An Evidence-Based Planning Support Methodology Estimating Value Creation of Planning Scenarios in the Chinese Context

Hong Hu, Stan Geertman and Pieter Hooimeijer

Utrecht University, Utrecht, The Netherlands
email corresponding author: h.hu@uu.nl

Abstract

In the transition to a market-driven post-industrial society, China's urban planners are dealing with sustainability issues such as reducing environmental pollution while maintaining urban growth. To realize such sustainability goals, planners can make use of the market force to create value for both end-users (residents) and investors (governments and developers). However, the current planning approaches hardly support planners to estimate value creation by planning decisions. This article considers the city-wide effects of planning interventions and proposes an evidence-based planning support methodology to assist planners estimating value creation of planning scenarios. It illustrates the methodology with two planning scenarios in Nanjing China. Results show that new metro construction will influence land prices city-wide instead of just within the direct vicinity of the new metro lines. And redevelopment of heavy industrial areas will have a spill-over effect beyond the redeveloped areas. This methodology can help planners to estimate the city-wide value creation by planning interventions.

Keywords: Evidence-based, planning support methodology, scenarios, what if analysis, value creation

Introduction

In the transition from a state-led industrial to a market-driven post-industrial urban economy, China's urban planners are struggling with their professional role in building a sustainable city. On the one hand, they need to reduce environmental pollution resulting from the increasing use of cars and the large state-owned heavy industries. It is reported that one fifth of Chinese cities are facing severe air pollution (UN-HABITAT et al., 2012). On the other hand, they need to maintain urban growth by accommodating more urban residents and restructure the city. Currently, China has 665 million urban residents, up from 191 million just 30 years ago; and it will have 350 million new urban residents in the coming 20 years (Baeumler et al., 2012). The urban restructuring is mainly characterised by a property-led process during the transition (Zhou & Ma, 2000; Yang & Chang, 2007; Qian, 2012). The planning decisions of local governments are increasingly influenced by the market since the land lease generates substantial amounts of revenues (Wu & Yeh, 1999; Ma, 2004).

Planning in China is often criticized by its market-driven characteristics because local governments often give priority to short-term economic growth over long-term environmental sustainability (Wang, 2003). Instead of a market-driven planning, a more market-conscious planning might help planners to achieve their sustainability goals practically (Hoetjes et al., 2006). The market reflects the willingness to pay or the preferences of residents for their living environment (Li, 2012). If planners make proper use of the market, they can create value for both end-users (residents) and investors (governments and developers) and meanwhile realize the overall goal of sustainability. The value for residents relates to the increased property prices as well as to improved living quality. The value for investors consist of monetary profits.

The pre-condition of making use of the market is to systematically estimate value creation of planning interventions. Besides direct effects, planning interventions can have spill-over effects and/or have an impact city-wide. For instance, improvement in transit facilities will impact the market values of properties within the transit corridors, however sometimes it will also influence the property values at

other localities city-wide or even in the metropolitan region (Smith & Gihring, 2006). Planners need to be aware of these spill-over effects and are advised to estimate value creation of planning interventions at forehand at a wider scale. This knowledge can be of help in substantiating and/or financing planning interventions.

In China, the master plan is the main plan for the restructuring of the city (Qian, 2013). Therein, however, it fails to provide insight into the estimated value creation by planning decisions, nor into its city-wide effects. This can be illustrated by the present insufficient integration between land use and transportation planning. Land-use planning would ideally allow for higher density development in the vicinity of transit nodes, which makes the land market to capture the benefits of reduced travel times (Liu & Salzberg, 2012). However, this kind of knowledge and policy integration is not yet applied in China, although some cities start to move in this direction (Liu & Salzberg, 2012). A better approach is needed to assist planners to understand and determine the effects of integrated planning interventions, also at a city-wide scale.

The current master plan is mainly build upon information sources like statistics, surveys, planning experiences, and planners' professional knowledge (Qian, 2013). These broad sources of data, information, and knowledge are not related to an understanding of the value creation at a city-wide level of certain planning interventions. Planning support systems (PSS) using 'What If?' analysis might provide planners with such insights by defining scenarios (Geertman, 2002; An et al., 2005; Vonk et al., 2005). In China, most PSSs contain spatial models to solve issues such as urban spatial layout and spatial strategic adjustments (Li & Jiao, 2013). However, at the moment, no PSSs in China are dedicated to estimate value creation due to planning interventions.

Using evidence in planning depends on the planning context (scenarios) and the purpose of using it (Davoudi, 2006; Faludi, 2006; Lord & Hincks, 2010). This article explicitly considers the city-wide effects of spatial planning interventions and proposes an evidence-based planning support methodology to assist planners estimating value creation of planning interventions. This methodology will help planners to use market force to maintain urban growth while reducing environmental pollution. This article illustrates the methodology

with two scenarios (transportation network extension and land use change) in Nanjing China, and uses 'What If' analysis to estimate value creation at a city-wide level of particular planning interventions.

The next section briefly gives some insight into the theoretical background. Thereafter, a conceptual framework is proposed, followed by an elaboration of the application of the evidence-based planning methodology in two different case studies. Finally, the conclusions are drawn.

