CHAPTER 2

THEORETICAL FRAMEWORK AND LITERATURE REVIEW

This chapter summarizes the traditional residential location theory of Alonso (1968) in order to clearly understand the fundamental residential location concept and residential location decision of an individual with single transport mode. Then it is easier to follow the bimodal choices of transit model of LeRoy and Sonstelie (1983). Moreover some fruitful empirical studies involving the influence of transportation innovation on residential location patterns are reviewed.

2.1 Theoretical Framework

2.1.1 Simple Trade-Off Model and the Applications

The traditional theory developed by Alonso (1968) and Muth (1969) are well-known fundamental concepts of residential location decision. Developed from the basic consumption theory, Alonso-Muth's model derives from residential location equilibrium of an individual household by maximizing his/her utility with respect to budget constraint. And then, implying from the maximizing-utility first order condition, they generate the significant trade-off model. As trade-off concept, household trade off accessibility (access to the city center) for housing space in making their residential location decision.

The initial assumptions in Alonso model are required to simplify the analysis, although unrealistic, it can be classified under three headings;

- The assumption related to center of the city: A city is assumed to be monocentric, all employment and all goods and services are available only at center of the city which is called "Central Business District" or "CBD". It lies on a featureless plain where an urban area is characterized as one dimension.

- The assumption related to land and housing: Land is bought and sold by free contract, without any institutional restraints, and without having its character fixed by any structure existing upon the ground. Municipal services and tax rates are uniform throughout the city. And the price of land at every location is not affected by individual decision. For houses, they are assumed to be available everywhere to accommodate all preferences. Therefore, there is neither any search nor relocation cost that would prevent households from attaining the equilibrium location. However, the differences in housing structures are frequently ignored by treating housing demand as a demand for urban land.
- Another set of assumptions relates to transport costs incurred by consumers: Transportation is assumed to be a uniform pattern so that the CBD is accessible in all directions with a cost proportional to the number of travel trips and the distance, measurable in terms of a straight line between a residence and CBD. Additionally the city is assumed to be congestion-free. Thus, traffic generally moves more rapidly at greater distances from the CBD. Therefore, transport costs increase at a non-increasing rate with distance from the CBD.

In addition, market competition is assumed to ensure that the necessary information relevant for the consumer’s decision is available to allow demand and supply to work interactively to attain the equilibrium location for households. Finally, preferences for housing, leisure, and consumption of other goods and services are assumed to be identical among all households.

According to Alonso’s framework, individuals must pay for housing costs, for all other goods and services (included savings), and commuting costs from his/her residential area to the city center. Note that, in this framework, housing means the bundle of services yielded both by structures and also by the land or sites on which they are built. Thus housing refers to the flow of services and the satisfactions they yield per unit of time from residential real estate, not to activities associated with newly constructed assets of this type. Thus the price per unit of housing means the price of a flow of service from housing. And in this analysis, the behavior of individuals as consumers is limited to their consumption of housing and other commodities. Owners of houses or apartment units in which they reside are treated as both consumers of and producers of housing.

In Alonso's framework, even though a household must maximize his/her utility based on consumption bundle of all three commodities, deriving for location equilibrium is easier if considering each of the two commodities when keeping the other commodity constant. Therefore, the household regarded as an individual, has at his disposal a certain income, y, which he may spend on land and other goods and services consumed after paying for commuting costs $K(l)$ to his location, where l stands for distance from the city center. All the other goods and services are grouped into one composite good, z. The expenditure on this composite good is $p_z z$. From the point of view of a consumer, price of land, $P(l)$, varies with distance from the center, l. So, the price of land at every location is $P(l)$. Together with location chosen in their purchase of land, the consumer also decides upon the quantity of the land, h. Thus the expenditure on land is $P(l)h$. The commuting cost $K(l)$ is assumed to increase with the increase in distance from the city center (CBD).

In Alonso's model, the household's choices of location and the amount of land (housing) depends on a trade-off between cheaper rents and longer distance to travel to work. They make their decision by maximizing their utility subject to a budget constraint that includes the cost of housing, the costs of traveling to work, and the costs of composite goods. The budget constraint will depend on the household's income, price of the composite goods and price of land.

The utility maximization function of the household with a combination of the quantity of composite goods, quantity of land, and distance from the center of the city in the utility function which can be expressed as follows:

$$Max \quad u(z,h,l) \tag{2.1}$$

Subject to budget constraint:

$$y = p_z z + P(l)h + K(l) \tag{2.2}$$

where	y	=	income
	p_z	=	price of the composite good
	z	=	quantity of the composite good
	$P(l)$	=	price of land at distance l from the center of the city
	h	=	quantity of land
	$K(l)$	=	commuting costs to distance l
	l	=	distance from the center of the city

Solving for the first-order condition:

$$L = u(z,h,l) + \lambda\left[y - p_z z - P(l)h - K(l)\right] \quad (2.3)$$

$$u_z = p_z\lambda \quad (2.4a)$$

$$u_h = P(l)\lambda \quad (2.4b)$$

$$u_l = \lambda\left[h\,dP(l)/dl + dK/dl\right] \quad (2.4c)$$

Then applies marginal rate of substitution from the first order conditions, we get

$$\frac{u_h}{u_z} = \frac{P(l)}{p_z} \quad (2.5)$$

$$\frac{u_l}{u_z} = \frac{\left[h\,dP(l)/dl + dK/dl\right]}{p_z} \quad (2.6)$$

It can be interpreted form equation (2.5) and (2.6) that, at equilibrium, the marginal rate of substitution between the two goods is equal to the ratio of their marginal costs. More precisely, the numerator of equation (2.6) represents the marginal costs of the spatial movement. As the model assumed that a commuting is regarded as a nuisance, moving outward would produce disutility to the consumer $(u_l < 0)$. It is also assumed that the increase in composite goods consumption generates more utility $(u_z > 0)$, and implicitly the price of composite goods is positive, $(p_z > 0)$. So, the marginal costs of moving outward from CBD must be negative for equation (2.6) to hold. As travel costs increase with the increased distance, the saving in housing costs has to be, $\left[dP(l)/dl\right] < 0$. Therefore, with the increasing distance from the city center, the price of land reduces to offset the increased travel costs. A household then substitutes more land and composite good consumption for accessibility and he would located only at the location where the saving from the cheaper land costs equal the increased commuting cost.

