The Housing Location in Taipei Area

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Abstract

Alonso (1964) considered that the American rich to live in suburban area and the American poor in urban center an anomaly to traditional European and third world cities where the poor usually inhabit in the peripheral areas, while the rich and middle class live centrally. Mills and Hamilton (1989) postulated that once the level of income of an economy increases, the American type of spatial ordering of households according to income will then appear. Both ignore the effects of institutional setting on residential choice. Fischel (1985) acknowledged that American minimum lot size zoning in the suburban area is the most important reason for the poor to shelter in the urban apartment. This paper then hypothesize that the maximum lot size regulation will make the bid-rent function of the rich steeper. Empirical study finds that in Taipei Area households' income levels and their locational distances from CBD are conversely related. This finding may

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be a good footnote not only to the arguments of the locational pattern of household between Alonso and Mills and Hamilton, butalso to Fischel's postulation.The Housing Location in Taipei Area

1. Introduction

It has been shown that once the utility function and the budget constraint equality are specified, the bid-rent criterion to examine the spatial distribution of households according to income can be applied to determine the spatial ordering of households according to income can be applied to determine the spatial ordering of households according to income.

Applying von Thünen's (1826) agricultural location theory and Isard's (1956) urban land use theory, Alonso (1964) shows that if the slope of the bid-rent function of household j is steeper than that of household i, then in market equilibrium household j will be located closer to the center. More specifically, if one finds that the slope of the bid-rent function is always negatively affected by income, then richer households will live farther away from the center; but if the slope of the bid-rent function is always positively affected by income, then the richer ho useholds will live closer to the city center. However, if the direction of this income effect is not consistent, then the locational pattern of households according to income is ambiguous (Pines, 1975).

There are many studies on the income effect on t he flattening of the slope of the bid-rent function of the richer households. It is capable of explaining the flight to the suburban of the richer households in the United States (Muth 1969; Mills 1972; Mills and Hamilton 1989). However, negative income effect on the slope of the bid-rent function is closely related to the assumption that households consume land freely or under zoning regulation. Therefore, an argument with

binding land consumption of maximum lot size restraint on households is interesting to urban economists. In Taiwan, Article 17 of Land Tax Act and Article 20 of the Statute of Equalization of Land Right (SELR) offers a low land value tax rate 0.2% to urban land user whose dwelling land unit less than 300 square meters and to non-urban land user whose dwelling land unit less than 700 square meters. Those who consumes land more than these restraints will suffer higher land value tax rate 1% up to 5.5% according to the progressive land value tax rule of Article 19 of SELR. In addition, for the protection of agricultural land for farming, nobody can build housing unit on agricultural land but farmer. However, farmer can only makes use of one tenth of his farming land to build farm house. And, people could not be a farmer unless he owns a farm and works on the farm, in the meantime, farming lands are not allowed to be held in the land of non-farmer. Therefore, as a Taiwan citizen even he is very rich is usually subject to these strict land consumption regulations while he is buying a housing unit. Then, it is reasonable for the rich, such as plastic zaibatsu Wang's families, cement tycoon Koo's families, and the richest Chinese in the world, the insurer Tsai's families are all dwell in the downtown area of Taipei City instead of live far away from downtown to enjoy suburban or rural amenities. This fact provides us to hypothesize that the maximum lot size, 300 m^2 in urban land, and 700 m^2 in non-urban non-farming housing land, has made bid-rent function positively affected by income, so that the rich in Taiwan are usually live close to CBD and that the poor are bid away from CBD.

The purposes of this paper are to develop a simple model capable of explaining the hypothesis that maximum lot size land consumption restraints are important factors in household residential choice behavior in Taipei Area and to empirically test the spatial ordering of household according to income.

Section 2 of these paper sets forth a simple model to show that the maximum lot size land use restraint for housing s teepens the bid-rent function of the richer households. Section 3 makes use of DGBAS 1981 and 1991 household survey data to verify the hypothesis that maximum lot size regulation in Taiwan has steepen the slope of the bid-rent function of the richer households. In the last section we summarize the findings.

2. The Model

Considering one urban area which includes central business district (CBD), residential area, and agricultural area. For the protection of agricultural land for agro-production, the land in the agricultural area can only build farmhouse for farmers. In other words, residents can not build housing in the rural area unless he changes his job status as a farmer, or the land in the rural area is transformed into a residential area by law due to the expansion of the city size. For the shortage of the urban land, the land tax law encourages households to consume land less than or equal to the maximum lot sizes by use of a low tax rate; and discourages land consumption beyond this maximum lot size through a high tax rate.

