frontiers | Frontiers in Environmental Science

ORIGINAL RESEARCH
published: 30 June 2022
doi: 10.3389/fenvs.2022.937834

Effect of Financial Development, Foreign Direct Investment, Globalization, and Urbanization on Energy Consumption: Empirical Evidence From Belt and Road Initiative Partner Countries

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Specialty section:
This article was submitted to Environmental Economics and Management, a section of the journal Frontiers in Environmental Science

Received: *06 May 2022*
Accepted: *06 June 2022*
Published: *30 June 2022*

Citation:
Ullah A, Kui Z, Pinglu C and Sheraz M (2022) Effect of Financial Development, Foreign Direct Investment, Globalization, and Urbanization on Energy Consumption: Empirical Evidence From Belt and Road Initiative Partner Countries. Front. Environ. Sci. 10:937834. doi: 10.3389/fenvs.2022.937834

This research aimed to determine the dynamic endogeneity nexus among energy consumption (EC), financial development (FD), foreign direct investment (FDI), globalization (Gl), and urbanization (URBAN). The study used 64 countries' annual panel data on "the Belt and Road Initiative (BRI)" from 2009 to 2019. Moreover, it employed a two-step system GMM, robust and results, that indicates financial development and urbanization are positively correlated with energy consumption, suggesting that these two factors raise the energy demand. Contrastingly, globalization negatively impacts energy demand, implying that global connectivity is essential for BRI countries. Foreign direct investment (FDI) has a positive but insignificant connection with energy consumption. Additionally, the Granger causality test was employed to explore the causal association among the variables, and outcomes reveal a bidirectional causal connection between FD and energy consumption. The study also suggests sustainable energy policy implications, which will be helpful to policymakers and governments for ensuring a balanced, sustainable growth.

JEL Code: P48; P25; Q4; F6; G00; E2

Keywords: financial development (FD), globalization, urbanization, foreign direct investment (FDI), energy consumption

1 INTRODUCTION

Energy plays a significant part in industrial growth and sustainable development since it has been used to enable' growth, distribution, and consumption in nearly every area of life as input. Besides, speeding up economic growth requires more resources as a driving force for developing goods and services (Mukhtarov et al., 2020; Usman et al., 2022a). Around 22 percent of global population do not have access to electricity' especially in rural areas distant from power grids (Huda, 2019). The International Energy Agency (IEA) estimated that approximately 85 percent of people live without electricity access in rural zones of developing regions such as sub-Saharan Africa and South Asia. As per the IEA, about 1.4 billion people will not have access to electricity even by 2030, especially in Africa and South Asia (Alam and Murad, 2020). The United Nations (UN) General Assembly launched a global initiative to make energy services accessible to the whole world by 2030 and declared 2014–2024 to be the Sustainable Energy Decade. For this purpose, they advised the member states to prioritize making modern and renewable energy accessible (Mahbub and Jongwanich, 2019). Several studies reveal that a critical factor in the progress of electrification projects is access to finance (Ji and Zhang, 2019; Xie et al., 2021).

With rapid development, the world is undergoing unceasing expansion, and the demand for energy sources has substantially increased (Bilgili and Ozturk, 2015; Yang et al., 2021). Energy consumption refers to the amount of energy used to perform a particular task or work (Salim et al., 2017). The term energy efficiency has been variously used to reflect the conservation, consumption, or conservation of the energy (Nie et al., 2019). There are some modern theories of energy consumption, namely energy efficiency, sustainable development theory, and green growth theory. The rebound effect theory, developed in 1865, and Khazzoom Brookes' theory, advanced in 1992, are among the most notable theories of energy consumption or energy efficiency. In 2011, the United Nations Environment Program (UNEP) and the Organization for Economic Cooperation and Development (OECD) proposed other modern theories such as the sustainable develop pment theory and the green growth theory (Zaman et al., 2021). The sustainable development theory focuses on providing the solution to problem of extreme carbon emissions that can be harmful to environment and habitats. The concept of "green growth" focuses the protection of environment by reducing environmental pollutions and preserving natural resources from environmental destruction (Nkalu et al., 2020; Ullah et al., 2022).

Financial growth stimulates energy demand. Further, it improves a country's financial performance, promotes FDI, reduces borrowing restrictions and financial risk, and increases transparency among lenders and borrowers; thus, energy demand is impacted by growing consumption and fixed investments (Sadorsky, 2010; Ke et al., 2022). In developing countries where the goods and services industries are expanding, financial institutions also play a vital role. Financial institutions, including banks and financial companies, finance to investors and the household sector, which act as a lifeline in a country's economy (Ullah et al., 2021b). Thus, financial development also impacts energy consumption as it increases economic activitiy which in turn raises the energy demand. Sadorsky (2011) also stated that financial development promotes FDI and improves banking and stock market activities. It stimulates the economy's growth by reducing financial risk and the cost of debt. Moreover, it affects the demand for energy as it enables investors or household borrowers to buy houses, automobiles, electronics appliances, etc. Sheraz et al. (2022) expressed that a well-managed and efficient financial sector helps distribute ample financial capital to the energy sector and manage energy supply and demand.

Financial development can also facilitate energy projects by meeting the required liquidity in the energy sector. Moreover, it promote the construction of new infrastructure facilities, and it can thus positively influence energy use and generation (Dumrul, 2018). Financial development is considered one of the vital factors influencing/impacting the demand for energy as it enhances a country's financial efficiency, facilitates/promotes the flow of financial capital and FDI, increases banking activities, and reduces loan costs and financial risk. Moreover, it increases transparency among borrowers and lenders, which can influence the energy demand by raising energy utilization and fixed investments (Mukhtarov et al., 2020). FDI affects a country's economic growth and encourages environmental protection (Yue et al., 2016). Hence, FDI plays a crucial role in the economic progress of the energy sector. Since FDI seeks benefits by making a long-term investment in overseas countries, it becomes a vital source of technology transfer and financial development (Sirin, 2017; Jiang and Martek, 2021).

New and highly advanced technology has converted the world into a global village. Because of globalization, the competition among countries' economies is accelerated; on the other hand, it creates opportunities for trading, investing, and undertaking economic activities the limitations of any physical boundaries. The world takes part in these productive activities without being affected any border restrictions, thus impacting energy consumption. Moreover, the world now acts as a global village, so people are more interconnected politically, socially, and economically. Latif et al. (2018) argued that globalization links countries culturally, socially, politically, and economically. Furthermore, it greatly promotes economic growth through FDI and trade.

Thus, globalization helps eradicate cross-border constraints; these economic activities positively or negatively influence energy consumption. Additionally, globalization brings about progressive technologies and knowledge diffusion, which reduces the energy consumption from using conventional means and lessens energy demand as well.