However, if $P(l)$ decreases with distance, then the price of land must increase with distance from the center of the city to maintain the same level of resident's satisfaction, thus with inconsistency, everyone would move toward the center that has cheaper land with less commuting costs. But for equilibrium, it is necessary that $\left[h\,dP(l)/dl + dK/dl\right]$ must be less than zero, then the individual will never settle where $-(h\,dP/dl) < (dK/dl)$ or the individual will only settle where the savings derived from cheaper land exceed the increased commuting costs.

In conclusion, given these equilibrium conditions for the housing market as a whole and the spatial pattern of housing prices, it was also implied in traditional theory that households of the same income will be indifferent among all residential locations in the city. At each distance from single workplace, the incremental savings in housing expenditures associated with an increase in distance will be exactly offset by the incremental transportation costs to the city center.

Following the trade-off concept of traditional residential location theory, Alonso has adapted the bid-rent curve. As outward movement produces disutility this saving must occur in land costs, because commuting costs are increasing where the marginal cost of movement is equal to the quantity of land multiplies the change in the price of land plus the increase in the cost of commuting. The bid-rent, then, has been defined so that the income effect of cheaper land will counteract the depressing effect of commuting cost on income, and will permit the consumer to maintain a given level of satisfaction by substituting land and composite good for accessibility as distance from the center increases.

Again, let us examine the first order condition. The marginal rate of substitution between land and the composite good is equal to the ratio of their prices (recall equation 2.5).

$$\frac{u_h}{u_z} = \frac{p_i(l)}{p_z}$$

where $p_i(l)$ is the bid-rent at location l for individual i with reference to the given level of satisfaction[1]

We also found that the marginal rate of substitution between movement from the center and composite good is equal to the ratio of their marginal costs (recall equation 2.6)

$$\frac{u_l}{u_z} = \frac{\left[h\,dp_i(l)/dl + dK/dl\right]}{p_z}$$

[1] See for more detail in Alonso, W. (1968). Location and Land Use: Toward a General Theory of Land Rent. Cambridge, Massachusetts, Harvard University. 59-68.

Combining these equations, we obtain that the marginal rate of substitution between land and movement is equal to the ratio of their marginal costs:

$$\frac{u_l}{u_h} = \frac{\left[h\, dp_i(l)/dl + dK/dl\right]}{p_i(l)} \tag{2.7}$$

To examine the slope of the bid-rent curve easily, let us rewrite the equation as

$$\frac{dp_i(l)}{dl} = \frac{p_i(l)}{h}\frac{u_l}{u_h} - \frac{1}{h}\frac{dK}{dl} \tag{2.8}$$

By identifying the bid-rent function and its slope implying from the first order conditions, Alonso concluded that bid-rent function of the same-income households are identical. However, as it is basically assumed that income elasticity of demand for housing is greater than income elasticity of marginal transportation cost, it can show that higher-income persons will live further from the central workplace. Therefore the application on the bid-price concept as the effect of income difference will be shown.

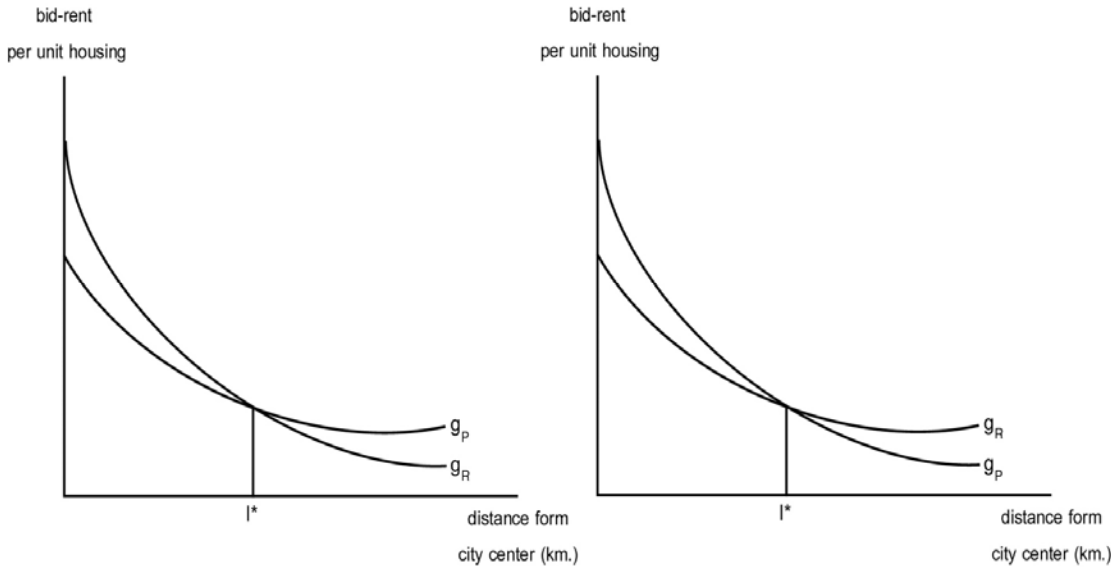
The Effects of Income difference on Locations

If we can show that higher incomes lead to more gently sloped curves, it concludes that the wealthy will tend toward peripheral and the poorer toward central locations. To this purpose we shall examine the right-hand side of equation (2.8), to see how steepness of the bid price curve is affected by income for individuals of identical tastes. With income increases, considering to the second term, $-\left(\frac{1}{h}\right)\frac{dk}{dl}$, if commuting costs do not vary with income, more land holdings are needed, increase in h will decrease the value of a whole term, thus a smaller rate of change in prices is necessary to produce the income effect to offset the increased commuting costs.

