Working Paper 2024.3.3.11
- Vol. 3, No. 3

TÁC ĐỘNG CỦA ĐA DẠNG HÓA XUẤT KHẨU ĐẾN CƯỜNG ĐỘ SỬ DỤNG NĂNG LƯỢNG: NGHIÊN CỨU THỰC NGHIỆM VÀ HÀM Ý CHÍNH SÁCH

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Tóm tắt

Nghiên cứu được thực hiện nhằm mục đích hiểu được tác động của đa dạng hóa xuất khẩu đến cường độ sử dụng năng lượng của một số quốc gia châu Á và châu Mỹ, sử dụng phương pháp Bình phương nhỏ nhất thông thường (OLS) và Bình phương nhỏ nhất tổng quát khả thi (FGLS), để phân tích dữ liệu bảng với 21 quốc gia trên mỗi khu vực trong giai đoạn từ năm 2002 đến năm 2021. Kết quả nghiên cứu chỉ ra rằng đa dạng hóa xuất khẩu chỉ có thể giảm thiểu cường độ sử dụng năng lượng đối với các quốc gia châu Á, thêm vào đó là GDP và mức tiêu thụ năng lượng tái tạo, trong khi sự ổn định chính trị có tác động đáng kể nhưng trái ngược nhau đối với cả hai khu vực. Hơn nữa, phát triển tài chính, đô thị hóa và giá năng lượng có thể ảnh hưởng cùng chiều đến mức độ cường độ sử dụng năng lượng bất kể khu vực nào. Dựa trên kết quả nghiên cứu, nghiên cứu trình bày chi tiết về những hàm ý đối với các nhà hoạch định chính sách liên quan về mối liên hệ giữa đa dạng hóa xuất khẩu và cường độ sử dụng độ năng lượng đối với các quốc gia châu Á và châu Mỹ.

Từ khóa: đa dạng hóa xuất khẩu, cường độ sử dụng năng lượng, các quốc gia châu Á, các quốc gia châu Mỹ

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IMPACT OF EXPORT DIVERSIFICATION ON ENERGY INTENSITY: EMPIRICAL STUDY AND POLICY IMPLICATIONS

Abstract

The paper aims to understand the effect of export diversification on the energy intensity of selected Asian and American countries, using the Ordinary Least Squares (OLS) and Feasible Generalized Least Squares (FGLS) method, to analyze a panel data with 21 countries per region between 2002 and 2021. The investigation indicated that export diversification can minimize energy intensity only for Asian countries, in addition to GDP and renewable energy consumption, while political stability has a significant but contradictory effect for both regions. Furthermore, financial development, urbanization and energy price can positively affect energy intensity levels regardless of region. Based on research results, the paper elaborates on implications for policymakers regarding the export diversification and energy intensity nexus for Asian and American countries.

Keywords: export diversification, energy intensity, Asian countries, American countries

1. Introduction

Energy expenditure is unavoidable to facilitate economic growth through international trade and industrial production, while an increase in energy consumption will contribute to the aforementioned environmental challenges. Consequently, countries and international organizations are encouraging greater energy efficiency, such as reaching a 32.5% improvement in energy efficiency across all European member states by 2030. Existing literature also confirms that reducing energy intensity and carbon intensity is one of the crucial factors in achieving energy efficiency targets. According to UNECE, energy intensity "indicates the general correlation between energy consumption and economic development and provides a basis for an approximate assessment of energy consumption and its environmental impact as a result of economic growth" and is an indicator of sustainable development. Theoretically, because international trade is a well-known driver of energy consumption and economic growth, diversification of exports should affect energy intensity. However, while the role of export diversification in other aspects of sustainable development, such as economic progress and environment quality has been investigated previously, there is few existing literature that has examined the relationship between this factor and energy intensity.

