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Impact of a sharing economy on sustainable development and energy efficiency: Evidence from the top ten Asian economies

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ABSTRACT

Changes over the last few decades around the globe highlight concepts such as sustainable economic development (SED). Globalization has accelerated the competition between firms and they require sustainable development (SD) in order to survive in such a competitive environment. In this scenario, SED and energy efficiency can be achieved through an effective sharing economy. This phenomenon has received wide global attention and is the focus of many recent studies. This article investigates the impact of a sharing economy, including the sharing economy users and sharing economy values, on energy efficiency and SED in the top ten Asian economies. It takes inflation, employment rate and population growth as control variables. The study extracts secondary data from the Statista and World Development Indicators (WDI) databases from 2006 to 2020 and uses the method of moments quantile regression (MMQR) to examine the nexus between these constructs. The results reveal that sharing economy users, sharing economy values, inflation, employment rate and population growth have a positive association with energy efficiency and SED in the top ten Asian economies. This serves as a guide for policymakers establishing relevant policies related to the achievement of SED and energy efficiency using a sharing economy.

Introduction

Changes over the last few decades around the globe highlight concepts including sustainable economic development (SED). Globalization has accelerated the competition between firms, and they require sustainable development (SD) in order to survive in such a competitive environment. The term sustainable development was first introduced in 1987 to describe development which satisfies present needs without compromising future generations' ability to meet their own needs (Chien et al., 2021a; Li, Li & Guo, 2020; Zhao et al., 2021; Zygmunt, 2020). Sustainable economic development is economic development that attempts to fulfil human needs in a manner which protects natural resources and the environment for future generations. It refers to economic function within the ecosystem, which can never be separated from the economy. Land, natural resources, labour and capital, all part of the environment, feed economic growth. In this regard, sustainable economic growth involves managing resources in such a way that they are not depleted and are accessible to future generations. Significant economic development in the Asia-Pacific region has revolutionized its socioeconomic environment, bringing a billion people out of extreme poverty over the last two decades and boosting the living standards of millions of others (Cheng, Mou & Yan, 2021; Lisha & Abdullah, 2021; Štreimikienė & Ahmed, 2021). However, this expansion has been accompanied by increasing wealth and opportunity inequality, and is beginning to violate planetary boundaries and threaten the well-being of future generations. If the current scenario continues, the Asia-Pacific region will not be able to fulfil any of the 17 United Nations Sustainable Development Goals by 2030. The region has an abundance of natural resources and skilled labour, and thus the concept of the sharing economy could lead to greater parity in the region. There is a need to investigate the Asia-Pacific region as its economic stability is accelerating at a rapid pace. The sustainability of any country or region can be seen in its GDP growth. The GDP of emerging Asian economies, shown in Fig. 1, reflects the region's prominent economic growth. Better use of resources in terms of a sharing economy as well as economic efficiency can lead to the betterment of the region.

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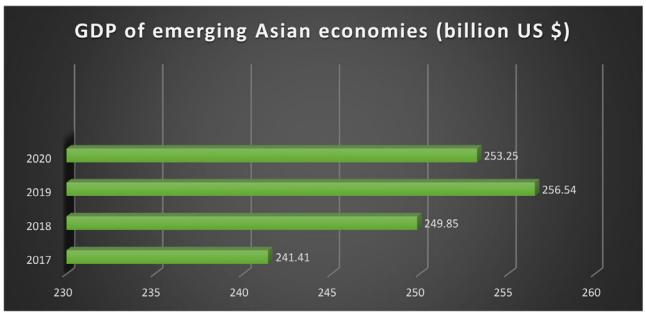

Fig. 1. GDP of emerging Asian economies

The sharing economy is another focus of world attention, as it relates to the economy and sustainability. It is commonly framed as: 1) an economic opportunity; 2) a better and more sustainable form of consumption; and 3) a pathway to an equality-based and sustainable economy. There is a lack of a clear definition of the sharing economy in the literature, but with the passage of time, many authors put a spotlight on the topic, transforming it into an umbrella term for the organizational model (Chien et al., 2022; Kuhzady, Olya, Farmaki & Ertaş, 2021; Miller, Ward, Lee, D'Ambrosio & Coughlin, 2020; Sharma, 2020). A sharing economy is defined as an economic system in which a firm's assets or services are shared among internal and external stakeholders with the intention of facilitating collaboration. It is commonly based on three pillars: 1) an accessible economy, with collaborative efforts to maximize the utilization of underused assets (material resources or talents); 2) a platform economy, with intermediation of decentralized peer-to-peer trades via digital platforms; and 3) a community-based economy, with coordination via non-contractual, non-hierarchical and non-monetized contacts (Al Mamun, Muniady & Nasir, 2021; Miller et al., 2020; Rojek-Adamek, 2021). Sharing economies facilitate the use of resources within communities without the need to consume or purchase each time. The ability to share assets allows them to be used only when necessary. This type of consumption implies that property is less essential and not everyone who wants to consume has to own every asset; hence, production might be lower than it would be without sharing. The reduced output undoubtedly has a good influence on sustainability. The sharing economy has grown in popularity in recent years as a new business model that can shift consumer connection away from a materialistic lifestyle, and it is predicted to develop at 25% per year (Kuhzady et al., 2021; Richterová, Richter & Sojková, 2021). It is one of the promising sustainable development tools which supports the community, contributing to the economy as a whole.

