Impacts of Transport Projects on Residential Property Values in China: Evidence from Two Projects in Guangzhou

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Impacts of Transport Projects on Residential Property Values in China: Evidence from Two Projects in Guangzhou

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Summary
Introducing public transport usually creates expectations of property value changes, and there have been substantial studies on the impacts of public transport on property values in developed regions. Little research, however, has been conducted in developing countries due to incomplete information, and the lack of research has limited the extent to which transit agencies can develop strategies to maximize positive property value impacts and minimize negative ones. This paper summarizes a comprehensive survey of recent research on impacts of two transport projects on residential property values in Guangzhou, China, and explores policy implications in recovering surplus land value and compensating hardship generated by transport developments. The application of a repeat-sales model and a hedonic pricing approach has shown consistent results in estimating the effect of the Metro Line 2 on values of residential property within the walking distance of its stations. The evaluation result of the Inner Ring Road through a repeat-sales model reveals that values of residential property directly facing the elevated road decreased dramatically.

Keywords: Transport, property value, land market, Guangzhou, China

1. Introduction

The impact of public transport on property values has been heatedly debated for over a century. There has been a large number of studies that reveal the impact of transport facilities on property value, and much empirical research is from developed countries such as the USA, UK, Canada and Japan (Gatzlaff and Smith, 1993; Cervero and Duncan, 2001; Gao and Asami, 2001; Bowes and Ihlanfeldt, 2001; Parker, 2002; Ryan, 2005). Very few studies, however, have been carried out to examine the influence of transport on property values in land markets of developing countries, partly because transactional data is not disclosed or readily available.
Demands for transport infrastructure investment have usually been very high and substantively unmet in the fast-growing cities of developing countries, and investment in infrastructure facilities can lead to the soaring land prices. It is therefore reasonable for the government to recover surplus land value generated by its investment and thus recover, if not all, at least part of its cost for further investment. On the other hand, construction of transport facilities does not necessarily yield benefits. Land users may be adversely affected by being located very close to a transport station or along a transit line, and nuisances include noise, air pollution, and increased automobile traffic from users. The advantages of the enhanced mobility afforded by an elevated road may, therefore, be offset by these stigmas to some extent. Evaluation of impacts of transport developments on property values can assess the degree to which there are positive or negative consequences of transit investments, and thus is critical for internalizing externalities of public transit investment. Furthermore, any gain in value can open up opportunities for new forms of creative financing such as advance requisition of land near transport facilities and increasing property tax rate (Cervero and Duncan, 2001), thus alleviating the deficiencies in cost recovery of fast-growing cities in developing countries.

In spite of theoretical advantages, there have been many practical difficulties in assessing the impacts of transit projects on property value. One of the basic methodological problems is how to build the causality, in other words the specification of the counterfactual (what would have happened if there had been no investment) is difficult, particularly where many other factors influencing property values are also changing. Moreover, the treatment of time in the analysis of transport and urban development is weak, as it has proved difficult to isolate the impacts over time. In spite of methodological difficulties, it is important to measure the impacts of transport, even roughly, as this is the only way to achieve a better understanding of the full effects of transport investment (Rice Center, 1987; Banister and Lichfield, 1995).

Besides these practical reasons, this study is carried out in the hope of filling research gaps, overcoming data problems and refining our understanding of influences of transport on land values in the emerging land market of China, taking two transport projects – Metro Line 2 (ML2) and Inner Ring Road (IRR) – in Guangzhou as case studies. There are six sections in this paper, including this introduction. The next two sections examine empirical evidence and discuss methodological arguments of assessing the effect of transport on property values; the fourth section briefly describes the two projects and the data collection process, and difficulties in data collection are addressed. The fifth section reviews impacts of the ML2 and IRR on residential property values. The final section concludes with the findings and policy implications of this research.

2. Issues of Transit and Property Values

There have long been concerns over the relationship between transport accessibility improvements and property values. The value of accessibility has been widely studied in urban economics, land economics and urban planning. Cervero (1998) argues that transit can not only affect land use but also redistribute growth. Smith and Gihring (2004) assert that, in general, the more accessible a location, the higher the property values, all else being equal. With the growth in automobile ownership, public transport accessibility was given lower priority than automobile accessibility in developed
countries, but in recent years there has been increasing recognition of the potential importance of public transit, and high proximity to quality transit service can increase nearby property values (Litman, 2002). Moreover, recently there has been growing support for transit-oriented development (TOD), which recommends transit stations to be a catalyst for mixed-use developments, offering improved accessibility, reduced consumer transportation costs and reduced traffic congestion, reduced parking costs, plus environmental and health benefits (Litman, 2004).

Empirical evidence has shown various impacts of transit on property values, and the context seems critical in analysing the effect of transit on land values. For instance, a survey of 150 references on land values and public transport conducted by RICS (2002) reveals that similar transport investments have different impacts in different locations where local economies are vibrant or stagnant, and there are different population densities. While Wegener’s collection of evidence from north American cities (1995) reveals that locations close to rail stations in general have neither attracted more development nor generated higher land values than more remote locations do, Banister and Berechman (2000) conclude that in Japan, where population densities are quite high, rail transport dictates development patterns in Tokyo and other major Japanese cities, as employment is highly centralized with limited parking, making land values a critical factor in travelling to Tokyo and other cities. They realize that transit may have a clearer impact on the economy in developing countries, where the transport network is sparse and of a lower quality than in developed countries, where the transport network has been more developed. Thus it is not possible to generalize with regard to the general effect of impact across the world.