In the post-pandemic period between 2020 and 2021, Asian and American countries continued to recover at a steady pace. However, economic recovery and subsequent growth have also caused environmental challenges. Every year, 3.3 million people die due to air pollution, of which the People's Republic of China, India, Pakistan, and Bangladesh suffer the highest number of fatalities (World Health Organization, 2022). In Latin America and the Caribbean, temperatures have increased between 0.7°C and 1°C compared to the 1961–1980 period average (World Meteorological Organization, 2023). Located in regions more susceptible to global climate change, Asian and American countries have more diverse income levels, varying from low, middle to high-income levels with large income gaps. This complicates efforts to effectively implement green lifestyles, due to a prioritization of meeting basic needs over environmental protection. Moreover, these countries export globally with diverse product baskets but economic development leading to increased FDI inflows is unlikely to increase their motivation for research and development of energy-saving technologies. The study sets out to assess the effect of export diversification on energy intensity in a number of Asian and American countries between 2002 and 2021.

2. Theoretical framework

2.1. Literature review

Many previous empirical studies in the late nineteenth century have been carried out to examine the export diversification or energy intensity separately; however, it was not until the early 20s of the 21st century that the relationship between export diversification and energy intensity and the impact of diversified exports on energy intensity were noticed and researched and examined. Research on the relationship between export diversification and energy intensity has yielded valuable insights, particularly in developed countries. The present studies offer three main innovations.

First, regarded as one of the pioneers in researching the nexus between export diversification and energy intensity, Shahbaz et al. (2018) indicated that export diversification was one of two new determinants of energy demand in the U.S. Their study shows there is a feedback effect between export diversification and energy demand which means that export diversification can promote energy efficiency by decreasing energy consumption and the greater energy efficiency can create a higher level of economic growth in the U.S. by producing new products and this process can be defined as a diversification of the U.S. export basket. As for Bashir et al. (2020), they carried out research with a wider scope with a sample of 29 OECD countries in a period from 1990 to 2015. They studied the role of three indexes representing export diversification including export product diversification, expansion margin and intensification margin on energy intensity. The empirical results show a significant negative relationship between the three indices with energy intensity. In other words, increased export diversification helps control energy intensity and improve energy efficiency more effectively. Similar results were also found in the study of Doğan et al. (2022). This consensus suggests that through the negative impact of diversified exports on energy intensity, export diversification could serve as an effective policy tool for mitigating energy consumption per unit of economic output, especially in economically advanced regions, and building a sustainable environment through accelerating trade liberalization, improving the quality of the institutions and meeting the sustainable economic goals of the trading policy.

Second, Contrary to the above-mentioned research results, research by Khan et al. (2021) on a similar topic, how energy intensity is influenced by export diversification associated with the energy crisis, came to different conclusions. Their findings indicated that export diversification increases energy intensity due to economic growth, and countries with higher levels of export diversification have higher energy intensity. Employing the Fixed Effects Regression model and GMM method to assess the nexus between export diversification and energy intensity in 121 countries in the period of 1990-2014, Lee & Ho (2022) pointed out that export diversification leads to higher energy intensity, meaning more energy is consumed per unit of economic output. Similar empirical results were also found in the study of Zhang et al. (2022) examining the contribution of export diversification with both extensive export margin and intensive export margin to energy and carbon intensity of the top 9 highest carbon emitter countries from 1990 to 2016. The research defined that export diversification contributes to a significant increase in energy intensity, which they interpret as evidence of stock market development and income inequality.

To better understand the export diversification-energy intensity nexus, besides export diversification, other factors, i.e. economic development (Lee & Ho, 2022), urbanization, trade openness (Pan et al., 2019), FDI (Jiang & Ji, 2016), technological innovation (Pan et al., 2019), energy price (Cheng et al., 2021) are suggested as drivers of increasing or accelerating energy intensity.

