

# Study of Rail Transit and Urban Spatial Structure Based on Urban Economics

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**ABSTRACTS** The spatial changes of utilization intensity of urban lands are decided by the dual substitute relation of transportation costs and rent's substitute and elements substitute (producer) or consumption substitute (residence). The land use intensity affects the urban spatial form directly. This paper aims to study the relation between construction of rail transit and urban spatial form from the perspectives of urban economics, urban traffic conditions and spatial structure evolution. It takes the metropolitan areas of Tokyo and Singapore as sample cases to analyse the influence of urban development brought by the rail transit.

## KEYWORDS

Urban economics  
Transportation cost  
Urban spatial structure

## 1. Introduction

The core theory of urban economics is the substitute of transportation cost and land rent and elements substitute (producer) or consumption substitute (residence). The substitute of transportation cost and land rent makes the rent curve of corporates and residents decreasing from the centre to outwards, that is a descending curve; the substitute of land and capital makes the capital density decreasing from the centre to outwards that is from the view of landscape the heights of buildings are getting lower; those two substitutes co-decide the urban house price, land price, capital density and density of population decreasing from centre to outwards that is the land development density is decreasing from the centre to outwards. The actual reflection is the skyscrapers which is located at CBD areas while townhouses are located within the suburbs [1].

According to the law of urban space growth, it is typically known that the land utilization and transportation are an interactive one-way circulation system. From the transportation planning perspective, different land utilization will reflect the traffic occurrence, attraction as well

as the traffic distribution, which eventually determines the transportation structure to some degree. On the other hand, the transportation condition mirrors both the price of land and the land-use intensity which ultimately affect the urban spatial form.

As an advanced transportation approach, rail transit has direct effects on urban spatial form. The urban transportation development in the future will not be sustained by vehicles so that it is necessary to develop rail transit. Therefore, this paper aims to provide few conceptual basis on the relationship between urban rail transit construction and land utilization intensity from the urban economics perspective.

## 2. Relation between Transportation Modes and Urban Spatial Forms

Basically, the transportation condition decides the price of land and affects the land utilization intensity. However, different transportation modes have different effects on urban spatial forms. The influential factors are mainly relying on the distances of travelling. If the travelling distances are affected by transportation modes, the impact of the transportation modes to urban land utilization will be more obvious. The evolution of transportation has seen the development of urban cities from walking period to carriage period, railway (including tramcar) to car modes and rapidly switches to the modern transportations. Different transportation modes are a comprehensive reflection of urban forms, economic development levels and life styles.

The urban forms of walking and carriage periods were focused on small scopes [2]; cities started to develop along the transportation line in tramcar period; motor vehicles

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appeared during World War II, the highway system were rebuilt; people's travelling distances became longer; cities went into express way period. The transportation was improved greatly; the transportation cost was low; urban residences started to use transportation costs to replace rent and moved to further areas from the centre in order to get better living environment and bigger houses; those formed irregular urban spatial forms along express ways.

Rail transit would have more obvious impact on urban spatial forms as well as on people's lifestyle. The rail transit is attractive due to the speed, safety, and large capacity that helps to release crowds timely. Besides that, rail transit makes the places along the routes reachable which indirectly provides alternatives for people to stay far from the city centre. On top of that, the cost is comparably cheaper with respect to motor vehicles.

The transportation system of cities with rail transit would set the public transportation as the main body, the rail transit as the backbone with support of combination of multiple transportation modes that is multi-levels, functions and typed transportation system. People lived in the centre of cities will move out of cities along with the construction of rail transit. They would move around the stations out of the cities. Ultimately, the population intensity of the outer areas will be higher than that of downtown. Those new centres are new urban space growth points. The intensity of construction will decrease from the centre to outwards. At the initial stage of rail transit construction, the form would be 'a string of beads'. When the rail transit is mature, those transportation hubs will become new urban centres. Eventually, a city would develop towards multi-centres mode.

### **3. Relations of Different Rail Transit Types and Land Utilization Intensity**

The competitive tenders' different use of lands decides the structure of urban lands. Typically, residential lands belong to medium and high intensity exploitation; public facilities especially commercial lands belong to high intensity exploitation; highways, squares and greenbelts belong to low intensity exploitation. Commercial lands need aggregation effects; the substitute of capitals and lands could seek optimization of profits through high rise buildings, therefore, the development of transportation has lagging effects on commercial lands or we could say those lands are insensitive to rents. The lands around different stations would have different usage, so the development intensity is different. However, the development intensity would change along with the distances of stations in general. Out of 500 m, with the distances of stations increase, the land exploitation intensity would decrease.