The world has become a global village through globalization, enhancing business. One reason for increased production is high demand due to the rapid increase in population. A common factor to both developed and developing countries is energy usage. Previous literature proposes that there is a direct relationship between energy and economic development (Aceleanu, Şerban, Pociovălişteanu & Dimian, 2017; Chien et al., 2021b; Piligrimienė et al., 2021). It is reported that energy usage has been increasing at a rapid pace throughout the Asia-Pacific region, from 241.41 oxyjoules in 2017, to 249.85 in 2018, and 256.54 in 2019. Such a rapid increase is alarming for the region and direly necessitates a more efficient use of energy to support the economy. This is supported by past literature that suggests a direct relationship between energy efficiency and economic development (Khan et al., 2022; Liu, Huang & Zhou, 2019; Nurwani et al., 2020).

The present study addresses several gaps in the literature: 1) offering an important nexus between sharing economy, energy and sustainable economic development from the Asian perspective, which has scarcely been investigated; 2) while Ainou, Ali & Sadiq (2022) and Govindan, Shankar & Kannan (2020) investigate whether sustainable development goal achievement is affected by a sharing economy, the present study adds energy efficiency as a variable in light of its accelerating importance in the Asia-Pacific region where the consumption of energy is extremely high; 3) while Hu, Liu, Yuen, Lim & Hu (2019) investigate whether energy and sharing economies affect sustainable supply chain management, the present study looks at the effects of a sharing economy on energy efficiency and sustainable economic development in top Asian economies; 4) while Lyaskovskaya & Khudyakova (2021) investigate whether a sharing economy is favourable for sustainable development, the present study determines whether a dual effect such as a sharing economy affects energy efficiency and sustainable economic development achievement in Asia using an updated data set; 5) the model used in this study consists of sharing economy users, sharing economy values, inflation, population growth, employment rate, energy use and sustainable economic development, which have never been tested in top Asian economies, using a new data set; 6) while Ucal & Xydis (2020) look at the connection between SD and energy, the present study adds the sharing economy factor and uses the latest data; and 7) while Khan et al. (2022) investigate the effect of renewable energy on sustainable development growth, the present study determines whether a sharing economy affects both renewable energy and sustainable development growth in top Asian economies.

The study contributes in the following ways: 1) it highlights the significance of a sharing economy for energy efficiency and achieving sustainable economic development particularly in Asian economies; 2) it helps relevant stakeholders revamp their policies for the betterment of sharing economies in order to support energy efficiency and SED in top Asian economies; and 3) it offers valuable insights into the sharing economy, energy efficiency and sustainable economic development.

This research is divided into five sections. It begins with an introduction followed by a review of past literature, discussing the existing evidence on sharing economy users, sharing economy values, inflation, population growth, employment rate, energy use and sustainable economic development. The third section explains the methodology and the collection of data on sharing economy users, sharing economy values, inflation, population growth, employment rate, energy usage and sustainable economic development, along with an analysis of its validity. In the fourth section a comparison is made between the current findings and past studies, followed by the final section that concludes the paper by discussing the research implications and offering future recommendations.

Literature review

Energy efficiency and sustainable economic development are major concerns for the whole world. There are potential implications and quantitative approaches to a sharing economy that are used for energy efficiency and sustainable economic development. Cheng et al. (2021) and Méndez-Picazo, Galindo-Martín & Castaño-Martínez (2021) discuss the regulatory, privacy and trust issues of a sharing economy that prompt changes in efficient energy use. It is important for energy efficiency to be properly managed to achieve the best benefits of sustainable economic development. Top Asian countries such as Thailand, Saudi Arabia, Taiwan, South Korea, Indonesia, Japan, Turkey, India and China emphasize energy efficiency. Gyimóthy, Pérez, Meged & Wilson (2020) and Huang, Chien & Sadiq (2021c) look at the spaces within a sharing economy in which users and platforms disrupt and trigger transformation of governance and energy use. Excessive energy use is harmful to the environment and human life, impacting traditional business activities. The high dependency of economic systems on the environment is linked to energy efficiency and responds to market demand. Griffiths, Perera & Albinsson (2019) and Huang, Sadiq & Chien (2021a) report a positive relationship

between the negative externalities and contrived surpluses of sharing economies that helps in efficient energy use. Moreover, there is a possible disruption of market demand after inappropriate use of energy, which affects the consumption of natural resources. Apart from the disruption of natural resources, economic instability also increases due to a lack of emphasis on energy efficiency. Thus, it is important to have energy efficiently, as lower energy use can generate better outcomes for economic development. Huang, Sadiq & Chien (2021b) and Kutan, Paramati, Ummalla & Zakari (2018) investigate energy financing projects in emerging economic markets with sustainable development, and show that deterioration of the environment leads to higher prices of resources which affects sustainable economic development. These higher resource prices are due to the misuse of energy that not only damages the environmental system but also economic growth. A number of innovative methods adopted by top Asian countries support the technological implementation of effective energy use, especially in Asian countries. Such innovative technology has considerably changed the association between degradation of the environment and sustainable economic development.