In general, diversification in export portfolios and trade relations helps improve energy efficiency in OECD countries. The diversification of the export basket is a good strategy as it can help establish new industries, develop existing products, and distribute risks across industries during economic crises and unfavorable trading conditions. However, most studies focus on specific economic regions or organizations (e.g. OECD countries) and have not made any comparisons between countries or geographical regions, overlooking regions with diverse economic contexts, such as Asia and Latin America. There is a limited understanding of how export diversification influences energy consumption in these areas, where different socio-economic factors and policy priorities might alter the effects seen in OECD countries. Furthermore, while studies like those by Lee & Ho (2022) discuss export diversification in a global sample, they have not delved into specific challenges faced by developing countries. Meanwhile, Asian and American countries are mainly developing countries with big gaps in income levels. They are also large exporters with diverse product baskets, accounting for a large percentage of total export volume worldwide, such as Vietnam, Thailand, etc. As a result, higher energy usage is inevitable to provide for the manufacturing and ready-to-export process in order to generate exports.

Additionally, the availability of recent and complete data presents a challenge for the field. Most studies rely on export diversification data up to 2015 or 2017, limiting their ability to capture current trends and emerging shifts in global trade. This restricts our understanding of how more recent economic and environmental policies may influence the export diversification-energy intensity nexus. Few studies employ methodologies that account for potential endogeneity issues in the relationship between export diversification and energy intensity. Addressing these limitations with up-to-date data and more robust models could enhance the reliability of future research findings.

To address these gaps, future research should use longitudinal datasets that include post-2017 data to capture the effects of recent trade liberalization policies and green and less intensive energy advancements. Examining these influences could help clarify how contemporary trade dynamics affect energy efficiency. Comparative studies could provide insights into how export diversification impacts energy intensity differently in developed and developing economies.

In conclusion, the export diversification index helps to better explain a country's economic status; however, it has not been widely applied due to data inadequacies (the majority of recent studies used the export diversification index data collected up until 2017), and incomplete research models and theories. Therefore, when conducting this research, the research team wants to delve deeper into the degree, role, and nature of the effect of export diversification on energy intensity in export-intensive Asian and American countries.

2.2. Hypotheses Development

In general, previous studies agree that export diversification positively affects domestic economic diversification, which is linked with new economic activities through entrepreneurship (Schrank, 2005) or increasing development in technology (Xuefeng & Yaşar, 2016). The study expects export diversification to have a negative impact on energy intensity with the main research hypothesis:

H0: Export diversification has a negative impact on Asian and American countries' energy intensity

Besides the main independent variable energy intensity, the study suggests a research model that includes other independent variables presented in the table below:

Table 1: Description of research variables and sources

Variable	Variable explanation	Source	Data
Energy Intensity (ENI)	The energy intensity level of primary energy indicates how much energy is used to produce one unit of economic output.		World Bank
Export Diversification (EXPDI)	The export product diversification index indicates to what extent the structure of exports or imports by product of a given economy or group of economies differs from the world pattern.	Xuefeng & Yaşar (2016)	UNCTAD

Variable	Variable explanation	Source	Data
Urbanization (UR)	Urban population	Pan elt al. (2019)	World Bank
Renewable Energy Consumption REC)	Renewable energy consumption (% of total final energy consumption)	Khan et al. (2021)	World Bank
Political Stability (PS)	Political Stability and Absence of Violence/Terrorism: Estimate	Doğan et al. (2022)	World Bank
GDP (GDP)	Gross domestic product (current US$)	Samargandi (2019)	World Bank
Finance Development (FD)	Financial development index	Doğan et al. (2019)	IMF
Energy Price (EP)	Price of crude oil.	Samargandi (2019)	OECD

Source: Synthesized by the authors (2024)

3. Research method

3.1. Regression model

The study is conducted in Asian and American countries with a time scope of 20 years, between 2002 and 2021 to ensure the balance of data and amount of selected countries (Energy intensity-related data on WDI's database is only updated from 2002 to 2021). After collecting, processing, and eliminating substandard observations, the dataset of 21 Asian and 21 American countries (n=420 for Asian and n=420 for American countries) was selected for analysis using appropriate tests and statistical analysis techniques.

