THE EFFECTS OF URBANIZATION ON ENERGY CONSUMPTION AND GREENHOUSE GAS EMISSIONS IN ASEAN COUNTRIES: A DECOMPOSITION ANALYSIS

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Overview

Due to the rapid economic development of the Association of South East Asian Nations (ASEAN) countries since the mid-1980s, the ASEAN region has emerged as a growth center of the global economy. As ASEAN countries continue to pursue their economic goals, energy demand is projected to almost double in the region by 2035, which will cause CO_2 emissions in the region to increase threefold. As a result, ASEAN countries could face resource shortages and reduced environmental quality problems in the near future. The pressure on energy security and global environmental stability is not only placed on the shoulders of individual countries but on all countries in the region.

Energy consumption and emissions from energy use are influenced by abundant factors like economic growth, economic structure and population growth. In the context of sustainable economic development, while all ASEAN countries have attempted to reduce the growth rate of energy consumption and the emissions from energy activities, a new challenge is arising in the form of rapid urbanization. According to the World Urbanization Prospects 2014, "no country in the industrial age has ever achieved significant economic growth without urbanization". To support further development, therefore, the ASEAN governments are also advocating urbanization. As a consequence, the percentage of people living in urban areas is projected to increase from 47% today to 56% in 2030 and 67% in 2050. This poses questions related to the effects of urbanization on energy consumption in this region. Understanding these factors is of first-order importance for academics and policy makers in order to address energy-hungry economies.

In summary, the objectives of the paper are to (1) estimate the urbanization effect on energy consumption and emissions from energy use based on different indicators and according to the contribution of other effects (population, economic development…); (2) compare the effects between ASEAN countries; (3) draw some conclusions about the implications for policy makers in the context of economic development and urbanization. Follow that, this abstract describe a brief of methods, some first results, and orienting analysis.

Methods

In this field of research, regression methods pose limitations in multi-tiered analysis, especially when applied to diverging influences on energy use from national sector levels to sectorial levels. The decomposition method on the other hand, has proved to be an effective and powerful tool to explain the changes and impacts that occur in any variables over time or space.

To gain a better understanding of the mechanisms of changing energy use under economic and urbanization pressure, with limited available data, this paper employs the index decomposition analysis (IDA) method with a top-down approach, for the period from 1995 to 2013 in ASEAN.

The decomposition is carried out according to Eq. (1).

$$\Delta C_j = \Delta C_{emf} + \Delta C_{mix} + \Delta C_{int} + \Delta C_{str} + \Delta C_{act} + \Delta C_{de} + \Delta C_{rsd} \quad (1)$$

This IDA method is used to separate 6 factors effected to total emission changes from sector j - ΔC_j including activity change (activity effect - ΔC_{act}), modification of activity composition (structure effect - ΔC_{str}), changes in sectorial energy intensity (intensity effect - ΔC_{int}), adjustment of used energy types (energy mix effect - ΔC_{mix}), changes in emissions from different type of energy used (emission-factor effect - ΔC_{emf}) and especially demographic changes (demographic effect - ΔC_{de}). Thereby, demographic effects are compared between population (Po), urban population (Urban 1) and non-agricultural workers (Urban 2), which represents a novelty in the approach.

Results

This paper compares the different results obtained by calculating with thte LMDI[1] 2 different approaches that are additive and multiplicative approach. Some small errors are caused by adjusted zero-value data for the LMDI method, but these are acceptable.

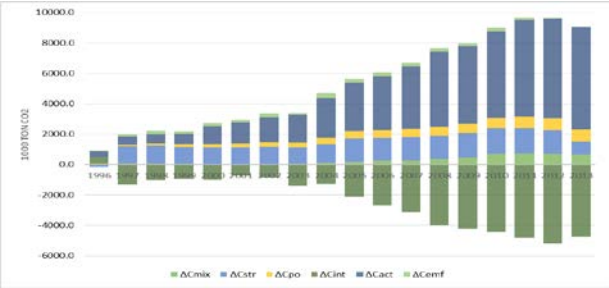

Fig 1. The relative effect of the factors on annual emissions

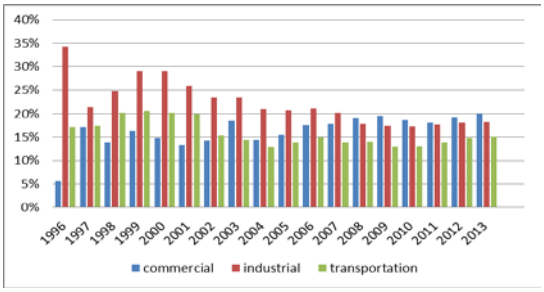

Fig 2. The effect of urban population on emissions for each sector

After calculating with absolute values and decomposing the aggregate energy consumption trend, the index number is used to compare across countries and sectors and analyze long term trends of each factor on energy consumption and emission changes over the last two decades, as well as the dynamics of sectorial contribution to overall energy use changes.

Overall, except for the energy intensity effect, the other effects including urbanization drive the increasing trend of energy consumption and emissions. Besides, from the calculation results, the impact of demographic factors on energy consumption and emissions seems not as strong as the intensity and activity effects, but it has grown gradually during the assessed period (1995-2013).

The results also show that the effect of non-agricultural workers is the largest among the considered demographic factors. The different effect levels also relate to separate costs and benefits among different stakeholders. Urban 1 relates to the general effect like rural-urban migration, whereas Urban 2 represents the effect of urban pull factors with industrialization and urban-biased policies. The larger Urban 2 factor reflects the growth in industrial-bias development in this region.

When comparing the effect of urbanization on sectors over the region, changes in both urban dwellers and employees in the non-agricultural field had the largest effect on increasing energy consumption and emissions in households, while their influence seems to have a marginal difference between commercial and industrial sectors. Based on these results, the paper discusses the reason for the higher effect of urban indicators than population as well as the higher non-agriculture worker indicator than urban population.

The paper also compares the urban effects across countries and sectors to give suggestions of sectorial priority in conducting energy efficient measurements. The paper also suggests an alternative measurement to control energy consumption and emission in ASEAN. This system is a tool to rank and give a best practice for each country by identifying the best combination of the considered factors.

Conclusions

While there has been controversy about the effect of urbanization on energy consumption and emissions, this paper proved the significant positive effect of urbanization in ASEAN, not only on whole energy consumption but also each energy user sector. Moreover, the paper will propose a uniform approach for all ASEAN countries to design and analyse multi-factors on energy consumption and emissions. The benchmark function is established based on a individual target benchmark for each country and it could be impoved for a broad class of several countries.

Although urbanization is a larger driving force of energy consumption in the household rather than in industrial, transportation and commercial sectors, rapid urbanization has caused much pressure on energy demand in this region when they want to re-adjust the economic structure in an industrial direction. In the context of managing the consumption of non-renewable resources, urbanization is one of the reasons for increased energy consumption, especially fossil fuel, and it is even worse when it directly creates the difficult challenge of mitigating air, noise pollution and controlling wastes. As a result, policy makers should consider encouraging decentralizing urban areas associated with decentralized energy supply in order to develop renewable energy supply networks in the context of growing cities.

[1] LMDI: Log mean divisia index

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