For the first term, $\left[\frac{p_i(l)}{h}\right]\frac{u_l}{u_h}$, is more complicated. Again, extensive land holdings militate for a gentler slope with rising income through these denominators. However, these very increases lead to a decrease of the negative term, u_l/u_h, for accessibility may be expected to become more desirable as it becomes scarcer relative to land. If the marginal rate of substitution decreases at a faster rate than the holdings of land increase (that is, if there is no great desire to increase the quantity of land), the net result will be steeper bid-rent curves and a central location for the wealthy. However, if the desire for land is strong and not easily satisfied, the rate of decrease of the marginal rate of substitution will be less than the rate of increase of land, resulting in a gentler slope for higher income (depicts as Figure. 2.1)

Figure 2.1

The Bid-Rent Functions of Different Income Households



Source: Alonso, W. (1968)

The figure on the left hand side shows the case when the marginal rate of substitution decreases at a faster rate than holdings of land increase; in other words, income elasticity for land holding is less than income elasticity for marginal commuting costs; therefore, the wealthier will outbid the poorer for land in the city center. Contrary to the figure on the right hand side, when the marginal rate of substitution decreases at a slower rate than holdings of land increase or income elasticity for land holdings is greater than income elasticity for marginal commuting cost, the wealthier will outbid the poorer in peripheral areas.

Technical Improvement in Transportation

Since the bid-rent function derived in Alonso's model can be affected by not just the difference in income of each individual household, the transportation facility improvement which changes household transport cost function should be considered; so, now, we will review the application of Alonso's model when technology of transportation is improved. Technical improvements in transportation may have two effects: (1) they may make commuting easier, and (2) they may make it less expensive. Both of these effects tend to reduce the steepness of the slope of residential bid price curves. It can be seen in equation (2.8) that making commuting easier reduces the marginal disutility of distance u_l (that is, it reduces the absolute value of the negative quantity u_l), resulting in a gentler slope. A reduction in the costs of commuting, on the other hand, would be reflected in a reduction of the term, dK/dl, also resulting in a more gently sloped bid price curve.

It is important to differentiate these two effects because various innovations may affect them differently. An automobile may be more expensive than public transportation (leading to steeper curves through increases in dK/dl), but may be a more pleasant way of commuting (leading to less steeply sloped curves through a decreased absolute value of u_l). Increases of population, although not in a technical change, may lead to a situation where the city may enjoy the economies of scale of mass transportation. Then the cost may be reduced, but the associated congestion may make commuting more unpleasant. In general, it was accepted only when their net effect on cost and convenience is favorable. This will be reflected in more gently sloped bid-rent curves.

2.1.2 The Bimodal Choices of Transit Model

In Alonso's model, the former effect dominates and the rich live farther from the CBD than the poor if and only if the income elasticity of housing demand exceeds that of marginal commuting costs. However, it assumed that everyone commutes to work in the CBD by using the same transportation mode (transport is assumed identical throughout the city). Nevertheless, LeRoy and Sonstelie extended the Alonso model to incorporate two competing modes of commuting. LeRoy and Sonstelie have considered why residential patterns begin change; the key to the explanation is the altered role of transport mode as a means of commuting to work.

This analysis dealing with bid-rent function determines the residential location equilibrium in a static framework given a level of satisfaction. Individuals choose residential location and commuting mode simultaneously, given costs of competing modes. This analysis permits observed change in residential location patterns without relying on assumed income elasticity of housing demand which must be greater than that of marginal commuting costs and also without assumed change in preference overtime. Furthermore its explanatory variables can plausibly be taken as exogenous with respect to urban residential pattern. And this model is parsimonious in the specification of the behavior assumed for exogenous variables, namely, the return of the rich to downtown is generated by a continuation of the same behavior.

Let's start the model that individuals work in the CBD and live in residential areas surrounding it. Each individual consumes two goods, housing services h and a composite good z representing all non-housing consumption. All individuals have the same preferences, represented by the well behaved utility function $U(h,z)$. By relaxing identical transportation in Alonso's model, LeRoy and Sonstelie assume there are two competing mode choices of transits. Commuters can choose between two modes of traveling to work, generally labeled the initial transit and the alternative transit. The alternative transit travels 2 mile[2] in t^A hour (A for the

[2] To represent a mile for home-to-workplace trip and another mile for workplace-to-home trip, basically for a daily trip.

alternative mode), and has a variable material cost of $\frac{c^A}{2}$ per mile and a fixed cost of f^A per day. The corresponding parameters of the initial transit are t^I, c^I and f^I. The alternative transit is assumed to be faster than the initial transit $\left(t^A < t^I\right)$ but also more expensive ($f^A > f^I$ and $c^A > c^I$). An individual, who has income w living at the distance l, faces a daily commuting cost of $f^A + c^A l + wt^A l$ for the alternative mode and of $f^I + c^I l + wt^I l$ for the initial mode.[3] At any distance l an individual will commute by the alternative mode if and only if $f^A + c^A l + wt^A l < f^I + c^I l + wt^I l$. Individual with a sufficiently low income will find that the marginal cost of commuting by the alternative transit exceeds that of the initial transit commuting (since $c^A > c^I$), implying that those individuals will commute by the initial mode regardless of distance.