To mitigate the standard deviation of the data in the research model, this study takes a natural logarithm of variables including Energy intensity (ENI); Renewable energy consumption (REC); Gross Domestic Product (GDP), and Energy price (EP), this study employs a log-linear single-equation multivariate model as follows:

$$\ln EI(B,t) = K + \beta 1 EDI(B,t) + \beta 2 \ln REC(B,t) + \beta 3 UR(B,t) + \beta 4 PS(B,t) + \beta 5 \ln GDP(B,t) + \beta 6 FD(B,t) + \beta 7 \ln EP(B,t) + \varepsilon$$

ε denotes the random error term and B represents the country observed at time t. β1, β2,..., β6 represent the coefficient of the corresponding variable, and K represents the estimated residual. The independent variables, in order are Energy Intensity (EI(B,t)), Export Diversification (EDI(B,t)), Renewable Energy Consumption (RE(B,t)), Urbanization (UR(B,t)), Political Stability (PS(B,t)), GDP (GDP(B,t)), Financial Development (FD(B,t)) and Energy Price (EP(B,t)) with the descriptive statistics are presented below:

Table 2: Descriptive statistics of Asia countries

Variable	Obs	Mean	Std. Dev.	Min	Max
lnENI	420	1.587567	.424036	.6418539	2.862772
EXPDI	420	.6296284	.1509943	.353334	.894969
lnREC	420	2.730775	1.229231	.0953102	4.521789
lnUR	420	.52534	.2397913	.1424	.92674
PS	420	-.5869541	.8873128	-2.810035	1.284487
lnGDP	420	11.58195	2.328783	6.326767	16.69586
FD	420	.2875579	.2412719	.0275819	.9744189
lnEP	420	4.096699	.4248994	3.192942	4.695468

Source: Synthesized by the authors (2024)

Table 3: Descriptive statistics of American countries

Variable	Obs	Mean	Std. Dev.	Min	Max
lnENI	420	1.264956	.330052	.2926696	2.088153

Variable	Obs	Mean	Std. Dev.	Min	Max
EXPDI	420	.6699568	.1235449	.330779	.884814
lnREC	420	3.324907	.6968722	1.029619	4.409155
lnUR	420	.6788981	.1627472	.3114685	.9560299
PS	420	-.1280423	.7051257	-2.376027	1.27792
lnGDP	420	10.94243	1.841698	7.122915	14.77722
FD	420	.363741	.2775836	.0264405	.9257486
lnEP	420	4.961326	.3744896	4.135475	5.449135

Source: Synthesized by the authors (2024)

3.2. Research method

The first step is to check whether or not there are correlations between independent variables. After that, multicollinearity tests are performed to detect and remove variables that can cause overlapping and affect the regression model's accuracy. To analyze panel data, researchers employ a variety of models, among which are Pooled OLS; FEM (Fixed Effects Model) and REM (Random Effects Model). They are frequently used in experimental studies utilizing this type of panel data.

Overall, the Pooled OLS method will select regression coefficients in the model such that the squared error of the estimated model is minimal. This regression model is one in which regression coefficients remain unchanged when considered in any time and space conditions, referring to the intercept and slope coefficients of the model. Pooled OLS considers all observations in the dataset to share basic characteristics, doesn't consider their special features and then the research compiles all available data and uses an ordinary least squares regression model. FEM is used to analyze the relationship between dependent variables and independent variables in panel data when observations in the dataset undergoes change in time and space. FEM is also used to resolve the problem of differences between variables - fixed effects. With the assumption that every observation has its own special features that cause deviations to explanatory variables, FEM is used to control and separate the effect of the special features (constant over time) from explanatory variables. As for the REM model, the residual is considered as a new explanatory variable and the unit's random effect is solved by assuming these random effects as random and mismatching variables between the units. These effects are assumed to have been distributed according to standard distribution and there are random effects for some characteristics of the units.

To inspect data probability, F-test is employed to choose between FEM and Pooled OLS, while Breusch - Pagan Lagrangian test is for choosing the most optimal choice between OLS and REM for the regression model and lastly, Hausmann test is used to choose between FEM and REM. Finally, the research tests the suitability of the selected model and determines errors such as multicollinearity and heteroscedasticity. To correct these errors, FGLS is used, which is suited to resolve multicollinearity, and heteroscedasticity and ensure that the estimated results are not biased.