The world is taking several steps towards the sustainability and maintainability of economic development with the help of sharing economy users. There are several users in the economy who benefit from the ability and opportunity to strengthen economic development. A sharing economy thus provides a wide range of opportunities for these users to sustain their businesses in the competitive environment. Key (2017) and Mahmood et al. (2021) analyse the domains and channels of digital marketing in a sharing economy that contribute significantly to sustainable economic development. Through sustainability of economic development, there is information and numerous choices available to users in most Asian countries. Thus, a sharing economy eradicates demands which are regulated in various situations for the sustainability of economic development. Kamaruddin et al. (2021) and Thorne & Quinn (2017) emphasize supplier resources in a sharing economy and the regulatory concerns of economic development. Users in a sharing economy enhance their businesses through various innovative applications and ideas. The lifting of businesses via a sharing economy results in the prominent enhancement of sustainable economic development. Ferrell, Ferrell & Huggins (2017) and Pintuma & Aunyawong (2021) enumerate the shifts in sharing economies, including in supply chains and marketing channels. By using a sharing economy around the world, top Asian countries such as Thailand, Saudi Arabia, Taiwan, South Korea, Indonesia, Japan, Turkey, India and China strive for economic development. These Asian countries are where the prominent and significant values of a sharing economy have emerged. In various situations, service providers and users establish significant strategies for the development of the economy. Oanh et al. (2021) and Schismenos et al. (2020) investigate the application of energy plants within a sharing economy that helps promote sustainable development. The economic systems of top Asian countries are dependent on the environment of traditional markets that allow sharing economy users to benefit from sustainability. Furthermore, market demand contributes significant value where a sharing economy is feasible for growth and sustainability. Sharing economy users make significant changes to their existing opportunities and choices in order to uplift economic development, especially in Asian countries (Pilinkienė et al., 2021).

Gaining economic value in a competitive world improves the world by enabling efficient energy use in innovative ways, through less expensive channels, using digital platforms and technological advancements to improve economic development. Moreover, sharing economy value has a vital role in enhancing energy efficiency and usage, particularly for trading and commerce practices. Al-Omoush, Simón-Moya & Sendra-García (2020) and Marukawa (2017) discuss the platforms of the sharing economy in reference to economic activity, socio-economic structure and energy use. There is a dire need for effective energy use to strengthen economic development. Energy must be used in such a way that can support increasing production using low energy. There is an efficacy of production and operation with a sharing economy in industries, which can be achieved by the proper use of energy. Kuhzady et al. (2021) and Ojogiwa (2021) analyse the sharing economy in the tourism and hospitality sectors, emphasizing efficient energy use. Less energy is used in the industrial sectors of top Asian countries such as Thailand, Saudi Arabia, Taiwan, South Korea, Indonesia, Japan, Turkey, India and China, enabling quality production. Whereas quality production was previously dependent on innovation and technological advancement, the sharing economy has helped sustain economic development. Meanwhile, Mane, Ahuja & Krishnamurthy (2020) and Thuy et al. (2021) investigate the endogenous networks of sharing economies along with the social networks that support the experience and benefits. For the use of energy, various facilities are established to support economic development. Proper inducement of sharing economy value, along with its proper use, help both industries and economies to achieve efficient energy use. Other aspects of energy efficiency and sustainable economic development include operational and reserve energy. Bellos & Knio (2021) and Zhao et al. (2021) estimate the impact of natural resources in a sharing economy that boosts economic development, supporting the use of equipment for upgrading the economic development through sharing economy value. Many Asian countries integrate systems of energy use with certain limits that increase the standard of production and quality of products.

