# Special and temporal effects of the urban rail transit on the real estate values

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**Abstract**

Urban rail transit is the combination of an urban underground rail, light rail, monorail, tram, new traffic, high-speed maglev trains, suburban trains and other rail traffics. Because of its many advantages, such as fast and efficiency, safe and comfortableness, energy saving and environmental protection, urban rail transit is welcomed by the public and urban transportation systems and it is a major part of the urban public transport In order to research the effects of urban rail transit on real estate value. First, this paper introduces the concept and characteristics of urban rail transit, then sorts out the influence factors of the real estate value and points out the primary factor, which is the rail transit. Through building mathematical function model, we discover that property value and the rail transit are the differential multiple relationships. The study benefits the research and practice in related industries.

*Keywords:* urban rail transit, real estate value, the function model

## 1 Introduction

Urban rail transit is the combination of an urban underground rail, light rail, Monorail, tram, new traffic, high-speed maglev trains, suburban trains and other rail traffics. Because of Its many advantages, such as fast and efficiency, safe and comfortableness, energy saving and environmental protection, urban rail transit is welcomed by the public and urban transportation systems and it is a major part of the urban public transport (Wu, X.P., 2012).

Urban rail transit is a convenient and quasi-public welfare road transport facility, which not only requires large amount of capital and very strict building technology, but also needs the government to stand up to resolve lots of relocation works because most projects go through the city's bustling and densely populated areas. Rail transit makes the public enjoy a more convenient way to travel while undertaking lower travel costs and it improves the public net social welfare level to some extent. Therefore, the rail transit project, dominated by the government, serves the city residents and reflects the nature of social commonality.

On the one hand, the construction of urban rail transport improves the local employment rate, on the other hand, it leads to the development of the transport industry and real estate, which has broadened the city space, promoted the land and real estate value along the rail line and has obvious external economy. Although the ticket profit of urban rail transit project itself is very limited, its external economic effects are often relatively large. The powerful network aggregation and release effect is an important feature of the rail transit external economy effect, which can make the people, logistics, capital and information flow to the scope within the rail transit areas, accelerate the rapid flow of the services and productions of the various areas in the city, greatly change people's way of life, and enhance the overall level of economic development of the entire city (Song, S.J., 2011).

## 2 The real estate value and its influencing factors

*The value of the real estate:* "Real estate" means land, buildings and an inalienable part solidified on them, including material entities and interests based on physical material interests. In the paper, it means the real estate, ground attachments and related equipment and real estate, (real estate) collectively, the estate includes land substances and ancillary rights and assets, real estate is the land attachments, and only with land not separated state will not destroy the original use of performance of various houses and structures. From the theoretical point of view of the land value, the value of real estate not only includes the social necessary labor put into the parcel of land, but also the land within a certain range, all other infrastructure construction, these will be the real estate radiation effect occurs, so that the value-added real estate value. In this sense, the values of real estate were made two: real estate values and the real estate value of the former is that the quality of the house itself, the latter location, also called lots (Tong, et al., 2011).

Location human characteristics and natural characteristics. From the location for the main characteristics of real estate where the social and economic changes in the position of change; humanities feature is the diversity of people in the process of buying used real estate, real estate exhibit uses, as well as a combination of segmentation possibilities various characteristics; natural characteristics generally refers to the real estate due to its shape, characterized limitations rather than be moved, or moves own nature, will cause a change in shape.

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According to the principle of Marxist political economy the practical value and the value of goods the value of a commodity is the basis of price. Namely the production of socially necessary labor time is actually. A commodity is the commodity price formation on the basis of the process of the production of goods includes production workers labor costs and other factors. The value of the merchandise is materialized as the value of the goods. The sum of labor, is divided into three parts: first, it is consumed and transferred to the value of commodity production $c$, two necessary labor value of $v$, the surplus labor value $m$, *commodity value = c + v + m*. The price of the commodity is three currency performance (Yan, et al., 2009).

In addition, from the Western economics theory, the relationship between supply and demand of goods determines the price of the commodity, the price of goods in the supply and demand equilibrium is the equilibrium price of commodities, commodity supply and demand relationship largely determine the price of the commodity, WalrasSri Lanka general equilibrium theory and Marshall's theory of the equilibrium price further believes that the price of a commodity is not only determined by the supply and demand situation, he is also affected by the impact of the price itself substitutes only alternatives and commodity supply and demand have reached equilibrium, supply and demand conditions in order to determine the price of the commodity on this basis.