However, the income can be high enough to ensure that the marginal cost of the alternative mode commuting is less than that of the initial mode commuting, in which event the decision of whether or not to commute by the alternative transit will depend on the length of the trip. For every short trip, the savings in variable cost from commuting by car will not offset its higher fixed cost, which is justified only for relatively long journeys. Evidently LeRoy and Sonstelie may define a break-even distance at which the lower variable cost of the alternative transit exactly offsets its higher fixed cost:

[3] Alonso simply assumed that time cost are a function of income , since additional work is an alternative forgone by time spent in travel, but need not to be equal to income. By initially assuming that the household makes a fixed number of trips to and from the CBD per day, regardless of location, then we can express transport costs as a given function of location and income level.

$$l^{*} = \frac{f^{A} - f^{I}}{(c^{I} + wt^{I}) - (c^{A} + wt^{A})} \quad (2.9)$$

4

Assuming that $c^{I} + wt^{I} > c^{A} - wt^{A}$ (in the reverse case, the slower mode is adopted for any distance, as just indicated; denoting this by adopting the conventional $l^{*} = \infty$). Note that the break-even distance varies negatively with the income.

Bid-rent functions now are defined conditional on the mode of commuting. The bid-rent function conditional on the alternative mode commuting is defined by

$$g^{A}\left(l;u,w\right) \equiv \max\left(\frac{w - f^{A} - c^{A}l - wt^{A}l - z}{h}\right) \quad (2.10)$$

subject to $U\left(h,z\right) = u$. That means the bid-rent function is maximum spending per unit housing given level of utility satisfaction. According to the traditional Alonso model, each individual consumes a bundle of three goods; housing goods, composite goods, and transportation; thus, to achieve maximum utility an individual must spend all of his/her budget on the bundle of three goods. Therefore, after deducting transportation costs and expenditure of composite goods (which assume its price is unity according to Alonso model) and divided by amount of housing consumption, we will get maximum rent per housing unit paid by the bidding individual. The budget constraint implicit in equation (2.10) contains the assumption that the number of hours available for working and commuting is given; without loss of generality, this number is normalized at one.

Therefore, the gradient of the bid-rent function (2.10) is

$$\frac{\partial g^{A}\left(l;u,w\right)}{\partial l} = -\left(\frac{c^{A} + wt^{A}}{h}\right) \quad (2.11)$$

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[4] Break-even distance is defined as the lower variable cost of the alternative transit exactly offsets its higher fixed cost:

$$f^{A} + c^{A}l + wt^{A}l = f^{I} + c^{I}l + wt^{I}l$$

$$f^{A} - f^{I} = c^{I}l + wt^{I}l - c^{A}l - wt^{A}l$$

$$f^{A} - f^{I} = (c^{I} + wt^{I} - c^{A} - wt^{A})l$$

$$l^{*} = \frac{f^{A} - f^{I}}{(c^{I} + wt^{I}) - (c^{A} + wt^{A})}$$

by the envelop theorem. The bid-rent function conditional on the initial mode commuting, $g^I(l;u,w)$, is defined similarly.

$$g^I(l;u,w) \equiv \max\left(\frac{w - f^I - c^I l - wt^I l - z}{h}\right) \tag{2.12}$$

with gradient

$$\frac{\partial g^I(l;u,w)}{\partial l} = -\left(\frac{c^I + wt^I}{h}\right) \tag{2.13}$$

The unconditional bid-rent function is just the maximum of the conditional functions:

$$g(l;u,w) = \max\left(g^A(l;u,w), g^I(l;u,w)\right) \tag{2.14}$$

Or, equivalently,

$$g(l;u,w) = g^I(l;u,w) \qquad \text{if } l \le l^*$$

$$g(l;u,w) = g^A(l;u,w) \qquad \text{if } l > l^* \tag{2.15}$$

with gradient

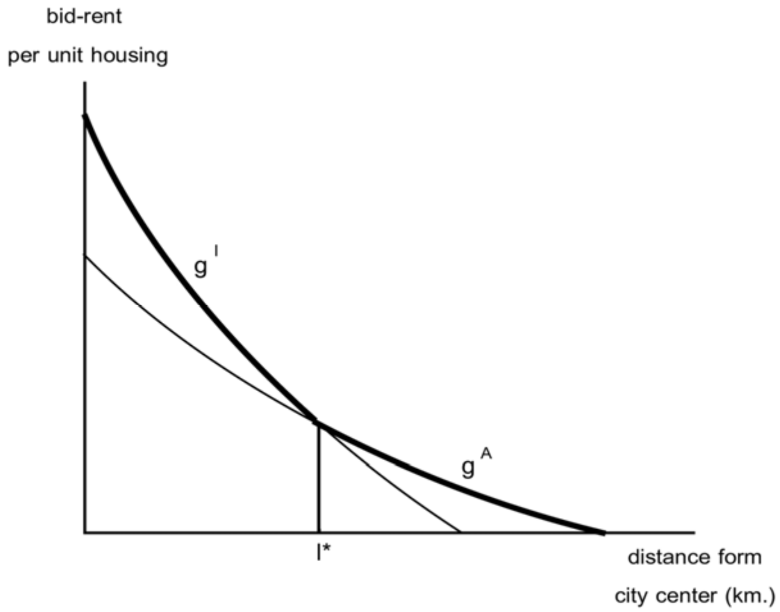
$$\frac{\partial g(l;u,w)}{\partial l} = -\left(\frac{c^I + wt^I}{h}\right) \qquad \text{if } l \le l^*$$

$$\frac{\partial g(l;u,w)}{\partial l} = -\left(\frac{c^A + wt^A}{h}\right) \qquad \text{if } l > l^* \tag{2.16}$$

Thus the bid-rent function has a kink at l^*, reflecting the switch to a faster mode of transportation at the location. A typical bid-rent function is drawn as Figure.2.2. The thick line shows maximum bid-rent on each location which kink at l^*.

Figure 2.2

The Bid-Rent Function



Source: LeRoy and Sonstelie (1983)

Now considering a position to informally describe equilibrium residential patterns of different income groups and to determine how they vary with the material cost of the faster mode, assume that two groups differing only in their income compete for housing in the city. Let w_R be the income of the rich and $w_P ; w_P < w_R$ be the income of the poor. The break-even distance for a group depends on whether the income of that group is or is not high enough that the lower time cost of the faster mode offsets its high material cost. Thus, if an income group uses a particular mode at one location, it does so at all locations. Now, suppose that fixed and variable material costs of the faster mode falls steadily over time with respect to the incomes of both groups. This assumption generates four different eras.

