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Article

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International Journal of Energy Economics and Policy

Provided in Cooperation with:
International Journal of Energy Economics and Policy (IJEEP)

Reference: Vo Thi Van Khanh/Thao Nguyen Le Phuong (2023). Factors affecting the environmental quality : the role of renewable energy consumption and the financial market. In: International Journal of Energy Economics and Policy 13 (3), S. 586 - 591. https://www.econjournals.com/index.php/ijeep/article/download/14373/7347/33439. doi:10.32479/ijeep.14373.

This Version is available at:
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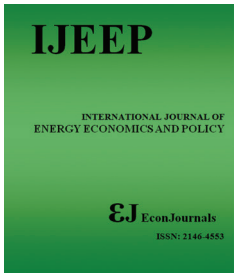

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2023, 13(3), 586-591.

Factors Affecting the Environmental Quality: The Role of Renewable Energy Consumption and the Financial Market

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Received: 21 February 2023 **Accepted:** 05 May 2023 **DOI:** https://doi.org/10.32479/ijeep.14373

ABSTRACT

The objective of the study is to evaluate the effect of renewable energy and factors such as financial development, foreign direct investment, population size and urbanization rate on CO2 emissions in six typical Southeast Asian Country between 2000 and 2020. Using quantitative analysis, the study results confirm that the use of renewable energy has the potential to improve environmental quality due to its ability to reduce energy CO2 emissions. However, increasing urbanization rate has a negative impact on environmental quality because urbanization is associated with labor mobility and increased CO2 emissions. There is no evidence of between population size, financial development, foreign direct investment and CO2 emissions.

Keywords: Renewables, CO2, Association of South East Asian Nations, Financial development, Foreign direct investment
JEL Classifications: Q52, Q53

1. INTRODUCTION

Environmental pollution is a problem that threatens the living environment of people and affects sustainable development. Increased environmental pollution leads to consequences such as climate change, sea level rising, global temperature rising and at the same time droughts and floods occur more frequently, affecting human life (Le, 2022). When the environment is polluted, the environment deteriorates, increasing costs for people and costs for society. Specifically, diseases, toxic gases and pollution affect human health, burden medical costs and affect human income. The economy incurs additional costs due to environmental impacts and can further reduce economic growth and common prosperity for human development (Grodzicki and Jankiewicz, 2022).

In that context, economies need to switch to more optimal production activities. In particular, the financial market with the function of allocating financial resources based on the circulation and allocation of savings and investment needs to perform this function well through the mechanism of allocating capital to investment projects that have a scientific and technological content and use advanced production, cleaner production, or dynamic production to save energy and protect the environment (Tan et al., 2023; Bui Minh and Bui Van, 2023). When capital flows are allocated to an efficient and environmentally friendly place, it means that the financial market has had a positive impact on reducing environmental pollution (Le et al., 2022). In contrast, when the financial market allocates capital to projects that use a lot of energy and use low production technology, it means that the financial market has not effectively allocated the economy's resources to production and doing business (Tan et al., 2023; Tiwari et al., 2022).

Along with efficiency in capital allocation, production activities in particular and especially people in general should aim to increase the use of renewable energy. Renewable energy sources come from wind energy, solar energy and other renewable energy sources that are less polluting to the environment (Mai Hoa et al., 2023). Using renewable energy has the ability to reduce CO2 emissions causing the greenhouse effect and thus the level of emissions of

toxic substances and gases into the environment is significantly reduced. Therefore, increasing the use of renewable energy sources is a useful solution to help the economy reduce pollution costs and thereby increase production efficiency in the economy. At the same time, renewable energy helps to protect the environment and thereby reduce the medical and personal expenses incurred due to the effects caused by the environment, increasing personal savings and saving the economy. Economy and is an important resource in promoting investment capacity of the whole society. It can be said that the economic and social benefits that renewable energy bring to human activities and the whole society are huge (Tiwari et al., 2022).

In recent years, Southeast Asia has been assessed as having a dynamic level of economic development and economies in the region have achieved many achievements in economic development. The achievement of the above achievements in Southeast Asia must be attributed to the great contribution of major countries in the region, typically the Association of South East Asian Nations 6 (ASEAN6) group of countries including: Vietnam, Thailand, Singapore, Malaysia, Indonesia and the Philippines. However, environmental pollution is also an ongoing problem in Southeast Asian countries when CO2 emissions are increasing every year in this region, drought, flooding and sea level rise are also a serious problem. is threatening to affect people and countries in the region. Meanwhile, countries in the region agree to increase the use of renewable energy to limit the effects of climate change and environmental pollution and at the same time maintain sustainable growth. That is the reason for this study.