Theoretical background

Since 1978, China has been in the transition from a centrally planned economy to a market-oriented economy. The planning system becomes significantly different from that during the pre-reform era (Ma, 2002). With the rise of market forces, urban planning is required to alleviate the negative impact of rapid urban sprawl, to incorporate pre-set sustainability goals, and to balance economic and social development (Qian, 2013). In studying China's urban planning, several questions remain like for instance: "To what extent has the majority of the urban residents benefited from the on-going developments?" Planners should keep this kind of questions in their work at the forefront of their minds (Ma, 2004).

As a forward-looking activity urban planning seeks to identify actions for the future of cities and regions and identify on forehand the positive and negative, and the direct and indirect (spill over) effects of their planning interventions. Therein, planning strives for a fair distribution of amenities and disamenities, and of advantages and disadvantages over distinctive groups in society. However, in practice, with the growing complexity of urban processes, planners and policy makers are more often than not struggling with their professional role (Nadin & Stead, 2008). More specifically, planners strive for a balance between planning goals representing public interests on the one hand and de facto development opportunities determined by the market forces on the other hand. Therein, planning is required to provide flexibility to facilitate decision-making by multi-stakeholders; however, planning is sometimes criticized as being too

flexible in that the public sector loses its controlling power while the private sectors gains increasing influence in urban development (Gielen & Tasan-Kok, 2010). Furthermore, it is necessary for planners to estimate on forehand the positive and negative effects at a city-wide level of market forces and of the returns and compensations that planning interventions can have. Understanding the market forces behind urban investments and the estimated effects of potential planning interventions can help planners to gain insight into the balances of economic and social development. Increases or decreases of land and property values can be seen as examples of potential (side-)effects of planning interventions (Gielen & Tasan-Kok, 2010). By taking these effects into account, the feasibility to achieve planning goals might increase (Hoetjes et al., 2006).

The integration of transport and land use planning can be envisioned an example of planning with potential effects that might increase the feasibility of achieving planning goals. For example, Bertolini et al. (2005) consider the integration of transport and land use planning to be crucial in achieving more sustainable urban spatial forms. Moreover, transportation plans often show spill-over effects on land prices (Smith & Gihring, 2006). From that, it can be argued that transportation plans need careful consideration of the land uses surrounding infrastructure projects (Heeres et al., 2012). However, real integration of transport and land use planning is often absent in planning practice (te Brömmelstroet & Bertolini, 2008). One of the key barriers to the integration is the lack of shared visions from planners in both domains. As a consequence, plans and interventions from both domains are often suboptimal or even conflicting (Beukers et al., 2012). To support the integration, Brömmelstroet & Bertolini (2008) propose a Planning Support System (PSS), called Mediated Planning Support (MPS). With the help of this PSS bottlenecks blocking the integrated implementation of land use and transport planning can be addressed. However, this planning tool has not considered utilizing market forces for integration of land use and transport planning.

In China, there are some PSSs using geospatial analysis (e.g. GIS) for decision makers to compare different planning strategies and to find out the best urban developments. These PSSs mainly apply spatial information such as land use and transportation data based on

GIS techniques, or they assist in urban design by using CAD software (e.g. Yeh, 2008; Wang & Zou, 2010). Planners however, are in need of useful tools to bring market knowledge into planning and decision making. So-called 'What If?' analysis can be of help to provide planners and policy makers with such knowledge of the potential value creation of planning interventions. Therein, scenarios can be used to anticipate various 'What If?' questions, besides generating discussion among stakeholders (e.g., see An et al., 2005; Johnson & Sieber, 2009).

Conceptual framework

Our planning support methodology attempts to integrate market models into the planning process to meet the information needs of decision-makers. This planning methodology is embedded in the Chinese context. Therein, planning is guided by urban development strategies. Since the current urban planning in China is highly influenced by market forces, we define two urban development strategies: on the one hand, creating value for both end-users (residents) and investors (governments and developers), and on the other hand, achieving sustainability. Creating value for end-users and investors implies the estimation of direct and indirect effects of planning interventions. Achieving sustainability is oriented towards reducing environmental pollution while maintaining urban growth.

These urban development strategies guide planners heading towards win-win situations within the urban development. The urban development strategies influence the forming of different planning scenarios. Usually, these scenarios are based on land use policies or infrastructure improvements which can influence the land lease market, the housing market, and the quality of life of residents.

To estimate the direct and indirect effects of the defined planning scenarios, we have built a corresponding evidence database. The basic evidences consist of housing transaction data at individual level, housing stated choices at individual level, urban land use which can be detailed into the residential blocks, transportation network including public transportation network and the road network. To analyze housing valuations of residents, hedonic price models and conjoint

models are adopted. Hedonic price models (HPM) decompose the price into separate components (Goodman, 1978). House price formation is generally explained by indicators from three broad categories: dwelling attributes, accessibility, and neighbourhood quality. The attributes selected in each category vary according to the local urban context. Conjoint models (CM) or stated preference methods are used to estimate the willingness to pay for a bundle of housing attributes (D. Wang & Li, 2004). HPM is a revealed preference model indicating how residents purchase houses in reality while CM is a stated preference model indicating how residents subjectively value housing environment. Based on these valuation models, we construct the residents' valuation database, including data of housing preferences, housing affordability, and willingness to pay for housing.