New technology develops innovative production methods that reduce energy consumption (Shahbaz et al., 2016). In addition, the acceleration of globalization and urbanization rises energy demand globally (Kahouli, 2017). Seminal studies by Fan et al. (2017), Kandil et al. (2017), Danish et al. (2018), Sheraz et al. (2021), and Shahbaz et al. (2021) recommended focusing on the relationship between economic activities, globalization, urbanization, and energy.

Urbanization is considered a leading source of economic growth, especially in developing countires. Migrating from rural areas to urban areas make economic sense since people can get better access to education, employment, cheaper transportation, and better living conditions. As of 2010, the global urbanization rate reached 50% as per UN's Population Division. Further, it is estimated that by 2050, about 86% of developed and 64% of developing economies will be urbanized. Considering the expected growth in urbanization, the public and researchers have focused on reshaping the energy landscape (Sheng and Guo, 2018). Establishing the connection between urbanization and energy consumption is considered an academic riddle as well as a practical challenge.

China has continued making active use of foreign capital since its reforms and opening-up policies that began 40 years ago. The GDP and FDI flow have risen dramatically; simultaneously, energy consumption has substantially risen in China. Being the world's largest energy consumer, China represents 23.2% of global energy consumption and 33.6% of global energy consumption growth (Zeng et al., 2020). In the developing Belt and Road regions of Asia (e.g., Pakistan) and Africa, electricity demand is driven by several issues, such as economic expansion, electricity prices, rapidly growing rural–urban migration. In the Belt and Road countries, electricity shortages were caused by problems such as excessive use of electricity in industrial and domestic sectors, theft, mismanagement, extensive loss of power lines, and political controversy surrounding mega-power projects. Therefore, energy consumption is an important policy issue in 64 BRI countries, and China may offer help in resolving this issue. The energy shortage issue can be resolved by attracting FDI and improving financial development. However, higher inflation may hurt the consumption of energy as it would become unaffordable for households and industry. It can be further noted that FDI increases energy consumption due to industrialization and increased business activities. There are numerous reasons behind studying the impact of FDI, financial development, globalization, urbanization, inflation, and electricity access on energy consumption. This area of study investigate the long-term effects of these variables on energy consumption.

This research explores the impact of financial development, foreign direct investment, globalization, urbanization, inflation, and electricity access on energy consumption in 64 BRI partner countries by using data from 2009 to 2019. Furthermore, this study will make comprehensive policy recommendations that would be helpful for policymakers and governments in making decisions to fulfill the need for energy because they should be careful in managing FDI, financial development, and inflation to achieve optimal energy efficiency.

This empirical study, in many ways, contributes to the existing body of knowledge, including past studies considering energy as a dependent variable in a single framework with different economic determinants such as GDP and trade openness. This study pioneers to reveal the effect of financial development composite (comprised of the financial market development index and financial institution development index factors of access, depth, and efficiency), FDI, globalization, urbanization, inflation rate, and access to electricity on energy consumption under a multivariate framework by employing a two-step system generalized method of moment (GMM) approach for the panel data from the 64 BRI countries. We also used the Granger causality test to inspect the cause–effect connection among the variables. In nations under the BRI plarform, mainly developing countries, energy is a primary concern as it directly impacts sustainable growth; many countries are unable to fulfill their energy demand due to a lack of financial resources and foreign investment while the urban population increases global awareness.

In addition, an important source of sustainable growth is financial institutions and financial markets' development as the institutions provide the funds to the investors at a cheaper interest while the markets help them increase profitability and market share on investments. This is because achieving energy efficiency needs investment in different projects that help generate energy. Past studies use a single-indicator proxies for financial development such as board money and money supply, which do not depict an accurate picture regarding financial development. In contrast, this study adopted a new financial development index proposed by the International Monetary Fund (IMF) that comprises six different sub-indexes based on financial development and financial market development. It will give new insights for scholars and policymakers. Similarly, another important focus of the study is FDI as all investment from other countries has a significant impact on economic activities, which in turn affects the demand for energy. Therefore, we have adopted FDI as an important factor within our framework to expand the existing body of relevant literature concerning BRI countries.

Further, we accounted for globalization as an independent factor; for this, we used an index comprised of social, economic, and political sub-indices including several indicators. The main reason for selecting this variable is because the BRI platform connects all partner countries in terms of global integration and the existing literature on globalization and energy is limited in BRI countries. Examining the impact of globalization on energy demand is essential because it leads to economic, social, and political activities that raise the energy demand. Last but not least, we explore urbanization because under the BRI platform, partner countries' have a vast population; hence, it is very important to address their energy concerns. Due to increased economic activities, the income level of the common person increases, encouraging them to look for better living conditions. As a result, people migrate from rural areas to urban areas, which impacts the energy demand and rural—urban migration leads to the existing body of knowledge.

Moreover, the two-step GMM system outcomes, highlight that financial development significantly and positively contributed to energy consumption at a significance level of 1%. At the same time, foreign direct investment also positvely influenced energy consumption, although insignificantly. Globalization has a negative but significant influence on energy consumption at the significance level of 1%. Meanwhile, both urbanization and inflation contributed positively and significantly to energy consumption at a significance level of 1%. In contrast, access to electricity negatively influenced energy consumption at a significance level of 10%. Therefore, policymakers should carefully manage FDI, financial development, and inflation to achieve optimal energy efficiency.

Section 2 in the paper presents the review of literature on all variables, including dependent, independent, and control variables. **Section 3** describes the methodology, which contains a complete description of the modeling and estimation—the empirical. **Section 4** presents the result and discussion, and lastly, **Section 5** provides a conclusion to the study based on the research approach, gives policy recommendations, and suggests directions for future work.

2 LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

2.1 Financial Development and Energy Consumption

Financial development constitutes the actual amount of financial capital offered for growth, channeling funds through banks and stock markets (Shahbaz et al., 2018). It encompasses a sophisticated financial market that enables the efficient distribution of credits that boost the sustainable economic growth and increase the need for energy in private businesses progressively. In a matured financial market, the provision of affordable credit empowers families to buy personal-use commodities that in turn increase the demand for energy (Sadorsky, 2011). However, it minimizes energy demand in the long run by enabling households and businesses to utilize energy-conserving technology by lowering the cost of borrows (Islam et al., 2013).

The financial development factor money supply is the amount of money in a region, and domestic credit is a factor leading to money transition. Financial development raises the accessibility of consumers to consumption credit, which encourages them to buy more commodities such as electric appliances and automobiles that further increase energy demand. Enterprises also increase their investment in research and development (R&D) and in advanced energy-saving products' design and manufacturing that leads to financial development; thus, the aggregate of energy consumption reduces. Accordingly, Tamazian et al. (2009) suggested that financial development decreases energy consumption because a sophisticated financial system helps enterprises update equipment and production technologies, which could effectively increase energy efficiency due to the mitigation of' financial constraints. Studies by Sadorsky (2010) and Ozturk and Acaravci (2013) show that financial development, in theory, boosts energy consumption as a sophisticated financial system could provide funds with much lower costs to enterprises, thereby expanding their production and eventually increasing energy consumption.