4. Result and discussion

4.1. Model testing

After compiling, removing substandard observations and performing the Pearson correlation test to verify the relationships between variables and the presence of multicollinearity in the model, simultaneously, a mutual correlation exists between independent variables. The research therefore suspects multicollinearity in the model for both regions and will use VIF multicollinearity test in the next section to check for this model issue.

Multicollinearity tests for both regions return valid preliminary results with VIF<10, which indicates the model does not have severe multicollinearity and no independent variables are removed.

Table 4: Multicollinearity test's result

Asia			**America**		
Variable	***VIF***	***1/VIF***	***Variable***	***VIF***	***1/VIF***
lnUR	3.77	0.265236	lnGDP	5.06	0.197571
lnREC	3.72	0.269078	lnUR	3.09	0.323437
EXPDI	2.27	0.440295	EXPDI	2.24	0.446499
lnGDP	2.14	0.466616	PS	1.34	0.744968

Asia			America		
Variable	***VIF***	***1/VIF***	***Variable***	***VIF***	***1/VIF***
PS	1.17	0.854670	lnREC	1.30	0.768189
FD	1.12	0.894694	FD	1.28	0.778432
lnEP	1.03	0.974725	lnEP	1.03	0.968561
Mean VIF	2.17		Mean VIF	2.19	

Source: Synthesized by the authors (2024)

4.2. Regression Results & Discussion

The OLS, FEM, and FEM models' regression results along with other model selection tests were respectively conducted for the dataset of Asian and American countries (Table 5). F-test results showed that between OLS and FEM models, FEM is the more optimal model when the corr(u_i, X) =0 with prob=0.000 indicates REM is more suitable than OLS. Then, finally Hausman test was implemented to choose between FEM and REM, the result showed that REM is the appropriate model to estimate the impacts of export diversification towards energy intensity in both Asian and American countries.

Table 5: OLS, FEM, REM results

	Asia				America		
	OLS	**FEM**	**REM**		**OLS**	**FEM**	**REM**
	lnENI	**lnENI**	**lnENI**		**lnENI**	**lnENI**	**lnENI**
EXPDI	-0.312	0.0472	-0.00367	EXPDI	-0.104	0.291**	0.227*
	(-1.86)	(0.33)	(-0.03)		(-0.63)	(2.95)	(2.33)
lnREC	-0.181***	-0.0665**	-0.0634**	lnREC	0.123***	0.0509*	0.0571*

	Asia				America		
	OLS	**FEM**	**REM**		**OLS**	**FEM**	**REM**
	lnENI	**lnENI**	**lnENI**		**lnENI**	**lnENI**	**lnENI**
	(-6.87)	(-3.03)	(-3.08)		(5.47)	(2.19)	(2.49)
UR	-1.185***	-0.162	-0.281	UR	-1.484***	-0.979***	-0.977***
	(-8.70)	(-0.71)	(-1.46)	(-10.02)	(-5.92)	(-6.05)	
PS	0.155***	-0.0197	-0.0199	PS	0.116***	0.0291	0.0290*
	(7.56)	(-1.20)	(-1.22)		(5.14)	(1.96)	(1.96)
lnGDP	-0.0431***	-0.176***	-0.161***	lnGDP	0.0816***	-0.0693***	-0.0564***
	(-4.07)	(-10.03)	(-10.72)		(4.87)	(-4.98)	(-4.21)
FD	-0.228**	-0.528**	-0.571***	FD	-0.184**	0.0257	-0.0863
	(-3.10)	(-3.07)	(-3.70)		(-3.29)	(0.23)	(-0.85)
lnEP	-0.0350	0.0267	0.0203	lnEP	-0.0556	0.0163	0.0115
	(-0.87)	(1.96)	(1.51)		(-1.50)	(1.46)	(1.04)
_cons	3.701***	3.893***	3.847***	_cons	1.399***	2.237***	2.181***
	(12.14)	(22.33)	(20.35)		(5.24)	(15.12)	(13.51)
N	420	420	420	N	420	420	420

.