Next step, 'What If' analysis can be applied based on the scenarios and residents' valuation database. The 'What If' analysis can provide planners and policy makers with insights into the interaction between markets and planning interventions. These insights help planners and policy makers to compare the pros and cons of different urban policies.

China's planning is influenced by various administrative levels. According to Liu and Salzberg (2012) the central government establishes broad national policies and targets and reviews and approves urban master plans for major cities, mega-investment projects, and applications for rural-to-urban land conversion; while the local governments (municipalities) are responsible to make master plans for the local economy and employment, as well as the provision and management of municipal services. In theory, the performance of the local governments are supervised by higher level authorities, but also by the local People's Congresses. The members from People's Congresses represent various defined groups of society and are vested with great law making powers. However, they have neither sufficient technical capacity nor sufficient representation from all stakeholders to intervene (Liu & Salzberg, 2012). Quite recently, the planning process has increasingly been opened up for residents and has given them the rights of inquiry and monitoring (see *City and Country Planning Law, China, 2008*). In practice, they are usually informed via the planning publicity after a plan has been prepared

(Liu & Salzberg, 2012). Given the intervention during planning process by other stakeholders, we suggest that different stakeholders comprise a planning committee to reach a decision. It has been argued that 'What If' analysis offers added value in particular in cases where plan development is an outcome of a group planning process involving planners, the local community, and other possible stakeholders (e.g. An et al., 2005). The planning committee fitting the Chinese planning context can be comprised of planners, policy makers, developers, representatives from land bureau, representatives from transportation bureau, and representatives from the local Peoples' Congress.

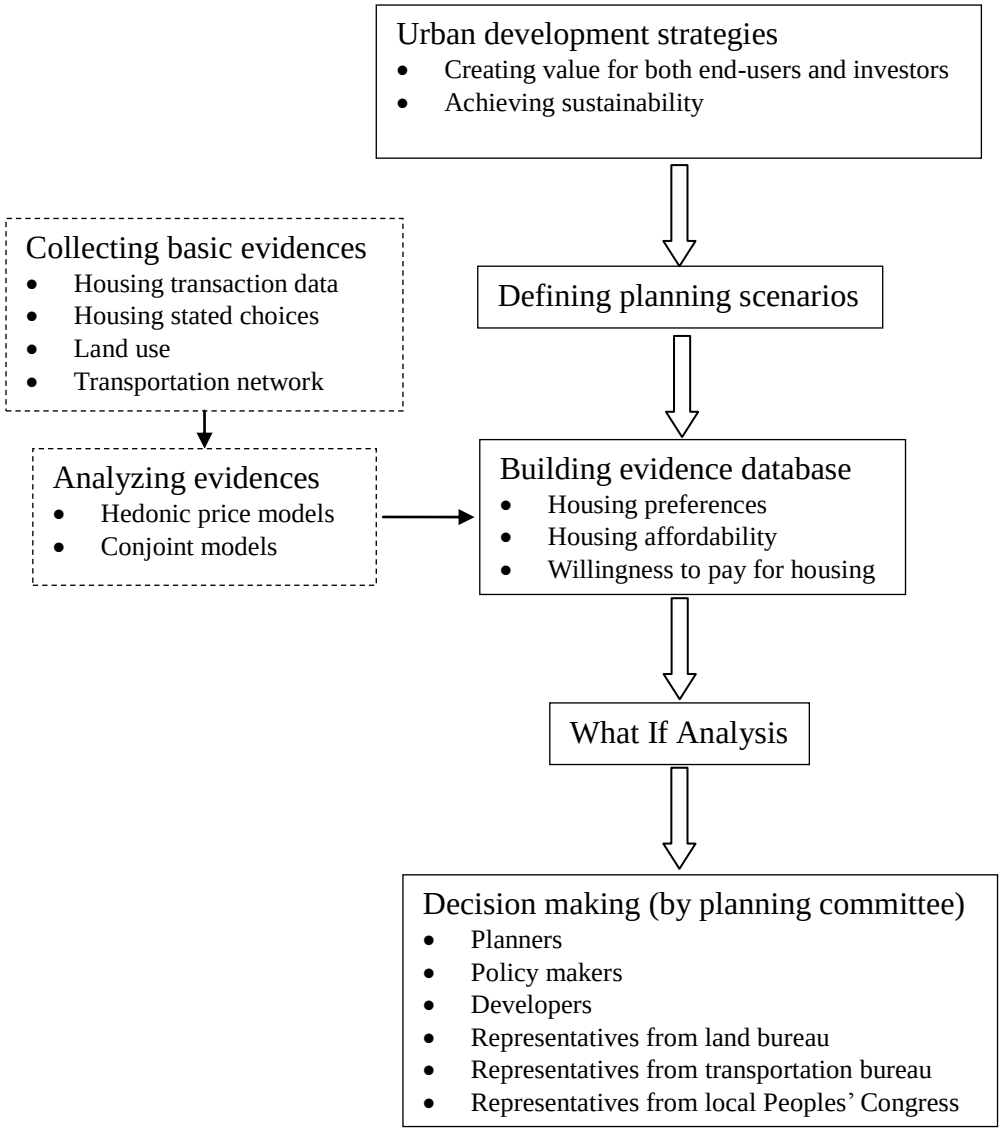

Fig.1 Conceptual framework of evidence-based planning support methodology estimating value of various planning scenarios in the Chinese context

