# Integrating model of CGE and CUE modelling for evaluation of urban transport projects

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## INTRODUCTION

Urban transport projects generate indirect economic effects other than direct effects by being reduced required transport times, such as locating change of households and firms, creation of employment and expansion of firm products or household incomes. The CUE (Computable Urban Economic) model has been built to evaluate influences on locating change in the indirect effects by Muto, Takagi and Ueda (2003) or Ueda, Tsutsumi et al. (2012). The CUE model is based on urban economic models and Land-use/Transport interaction (LUTI) models, and characterized in modelling fully based on microeconomics foundation, so that it can evaluate urban transport policies consistently with welfare economics and cost benefit analysis. However, the CUE model is partial equilibrium focus on only land markets, so that it cannot evaluate indirect effects on the creation of employment and the expansion of firm products or household incomes. Because the creation effects of employment occur through the labor market and the expansion effects of products or incomes are generated by the markets of commodities or factors. It is important task to expand the CUE model to general equilibrium formulation.

The CGE (Computable General Equilibrium) model is another analytical model of the public policies for the CUE model, which outputs equilibrium price or quantity in all markets. Because the CGE model is the general equilibrium formulation, it can evaluate the all indirect effects that include the creation effects of employment or the expansion effects of products and incomes. However the CGE model is not treated the region as divided spaces or areas. Although the SCGE (Spatial CGE) model which incorporated the concept of space to the CGE model has been developed, the SCGE model is necessary to the interregional input-output table for objective region in principle. Because we will apply the model to detailed areas and it is difficult to make the interregional input-output data for such areas, we resigned to apply the SCGE model.

In this paper, we try to expand the CUE model to general equilibrium form that is called the integrating model of CGE and CUE modelling. We will build the urban economic model, though the CUE model is focusing on only land markets, new type model is incorporated all market equilibrium of commodities or factors. Although the integrated

model is similar to the idea of Anas (1987) that has applied a discrete choice model to locating behavior based on general equilibrium formulation, we will adopt the location behavior formulation by CES function approach to keep consistency to the CGE model. And we will treat the markets separately by the integrated market cleared for whole urban area and the market cleared for each zone. By the modelling, the integrated model becomes to be considered the balance of appropriate computational complexity and necessary information.

## THEORETICAL FRAMEWORK

We suppose that an urban area is divided in the some zone. In each zone there are households, a representative *m* good producing firm and a real estate firm who provides land services.

The behavior of agents is explicitly formalized as expenditure or cost minimizing in framework of CGE model. Although the interactions at the inside of markets are modeled as a price adjustment mechanism, the agriculture good, manufacture goods and factors are adjusted prices at integrated markets for whole urban area, and commercial, private service and real estate service are adjusted prices at market for each zone.

Outline of the locating mechanism in this model is as next. At first, the amount of firms' products is determined for each zone depending on the demand volume. The volume of labor inputs is decided from firms' products, and its employee chooses the locating zone based on his utility mainly determined by the accessibility of commuting trip and private trip such as shopping or amusing and so on. This location choices are modeled to all firms' employee in each zone. Although the volume of location is increasing at a zone of higher accessibility, we assume that household who will locate a zone should be consumed real estate service at the locating zone. The real estate firm produce the service by inputting only capital of its zone, so the capital rent of increasing location zone is rising and the real estate service price also is rising. The location equilibrium that household has no incentive of locating change is accomplished.

The Household determines where zone he works, that is decided from the balance to firms' inputting labor volume. A represent household who decide on working at a zone chooses zone where he generates commuter trip from, and this zone choosing behavior is interpreted as household's location choice behavior. By determining the locating zone, the amount of household income spent at the zone is obtained, so the amount of expenditure is also yielded. Household decides of consuming volume of commodities/services so as to minimize his expenditure under keeping constant his utility level, and when consuming commodities/services, it is necessary to input

transport services.

Transport sectors are also characteristic in the point of being incorporated explicitly those producing behaviors in our model. Freight and passenger transport sectors are assumed to produce transport services by inputting the required time added labor and capital, so when the required time is reduced, the efficiency of labor and capital inputting improves. And reducing the transport prices brings to spillover effects to households or firms.

## FIRST RESULTS

We applied this integrating model to evaluation of Yamanashi Ring Road Project. The Ring Road is in Kofu city, Yamanashi, Japan and has the total length of 43 km. It is expected the effects by decentralizing traffic volume or locating firms and households.

We calculated the integrating model and obtained the results of products of each firm, inputting labor, inputting freight and passenger road transport including self-transport of firms and households respectively, locating volume of household and zone incidence benefit. The accessibilities are rising not only around Yamanashi Ring Road that is carried out the project, but also around central area of Kofu city, because the traffic volume of central area of Kofu city is decentralized. The locating volume of household and area incidence benefit also are increasing around the Ring Road and around central area of Kofu city.

Total benefit is about 40 million yen, and cost benefit ratio is 3.3. The Ring Road brings significant effects to Kofu urban area.