2. LITERATURE REVIEW

Assessing environmental commitments to the Paris Agreement on climate change COP21 and the role of economic complexity, renewable energy, financial development, urbanization and energy innovation, Bashir et al. (2022) looked for empirical evidence from the data of countries that signed the Regional Comprehensive Economic Partnership from 1990 to 2019. The results show a significant relationship between environmental quality, economic complexity index, renewable energy consumption, financial development, urbanization and energy innovation in the short and long term. Based on econometric analysis with many models such as cross-sectional-autoregressive-distributed lag CS-Autoregressive distributed lagged (ARDL), or AMG, pooled mean group (PMG), FMOLS and DOLS models, the conclusions are found that economic structural complexity, renewable energy and energy innovation effectively reduce environmental degradation. At the same time, financial development and urbanization have adverse effects on the environment. These findings have far-reaching policy implications for policymakers and environmental stakeholders, who are working towards achieving sustainable energy policy and economic growth to meet their goals. Meet environmental commitments under the Paris Agreement on climate change.

To highlight the role of renewable energy in economic factors, urbanization, physical infrastructure and institutional quality, Islam et al. (2022) analyzed both consumption variables. Renewable and non-renewable energy in relation to those economic variables in quite detail. Specifically, the authors analyzed the effects of income growth, foreign direct investment, domestic investment, degree of urbanization, physical infrastructure, and institutional quality on energy consumption. Renewables and non-renewables in Bangladesh between 1990 and 2019 thanks to a dynamic ARDL model (DARDL model). Empirical findings show that income growth has both a positive effect on renewable energy consumption but a negative effect on non-renewable energy consumption. Domestic investment has a positive impact on renewable and non-renewable energy consumption. Foreign direct investment has a positive impact on renewable energy consumption. Urbanization negatively affects renewable energy consumption but urbanization positively affects non-renewable energy consumption. Physical infrastructure has a negative impact on renewable energy consumption and has a positive effect on non-renewable energy consumption. Institutional quality positively affects renewable energy consumption.

Commenting around the asymmetric link between renewable energy consumption, financial integration and ecological sustainability, emphasizing the mediating role of technological innovation and urbanization, Zhang et al. (2022) on case study of the world's top five major emerging economies (BRICS), including Brazil, Russia, India, China and South Africa. The authors assessed the impact of financial integration (globalization) on the ecological footprint. Other ecological footprint drivers were also mentioned, including economic expansion, urbanization, renewable energy and technological innovation. The study uses the data set from 1990 to 2018 as well as uses the method of moments quantile regression (MMQR). Empirical results show that the impact of financial globalization on ecological footprint is positive across all percentiles (0.1–0.90), thus leading to the acceptance of the bias hypothesis. Pollution haven hypothesis in BRICS countries. Furthermore, both renewable energy and technological innovation limit the ecological footprint across all percentiles (0.1–0.90). In addition, technological innovation has a positive impact on the environment across all percentiles (0.1–0.90) through urbanization. Therefore, technological innovation is expected to help BRICS countries achieve sustainable urbanization. The results used dynamic least squares (dynamic ordinary least square [DOLS], long-term corrected least squares [FMOLS], fixed effects – least squares [Fixed] effect - ordinary least square - FE-OLS) affirms the robustness of the results using MMQR.

In line with Zhang et al. (2022), Sun et al. (2022) analyzed the asymmetric impact of natural resources on ecological footprint: Exploring the role of economic growth, foreign direct investment (FDI) and renewable energy in the G-11 countries, instead of the BRICS group of countries. The analytical model used in this paper is a nonlinear delay self-distribution model. The authors also integrated the asymmetric effects of natural resources while addressing cross-sectional dependence and slope heterogeneity. Research results show that positive shocks on natural resources increase ecological footprint by 0.120% compared to negative shocks reduce ecological footprint by 0.072%. These results confirm the asymmetric impact of natural resources. Renewable energy has significant negative impacts, while economic growth reports a positive impact on ecological footprint. Furthermore, the results confirm the hypothesis of FDI in the long run. There is also a short-run relationship between the variables, with different

estimators and significance levels. Furthermore, a statistically significant negative error correction term represents a move towards long-run equilibrium.