3. Methodological Considerations

In assessing property price change, various methods have been adopted, such as qualitative analysis, descriptive analysis, hedonic pricing, repeat sales and projected rateable values. Two basic models, repeat sales and hedonic regression, have been frequently suggested for building price indices. Most studies use either repeat-sales or hedonic regression to evaluate the impacts of specific events, and the latter is more widely applied. Only Gatzlaff and Smith (1993), and McMillen and McDonald (2004) employ both of them to estimate the effects of transit lines and test the consistency of different methods application.

Effective analysis needs to be conducted with reliable data collected at a series of points in time or continuously over time. According to RICS (2002), the most reliable data are transactional data, which can reflect the real effects more precisely than valuation data. In developed countries, the valuation agency can provide detailed transactional data, embedded with Geographic Information System (GIS) which allows more detailed spatial and financial analysis. In developing countries, however, transactional data are neither recorded systematically nor readily available.

3.1. Repeat-sales Model

The idea of repeated sales regression is to use observations on houses that have been sold more than once to estimate a quality corrected index. It assumes that characteristics of a house, such as living area, surrounding public facilities and open space, do not
change as time goes by. Therefore, a house price index of properties whose value is affected by transport services can be constructed to compare with an overall house price index to examine the difference.

The house price index of affected property can be expressed as:

\[ P_i = P_1 (1 + r_1)^{D_1} (1 + r_2)^{D_2} \cdots (1 + r_n)^{D_n} \] (1)

Where \( P_1 \) is the initial transaction price; \( P_i \) is the \( ith \) transaction price; \( 1 + r_n \) is the cumulative index of appreciation at period of \( t \); \( D_n \) is an exponent equal to \(-1\) if period \( t \) is the second most recent sale, \(+1\) if it is the most recent sale and \(0\) for all others. \(^1\) To normalize the index, \( D_1 \) is set equal to \(0\). Taking the natural log of (1) yields:

\[ \ln(P_i/P_1) = D_1 \ln(1 + r_1) + \cdots + D_n \ln(1 + r_n) \] (2)

Then the \( r_n \) can be compared with the house price index of the entire city to assess the impact of transport services (Gatzlaff and Smith, 1993). If \( r_n \) is higher than the general house price index, it means that the transport service has a positive impact on property values, and vice versa. This technique, however, has been criticized because of small sample sizes involved after discarding the information on houses sold only once, thus possibly resulting in larger sampling errors (Bover and Velilla, 2002). Also, changes in asset composition and quality characteristics between sales, such as the change of house structure and neighbourhood characters, are difficult to measure and may go unobserved (Hill et al., 1997).

3.2. Hedonic Pricing Regression

Hedonic valuation was originally developed in the US in the 1950s. Since then, it has been officially used in the Netherlands, Norway, Sweden and the UK. Hedonic modelling has often been used to account for prices of heterogeneous goods, such as real estate rents and capitalized values for land and buildings, and is based on the assumption that people value characteristics of a good, or the services it provides, rather than the good itself. Thus, prices reflect the value of a set of characteristics, such as plot size, living area, proximity to public transport facilities, and surrounding environment and facilities, that people consider important when purchasing a good (RICS, 2002). In hedonic valuation, heterogeneity means that the properties of one good can differ markedly from those of another. It is therefore impossible to make a direct comparison of the market prices of such goods. On the basis of recent prices that have been paid for property, a proven statistical method (multiple linear regression) is used to calculate the proportion of total value accounted for by each of a property’s individual features (Llewelyn et al., 2004).

A simplified equation of hedonic pricing can be expressed as follows:

\[ P_i = \beta_0 + \beta_1(X_1) + \beta_2(X_2) + \cdots + \beta_N(X_N) \] (3)

Where \( P_i \) denotes the most recent selling price of the \( ith \) observation. \( \beta \) is the regression coefficient, and \( X \) means different explanatory variables such as lot size,\(^1\) This model was first introduced by Bailey et al. (1963).
living area, age, distance from transport facilities, and surrounding public facilities. Depending on different contexts, equation (3) can be revised.

Hedonic regression, however, is very demanding on both assumptions and data. If there are unobservable characteristics that are correlated with those included, hedonic regression estimates could be severely biased. One of a hedonic model’s key assumptions is identical preferences among households, but preferences are not identical even among households with similar socioeconomic and demographic characteristics (Guiliano, 1995). Furthermore, the adoption of hedonic methods requires a considerable data collection effort for not only product prices but also their related characteristics is needed (Bover and Velilla, 2002).

Therefore, in terms of methodological issues, the hedonic pricing and repeat sales methods are both imperfect. Furthermore, both of these approaches require a sophisticated housing registration system, which registers transactional data and relevant characteristics of houses. Banister and Lichfield (1995) argue that links between land use, transport and development are much more profound than just an examination of physical, social and economic relationships. Institutional, organizational and financial concerns are equally important. Therefore, no model can be generally applied across geographic areas because of its sensitivity to small changes in model parameters and assumptions.

4. Description of Transport Projects and Data

4.1. Study Area

Guangzhou is the ‘Southern Gateway’ of China; it straddles over 7434 square kilometers and its population reached 10 million in 2002. Guangzhou has been one of the fastest growing cities in China in terms of both economic performance and built-up area growth. From 1980 to 2003, the average annual gross domestic product (GDP) growth reached 14.2%. In the same period, the central built-up area and population more than doubled. Accompanying the rapid city growth, investment in infrastructure facilities grew 13-fold between 1992 and 2004.