In terms of methodology, Sadorsky (2010) used the GMM technique to examine financial development's effect on energy consumption. This study used sample data from 1990 to 2006 from 22 emerging countries. Reported findings show that financial development has a significant positive relationship with energy consumption. Sadorsky (2011) also studied financial development's impact on energy consumption using sample data on nine countries in Eastern and Central Europe. The results demonstrated that financial development has a positive correlation with energy consumption. Kakar (2016) utilized an error correction model (ECM) and the Granger causality and cointegration approaches to investigate the dynamic relationships among financial development, economic growth, and energy consumption over the period 1980–2010 in Pakistan and Malaysia. He found that financial development has a unidirectional causal relationship with energy consumption in both economies. Gomez and Rodriguez (2019) employed longitudinal data to examine the association among economic growth, financial development, urbanization, and energy consumption in North American Free Trade Agreement (NAFTA) countries. Reported results indicated a positive correlation between economic growth and energy consumption, whereas financial development, inflation (consumer price index), urbanization, and trade openness were negatively correlated with energy consumption.

Initially, energy consumption increases due to financial development, but after achieving financial, it declines. Mukhtarov et al. (2020) confirmed that both financial and economic growth positively impacted energy demand. Also, found the significant positive influence of financial development on energy consumption. Therefore, financial development impacts energy-saving policies as it can influence energy demand and economic activity (Sheraz et al., 2021). Moreover, relevant literature on finance and energy empirically suggested that financial development has a positive influence on energy usage, which eventually increases energy demand.

H_1: An efficient financial development system has a significant and positive effect on energy consumption per capita, whereas less availability of financial resources has an inverse effect.

2.2 FDI and Energy Consumption

FDI positively impacts the host country's energy consumption because foreign investors join the host economy with managerial experiences, manufacturing technologies, and new ideas like an economy with low-carbon, emission-reducing, energy-conserving, and encouraging policy that channels more money into environmental pollution management and the reduction of energy misuse. This leads to the improvement of nationwide sustainable development ability (Perkins and Neumayer, 2008). Nonetheless, an increase in FDI slightly decreases energy consumption intensity (Sun et al., 2011). According to Sirin (2017), long-term investment in a foreign country translates to foreign direct investment to boost technology in the energy sector and the economy.

Furthermore, Sadorsky (2010) indicated that FDI raises energy utilization, leading to a higher energy demand in developing countries. He further revealed that FDI inflows increase liquidity (financial development indicator—money supply) and stimulate investment in new factories and plants that drive up energy demand. Interestingly, Omri and Kahouli (2014) showed that FDI has a bi-directional causal association with energy consumption in low- and middle-income countries. Meanwhile, Doytch and Narayan (2016) demonstrated a constructive association among the renewable energy demand and aggegated FDI, as well as with the FDI in the mining and financial services sectors. They concluded that demand for renewable energy rises due to the FDI contribution in the financial services sector. However, renewable energy demand reduces with FDI in the fabricating sector.

FDI inflows enhance energy consumption by contributing to the industrialization and the expansion of transporation infrastructure and the manufacturing sector, which requires energy to support the production process (Tsaurai, 2018). Latief and Lefen (2019) claimed that FDI and energy consumption structures are useful in resource-intensive sectors for improving productivity. They found a higher FDI in the energy and power sector compared with the other sectors in Pakistan by examining production and usage trends of energy throughout 1990–2017. Adom et al. (2019) explored the driving factors for FDI's energy-saving position and industrialization in East Africa, concentrating the impact of FDI's conditional effects and industrialization on energy output. They investigated the relationship between energy demand and FDI by using the impact of 27 African countries throughout 2000–2014 argued that FDI has a converse effect on energy consumption.

Therefore, the industrial distribution of FDI plays an essential role in energy consumption. FDI facilitates accessibility to finance, which companies can utilize to expand operations that substantially increase energy demands, thus requiring more resources and investing to generate energy efficiency.

H_2: FDI plays a crucial positive role in the energy consumption efficiency of a country.

2.3 Globalization and Energy Consumption

Globalization determined modern society's evolution and stimulated political, social, and economic development. As one of the engines of socio-economic growth, globalization plays a formidable role in energy evolution (Shahbaz et al., 2016; Li et al., 2022). Globalization urges cooperation critical for invention and knowledge transmission, which is beneficial for advancing energy technology and efficiency that the energy consumption structure (Danish et al., 2018; Huang et al., 2020), as it significantly contributes to energy consumption (Shahbaz et al., 2021).

Danish et al. (2018) claimed that energy consumption increased from globalization, but from analysis a single country's impact of globalization on the demand of energy is varied. Therefore, economic growth and energy consumption have a bidirectional causal association. For policymakers, it is crucial to develop strategies/policies to decrease the effect of energy consumption by ensuring its optimal use and transfer globalization. Moreover, globalization boosts economic growth, which raises energy demand. Therefore, energy is one of the key elements in developing products and services and is required to boost economic growth (Gomez and Rodriguez, 2019; Wan et al., 2022).

Due to globalization, direct investment increases; hence, it directly impacts the energy demand in emerging countries (Apergis and Payne, 2010). Therefore, emerging countries need more production to satisfy their rising requirements, which results in more energy consumption. However, the rapid rise in energy consumption puts enormous pressure on the environment. Shahbaz et al. (2016) explored the association between globalization and energy consumption using the dataset from India throughout 1971–2012. They discovered that the increase in globalization caused a reduction in energy demand in the long run. Additionally, Saud et al. (2018) showed that globalization has a significant negative influence on energy consumption. Huang et al. (2020) investigated globalization's impact on energy consumption by utilizing the cross-sectional dependence with panel VECM. They found that globalization has a U-shaped association with energy consumption in the long terms, indicating that when globalization reaches a certain level, energy consumption begins to decrease while globalization keeps increasing.

H_3: Globalization has a considerable negative impact on the energy consumption in a country.

2.4 Urbanization and Energy

An increase in urbanization causes a variation in the energy consumption pattern in each sector. A country's energy sector plays an active part in its sustainable growth and development, which urbanization also influences. As a form of energy, electricity plays a crucial role in improving sustainable economic growth, across all sectors. The massive generation of sustainable electricity can enhance people's quality of life and social well-being (Maxim, 2014; Usman et al., 2022b). Therefore, the electricity consumption either demand of cities is significantly increased due to urbanization; an increase in urbanization causes an increase in the per capita energy consumption. An increase in urbanization can significantly influence the energy consumption in the road and transport sectors. Hence, urbanization positively influences energy consumption. Accordingly, Halicioglu (2007) showed that per capita electricity consumption increased during Turkey's urbanization process throughout 1968–2005. Moreover, Madlener and Sunak (2011) maintained that an increased mechanisms of urbanization varied substantially and increased energy consumption among developing and developed countries. Iftikhar et al. (2022) claimed that urbanization hurt the sustainable development by increasing the demand of the energy consumption.