Similar to the idea of studying ecological footprint as in Zhang et al. (2022) or Sun et al. (2022), but with the context of countries in Southeast Asia (ASEAN), Nathaniel and Khan (2020) studied the relationship between urbanization, renewable energy, trade, and ecological footprint in the period from 1990 to 2016. Energy consumption in the main ASEAN region mainly non-renewable energy, which can affect sustainable development. Cointegration and unit root tests were used in the analysis of empirical data. Empirical results show that economic growth, trade and non-renewable energy contribute significantly to environmental degradation in ASEAN countries. This shows that the area is growing at the expense of its environment. Other results include a one-way causality from urbanization to non-renewable energy consumption.

The issue of using renewable energy is an urgent issue in regional countries in Asia. That is why many studies have been done on the empirical data of these countries, for example Tiwari et al. (2022) conducted a study on the impact of stock market developments on the stock market. Renewable energy consumption, with comments on the role of FDI, trade openness and economic growth. Panel data set of 16 Asian economies for the period 1990–2019, analyzed using new techniques of percentile regression with panel data (panel quantile regression [PQR]). In particular, the empirical results provide empirical evidence of a negligible impact of stock markets on renewable energy consumption in the Asia region. The findings further describe that expanding commercial activities and enhancing economic growth can significantly reduce energy consumption through technical efficiency. In addition, the PQR results show that the development of equity markets encourages renewable energy projects in the high quintile (0.70) of countries with its developed equity markets. FDI encourages renewable energy consumption by promoting investments in lower Asian countries, where capital is relatively scarce.

With a space-time approach, Grodzicki and Jankiewicz (2022) analyzed the impact of renewable energy and urbanization on CO2 emissions in Europe. The study confirms that renewable energy use and the degree of urbanization have an impact on air quality – which in this paper is represented by the variable CO2 emissions. It should be clarified whether they have a positive or negative effect on the environment. Logical thinking suggests that generating energy from renewable energy sources will benefit air quality. However, no energy source, including renewable ones, does not create an environmental impact. The same holds true when studying urbanization, which is a phenomenon that in theory should produce more CO2 emissions. Therefore, the paper assessed the impact of renewable energy use and urbanization on CO2 emissions in Europe from 1995 to 2018. The spatial approach was chosen. Experimental results show that the level of CO2 emissions and urbanization gradually decrease to the East and gradually increase to the North, while the proportion of renewable energy use gradually increases to the North. The value of the share of renewable energy use and urbanization increases over time, while the level of CO2 emissions has decreased linearly over the years. The analysis demonstrated that increasing the share of renewable energy leads to less CO2 emissions, while increased urbanization harms air quality.

Continuing to discuss the relationship between urbanization, energy consumption, economic growth and CO2 emissions, Liu et al. (2023) experimentally with China's array data from 1995 to 2020 using the model PMG-ARDL. The urbanization variable was included in the model to determine its importance in the interaction between GDP growth, energy consumption and carbon emissions. Empirical results show that urbanization has no significant impact on immediate or long-term environmental quality. In addition, energy use has been shown to significantly increase harm to the environment both in the short and long term.

In an environmental perspective study on the impact of trade and natural resources on renewable energy use in sub-Saharan Africa taking into account foreign direct investment, income and urbanization trends, Dingru et al. (2023) asserted that trade has always been an important component of the economic development of many sub-Saharan African (SSA) countries, which is a resource-rich area. However, considering the environmental aspects of trade activities among rich natural resources is of great interest to position SSA countries with the goal of sustainable economic development. The analysis in this article uses an ARDL model for renewable energy consumption data in relation to other variables such as the income of countries. SSA, FDI and urbanization trends among countries in this region. The results show that commercial openness and urbanization have significant adverse effects on renewable energy consumption in SSA countries, while resource rents affect renewable energy consumption. Regenerate is insignificant. In contrast, rising income levels coupled with higher FDI are observed to lead to a significant positive impact on renewable energy use. This implies that poverty reduction and foreign capital flows can significantly promote renewable energy use in each SSA country.

Recently, Tan et al. (2023) continued to develop new variables in the study including financial technology development, renewable energy consumption, government efficiency and natural resource management. The data selected for the study was a table of 22 countries from 2006 to 2021. Using the panel-corrected standard errors (PCSE) approach helped calculate the experimental results. The results show that the development of Fintech positively affects natural resource management. Renewable energy consumption and FDI also significantly influence the natural resource management index. The research results also confirm the positive role of the government's effective natural resource management. In contrast, the role of urbanization is found to be negative, indicating that increasing urbanization places great pressure on the management of natural resources. This study has promising implications for the development of natural resource management policies.