Case study

We used the city of Nanjing as the case study area. Nanjing is located in the Yangtze River Delta with the population of 8 million. It has been the capital of China during several dynasties since the third century. After 1950, the Nanjing government has invested heavily to build a series of state-owned heavy industries, which converted Nanjing into an important industrial production centre of East China, but also caused serious air-pollution. The heavy industries that occupy large lots are mainly concentrated along the Yangtze River, but smaller ones can be found in nearly half of the neighbourhoods (Figure 2). More recently, the Nanjing government has made great efforts to transform from an industrial production centre to a regional service centre by restructuring old urban districts and creating new urban areas surrounding the city centre. The 12th five year plan of the Nanjing government (2010) indicates that some heavy industries in the southern districts along the Yangtze River will be relocated to the urban fringe. After the relocation, the brown fields need to be reconstructed to become attractive for new functions.

The Yangtze River splits the built-up area into two parts. Because the CBD, the major jobs concentrations and larger facilities lie in the southern part and because there are only four bridges, the northern part has relatively poor accessibility to most activity places. The existing two metro lines, which are only located in the south of Yangtze River, are crucial for rapid transportation in the city. Four metros line are under construction to connect the north and south. They will be finished in 2014. The extent to which the new metro network will influence land prices within the city has not been systematically estimated.

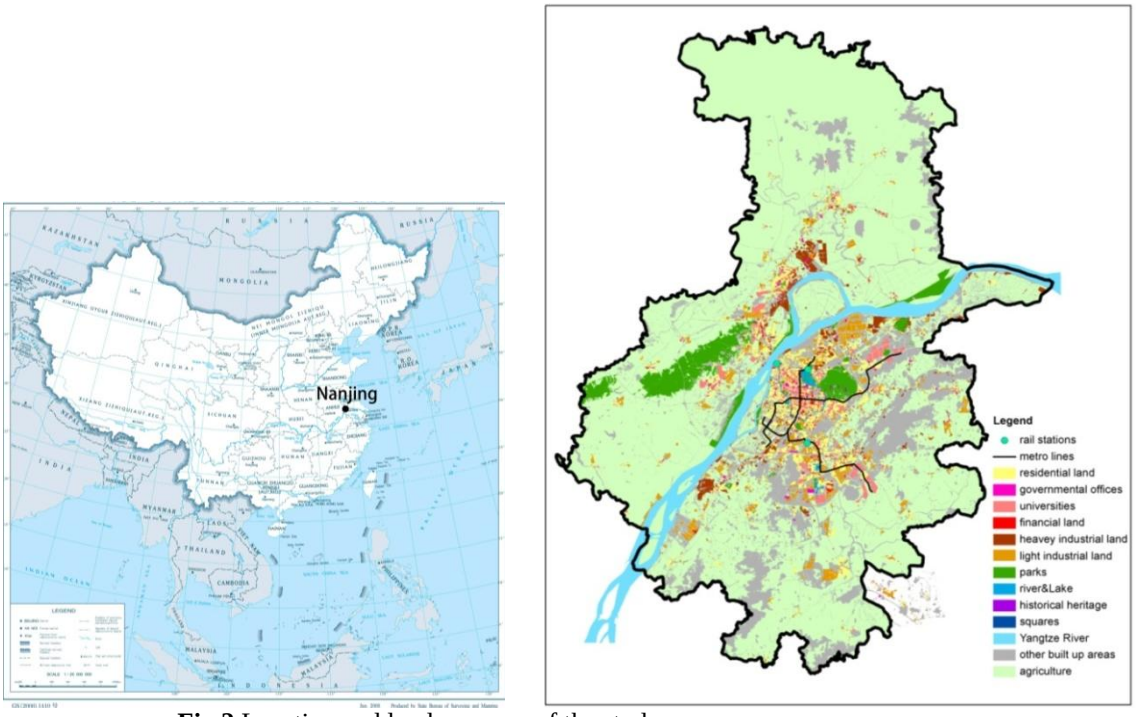

Fig.2 Location and land use map of the study area

We illustrate the evidence-based planning support methodology as follows.

Urban development strategies

Given the local planning context of Nanjing, we define the urban development strategies as:

- creating value for both end-users and investors
- improving quality of life for residents

Defining planning scenarios

Given urban development circumstances in Nanjing, we can define 2 scenarios to (re)develop the city. Both scenarios are helpful to increase land revenues and to reduce air pollution.

Scenario 1: new metro network. There are four metro lines under construction which will extend the existing metro network of two

metro lines. This scenario will simulate the effects of the new metro network on the land prices city-wide.

Scenario 2: replacing heavy industrial areas with residential neighbourhoods. The Nanjing government plans to move some heavy industries outward. It raises the questions as how to develop the brownfields and how to subsidize the moving out of heavy industries. This scenario will simulate the land prices for all brown fields and the price change of the surrounding residential lands.