The world has established various technological innovations through which sharing economies encourage innovative ideas for fostering economic development. Numerous business models have been generated based on sharing economy values that help countries attain sustainable economic development. This promotes sustainable economic growth and allows the inauguration of feasible economic plans and platforms for immense growth. Gibbs, Guttentag, Gretzel, Morton & Goodwill (2018) and Lan et al. (2022) examine the sharing economy prices and pricing strategies that lead to sustainable economic development, and indicate that sharing economy values establish yields and societal advantages for making and saving money. They also enable consumer behaviors with every positive advantage for promoting the practice of sustainable economic development. A sharing economy thus appears to be a positive environment that offers socio-economic benefits, particularly for top Asian countries such as Thailand, Saudi Arabia, Taiwan, South Korea, Indonesia, Japan, Turkey, India and China. Miller et al. (2020) emphasize the potential care of a sharing economy that supports the aging, in place of economic development. This helps countries eradicate any stress in the sharing economy values over economic sustainability. With the help of sharing economy values, consumers can attain benefits by consuming more energy, which has impacts on sustainable economic development. Cui, Hou, Liu & Zhang (2021) and Tan et al. (2021) explore the influencing factors between a sharing economy and social and economic development. They report that economic development can be weakened by restraining the potential benefits of sharing economic values, due to the weakening of the sharing economy through legal and regulatory frameworks that impact economic growth. Through sharing economy values, top Asian countries assert their advantages of opportunity, employment and economic growth. Bilgen & Sarıkaya (2018) and Sadiq et al. (2021) report that both environment and energy use policies help in sustaining the economic future, which subsequently affects the understanding of sharing economy values that establish various barriers. In many Asian countries, a sharing economy rapidly enhances opportunities in the traditional economy. There are numerous potential implications of a sharing economy that enable energy efficiency with sustainable economic development.

Industries around the world influence rates of inflation through their products and services. A slight decrease in inflation positively boosts the prices of energy leading to changes in efficient energy use

Table 1
Measurements of variables

S#	Variable	Measurement	Source
01	Sustainable Economic Development	GDP growth (annual %)	WDI
02	Energy Efficiency	Energy use (kg of oil equivalent per capita)	WDI
03	Sharing Economy	Sharing economy users (in millions)	Statista
		Sharing economy values (in billions US dollars)	Statista
04	Inflation	Consumer prices (annual %)	WDI
05	Population Growth	Population growth (annual %)	WDI
06	Employment Rate	Employment to population ratio, 15+, total (%)	WDI

and sustainable economic development. Dammak & Helali (2017) examine the relationship between economic growth, inflation and threshold effects on energy use. Their findings report a clear variation in the influencing factors, towards sustainable economic development and energy use. Meanwhile, Ghorbani Dastgerdi, Yusof & Shahbaz (2018) and Sadiq et al. (2022b) analyse the nexus between inflation and economic sanctions which contributes to the role of energy and sustainability. The link between trade, labour force, capital stocks and inflation, with its corresponding elements, increases the sustainability of energy use and economic development. Therefore, inflation is indeed a clear indication and disrupting element for the sustainability of economic growth and energy use (Tetrevova, Jelinkova & Munzarova, 2021), due to hikes in energy prices along with reductions in money value in economic markets, especially in Asian countries such as Thailand, Saudi Arabia, Taiwan, South Korea, Indonesia, Japan, Turkey, India and China. Azam, Rafiq, Shafique, Ateeq & Yuan (2021) and Sadiq et al. (2022a) investigate the impacts of inflation and macroeconomic factors on sustainable economic development and energy consumption, and show that the dynamics of inflation are significant with the mitigation of targets for energy use and economic development. Frequent changes in the price of goods and services and the devaluation of money contribute to feasible measures for industries. With the devaluation of money and rising inflation, industries take adaptive steps to use less energy for better production and sustainable economic development (Gadeikienė & Švarcaitė, 2021).

The rising global population strains facilities and forces the world to enhance production, impacting economic sustainability. A significant relationship has been ascertained between livestock production, population growth, economic growth and the efficacy of energy use. Al-Refaie, Al-Tahat & Lepkova (2020) and Searle (2020) discuss the outcomes of development and population growth for the governance of energy use. The growing population, both in the world as a whole and in top Asian countries such as Thailand, Saudi Arabia, Taiwan, South Korea, Indonesia, Japan, Turkey, India and China, affects global energy and economy, through various modes of opportunities that either exist or need to be established. A study by van Staden & Haslam McKenzie (2021) assesses the efficacy of policies that sustain the impact of population growth on sustainable economic development and energy use. The growing population has diverted energy use by enhancing sustainable economic development. People in top Asian countries are raising their demand for food production and this constructive approach influences sustainable economic development. Criado-Gomis et al. (2020) and Liu et al. (2019) analyse economic assessment and energy use with the application of population growth and culture systems. They report that these constructs are dependent on energy utilization and sustainable economic development that strategically depend on population growth. This suggests that the need for technology, innovation, energy use, and increasing production has attained greater importance with the rising population of many Asian countries.

Economic growth is not the sole contributor to opportunities and jobs for people, but rather it is considered a prerequisite for the production of employment that has an impact on energy use and sustainability. Dayaram, Rola Rubzen, Ahmad & Britten (2020) and Jelača et al. (2020) investigate prosperity, economic development, youth employment and energy use. Their findings suggest that employment is a prominent factor in economic growth, and has a significant impact on efficient energy use. Moreover, the increasing employment in top Asian countries such as Thailand, Saudi Arabia, Taiwan, South Korea, Indonesia, Japan, Turkey, India and China generates efficient energy use. Li et al. (2021) and Sohrab, Karkoodi & Roumi (2021) investigate the potential impact of the employment rate on economic development and energy use. They find a wide range of factors, including labour intensity and composition of growth, that drive productive transformation for sustainable economic development. In the energy sector, greater requirement for energy improves the employment rate, and it is weakened by less energy use. Aceleanu et al. (2017) and Liu et al. (2022b) examine the influence of macroeconomic factors such as employment rate on sustainable development and energy use. Energy consumption and production, along with its efficient use, are significantly linked to sustainable economic development. The price of energy is negatively related to employees, while the use and production of energy are sustained by the efficacy of the employment rate (Table 1).