Suppose that a first f^A and c^A are high enough that $l_R^* = l_P^* = \infty$ (where l_R^* and l_P^* representing the break-even distance traveling by any transport mode for the rich and the poor respectively). Equilibrium locations will be the outcome of competition for housing among individuals in the same group and between groups. Competition for housing within either group will ensure that all individuals in that group have the same utility level regardless of location. Thus, the rent paid by either group will be consistent with the bid-rent function evaluated at one particular utility level, and competition among the groups will determine the utility level for each group. Housing at any location will go to the group with the highest bid-rent at that location, and the utility level for each group must be such that demand for housing per individual in each group is consistent with the number of individuals in that group and the supply of housing allocated to that group.

When evaluated at equilibrium utility levels, the bid-rent functions of rich and poor will intersect at the boundary of the areas in which each income group lives. The group that lives on the side of that boundary closer to the CBD must have the steeper bid-rent function at that intersection. From absolute value of the bid-rent gradient the rich will live on the CBD side of the boundary if and only if

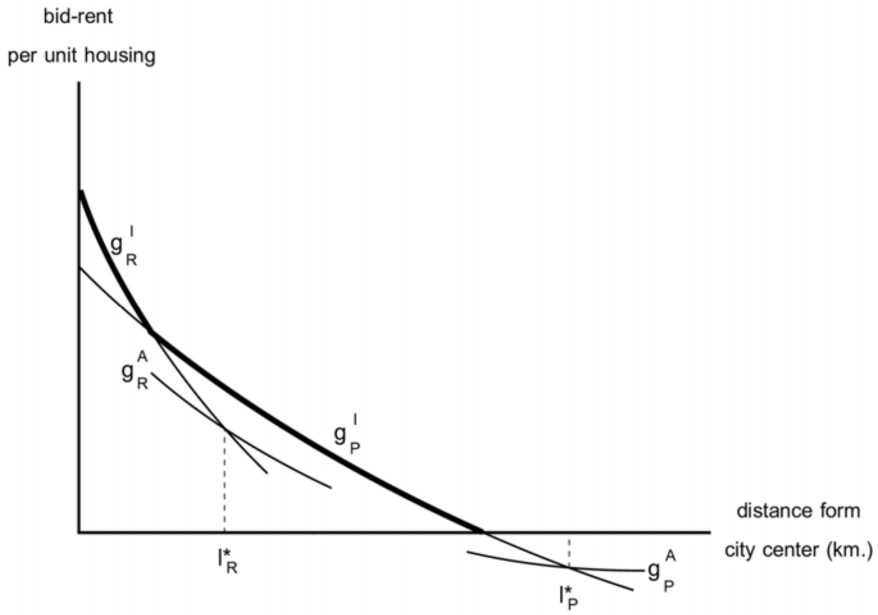
$$\frac{c_R + w_R t_R}{h_R} > \frac{c_P + w_P t_P}{h_P} \tag{2.17}$$

where h_P and h_R are the housing consumptions of the poor and the rich, respectively, at the boundary. Here c_P and t_P are the variable material costs and travel times of whichever mode is taken by the poor, and c_R and t_R are the comparable parameters for the rich. The numerators of the fractions in inequality (2.17) are the marginal commuting costs of the rich and the poor. Inequality (2.17) will therefore be satisfied if and only if the arc income elasticity of marginal commuting cost, η_c, exceeds the arc elasticity of housing consumption with respect to income, η_h.[5] Then we have "the Paradise Era" (depicted as Figure 2.3).

[5] Polinsky (1977) and Polinsky and Ellwood (1979) provided evidence that the income elasticity of housing consumption is less than unity, while the income elasticity of marginal commuting costs will depend on the transport modes. When all income groups commute by the same mode, it is likely that $\eta_c > \eta_h$, so the rich live on the CBD side while the poor live on the peripheral side.

Note that in Figure 2.3 g_R^A and g_R^I is the bid-rent curve of the rich who commute by the alternative and the initial transit in order, while g_P^A and g_P^I is the bid-rent curve for the poor who commute by the alternative and the initial transport mode, respectively.

Figure 2.3
The Bid-Rent Function in Paradise Era



Source: LeRoy and Sonstelie (1983)