The Metro Line 2 (ML2) was announced in 1998 in order to promote development of the south of the city through launching a TOD strategy, and its construction began in 2001. ML2 includes 20 metro stations, and its whole length is 23.27 km. The total cost of ML2 was estimated to be 950 million euros, and its first part was put into operation in June 2003 (Figure 1). Although there is a lack of official statistics, from interviews and observations of the author, it appears that the price of commodity houses adjacent to metro stations has greatly increased, indicating a change of land values.²

The IRR is another example (Figures 2 and 3). The IRR was also announced in 1998 and its construction was completed in 2000. It has been one of most expensive infrastructure projects in Guangzhou to resolve the serious traffic congestion in the old city. The IRR is 26.7 km in length and most, 20.26 km, is elevated. The whole project

² According to several realtor agencies in Guangzhou, the average resale price of some residential buildings along the ML2 increased by 200 Yuan per square meter of floor space within one year after completion of the ML2.
cost around 770 million euro, and was partly sponsored by the World Bank. Property values along the IRR were considerably affected. While the value of some property increased, thanks to increased accessibility, the value of other property was reduced due to noise, pollution and visual disfigurement caused by the elevated road. In other words, it bestows benefits on some groups and imposes costs on others. The IRR is therefore a project involving worsenment as well as betterment.

There are several reasons why these two projects have been selected for case studies. First, the impact of ML2 and IRR on the land market appears to be substantial, not trivial, which makes the quantification of the effects of transit somewhat easier. Second, the investment in these two projects is huge, but the municipal government has not considered value capture or hardship compensation, and has not made any ex-post evaluation of them. Therefore, the research on these two projects is expected to draw some attention to their significance on the land market of Guangzhou city.

Residential projects whose values were affected by the ML2 and IRR were then selected. The construction of infrastructure facilities may also have effects on commercial and office property markets, but transactional data are not as plentiful nor as readily available as those of residential projects. Moreover, in the catchment areas of the ML2 and IRR, the majority of development is residential. Welfare housing, although permitted for resale at market value and covering a substantial part of affected areas, is excluded because the original sales price could not reflect market value of the

Fig. 1. Project locations along Guangzhou Metro Line 2
property. Therefore, the chosen samples focus on commodity houses\(^3\) that were mostly built after 1990. The author spent one week visiting all commodity residential projects along the ML2 and IRR and marked them on a map. The samples of ML2 are limited to within walking distance (less than 15 minutes) of metro stations and those of IRR to residential projects which, or a part of which, directly face the elevated road and are

\(^3\) In China, commodity houses mean commercially provided houses, and commodity property means commercially provided property. They are named as ‘commodity’ to differentiate buildings built by government agencies or state-owned enterprises.
therefore adversely affected by the traffic noise, pollution and visual disfigurement (Figure 3).

It should be noted that this research mainly focuses on the analysis of positive impacts of the ML2 and negative impacts of the IRR, although the ML2 and IRR have much wider effects on the city. According to interviews by the author, the construction of the ML2 has been regarded as achieving the goal of promoting development of the south Guangzhou within the last three or four years (Guangzhou Urban Planning Bureau, 2004) and there have been very few complaints against the ML2. Although close proximity to a metro station may mean an agglomeration of people, house owners in populated Chinese cities seem to value more the increase of accessibility. The IRR has been a controversial project, not only because it causes certain hardship for some property owners but also because it is mainly targeted for the use of private cars, rather than public transport. There is also criticism that the elevated road encircling the old city has somewhat damaged the historical atmosphere of Guangzhou, a city with a history of more than 2100 years, and has caused displacement of around 20000 residents. On the other hand, the IRR has increased the accessibility of its surrounding areas and reduced air pollution because of the reduction of traffic congestion. Nonetheless, a comprehensive evaluation of these two projects from various perspectives is beyond the scope of this research.

4.2. Data Collection and Description

The availability of property information is one of the key factors for achieving an efficient property market. In most developed countries, property information is readily available from various sources such as real estate agents, local authorities, land title office, the press, or other information providers. In mainland China, it is very difficult to obtain such information. Property information is mainly controlled by relevant government departments, and the formerly closed nature of China still has a strong influence on the release of information. Accordingly, public access to real estate information tends to be restricted (Chan, 1999).

Since the middle 1990s, Guangzhou Municipal Real Estate Transaction Center (RETC) has been recording transaction information on commodity buildings, but transaction data are not released to the public. Furthermore, the registration systems for sales of new houses and second-hand houses are separate, in other words, the complete record of one dwelling unit is not available in one place in the RETC. With the help of some employees in RETC, the author collected information on the average selling price (ASP, Unit: yuan/m²) of all relevant residential projects for the first transaction between developer and house purchasers. The ASP of a project is calculated by the developer and registered by the Land Resources Bureau.