Thus, in the absence of migration among jurisdictions, the total demand for housing land under land consumption restraint is far less than the total demand without the restraint. As a result, the bid price of land in the residential area will decrease. To the poor, whose land consumption is small and the land consumption restraint is not binding, will be better off to consume more land farther away from the CBD. To the rich, whose land consumption is large beyond restraint, will be worse off either subject to binding of land consumption restraint or paying higher taxes. Since the higher income households cannot

flight freely to the rural area to consume more land, they tend to locate closer to the CBD to live in the high quality house. So that, under the land consumption restraint, the rich might have a steeper slope of bid-rent function and the poor have a flatter one, and the spatial distribution of households according to income is quite different to what the United States has.

Suppose the utility level of a household depends on the quantity of land (which monontonically transforms into the housing space) H and the quantity of composite goods Z, i.e.

(1) $U = U(H, Z)$

The household is assumed to maximize its utility level subject to its budget constraints and land consumption restraints:

(2) $y = R(x)H + PZ + t(x, y)$

(3) $H \quad \overline{H}$

where

$R(x)$ = land rent as a function of distance, x, from the CBD

P = given price of the composite goods

$t(x, y)$ = transportation costs of the household as a function of distance from CBD and its income as Muth (1969) assumed, where $\frac{\partial t}{\partial x} > 0$ and $\frac{\partial t}{\partial y} > 0$ for wage income

y = income of the household

Besides, we define the bid-rent function of the household in any given location $\overline{x}$ as B which solves the maximization problem below:

(4) $\underset{H, Z}{\text{Max}}\ B$

subject to

$$\bar{U} \quad U(H, Z) \quad 0$$

$$BH+PZ+ t(\bar{x}, y) \quad y \quad 0$$

$$H, Z \quad 0$$

$$H \quad \bar{H}$$

where $\bar{U}$ and $\bar{x}$ are given level of utility and distance respectively. Solving this problem for every $\bar{x}$ with constant $\bar{U}$ we obtain a bid-rent function $B(x, \bar{U})$ of the household. Following Casetti (1971) the market equilibrium implies

$$(5)\ R(x) \quad B(x, U^*), \quad for \quad 0 \quad x \quad r$$

$$[R(x) \quad B(x, U^*)] \quad H(x)=0$$

$$R(x) \quad R_A \ ; R(r)= \quad R_A$$

where

U^* = utility level of the household in equilibrium

R_A = rent of agricultural land

r= distance of the city boundary from CBD

Since H(x) 0, equation (2) becomes

$$(2)' \qquad y = B(x, U^*)H + PZ + t(x, y)$$

Applying Kuhn-Tucker Theorem to equation (1), (2)' and (3), we obtain the necessary conditions for such an optimum[1]. Since $y \quad B(x, U^*)H \quad PZ \quad t(x,y)=0$ totally differentiating this necessary condition gets:

$$(6) \qquad \frac{\P B}{\P x} = \frac{-1}{H}\frac{\P t}{\P x} < 0$$

where $\frac{\P t}{\P x}$ is the marginal cost of commuting for an extra unit of distance. This equation delineates the negatively sloped bid-rent function. Further differentiating this equation with respect to income yields

$$(7) \qquad \frac{\P^2 B}{\P x \P y} = \frac{-1}{H}\left(\frac{\P^2 t}{\P x \P y} - \frac{\P t}{\P x}\frac{h}{y}\right) \gtrless 0$$

where $\frac{\P^2 t}{\P x \P y}$ is positive as shown by Wheaton (1977) and h = income elasticity of demand for housing land. The sign of the right-hand side of equation (7) is indeterminate. Now suppose the land consumption constraint is binding for the higher income households, namely, $H_i = \overline{H}$, then h_i will be zero and we obtain

$$(8) \qquad \frac{\P^2 B}{\P x \P y_i} = \frac{-1}{\overline{H}}\frac{\P^2 t}{\P x \P y_i} < 0$$

Thus, the slope of the bid-rent function of the rich households is positively affected by income, and the rich households will live closer to the city center[2].

Exogenous Labor Supply

Suppose work hours are institutionally fixed to households. The leisure, a normal good in the utility function, depends on the time spent in commuting and thus is a function of the distance of housing location from CBD. In other words, the distance x is one of the arguments in the utility function, since the shorter the distance from CBD, the more the leisure and the higher the level of satisfaction.