Building evidence database

In this section, we use the hedonic price model (HPM) to illustrate our methodology. To employ HPM in Nanjing, we need to collect data from five categories: spatial information, house price, dwelling attributes, accessibility calculation, and neighbourhood quality.

Spatial information includes land use map at residential block level; road network map with 5 levels of roads such as City express way, arterial road, secondary truck road, branch road, and path; neighbourhood division map, school district map, public transportation map with bus lines and metro lines. House price data was collected from relevant websites on the Nanjing housing market in June, 2010. In total, 9948 apartment records from the housing market and in 511 neighbourhoods qualified (3762 newly built, 6186 second hand). From the records we calculated the price per square meter. Dwelling attributes concern the physical characteristics of the dwelling. We collected dwelling information such as building year, number of bathrooms, total floor area, and floor level. We measured job accessibility potential, access to the CBD, to metro stops, to access points of city expressways, to the railway station, to squares, to large parks, and to rivers and lakes. To distinguish urban and suburban as well the effect of Yangtze River, we use a dummy for apartments located in urban districts and a dummy for apartments located in southern suburban district of Yangtze River. To measure neighbourhood quality, we included the presence of squares and parks in a neighbourhood to measure the proximity of cleaner air, less noise, and the chance to have a scenic view. We set a threshold of 500 meters from the apartment to calculate the proximity effect of

river and lakes. The quality of the schools is an important indicator of house price. In Nanjing, whether a child can go to a specific school depends on whether they live in that particular school district. The boundaries of neighbourhood and school district do not coincide. We chose 20 school districts which have high quality elementary schools and measured whether an apartment is located in these school districts. Nanjing is rich in historical and cultural heritage. We included the location in neighbourhoods of historical heritage as an indicator of neighbourhood quality.

We chose public transport accessibility as our major measure given the modal-split in Nanjing. To capture public transport accessibility, we set the rules that 1) people have to walk to the nearest stop from an apartment location to enter public transport network, leave the network at the nearest stop from the destination, and then walk to the destination; 2) people walk to transfer between bus stops and metro stops.

To distinguish the effects of jobs in different sectors of the economy, we calculated the job accessibility potential score to higher education, large governmental institutions, and financial and business services. When calculating the distance between apartments and jobs we found that it was not appropriate to only use road network or public transport network. Many employment locations are dispersed in the study area and many jobs are within walking distance of apartments. Using the formal road network, or the public transportation network, would incur lengthy detours rather than those short direct connections. Therefore, we built a Delauney network as our walking network (directly connect all the nodes in the network, apartment locations and job locations), and combined it with the road network and public transport network to precisely calculate job accessibility.

We used a gravity model to calculate the potential score of job accessibility, measuring the weighted time cost from each apartment to all employment locations (Geurs & Ritsema van Eck, 2001; Geertman & Ritsema Van Eck, 1995). However, in the modelling process, we found that job accessibility of heavy industry shows positive effect at long distance and shows negative impact at short distance. Therefore, we use accessibility counts of heavy industrial jobs

within 20 minutes and between 20 and 40 minutes to capture different effects of heavy industry.

The equation of gravity model is:

$$P_i = \sum_j \frac{M_j}{D_{ij}^a}$$

Where Pi is the potential score at apartment i; Mj is the total number of jobs in each land use parcel j (differentiating between industrial, commercial, governmental, and educational land use); Dij is the distance in time costs between i and j; a is the parameter that reflects the rate of increase of the friction of distance. The parameter usually varies between 1 and 2. Since we do not know the exact distance decay rate, we did a sensitivity test with 1.0, 1.3, 1.5, 1.7 and 2.0. Given the fit of the model as well as considering the average commuting time of Nanjing people (around 30mins), we chose value 1.5 in our final model.

People usually choose to walk to a bus or metro stop, and take the car to the access point of the city expressway. We chose Euclidean distance to these points as our measurement. Accessibility to CBD appeared to be highly correlated with other accessibility indicators. We chose to study alternative accessibility indicators instead of CBD in order to investigate accessibility value of various amenities.

In this paper, we use a mix of more theoretical, pragmatic, and empirical considerations to decide on the functional form. From a theoretical point of view it is clear that the relationship between accessibility and house price is non-linear and not monotonic. The distance gradient (distance decay or rise) is steep at short distance and gradually becomes flatter at increasing distance. We pragmatically chose relatively simple regression functional forms to describe this relationship because these normally reduce random errors and inaccuracies which are usually more apparent in complicated models (e.g. Box-Cox); moreover, simple functional forms are relatively easy to interpret (Cassel & Mendelsohn, 1985). Empirically we tested the semi-log model, exponential model, quadratic model, inverse-log model, double-log model to assess accessibility indicators. In the end, we decided to adopt a double-log model, which shows

the percentage increase in house prices for any percentage change in accessibility indicators. This model has some desirable qualities: firstly, high correlations among indicators are reduced considerably after log-transformation; secondly, the double-log model shows the highest adjusted R square; thirdly, looking at the residual plots, the double-log model has the better normal distribution; fourthly, it is effective in transforming the nonlinear relationship into the standard linear one. Neighbourhood quality has proximity effects on house prices. To capture these effects we chose the semi-log model, using dummy variables. This approach has been widely used and been demonstrated to have a good statistical fit (Jim & Chen, 2010). In the semi-log model, neighbourhood qualities are valued at a given percentage of house prices.

