countries. Households in Nepal are willing to pay a significant premium for improved service reliability of electricity [49]. Similar expectation is found in manufacturing sector also. So, promoting domestic renewable energy generation is an effective strategy for mitigating a country's reliance on external energy sources[49] which could have spillover positive impact on all the sectors including export trade. So, hydro resource rich country should focus on developing energy infrastructures and promote renewable energy that could support for trade balance by promoting competitive export trade. Nepal can take lesson from emerging market economies that have already reduced energy import dependency by promoting renewable energy use[22,29].

Nepal has already signed the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC) Free Trade Area Framework Agreement. All member nations have a growing market and potential for development as well as their strategic location on major trade routes could create ample benefits for export trade[50]. Therefore, Nepal should try to grasp this opportunity by reducing trade costs and promoting green trade through increased use of renewable energy in the manufacturing sector. However, growing geopolitical tension of United States of America with Nepal's close neighbors China and India have further created uncertainty and future possible trade shocks in Nepalese International trade. So, Nepal should keep close eye on macroeconomic variables that could have severe impact of export trade like energy import, and export of major commodities.

6. Conclusion and policy implications

6.1. Conclusion

This research paper mainly explores the impact of energy variables on export trade. The study has used 32 years of data, ranging from 1990 to 2021. ARDL model revealed the significant positive influence of gross fixed capital formation, renewable energy use and energy import on export trade of Nepal. However, insignificant influence of exchange rate on export is of prime concern in Nepalese scenario. It raises concern

for other controlling variables, like the fixed exchange rate regime with India and the level of trade dependency with India. Reliability and stability tests confirmed the suitability of the selected variables. The findings in this study support the prior research works and signify the growth of renewable energy and balance of energy import by increasing the generation of hydropower and other renewable energy sources in Nepal.

Use of energy prices could further enhance the strength of the study. However, the study was unable to include energy price due to the unavailability of consistent and reliable data. Study on renewable energy used by specific export-based Nepalese industries and the causal relationship of major imported energy products with export trade could further explore the impact of renewable energy use on Nepalese export trade.

6.2. Policy implication

The study's findings are crucial from a policy perspective. Green trade, green economic growth, and the use of renewable energy are getting priority these days in developed, developing, and least developed countries in the context of sustainable development. Promotion of export trade through the enhancement of renewable energy could help to achieve triple target at once: increase export competitiveness by lowering export cost by the massive use of hydropower energy and other renewables in the form of renewable energy; decrease trade deficit and achieve target of Sustainable Development Goal: 7. Small, landlocked country like Nepal can transform abundant energy to increase the productivity of manufacturing sector. Further findings indicate that Nepalese export trade is not getting an advantage from the prevailing exchange rate system. Exchange rate policy can influence exports, but is constrained by broader economic structures in Nepal.

In the context of the geographical situation of Nepal (situated between India and China), renewable energy is a means of energy security as well as export earnings to Nepal. Therefore, investment in energy infrastructure, such as transmission lines, petroleum pipelines, and renewable energy sources, should be accelerated to enhance the export competitiveness of Nepalese firms. Similarly, national trade strategies have identified the high cost of energy and reliable supply of energy as a threat to existing and emerging large manufacturing industries. However, promotion of renewable energy use and an energy-based cost reduction strategy is lacking in the trade strategies. In the context of growth and increasing concern for green trade and green products, connection of renewable energy use with export products seems essential. Effective implementation of sector specific energy efficiency strategy could further promote domestic production. Strategic coordination between federal, provincial and local government for promoting exportable goods at market nearby Indian border might also enhance export trade of Nepal.

Author contributions

Conceptualization, Keshav Raj Panthee and Pramshu Nepal; methodology, Keshav Raj Panthee; software handling, Keshav Raj Panthee; formal analysis, Keshav Raj Panthee; data curation, Pramshu Nepal; writing, Pramshu Nepal, Pitri Raj Adhikari; review and editing, Pitri Raj Adhikari

Conflict of interest

The authors declare no conflict of interest.

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