Research methods

This research investigates the impact of sharing economy users, sharing economy values, inflation, employment rate and population growth on energy efficiency and sustainable economic development (SED) in the top ten Asian economies, namely China, India, Japan, Indonesia, Turkey, South Korea, Saudi Arabia, Iran, Thailand and Pakistan. These countries are selected based on having the highest gross domestic product (GDP). The researchers extract secondary data from the Statista and WDI databases from 2006 to 2020. The equations of the article are:

$$SED_{it} = \alpha_0 + \beta_1 SEU_{it} + \beta_2 SEV_{it} + \beta_3 INF_{it} + \beta_4 POPG_{it} + \beta_5 EMR_{it} + e_{it} \quad (1)$$

$$EU_{it} = \alpha_0 + \beta_1 SEU_{it} + \beta_2 SEV_{it} + \beta_3 INF_{it} + \beta_4 POPG_{it} + \beta_5 EMR_{it} + e_{it} \quad (2)$$

Where;

SED = Sustainable Economic Development
EU = Energy Use i = Country
t = Time Period
SEU = Sharing Economy Users
SEV = Sharing Economy Value
INF = Inflation
POPG = Population Growth
EMR = Employment Rate

The present research takes SED as the dependent construct and GDP growth (annual %) is used to measure SED. Energy efficiency is taken as the dependent variable, measured as energy use (kg of oil equivalent per capita). Sharing economy is an independent variable, measured by two indicators, sharing economy users and sharing

economy values. Inflation is measured by consumer prices and employment rate by the proportion of employment to the population. Finally, the control variable, population, is measured as the population growth (annual %). The details of the variables and respective measurements and sources are given in following table.

Descriptives are conducted to evaluate the properties of data, standard deviation (SD), minimum and maximum. The year-wise descriptive statistics show details of the constructs according to year, and the country-wise descriptive statistics show details of the constructs according to the countries. A correlation matrix is employed to examine the correlation between the constructs. Finally, a variance inflation factor (VIF) is applied to check the multicollinearity using the equations:

$$R^2 Y\ Y_{it} = \alpha_0 + \beta_2 X_{2it} + \beta_3 X_{3it} + \beta_4 X_{4it} + \beta_5 X_{5it} + e_{it} \quad (3)$$

$$j = R^2_Y,\ R^2_{X1},\ R^2_{X2,}\ R^2_{X3,}\ R^2_{X4,} R^2_{X5} \quad (4)$$

$$Tolrance = 1 - R^2_j\ VIF = \frac{1}{Tolerance} \quad (5)$$

This research employs a new assessment method known as the method of moments quantile regression (MMQR) (Machado & Silva, 2019) with a fixed-effects approach. The estimation method has the feature of being robust to outliers but cannot account for overlooked heterogeneity across panel cross-sections. By permitting individual effects, this method allows conditional heterogeneous covariance effects of the SED and energy efficiency factors to affect the whole distribution, in contrast to panel quantile regression which only allows for shifting means. Moreover, it provides dynamic evaluations in numerous conditions even if the model is nonlinear. Thus, MMQR is considered the most appropriate method as it comprises both asymmetric and nonlinear associations by simultaneously dealing with heterogeneity and endogeneity. Hence, the conditional quantile estimations are $Q\tau(\tau/X)$ for the locational-scale alternate model given by:

$$Y_{it} = \alpha_i + X_{it}\beta + (\delta_i + Z_{it}\lambda)U_{it} \quad (6)$$

where the probability is $P\{\delta_i + Z_{it}\lambda > 0\} = 1$; $\alpha,\ \beta,\ \lambda$ and δ are the parameters that must be assessed; $\alpha_i,\ \delta_i$ i $= 1, \ldots.., n$ highlights individual fixed effects; and z represents the k-vector of component X. The components are transformed with constituent l shown as:

$$Zl = Zl\ (X),\ l = 1, \ldots\ldots, k \quad (7)$$

where U_{it} is orthogonal to X_{it} and is reliable to achieve moment situations that do not include stringent heterogeneity. Thus, in Equation (6), the conditional quantile of Y is given as:

$$Q\tau(\tau/X_{it})\ = \left(\alpha_i + \delta_i q(\tau)\right) + X_{it}\beta + Z_{it}\ \lambda\ q(\tau) \quad (8)$$

where X_{it} represents the predictive variables such as SEU, SEV, INF, POPG and EMR, while Y_{it} represents the dependent variables such as SED or EU, which are conditional on X_{it}. In contrast to the standard least-square fixed effect, the distinct effects do not validate intercept shift. Because of time invariants, heterogeneous effects are allowed to change across the quantiles of the predictive variable Y. Hence, the $Q(\tau)$ equation is given as:

$$Min_q = \sum_t \sum_i p\tau(R_{it} - (\delta_i + Z_{it}\ \lambda\ )q) \quad (9)$$