The multivariate functional form of our model is as follows:

$$LN(P) = \alpha + \beta H + \gamma LN(A) + \eta N + \varepsilon$$

where P represents the house price; H represents dwelling attribute variables; A represents accessibility variables; N represents neighbourhood quality variables; α, β, γ and η are associated parameter vectors we have already known; and ε is random error terms.

Based on these basic evidences, we used HPM to estimate the parameters ($\alpha, \beta, \gamma, \eta$) determining the housing valuations of residents in Nanjing (Table 1).

Table 1 Coefficients of the variables in the hedonic price model

Variable	Description	B
LN_PRICE-m^2	Logarithm of house price per square meter (Yuan/m2)	-14.747
DWELLING ATTRIBUTES (H)		
BUILDYEAR	Building year	0.013
BATHROOMS	Number of bathrooms	0.063
SIZE	Total floor area (m2)	0.000
FLOOR	Floor level	0.000
ACCESSIBILITY	(A)	

URBAN	Dummy: 1 if urban	0.424
SSUBURBAN	Dummy: 1 if in southern suburb	0.098
LN_BTJOBEDU	Job accessibility potential in higher education (log)	0.174
LN_BTJOBGOV	Job accessibility potential in large governmental institutions (log)	0.119
LN_BTJOBF&B	Job accessibility potential in the financial and business services (log)	0.051
BTJOBHIND<20	Accessibility count of heavy industrial jobs within twenty minutes	-4.39E-06
BTJOBHIND20-40	Accessibility count of heavy industrial jobs between twenty to forty minutes	9.43E-07
LN_DEXPRESS	Log distance to nearest access of city expressway (km)	-0.037
LN_DMETRO	Log distance to nearest metro stop (km)	-0.066
LN_BTSQUARE	Log time cost by public transport to the nearest square (minutes)	-0.012
LN_BTPARK	Log time cost by public transport to the nearest large park (minutes)	-0.033
LN_BTTRAINS	Log time cost by public transport to the railway station (minutes)	-0.020
NEIGHBOURHOOD QUALITY (N)		
NSCHOOLDIS	Dummy: 1 when apartment is in a high quality school district;	0.109
NHERITAGE	Dummy: 1 when in a neighbourhood with historical heritage;	0.065
NRILAKE	Dummy: 1 when there is a urban river or lake within 500 meters	0.060
NPARK	Dummy: 1 in a neighbourhood with a park	0.028

What If analysis

We conducted two 'What If' analyses based on the two scenarios:

- In what sense will land prices change due to extension of existing two metro lines with an additional four lines?
- In what sense will land prices change city-wide due to the replacement of heavy industries by residential neighbourhoods?

1) What If analysis for scenario 1

The weights of each attribute to determine housing prices is given in evidence database (e.g. $\alpha, \beta, \gamma, \eta$). We calculated the accessibility condition and neighbourhood quality for each residential block based on the spatial information. Then the average housing price of each residential block using attributes' weights, the location of residential block, and the assumed dwelling attributes. And then we estimated the land price of each residential block using the following equation:

$$P\_land = P\_house * FAR * GS$$

Where P_land is the land price of each residential block (yuan/m2), P_house is the average housing price of each residential block (yuan/m2), FAR is the average floor area ratio (we chose 1.2 in this article, it can be different according to the residential building type) and GS is the government share from housing price (we chose 50% according to the interview with developers in Nanjing).

Figure 3-5 show that new constructed metro lines change the metro network and as a consequence change the land price at city level. The increase in metro lines has spill-over effects on land prices, which means the influence of new metro lines is not only on lands near the metro lines but also on the whole built-up area. The effects are non-linear and distance decay. The land price premium gradually reduces when the distance to the metro lines increases. The urban land use and transportation is an interacting system. The land prices are not only influenced by metro line itself, but also by its relative locations, the multi-accessibility conditions. Since new metro lines change the accessibility to jobs and other facilities, they have impacts at a city-wide level instead of only at areas along the metro line. This can be exemplified in the northern districts. Since metro lines are the rapid public channels for people living in northern areas to go to the city centre, the metro lines show the spill-over effects on lands even far away from them. Apparently, the new metro lines can improve the accessibility condition of diverse northern districts. Land prices in urban central and southern districts also increase within some ranges. Remarkably, the lands with most price premium are not the urban central areas but the areas surrounding city centre. This indicates that new metro lines do not improve the accessibility to jobs and services of the city centre very much but instead has a much bigger impact on the surrounding areas.