Yang et al. (2018) investigated urbanization's influence on household consumption of energy by employing China's provincial annual data for 1996–2014. They reported that urbanization has a positive relationship with residential electricity consumption and found heterogeneity across regions and different per capita incomes. Another study by Sheng and Guo (2018) used the generalized method of moments to investigate the impact of urbanization on energy consumption and efficiency. They showed that urbanization significantly boosts energy consumption and improves energy efficiency in China. They concluded that urbanization leads to a significant increase in both the actual and optimal consumption of energy but reduces energy-efficient consumption.

H_4: Urbanization has a considerable positive impact on the energy consumption and energy efficiency in a country.

2.5 Control Factors

Derived from the word "inflate," inflation refers to the increase in the overall price levels of goods and services in a country (Bashir et al., 2016). Inflation hinders sustainable development and energy consumption at two levels: high and low. A low inflation rate positively influences economic development, while a higher inflation rate hurts economic development and

TABLE 1 | Measurement of variables.

Dependent variable	Description
Energy Consumption Per Capita	Proxy of Electricity Consumption Per Capita, WDI Database
Independent Variables	
Financial development	Financial Development Index based on financial markets development and financial institutions development index. IMF Database
Foreign Direct Investment	FDI: USD mn, WDI Database
Globalization	KOF Globalization Index is based on social, political, and economic globalization. The Swiss Institute of Technology in Zurich Database
Urbanization	Urban population as percent of the total population, WDI Database
Control Variables	
Inflation	Inflation monthly percent change in the consumer price index (CPI) IMF Database
Access to Electricity	Access to electricity population as percent of the total population, WDI Database

energy trends (Kryeziu and Durguti, 2019). Electricity access in rural areas, another control factor, contributes to sustainable growth and progress in health, education, gender equality, and agriculture, in addition to raising the demand for energy (Danish et al., 2015; Palit and Bandyopadhyay, 2016). Electrification is one of the main elements for a country's development because regions deprived of access to electricity are less advanced than the electrified areas (Kabir et al., 2017). Electricity access enable efficient means of cooking and lighting, increase convenience of household energy consumption, especially in rural areas, enhance productivity, and improve sustainable growth (Nock et al., 2020).

3 RESEARCH METHODOLOGY

3.1 Data and Measurement

This research examines the impact of financial development, FDI, urbanization, and globalization on energy consumption in the Belt and Road countries; the sample consists of 64 BRI partner economies' balanced annual panel data from 2009 to 2019. The details regarding the countries are reported in **Supplementary Appendix A**. The dependent variable is energy consumption, while the independent variables include financial development, foreign direct investment, globalization, and urbanization. Meanwhile, inflation and access to electricity are the control variables. The collected data were processed and analyzed using Stata. The description and measurement of the variables are reported in **Table 1** below.

3.2 Cross-Sectional Dependence Test

Cross-sectional dependency (CSD) issues could possibly emerge in a panel-based study. Not addressing these issues could lead to bias and unclear results. Therefore, before checking data stationarity, it is imperative to conduct the cross-dependence test. The Lagrange multiplier (LM) and cross-sectional tests, recommended by Pesaran (2004), are employed in the study as follows:

$$\mathrm{CD} = \sqrt{\frac{2T}{N(N-1)}\left(\sum_{i=0}^{N-1}\sum_{j=i+1}^{N}\rho ij\right)} \tag{1}$$

CD indicates the dependency of cross-sections, n indicates the number of cross-sections, and t denotes the time. Further, between j and i, s is the error correlation of cross-sectional and is explained by ρij. For examining CD, the equation (LM test) can be expressed as follows:

$$y_{it} = \alpha_{it} + \beta_i x_{it} + \mu_{it} \tag{2}$$

Here, i and t indicate the data pertaining to time period and cross-section. The null hypothesis showed that cross-sections among the variables are independent. Additionally, the alternate hypothesis indicates each cross-section's dependence.

3.3 Unit Root Test

After confirming the cross-sectional dependence among the variables, the next step is to check the stationarity of the data. For that purpose, this study used the second-generation unit root test proposed by Pesaran (2007) as well as the CIPS and CADF tests. However, examining the unit root order also addresses the cross-sectional issues. The CIPS test is carried out based on the following:

$$y_{it} = \alpha_{it} + \beta_i x_{it-1}\rho_i T + \sum_{j=0}^{n}\theta_{it}\triangle x_{i,t-j} + \mu_{it} \tag{3}$$

For CIPS and CADF, the null hypothesis suggests that data have unit roots, and the alternate hypothesis confirms the data's stationarity. The CDF test shows as follow:

$$CIPS = \frac{1}{N}\sum_{i=1}^{N} CADFi \tag{4}$$

Further, xi and μit indicate the residuals of the variable i, and t are the time and cross-sections of the data.

3.4 Econometric Estimation

The two-step sys-generalized method of moment (GMM) is employed in this study. It considered the most appropriate technique to examine the over-identifying restriction, errors' measurement, omitted variables, endogeneity biases, and auto-correlation in the panel dataset (Arellano and Bond, 1991; Ullah et al., 2022). Controlling measurement errors in the analysis is considered/incorporated in a two-step sys-GMM approach (Ozkan and Ozkan, 2004). Using GMM as a basis, this study's data met the condition that N (total number of cross-sections) >

T (time period) (N > T). For this reason, the sys-GMM is effective due to its robustness against heteroscedasticity and autocorrelation. The Arellano–Bond sys-GMM has one and two step variants (Roodman, 2009). The GMM estimator is best-suited to deal with potential endogeneity issues. The two-step system GMM contains both OLS and 2SLS in its econometric trick, with 2SLS indicating that it is a specific case of GMM (Ullah et al., 2021a).

Autocorrelation is initially controlled *via* GMM. The obtained through sys-GMM can be better differentiated and evaluated (Zaman et al., 2021). The Hansen–Sargan test was used to further enhance the analysis authenticity, which determines the instrument's dependability and regulates the overidentifying limits that lead to the best possible analysis, which is observed by (Abbas et al., 2020; Ullah et al., 2021a).

The study employed the following model equation:

$$\text{Energy Consumption (ECPC)} = \int (\text{FD, FDI, GI, Urban} + \int (\text{Control Factors}) \quad (5)$$

Following Arminen and Menegaki (2019), Ahmad et al. (2020), and Ullah et al. (2021a), the two-step system GMM model can be written as:

The static model is as follows:

$$ECPC_{i,t} = \beta_0 + \beta_1 (FD)_{i,t} + \beta_2 (FDI)_{i,t} + \beta_3 (GI)_{i,t} + \beta_4 (URBAN)_{i,t} + \beta_5 (Conrol\ factors)_{i,t} + \varepsilon_i + \mu_{i,t} \quad (6)$$

The dynamic model is as follows:

$$ECPC_{i,t} = \beta_0 + \beta_1 (ECPC)_{i,t-1} + \beta_2 (FD)_{i,t} + \beta_3 (FDI)_{i,t} + \beta_4 (GI)_{i,t} + \beta_5 (URBAN)_{i,t} + \beta_6 (Control\ factors)_{i,t} + \varepsilon_i + \mu_{i,t} \quad (7)$$

Here, ECPC represents energy consumption per capita, FD denotes financial development, FDI represents foreign direct investment, GI denotes globalization, URBAN signifies urbanization, "Control factors" indicate inflation, and access to electricity and μ represent the error term i, t indicates time and cross-sections, and t-1 denotes a one-year lag.

