

On the New Town's Rise and Fall and Location Choice Based on Alonso Model: A Case Study of Pukou University Town of Nanjing

ZENG Huaxiang^{[a],*}; ZHU Xianchen^[a]

^[a]School of Economics and Management, Nanjing University of Science and Technology, Nanjing, China.

*Corresponding author.

Supported by Fundamental Research Funds for the Central Universities (30920140111006); National Social Science Foundation Project (08BJY009); Soft Science Research Project of Ministry of Housing and Urban-Rural Development (2011-R5-16); Jiangsu Social Science Foundation Project (11GLB006).

Received 16 February 2015; accepted 18 April 2015
Published online 26 May 2015

Abstract

In the process of rapid urbanization, in order to adapt to the continuous development of the city, improve the city's industrial structure and optimize the layout of urban space, many cities start the planning and construction of a new town. However, not all the new towns can develop well. Why? Based on the comprehensive literature review at home and abroad, this paper takes Pukou University Town of Nanjing as an example and uses the Alonso model to deduct the decision maker's bidding curve, and tries to illustrate the reasons of the development advantages and disadvantages of new town from the perspective of new town's location choice, thus it concludes: (a) in the same utility, the price that resident is willing to offer decreases with the increase of commuting distance (or time); (b) the increase of commuting distance (or time) will result in the decrease of land price (house price), and when the saved expenses can't cover the increased commuting costs, the location's prospect is worrying.

Key words: Spatial structure; New town; Location choice; Alonso model

Zeng, H. X., & Zhu, X. C. (2015). On the New Town's Rise and Fall and Location Choice Based on Alonso Model: A Case Study of Pukou University Town of Nanjing. *Canadian Social Science*, 11(5), 43-47. Available from: <http://www.cscanada.net/index.php/css/article/view/7050>
DOI: <http://dx.doi.org/10.3968/7050>

INTRODUCTION

With the increasingly enlarged scale of the central city, the high concentration of resident and employed population and heavy traffic, the urban quality and development have been influenced seriously. To relieve the pressure of population growth in the old town of a city, explore new urban development space and upgrade the urban comprehensive competitiveness have become the important issues in the urban planning. In the history, during the process of rapid development of many cities at home and abroad, the model of building new town to explore the urban development space has been always adopted to guide the external flow of resource factors.

In the current and previous periods, to support the urban new development strategies, fasten the urbanization process, push the adjustment on the urban industrial structure and employment structure, the planning and construction of new town such as development zone and university town have been on the rise, which has pushed the comprehensive development of the local economy, policy and culture.

However, as seen from the increasingly built new towns in China, not all the new towns have achieved the above expected results, on the contrary, some new towns develop slowly or are on the decline, which is opposite to the original planning aims. Hence, this paper, taking Pukou University Town of Nanjing as an example, analyzes and explains the reasons of rise and fall of new towns.

1. LITERATURE REVIEW

Whether the development zone, industrial zone or the university town as the new town with special functions, they have their own characteristics and requirements on the location—space layout. In the theory of “the Isolated State”, Von Thunen stated that: suppose that there is a sole transaction market in a homogeneous area and all the

agricultural goods have to be traded in the market, then the transportation cost of landowner is increased with the increase of distance to the sole market and hence the land rent is gradually decreased. Alonso made model on Thünen's thoughts and deducted the space layout of the urban activities like commerce and living, as well as the bidding curve based on the supposition of single center (Alonso, 1964; Epple, Gordon, & Sieg, 2010; Ding, 2006; Ren & Zheng, 2008). Such theory has been proved and expanded subsequently by many scholars such as Muth and Mills.

Many foreign scholars have made research on the urban space layout and location in recent years. Cervero used hedonic price model to research on the effects of proximity to light and commuter rail transit on commercial land values in Santa Clara County, California, which stated that: on the order of 23% for a typical commercial parcel near an LRT stop and more than 120% for commercial land in business district and within a radius of 400 m, showing that the convenient level of access to CBD is an important factor on the location choice of a house buyer (Cervero & Duncan, 2001). David R. Bowes used hedonic price model and the supporting model on criminal activities and retail activities to analyze the residential lands' trade data of the proximity to light rail and found that: the urban rail increases the convenient level of a resident's access to CBD and the chances to work in other cities, hence, the urban transportation factor can increase the urban land values; however, the increase on the land values is not as large as expected, which is due to the adverse effects such as noise and high crime rate caused by the urban rail (Bowes & Ihlanfeldt, 2011). Donghan Kim and Michael Batty, based on the supposition of rational person and through agent-based model, explained the complex urban systems so as to study the effects of various policy behaviors (Donghan & Batty, 2011).