From the above theoretical analysis point of view, the real estate in the lives of the residents must have the goods, so real estate has the basic characteristics of ordinary commodities, the value of real estate price basis, in real life, is closely related to the value of real estate and real estate prices, if the real estate prices rise, the value of real estate will rise sharply, so that its value generally to the price or rental of real estate transactions, real estate price changes on indirect changes in the value of the real estate.

*The influencing factors of real estate value:* As a special commodity, scarcity of the resources of the land occupied by the real estate in the production process is undoubtedly a great impact on its ultimate value, if we take into account the basic functions of the city's real estate bear (living, working of leisure traffic), the socio-economic factors, political factors will become a factor affecting the value of real estate.

Location factors. Location factors is the relative position of the areas of real estate in the city with a certain degLenusikree of particularity, mainly includes three aspects of the real estate supply and demand situation, the relative location and transportation convenience. Real estate supply and demand situation is in terms of the supply and demand situation, the basic factors affecting the real estate value, real estate location fixity, immobility also decided to essential factors that affect the price of a real estate is only of the land area of the real estate. The supply and demand situation. In the long run, due to limited supply of scarce land resources required in the process of urban development, urban development, the demand for land is far greater than the effective supply of land available, therefore, the rising value of real estate is an inevitable trend. Relative location is mainly reflected in the real estate location of the distance from the city center, is reflected in

and distance from the city center, and business center distance. Different types of real estate is not the same as the requirements of its geographical location, such as commercial real estate are more likely to affect the role of the consumer, entertainment, work conditions, geographical location of the city center, because the people of the city center traffic intensive, more gathered to attract consumer groups so as to achieve the purpose of effective; for residential real estate for more focus on house location and convenient transportation. Rail traffic in the most significant effect on the degree of convenient transporttation, to some extent, closer to the remote lots and the distance of the city center, the original remote areas neither bear the shackles of the location, change the pattern of the traditional real estate market, and promote development and prosperity of the city as a whole (Wu, et al., 2011).

Neighborhood factors. The neighborhood factors involves in the aspects of the real estate area of socio-economic and natural environment, and infrastructure and supporting facilities. Mainly from a certain area within the micro-environment, the study found that neighborhood factors influencing factors of the different types of real estate is not the same. There are some other neighborhood factors, such as social order in good condition, a low crime rate, making people feel safe and are willing to invest and live, which also leads to a rise in real estate values.

Structural factors. The structure factor is a real estate development and construction, the project itself affect the value of characteristic factors. Real Estate structural features, including the characteristics of real estate projects and housing unit characteristics; overall layout, floor area ratio, residential construction area, neighborhood greening rate, property costs, real estate project features basic supporting facilities in the form of housing construction, developers and property management unit etc.; characteristics of housing units, including floors, orientation, structure and layout of the landscape, size, decoration and housing area.

In this paper, the independent variables are selected according to the situation of the rail transit construction, the characteristics of the real estate market, the difficulty of the data collection and the degree of the correlation between each other. In the investigation of the real estate prices, we find that the owners mainly focus on the traffic conditions, supporting infrastructure conditions and the environment surroundings. Therefore, in this paper, these problems which are concerned commonly by the owners have been analyzed in detail. Finally, eight independent variables have been selected and assigned scores:

1) The condition of subway (X1), represented by the actual distance (m). Usually, the subway traffic conditions and the convenience degree of connect with the outside of a certain building can be judged by the shortest route distance from this building to one station of subway line 1, which maybe has been completed or will be constructed before 2013.

2) The conditions of public transport (X2), represented by the number of public transport passing through the bus station (number). A city has the bus routes in all directions and the bus rapid transit, completed in 2009, has made the traffic of city be generally better. Because

the public transportation has been the main means of the transportation for the most people before the completion of the subway, it is an important influence on the price whether there is a convenient public transportation near the residential areas.