3.5 Panel Granger Causality

The Granger causality, proposed in 1969, explains the relationship between two variables. As per Granger, when two variables{X_t, Y_t, t ≥ 1} are stationary, $\{Y_t\}$ causes $\{X_t\}$ if the present or past value of X has additional information about the future value of Y.

For example, $\boldsymbol{X}_t^{lx} = (X_{t-1\ \ X+1}, \ldots, X_t)$ *and* $\boldsymbol{Y}_t^{ly} = (Y_{t-1\ \ y+1}, \ldots, Y_t)$ are delay vectors, where $l_X\ l_Y \geq 1$. Diks and Panchenko (2006) considered the null hypothesis that observations of past $\boldsymbol{X}_t^{lx}$ have additional information about Y_{t+1} (beyond that, in $\boldsymbol{Y}_t^{ly}$):

$$H_0:\ Y_{t+1}\ \left| \left(\boldsymbol{X}_t^{lX};\ \boldsymbol{Y}_t^{lY} \right) \sim Y_{t+1} \right| \boldsymbol{Y}_t^{lY} \quad (8)$$

The equation in static form is as follows:

$$T_n(\varepsilon_n) = \frac{n-1}{n(n-2)} \cdot \sum_i \left(\hat{f}_{\cdot X,Z,Y}(X_i, Z_i, Y_i) \hat{f}_{\cdot Y}(Y_i) - \hat{f}_{\cdot X,Y}(X_i, Y_i) \hat{f}_{\cdot Y,Z}(Y_i, Z_i) \right) \quad (9)$$

Here, $f_{X,Y,Z(x,y,z)}$ pertains to probability density function. Moreover, $l_X = l_Y = 1$ if $f_{X,Y,Z(x,y,z)}$ is the joint probability density function. For $l_X = l_Y = 1$ and if $Cn^{-\beta}\ (C > 0,\ \frac{1}{4} < \beta < \frac{1}{3})$ shown in the equation below:

$$\sqrt{n}\ \frac{(T_n(\varepsilon_n) - q)}{S_n} \xrightarrow{D} N(0, 1) \quad (10)$$

Granger causality equations are proven by Diks and Panchenko (2006) in detail.

4 RESULTS AND DISCUSSION

4.1 Results of Descriptive Summary

Table 2 provides the summary of variables through descriptive analysis. Both descriptive and inferential statistics are used for data analysis in which mean and median indicate the central tendency. Reported results of minimum, maximum, and standard deviation demonstrate the data flexibility and data variability. The descriptive analysis is based on the mean, standard deviation, minimum and maximum value, and observation count. Skew. and Kurt. values showed that data is normally distributed, and most of the variables have 704 observations.

Moreover, referring to energy consumption as a dependent variable, its mean value is -4.395, whereas its minimum and maximum values are −8.206 and 0.543 respectively. Meanwhile, the standard deviation is computed as 1.787%, which shows the divergence of energy consumption per capita. While examining the independent variables, financial development has a mean value of −1.31, whereas the minimum and maximum value are −2.574 and −0.332 respectively. In contrast, the standard deviation is computed as 0.586%, which shows the dispersion of financial development.

Foreign direct investment's mean value is 0.531, whereas the minimum and maximum values are −4.605 and 5.673 respectively, which indicates that foreign direct investment significantly improved. Further, its standard deviation is computed as 1.84%, showing that FDI can either increase or decrease. The mean value of globalization was evaluated at 4.163, and its minimum and maximum values are 3.51 and 4.444 respectively, suggesting that globalization is increasing. Moreover, its standard deviation is computed as 0.194%, which shows that globalization can either increase or decrease by 0.194%. Besides that, urbanization has a mean value of 3.937 and minimum and maximum values of 2.78 and 4.605 respectively, indicating that urbanization is on the rise.

TABLE 2 | Descriptive statistics.

Variables	Obs	Mean	Std. Dev	Min	Max
Energy Consumption	704	−4.395	1.787	−8.206	0.543
Financial Development	704	−1.31	0.586	−2.574	−0.332
Foreign Direct Investment	682	0.531	1.84	−4.605	5.673
Globalization	704	4.163	0.194	3.51	4.444
Urbanization	704	3.937	0.457	2.78	4.605
Inflation	642	1.307	1.01	−2.303	3.288
Access to Electricity	704	4.417	0.396	2.505	4.605

TABLE 3 | Pairwise correlations.

Sr No	Variables	1	2	3	4	5	6	7
1	Energy Consumption	1						
2	Financial Development	0.160***	1					
3	Foreign Direct Investment	0.576***	0.569***	1				
4	Globalization	−0.099***	0.662***	0.460***	1			
5	Urbanization	0.239***	0.532***	0.321***	0.675***	1		
6	Inflation	0.303***	−0.242***	−0.01	−0.275***	−0.269***	1	
7	Access to Electricity	−0.027	0.561***	0.378***	0.597***	0.586***	−0.115***	1

****p < 0.01, **p < 0.05, *p < 0.1 *, ** and *** are represent 1, 5 and 10%, respectively*

TABLE 4 | Variance inflation factor.

Variables (dependent: Energy consumption)	VIF	1/VIF
Financial Development	2.222	0.45
Foreign Direct Investment	1.553	0.644
Globalization	2.615	0.382
Urbanization	2.043	0.489
Inflation	1.156	0.865
Access to Electricity	1.802	0.555
Mean VIF	1.899	

While computing the control factors, the inflation mean value is 1.307, with the minimum and maximum values being −2.303 and 3.288 respectively. The standard deviation is further evaluated as 1.01%; this shows that it can increase or decrease by 1.01%. Lastly, the mean value of electricity access is 4.417, and the minimum and maximum values are 2.505 and 4.605 respectively, indicating that access to electricity is good in BRI countries. Moreover, its standard deviation is computed as 0.396%, which shows the access to electricity can either increase or decrease by 0.396%.

Table 3 demonstrates the pairwise correlations among variables. FD, FDI, urbanization, and inflation correlate with ECPC at a 1% significance level. Moreover, globalization has a significant negative association with energy consumption at a significance level of 1%. Meanwhile, the control variable access to electricity is negatively correlated with energy consumption, although not significant.

Table 4. Variance inflation factors indicate that all independent and control variables are moderately correlated because all variables are between 1 and 5.