Chinese scholars Xiao Ling and Chen Zhongnuan have analyzed the location of Guangzhou University Town from the macro, medium and micro angles and think that its location at Xiaoguwei island of Xinzao Town, Panyu District of Guangzhou City and the south area has good location advantages (Xiao, 2002; Xiao & Chen, 2002). Hao Qianjin and Chen Jie have analyzed the effects of distance to CBD, accessibility of rail transportation and accessibility of public transportation on Shanghai residential houses' prices based on the supposition of a single center and by means of hedonic price method, concluding that (a) Shanghai residential houses' prices have been decreasing with the increase of the distance to CBD, but with slow declining trend; (b) the accessibility of rail transportation has significant influence on Shanghai residential houses' prices; (c) the accessibility of public transportation has relatively obvious influence on the prices of the residential houses in Shanghai outer ring (Hao & Chen, 2007).

2. ALONSO MODEL CONSTRUCTION OF UNIVERSITY TOWN'S LOCATION CHOICE

This paper supposes that the university as a decision maker on selecting the new office building's location is a decision maker that has rational judgment and is able to count the cost-benefit relationship, and the highest bidding rent that university can afford for each location to reach the established utility with Alonso's urban spatial structure theory as frame, within the constraints of commuting cost and budget expenditures, thus the bidding curve of new location choice is constructed based on these factors.

Then, to push the bidding of university town's location choice, we first need to know all the available possibilities and the preference model of the university as a decision maker.

2.1 All the Available Possibilities

The university has certain budget expenditure y , among which, land costs of building university town (including the land demolition costs and residents settlement expenses), commuting costs (mainly referring to the discounted present value of cost subsidy paid by the university on its staff's commuting) and the purchase of all other goods and labors (such as hiring staff, purchasing equipment). Then, the budget constraint can be expressed as follows:

$$y = \text{land costs} + \text{commuting cost} + \text{all other expenditures}$$

Let's first analyze the university's purchase expenditures on all other goods and labors (besides the land and commuting costs). They mainly include two categories: (a) payroll for the staff's labors; (b) various goods (such as: used for the construction of the supporting facility) purchased from the enterprise. We use z_1, z_2, \dots, z_n to express the amount of n -category goods and labors purchased by the university. If the prices for the n -category goods and labors are p_1, p_2, \dots, p_n , then the university's expenditure on any goods or labor z_i equals to the price for such goods or labor multiplying the purchased amount of such goods or labor, i.e., $p_i z_i$. To make it simple, we summarize all these various goods and labors as comprehensive goods z . Its price is p_z . As a kind of choice, z can be taken as currency and p_z as unit price.

Then we analyze the university's expenditure on land. p is the supposed land bid price that refers to the university's highest bidding rent for the location after the commuting costs at any location being paid based on "highest rent principle" and it does not represent the actual trade price. When purchasing land, the university not only needs to select location but also has to decide the amount of land to be purchased. q represents the amount. Then the land expenditure equals to the land price multiplying the land amount: $p(t)q$.

Finally, the commuting cost caused by the space distance needs to be considered. Here, the commuting cost

ct mainly refers to the cost of the distance t for the staff from their resident locations to the office—university (we can suppose it as the commuting discounted present value offered by the university to its staff). The commuting cost is mainly measured by the commuting distance and time.

Therefore, we express the budget equation for the new university town's location choice as Equation (1).

$$y = p_z z + p(t)q + ct. \quad (1)$$

2.2 Preference Model

As seen from the above suppositions, the university as a decision maker pursues its maximum utility on deciding the new university town's location; therefore, we can use the curve similar to the consumers' indifference curve in classical economic theory to express the university's preference model.

