

A Quantitative Analysis of the Induced CO₂ Emissions Structure of ASEAN

Topic: Input-Output Analysis: Trade and Global Value Chains policies (2)

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Over the past quarter century, globalization has advanced significantly, bringing transformations to global affairs in terms of people, economies, and politics. Among these changes, the ASEAN region has assumed an increasingly important role. Many ASEAN countries possess relatively low-cost labor forces and thus serve as key suppliers of intermediate goods. As a result, the region has become highly attractive to multinational corporations as both a production base and a consumer market.

While China once exerted substantial global influence as the “world’s factory,” recent geopolitical risks and shifting tariff policies have prompted firms to reconsider their supply chain configurations. In this context, the ASEAN region can be understood as functioning as a “geopolitical buffer zone,” offering diversification and risk mitigation within the evolving international economic order.

Often referred to as a global growth center, the ASEAN region is experiencing a surge in energy demand driven by rapid economic expansion and population growth. Over the past seventy years, ASEAN’s population has increased approximately fourfold and is projected to reach 790 million by 2050. This demographic and economic momentum raises concerns regarding the stability and sustainability of future energy supply in the region.

The ASEAN region continues to exhibit a high dependence on relatively inexpensive and abundant fossil fuels, while the share of renewable energy remains comparatively low. As energy demand expands, greenhouse gas (CO₂) emissions associated with fossil fuel-based energy consumption are expected to increase. Moreover, fossil fuels are used directly and indirectly as raw materials and energy inputs across industries through complex supply chains, generating substantial CO₂ emissions throughout the ASEAN industrial system.

Given the dense and interconnected production networks within the ASEAN region, as well as emissions induced by demand from countries outside the region, it is essential to quantitatively assess both direct and indirect CO₂ emissions attributable to ASEAN’s economic activities.

To quantify the CO₂ emissions generated in ASEAN countries, this study utilized the GLORIA database, which provides the 2019 multi-regional input-output table (MRIO) covering 164 countries and 120 industrial sectors. Using environmentally-extended input-output analysis (EEIOA), we estimated direct and indirect CO₂ emissions for each of the 10 ASEAN countries induced by global final demand. By decomposing the MRIO into ASEAN and non-ASEAN components, we distinguished CO₂ emissions induced within and outside ASEAN, enabling discussion of emission responsibility and carbon leakage. Additionally, using a skyline chart, total emissions were decomposed into final demand and emission intensity components to identify the factors contributing to emissions.

The results indicate that the Building Construction sector in Indonesia exhibits the highest level of CO₂ emissions, amounting to 113,574 kt-CO₂. Substantial CO₂ emissions are also observed in Indonesia’s electricity sector and in the gas fuel sector in Vietnam. These elevated emission levels can be partly attributed to the role of these countries as major production hubs, particularly in manufacturing, supported by significant inflows of foreign direct investment (FDI). These findings

underscore the importance of identifying which regions are responsible for inducing CO₂ emissions generated within the ASEAN region. A clearer understanding of the geographical sources of demand driving these emissions is essential for designing coordinated decarbonization strategies.

Furthermore, ASEAN member states and non-ASEAN countries were aggregated and treated as single regions, and CO₂ emissions embodied in net trade between the two regions were analyzed to examine the potential for emission transfer to the ASEAN region. The results indicate that 260,990 kt of CO₂ were emitted within ASEAN to satisfy final demand in non-ASEAN countries, whereas 199,114 kt of CO₂ were emitted in non-ASEAN countries to meet final demand in ASEAN member states. These findings suggest the possibility of emission transfer from non-ASEAN countries to ASEAN, particularly in relation to the production of final goods.

This study employs an input–output modeling framework to estimate direct and indirect CO₂ emissions embodied in ASEAN supply chains. Furthermore, it identifies in detail the sources of demand—both within and outside ASEAN—that drive these emissions. Based on the structural characteristics and national contexts of individual ASEAN member states, the study discusses policy implications for advancing decarbonization strategies in the region.