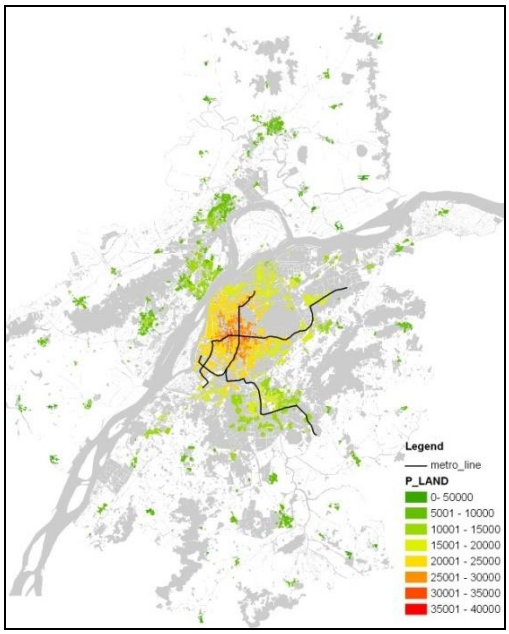

Fig.3 Land price before new metro lines constructed

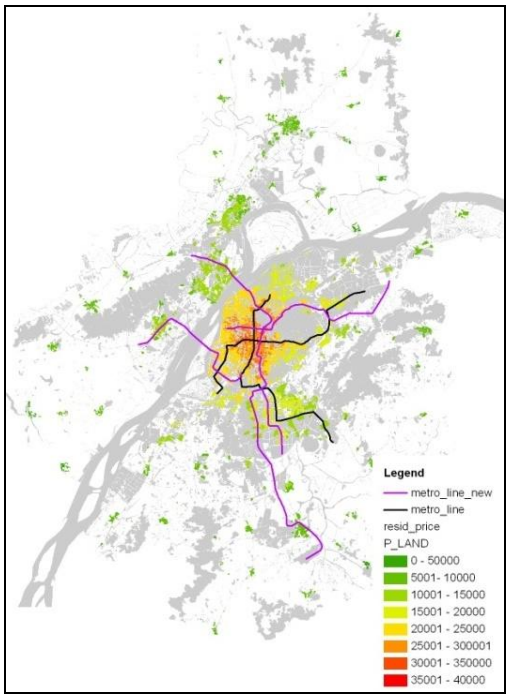

Fig.4 Land price after new metro lines constructed

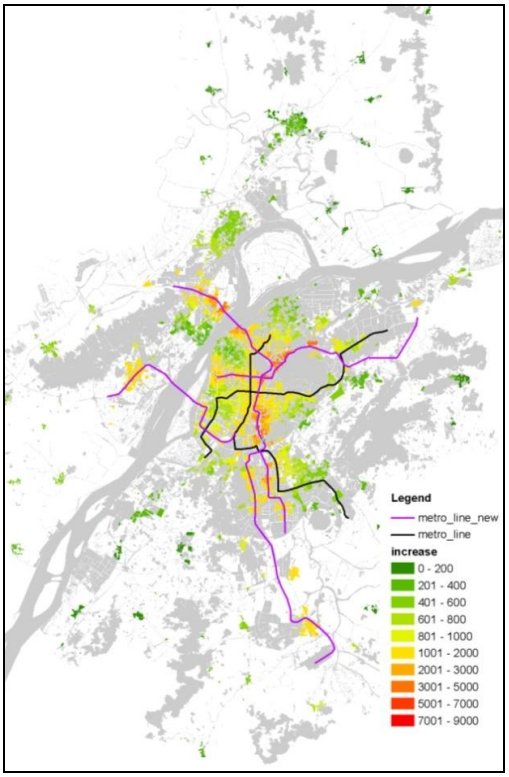

Fig.5 Land price increase after new metro lines constructed

2) What If analysis for scenario 2

In scenarios 2, heavy industries within the urban city of Nanjing are assumed to be decentralized into suburban areas. Therefore, the effects of heavy industry on house price should be removed from the HPM calculation. We can still adopt the same methodology we used in What If analysis for scenario 1 by excluding the variable of heavy industry.

Heavy industry provides both employment opportunities and nuisances, its negative impact such as pollution and noise takes the leading position at proximate distance, and its positive effect of providing jobs gradually shows up at longer distance. Figure 6 shows that the heavy industrial lands in the urban central areas and along the southern bank of the Yangtze River have higher land prices than

in northern areas due to better accessibility conditions. Figure 7 show that after redevelopment of heavy industrial lands, those residential areas close to heavy industries will receive the price premium. These two figures show that there will be a price premium if the present policy of the Nanjing government to redevelop old sites of heavy industry is pushed forward. The simulation helps the government for example to set the compensation level for removing heavy industry.

Although lands close to heavy industries have a price increase due to the moving out, the city centre proper has a price reduce. This is because the city centre is not at proximity to those heavy industries and it is not influenced by its negative effects but just by its positive impacts of job opportunities. Since these positive effects move out with the moving out of the heavy industries, the land prices in city centre decrease. This result indicates that the residential neighbourhoods after redevelopment of heavy industrial areas need to become multi-functional. If planning only replaces heavy industry with residential function without providing other job opportunities, the land prices will decrease in certain areas. It is better to replace heavy industrial jobs with other jobs such as educational, commercial, financial ones.