3) The distance to downtown (X3), represented by the actual distance (m). According to the layout and structural zoning of the city. The development of the new district is still in the primary stage and its center is still in planning. Neither the population scale nor the degree of commercial prosperity of new district is more than that of Erqi square. So this paper takes Erqi square area, near the railway station, as the commercial center of a city, and the variable X3 can be measured by the nearest route distance between the residential building and Erqi square.

4) The educational facilities (X4). Education environment has a positive impact on real estate. Usually good educational environments nearby the property will enhance the value of the property to some extent. According to the survey about the education condition near the real estate, the factors considered by the buyers include the educational system of middle and primary school with the entrance for the nearest school, the good cultural environment around the real estate, the convenient leisure and entertainment facilities, and so on. Therefore, this paper determines the score of each property according to the actual situation. The property near the university scores 5, the property near the middle school scores 3 and the property near the kindergarten scores 1.

5) The medical condition (X5). In order to reflect the hospital facilities as an important factor, the hospital facilities, located within 800 meters of the property, better score 5, good score 3, and other score 1.

6) The shopping conditions (X6). In order to reflect the convenience of shopping conditions impacting on the property, the property which is near the supermarket within 300 meters around the property scores 5, near the supermarket within 300 ~ 900 meters around the property scores 3, and other scores 1.

7) Whether the residence community has the parking space or not (X7). With the improvement of the residential living standards in Zhengzhou city, more and more people have private cars, and a parking space brings convenience to people's life. The residence community which has parking places scores 1, or scores 0.

8) Environmental factors: Environmental factors (X8). With the improvement of living standards, people pay more attention to the good natural environment and the convenient exercise place when purchasing a house. If the property is very close to the park, the living environment should have many advantages. So making whether there is a park near the property or not as a factor to be measured, the property which is near the park within 500 meters around the property score 5, within 500 ~ 1000 meters around the property score 3, and other score 1.

## 3 Impact mechanisms of rail transport on real estate values

The construction of rail transit can greatly improve the reachability of the areas along the line and save the travelers'' time and cost by reducing the road crowd congestion level. According to the reachability improvements, the concentration of the infrastructure such as businesses, entertainments, culture and life will stimulate the high-density development of the land along the line and the promotion of the real estate value-added, which is shown in Figure 1.
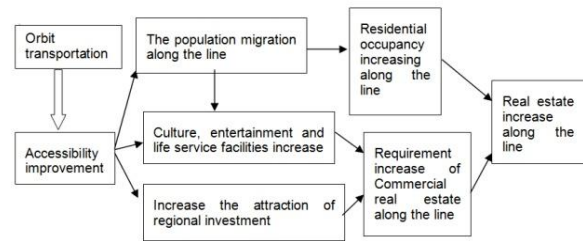


FIGURE 1 System analysis diagram of the impact of urban transit on the real estate value-added along the line

The economic theory explanation of the rail transit and land value-added. According to the general equilibrium theory in economics, the total value of each piece of land in the city is equal when the spatial layout of the entire city has achieved a balanced state, that is:

$$APL_i + ATC_i = K \ (i=1,2,\dots,n; \ K \text{ is constant}) \qquad (1)$$

In Equation (1) $APL_i$ is the average price of the block $i$, $ATC_i$ is the average total cost of the work and life in the land. Obviously, the better location the block $i$ has, the more perfect its' infrastructure possesses, the lower the total cost of the working life of the land is, the higher value of the land will be. These relations can be expressed as:

$$APL_i = f(X_{1i}, X_{2i}, \dots, X_{mi}) \ (i=1,2,\dots,n) \qquad (2)$$

In Equation (2) $X_{mi}$ indicates the various factors influencing on the block $i$, such as land use, allowing the development density, the degree of convenient transportation, schools, hospitals and other infrastructures.

If other factors affecting urban land prices are exactly the same, only varying degrees of convenient transportation, there is the following relationship:

$$APL_i + AC_{ti} = K \ (i=1,2,\dots,n; \ K \text{ is constant}) \qquad (3)$$

In Equation (3), $AC_{ti}$ shows the average transportation cost of the land $i$, including the normal transportation costs and the cost of traffic congestion. If a city rail transit line is just built near the land $i$, and the traffic conditions of block $i$ are significantly improved, so $AC_{ti}$ is reduced, a corresponding increase will happen to $APL_i$, the price of land will be increased significantly (Liu, et al., 2011).