	Asia				America		
	OLS	FEM	REM		OLS	FEM	REM
	lnENI	lnENI	lnENI		lnENI	lnENI	lnENI
R-sq	0.351	0.555	0.554	R-sq	0.289	0.377	0.374
F(20, 392)		264.74***		F(20, 392)		333.45***	
corr(u_i, X)			0***	corr(u_i, X)			0***
Hausman			1.07	Hausman			0.50
F(1, 20)			87.832***	F(1, 20)			31.769***
Var(u) = 0 chibar2(01)			2851.67***	Var(u) = 0 chibar2(01)			3239.22***

t statistics in parentheses: * * p<0.1, **p<0.05, *** p<0.01

Source: Synthesized by the authors (2024)

After choosing REM as the appropriate model, the research conducted tests to check for defects in the model, including autocorrelation and multicollinearity, by using the Breusch, Pagan-Lagrangian, and Wooldridge tests. The tests indicated that the model has suffered from both of the above-mentioned defects, hence, the research team carried out FGLS to overcome the REM model's defects. FGLS's results are shown in Table 6 below.

Table 6: Feasible generalized least squares result

Asia			America		
lnENI	Coef.	P>z	lnENI	Coef.	P>z
EXPDI	-.167827**	0.064	EXPDI	-.102768	0.219

lnREC	-.1433066***	0.000	lnREC	.0142107	0.485
UR	-.9638683***	0.000	UR	-.6854494***	0.000
PS	.0308195***	0.008	PS	-.0239407**	0.032
lnGDP	-.0453752***	0.000	lnGDP	.0049347	0.709
FD	-.1715384**	0.025	FD	-.1818726***	0.005
lnEP	-.017419**	0.042	lnEP	-.0240547***	0.002
_cons	3.23229***	0.000	_cons	1.921203***	0.000

*t statistics in parentheses: * $p<0.1$, ** $p<0.05$, *** $p<0.01$*

Source: Synthesized by the authors (2024)

In general, all proposed variables in the model have significant effects on energy intensity levels in Asian countries. Meanwhile, in American countries, the main independent variable (export diversification), along with GDP and renewable energy consumption, has no significant impact on the dependent variable.

Export diversification in this study performed in 21 selected Asian countries was shown to have a significant effect on energy intensity, which can be explained by the fact that export diversification helps mitigate the dependence on energy-intensive industrial fields such as manufacturing, petrochemicals, mining, etc. Once the economy expands and develops other high-value export sectors that consume less energy, energy intensity will decrease as a result. Not only will this improve energy efficiency levels but also promote technological innovation and sustainable development. Similar results are found by Olasehinde-Williams et al. (2023) in the general Asia region. Meanwhile, the export diversification variable has little measurable effect on energy intensity when conducting research in the scope within American countries. Majeed & Asghar (2021) investigated D8 and G7 countries, pointing out that export diversification had no significant effect on the level of energy intensity. Especially, in American countries, there is no clear linkage between these two variables, due to the dependence on traditional export industries less affected by export structure’s changes. The differences in the impacts of export diversification on energy intensity among Asian countries and American countries might come from the economic structure and industrial development level.

Renewable energy consumption also is one of the determinants having a significant impact on the reduction of energy intensity in Asia, but it is insignificant when considered in American nations. Similar results about the effects of renewable energy consumption on energy intensity in Asian countries was proven in the study of Jiao et al. (2024). Research of Yu et al. (2022) demonstrated the similarity between renewable energy consumption and energy intensity nexus results in American countries. For Asian countries, the main reason for this result is that these countries, especially China and India, have strongly invested in renewable energy to minimize the dependence on traditional fossil fuels, improve energy efficiency and reduce greenhouse gas emissions. However, in terms of American countries the major energy source is still fossil fuels, and the transfer to more energy-saving and renewable energy sources is facing a lot of challenges, for instance, the energy price is too high or the infrastructure has not been developed enough and the authorities do not have enough assistant policies. Similarly, GDP shares the same result as the renewable energy consumption variable when GDP is demonstrated to help reduce energy intensity in Asian countries while it is not statistically significant when considering American countries. This is because many Asian countries are in the rapid economic development stage with strong industrialization and urbanization processes. Young economies or emerging ones heavily rely on old and somehow out-to-date technologies which leads to the result that the level of energy intensity there is high. In contrast, when examining American countries, they passed the industrialization stage a long time ago, and at the moment they are focusing on service sectors, high-tech and financial fields which have less energy consumption.