Under such circumstance, the indifference curve is the various combinations of consumed land amount q , consumed comprehensive goods and labor amount z and distance t , among which, any combination can make the university be satisfied with the same level and the university has indifferent choice on the various combinations on the indifference curve. Then, we can express the utility function of the university's location decision making as:

$$u = u(z, q, t). \quad (2)$$

In such utility function, when other conditions keep unchanged, the larger the purchased amount of other goods and labors z or the purchased amount of land q , then the higher the utility u ; while distance t is the disutility in the equation as the larger t is, then the commuting is less convenient and the more cost is needed, hence the utility is reduced.

2.3 Mathematical Deduction of the New University Town's Location Choice

Then, now we expect to find the bid price p_0 at any location t_0 that can make the university reach the maximum satisfaction level u_0 and not higher. As u_0 and t_0 are known, then the utility function and budget constraint equation can be expressed as follows:

$$u_0 = \text{Max}u(z, q, t_0), \quad (3)$$

$$y = p_z z + p_0 q + ct_0. \quad (4)$$

Put the solution t_0 from Equation (4) into Equation (3), we get:

$$\text{Max}u[z, q, (y - p_z z - p_0 q) / c] = u_0. \quad (5)$$

As the condition for equilibrium requires that u_0 is given and unchanged, namely, wherever the decision maker goes, they have the same satisfaction level. Hence, we can get the amount relationship between q^* and z^* to reach the given satisfaction level u_0 when the university has to land price p_0 at location t_0 through the partial differential of equation (5):

$$u/z = u_1 - p_z u_3 = 0, \quad (6)$$

$$u/q = u_2 - p_0 u_3 = 0. \quad (7)$$

Take the equilibrium solutions q^* and z^* for Equations (6) and (7) into Equation (3), we can get an implicit function of the bid price p_0 at t_0 under given utility u_0 , which is abstracted as:

$$u_0 = u[z^* | p(t_0), q^* | p(t_0), t_0]. \quad (8)$$

Namely, the implicit function determines the highest bid price $p(t_0)$ to reach the satisfaction level u_0 at t_0 .

Similarly, to deduct the university's bid price curve, now we don't take distance t as a known constant, the university's bid price function $p(t)$ at any location t can be determined by Equation (9) under given satisfaction level u_0 :

$$u_0 = u[z^* | p(t), q^* | p(t), t]. \quad (9)$$

Make $p(t)=0$, we can get the critical value of commuting t_{\max} , namely:

$$u_0 = u[z^* | p(t)=0, q^* | p(t)=0, t_{\max}]. \quad (10)$$

As the above functions are expressed in the abstract forms and the detailed forms are unknown, we can't grasp the bid price curve visually, but we can get the general properties of the bid price curve determined by the implicit function through the following proofs:

(a) The bid price curve is single-valued, namely, only a price $p(t_0)$ at distance t_0 can make the person reach the highest satisfaction level u_0 , and the group of z_0 and q_0 can be gotten.

If not, we can assume that there's another price $p'(t_0) < p(t_0)$ on the same curve can reach the satisfaction level u_0 , and then we can get to another group of z_0 and q_0 from the Equation (9). Therefore, the budget equation y can be expressed as:

$$y = p_{z_0} z_0 + p(t_0) q_0 + ct_0 = p_{z_0} z_0^* + p'(t_0) q_0^* + ct_0. \quad (11)$$

It's easily known that: under the conditions of $z_0^* < z_0$ and $q_0^* < q_0$,

$$p_{z_0} z_0 + p(t_0) q_0 + ct_0 < p_{z_0} z_0^* + p'(t_0) q_0^* + ct_0.$$

Therefore, there's at least a point can make $z_0^* > z_0$ or $q_0^* > q_0$ when the equation (10) is satisfied, as $u_z > 0$, $u_q > 0$ and t_0 is a constant, then

$$u(z_0^*, q_0^*, t_0) > u(z_0, q_0, t_0) = u_0.$$

There has no a lower price that can reach the same utility at price $p(t_0)$, similarly, we also can prove that there has not a higher bid price that has the same utility at price $p(t_0)$. Therefore, the bid price curve is single-valued.

