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SECURE Energy Performance in Shanghai  
Cooperation Organization**

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## Financial Inclusion and Modernization: SECURE Energy Performance in Shanghai Cooperation Organization

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**Abstract:** *The present work investigates the relationship among financial inclusion, modernization, and energy performance in SCO member countries during the years 2011–2021. PCA is used to create composite indexes of financial inclusion, modernization, and energy performance. We used panel regression models that are both reliable and heteroscedasticity-consistent to look at the relationship among variables. The findings indicate that financial inclusion (FI) and modernization along with the increased FDI all appear to contribute to the energy performance in the SCO member countries. However, per capita GDP has a negative impact on energy performance. These results are unbiased and consistent with the robust results obtained by applying different econometric models. Feasible Generalized Least Square estimation (FGLS) is also used to check the uniformity of the main model results. This research work concludes that there has been no policy coherence in SCO member countries regarding the coordination of growing financial inclusion and modernization for energy sustainability in recent years. In order to improve energy performance with modern development, policies regarding financial inclusion and modernization should be integrated at the national and international levels.*

**Keywords:** Financial inclusion, energy performance, modernization, technological development, SCO.

## Introduction

The Global Goals of the United Nations aim to guarantee that reliable, affordable, and efficient energy has to be accessible to everyone (SDG-7). Climate change addresses the problem of decarbonization, which causes environmental and economic challenges. For the environment to be sustained globally, increasing economic activity and reducing carbon dioxide emissions are complementary goals (Amin, Song, & Khan, 2022). However, financial inclusion is an emerging factor in maintaining sustainability with regard to renewable energy technologies and purchasing products that save energy to improve energy performance. Furthermore, encouraging financial inclusion is essential for the sustained growth of renewable energy performance, as it enables the production of commodities that are both technologically modern and energy-efficient (Chang, Iqbal, & Chen, 2023). Around

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the world, financial inclusion is considered a key measure of societal growth and well-being. In many nations, offering inclusive financial services—that is, financial services that are affordable for everyone, both families and the business community—has taken the place of a fundamental objective. The G-20 nations have placed a strong emphasis on United Nations SDGs, such as clean energy and that can be achieved through financial inclusion (Koomson & Danquah, 2021). A stable financial system enables more innovation and mass production, which benefits affordable green energy and a healthy environment.

According to Fu, Huang, Xu, and Zhang (2023) modernization is the broad trend of advancement within a socioeconomic system and human civilizations. It includes a variety of advancements, including higher living standards and higher industrial, environmental, and technical norms. Estimating the dynamic impact of modernization on environmental stability with respect to energy performance is crucial. Additionally, according to Ozturk and Ullah (2022) the relationship between modernization, environmental sustainability, and financial inclusion may not be linear.

Modernization and Financial inclusiveness, as advanced strategies, can improve economic growth and environmental sustainability (Rehman, Malik, Md Isa, & Jais, 2023; Saqib, 2022). The anticipated effect of FI, modernization on energy performance, however, has given rise to certain concerns. Logically, spending can be increased by businesses and individuals when financial and socio economic services accessibility and availability increases and, as a result, CO2 emissions, which can be decreased by encouraging renewable energy resources and energy-saving products.

Numerous studies like Chang et al. (2023) have looked at how financial inclusion affects current energy production and consumption activity, and in order to enhance the average level of energy access among energy consumers and improve energy performance across all E7 economies, they have underlined the necessity to maximize financial resource distribution. One aspect of the economic interactions among SCO members is energy cooperation. like China, India, Pakistan, and Russia. Since 2016, when the "SCO SECURE" Act was created, financial inclusion has developed from financial sources as a result of the merging of fund availability and effective combining of financial resources (SCO report, 2022). The development of inclusive finance has been aided by superior plans for financial inclusion and expert assistance. When energy-producing firms and financial inclusion are integrated, the advantages of shared prosperity are also created in financial inclusion. China's attempts to improve its energy performance are studied and noticed all over the world because it is the most populous nation in the world and has almost 1.3 billion residents (World Bank, 2017). These people struggle with energy poverty in remote places where there are few financial resources and poor earnings. Financial inclusion an important component of economic growth, helps in energy poverty reduction and maximized the energy performance in China by the year 2020. Financial inclusion and its importance for energy sector has been recently studied by Liu, Zhang, Hafeez, and Ullah (2022).

