



The effects of FDI, economic growth and energy consumption on carbon emissions in ASEAN-5: Evidence from panel quantile regression



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ABSTRACT

This study investigates the impact of foreign direct investment (FDI), economic growth and energy consumption on carbon emissions in five selected member countries in the Association of South East Asian Nations (ASEAN-5), including Indonesia, Malaysia, the Philippines, Singapore and Thailand. This paper employs a panel quantile regression model that takes unobserved individual heterogeneity and distributional heterogeneity into consideration. Moreover, to avoid an omitted variable bias, certain related control variables are included in our model. Our empirical results show that the effect of the independent variables on carbon emissions is heterogeneous across quantiles. Specifically, the effect of FDI on carbon emissions is negative, except at the 5th quantile, and becomes significant at higher quantiles. Energy consumption increases carbon emissions, with the strongest effects occurring at higher quantiles. Among the high-emissions countries, greater economic growth and population size appear to reduce emissions. The results of the study also support the validity of the halo effect hypothesis in higher-emissions countries. However, we find little evidence in support of an inverted U-shaped curve in the ASEAN-5 countries. In addition, a higher level of trade openness can mitigate the increase in carbon emissions, especially in low- and high-emissions nations. Finally, the results of the study also provide policymakers with important policy recommendations.

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1. Introduction

In recent years, climate change and global warming have emerged as some of the most serious problems facing the international community. The human effect on the climate system is clear, and the recent anthropogenic emissions of greenhouse gases, especially carbon emissions, are the highest in history. Climate changes have had a widespread influence on human and natural systems.¹ Therefore, across the world, a considerable amount of attention has been paid to controlling carbon emissions and developing a low-carbon economy. The two most important variables related to environmental degradation are economic growth and energy consumption. Although they have become decisive factors in environmental pollution, the majority of studies limit their analyses only to environmental pollution, particularly CO₂ emissions, which correlate with energy consumption and economic growth. Energy consumption and economic growth alone may not explain CO₂ emissions (Zhang,

2011; Ozturk and Acaravci, 2013). Therefore, we need to consider other variables that are associated with carbon emissions.

Although FDI has become increasingly important, few details have been discussed in this regard, especially in the ASEAN context. Indeed, the rising FDI flow in developing countries raises an important question regarding whether it has any environmental consequence (Zeng and Eastin, 2012). Therefore, research on the effect of FDI on carbon emissions is necessary. Although ASEAN is active in attracting FDI, previous studies lack an analysis of the complexity correlation of FDI and CO₂ emissions as well as the causality, which leads to poorer discernment in the pollution haven hypothesis. The conventional view may suggest that, with relaxed environmental standards in developing countries, FDI may promote CO₂ emissions at large (Pao and Tsai, 2011). To attract foreign investment, developing countries have a tendency to ignore environmental concerns through relaxed or non-enforced regulation; in economic theory, this phenomenon is designated the pollution haven hypothesis. However, the effect of FDI can be inverted when low-carbon technologies are introduced to reduce the carbon dioxide emissions by FDI as a whole or when FDI flows to focus on the service industry. It is believed that foreign companies use better management practices and advanced technologies that are conducive to a clean environment in host countries (Zarsky, 1999), which is known as the halo effect hypothesis. Similarly, Zeng and Eastin (2012) find that overall

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¹ IPCC (Intergovernmental Panel on Climate Change), 2014, climate change 2014 synthesis Fifth Assessment Report.

FDI inflows in less-developing countries promote better environmental awareness.

In addition to these issues, existing studies also fail to find evidence of a consensus concerning the impact of economic growth on CO₂ emissions. Although the Environmental Kuznet Curve (EKC) hypothesis postulates an inverted U-shaped relationship between economic growth and CO₂ emissions, there is some evidence that the EKC hypothesis is a linear relationship (Khalid and Muhammad, 2013) and an N-shaped relationship (He and Richard, 2010), and some find that the EKC hypothesis is invalid. Several reasons may explain the considerable differences in conclusion: The samples used for analysis are different; the model and the method employed to estimate the relationship vary; and the control variables included in the model are diverse (Narayan and Smyth, 2009; Rafiq and Salim, 2009; Esteve and Tamarit, 2012). We argue that the main shortcoming of these studies is that the result may be biased due to neglect of distributional heterogeneity. In this paper, we examine the determinants of CO₂ emissions considering distributional heterogeneity in panel quantile regression framework.

The impact of energy consumption on CO₂ emissions is also controversial. Some studies find that energy consumption has a positive effect on CO₂ emissions (Acaravci and Ozturk, 2010; Pao et al., 2011), whereas some studies show that CO₂ emissions are not attributable to energy consumption (Salim et al., 2008; Apergis et al., 2010; Menyah and Wolde, 2010). One of the limitations of previous studies is that they involve only two or three variables and thus suffer from omitted-variable bias. Therefore, to avoid omitted-variable bias, we consider relevant variables as control variables. According to the previous literature, such as the studies by Shi (2003); Boutabba (2014); Rafiq et al. (2015) and You et al. (2015), we choose trade openness, population size, the industrial structure, and financial development as control variables.