Findings

The study uses descriptive analysis to reveal the SD, minimum value, mean value and maximum value of all the constructs. The results indicate that the mean value of SED is 3.779% while the average value of EU is 2614.767kg. The average value of SEU is 27.840 million while the mean value of SEV is USD196.927 billion. The mean value of INF is 6.062% while the average value of POPG and EMR are 1.118% and 55.159%, respectively. Table 2 shows further details of the variables.

Table 2
Descriptive statistics

Variable	Obs	Mean	SD	Min	Max
SED	150	3.779	3.903	-7.445	14.231
EU	150	2614.767	2002.084	431.615	7897.741
SEU	150	27.840	7.353	17.890	45.297
SEV	150	196.927	13.419	181.092	238.268
INF	150	6.062	6.657	-2.093	39.907
POPG	150	1.118	0.799	-0.340	3.091
EMR	150	55.159	10.277	34.99	72.710

The country-wise descriptive statistics show details of the constructs by country, revealing that the minimum value of SED is 0.265% in Japan while the maximum value of SED is 8.342% in China. The lowest value of EU is 461.821kg in Pakistan, while the highest value is 6776.012kg in Saudi Arabia. The minimum value of SEU is 19.257 million in Pakistan, while the maximum value of SEU is 42.324 million in China. The lowest value of SEV is USD182.852 billion in Pakistan, while the highest value of SEV is USD229.788 billion in China. The minimum value of INF is 0.331% in Japan, while the maximum value of INF is 19.326% in Iran. Meanwhile, the lowest value of POPG is -0.102% in Japan, while the highest value of POPG is 2.531% in Saudi Arabia. Finally, the minimum value of EMR is 37.221% in Iran, while the maximum value of EMR is 69.803% in Thailand. Table 3 shows details of the variables by country.

The year-wise descriptive statistics show details of the constructs by year. The SED minimum value is -1.837% in 2020, while the maximum value is 6.464% in 2010. The lowest value of EU is 2272.564kg in 2006, while the highest value of EU is 2938.491kg in 2020. The minimum value of SEU is 24.466 million in 2006, while the maximum value of SEU is 31.216 million in 2020. The lowest SEV value is USD192.279 billion in 2006, while the highest SEV is USD201.606 billion in 2020. The minimum value of INF is 3.236% in 2016, while the maximum value of INF is 10.203% in 2008. The lowest value of POPG is 0.826% in 2020, while its highest value is 1.215% in 2011 and 2012. Finally, the EMR minimum value is 53.253% in 2020 and its maximum value is 56.023% in 2017.

The study employs a correlation matrix to examine the correlations among the constructs. The results reveal that sharing economy users, sharing economy values, employment rate and population growth have a positive association with energy efficiency and SED in the top ten Asian economies. It is also found that inflation has a negative association with energy efficiency and SED in the top ten Asian economies. Table 4 shows the correlations among the variables.

The results reveal that sharing economy users, sharing economy values, inflation, employment rate and population growth have a positive association with SED in the top ten Asian economies.

Table 3
Descriptive statistics (country)

	SED	EU	SEU	SEV	INF	POPG	EMR
China	8.342	2203.693	42.324	229.788	2.665	0.527	67.867
India	5.735	616.796	36.675	203.280	7.117	1.229	50.395
Japan	0.265	3535.716	30.126	204.138	0.331	-0.102	57.963
Indonesia	4.972	870.967	29.358	198.290	5.570	1.264	63.237
Turkey	4.560	1569.546	29.707	197.098	9.714	1.445	44.397
South Korea	3.156	5252.914	24.985	190.761	1.997	0.480	60.401
Saudi Arabia	2.621	6776.012	21.971	188.863	3.157	2.531	50.293
Thailand	2.787	1919.343	22.560	187.179	1.769	0.432	69.803
Iran	1.749	2940.863	21.441	187.025	19.326	1.238	37.221
Pakistan	3.604	461.821	19.257	182.852	8.977	2.137	50.016

Table 4
Matrix of correlations

Variable	SED	EU	SEU	SEV	INF	POPG	EMR
SED	1.000						
EU	0.271	1.000					
SEU	0.295	0.235	1.000				
SEV	0.291	0.13	0.936				
INF	-0.147	-0.245	-0.232	-0.268			
POPG	0.112	0.03	-0.4	-0.429	0.334		
EMR	0.202	0.036	0.316	0.388	-0.638	-0.511	1.000

Furthermore, SEU is found to have a significant link with SED in quantiles 1 to 9, while SEV has a significant association with SED in quantiles 1 to 9. The findings indicate that INF has a significant link with SED in quantiles 1 to 9, while POPG has a significant association with SED in quantiles 1, 2, 3, 6, 7 and 9. Finally, EMR and SED are significant to each other in quantiles 1, 2, 3, 6 and 7. Table 5 shows the MMQR results for SED.