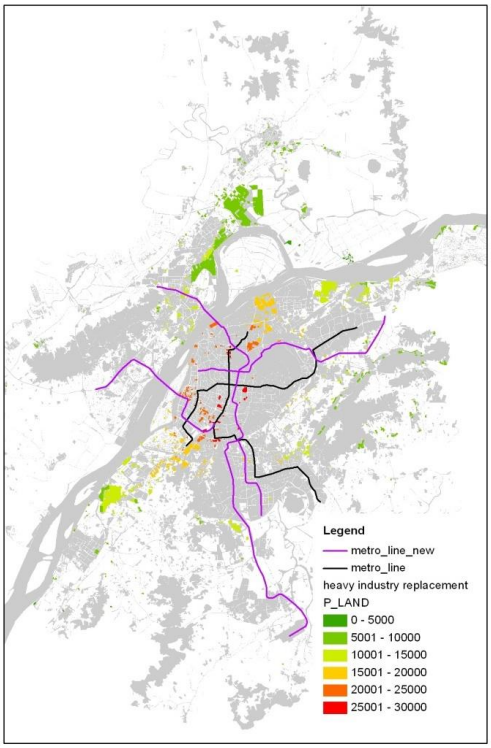

Fig.6 Land price of brown fields

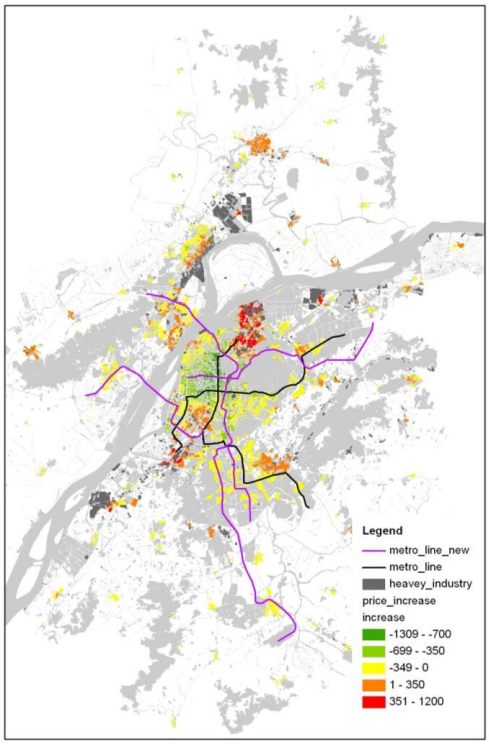

Fig.7 Land price increase of surrounding residential areas

Decision making

With the What If analysis, the planning committee can understand the potential outcomes of urban policies such as new metro line construction and heavy industrial land redevelopment. After negotiation and comparison, they can make a decision concerning urban development strategy to meet the requirements of end-users (residents), planners, policy makers, and developers.

Conclusions and discussion

With the rise of market force, urban planning in China is increasingly influenced by the market, particularly the land and property market. To build a sustainable city, planning needs to create value for both end-users (residents) and investors (governments and developers). In that, Chinese planners need to estimate value creation

by various planning interventions, and utilize the market force to help them achieve the planning goals set. This article proposes an evidence-based planning methodology in which evidences of the housing market are collected, analyzed, and used to estimate market value creation of two planning scenarios in Nanjing China. This methodology considers the city as an integrated system. Therefore, it analyzes spill-over effects of planning intervention at a city-wide level.

The conceptual framework of this methodology consists of five parts: urban development strategies, defining planning scenarios, building evidence database, 'What If' analysis, and decision making. We define two urban development strategies: creating value for both end-users (residents) and investors (governments and developers), and achieving sustainability. The planning scenarios are based on land use policies or infrastructure improvements which will influence the land lease market, the housing market, and the quality of life of residents. To estimate the market value of the defined planning scenarios, we use Hedonic price models (HPM) to analyze housing preferences of residents. A 'What If' analysis is used to provide planners and policy makers with insights into the interaction between markets and planning interventions. And we suggest that different stakeholders comprise a planning committee in which a decision is reached, based on the provided evidences. The planning committee fitting the Chinese planning context can comprise of planners, policy makers, developers, representatives from land bureau, representatives from transportation bureau, and representatives from the local Peoples' Congress.

We applied the conceptual framework in the city of Nanjing China. In that, we made use of two planning scenarios: the extension of the metro network from two lines up till six lines; and the moving out of heavy industries from central locations to suburban locations. The outcomes of the two planning scenarios are that the newly constructed metro lines will exert an influence on land prices not only along the lines itself but at a city-wide level too. And the redevelopment of old sites of moved out heavy industries will result in a price premium both in the brownfield areas themselves and in the surrounding residential areas. The two outcomes confirm that planning interventions may have city-wide effects. The results can be

used for instance to raise property tax at the city level and to estimate subsidies for removing heavy industries.

Since this methodology is based on general valuation models, the hedonic price model, and Chinese planning context, it can be generalized to other Chinese cities, particularly big cities facing redevelopment challenges in the transition from an industrial to a post-industrial society. Given that each city has its local characteristics, the variables chosen in the valuation models could be different from the ones in our example. For instance, Nanjing is a historic city, and as a consequence, the cultural heritage will influence house prices. In the much younger cities like Shenzhen, this variable is obsolete. Besides, the equilibrium is based on data of 2010, so it needs to be adjusted when new residents fluxing in the market or new constructions are realized. The land prices we estimated in this article might not be correct in the real-world land market. We foremost used them to illustrate our methodology. In this article, we only applied the hedonic price model to estimate residential lands. One can imagine this can be extended in the future to estimate other land uses such as commercial lands and industrial lands. In that case, the whole urban system can be analyzed more comprehensively.

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