From an empirical perspective, numerous policy decisions have been adopted for energy policy to maximize renewable energy resources and technological advancement. From the perspectives of financial inclusion, modernization, and energy performance, the following factors are of significant importance:(1) financial inclusion expansion (2) im-

provement in current modernization standards; (3) investigate the role of financial inclusion and modernization on energy performance. The first two options rely on increasing and fostering modernization and financial inclusion. With regard to the third scenario, a number of practical studies have shown that financial development may significantly contribute to increasing energy resources by encouraging technological advancement in the financial industry (Liu et al., 2022).

Most of the existing literature used a single indicator of financial inclusion to check its impact on a single indicator of energy performance (Ozturk & Ullah, 2022). Only a few of the studies used multiple factor analysis to check their impact on environmental sustainability (Le, Le, & Taghizadeh-Hesary, 2020). To the best of our knowledge, no research has examined this study topic in a wide framework and investigated the dynamic relationships among financial inclusion, modernization, and energy performance in the available empirical literature.

By examining the relationship between financial inclusion, modernization, and energy sustainability performance and determining their movements by applying control variables like Foreign direct investment and per capita GDP using ARDL panel estimators (ARDL stands for Auto-regressor distributed lag), Additionally, this study included the SCO nations, which are far more important from a research perspective because their primary motive is to exchange energy cooperation.

Regardless of the importance of SCO countries, these economies' energy challenges are of great concern. Research on these economies is essential because they are growing. According to Gyamfi, Adedoyin, Bein, and Bekun (2021) the majority of them are middle-class economies. According to the World Bank (2017), middle-income economies are the main contributors to the growth of energy poverty. The two largest and highest-emitting economies in the E7 are China and India (World Bank, 2020). Central Asian countries have huge reserves of oil and gas. After the "SECURE" acts of SCO countries, the importance of energy cooperation increases (SCO Report, 2016). On the basis of these arguments, it may be claimed that these nations still need to concentrate on economic and energy policies to achieve complementary.

## Literature Review

### Financial Inclusion and Energy Performance

Financial inclusion has been of considerable importance and a center of research for many scholars over the last decade. Having access to a bank account with a financial institution that is properly regulated is seen as one of the first steps toward financial inclusion, which has taken center stage in economic development plans and emerged as a significant policy objective on the global development spectrum (Demirgüç-Kunt, Klapper, Singer, Ansar, & Hess, 2020). According to Dev (2006) financial inclusion is essential to achieving the United Nations' goals for sustainable development. Financial inclusivity has been discussed by many researchers in numerous ways, but there is still no such consensus in this regard as Pahlevan Sharif, Naghavi, Waheed, and Ehigiamusoe (2022) stated that fi-

financial inclusion is a formal financial services usage to benefit individuals. According to [Antonijevic, Ljumovic, and Ivanovic \(2022\)](#), Financial inclusion is essential for poverty alleviation because it provides saving, investment and credit facility to vulnerable group at low cost. Financial inclusion reduces income inequality ([Demir, Pesqué-Cela, Altunbas, & Murinde, 2022](#)). They claimed that the proportion of people and companies who utilize financial services is known as financial inclusion.