The results suggest that sharing economy users, sharing economy values, inflation, employment rate and population growth have a positive association with energy efficiency in the top ten Asian economies. SEU has a significant link with energy efficiency in quantiles 1 to 9, while SEV has a significant association with energy efficiency in quantiles 1 to 9. In addition, INF is found to have a significant link with energy efficiency in quantiles 1 to 4 and 6 to 9, while POPG has a significant association with energy efficiency in quantiles 1 to 5 and 7 to 9. Finally, the results indicate that EMR has a significant link with energy efficiency in quantiles 1, 2, 3, 8 and 9. Table 6 shows the MMQR results for energy efficiency.

Discussion and Implications

The results reported in this study show that sharing economy users have a positive impact on sustainable economic development. This is supported by Buletova & Stepanova (2020) who show that an increase in the number of sharing economy users in a country provides individuals with equal rights to utilize natural or manufactured resources despite differences in income and living standards. Hence, sustainability in economic development is possible, as everyone can equally create or pick economic opportunities.

The results reveal that sharing economy users have a positive impact on the efficient use of energy. This result is supported by Jin, Kong, Wu & Sui (2018) who report that an increase in sharing economy users within a region enhances the optimal use of physical, information and technological resources, because more individuals or commercial enterprises can access and utilize the same resources without them being wasted in spare time. Instead of acquiring and using other resources, the optimal use of existing resources reduces the use of energy on the same practices without disturbing the production of goods and services.

Sharing economy values have a positive impact on sustainable economic development. This result is in line with Ma, Lan, Thornton, Mangalagiu & Zhu (2018) who show that a tendency to create value in an economy by sharing resources instead of holding ownership or renting can save environmental quality due to getting the best usage of resources such as machines, transportation and infrastructure. The improved environment thus ensures further improvement in human capital and natural resources that lead to sustainable economic growth.

The results also indicate that sharing economy value has a positive impact on the efficient use of energy. This agrees with Liu et al. (2021) and Pouri & Hilty (2018), who demonstrate that increased sharing economy within a country encourages the optimal use of technological and other physical resources. In this situation, people refrain from keeping transport vehicles or other operational technologies in their own possession, which need to be in working condition all the time. As a result, the reduced use of transportation and other technologies helps reduce energy resource use. Thus, improvements in sharing economy value encourage efficient use of energy resources.

The results reveal that inflation has a positive impact on sustainable economic development. This is supported by Liu et al. (2022a) and Roncaglia de Carvalho, Ribeiro & Marques (2018) who show that inflation within a country prompts businesses in all economic sectors to work hard to keep operations running smoothly, produce goods and services at a faster rate, and maintain a high level of quality. As a result, a vast number of resources eventually become available for commercial use and the path to sustainable economic development is apparent. This is why an increase in inflation enhances sustainability in economic development.

The results further show that inflation has a positive impact on the efficient use of energy. This is in line with Mishchenko, Naumen-

Table 5
Panel quartile estimation (MMQR) for SED

Variable	Method of Moments Quantile Regression (MMQR)										
	Location	Scale	Grid of Quartiles								
			0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90
SEU	0.783**	0.548*	0.622**	0.793**	0.548*	0.734**	0.783**	0.892**	0.903**	0.599*	0.893**
SEV	0.872***	0.742**	0.290*	0.209*	0.882**	0.302*	0.293*	0.329*	0.201*	0.672*	0.722**
INF	0.372**	0.637**	0.498*	0.287*	0.908**	0.873**	0.209*	0.492*	0.532*	0.812**	0.321*
POPG	0.983***	0.377*	0.893***	0.873*	0.783**	0.102	0.192	0.298*	0.128*	0.289	0.160**
EMR	0.721*	0.278*	0.903***	0.721**	0.702*	0.100	0.122	0.433*	0.382*	0.133	0.122

***, ** and * represent significance levels of 1%, 5% and 10%, respectively.

Table 6
Panel quartile estimation (MMQR) for EU

Variable	Method of Moments Quantile Regression (MMQR)										
	Location	Scale	Grid of Quartiles								
			0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90
SEU	0.783***	0.671*	0.530*	0.619**	0.732*	0.299*	0.492*	0.423*	0.510*	0.553*	0.762**
SEV	0.879**	0.981*	0.712*	0.724**	0.913**	0.533*	0.582*	0.620**	0.324*	0.534*	0.333*
INF	0.672**	0.902**	0.824**	0.278*	0.539*	0.419*	0.142	0.542**	0.192*	0.322*	0.421*
POPG	0.517*	0.884*	0.901**	0.723**	0.522*	0.832**	0.453*	0.104	0.209*	0.734**	0.530*
EMR	0.592*	0.458**	0.521*	0.192*	0.421*	0.299	0.109	0.133	0.109	0.632**	0.676**

***, ** and * represent significance levels of 1%, 5% and 10%, respectively

kova, Mishchenko & Ivanov (2018) who posit that there is development in all economic sectors during inflationary periods. When there is progress in a technological field, such technologies are invented, acquired and add value to existing technologies, which can give maximum production with minimum resources. Adopting such technologies thus reduces the use of energy resources within a country. Hence, spreading inflation enhances energy efficiency.