Hence, equation (1) can be rewritten as

$$(9)\quad U = V(H, Z, L(x)) = U(H, Z, x)$$

where leisure L(x) = total hours minus constant work hours and commuting hours which is a function of distance. Equations (9), (2)', and (3) thus constitute a new model which is the same as what Alonso (1964) and Pines (1975) have done. Forming Lagrangean function and using Kuhn-Tucker Theorem, we obtain

$$(10)\qquad \frac{\partial B}{\partial x} = \frac{1}{H}\left(\frac{R(x)U_x}{U_H - \mu} - \frac{\partial t}{\partial x}\right) < 0$$

where μ is the Lagrangean multiplier and is interpreted as the marginal cost of land consumption constraint. It is zero if the constraint is not binding, while it is negative if it is binding. Thus, the larger the $\overline{H}$ the smaller the absolute value of μ. U_x is the marginal disutility to have an additional mile from CBD. It is negative, since x is the bad 'good' in the utility function. Equation (10) also displays the negative slope characteristic of the bid-rent function. Differentiating equation (10) with respect to household income, we obtain

$$(11)\quad \frac{\partial^2 B}{\partial x \partial y} = \frac{1}{H}\Big[(U_H - \mu)^{-1} R(x)\frac{dU_x}{dy} - R(x)Ux(U_H - \mu)^{-2}\frac{dU_H}{dy} - \frac{\partial^2 t}{\partial x \partial y} - \left(\frac{R(x)U_x}{U_H - \mu} - \frac{\partial t}{\partial x}\right)\frac{\eta}{y}\Big]$$

It is reasonable to assume that $\frac{dU_x}{dy}$ and $\frac{dU_H}{dy}$ are zero while the system is in equilibrium, since x and H are determined and the marginal disutility of distance and marginal utility of housing land consumption are unambiguous negative and positive respectively. Equation (11) can be rewritten as

$$(12) \qquad \frac{\partial^2 B}{\partial x \partial y} = \frac{-1}{H}\left[\frac{\partial^2 t}{\partial x \partial y} + \left(\frac{R(x)U_x}{U_H - m} - \frac{\partial t}{\partial x}\right)\frac{h}{y}\right] \gtrless 0$$

Again the sign of the right hand side of equation (12) is indeterminate. But with binding land consumption constraint to the higher income household i, the income elasticity of demand for housing land is zero and we get the same result as equation (8). Thus, imposing land consumption restraint on Alonso-Pines model, we can clearly get a more definite effect of income on the housing location. And, we find that the effect of land consumption constraint is to induce the higher income household to live closer to the CBD in the case of constant labor supply.

Endogenous Labor Supply

Suppose labor supply is variable. The work hours are not institutionally fixed for households. Leisure as a choice variable does not depend on distance only. It also depends on wage rate which determines work hours denoted by k, and on commuting time which is the function of distance and denoted by c(x). In this case, we might formulate a utility function for the households as

$$(13) \quad U = U \quad H, Z, K$$

where K = k + c(x) is the hours spent on work and commuting. In equilibrium, we can see that the marginal rate of substitution between distance x and the numeraire good Z is equal to Wc'(x) since

$$(14) \qquad \frac{U_x}{U_Z} = \frac{\partial U / \partial K}{\partial U / \partial Z} c'(x) = -Wc'(x)$$

where W is the wage rate. Wc'(x) is the marginal cost (value) of living an extra unit of distance away from CBD. Suppose we measure bid-rent function in terms of unit of time we can define the shadow price of time as

$$(15) \qquad -B'(x) = \frac{\partial B(x)}{\partial x} = \frac{\partial U / \partial L}{\partial U / \partial Z} = Wc'(x)$$

The last equality hold only if it is in equilibrium. Then equation (15) is the locational equilibrium condition in terms of benefits and costs of time. Thus we can try to introduce shadow value of commuting time into the model. Equations (13), (2)',and (3) together with system (4) we obtain

$$(16) \qquad \frac{\partial B}{\partial x} = \frac{1}{H}[P\frac{U_K}{U_Z}c'(x) - \frac{\partial t}{\partial x}] = \frac{-1}{H}(PWc'(x) + \frac{\partial t}{\partial x}) \quad < 0$$

which again yields the negatively sloped characteristic of the bid-rent function. Differentiating equation (16) with respect to income we get

$$(17) \qquad \frac{\partial^2 B}{\partial x \partial y} = \frac{-1}{H}[Pc'(x)(1 - W\frac{h}{y}) + \frac{\partial^2 t}{\partial x \partial y} + \frac{\partial t}{\partial x}\frac{h}{y}] \quad \gtrless 0$$