The calculation equation is

$$ASP = \frac{\sum f_i P_i}{\sum f_i}$$

Where:

- $f_i =$ floor space of the $i$th apartment
- $P_i =$ selling price per square meter of floor space of the $i$th apartment.
To conduct the repeat-sales analysis, resale information of samples is needed. Interviewing realtors has been an effective way to collect information on real estate transactions, but not all realtors are willing to release transaction data because they regard them as commercial secrets. Therefore not enough information can be collected from realtors alone, and other sources have to be explored. For instance, real estate magazines such as *Real Estate Information* and *Real Estate Weekly* publish advertisements of property sales periodically. The internet is also a useful tool in gathering information: http://house.gznet.com is a popular internet website, and many residents who want to re-sell their houses put information, including floor space and expected price, on the website. Although these prices are asking prices, there are some tips that can be used to discern which one is nearest to the transaction price. For example, if the seller overestimates the value of his/her apartment, and nobody is interested at this price, s/he has to ask for a lower price until somebody is interested and a transaction happens. Therefore, the last price s/he asks before the information on his/her apartment disappears can be regarded as closest to transaction prices. By utilizing multiple sources, data on 397 dwelling units along the ML2 and 184 dwelling units along the IRR were collected as samples (Table 1).

Among the sample prices of the ML2 project, 60.71% are transaction prices, and the remaining 39.29% are asking prices; for the IRR project, 72.18% are transaction prices and 27.72% are asking prices. Since the asking price is always higher than, or equal to the transaction price, the impacts of the ML2 and IRR may be a little overestimated.

5. Empirical Analysis Results: Impacts of ML2 and IRR on Property Values

While it is impossible to exclude all the external factors affecting property price, two alternative approaches, repeat-sales approach and hedonic regression, have been adopted for building price indices.

5.1. Repeat-sales Analysis of the ML2 and IRR

In developed countries such as the UK and USA, it is usual for one house/apartment to be transferred several times during its physical life. In China, however, since the real estate market emerged less than two decades ago, it is much less common for one house/apartment to have been transferred several times. A distinctive feature of the Chinese housing market is the dominant proportion of newly built houses. Usually developers purchase the Land Use Rights (LURs), build dwellings and sell the finished houses to individual occupants. A property development takes the form of one or several blocks of

<table>
<thead>
<tr>
<th>Table 1. Property information sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dwelling units along the ML2</td>
</tr>
<tr>
<td>RETC</td>
</tr>
<tr>
<td>Realtors</td>
</tr>
<tr>
<td>Internet and media</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>
apartments with similar building quality standards built together or in several stages on the same site. They may share certain facilities such as a garage area, a garden or a swimming pool. Recently the resale housing market has been emerging and becoming more significant. Statistics from the Guangzhou Land Resources Bureau shows that resold houses only occupied 6.1% of the total transactions in the housing market from 1992 to 1998, but their share jumped to 32% in 2001 and 43% in 2004 respectively.

To estimate property value changes caused by the ML2 and IRR, the original transaction price between the developer and the purchaser, and the resale price between the purchasers will be independent variables. As mentioned above, historical records of real estate transactions are not available in the RETC. To make the repeat-sales analysis manageable, an assumption is made that all units in one project share the ASP for their first transaction. Among the selected 26 housing development projects along the ML2 and the 20 projects along the IRR, only 20 projects along the ML2 and 15 projects along the IRR were completed before the construction of the ML2 and IRR, enabling data before and after the construction to be compared.

The assumption that housing characteristics are constant over time is the basis of the repeat-sales model. However, under the LURs system of China, a building’s age has a significant effect on property value and cannot be neglected. When a house is owned under a freehold system, costs related to the land are usually not depreciable. Under the LURs system, however, the residential ‘leasehold’ is 70 years at most. When the ‘lease’ expires, the government will re-possess the land and the on-site improvements. Therefore land is depreciable and its recovery period is 70 years. Moreover, the state of interior decoration and fittings has an impact on house price in China. In Guangzhou, many developers sell houses with full decoration, and the most common standard for decoration is 50 euros per square meter of floor space. The physical life of decorations varies according to the quality of materials and maintenance, but its economic life is usually regarded as five years. In other words, new purchasers are not willing to pay for decorations and fittings more than five years old. In order to make the evaluation manageable, the author assumes that the decoration cost of all dwelling units is 50 €/m², and the recovery period of decoration is five years.

According to interviews with realtors and developers in Guangzhou, new properties depreciate in value faster at their early years and slower in their later ages. Thus the depreciation is not based on a straight line. The quantification of this depreciation speed, however, has been very complicated and beyond the scope of this research. The tradeoff strategy to achieve both manageability and precision in this research, therefore, is to make an assumption, that is, the recovery period of decoration cost (50 €/m²) is five years, and the recovery period of other costs (that is, the sale/purchase price less the depreciated decoration cost) is 70 years. Both of them have been assumed to depreciate on a linear basis. Given the characteristic of the higher depreciation speed at the early stage of property, the introduction of decoration cost can somewhat offset the bias of the assumption of straight-line depreciation.

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4 Land users are permitted to apply for renewal of their leases before the lease expires, after paying the reassessed LUR’s fee, provided that their land will not be converted into other uses.
5 The decoration usually includes appliances in the kitchen and bathroom, wall painting and carpeting in Guangzhou.
6 Source: *Real Estate Information, Real Estate Weekly* and consulting with developers and realtors.
Since the assumption of the standard repeat-sales model cannot be supported under the LURs, its application has to be modified. In this research, all sampled dwellings have been transferred only twice, and building age should be incorporated into the equation in order to take the land depreciation into account. Then a new equation can be obtained as follows:

\[ P_2(1+r)^{N-n} = P_1(1+r)^N \]  

(5)

Where:

- \( P_1 \) = the first transaction price
- \( P_2 \) = the second transaction price
- \( N \) = the lease period, unit: year. It is 70 for residential projects in Guangzhou
- \( n \) = the period from the purchase to resale, unit: year.