4.2 Results of Cross-Sectional Dependence and Unit Root Test

In **Table 5**, the results of a cross-sectional dependence test is reported. The findings suggest that cross-sectional dependence between the variables of BRI countries is rejected as per the null hypothesiss, and the alternative hypothesis is accepted. It shows that all variables are highly depended.

Table 6 presents the results of second-generation CIPS and CADF unit root tests, proposed by Pesaran (2004). The findings indicate that for the CIPS test, ECPC, FD, FDI, GI, and INF are stationary at level supporting the alternative hypothesis. However, urbanization (URBAN) and access to electricity (ATE) are stationary at first difference. Further, in the CADF test, ECPC, FDI, GI, INF, and ATE are stationary at level. However, FD and URBAN are stationary at first difference. The detailed results are reported below.

TABLE 5 | Cross-sectional dependence test.

CD Test	Statistic	*p*-value
Breusch-Pagan LM	4,292.180	0.0000
Pesaran scaled LM	34.83855	0.0000
Pesaran scaled LM	41.46815	0.0000

4.3 Results of the Two-Step System GMM

Table 7 shows the two-step sys-GMM analysis of static and dynamic model outcomes. The static models consist of Column 1) pooled OLS and Column 2) panel fixed effect while the dynamic models consist of Column 3) of pooled OLS, Column 4) of panel fixed effect, and Column (5), based on the final model of the two-step system GMM. Moreover, Column 1) of static models shows that financial development, FDI, and inflation positively impact energy consumption at a significance level of 1% and an R^2 value of 0.639; globalization and urbanization have a significant, negative impact at 1% confidence level; and access to electricity negatively influences energy consumption at a significance level of 10%. Column 2) of static models shows that independent variables (financial development, FDI, and globalization) negatively impact on energy consumption.

In contrast, control variables (urbanization, inflation, and access to electricity) positively impact energy consumption

TABLE 6 | Unit root test results.

Variables	CIPS			CADF		
	Level	First Difference	Decision	Level	First Difference	Decision
EC	−9.75***	-	I (0)	−3.24***	-	I (0)
FD	−1.63*	-	I (0)	-	−2.043***	I (I)
FDI	−18.1***	-	I (0)	−5.233***	-	I (0)
GI	−17.37***	-	I (0)	−2.098	-	I (0)
URBAN	-	−5.45158	I (1)	-	−4.645	I (0)
INF	−5.26***	-	I (0)	−3.545	-	I (0)
Access to Electricity	−6.356	4.563**	I (1)	5.647**	-	I (0)

***p < 0.01, **p < 0.05, *p < 0.1 *, ** and *** are represent 1%, 5% and 10%, respectively.

with an R^2 value of 0.151. Column 3) of dynamic models shows that financial development, FDI, and urbanization positively affect energy consumption. In contrast, globalization, inflation, and electricity access negatively impact energy consumption with an R^2 value of 0.994. Column 4) of dynamic models indicates that financial development, globalization, and inflation have a positive impact, while FDI, urbanization, and access to electricity negatively impact energy consumption with an R^2 value of 0.631. Hence, Columns 1) to 4) provide mixed results of variables.

Column 5) of dynamic models demonstrate the results of the two-step sys-GMM evaluation. The dependent variable, i.e., energy consumption, is positive, and the value of its coefficient is 0.969 at a significance level of 1%. Moreover, referring to the independent variables, financial development positively influences energy consumption with a 0.142 value and a 1% confidence level. It indicates that a 1% rise in FD caused a 0.142% increase in energy consumption at a significance level of 1%. Therefore, financial institutions provide finance at low-interest rates, encouraging investors and household to invest in different projects and buy household appliances. Those investments lead to economic activities that in turn raise energy demand. The results are consistent with Sadraoui et al. (2019), who found that financial development is positively and significantly associated with economic growth in the Middle East and North Africa region. The results are also in line with Mukhtarov et al. (2020), who found that FD showed a significant, positive impact on Azerbaijan's energy consumption per capita and increase in demand.

Another independent variable FDI, with a 0.002 value, positively impacts energy consumption, although not significant. This means that a 1% increase in FDI will cause a 0.002% increase in energy consumption per capita, which is insignificant. The findings are supported by Mohamed and Mamat (2016), who found that energy consumption was augmented by FDI inflows in Yemen in the short term as well as long term by using Autoregressive Distributed Lag (ARDL). The study by Salim et al. (2017) supported our results; they showed that FDI amplified per capita energy consumption in the short run, while it declined in the long run in response to FDI inflows in China by using ARDL.

The subsequent independent variable is globalization, which shows a significant negative influence on energy consumption with a 0.400 value and a 1% confidence interval. This means that a 1% increase in globalization will result in a 0.400% reduction in energy consumption with a significance level of 1%. It is suggested that because of globalization, the global borders are open and bring investments, skills, training, and help to import new efficient technologies from developed countries to developing countries. The advances in technology improves the efficiency process and reduces energy consumption, indicating that globalization decreases the demand for energy consumption in BRI countries. The study of Saud et al. (2018) supported our findings, which found that globalization negatively influences energy consumption. The results agree with Shahbaz et al. (2021), who maintained that globalization reduces energy consumption.

Besides that, urbanization reveals a significant positive impact on per capita energy consumption with a 0.040 value and a 1% confidence interval. It shows that a 1% rise in urban population will increase the energy consumption per capita by 0.040% at a 1% significance level. It demonstrates that the occurrence of economic activities improves the per capita income of an ordinary person. Having a better income level, people look for better facilities and more comfortable lifestyles, so they migrate from rural areas to urban areas, resulting in urbanization. People in urban areas look for more facilities and luxuries, so they are willing to pay more for them; when they purchase many household appliances and luxury items, the energy demand is raised. Our findings from BRI countries are in line and supported by Sheng and Guo (2018), which show that urbanization significantly increases energy consumption per capita. Still, there is very less evidence on the increase of energy efficiency in China. Therefore, a rise in urbanization increases the actual and optimal energy consumption per capita. Our findings are supported by Yang et al. (2019), who showed that urbanization positively affects electricity consumption per capita of households and demonstrated the heterogeneity across regions and different per capita incomes.

The following control variable is inflation, which positively and significantly impacts energy consumption with a 0.028 value and a 1% confidence interval. This indicates that a 1% increase in inflation will lead to 0.028% increase in energy consumption with a 1% significance level. Another control variable is access to electricity that negatively impacts energy consumption with a 0.028 value and a 90% confidence interval. This implies that a 1% increase in electricity access will cause a 0.028% increase in energy consumption at a 10% significance level.

Post-analysis diagnostic tests of the two-step system GMM final model in Column 5) show a zero correlation in the first difference using Arellano–Bond AR testing. The findings indicate

TABLE 7 | Results of FD, FDI, Globalization and Urbanization impact on Energy Consumption.