[Kabakova and Plaksenkov \(2018\)](#) have looked at the political, socio-demographic, and economic elements that are thought to be important in promoting financial inclusivity in emerging nations. According to the studies, 83 countries with regulations requiring banks to participate in a variety of financial activities have more inclusive financial systems and have more credit financing products which help people to get loans. From policy prospective, Financial inclusion is prioritized in various Asian nations ([Ozili, 2023](#)). Levels of financial inclusion in China is quite high because of formal accounts and formal saving. According to [Bagli and Dutta \(2012\)](#), social banking initiatives in India have been essential in fostering financial inclusion across various regions. [Ahmad, Majeed, Khan, Sohaib, and Shehzad \(2021\)](#); [Li et al. \(2021\)](#), who conducted a more recent study, clarified the relevance of financial inclusion and stated that FI promotes economic growth and development ([Arif, Kazmi, & Khan, 2017](#)). Financial inclusion has a greater impact on low-income EU (European Union) nations than on high-income nations, according to the authors. These studies show that financial inclusion is a vital component of every economy. De-carbonization is viewed as an important strategic initiative to solve energy and economic difficulties because of climate change ([Rehman et al., 2023](#)). Reducing carbon emissions and boosting economic growth are two objectives that must be met in order to pursue low-carbon approaches. Because of this, evaluating low-carbon performance is viewed as a useful tool from a policy-making perspective. Other metrics were utilized by [Zhang, Peng, Liu, and Tan \(2015\)](#) assess the success of low carbon in Chinese provinces. Additionally, an integrated viewpoint is included in other research by [Hao, Liu, Lu, Huang, and Zhao \(2018\)](#) for quantifying low-carbon entities.

In this regard, [Amankwah-Amoah, Khan, and Osabutey \(2021\)](#) have argued that many industries during COVID -19 pandemic, especially the Airlines industries have abandoned their energy sustainability commitments in favor of focusing on overcoming pandemic obstacles such cost cuts, survival considerations and stopped given priority to energy sustainability initiatives. Energy-related issues like global warming and carbon emissions have a negative impact on the China, Indian, and Russian economies as well ([Gyamfi et al., 2021](#)). Consequently, it is relevant to assess how financial inclusion and energy performance are related in SCO member countries. The change in the global economy in SCO countries makes the importance of these economies clear. Despite their importance, these economies have faced serious risks from energy issues and climate change as a result of their high levels of energy consumption and performance. China leads SCO in terms of carbon emissions in 2020, with a total of about 9893 million tons (World Bank, 2020), and has shown an upward trend since 1981 (Statistical, 2021).

According to [Wang, Sun, and Iqbal \(2022\)](#), financial growth has increased the volatility of the energy performance index in the emerging economies nations. [Shoaib, Rafique, Nadeem, and Huang \(2020\)](#) comparing emerging and developed nations' energy implica-

tions of financial development and concluded that financial development decreases levels of energy performance. The influence of energy is still more problematic in industrialized countries. We contend, based on prior research, that the performance of energy sustainability may be significantly influenced by financial inclusion, so the study hypothesized that:

*H1: Financial Inclusion has a significant relationship with energy performance.*

## **Modernization and Energy Performance**

The IPAT theory states that it is not just the population but also other three factors, like affluence, consumption, and technology, that contribute to the environmental impacts. According to [Li et al. \(2021\)](#), economic growth and development are thought to contribute more to carbon emissions. According to a recent study by [Ehigiamusoe, Lean, and Smyth \(2020\)](#), economic expansion encourages CO<sub>2</sub> emissions and vice versa. ([Hao et al., 2018](#)) also discovered a bidirectional causal relationship between modernization and energy sustainability. [Li et al. \(2021\)](#) determined that technological innovation is a significant component in explaining environmental sustainability, considering China as a rising economic power. According to an applied study conducted in Malaysia ([Pui & Othman, 2019](#)) and GCC nations ([Al-Saidi & Elagib, 2018](#)), industrialization and energy usage are the main causes of environmental deterioration.

