[*PAPER/POSTER TITLE*]

Integrated Assessment of Low-Carbon Urban Planning Policies using a Dynamic Computable Urban Economic Model

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Overview

Since the last few decades, China has been experiencing very rapid urbanization all over the country. In this wide wave of urbanization, different urban planning policies shape the various forms of cities and influence the daily life patterns of several generations of residents. Considering the deep impacts of urban planning policies, it is very important to have an integrated assessment of these policies' city-level impacts from long-term viewpoint. However, current integrated assessment models (IAMs) applied in this field either focus on the country or global level or only consider the static analysis of a base year, and there is a research gap on using IAM to analyze the long-term impacts of city-level urban planning policies. Besides, as global warming becomes more and more serious, low-carbon development also becomes an important issue when formulating urban planning policies. To study the long-term impacts and complete the low-carbon analysis of city-level urban planning policies, this paper uses a dynamic computable urban economic (CUE) model and constructs 3 different urban development scenarios from the perspectives of land, transport and population. Taking the Chinese city, Changzhou, for numerical simulation. It shows that a sustainable urbanization scenario in terms of moderate growth of population, fast growth of electric vehicles and compact city planning, could help reduce the carbon emission from transport by 40% in Changzhou by 2030.

Methods

The methodology mainly consists of three parts: the construction of a city-level CUE model and urbanization scenario design.

To build a city-level CUE model, we follow the methodology of a traditional CGE/CUE model and analyse the urban planning policies in a closed city model. In the model, there are i zones in the city and the land area for each zone is A_i, and households and firms can decide their locations in any subset of zones. We assume that firms produce products by using labor and land, with constant returns to scale property. The products are zone-specific and the differentiation is caused directly by the location differentiation, and the products in the same zone are homogeneous. Consumers travel to different zones to buy differentiated products as essential goods, and one unit of a single commodity is purchased per trip. Based on utility maximization, households decide their residential, employment and shopping zones in the city, and households also decide different transportation modes for commuting and shopping. We will use user equilibrium methods for transport optimization to satisfy the transportation needs of households, and calculate the CO_2 emission from transport in the city. In brief, this closed-city model implicitly determines location choice of firms and households, and calculate the resulted GHG emission.

In the next step, we need to design 3 urbanization development scenarios utill 2030. Learning from the shared social-economic pathways (SSPs), we propose 3 sustainable scenarios for our simulation, where S1 is a sustainable scenario, S2 is a middle-road scenario and S3 is the least sustainable scenario. In each scenario, the main assumptions are made on population growth, newly added land area in each zone and transportation mode change.

1) Population growth: the SSPs give assumptions on national population growth rate in different scenarios. We assume the same population growth rate in our city model as the national level. Based on the population of the base year, we can draw the population in different scenarios.

2) Newly added land area in each zone. The Changzhou city has already a plan for adding a certain amount of land, but the added location has not been decided. From Zhang et al. (2016), we learn that compact city mode is more sustainable in terms of carbon emission and traffic cost. Thus, we assume in SSP1, all the newly added land will be supplied from suburb zones; in SSP2, the newly added land will come from evenly from all the zones; in SSP3, the newly added land come from central zones.

3) Transportation mode change. Electric Vehicles (EV) are becoming more and more popular and the government regards it as an important solution to solve the traffic pollution problem. We also introduce electric vehicles into our model, and its market percentage increases fastest in the most sustainable scenario SSP1, and slowest in the least sustainable scenario SSP3.

Results

The result shows the accumulated influence of city planning strategies, and prove that current urban planning decisions will have a long-term influence. In the case of Changzhou, compared to the CO_2 emission in the least sustainable scenario SSP3, the emission will be reduced by 20% in a middle road scenario SSP2, and by 40% in a most sustainable scenario SSP1.

Conclusions

This dynamic CUE model integrates the interactive mechanism among land use and transport in a closed-city model, and analyses the long-term and environmenttal impacts of different urban planning policies. By introducing three urbanization scenarios, it also provides solid quantitative on how sustainable development strategy could help us achieve economic growth as well as environmental protection goals at the same time.

However, there are still many other issues to be solved in the future. First, we only consider one common commodity in our current closed-city model, and it would be better to further develop the model with multiple types of commodities and open-city assumption. Second, we do not distinguish different types of households and firms, and it would also be better to distinguish the different type of needs among households and firms. Third, we could also consider more detailed sources of city-level carbon emission, like the emissions from production and household consumption.