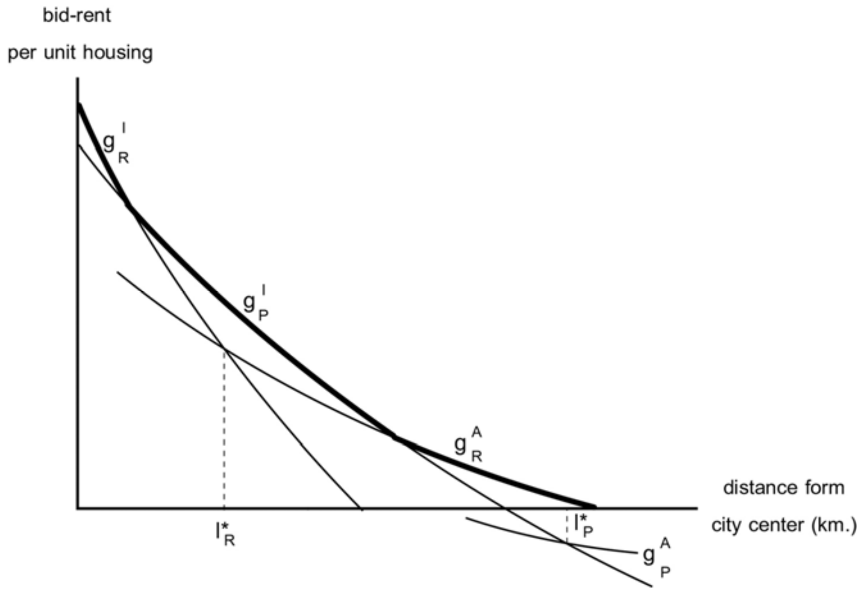
In the second period, assume now that f^A and c^A drop enough relative to incomes that the rich can economically commute by the alternative mode, or at least find it economical to commute for any distance. In terms of this model, we are assuming that the relative costs of the alternative mode commuting have fallen enough that l_R^* lies well inside the boundary of the city, but that l_P^* is still either infinite or very high. The city can then be divided into two zones. In zone 1, defined by $0 < l \leq l_R^*$, both groups commute by the initial transit, while in zone 2, defined by $l > l_R^*$, the poor commute by the initial transit but the rich by the alternative transit. Of course, this classification does not tell us which income group lives at a particular location; it only describes the mode of transportation used by which group lives there. A boundary between the residential areas of the rich and the poor is possible in either zone 1 and 2. If the only boundary occurs in zone 1, as in the paradise equilibrium, the rich will live on the CBD side of that boundary under the maintained assumptions. But as f^A and c^A drop relative to incomes, l_R^* decreases and the supply of land available accommodate the housing demands of the rich; consequently, there must come into existence a boundary in zone 2. At such a boundary the rich will commute by the alternative transit and the poor by the initial transit, the bid-rent function of the rich may be flatter than that of the poor. In that event the rich will have a comparative advantage living on the suburban side of the boundary. It is necessary and sufficient that the bid-rent function of the rich be flatter than that of the poor, which is called "the Paradise Lost Era".

$$\frac{c^A + w_P t^A}{h_P} > \frac{c^I + w_R t^I}{h_R} \tag{2.18}$$

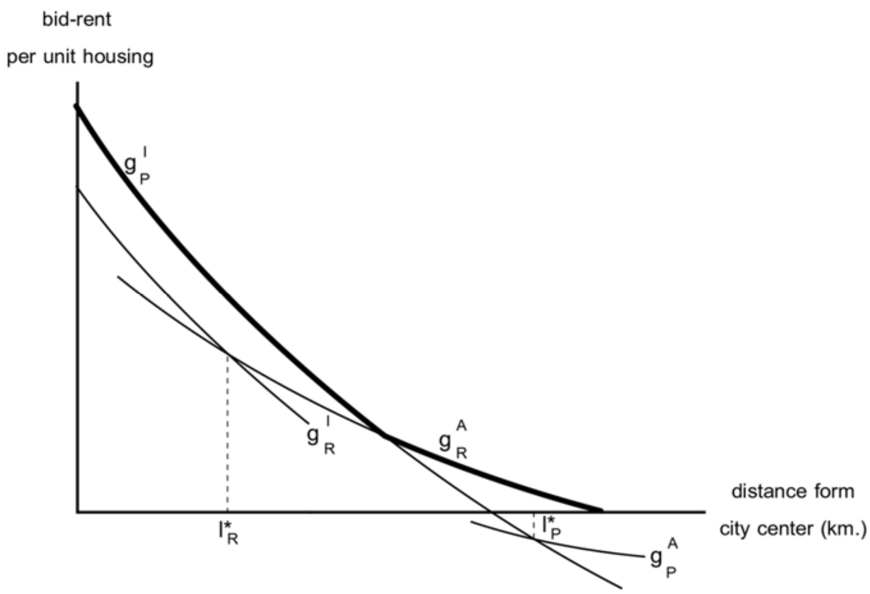
We see that the decline in material costs of the alternative mode commuting will sooner or later lead some of the rich to commute by this transit and move to the suburbs (depicts as Figure.2.4a). Note that the residential equilibrium just described in which some of the rich commute by bus and some by car, and in which the downtown and far-suburban residential areas of the rich are separated by near- suburban area populated by poor commuted by the initial transit, depends essentially on the presence of fixed costs, since we have the rich using different modes at different locations. Depending on parameter values, however, it may or may not be the case that all the rich will eventually move to the suburbs (as illustrated in Figure.2.4b). Any residential equilibrium in which the outermost residential area is occupied by the rich using alternative transit will be termed a paradise lost equilibrium, although the term evidently applies better to equilibria of the type indicated in Figure.2.4b than to that shown in Figure.2.4a.

Figure 2.4

The Bid-Rent Function in Paradise Lost Era



(a)

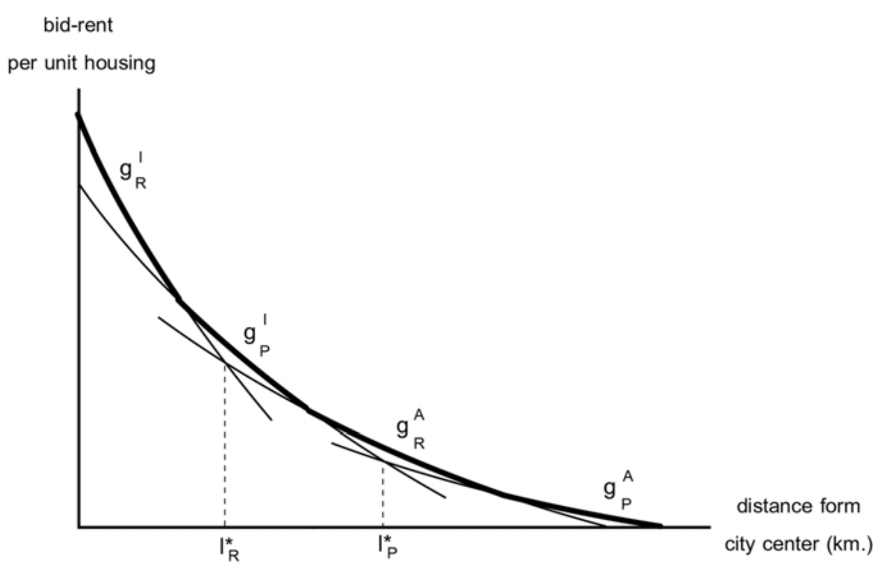


(b)