Urbanization and innovation have been shown to positively correlate with environmental sustainability in existing empirical research on various nations ([Ehigiamusoe et al., 2020](#)), but some studies have revealed an inverted U-shaped link between innovation and CO<sub>2</sub> emissions ([Al-Saidi & Elagib, 2018](#)). Innovation was discovered to have a twofold influence on environmental sustainability in the context of developing nations. From an empirical perspective, the study hypothesized that:

*H2: Modernization and energy performance have a significant relationship.*

## **Research Methodology**

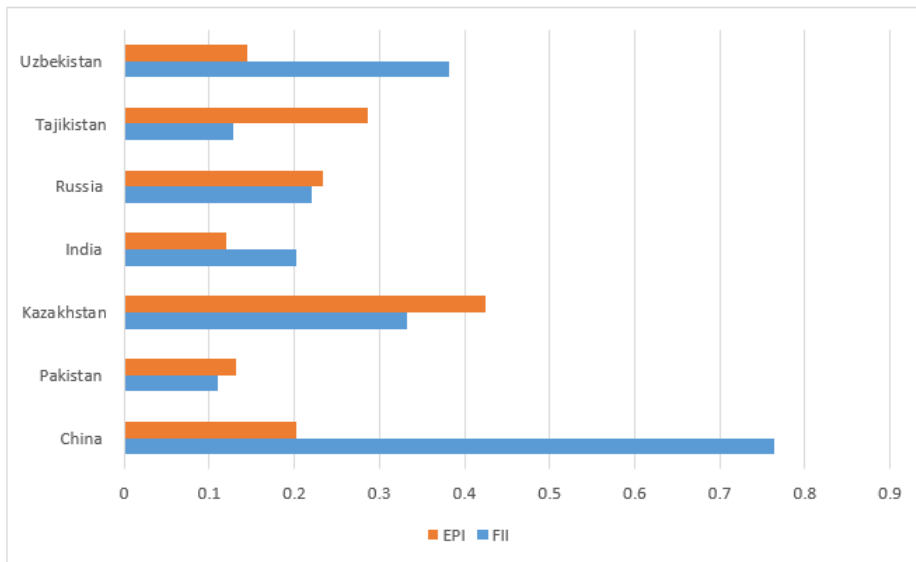
### **Data Structure**

The main purpose of the study is to check the linkage between FII, modernization Index and energy performance index. Performance indicators are important in order to check the effectiveness of energy performance index so these indicators should be taken into account. The study used the proxies index of financial inclusion same as ([Ashraf & Goodell, 2022](#)), the modernization proxies index ([Amin et al., 2022](#)), and energy performance proxies index ([Chang et al., 2023](#)). FDI and PCGDP are used as control variables in this study. Description of the indicators along with their data sources is shown in Table 1. Data collected from 2011 to 2021 of SCO countries from the world bank database.

## Importance of taking SCO Countries

Regardless of the importance of SCO countries, these economies' energy challenges are of great concern. Research on these economies is essential because they are growing. According to [Gyamfi et al. \(2021\)](#) the majority of them are middle-class economies. According to the World Bank (2017), middle-income economies are the main contributors to the growth of energy poverty. China and India are the two largest and highest-emitting economies in the E7 (World Bank, 2020). Central Asian countries have huge reserves of oil and gas. After the "SECURE" acts of SCO countries, the importance of energy cooperation increases (SCO Report, 2016). On the basis of these arguments, it may be claimed that these nations still need to concentrate on economic and energy policies to achieve complementarity. Fig. 1 shows the average values of the FI index and the energy performance index for the period 2011–2021. This shows the co-movement of FII and EPI across SCO member countries. China, as a rising economic power, focuses mainly on financial inclusion implications.

**Figure 1**  
Average of FII and EPI across SCO countries from the selected period



## Panel Data Model

The main idea behind the study is to examine the relationship between financial inclusion, modernization, and energy performance in the context of emerging economies. The study used the following panel data model based on these studies ([Amin et al., 2022](#); [Chang et](#)

al., 2023). The specific model is given below.

$$EPI_{it} = \alpha + \beta_1 FII_{it} + \beta_2 MOD_{it} + \beta_3 FDI_{it} + \beta_4 PCGDP_{it} + \epsilon_{it} \quad (1)$$

Where the dependent variable, EPI is energy performance composite index, and the independent variable FII financial inclusion composite index, MOD modernization composite index, FDI foreign direct investment, and PCGDP stands for per capita GDP, respectively. The panel data is collected from WDI database covering the period 2011 to 2021.