### **4. Rail transit's Influence on Land Price**

The appealing features of rail transit are high speed and convenient. These features facilitate the prosperity in

economy and land development intensity along the lines, hence it flourishes several external benefits. It could bring huge value-added benefits to the lands (real estate) along the line. Based on experience, re-development of the land along the rail system could optimize urban structure, improve the utilization efficiency of urban lands and promote formation of new economic growth points.

The survey done by American scholar of the areas of Washington and real estate along the metro indicated that by the end of 1981, Washington invested \$3 billion (40% of the total investments) in metro and generated \$2 billion value-added benefits to lands. By January 2001, the accumulated investments to metro was up to \$9.5 billion, in which, the newly added value to lands has reached \$10–15 billion. The lands used as commercial purposes along the metro were increased by 100%–300%.

Through the analysis of Guangzhou land price, it was found that the prices of land along metro line was much higher than the land at same districts (2003); and the prices decreased from the centre of the metro station to outwards; resulting improvement in terms of value-added benefits, utilization intensity and property's value. It was much obvious at special metro stations. Guangzhou metro line three's construction for instance, have a bunch of residential buildings under construction and planned to be built along line 3. There is also the existence of relatively large scale projects like South Olympics Garden, JXXJ and etc. The development and market acceptance both are good. It forms the property's value along metro line.

## **5. The Guidance of Rail transit to Urban Development**

The above analysis indicates the transportation is the most effective method to plan and manage the utilization of urban land. For those plots of lands that are planned to be developed, the construction of corresponding transportation routes and infrastructure could push the utilization of land accordingly under the market environment. On the contrary, for those plots of lands that are planned to be protected, higher transportation costs (as the threshold) is required as it could prevent the land price from increasing.

### **5.1. Tokyo Metropolitan Area Development under the Guidance of Rail Transit**

Tokyo is a typical rail transit led metropolitan area in the world as it is honoured as the kingdom of rail transit. From the historical development of urban areas and evolution of rail transit network of Tokyo, the city was basically expanded along the railway. Rail transit played an important role in the urban evolution of Tokyo. The ring-shaped rail transit, JR, private metro and multiple rail transit systems made irreplaceable contribution to the successful evacuation of people from the downtowns and controlled the urban population intensity at a bearable level of Tokyo [3].

The residential areas of suburbs of Tokyo formed development zones along and around the urban rail transit

stations. Moreover, in Tokyo metropolitan areas, the distribution of commercial areas is more and more intensive along the railway. For instance, Ikebukuro, Shinjuku and Shibuya are transfer stations on Yamate line; the commercial areas around those stations are more intensive than that of downtown. The influences from rail transit system to Tokyo metropolitan areas development are through the 'Comprehensive Development Strategy of Rail Transit and Real Estate'. The comprehensive development of rail transit and real estate makes the ideal concept of 'garden city' into a profitable commercial investment. The comprehensive development of lands along railways could push the development of lands based on railways and foster the source of passengers based on land development.

### 5.2. Singapore Rail Transit Used the Principle of Urban Economics to Guide Comprehensive Development of New Towns

Singapore raised the proposal in conceptual plan in 1971 that was to connect the downtown with new satellite cities through fast and large capacity transportation system. Singapore outlined five high intensive urban passages along the fast rail transit route and set 17 new towns along the railway. All those towns were connected by railway system. People could switch to take bus in the metro station or have access to every community of those new towns through wide and vehicle-only or passengers-only roads and sidewalks.

The development strategy of Singapore rail transit took full use of the market law and urban economics theory. At the beginning of the development of new towns, the major work was to build a lot of residential buildings and public service facilities. The commercial areas around the metro would not develop until the new towns reached a certain scale and observed the increment of the land prices concurrently. By then, it will attract the privates and developers to receive high intensive investments through auction

and bidding process in order to give full play of those new towns' potential which is under schedule.

### 6. Conclusion

The spatial changes of utilization intensity of urban lands are decided by the dual substitute relation of transportation costs and rent's substitute and elements substitute (producer) or consumption substitute (residence). According to urban space growth law, the utilization of land and urban transportation is an interactive one-way circulation system. From the perspective of transportation planning, different utilization of lands would reflect the traffic occurrence, attraction and distribution, which eventually determines the transportation structure to some degree. On the other hand, the transportation condition decides the price of land and the land use intensity which ultimately affect the urban spatial form. As a large transportation capacity, fast, comfortable and modern transportation approach, rail transit improves the possibility of getting access to more destinations. It changes the districts' conditions by attracting large amount of commerce, residences and office works to the areas along the railways. Besides that, it helps to evacuate the population from downtown and leads the utilization of urban lands towards a rational development.

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