In the third period, assume that the fixed and variable material costs of the alternative transit transportation drops further. Evidently the comparative advantage of the rich in bearing high material costs is diminished. At some point the poor, commuting by the alternative mode, will become the high bidders for suburban homes, again by maintaining the assumption that the income elasticity of marginal commuting cost is greater than the income elasticity of housing demand when both groups use the same mode. Accordingly, a new boundary between the rich and the poor will occur, the paradise lost era will have ended, since the rich no longer occupy the urban periphery. With the rich becoming less effective in competing for housing in the suburbs, due to the decline in the material cost of alternative transit, they must be competing relatively more effectively elsewhere, comparative advantage being what it is. The indicated area is, of course, the innermost urban residential area, where the rich also have a comparative advantage, since there both groups would commute by the same mode. This improvement in the competitive position of the rich in bidding for land in the innermost residential area will eventually establish them as dominant bidders (if they were not at the outset). Thus, the advent of the poor as the alternative transit commuters in the outermost residential areas will be accompanied by a return of some of the rich to the downtown areas. We have “the Re-gentrification Era” depicted in Figuer.2.5. Depending on the relative populations of rich and poor, the rich may not ever entirely evacuate the downtown area under the paradise lost equilibrium, in which event re-gentrification would refer to an increase in the size of the innermost residential area occupied by the rich, rather than to the creation of such a region. It may seem puzzling that a decrease in the cost of alternative transportation induces some of the rich to give up using the alternative mode and move to the city. It is less so if one recalls that mode choice depends on location, which in turn depends on comparative and not absolute advantage. With this in mind, it is not surprising that a decrease in material transportation cost will induce some of the poor to commute by the alternative mode and displace some of the rich in the suburbs, with the reverse occurring in the city center.

Figure 2.5

The Bid-Rent Function in Re-Gentrification Era



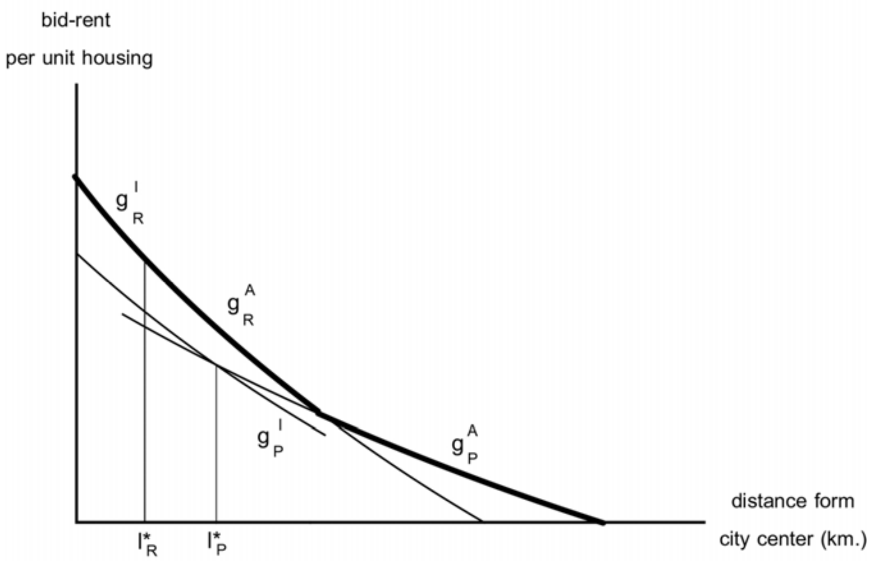
Source: LeRoy and Sonstelie (1983)

In choosing where to live, the rich and the poor do not think in terms of comparative advantage, of course, but simply do the best they can for themselves subject to incomes and prices. The poor see that a decrease in the variable material cost of the alternative commuting means that they can commute by this mode and move to the suburbs where housing is cheaper. The rich, on the other hand, who were willing to commute long distances when suburban real estate was very inexpensive, now see that (because the poor are bidding for suburban housing) suburban housing prices have risen to the point that the differential between suburban and urban housing prices no longer justifies the high time cost of commuting. Some, therefore, move downtown, where the short commuting time offsets the somewhat higher cost of housing. As the material cost of the alternative transportation declines, the rich using the alternative transit will become increasingly effective bidders for the land occupied during the re-gentrification era by the poor using the initial transit; the latter, in turn, find it increasingly attractive to acquire the alternative transit and move to distant suburbs.

Eventually the poor will be entirely displaced in the intermediate region, resulting in a pattern in which the innermost residential area is occupied by rich commuting on the initial transit as in the re-gentrification equilibrium, the intermediate region is occupied by rich commuted by the alternative transit, and the suburbs by poor commuted by the alternative transit. This new equilibrium, “the Paradise Regained”, resembles the original paradise pattern in that all the rich reside in the area closest to the CBD, whereas all the poor live in the more distant areas of the city (see Figure.2.6).

Figure 2.6

The Bid-Rent Function in Paradise Regained Era



Source: LeRoy and Sonstelie (1983)

2.2 Literature Review

To explicitly understand residential location decision, I consider empirical evidence of past studies that related to theories reviewed in the preceding section. However, focusing on the influence of transport innovation on residential location pattern through housing price or/and population density is needed.

Transportation facilities were mostly captured by accessibility index whether through distance or time duration to reach the CBD. Measuring by this method generally yields negative signs which mean an individual who locate farther from the CBD must pay more transportation costs to access the center of city and less willing to pay for that area with high accessibility index value. However, measuring transport facilities through commuting costs can represent its effect although its network is not ubiquitous. Dewees (1976) investigated property values along the Bloor Street and Danforth Avenue in Toronto before and after the subway replaced the streetcar service. Using multivariate regression analysis to estimate a hedonic price index from house sale prices, the result agreed that availability of feeder transit, subway, in Toronto, induced housing price gradient to be far shallower because of a lower disutility of commuting time and much higher average travel speed. However she found that the effect of replacing a streetcar line with a subway increased the site rent surface slope perpendicular to this facility especially at the station nearest the CBD.