Variables	(1)	(2)	(3)	(4)	(5)
		Static models (1–2)			Dynamic Models (3–5)
		Baseline models (1–4)			Final model
	Pooled OLS	Panel fixed effect	Pooled OLS	Panel fixed effect	Two-step Sys-GMM
	ECPC	ECPC	ECPC	ECPC	ECPC
L. Energy Consumption Per Capita	-	-	1.002***	0.751***	0.969***
	-	-	(0.006)	(0.032)	(0.011)
Financial Development	0.502***	−0.225	0.016	0.056	0.142***
	(0.119)	(0.301)	(0.017)	(0.080)	(0.039)
FDI	0.740***	−0.035*	0.001	−0.005	0.002
	(0.032)	(0.020)	(0.006)	(0.011)	(0.009)
Globalization	−2.330***	−0.132	−0.121**	0.014	−0.400***
	(0.394)	(0.878)	(0.057)	(0.241)	(0.116)
Urbanization	−1.180***	0.763	0.031	−0.305	0.040***
	(0.145)	(0.803)	(0.021)	(0.301)	(0.015)
Inflation	0.449***	0.040**	−0.002	0.015	0.028***
	(0.055)	(0.018)	(0.008)	(0.010)	(0.007)
Access to electricity	−0.279*	0.013	−0.025	−0.008	−0.031*
	(0.160)	(0.174)	(0.023)	(0.075)	(0.018)
2009			Base year		
2010	0.818***	0.039			0.000
	(0.248)	(0.036)			(0.000)
2011	0.689***	0.030	−0.125***	−0.079**	−0.165***
	(0.212)	(0.042)	(0.033)	(0.031)	(0.021)
2012	0.260	−0.073	−0.132***	−0.110***	−0.193***
	(0.206)	(0.045)	(0.033)	(0.032)	(0.018)
2013	0.501**	−0.097*	−0.050	−0.059*	−0.091***
	(0.214)	(0.049)	(0.033)	(0.032)	(0.015)
2014	0.554***	−0.088*	−0.040	−0.046	−0.107***
	(0.214)	(0.049)	(0.032)	(0.033)	(0.018)
2015	0.735***	−0.072	−0.033	−0.026	−0.058***
	(0.222)	(0.054)	(0.033)	(0.034)	(0.012)
2016	0.991***	−0.046	−0.039	−0.024	−0.030
	(0.238)	(0.068)	(0.034)	(0.037)	(0.020)
2017	0.968***	−0.037	−0.029	−0.014	−0.043***
	(0.232)	(0.066)	(0.034)	(0.037)	(0.014)
2018	0.596***	−0.104	−0.091***	−0.071*	−0.125***
	(0.217)	(0.070)	(0.033)	(0.036)	(0.013)
2019	0.591***	−0.206***	−0.150***	−0.138***	−0.179***
	(0.215)	(0.075)	(0.032)	(0.037)	(0.014)
Constant	10.598***	−6.912**	0.600***	0.254	1.740***
	(1.591)	(3.411)	(0.229)	(1.422)	(0.455)
Observations	571	571	511	511	561
Post Analysis Test					
R-squared	0.639	0.151	0.994	0.631	
AR1	-	-	-	-	−2.743
AR1 *p*-value	-	-	-	-	0.0060
AR2	-	-	-	-	−1.662
AR2 *p*-value	-	-	-	-	0.0966
Sargan test	-	-	-	-	49.78
Hansen	-	-	-		36.94
Hansen *p*-value	-	-	-	-	0.120
J-stat	-	-	-	-	47
Wald-Chi2	-	-	-	-	385,206
Wald-Chi2 *p*-value	-	-	-	-	0
Number of Groups	64	64	64	64	64

*Note: Standard errors in parentheses, ***p < 0.01, **p < 0.05, *p < 0.1 *, ** and *** are represent 1%, 5% and 10%, respectively.*

that AR1 has a −2.743 value and a *p*-value of 0.00608, which show zero autocorrelation and serial correlation in the first-order difference because the AR1 has a *p*-value < 0.05. While AR2 has a −1.662 value and a *p*-value of 0.0966 in second-order difference, the null hypothesis is accepted because the AR2 has a *p*-value > 0.05. As per the Hansen–Sargan test, the over-

TABLE 8 | Results of the Granger Causality test.

Null hypothesis	Obs	F-Statistic	Prob
FD does not Granger Cause ECPC	576	0.40004	0.0705
ECPC does not Granger Cause FD		0.32132	0.0253
GI does not Granger Cause ECPC	576	1.14285	0.3196
ECPC does not Granger Cause GI		2.28775	0.1024
FDI does not Granger Cause ECPC	576	0.26287	0.7689
ECPC does not Granger Cause FDI		1.32688	0.2661
URBAN does not Granger Cause ECPC	576	0.63248	0.5316
ECPC does not Granger Cause URBAN		2.88067	0.0569
INF does not Granger Cause ECPC	448	0.36609	0.6936
ECPC does not Granger Cause INF		3.67824	0.0260
GI does not Granger Cause FD	576	1.42173	0.2421
FD does not Granger Cause GI		0.09403	0.9103
FDI does not Granger Cause FD	576	1.67052	0.1891
FD does not Granger Cause FDI		0.18769	0.8289
URBAN does not Granger Cause FD	576	1.89864	0.1507
FD does not Granger Cause URBAN		1.45167	0.2350
INF does not Granger Cause FD	448	3.04849	0.0484
FD does not Granger Cause INF		3.04360	0.0487
FDI does not Granger Cause GI	576	0.40154	0.6695
GI does not Granger Cause FDI		0.04649	0.9546
URBAN does not Granger Cause GI	576	0.56782	0.5671
GI does not Granger Cause URBAN		1.38245	0.2518
INF does not Granger Cause GI	448	1.56751	0.2097
GI does not Granger Cause INF		6.47769	0.0017
URBAN does not Granger Cause FDI	576	1.53957	0.2154
FDI does not Granger Cause URBAN		0.70221	0.4959
INF does not Granger Cause FDI	448	3.22314	0.0408
FDI does not Granger Cause INF		0.20852	0.8119
INF does not Granger Cause URBAN	448	1.38677	0.2510
URBAN does not Granger Cause INF		4.09799	0.0172

*NOTE: EC, FD, GI, FDI, URBAN, INF, represent energy consumption, financial development, globalization, foreign direct investment, urbanization, and inflation, respectively. NOTE: *, ** and *** are represent 1%, 5% and 10%, respectively.*

identifying restriction is valid with a value of 49.78. In contrast, the Hansen test gives a 36.94 value and a p-value of 0.120, which is between 0.10 and 0.25, supporting the instruments' reliability and avoiding the rejection the null hypothesis. The Wald-Chi2 test shows that sample variables are significant and the model is fit for use. Moreover, the number of instruments are less than the groups; therefore, the two-step sys-GMM method is the best-suited method. Outcomes are briefly listed in are given in **Table 7**.