In Equation 5, the decoration cost should be deducted from the transaction price because its recovery period is different from that of land. To make the transaction prices comparable, decoration cost is deducted from both \( P_1 \) and \( P_2 \). For simplification, the depreciation of decoration cost is set as 10 \( \text{€}/\text{m}^2 \) per year. For instance, the first transaction price of one unit in Fujing Garden was 434.2 \( \text{€}/\text{m}^2 \) in 2001, and its resale price was 433.2 \( \text{€}/\text{m}^2 \) in 2004. Both of these prices include decoration. In order to exclude the influence of decoration cost, the first transaction price is adjusted to 434.2−50=384.2 \( \text{€}/\text{m}^2 \), and the second transaction price is adjusted to 433.1−[(5−3)*10]=413.1 \( \text{€}/\text{m}^2 \). In that instance, five years is the economic life of decoration and, since the building age is three years, the remaining economic life of decoration is two years, so the remaining decoration value is 20 \( \text{€}/\text{m}^2 \). The adjusted prices are regarded as \( P_1 \) and \( P_2 \) respectively. Taking the natural log of Equation 5 yields:

\[ (70-n)\ln(1+r) = \ln(P_1/P_2) + 70\ln(1+r) \]  

(6)

According to Equation 6, the cumulative appreciation index \((1+r)\) of all samples can be estimated. Tables 2 and 3 reveal the average index of all samples in every project, and then this index is compared with the general house price index. RETC publishes the general housing index of the whole city on its website, http://g4c.laho.gov.cn/. The house price index of the base year, 2004, is set as 1, and indices in other years are converted into the comparable value. For example, the average cumulative appreciation index of Fujing samples is 1.0244701 within three years, and the general house price index in 2001 is 0.962943, compared with 2004, indicating that the construction of the ML2 has a positive impact on property value.

Table 2 and Figure 4 show that the appreciation indices of two projects, Hongyun Garden and Huai Garden, are less than the general house price index, and the appreciation indices of the other 18 projects are higher than the general house price index. This indicates that the construction of the ML2 has induced property value increase for most residential projects. Likewise, Table 3 and Figure 5 compare the cumulative appreciation indices of residential projects along the IRR with the general...
house price index. The result reveals that the appreciation index of all samples, except Huanshi Xiyuan, is much lower than the general house price index, which implies a significant value reduction induced by the construction of the IRR.

5.2. Hedonic Regression Analysis of the ML2

Compared with the repeat-sales model, hedonic regression can select samples of dwellings completed after the construction of infrastructure through the introduction of a dummy variable, the construction dummy, and therefore can utilize more data. Except for the samples used in the repeat-sales model, more samples that are completed after the ML2 can also be adopted in the hedonic analysis. Nevertheless, the hedonic regression requires much more information than the repeat-sales model, including physical and neighbourhood characteristics of the samples. Constrained by a lack of sufficiently detailed data, it has been very difficult to apply hedonic regression to analyse the effects of the IRR. In the hedonic regression analysis of the IRR, whether a dwelling unit faces the elevated road is the most important independent variable, but the data registration does not provide information of the specific location of one unit in a residential project. In other words, whether the sample faces the elevated road is unknown. In theory, a data set of similar, non-affected properties can be defined.

Table 2. Comparison between cumulative appreciation index of projects along the ML2 and general house price index

<table>
<thead>
<tr>
<th>Project name</th>
<th>Site area (M²)</th>
<th>Sample size</th>
<th>n (Year)</th>
<th>Cumulative appreciation index</th>
<th>General house price index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Fujing Garden</td>
<td>16 712</td>
<td>32</td>
<td>3</td>
<td>1.0244701</td>
<td>0.962943</td>
</tr>
<tr>
<td>2 Qianxi Garden</td>
<td>38 088</td>
<td>14</td>
<td>2</td>
<td>1.1909488</td>
<td>0.974498</td>
</tr>
<tr>
<td>3 Shunjing Ya Yuan</td>
<td>41 976</td>
<td>19</td>
<td>5</td>
<td>1.0821106</td>
<td>1.039473</td>
</tr>
<tr>
<td>4 Liyinghua Ting</td>
<td>21 629</td>
<td>23</td>
<td>2</td>
<td>1.4543943</td>
<td>0.974498</td>
</tr>
<tr>
<td>5 Yujing Nanyuan</td>
<td>48 340</td>
<td>27</td>
<td>4</td>
<td>1.0119574</td>
<td>0.994776</td>
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<tr>
<td>6 Yajing Yuan</td>
<td>13 543</td>
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<td>6</td>
<td>1.1540565</td>
<td>1.101137</td>
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<tr>
<td>7 Dajiating Garden</td>
<td>27 300</td>
<td>8</td>
<td>4</td>
<td>1.0034635</td>
<td>0.994776</td>
</tr>
<tr>
<td>8 Yujingya Yuan</td>
<td>42 837</td>
<td>33</td>
<td>4</td>
<td>1.1632653</td>
<td>0.994776</td>
</tr>
<tr>
<td>9 Yuexin Plaza</td>
<td>21 827</td>
<td>15</td>
<td>7</td>
<td>1.1222505</td>
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<tr>
<td>10 Qile Yuan</td>
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<tr>
<td>11 Jiaxin Garden</td>
<td>20 654</td>
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<td>4</td>
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<td>0.994776</td>
</tr>
<tr>
<td>12 Meijing Garden</td>
<td>20 654</td>
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<td>4</td>
<td>0.997915</td>
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</tr>
<tr>
<td>13 Shunhuaming Ting</td>
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<td>1.0243029</td>
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</tr>
<tr>
<td>14 Hongyun Garden</td>
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<td>6</td>
<td>1.0017486</td>
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</tr>
<tr>
<td>15 Jiangnan Garden</td>
<td>43 583</td>
<td>28</td>
<td>6</td>
<td>1.1945004</td>
<td>1.101137</td>
</tr>
<tr>
<td>16 Huayi Garden</td>
<td>4590</td>
<td>16</td>
<td>7</td>
<td>1.009764</td>
<td>1.095322</td>
</tr>
<tr>
<td>17 Hengxinyu Yuan</td>
<td>9901</td>
<td>6</td>
<td>2</td>
<td>0.9969842</td>
<td>0.974498</td>
</tr>
<tr>
<td>18 Letao Yuan</td>
<td>18 728</td>
<td>11</td>
<td>4</td>
<td>1.107208</td>
<td>0.994776</td>
</tr>
<tr>
<td>19 Lijing Garden</td>
<td>2854</td>
<td>4</td>
<td>6</td>
<td>1.1188361</td>
<td>1.101137</td>
</tr>
<tr>
<td>20 Suifa Garden</td>
<td>1426</td>
<td>5</td>
<td>7</td>
<td>1.109771</td>
<td>1.095322</td>
</tr>
</tbody>
</table>