The real estate values growth for the improvements of the traffic conditions: Time savings brought about by urban rail traffic was opened to traffic, transportation cost savings as well as safety, and punctuality, etc. is the most direct influence the improvement of traffic conditions in the area of urban rail transit corridor and the surrounding social effects. The traffic time saving urban rail transit project impact on the value of real estate is the largest and most immediate improvement. Security and improve punctuality and transportation cost savings is due to the high usage rate of urban rail transit, the flow of people increased, the accumulation of public facilities so as to enhance the degree of urbanization, and thus shorten the travel time of the formation of the city on the geospatial relatively closer to become actual geographic disparity of real estate value differrential is closer, and that the original real estate price differrentials in the improvement of traffic conditions will improve.

And the real estate price level factors determine a region not just changing traffic conditions in the rail transportation. Among the factors determining the price level of the geographical impact of traffic conditions is bound to consider traffic this share of the region's premium constitutes best to get the value-added share of urban rail transit traffic conditions improve. With urban benchmark land price system, through the Urban Land Classification Gradation and establish premium function model of urban rail traffic conditions improve (Yan, et al., 2009).

Based on the above analysis, the analysis and calculation of the premium growth in the urban rail transit conditions change as follows:

$$P = \left( \frac{V_0 \times B}{B_0} - V_0 \right) \times a_i , \tag{4}$$

$P$ means the premium increases caused by the changing conditions of urban rail transit; $V_0$ shows the present price of the real estate; $B$ indicates the premium differentials multiples of the real estate after urban rail traffic conditions changed; $B_0$ is the benchmark land under the real estate status quo differential multiples; $a_i$ is the real estate traffic condition factors (value depends on the real estate uses may be).

Regional affect of urban rail traffic on real estate values: From the effects of the region of space, the urban rail transport on the area of influence of the value of real estate changing with the proximity of the real estate distance rail transit station location, and even if it is the same distance, due to the location of the rail transit site, its sphere of influence there are obvious differences. The rail traffic on the scope of the real estate value theory, there are three main theories, they are rent-theory, the reachability theory and spatial interaction theory. The following brief analysis of the calculation of the sphere of influence of the three theories on mass transit stations (Zhang, et al., 2010).

The so-called bid-rent theory is that changes in land use and the opportunity cost associated with that in any one region of the city's location, the land is always a way to use the higher remuneration for Government rent than any other purpose. Good analysis model based on the bid-rent theory to explain the scope of the mass transit stations, but the period of restrictive limitations in the model derivation process, and it is on the assumption that the case of rail transportation has been completed and has formed a network (Zhang Z L, 2010).

The theory of urban spatial interaction is due to the existence of the social division of labor between cities, between cities and suburbs have been conducting mutual exchange of personnel information and material and energy. Reflected in the rail transportation, mainly refers to rail transportation service facilities with respect to the effect of other competitive services to the residents as its own is proportional to the size is inversely proportional to the square of the distance, and between the two. Be seen two ways to calculate the impact of rail transit site, a scale of urban rail transit site itself, and the other is the distance rail transit site. Rail transit site the larger sphere of influence farther from the site, the less effect. Urban rail transit sites to reach equilibrium distance between the site of another site's attractive point is defined as the breaking point. Have the following Equation:

$$d_A = D_{AB} \big/ (1 + \sqrt{P_B / P_A}) . \tag{5}$$

In the Equation (5), $d_A$ shows the distance from the breaking point to the urban rail transit site. $D_{AB}$ indicates the straight-line distance between the two sites; said the scale of the station of the site $A$ and site $B$ and its' image is shown in Figure 2 (Zhang, et al., 2010):
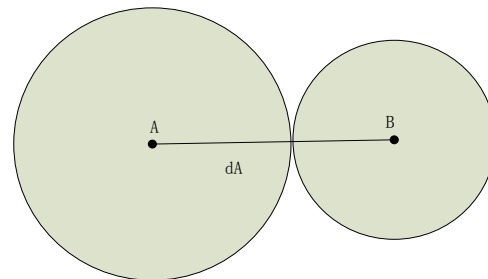