Political stability has shown to be statistically significant in both regions (Asia and America) but with opposite signs. This variable is performed to have a positive impact in Asian countries while it helps to reduce energy intensity in Americans. In many American countries, especially well-developed economies like the United States and Canada, political stability is usually accompanied by various efficient energy management and use policies. As for Asian countries, many countries in this region including developed countries such as China and India, or developing countries in the Southeast Asian area, are undergoing in rapid development stage and fast industrialization. When these nations have political stability, they often promote and increase investment in economic development, improving infrastructure and industrial manufacturing expansion. To make them successfully implemented in reality, these activities usually require a lot of energy consumed, which leads to the result that the level of energy intensity in the Asia region will increase dramatically.

The remaining independent variables in the model consist of Financial development, Urbanization and Energy Price, all show that they are statistically significant which means they contribute to cutting down energy intensity levels in two estimated regions, Asia and America. First, for the Financial development variable, if a country's finance develops well, it will play a significant role in facilitating easier and quicker access to raising capital for both households and businesses from many different sources in its region or even all around the world. This will lead to the consequence that it promotes more cooperation in investments in technologies and equipment related to energy saving, thereby reducing energy consumption in each production unit and concurrently mitigating energy intensity levels. Moreover, financial development also supports nations in building and deploying energy-efficient management systems, applying smart technologies in monitoring and optimizing energy usage with the ultimate goal of low energy intensity. Meanwhile, with the urbanization variable, the high rate of urbanization leads to increased population density, which aids in optimizing transportation infrastructure and public services such as electricity, water and heating. Big cities that have a better and more efficient public transportation system and more energy-saving designed buildings tend to contribute to the reduction of energy consumption and energy intensity more than suburban or rural areas (Bilgili et al., 2017). As for the energy price variable, energy price does have an impact on energy intensity by promoting energy saving, because when the energy price goes up, individual consumers and businesses have stronger incentives to save more energy to cut costs down, improve energy management capabilities, typically they will invest more in less energy consumption types of equipment and more energy-saving manufacturing processes, with the aim of maintaining competitiveness levels and then reducing energy intensity (Jimenez & Mercado, 2014).

5. Recommendation

Based on the research results and discussion, the research team proposes the following recommendations:

Asian and American countries, in particular those experiencing rapid industrialization like China, India and South East nations and heavily dependent on resource extraction like Brazil, Argentina and Andean nations, should encourage export diversification to reduce energy intensity and increase goods value. This not only helps in lowering energy intensity but also facilitates deeper integration into the global value chain, increasing competitiveness and enhancing sustainable economic growth. To make the export sector of one nation more diverse, the country can diversify its exports by increasing the number of active export lines through new product introductions and new market penetrations (extensive margin diversification) or increasing exports of a certain product to a certain market (intensive margin diversification). To support this process, governments need to invest in the development of infrastructure for green logistics, which is modern and eco-friendly. This includes building smarter port systems, green public transport networks and renewable energy-based warehouses. Not only will investments into modern traffic and logistics systems reduce transportation costs, but also the amount of energy consumed in the supply chain, and energy intensity can be lowered as a result. Besides, governments need to encourage domestic businesses to participate in the global value chain, through improvements in end product quality standards and ensuring sustainability in production.