Data source: RETC, Realtors, Internet and Media
Through the introduction of a dummy variable (it is 1 if sample faces the IRR, otherwise 0) the effect of the IRR can be estimated. The selection of a similar, unaffected data set, however, has been problematic. Unlike the ML2, where more than 90% of samples are located in one relatively less developed district – Haizhu district – and have many similar characteristics such as approximately the same distance from the CBD, and public facilities can be easily identified as falling in one of two categories (convenient and inconvenient), the IRR passes through four districts of the city, which have very different characteristics. Three of them are old districts: one is famous for schools of good quality; the second is an old business district; and the third has many historical 

Table 3. Comparison between cumulative appreciation index of projects along the IRR and general house price index

<table>
<thead>
<tr>
<th>Project name</th>
<th>Site area (M²)</th>
<th>Sample size</th>
<th>n (year)</th>
<th>Cumulative appreciation index</th>
<th>General house price index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Haiyi Garden</td>
<td>31 536</td>
<td>11</td>
<td>4</td>
<td>0.9664953</td>
<td>0.994776</td>
</tr>
<tr>
<td>2 Huanxishi Yuan</td>
<td>35 396</td>
<td>13</td>
<td>3</td>
<td>0.9935311</td>
<td>0.962943</td>
</tr>
<tr>
<td>3 Huiyang Yuan</td>
<td>21 000</td>
<td>8</td>
<td>3</td>
<td>0.9368553</td>
<td>0.962943</td>
</tr>
<tr>
<td>4 Hengfu Ge</td>
<td>7800</td>
<td>16</td>
<td>8</td>
<td>0.9047301</td>
<td>1.057269</td>
</tr>
<tr>
<td>5 Jingcheng Garden</td>
<td>49 961</td>
<td>17</td>
<td>5</td>
<td>0.9447005</td>
<td>1.039473</td>
</tr>
<tr>
<td>6 Taojin Garden</td>
<td>31 254</td>
<td>22</td>
<td>6</td>
<td>0.9349163</td>
<td>1.101137</td>
</tr>
<tr>
<td>7 Huaqiao Garden</td>
<td>13 284</td>
<td>19</td>
<td>8</td>
<td>0.9233265</td>
<td>1.057269</td>
</tr>
<tr>
<td>8 Tianxing Tower</td>
<td>–</td>
<td>5</td>
<td>7</td>
<td>0.9420996</td>
<td>1.095322</td>
</tr>
<tr>
<td>9 Yueqian Garden</td>
<td>–</td>
<td>6</td>
<td>6</td>
<td>0.9494336</td>
<td>1.101137</td>
</tr>
<tr>
<td>10 Luhu Ge</td>
<td>8536</td>
<td>7</td>
<td>7</td>
<td>0.9949264</td>
<td>1.095322</td>
</tr>
<tr>
<td>11 Jinhui Garden</td>
<td>30 738</td>
<td>9</td>
<td>6</td>
<td>0.9663796</td>
<td>1.101137</td>
</tr>
<tr>
<td>12 Jiangwan Garden</td>
<td>150 941</td>
<td>18</td>
<td>7</td>
<td>0.9397078</td>
<td>1.095322</td>
</tr>
<tr>
<td>13 Fengan Garden</td>
<td>6711</td>
<td>6</td>
<td>6</td>
<td>0.9563755</td>
<td>1.101137</td>
</tr>
<tr>
<td>14 Lyu Ji</td>
<td>5505</td>
<td>5</td>
<td>4</td>
<td>0.9699037</td>
<td>0.994776</td>
</tr>
<tr>
<td>15 Haiyiming Yuan</td>
<td>9463</td>
<td>9</td>
<td>4</td>
<td>0.8433674</td>
<td>0.994776</td>
</tr>
</tbody>
</table>

Data source: RETC, Realtors, Internet and Media

Fig. 4. Comparison between cumulative appreciation index of projects along the ML2 and general house price index
sites and parks. Moreover, the Metro Line 1 crosses these three districts. Therefore, the selection of a similar, unaffected data set requires many more variables that can encompass all these characteristics, which makes data collection very difficult. Therefore, the comparison, within one project, of units which have very similar characteristics except the difference that some face the IRR directly, and others not, is more practicable. Constrained by the data unavailability, hedonic regression can only be used for the analysis of the ML2.