3. RESEARCH METHODS AND RESULTS

3.1 Data Collection

In this study we use data from 6 typical Southeast Asian countries including: Vietnam, Thailand, Singapore, Malaysia, Indonesia

and the Philippines. Data collection period 2000 to 2020. Data is collected from World Bank, International Monetary Fund and some other statistical sources. The data is also treated for errors to ensure the best data quality used for quantitative research.

3.2. Research Methods

Based on the previous studies, we propose a research model as shown in the following equation regression:

$$EQ_{it} = \beta_0 + \beta_1 REN_{it} + \beta_2 FD_{it} + \beta_3 TO_{it} + \beta_4 URB_{it} + \beta_5 FDI_{it} + \varepsilon_{it}$$

Where:

EQ is a variable representing environmental quality, which is measured annually for CO2 emissions
REN is a variable that represents renewable energy use, measured by the amount of renewable energy used annually
FD is the variable that represents the level of financial development, measured by the expanded money supply M2 relative to GDP
TO is a variable that represents an economy's level of trade and is measured by trade openness relative to GDP
URB is a proxy for the country's urbanization rate and is measured by the total number of people living in urban areas relative to the population size.
FDI is a proxy for foreign direct investment.

Then, the research hypotheses are stated as follows:

H1: Using renewable energy REN has a positive impact on emissions reduction.
H2: Financial development has a positive effect on the ability to reduce emissions.
H3: Trade openness has a positive and statistically significant effect on emission reductions.
H4: The rate of urbanization has a negative impact on the ability to reduce emissions.
H5: Foreign direct investment has a positive effect on the ability to reduce emissions.

The study used the combined least squares regression method OLS, fixed effects FEM and random effects REM. The study also evaluates the influence of autocorrelation and variance in the regression model, and when this phenomenon occurs, the study performs regression according to FGLS to get the best results.

4. RESULTS

4.1. Descriptive Statistical Analysis

The results of descriptive statistics in Table 1 show that the CO2 reached an average value of 3.86 metric tons per capita and there has been a continuous increase in Southeast Asia in the period from 2020 to now. In terms of renewable energy use, this indicator is only 21.79% of total energy and tends to decrease slightly in most economies, reflecting the decreasing contribution of renewable energy in Southeast Asia. For financial development, this index averages 95.67% of GDP, and is a relatively high level reflecting the importance of money supply policy for regional economic growth. In terms of trade, Southeast Asia has a high level of foreign trade and is relatively integrated with other major economies. As for urbanization, Singapore has an urbanization rate of 100%, while other economies are smaller. At the same time, Singapore has a greater ability to attract FDI than other economies.

4.2. Correlation Analysis

Through the correlation analysis Table 2 shows that the pairs of independent variables have all correlations <0.8, so it is unlikely that multicollinearity will occur. The same is confirmed in Table 3 when the VIF coefficients are all <10.

4.3. Regression Analysis

The regression results in Table 4 show that the regression according to FEM is better than that of OLS (based on the F test). Similarly, according to Hausman test, regression according to FEM is also better than that of REM. So, it can be said that FEM can bring the best results. However, according to the test of variance and autocorrelation, the regression according to FEM both has problems in this regard, so the study performed regression according to FGLS.

In addition to testing the robustness of the estimated model, the study uses FE country regression analysis to assess the specificity of each country in the research model. Simultaneously, PCSE regression was performed to assess the dependence between countries, because the selected countries are located in Southeast Asia and have close relations with each other in terms of economy, foreign trade, and politics.

Research results show that: Variable REN has a negative impact on CO2 emissions, in the URB area has a positive effect. Other variables such as POP, TO and FD do not have clear evidence for

Table 1: Descriptive statistical analysis

Variable	Mean	Standard deviation	Min	Max
EQ	3.866625	2.953171	0.6482185	10.4571
REN	21.79275	15.97155	0.33	57.73
FD	95.67529	36.74034	36.00172	164.8682
TO	155.5073	105.5675	33.19059	437.3267
URB	56.51517	23.19203	24.374	100
FDI	5.668661	7.07992	-2.75744	32.16984