To analyze and determine the relationship among financial inclusion, modernization, and energy performance in emerging economies, this study used a baseline model of ARDL panel data estimations, to test the robustness, GMM, and FGLS is used. By using panel unit root test to diagnose the first- and second-order serial correlation, several assumptions about the error process, including unit root test and serial correlation, were checked. The ARDL model is given below.

$$EPI_{it} = \sum_{j=1}^p \lambda EPI(I - J) + \sum_{j=1}^q YXi, (t - 1) + \mu_{it} + \epsilon_{it}$$

where  $Xi,(t-1)$  represent the vector of independent variables and  $\mu_{it}$  is fixed effect. The ARDL model is most suitable to overcome the problem of collinearity because it includes lags of both dependent and independent variables. It describes the nexus among the economic variables in a single equation time series setup.

## Results and Analysis

### Baseline Result

PCA is used to make a composite financial inclusion index, modernization index and energy performance index. Per capita GDP and FDI both are used as control variables. Panel Data of SCO countries is strongly balanced. Table 2 shows VIF value, which is less than 10 this shows that there is no multicollinearity issue in our data.

**Table 2**  
Variance inflation factor

Variable	VIF	1/VIF
FII	1.44	0.695353
PCGDP	1.30	0.766949
MODERN	1.11	0.904027
FDI	1.09	0.920913
Mean VIF	1.23	

Table 3 displays the correlations between the study's variables. All independent variables like FII, modernization, FDI, have significant relationships. However, the relationship between, PCGDP is averse to Energy Performance Index.

**Table 3**  
Correlation matrix

	EPI	MODERN	FII	PCGDP	FDI
EPI	1				
MODERN	0.579	1			
FII	0.058	0.247	1		
PCGDP	-0.255	0.131	-0.473	1	
FDI	0.250	-0.137	0.182	0.005	1

## Result of Main Model

Table 4 shows ARDL approach results, this technique is used to describe both the long-run and short-run relationship, and is used for series at different levels of stationary. Hausman test value is insignificant so we run pmg ARDL estimation. Energy performance index, FDI, and PCGDP are stationary at lag level 1, while FII and Modernization become stationary at lag level 2. Results show that in the long run, all policy and control variables have an impact on the energy performance index whereas in the short run, financial inclusion and modernization both have an impact on energy performance index. Our study's findings demonstrated the importance of ecologically intensive modernization. It alludes to several societal customs that incorporate energy issues along with economic development.

**Table 4**  
Results of ARDL

VARIABLES	-1 ECT	(2) SR
ECT		-1.823***
D.MODERN		-0.195
		0.028*
		-0.064
D.FII		0.023**
		-0.039
D.PCGDP		-0.003
		-0.804
D.FDI		0.028
		-0.028
MODERN	0.008**	
	-0.0152	
FII	0.011***	
	-0.004	
PCGDP	-0.013***	
	-0.002	
FDI	0.016**	
	-0.006	
Constant		0.143
		-1.258
Selected model ARDL	(1,1,1,1,1)	
Prob >chi2 =	1.000	

## Robustness Check

There is no serial correlation among the variables, as AR (1) and AR (2) are insignificant. To check robustness, the GMM technique is used. The Sargan test and Hensen test results are insignificant, which shows the validity and reliability of the data. There is no heteroscedasticity issue in the data. GMM results are consistent with the baseline results which is shown in Table 5, GMM technique is the most effective method to address the problem of endogeneity which normally occurs when the independent variable correlates the error term. The results show that FII, Modernization, FDI, and per capita GDP have a significant impact on energy performance across SCO economies.