Haider and Miller (1999) have extended more transportation infrastructure, highway and subway, effects on residential real estate values. They adopt a spatial autoregressive (SAR) model to investigate the effect of combination of location elements, neighborhood characteristic, and structure attributes on property sale prices during 1995 in Toronto. They found that transportation factors were not strong determinants of housing value. It can be explained that both highways and subways have specific characteristics that have a perpendicular influence on these facilities at enter-exists or at stations, respectively. Therefore, using aggregate data on overall areas, and reducing housing price gradient by distance from center of the city might offset increases in gradient perpendicular to these transport facilities.

Debrezion, Pels, and Rietveld (2005) have also focused on the impact of railway accessibility (considered only inter-state commuter rail) feature on Dutch housing prices. The result was in accordance with the study of Haider and Miller (1999) that housing price gradient increases perpendicular to the rail lines.

Although many transportation – housing price relationships have been studied in America and Europe, little evidence in Asian cities have been investigated. Alex Chan and Chung Yi Tse (2001) have estimated the property price gradient in Hong Kong. They measured economic distance from CBD as commuting cost. The underlying reason is that there exists an imbalanced transportation network improvement in Hong Kong. Thus by relaxing the basic assumption, transport network dense in all direction, might be appropriate to imply for Hong Kong case study. The result showed that changes in commuting costs exerted a statistically significant effect on property values. The property price gradient was negative as Alonso-Muth's model. However, estimation suggested that the savings in commuting costs appears to be over-capitalized in property value.

Rather than dealing with identical transportation through a discrete choice of transit model, LeRoy and Sonstelie (1983) and Gin and Sonstelie (1992) have examined the significance of the existence of an alternative transport mode in the residential location model. By focusing on changes in transportation mode choice, LeRoy and Sonstelie attempted to explain the spatial income patterns of three distinct phases on the life cycle of a city: paradise, in which the rich live downtown; paradise lost, in which the rich flee to the suburbs; and paradise regain, in which the rich resettle downtown. To capture the effects of transportation innovations, they extended the Alonso-Muth's model to include a bimodal choice of transit. They illustrated that as income growth occurs and commuting cost varies, mode-switching may occur differentially across income groups. This switching can lead to location reversals and generate spatial equilibria that reflect all three phases above. In conclusion, historical data in Philadelphia from the era before 1970s confirmed the prediction of their model that the rich lived closer to CBD than the poor. For after 1970s, the prediction showed suburbanization of the rich as the advantage of a faster mode of commuting streetcar, and the introduction of the car also sped up the flight to suburbs of the rich.

Empirical results of LeRoy and Sonstelie (1983) and Gin and Sonstelie (1992) have supported only the first two phases; paradise, paradise lost, while Helms (2003) has extended to explain the re-gentrification in American cities. The result of this study suggested that re-gentrification, unlike earlier shifts in residential location patterns, is not a simple consequence of transportation innovation. Using a detailed parcel-level data set that documents all residential renovation activity in Chicago between 1995 and 2000, he concluded that the characteristics of a building and its neighborhood do indeed influence the likelihood that residential areas would be renovated.

Helms has concluded that transportation innovation could not solely explain re-gentrification of the rich, but also accessibility to CBD matter. Residential improvement was more attractive in the areas that are close to downtown and well-served by mass transit, however housing that was near the busy interstate highways was less likely to be renovated. The convenience of living near a highway was outweighed by the accompanying noise, pollution, and traffic congestion.

The vague factors determined re-gentrification of the rich in American cities has also been supported in the study by Kern (1981). Housing market showed evidence of rising in renewed upper-income demand for central residential locations after the last of the rich moved to suburbs in the automobile era and left the low-income residents living in the city center. Therefore Kern has extended the model of Alonso and Mill to explain why the rich move to the suburb by considering income elasticity for housing demand relative to income elasticity for marginal commuting cost. The evidence in New York showed that some specific characteristics which are childless household, unmarried adults and high education residents tended to relocate to the city center than the big families with children even though they are in the same income group. Because families with children need more space for their children, low density areas are more attractive to them while unrelated individuals (single or childless) and residents who have high education try to live close to city center for social connectivity.

The role of rapid rail transit on the relocation of the rich to central areas is less powerful in explanation relative to the influence of the automobile on pro-peripheral location. However Steen (1986) has presented that the introduction of a fixed-rail transit system into Philadelphia affected the distribution of population predicted by the non-ubiquitous transportation model. The key was that the basic assumption assumed identical transportation throughout the city should not be appropriate to explain the effects of this non-ubiquitous transportation.

Steen has explained that the coefficients for the transit variables were generally insignificant for two reasons. The reason was, firstly, within the existing economic borders of a given city, the effects of the introduction of a transit system increased density in areas near the transit line and decreased density elsewhere. Second, if the change in transportation system caused an expansion of the city beyond its former economic borders, the expansion would be only in the areas near the transit line. Therefore if a single density gradient was estimated over a circular city, most of these effects would average out and the effects of differences in transportation systems might not be large enough to be determined in either cross-section cities or time-series analysis.

Finally, Sanchez and Dawkins (2001) have applied a comparative static approach to support the hypothesized importance of transport life cycle and income in distinguishing suburb-to-city and city-to-suburb movers. The significant results supported the hypothesis that households were attracted to the city center from the suburbs for commuting reasons, however, the trade off between accessibility to employment and housing costs was not as straightforward as the monocentric model suggested. Although high-income households and those seeking to own their homes were attracted to the suburbs, a small but significant number of suburb-to-city movers cited the characteristics of the housing unit was the most important factor for choosing a central-city location.