The findings reported in this study show that population growth has a positive impact on sustainable economic development. This result is supported by Abildtrup, Hilal, Piguet & Schmitt (2018) who examine the impact of population growth on sustainable economic development. Their study implies that an increase in population growth enhances human capital within a country. Humans' effective thinking provides efficient management and supervision, while talented and skilled people can work as a highly productive labour force. Efficient management and a capable labour force can better perform business functions. Thus, enhanced social, environmental and economic development of businesses contributes to high sustainability in a country's economic development.

The results also show that population growth has a positive impact on the efficient use of energy. This is in line with Leontief (2019) and Moslehpour et al. (2022a) who argue that population growth impacts the efficient use of energy. The study reveals an increased need for resources to perform social and economic practices in a country where the population growth rate is high. Such need motivates people to find ways to preserve resources, including energy. Thus, an increase in population improves the efficient use of energy.

It is also found that employment rate has a positive impact on sustainable economic development. This result is supported by Manzoor, Wei, Asif, Haq & Rehman (2019) and Moslehpour et al. (2021) who claim that human resources perform business functions. Hence, an increase in employment rate prompts human resources to be greater in number, subsequently promoting consistency in economic activities. Consistent productivity, as a result of a consistent employment rate, brings sustainability in economic development. The results also show that employment rate has a positive impact on the efficient use of energy. This is in line with Kosovich (2019) and Moslehpour et al. (2022b) who observe the effects of employment rate on sustainable economic development and find a positive relationship between employment rate and efficient use of energy.

The current study has both theoretical and empirical implications. Firstly, the results significantly contribute to the literature by addressing a number of gaps. The study examines the impacts of sharing economy users, sharing economy value, inflation, population growth and employment rate on energy efficiency and sustainable economic development. This addresses two significant subjects, energy efficiency and sustainable economic development, where the majority of past studies merely focus on the impact of a sharing economy on either energy efficiency or sustainable economic development. Another significant contribution of this study is that it addresses the literary gap by analysing the impacts of sharing economy users and sharing economy value on energy efficiency and sustainable economic development, particularly from the perspective of the top ten Asian economies.

On the other hand, this study has practical significance for leading economies which wish to be proficient in energy efficiency and achieve high sustainability in economic development. This research guides policymakers in establishing policies related to the achievement of SED and energy efficiency via a sharing economy. It also serves as a guideline for economists and the government on how to promote energy efficiency and sustainable economic development. Governments must formulate relevant policies to encourage sharing economy users, sharing economy value, inflation, population growth and the employment rate for energy efficiency and sustainable economic development. The study suggests that economists must implement policies and strategies for increasing sharing economy users, sharing economy value, inflation, population growth and employment rate, so that energy efficiency and sustainable economic development can be attained.

Conclusions and limitations

The objective of this study is to examine the impacts of sharing economy users, sharing economy value, inflation, population growth and employment rate on energy efficiency and sustainable economic development. In order to obtain information about sharing economy users, sharing economy value, inflation, population growth and employment rate and their impacts on energy efficiency and sustainable economic development, an empirical survey is conducted of the top ten Asian economies. The results indicate a positive relationship between sharing economy users, sharing economy value, inflation, population growth and employment rate and energy efficiency. This suggests that an increase in sharing economy users increases the tendency to use the energy resources efficiently with reduced use of technologies. Similarly, an increase in the value of a sharing economy results in a proportional increase in energy efficiency with reduced technology use. The results show that a rise in inflation, population growth or employment rate enhances financial resources, while the use of efficient technologies and skilled human resources reduces the use of energy with the same productivity. Furthermore, this study finds a positive relationship between sharing economy users, sharing economy value, inflation, population growth and employment rate and sustainable economic development. An increase in sharing economy users and value helps provide access to resources, reduce the total use of resources and stimulate economic activity, thus leading to greater sustainable economic development.

Nevertheless, this study has several limitations that can be addressed by future research. Firstly, this study only examines the impacts of sharing economy users and sharing economy value, along with inflation, population growth and employment rate, on energy efficiency and sustainable economic development. There are many other essential factors which can be explored by future authors through practical analysis. In addition, the current study depends only on the empirical analysis of ten Asian economies, creating a lack of implications. Future research could therefore conduct investigations into more countries, so that the findings can be widened and generalized to any economy.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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