5.2.1. Variables used in the hedonic pricing model. The hedonic model assumes that property value is a function of a set of locational and property specific characteristics, where property price is the dependant variable and the vectors of physical and neighbourhood characteristics are independent variables. The following function can be estimated:

\[ P = \beta_0 + \beta_1(X_1) + \beta_2(X_2) + \cdots + \beta_i(X_i) \]  

Where:
- \( P \) = house selling price
- \( X_i \) = physical characteristics of house.
- \( \beta \) is the coefficient that needs to be estimated according to variables of the sample.

The explanatory variables can be divided into the following categories:

- **Building characteristics**
  - \( X_1 \) = floor space: the floor space of an apartment has a significant influence on property value.
  - \( X_2 \) = building age: as mentioned above, building age is an important determinant of property price under the LUR’s system where the residential land ‘lease’ is usually 70 years.
  - \( X_3 \) = building height: usually the high-rise residential building (more than 12 storeys with lifts) costs 300 to 500 yuan per square meter of floor space more than the medium-rise residential building (Usually 6 or under 6 storeys without lifts). The building height dummy is set as 1 if a high-rise building, otherwise 0.
There are other variables that have influences on property values, for example the orientation of the dwelling and the storey where the dwelling is located. Unfortunately this information is not readily available in the current registration system.

- **Land-use density**
  
  X4 = lot size: usually a larger lot can provide more facilities and a better living environment, compared with a small site.
  
  X5 = overall floor space: it is the sum of all dwelling units in one project. The more floor space, the more households and facilities can be provided in a project.

- **Surrounding facilities**
  
  There are two groups of variables reflecting the quality of surrounding facilities. X6 = public facilities, including shops, education facilities, open space, etc., have certain effects on property value. In general, the more facilities, the higher the property value. The level of public facilities is set as a dummy variable. It is 1 if there are shopping areas and education facilities within a radius of 1000 m of the project, otherwise 0.
  
  X7 = adjacent bus stations: it is also a key indicator of property value. In general, a developed bus network can increase accessibility and have benign effects on property values. It is set as a dummy variable. The value is 1 if the walking distance to the bus station is less than 500 m, otherwise 0.
  
  There are other variables of neighbourhood quality such as the views from a dwelling unit, noise and pollution levels that can influence property value, but that information is not available.

- **Accessibility and effects of the ML2**
  
  There are two variables measuring accessibility in this model:
  
  X8 = walking-time distance to the closest metro station. The accessibility of a property to public transport is a critical factor affecting property value.
  
  X9 = construction dummy. In regard to impacts of the announcement of the ML2 proposal on property values, some scholars use an announcement dummy instead of a construction dummy to measure effects of transit in developed countries (Gatzlaff and Smith, 1993). In China, however, because of the volatility of policies, announcements only have weak influences on the real estate market, but the construction shows a much stronger signal. Therefore the construction dummy is set as 1 if after 2001, otherwise 0.

The data of the dependent variable, P, includes the transactional information before and in 2004. To make the data comparable, 2004 is used as a current base year, and all transaction prices happening before 2004 are converted into present value of 2004.

5.2.2. Results of analyses. Three hundred and seventy-one dwelling units in 26 projects along the ML2 were selected for the linear regression analysis. The dwelling units in one project share some characteristics, for example surrounding public facilities and same walking distance to metro stations.\(^7\) A stepwise regression process, which adds

\(^7\)Strictly speaking, dwelling units in the same project do not necessarily have the precisely same walking time distance to the metro stations. Nevertheless, the lot size of the selected residential projects is not large enough to generate substantially different distances to metro stations and, therefore, all dwelling units in one project are assumed to share same walking distance.
significant variables and removes insignificant variables while constantly recalculating the model, was used to achieve an adjusted R-square value of 0.838 with an F-value of 214. Two variables, X4, lot size and X7, adjacent bus stations, are insignificant. The analysis result is presented in Table 4.

The regression coefficients in the hedonic model represent changes in the dependent variable attributable to changes in the explanatory variable. Variable X8 and X9 capture the effect of the ML2 on the value of properties close to metro stations. The regression coefficient of X8 shows that a longer walking distance results in a lower property price. Controlling for other factors, every one-minute increase in walking time was associated with a ¥5449 (€544.9) decrease in the mean price of sampled dwelling units. The regression coefficient of X9 means that the construction of the ML2 had a positive impact on property value. Because of the construction of the ML2, the mean price of sampled dwelling units increased by ¥68447 (€6844.7), all else being equal. Both of these coefficients are statistically significant.