FIGURE 2 The affecting scope between the two transit stations

Reachability theory of urban areas based on comparative analysis of public transport and rail transport mode of transport, urban rail transit to determine how they affect the surrounding area, the establishment of a functional relationship model to calculate the impact range. That is, regardless of whether this mode of transport to take rail transit, if at the edge of the affected area of the rail transit point, then the edge points to the center of reachability should be the same (Figure 3). Describe reachability of a variety of forms, some distance, and some time spent how much, as well as the transportation costs spent to describe. Area travel time to the city center more accurate reachability, rail traffic along the development interests of the impact of the scope of the theory is the model established on this basis (Wang X H, 2014).
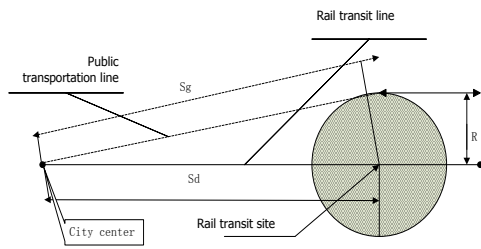
FIGURE 3 The calculation sketch diagram of the urban rail transit development interests

Reachability equal theory based on travel time to describe the accessibility of the transportation convenience, regardless ordinary traffic, or the use of rail transportation, travel time to the city center at any point from the sphere of influence of the traffic the site edge line are not will change, that is $T_d = T_g$. Particularly, $T_d$ indicates the travel time by taking a subway train from the furthest point within the subway affecting scope to the city center. Namely:

$$T_d = S_d/V_d + R/V_b . \tag{6}$$

$T_g$ means the travel time spent from the farthest point within the scope of urban rail transit development interests to the city center, $T_g = S_g/V_g$. $S_d$ is the distance from the urban rail transit site to the city center along the subway line. $V_d$ is the metro average speed. $R$ shows development radius of urban rail transit. $V_b$ is the average walking speed from the edge of the rail traffic impact point to the rail transit station. $S_g$ indicates the shortest travel distance from the farthest point within the scope of urban rail transit to the city center. $V_g$ is the average running speed of ordinary public transport in the city. The equation is:

$$S_d/V_d + R/V_B = S_g/V_g . \tag{7}$$

Both sides moved to:

$$R = \left(S_g/V_g - S_d/V_d\right) \times V_b . \tag{8}$$

In the Equation (8), the assignment of $S_g$, $S_b$, $V_g$, $V_d$ and $V_b$ may be different according to changeable traffic conditions in various cities. For the value of $V_g$, the average running speed of public transportation vehicles will be different in urban and suburbs because urban rail transit lines are generally connected from the urban to rural areas(Yan H, 2013).

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## 4 Conclusions

Urban rail transit greatly facilitates the travel of the residents, reduces the waste of urban land resources, and also has the advantage of environmental protection. In addition, as the main force of the transportation system, the city traffic is the key object and of the development of the urban road transport. It can greatly improve the reachability of the areas along the rail transit and extremely benefit the travelers'' time and cost. Besides we should pay attention to the following aspects (Cao et al, 2013 ):

1) The value-added effect of urban rail transit on the real estate is not instantaneous and it needs a time process. In general, with the planning and building of the urban rail transit, the value-added effect has a linear decreasing upward trend. Therefore, the impact of urban rail traffic on the real estate values is generally more great and evident in earlier planning and construction period and gradually weakened due to the smooth running of the transport line after the operation.

2) While providing fast, safe and comfortable urban transport facilities for the citizens, rail transport will drive the urbanization of the region along the rail line, particularly the suburbs, and enhance the regional real estate values. Urban rail transit system will greatly enhance the real estate value appreciation of the suburb by stimulating the investment gathering, attracting more traffic, and playing a larger role in the process of rural urbanization of the surrounding areas.

3) The other effects of urban rail transport on the land along the line are indicated in the following aspects: Firstly, the rail transit greatly shortens the distance to the city center, improves the urban traffic conditions and traffic accessibility and saves the traveler's time and costs. Secondly, rail transit has a strong economic agglomeration effect because of the high-density development of the land along the rail transit. Which not only has adjusted the structure of land use, also has reduced the waste of land resources and improved the economic benefits of the land. Finally the rail transit strengthens the linkage and complementary effects among the geographical areas, which has made the areas along the rail line an economically prosperous organic and promoted the upgrading of the regional real estate prices (Xing et al., 2011).

## Acknowledgments

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