The sign of the right hand side of equation (17) is indeterminate. If (i) h =1, as Muth (1969) has assumed, and W y or (ii) wage worker is unemployed, namely W=0, the right hand side of this equation is negative. Otherwise the sign is ambiguous. Again, with land consumption constraint binding to the higher income household, η_i =0 and the sign of the right hand side is definitely negative since equation (17) becomes

$$(18) \qquad \frac{\partial^2 B}{\partial x \partial y_i} = \frac{-1}{H}\left[Pc'(x) + \frac{\partial^2 t}{\partial x \partial y_i}\right] < 0$$

and the rich households will have housing location close to central city. The lower income households inhabit the peripheral areas, as in the European and Latin American cities(Alonso 1964).

3. The Evidence of Housing Location in Taipei Area

The above analysis bases on the maximum lot size land consumption constraint which is quite different to the minimum lot size zoning in the suburban areas in the United States. Both maximum and minimum lot size will lower the bid-rent function in the area which is subject to the constraint. In the maximum lot size case, the total demand for land consumption is less than that of no constraint. The land price, thus, is lower all over the area. In the minimum lot size case, the area subject to constraint will have lower capital-to-land ratio and population density. Only the higher income households can afford the costs of housing in those zoning areas even if the unit price of land is low but the quantity is large. Therefore, the total demand for land in zoning suburban areas are also restrained. People who might have been able to live in these areas are displaced due to the large-lot zoning regulation. They are forced to move to the central city (in our closed city model) where bid-rent function becomes higher due to higher capital-to-land ratio than before (Fischel 1985, p.260-261).

Thus, minimum lot size zoning restrains the lower income household from living in the zoning areas and maximum lot size land use regulation, on the contrary, discourages the higher income households to consume large size of land. Obviously, in the former case, the poor are worse off because they have to

crowd in the central city and consume higher unit costs of land; and the rich are better off since they consume more land with lower unit costs. In the latter case, the poor whose land consumption is smaller than the regulated maximum lot size are better off because the over all land price in the city is lowered; and the rich whose land consumption is larger than regulated maximum lot size are worse off because they might have to cut down their demand and decrease their welfare level(Tsai, 1994).

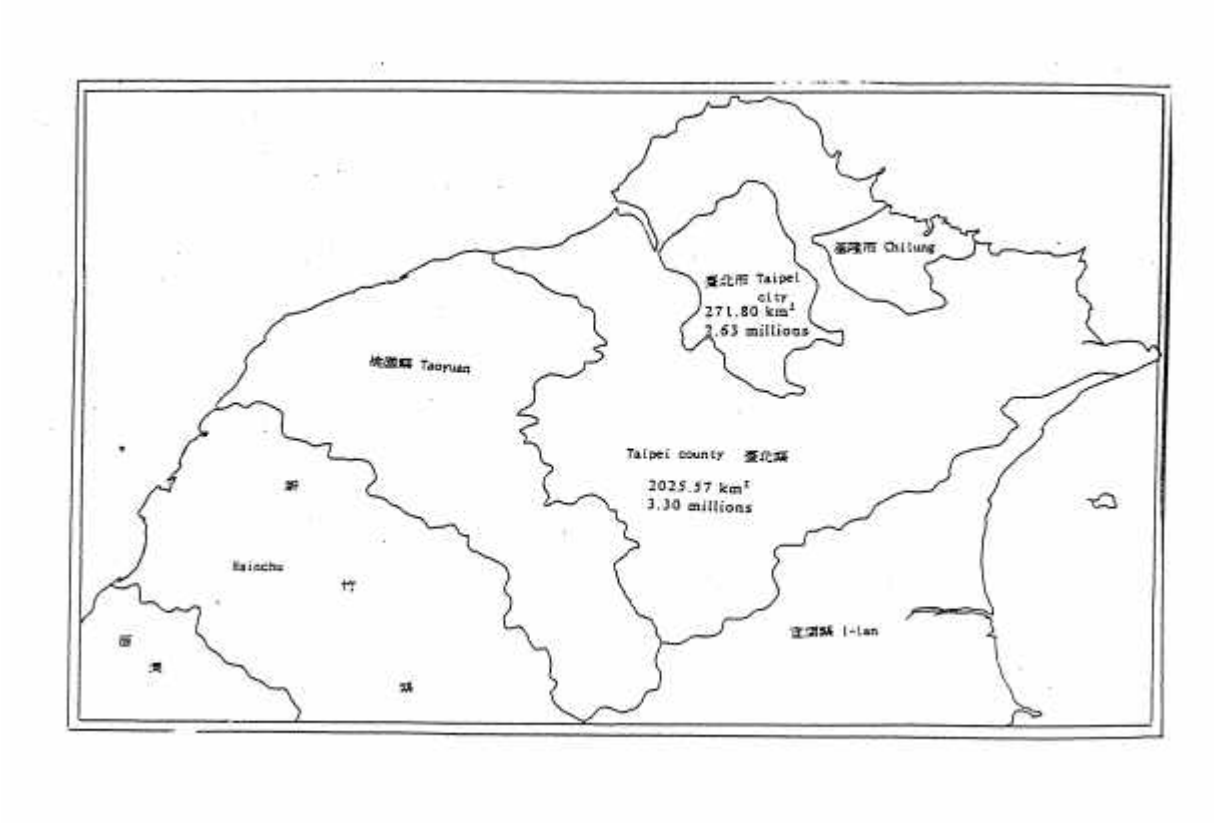
The strict maximum lot size regulation and farmer status land consumption restraint in addition to current account surpluses and foreign exchange reserves accumulation to have annual growth rate of money supply (M1b) over 21 % in the 1980s in Taiwan has skyrocketed the urban land price up to more than 10 times during 1986-1990 (Tsai,1996). In the meantime, successful economic development strategy in Taiwan has also raised general income level. The income per capita GNP at current price was 2,443 US dollars in 1981 and 8,189 US dollars in 1991.