(b) The lower bid price curve represents higher utility as lower curve represents lower land price.

(c) The gradient of the bid price curve is negative. Conduct the total differential of the utility function and budget constraint equation, we can easily get:

$$du_0 = u_z dz + u_q dq + u_t dt = 0, \quad (12)$$

$$dy = p_z dz + p(t) dq + q [dp(t)/dt + (dk/dt) dt] = 0. \quad (13)$$

Take q as a constant, then $dq=0$, and we can get the following from Equations (11) and (12):

$$u_z / u_q = [q dp(t)/dt + dk/dt] / p_z.$$

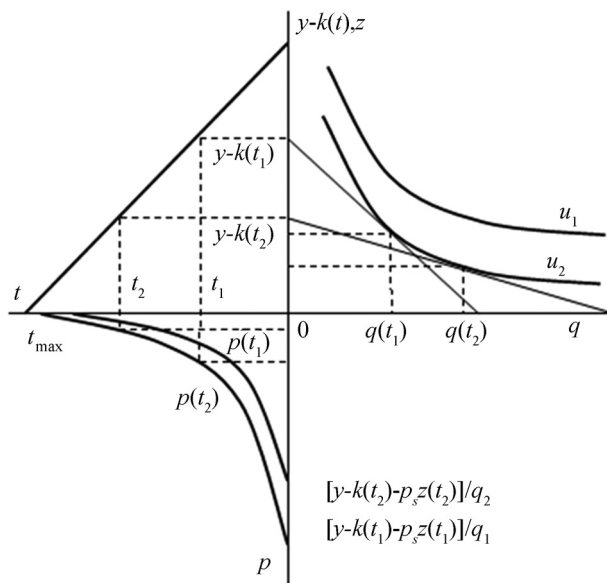


Figure 1
Graphic Deduction Process of Bid Price Curve Under Simplified Condition

Among which, we can find $u_1/u_2 < 0$ on the left side of the equation and $q > 0, dk/dt > 0, p_z > 0$ in the right side of the equation. Therefore, the gradient of the bid price curve is $dp(t)/dt < 0$ and $-(qdp/dt) < (dk/dt)$.

In summary, we adopt the deduction method similar to that of Alonso and construct the bid price curve when the university as a decision maker selects the new office's location. Then, the graphic deduction process under simplified condition is shown as Figure 1.

In Figure 1, the $p(t_1)$ curve and $p(t_2)$ curve in the third quadrant are the bid price curves of the new university town, such bid price curve represents that the highest bid price the university is willing to pay at the location t after paying the corresponding commuting costs, and the larger t is, the lower the bid price. The utility of $p(t_1)$ curve is higher than that of $p(t_2)$ curve, namely, the closer the bid price curve to the origin, the higher the utility.

We can also easily find that under the conditions of $t > t_{max}$ and $p(t < 0)$, namely, under the given utility, t_{max} is the critical value of commuting, when the commuting distance is very large or the commuting time is very long, the university will not select the place where the savings from the lower land price are less than the increased commuting costs.

3. SURVEY ON THE PUKOU UNIVERSITY TOWN OF NANJING

Currently, the main university towns in Nanjing are: Pukou university town constructed in the north of west Yangtze River in 1987, the Xianlin university town in the east planned in 2002; and the Jiangning university town in the south planned in 2002. Pukou university town, located in the Pukou district of Nanjing city, faced the main

town of Nanjing across the river, had planned building area of 4 square kilometers, and was planned to cover 12 universities and include 44,045 students. To expand the teaching space and push the economic development of the north river in the 1990s, many famous universities such as Nanjing University, Southeast University and Nanjing Institute of Meteorology settled in Pukou university town, which became the earliest university clusters in Nanjing.

This paper explains why the main university campuses of Nanjing University and Southeast University moved out of Pukou university town and only left the independent institutions there through the Alonso model of the above simplified university town's location choice, which made the Pukou university town that was constructed earlier than Xianlin and Jiangning university towns go downhill.