Source: Author's calculations

Table 2: Correlation analysis

Biến	EQ	REN	FD	TO	URB	FDI
EQ	1.0000					
REN	−0.9224	1.0000				
FD	0.6618	−0.6909	1.0000			
TO	0.8247	−0.7071	0.6109	1.0000		
URB	0.9032	−0.7473	0.3732	0.7729	1.0000	
FDI	0.6733	−0.5521	0.3801	0.7441	0.7195	1.0000

Source: Author's calculations

Table 3: VIF analysis

Variable	VIF	1/VIF
URB	8.77	0.114025
REN	8.36	0.119617
TO	7.08	0.141237
M2	5.00	0.199917
FDI	4.11	0.243528
VIF mean	6.66	

Source: Author's calculations

Table 4: Regression analysis

Variable	OLS	FEM	REM	FGLS	FE country	PCSE
REN	−0.0307**	−0.0244**	−0.0307**	−0.0307**	−0.0244**	−0.0307***
	(0.029)	(0.014)	(0.027)	(0.024)	(0.012)	(0.000)
FD	0.0215***	0.0026	0.0215***	0.0215***	0.0026	0.0215***
	(0.000)	(0.392)	(0.000)	(0.000)	(0.390)	(0.000)
TO	0.0036**	−0.0015	0.0036**	0.0036**	-0.0015	0.0036**
	(0.028)	(0.399)	(0.027)	(0.023)	(0.397)	(0.020)
URB	0.0777***	0.0767***	0.0777***	0.0777***	0.0767***	0.0777***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
FDI	−0.0297	−0.0212	−0.0297	−0.0297	−0.0212	−0.0297
	(0.118)	(0.122)	(0.115)	(0.106)	(0.119)	(0.152)
_cons	−2.2923**	0.1916	−2.2923**	−2.2923**	−1.2179	−2.2923***
	(0.029)	(0.845)	(0.027)	(0.023)	(0.158)	(0.000)
R-squared	0.9404	0.8579	0.9429		0.9829	
F test	F (5, 109) = 51.16 Prob > F = 0.0000					
The test of Hausman	χ^2 (5) = 468.03 Prob > χ^2=0.0000					
Variance	χ^2 (6) = 12251.81 Prob > χ^2=0.0000					
Autocorrelation	F (1, 5) = 37.194 Prob > F = 0.0017					

***, **, * are significance levels for 1%, 5% and 10% respectively. Source: Calculated by the author

CO2 and do not confirm the impact of these variables on the ability of CO2 emissions to cause greenhouse effects and environmental pollution.

Using renewable energy has the ability to reduce CO2 emissions that cause greenhouse effects and affect the environment. This evidence demonstrates the positive impact of economies on shifting from fossil energy to renewable energy and this shift has a positive impact on reducing environmental pollution. However, Southeast Asian countries, where the proportion of renewable energy use in the total energy is on a downward trend, partly reflecting the increasing use of renewable energy, which always faces many difficulties, especially difficulties in capital sources and difficulties in changing production activities of the economy. However, the benefits of using renewable energy are constant and sooner or later economies should switch to this energy source. Meanwhile, fossil energy sources are cheap and have large reserves, using this energy source can bring economic benefits in the short term, but in the long term, the economy must suffer negative impacts caused by environmental pollution and overall economic benefits can be reduced.

Increasing urbanization rate is often associated with labor movement from rural to city. Labor migration is taking place rapidly in most countries in the region. Although labor mobility gives low-wage rural workers access to higher-wage urban jobs and is the driving force behind the economy's consumption and production, ultimately economic growth. However, the process of urbanization also increases CO2 emissions, which adversely affects the economic and social environment and increases the burden that the economy has to pay. This poses a requirement to improve the quality of urbanization to optimize production activities and improve labor productivity to help the economy achieve the highest benefits and optimize the possibility of CO2 emissions into the environment.

5. CONCLUSIONS

Living environment is facing challenges day by day in the face of increasing pollution and leading to many consequences such as diseases, sea level rise, global warming climate, drought, floods and other economic and social consequences. The economies in Southeast Asia are shifting production towards cleaner production in order to protect the environment and develop the economy sustainably. Research in 6 typical Southeast Asian countries between 2000 and 2020, the research results confirm that the use of renewable energy has the potential to improve environmental quality because this process has the ability to reduce CO2 emissions into the environment. However, increasing urbanization rate has a negative impact on environmental quality because urbanization is associated with labor mobility and increased CO2 emissions. The study found no impact between population size, financial development, and foreign direct investment on CO2 emissions.

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