Furthermore, effective and sustainable urbanization management also matters because it is an essential element in optimizing energy consumption as well as reducing energy intensity. Countries need to promote smart urban planning and develop green, environmentally friendly cities which use renewable energy, emphasizing energy-efficient infrastructure such as green buildings, smart grids, etc. Investing in efficient public transport systems and developing modern urban infrastructure will help reduce cities' energy consumption and environmental impact. Urban planning should incorporate sustainable practices to reduce the energy intensity of urban areas. Along with the above-mentioned suggestions, Asian and American governments must also employ reasonable energy price management policies to accurately reflect the real costs of energy use, including environmental costs to encourage energy-saving behavior among consumers and businesses. Taxing energy consumption or emissions will push businesses and people towards improving their energy efficiency and investing in technologies that use less energy. Next, policymakers should enforce measures such as energy subsidies for low-income households, offering energy-efficient technologies and deploying public awareness-rasing campaigns about energy conservation. By this kind of approach, it can lead to more investments into more efficient manufacturing processes and equipments, ultimately helping to cut down energy intensity.

Besides that, based on the observed effect of the stability of the political situation on energy intensity, countries should strive for political stability while implementing energy policies. In Asia, nations where high levels of political stability can lead to higher energy consumption due to rapid infrastructure expansion, policymakers there should integrate many energy-saving methods into development projects. This means they need to set standards of energy efficiency, implement green building measures, and promote using more energy-efficient technologies in industries and infrastructure. As for American governments, they ought to continue maintaining political stability there and take advantage of it, then use it as a foundation to enforce effective energy management policies for encouraging businesses and households to manage energy consumption more effectively and using more clean energy sources with the ultimate aim of reducing energy intensity robustly. Since financial development is one of the determinants affecting energy intensity, hence, countries' leaders should create an enabling environment for financial institutions to have enough abilities to provide funding options for renewable energy projects or energy-saving ones. These funding options maybe include offering loans, subsidies as well as financial aids with low interest for businesses and households that want to invest in technologies and fields related to energy efficiency and renewable energy systems.

6. Conclusion

Using a quantitative approach with OLS regression and the FGLS method, the study's findings illustrate the effects of export diversification and other factors like renewable energy consumption, urbanization, political stability, GDP, financial development, and energy price on energy intensity. The results revealed that export diversification has a significant negative impact on energy intensity in Asian countries, implying that as these nations diversify their export portfolios, the levels of energy intensity will decrease dramatically. Conversely, in American countries, export diversification showed no statistically significant effect on energy intensity, which may be explained by the region's dependence on traditional export industries with limited changes in energy consumption patterns. This divergence in results underscores the different economic structures and stages of industrial development between the two regions, where Asian countries are undergoing rapid industrialization, while American countries are more service-oriented and less energy-intensive. The research also confirmed that renewable energy consumption plays a critical role in reducing energy intensity in Asian countries but is less impactful in American nations. Factors such as urbanization, financial development, and energy prices were consistently found to reduce energy intensity in both regions, further emphasizing the importance of promoting energy-efficient technologies and sustainable urban planning. Based on valuable insights into how export diversification, renewable energy, and other economic factors affect energy intensity, particularly in the context of rapidly industrializing and export-dependent countries, to achieve sustainable development and improve energy efficiency, governments and enterprises in both regions should promote export diversification, support investments in green technologies and implement appropriate policies that reflect the true environmental costs of energy consumption. Moreover, businesses should pay attention to the aspect of social responsibility in the process of energy-intensity reduction operations.

One of the study's main limitations concerns the time aspect of the data, which is limited to the period from 2002 to 2021. This prevented the study from assessing how factors changed over recent years, especially in the wake of the COVID-19 pandemic. Furthermore, since the study scope only takes Asian and American countries into account, future studies should expand the geographic scope to include other areas around the globe and achieve a better understanding of how export diversification affects energy intensity on a large scale. In addition, the study is conducted with congregated country-level data, which may obscure industry or area-specific factors in energy consumption and export patterns. Finally, the study has not accounted fully for external factors, such as geopolitical events or the global energy crisis, with the potential to disrupt existing trade and energy consumption patterns. Overall, future study needs to expand the time and research scale, consider sectoral differences in an economy, and include external shocks to provide a more in-depth understanding of factors related to export diversification and energy intensity.

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