

NON-LINEAR IMPACT OF ENERGY CONSUMPTION ON CO₂ EMISSIONS IN ASEAN-5 COUNTRIES

SIMON HIEW ^{1*}, JEROME KUEH ² and NOR AFIZA BINTI ABU BAKAR ³

^{1,2,3} Faculty of Economics and Business, Universiti Malaysia Sarawak (UNIMAS), Sarawak, Malaysia.

Email: ¹simonhiewxizen@gmail.com (*Corresponding Author), ²kshjerome@unimas.my, ³abnafiza@unimas.my

Abstract

Using the panel autoregressive distributed lag/pooled mean group estimator (ARDL/PMG) and non-linear autoregressive distributed lag (NARDL) approaches, this study seeks to examine the linear and non-linear impact of energy consumption on CO₂ emissions for the panel of ASEAN-5 countries (Indonesia, Malaysia, Thailand, the Philippines, and Singapore) over a period of 31 years (1990-2020). The empirical research revealed that all the explanatory variables, including energy consumption, have a negative impact on ASEAN-5's CO₂ emissions in the long-run. In the short-run relationship, energy consumption has a statistically significant effect on CO₂ emissions in the ASEAN-5, whereas the other explanatory factors have statistically insignificant effects. In addition, empirical results indicate that positive shocks of energy consumption reduce CO₂ emissions, whereas negative shocks to energy consumption contribute to an increase in CO₂ emissions in ASEAN-5 countries, indicating that the sources of energy move towards renewable energy sources in the long-run. In the short-run, the positive shock of energy consumption caused environmental damage, although the other variables suggest minor effects. This is because the ASEAN-5 tends to rely on fossil fuels to create energy in the short-run, resulting in an increase in CO₂ emissions. To improve energy efficiency, however, policymakers should impose appropriate policies and investment programs. The policymakers should also stimulate research and investment to enhance the generation of renewable energy sources. Lastly, ASEAN-5 should dedicate greater resources to the development of green technology.

Keywords: CO₂ Emissions, Energy Consumption, Non-Linear Analysis, ARDL/PMG Approach, NARDL Approach.

JEL codes: H23, K32, O13, O44, P28, Q56

INTRODUCTION

Climate change and global warming are instances of anthropogenic catastrophes that jeopardize the biodiversity of the Earth. The prominent global consequences of climate change include alterations in weather patterns and the escalation of sea levels. These changes pose a threat to food production and heighten the probability of catastrophic floods. The United Nations has acknowledged the significance of these exceptional events (UN, 2021). Bekun et al. (2019) argue that the principal factor behind climate change is the rising concentrations of carbon dioxide (CO₂) present in the atmosphere. BP's analysis reveals that the rise in CO₂ emissions in 2021 can be attributed to increased energy consumption, industrial operations, flaring, and methane emissions (measured in terms of carbon dioxide equivalent), collectively accounting for a 5.7% increase. Specifically, there was a 5.9% increase in carbon dioxide emissions, reaching the same levels as in 2019. The study reported a marginal rise of 2.9% in CO₂ emissions resulting from flaring, but emissions from methane and industrial activities exhibited a 4.6% increase. The primary driver behind the increase in CO₂ emissions is the substantial energy consumption, predominantly derived from fossil fuels such as coal, oil, and gas. The

majority of greenhouse gas emissions, accounting for almost three quarters, and about ninety percent of carbon dioxide emissions are derived from fossil fuels, establishing them as the primary catalyst for climate change (UN, 2021). The release of CO₂ emissions creates a barrier that captures solar heat, leading to climate change and global warming. The phenomenon of global warming is currently experiencing unprecedented acceleration on our planet. This phenomenon is causing several hazards to both humans and the environment, as it alters weather patterns and disrupts the natural equilibrium.

The ASEAN-5 nations, part of the Association of Southeast Asian Nations, face considerable vulnerability to the effects of global warming. As per the analysis in the 5th ASEAN Energy Outlook, there is an expected threefold increase in energy consumption by 2040. This represents a growth rate that is twice as high as the global average, almost 4% every year. Presently, electricity constitutes 18% of the overall energy consumption. Nevertheless, it is projected to undergo substantial expansion and attain a 26% share by 2040, aligning with the global average (EIA, 2019). The coal consumption in the ASEAN region is now seeing the highest growth rate globally in terms of energy demand. The energy output in the ASEAN area is predominantly contributed by four nations, namely Indonesia, Malaysia, Thailand, and the Philippines, which collectively account for over 90% of the total energy production (Suryadi, 2020). Out of the total installed capacity of 235.4 GW in ASEAN in 2017, more than 68.1% was derived from gas and coal sources. Nevertheless, hydrogen secured the third position in terms of installed capacity, amounting to 46 GW (ASEAN Focus, 2019).

The energy sector within the ASEAN-5 nations has emerged as the primary driver of climate change and the consequential surge in carbon dioxide emissions, thereby presenting formidable challenges for the well-being of humanity. Multiple research studies underscore the correlation between the escalation of CO₂ emissions and the consequential environmental deterioration, with energy consumption playing a pivotal role (Munir et al., 2019; Vo et al., 2019; Alharthi et al., 2021; Salari et al., 2021). The ASEAN-5 countries find themselves particularly susceptible to the escalating levels of CO₂ emissions, a situation that not only heightens the perils of climate change but also exacerbates global warming, thereby adversely affecting the economic and societal progress of nations. Indonesia, the Philippines, and Malaysia have borne the brunt of climate-induced disasters, experiencing the most pronounced human and economic tolls (Ding & Beh, 2022).

Furthermore, in light of the abundant recent research exploring the nexus between energy consumption and CO₂ emissions (for instance, Zhu et al. (2016), Munir et al. (2019), Vo et al. (2019), Munir & Riaz (2019)), the primary aim is to elucidate the intricacies of this relationship. It is crucial to tailor policy frameworks to accommodate the curvilinear correlation between these variables, in contrast to the linear correlation emphasized by Chunyu et al. (2021). Previous studies have predominantly focused on the linear connection between energy consumption and environmental impact, often neglecting the repercussions of CO₂ emissions on ecosystems when energy usage surpasses a specific threshold. This critical aspect is frequently overlooked in research endeavors. The ASEAN-5 member states consistently exhibit the highest energy demand compared to other nations in the group. Policy formulations