Table 4 also reveals that another five variables, including X1 (floor space), X2 (building age), X3 (building height), X4 (overall floor space), X6 (public facilities), are statistically significant in explaining the house prices. For every square meter increase in the mean floor space of a dwelling unit, the property value increased by ¥4138 (€413.8), all else being equal. The negative parameter of building age is consistent with expectation, i.e. the older the building, the less valuable it is, and the increase of one year in the building age could lead to the decrease of property value of ¥9990 (€999). The coefficient of the building height dummy means that a dwelling unit in a high-rise building had a ¥25805 (€2580.5) premium added to the dwelling, compared to a dwelling unit in a medium-rise building. The land-use density variable, overall floor space, has a coefficient of 77.8, which means that every increase of 1000 square meters in overall floor space of a residential project could result in an increase in the value of an individual property of ¥77.8 (€7.78), and this small number means that only a substantial increase of overall floor space can exert significant influence on the mean property price. The positive parameter of public facilities reveals that a dwelling unit with convenient surrounding public facilities was priced ¥30075 (€3007.5) higher than a dwelling unit without them, if all other conditions were equal.

Two variables, X2 (lot size) and X7 (adjacent bus stations), are not statistically significant in this model, which may be explained, in the first case, as overall floor space being a more precise indicator of the scale of a residential project. In the case of the bus station variable, the bus network is quite developed in Guangzhou and therefore there was no significant difference in the bus service among the residential samples.

5.2.3. Heteroscedasticity Test. Due to the existence of potential heteroscedasticity and bias, a heteroscedasticity test is needed. Table 4 lists the results of the heteroscedasticity test, and it shows that all coefficients remain unchanged after White’s heteroscedasticity consistency test, and only the standard errors, t value and the significance levels of variables that are not statistically significant are slightly changed. This shows that the hedonic analysis is robust, and the estimation result is reliable.
Table 4. Summary of regression estimates and heteroscedasticity test

<table>
<thead>
<tr>
<th>Variables</th>
<th>Unstandardized Coefficients</th>
<th>Standard error</th>
<th>t</th>
<th>Sig.</th>
<th>Adjusted R²</th>
<th>F statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>-17 852.024</td>
<td>15 205.301</td>
<td>-1.174</td>
<td>0.241</td>
<td>.838</td>
<td>213.8 (.000)</td>
</tr>
<tr>
<td><strong>Building characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X1 Floor space</td>
<td>4138.218</td>
<td>117.202</td>
<td>35.308</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X2 Building age</td>
<td>-9989.823</td>
<td>2312.399</td>
<td>-4.320</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X3 Building height (1 if high-rise, otherwise 0)</td>
<td>25 805.770</td>
<td>6765.806</td>
<td>3.814</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Land use density</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X4 Lot size</td>
<td>-0.016852</td>
<td>0.072785</td>
<td>-0.232</td>
<td>0.817</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X5 Overall floor space (1000M²)</td>
<td>77.818</td>
<td>0.262</td>
<td>2.944</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Surrounding facilities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X6 Public facilities (1 if convenient, otherwise 0)</td>
<td>30 075.488</td>
<td>12 396.102</td>
<td>2.426</td>
<td>.016</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X7 Bus stations (1 if convenient, otherwise 0)</td>
<td>-4972.910</td>
<td>10 653.14</td>
<td>-0.467</td>
<td>0.641</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Accessibility &amp; the effect of the ML2</strong></td>
<td>-5449.233</td>
<td>1022.564</td>
<td>-5.329</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X9 Construction dummy (1 if after 2003, otherwise 0)</td>
<td>68 447.460</td>
<td>12 233.763</td>
<td>5.595</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Summary of statistics: No. of observations=371
Adjusted R²=.838
F statistics=213.8(.000)

*Note:* The adjust values of White's heteroscedasticity consistency are presented in parentheses. Others remain same.
6. Conclusions

The above analysis reveals that the two transport projects have significant impacts on residential property values in Guangzhou. Through the repeat-sales and hedonic regression analyses of the ML2, we find strong evidence that the construction of the ML2 has positive impacts on the values of residential properties within walking distance of metro stations. This finding is consistent with the observation that, in a dense city where public transport has been dominant, the construction of a metro line can have substantial influences on real estate markets. The application of the repeat-sales model shows that construction of the IRR has induced value reduction in samples which face with the elevated road. Constrained by the unavailability of data, the hedonic analysis of the IRR could not proceed. Nevertheless, because of the short time period between the construction of the ML2 (2003) and IRR (2000), and the research base year, 2004, further impacts of the ML2 and IRR may well appear, and this requires future research.

In spite of dramatic influences of the ML2 and IRR on the property market of Guangzhou, the municipal government has not taken any measure to capture betterment or compensate worsenment caused by the transit projects. The result is that while some enjoy the unearned benefit, others have to bear the cost. The inability of the government to address betterment and worsenment issues can lead to several problems that are worthy of attention. The first problem is that inability to recover the surplus land value may weaken the fiscal capability of governments to provide public services. If users are not charged for services provided, large benefits may accrue to adjoining landholders, and thus cause the government to lose the opportunity to gain revenue that could have gone to public coffers, especially important for Chinese cities where the governments are faced with limited funding. The failure to capture subsequent land-value increments arising from public activities has made the financing of expensive public facilities more difficult. The second problem is that the failure to compensate hardship caused by government actions may lead to uncertainty in the land market and therefore be a restraint on long-term land market development.

Most transport infrastructures have been funded through the public sector, and there should be some means by which the transit-added value can be captured through development taxes or other forms of exactions – otherwise there will always be a ‘free rider’ problem (Banister and Lichfield, 1995). Values capture stands as a potential source of revenue to help pay off the debt on transport investments (Cervero and Duncan, 2001). On the other hand, compensation for hardship could help the government refrain from a hasty capital expenditure decision that the government does not really need to pay. Following the introduction of policies that can internalize these externalities, a fairer and more efficient land market could be expected to emerge.

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References