The motivation behind using a panel quantile regression fixed effect model on emissions is threefold: First, we employ the panel data framework to research the determinants of CO₂ emissions in ASEAN countries because it has the advantage over focusing on a single country of providing more informative data, more variability, more degrees of freedom and thus greater efficiency in estimation (Lean and Smyth, 2010). Moreover, panel data model accommodates the special heterogeneity indicated by region-specific, non-observable and time-invariant intercepts. In addition, many of the environmental problems confronting ASEAN members have a trans-boundary character and thus demand a collective response. Therefore, it makes sense to examine the determinants of CO₂ emissions for ASEAN countries within the panel data framework. Second, this method can describe the entire conditional distribution of the dependent variable; therefore, it helps us obtain a more complete picture of the factors associated with pollutant emissions. Specifically, quantile regression estimators provide one solution to each quantile. Using this methodology, we can assess the determinants of emissions throughout the conditional distribution, especially in the countries with the most and least emissions. From a policy perspective, it is more interesting to know what occurs at the extremes of a distribution. By contrast, OLS regression techniques are not suitable for making environmental protection policies for high-emissions countries. Third, the panel quantile regression estimation results are robust to outlying observations of the explained variable and are more effective than OLS regression, especially when the error term is non-normal, which will help policymakers formulate more accurate environmental protection policies. However, only a few papers have applied a panel quantile regression fixed effect model to investigate the relationship among variables (Damette and Delacote, 2012; Flores et al., 2014; Yaduma et al., 2015).

Therefore, we use a panel quantile regression fixed effect model to explore the impact of FDI, economic growth and energy consumption on carbon emissions in five selected ASEAN countries. This paper makes three contributions: First, this study provides a more detailed description of the determinants of carbon emissions throughout the

conditional distribution, especially in the highest and lowest quantiles. This approach provides a new perspective to understanding how the factors impact carbon emissions. Specifically, the analytical method of this study allows us to ascertain the validity of the pollution haven hypothesis, the halo effect hypothesis and the EKC hypothesis in five selected ASEAN countries. Second, certain related control variables are included in our model, which may resolve the omitted-variable bias problems that previous studies have faced. This issue has often been overlooked in previous studies, despite its importance (Lean and Smyth, 2010). Third, because of the method used, we find that economic growth and population have a negative effect on carbon emission among the high-emissions countries, in contrast with the previous findings. Therefore, the results of this study are also expected to provide useful information to policymakers in drafting effective environmental and economic growth policies.

The remainder of the paper is organized as follows. Section 2 is a brief introduction on the ASEAN context. Section 3 reviews the related literature. Section 4 introduces the methodology and data. Section 5 presents the empirical results and analysis. Finally, the conclusion and policy recommendations are presented in Section 6.

2. The ASEAN context

The selected ASEAN countries (ASEAN-5), i.e., Indonesia, Malaysia, the Philippines, Singapore, and Thailand, have developed well economically compared with other ASEAN members. These five countries were the original founding members of ASEAN in 1967, and they remain the most influential members of ASEAN in the 21st century. Among the ASEAN countries, in terms of per capita income in 2011, Singapore (USD 34,758) ranked the highest, followed by Malaysia (USD 6318), Thailand (USD 3163), Indonesia (USD 1570) and the Philippines (USD 1403). ASEAN's average annual economic growth rate remained above 5% from 2000 to 2013, which far exceeds the OECD average (1.6%) and is comparable to the growth experienced by India (7.2%) and Africa (4.8%).² The continuous growth of the ASEAN-5 raises an interesting question among policymakers. Have the ASEAN-5 suffered the Kuznets effect and hence reached a certain income threshold to reverse the influence of economic growth on carbon dioxide emissions? Similarly, the increasing per capita income may also significantly contribute to environmental pollution. Therefore, given the impressive growth rate of these countries in the past, validating and testing this hypothesis is necessary.

Experts expect that growth in the ASEAN energy demand will be higher, with an average annual rate of 4% compared with the world average of 1.8%.³ Indeed, there is evidence that higher fossil fuel use will become a challenge for policymakers, especially in terms of managing the issue of climate change. CO₂ emissions are expected to increase by 5.1% annually as a result of primary energy consumption. According to the latest statistics, ASEAN's share of global emissions, which was 4% in 2013, is small, but it will nearly double by 2040. CO₂ emissions grow at a faster pace than the primary energy demand because of the increasing share of coal in the energy mix.⁴ The goal of the ASEAN Vision 2020 is to pursue a consistent approach to regional cooperation in pooling and maximizing the efficient utilization of resources. Indeed, ASEAN's position in playing an important role in reducing the emissions footprint proves the importance of understanding the sources of emissions and their determinants.

The impact of FDI on carbon emissions has received considerable attention in developing countries (He, 2006; Kearsley and Riddell, 2010), but apart from a few studies, little is currently known with respect to ASEAN (Elliott and Shimamoto, 2008; Atici, 2012). By attracting a significant amount of FDI inflows to increase investment, ASEAN countries

² World Energy Outlook Special Report 2015: Southeast Asia Energy Outlook 2015.

³ IEA. World Energy Outlook 2009. Paris: International Energy Agency.

⁴ World Energy Outlook Special Report 2015: Southeast Asia Energy Outlook 2015.

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