Figure 1 shows the northern area of Taiwan in which Taipei City is surrounded by Taipei County. In the end of 1995, there are about 2.63 millions citizens live in Taipei City (271.80 km^2), and 3.30 millions population in Taipei County (2,025.57 km^2). The population density in Taipei City is 9687 per km^2. It is about 6 times as much as in Taipei County (1,632 per km^2). The unit price of land in Taipei City is also many more times than that in Taipei County. There are some of the rich households moved away from urban to suburban areas for the sake of congestion and air pollution. But, most of the famous rich families, such as Wan-lin Tsai (tycoon of insurance company), Young-ching Wan (tycoon of plastic industry), and Chen-fu Koo (tycoon of cement industry) dwell in downtown area of Taipei City for easily doing business in their office everyday.

And, most of the lower income households are forced to move farther away from CBD because they cannot afford the high cost of housing in the urban center. Thus, we hypothesize Alonso's argument that the rich live close to and the poor live away from CBD capable be explained by the spatial income distribution in northern area of Taiwan.

Figure 1

The Location, Area, and Populations of Taipei city and Taipei County



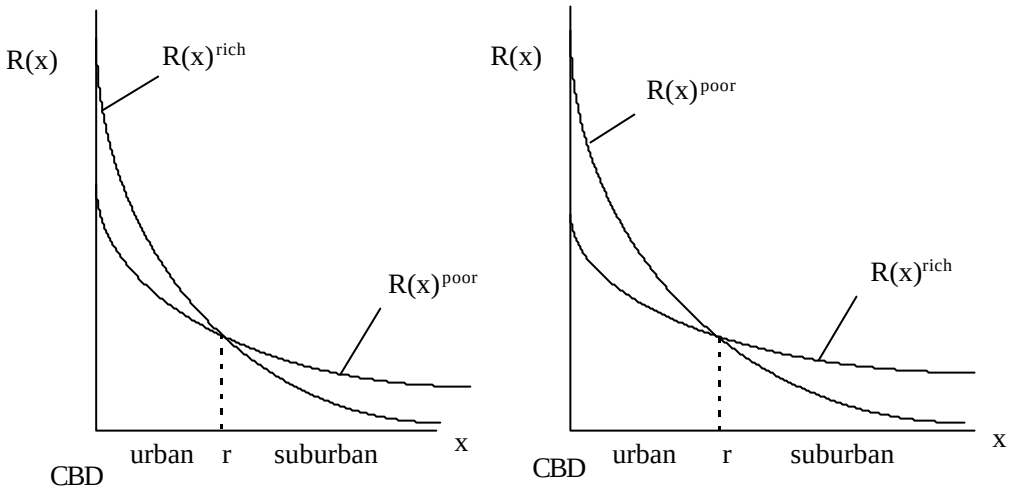
The Data

We make use of 1981 and 1991 DGBAS Household Survey Data (HSD) to test our hypothesis. The HSD in 1981 showed some useful information, such as money income, of 4,339 families scatter around in northern Taiwan in 190 basic neighborhood units (BNU). The basic neighborhood unit in small village is called CHUN, in town and city are called LI. The population size can be as small as 100 or 1,000 citizens in CHUN, and 1,000 or 10,000 citizens in LI. On average, there are 23 families in every BNU. Since we do not have exact information of distance of each family from CBD, because DGBAS do not provide name, address and telephone number of each family in detail for the user of HSD. We first find out the money income of each family in each BNU and to calculate their average income as the proxy of income of that BNU. So that we have 190 different i ncome levels. In the meantime we made telephone calls to the office of each BNU to check their distances from CBD (Taipei Railway Station) and find out 190 distances. By the same way, 4,500 families of the HSD in 260 BNU in 1991 have also measured. Thus we build up 190 samples in 1981 and 260 samples in 1991.

The Empirical Results

The empirical study wants to know whether residential distances and household incomes in Taipei area are negatively related (Alonso's argument) or positively related (Mills and Hamilton's postulation) as Figure 2.

Figure 2



a. The argument of Alonso (1964)

b.The argument of Mills and Hamilton (1989)

By transforming incomes of the rich and the poor into Figure 2, we can formulate the simplest function al form as x=a+by, where a and b are the intercept and slope of this linear equation respectively.

Finally, we make use of the above data to run regressions and have the following results:

$$(19)\quad x_{1981} = 12.6734 \quad 0.000025\, y_{1981} \qquad R^2 = 0.0576$$

