A Dynamic Rural-Urban-Natural Environment Interactive Spatial Model of a City in Indonesia

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1. Introduction

Permana and Miyata (2012) showed a partial equilibrium urban economic model to explain the existence of illegal settlements in flood prone areas in Palangkaraya City in Central Kalimantan Province, introducing the expected damage rate on household asset. Applying this new idea, one can derive the conclusion where the bid rents by low income households get higher than those by high income households in flood prone areas. This is the contrary conclusion being highlighted as compared with that in the traditional urban economics.

Following this paper, Permana and Miyata (2012) extended the partial equilibrium model into a general equilibrium model. And then Permana and Miyata (2009) developed a two dimensional city model applying Miyata's achievement (2011). However the study region, Palangkaraya City and its surrounding area, shows a complicated interaction between natural environment and human activities. Therefore this article aims at developing a rural and urban economic model with natural environment considerably extending our previous literature.

2. The Structure of the Model

(1)The study region consists of Palangkaraya City and its surrounding rural area. The city shape is assumed to be a disk where there are three flood prone areas. The land other than the flood prone areas is called normal land. The normal land is assumed to have no flood risk, while the flood prone areas are facing the flood risk with occurrence probabilities. The rural area is specified as dimensionless i.e. there is no spatial structure.

(2)There are two types of households which are high income households (H.I.H.) and low income ones (L.I.H.) in the city. High income households are assumed to reside on the normal land, while low income households are supposed to live in the flood prone areas. The city is assumed to be closed for high income households, and open for low income households. This reflects the fact that the utility of a high income household is much higher than that in rural areas, thus has no incentive to live outside the city. The low income households in rural areas expect the higher utilities in the city thus want to live in the city, but most of them results in residing in the flood prone areas due to the income gap. In the rural area there live only low income households. The number of the high income households is denoted by N_1, that of the low income households in the city by N_2, that of the low income households in the rural area by N_3.

(3)We consider different types firms in the study region. In the city all firms are assumed to be homogeneous and produce single type of goods, i.e. urban goods. In the rural area there are three types of industries, namely, agriculture, forestry and rural general goods. The number of firms in the city is M, while firms in the rural area are aggregated into the three types.

(4)Land in the city is owned by absentee landowners who reside outside the city. There is a unique local government in the city, and it rents all land in the city from the absentee landowners. The local government rents the land to households and firms at market rent, and then redistributes the rent revenues to the two types of households. In the rural area, land types are differentiated, namely, agricultural land, forest land, general firms' land and residential land. Supply of each type of land is exogenously given.

(5)Capital stock in the city is assumed to be freely mobile across firms. Thus the capital return rate is uniquely determined being irrespective firms' location. The capital service is assumed to be numerare.

(5)The parameters in the locational potential function for each firm are sufficiently large. In this case a simple von Thünen ring becomes an equilibrium urban configuration (Miyata (2011).

3. Comparative Static Analysis

Here we consider the stationary state, and derive some propositions from the comparative static analysis.

Proposition 1.

The flood prone areas are occupied by low income households, while the normal land is occupied by high income households. The reason is that the income derivative in the bid rent function is negative. Therefore if the per capita income increases, then the bid rent function decreases. So the flood prone areas are occupied by the low income households.

Proposition 2.

A slight increase in income of L.I.H. decreases the bid rent and increase the bid max lot size. So the parameter in the redistributed income can decrease the number of L.I.H. in the flood prone areas.

Proposition 3.

An increase in the residential area in the rural area increases the current value Hamiltonian, so the supreme utility of L.I.H. in the flood prone areas is increased. Thus the number of L.I.H. is decreased in the flood prone areas.

Proposition 4.

If the carrying capacity of forest in the rural area is increased, the bid rent by L.I.H. is increased and the bid max lot size is decreased, resulting in an increase in the population in the flood prone areas although the flood risk is decreased.

Proposition 5.

If the von Thünen parameters in commodity flow equations are decreased by a transportation project, the business district and residential area (normal land) increases and utility level of H.I.H. increases. In the flood prone areas, the bid max lot size decreases leading to an increase in the number of L.I.H.

4. Concluding Remarks

Up to now the authors have developed partial and general equilibrium urban economic models for Palangkaraya City. In these models we have obtained a conclusion where the bid rent by L.I.H. is higher than that by H.I.H. in flood prone area. This is due to the fact of introduction of the expected damage on household asset. This result is perfectly contrary to the result of the traditional urban economics.

Flood is a great concern in Palangkaraya City, and one of its causes is harvest of forest in rural area surrounding Palangkaraya City. Hence one must take into account the socio-economic activities and forest in the rural area. One of motivations of this study is this point. Moreover it is important to consider the plane city rather than a linear city for reality.

In this study Palangkaraya City is regarded as a plane city, and the external area of the city is assumed to be a point area (i.e. dimensionless). In the city and the external area, the natural environmental level and the externality of forest are taken into account. The role of forest is a reduction in flood damage in Plangkaraya City. Moreover the natural environmental levels in the city and the external area are improved by forest.

The important policy target of the Palangkaraya City government is to reduce the illegal settlements in the flood prone areas. For this policy target, an increase in the supreme utility level in the external area, a redistribution income policy and fostering the forest in the external area are studied by the comparative static analysis. And then this study suggests a possibility of reduction in the illegal settlements in the flood prone area.

By the way this analysis heavily depends on specific parameter values, hence it is necessary to estimate parameters by employing empirical data and to present more realistic policies. These are left for a future study.

References

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