**Table 5**  
GMM Results

VARIABLES	-1 EPI
Modern	0.0147* -0.0834
FII	0.030** -0.049
PCGDP	-0.0107* -0.00487
FDI	0.0186** -0.00674
AR(1)	0.140
AR(2)	0.230
Sargan	0.274
Hensen	0.244

Removing serial correlation, heteroscedasticity, and cross-sectional dependency from panel data. In order to cross-check the consistency of the main model results and to control the serial correlation, heteroscedasticity, and cross-sectional dependency from the panel data, we use feasible generalized least squares estimation (Hoechle, 2007). FGLS produces efficient estimations when the data set consists of a large time period as compared to cross-sectional numbers. The FGLS regression model is structured as follows:

**Table 6**  
Least Square Regression

VARIABLES	(4) EPI
MODERN	0.239*** -0.0801
FII	0.427*** -0.0745
PCGDP	-0.072*** -0.0115
FDI	0.013*** -0.0026
Constant	-0.260** -0.113
Observations	77
Number of cid	7

FGLS by default controls the cross-sectional dependency from the panel data. Results show that the modernization index, financial inclusion index, per capita GDP, and foreign direct investment have an impact on the energy performance index.

## **Discussion and Findings**

FII and modernization index have a significant relationship with the proxies of energy performance according to empirical results. All the control and policy variables like FII, Modernization index, FDI, and per capita GDP have a significant impact on energy performance. These findings are in line with (Amin et al., 2022). Moreover, GDP growth negatively assumes energy sustainability because many of the member countries' primary objectives are not to improve energy quality across the region. Foreign direct investment has a positive relationship with energy performance because of the increased demand and supply of Asian products and the industrialization and urbanization advancements in these countries. Most SCO countries like India and Pakistan have new industries of electricity and transportation and they have increased energy demands for them. According to the world bank energy report (2020), Energy consumption in Asia is expected to increase up to 70% till 2040. Financial inclusion and modernization as one of the most important variables in our data set. The empirical findings show that financial inclusion seems to have led to higher energy performance in SCO countries. With increased access to financial institutions and financial products, people in the SCO region increase their use of energy products. Similarly, modern industries have a high demand for energy products as compared to traditional industries. Manufacturing industries have higher energy consumption relative to agriculture and handicraft industries. Energy consumption is relatively higher in the manufacturing of goods and services thus results in Industrial modernization.

According to the study results, the importance of ecologically intensive modernization increases. It refers to many social actions that reorganize contemporary economic institutions along pro-environmental lines and integrate environmental concerns with economic development.

## **Conclusion and Recommendations**

The present work attempts to single out the effect of FII, modernization index on energy performance indicators in relation to SCO member countries. According to the findings, the independent and control variables like (Financial inclusion Index, Modernization index, FDI and per capita GDP) appear to have contributed to a rise in energy performance during the empirical examination of the period 2011-2021 in emerging economies in the long run. Financial inclusion is viewed in SCO countries as a means of enhancing the lives and economic activities of underprivileged households. Financial inclusion, as an emerging factor is an important component of economic growth and useful for achieving SDGs, reducing poverty by elevating the small and medium sized business.

Sustainable Development goals of the United Nations are achievable by creating a

comprehensive policy framework which can be based on the study's findings, and this framework can serve as a model for other regions and nations that are also struggling with clean energy-related sustainable development issues. In SCO member countries, Governments should support Infrastructure projects for zero-emission energy, if countries seek to develop renewable energy sources as India and China have, they may attract foreign direct investment. It would be beneficial to research and develop some of the newest waste minimization methods. Policymakers should focus on boosting energy resilience in the face of severe weather and natural disasters in order to advance energy fairness.

The major study limitation is the unavailability of data regarding energy risk factors and oil and gas reserves and regulations of the countries. Future researchers can use other financial inclusion indicators and energy performance indicators and can check the role of energy resources in financial inclusion. This research can be conducted across globe and other regions facing energy crisis like SAARC, ASEAN, and Sub-Sahara African countries.

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