$$(9.1910) \quad (-3.3910) \qquad F = 11.501$$

for 1981, and

(20) $x_{1991} = 19.4331 \quad 0.000012\, y_{1991}$ $R^2 = 0.1336$

(11.9580) (-6.3070) $F = 39.779$

for 1991. These results should capable of explaining our hypothesis that the rich households in Taipei area live closer to CBD and the poor reversely. Therefore, the housing location in Taiwan is quite the same as Alonso's argument. But, Mills and Hamilton may also be right since $(\frac{dx}{dy})_{1981} = -0.000025$ in 1981 has changed to being $(\frac{dx}{dy})_{1991} = -0.000012$. This means that one New Taiwan Dollar increase will make household move 0.000025 KM closer to CBD in 1981 and 0.000012 KM in 1991. Furthermore, if we intend to find the income gradient of Taipei area we can have the following functional form, $y = y_0 \quad bx$, where y_0 is the income level of household lived in CBD. Applying the same set of data, we get the results as below :

(21) $y_{1981} = 12.02303 \quad 0.02321\, x$ $R^2 = 0.2366$

(146.88) (-3.96) D.W.=2.1510

(22) $y_{1991} = 10.27854 \quad 0.010841\, x$ $R^2 = 0.0403$

(191.95) (-2.51) D.W.=1.9800

The results show that income declines by roughly a constant rate 2.3% per kilometer away from CBD in 1981, and 1.08% in 1991.

Both the change of slope and the change of gradient between 1981 and 1991 as equations (19)-(22) have shown that the income levels of suburbanites are increasing. Particularly, after economic boom during 1986-1990, there are

many newly money-maker tried to breakthrough the land use regulations by illegal changing their job status as a farmer to buy and consume suburban or rural land.

4. Concluding Remarks

This paper introduces land consumption maximum lot size restraint of Taiwanese institutional setting into the slope of the bid-rent function of the households to investigate the changes of spatial income gradient under the restraint. We find that the maximum lot size restraint will steeper the slope of the bid-rent function of the higher income households. Therefore, the poor households will be lived out of the centrally urban area by the rich households. The housing location in Taiwan, thus, is contrary to the American cities but quite the same as the European and The third world where the poor usually inhabit in the peripheral areas while the rich and middle class live centrally.

Empirical studies show that the relationships of residential distance and household income in Taipei area are negatively related both in 1981 and 1991. It proves Alonso's argument. But, the slope of distance-income function is smaller in 1991 than that of 1981 while general income level has been raised higher than before. One NT dollar increase will make household move 0.000025 kilometer closer to CBD in 1981 and 0.000012 kilometer in 1991. These slopes indicate that there is a trend of suburbanization. The arguments of Mills and Hamilton may also right in the case of maximum lot size restraint when general income level is large enough to have positive slope of distance-income function. If so, the change of income gradient will be positive instead of -2.3% in 1981 and -1.08% in 1991.

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