4.4 Granger Causality Results

The causal relationship between the variables (EC, FD, GI, FDI, URBAN, and INF) are presented in **Table 8**, which has interesting findings. The results potray a bidirectional causal connection between FD and EC. The study also reveals a causal relationship between EC and URBAN as well as EC and INF in BRI countries. Similarly, a bidirectional causal relationship exists between INF and FD. Also reported is a unidirectional causal associations of GI to INF, INF to FDI, and URBAN to INF. The detailed Granger causality test results are shown in **Table 8** below.

4.5 Discussion of Results

This study investigates the impact of FD, FDI, globalization, and urbanization on the Belt and Road countries' ECPC. It particulary focuses on the long-term effect of these variables on energy consumption. The two-step sys-GMM was employed in this study as it considered the finest and advanced technique to examine the over-identifying restriction, endogeneity biases, auto-correlation, and omitted variables in the panel dataset. Moreover, the two-step sys-GMM is appropriate for controlling the measurement errors in the analysis. In light of our first hypothesis, FD significantly and positively contributed to ECPC at a significance level of 1%, which is supported by Sadraoui et al. (2019) and Mukhtarov et al. (2020) leading to the acceptance of the alternate hypothesis. Apart from that, foreign direct investment also contributed positively to energy consumption, but insignificantly; this is consistent with Mohamed and Mamat (2016) and Salim et al. (2017), which led to the rejection of our hypothesis as FDI is insignificant.

Further, globalization show a significant negative influence on ECPC with a significance level of 1%, which leads to the acceptance of our third hypothesis, and this is consistent with the findings of Saud et al. (2018) and Shahbaz et al. (2021), which suggest that globalization improves energy efficiency facilitating the import of new technology. Urbanization contributes positively and significantly to ECPC at a 1% significance level. Therefore, our fourth hypothesis was accepted, and is supported by Sheng and Guo (2018) and Yang et al. (2019), who conclude that urbanization raises energy demand therefore Governments should be efficient by following the demand and supply approch. In addition, referring to control variables, inflation also contributes positively and significantly to ECPC at a significance level of 1%, while access to electricity negatively influences ECPC at a significance level of 10%. The study also used the approach of Granger causality to examine the causal connection between the variables. Findings demonstrate that FD and ECPC have a bidirectional relationship.

5 CONCLUSION, POLICY IMPLICATIONS, AND FUTURE RECOMMENDATIONS

Energy consumption is an important policy issue in the 64 BRI countries, and China may provide help in resolving this issue. This research explores the impact of financial development, globalization, foreign direct investment, urbanization, inflation, and access to electricity on energy consumption in 64 BRI partner nations by utilizing data from 2009 to 2019. The results of unit root test indicate that all variables are stationary at the level or first difference, which shows the stationarity of the data. The study employed the two-step sys-GMM to address the issues of endogeneity in the panel data. The study's findings are diverse as financial development has a positive correlation with energy consumption, suggesting that an increase in investment in different economic projects leads to a rise in the demand for energy. However, in BRI countries, foreign direct investment is positively correlated to energy consumption, although insignificantly.

Similarly, globalization, another crucial determinant of the study, decreases the demand for energy. The global connection between the countries helps investors make investments in other countries and helps the developing countries import energy-efficient technology from developed countries, which decreases the energy demand. Moreover, urbanization, another vital factor affecting energy demand, positively impacts energy consumption. This confirmed that urbanization, involving the migration of people from rural areas to urban areas for better facilities, raises the energy demand. Moreover, we also establish the cause-and-effect relationship between the variables. The findings show that FD and EN and INF and FD have a bi-directional relationship.

Based on the findings of the study, we recommend the following policies:

- The BRI partner developing countries need to increase energy production capacity, enhanced the overall efficiency, outsource green energy infrastructure, implement green energy conservation to achieve the sustainable economy's and green growth.
- Findings indicate that financial development has a negative impact on for energy consumption per capita in BRI nations. Therefore, financial institutions must offer low-interestloans to green energy or energy essentials. Financial institutions should deliver low-interest rate loans to promote green energy or energy essentials for sustainable energy-efficient projects. Besides that, financial institutions must impose lesser financing restrictions on investors who are willing to invest in renewable and clean projects—further increasing investment in technology-related research and development, leading to an increase in the energy production capacity and green energy efficiency.
- Governments should encourage foreign investment in cheap and sustainable clean-energy projects. It helps a country fulfill its demand and decrease electricity prices, which can directly impacts the living standards of an ordinary person and sustainable development of a country.
- The negative effect of globalization on energy consumption indicates that BRI countries should need to continue following the current policies related to global cooperation, as it helps improve trade and investment in the host nation and reduces energy consumption. Moreover, trade with global countries is a step towards improving energy efficiency and boosting the economy. Furthermore, globalization is helpful for governments and financial institutions in importing technology. Giving loans' to private investors brings financial development to the economy. Therefore, financial development and globalization create a win-win situation for countries' long-run economic growth along with efficient energy use.
- Urbanization plays a decisive part in increasing the energy demand in BRI partner nations. To curb the rise of urbanization, governments should take preventative efforts to ensure that local residents have the resources they need to thrive. Launching green-housing projects in remote areas could be an essential step to mitigating urbanization.
- Lastly, creating awareness at urban centrrs regarding the use of energy-efficient equipment at home or office.
- On a governmental level, all countries should issue green and blue bonds so that funds they raise through it should be spent on environmentally friendly projects.
- New projects are crucial to meet the demand for energy; however, it is vital to encourage the BRI countries to switch toward green energy or renewable energy, which is preferable in terms of cost and environment impact.

This research is limited to the BRI partner countries' sample based on annual panel datasets of 64 countries from 2009 to 2019. In light of the findings, we also recommend some future directions: our study sample is from 64 BRI countries that are developing; therefore, the study's border overview sample should be extended globally. We can also change the alternative proxies for urbanization as total population and globalization as regional integration. We can also use the energy efficiency proxy instead of energy per capita. We can further examine the non-linear relationship rather than linear. Lastly, the nexus of natural resources, energy efficiency and sustainable development can be untapped with the multi-dimensional regional integration and institutional quality factors.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author.

AUTHOR CONTRIBUTIONS

Conceptualization, AU; methodology, AU and MS; software, AU; validation, ZK and CP; formal analysis, AU and MS; investigation, AU; re-sources, CP and ZK; data curation, AU; writing—original draft preparation, AU and MS; writing—review and editing, MS and ZK; visualization, CP; supervision, CP; project administration, CP; funding acquisition, CP and ZK. All authors have read and agreed to the published version of the manuscript.

FUNDING

This work supported by HUST, Wuhan and ILMA University, Karachi.

ACKNOWLEDGMENTS

We are very grateful to the editor's, reviewers and Dr. Saif Ullah for their helpful comments and suggestions which improved the draft.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fenvs.2022.937834/full#supplementary-material

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