The main resident places of the staff of Nanjing University and Southeast University are mainly located in the west of Yunnan road and the east of Ninghai road in Gulou district, which is 13 km away from Pukou university town and 16 km away from Xianlin university town.

As seen from the advanced foreign experience, the university town is usually constructed in the place that is 60-100 km away from the city center, is within 1-hour distance of modern transportation, has good road and transportation facilities, is away from the city's pollution, has rich water resources, abundant power supply and wide space (Zhao, Zhang, & Gao, 2009). Therefore, if the commuting time is used to measure the commuting cost, then, without loss of generality, we can hold the critical value $t_{max} \leq 1$ h.

Then, even if Pukou university town is only 13 km away from the resident place in Gulou district, Yangtze River No.2 bridge, No.3 bridge and No. 4 bridge to the north of the river are still far away from the main town that cannot share the pressure of crossing the river. Yangtze River Bridge has large traffic flow and the traffic jam at rush hours is quite frequent, and it takes 1 hour to go up and down the bridge (compared with the Xianlin university town in the east that's close to No.2 route of subway with only 25 minutes' driving distance from the main town), the total commuting time exceeds the critical commuting time, namely, $t > t_{max}$, which seriously affects the accessibility to Pukou university town. Under such condition, to reach the given utility u_0 , the university will not settle in the place of $-(qdp/dt) < (dk/dt)$, namely, the savings from lower land prices due to inconvenient transportation are less than the increased commuting costs, which explains why Nanjing University settles in Xianlin university town while Southeast University in Jiangning university town.

CONCLUSION

This paper tries to explore the rise and fall of some functional areas in the rapid urbanization process, and

takes Pukou university town of Nanjing as an example to construct the Alonso land bid model based on rational decision making, analyzes and explains the reasons of rise or fall of the new town. We come to the following conclusions:

(a) Under the same utility, with the increase of commuting distance (or time), the land price (or house price) that the decision maker is willing to offer is decreasing as the living cost increases with the increase of commuting distance (or time) and the transportation accessibility and living convenience reduce as well.

(b) The increase of commuting distance (or time) can save the expenditure on the land price (house price), namely, inconvenient commuting results in low land price. However, when the saved expenditure can't cover the increased commuting costs, then within certain period, if without the exogenous changes such as the location as transportation hub and center business center, such place can't succeed in introducing the investment and talents and population. The paper is of certain reference significance on the policy making related to new town's location choice and development plan.

REFERENCES

Alonso, W. (1964). *Location and land use*. Massachusetts: Harvard University Press.

Bowes, D. R., & Ihlanfeldt, K. R. (2011). Identifying the impacts of rail transit stations on residential property values. *Journal of Urban Economics*, 50(1), 1-25.

Cervero, R., & Duncan, M. (2001). *Rail transit's value-added: Effects of proximity to light and commuter rail transit on commercial land values in santa clara county, California*. Urban Land Institute National of Association of Realtors Washington.

Ding, C. R. (2006). Theory on urban spatial structure—Static model of single-center city. *Urban Studies*, 13(4), 121-126.

Donghan, K., & Batty, M. (2011). *Modeling urban growth: An agent based microeconomic approach to urban dynamics and spatial policy simulation* (p.165). UCL Centre for Advanced Spatial Analysis.

Epple, D., Gordon, B., & Sieg, H. (2010). A new approach to estimating the production function for housing. *American Economic Reviews*, 905-924.

Hao, Q. J., & Chen, J. (2007). Distance to CBD and the transportation accessibility and the geographic difference of Shanghai residential houses' prices. *World Economic Papers*, (1), 22-35.

Ren, R. R., & Zheng, S. Q. (2008). Research on the spatial structure of office and residential land development—Price gradient, development amount and development location. *Progress in Geography*, 27(3), 119-126.

Xiao, L. (2002). Research on the location of university town. *Economic Geography*, 22(3), 274-276.

Xiao, L., & Chen, Z. N. (2002). Analysis on the location conditions of Guangzhou university town's location choice. *Journal of South China Normal University*, (2), 32-37.

Zhao, S. B., Zhang, Z. G., & Gao, W. J. (2009). Thoughts on the urban development driven by the location change of university town. *Urban Studies*, 16(3), 15-18.