

Chapter 2

Methods of Measuring Externalities

Urbanization is a complex process and has multiple dimensions. There is the presence of positive and negative externalities associated with every economic activity undertaken in our society; however, these externalities are frequently ignored because of difficulties of measurement.

Positive externalities of urbanization are discussed through the contribution of urbanization to economic development or a nexus between urbanization and development in various studies. Measuring positive externalities of urbanization may not be the problem; however, defining and measuring the negative externalities are not straightforward. The growth of unorganized squatter settlements with rapid urbanization often leads to negative externalities. These are magnified by an inadequate supply of public services and the behavioral pattern of the individual squatters. A handful literature is found to examine the characteristics which contribute to the incidence and intensity of these negative externalities. However, the coverage and depth of those studies are inadequate. In a society, it is not only difficult to measure the externalities, but also difficult to track the cause of those externalities (especially negative externalities).

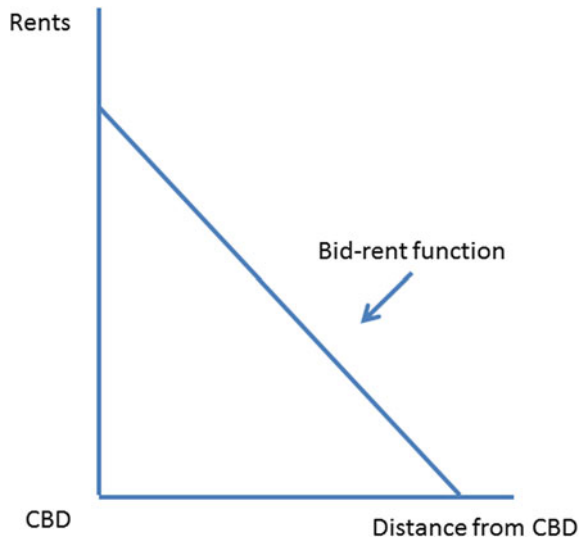
The extensive search of the literature suggested that externalities created by the individual/household/community, particularly negative externalities, have not been systematically measured. In economics, measurement of externalities is a challenging task and demands innovative research design. Measuring the value of externalities in economic activity is extremely complex, almost always controversial, and cannot be undertaken without the imposition of simplifying assumptions. Most of the studies particularly from developed countries used the tools of urban economic theory to discuss the urban externalities. Choice of residential location and neighborhood externalities are important components of the urban economic theory.

2.1 Theory of Urban Externalities

Residential location plays a role in shaping many other urban elements. Where people live plays a particularly important role with respect to economic development. The relationship between place of residence and place of work has become an important concept in urban development. The planning of urban development can provide equitable opportunities for people of different socioeconomic backgrounds or people of a different location. Selection of location is crucially important for the people. Economists use a bid rent concept to describe the relationships between land value, socioeconomic activities, and working place or commercial location. Rent may include the opportunity cost of access, construction cost and cost of location or travel cost. Rent is a function of distance from the center of economic activity. The “bid-rent” is the maximum rent that a potential user would be willing to pay for a site or location. The different land users all compete with one and other for more accessible land or central business district (CBD). More amount of money is willing to pay for the land close to the CBD and less for land further away from this area. The amount of money that they are willing to pay is called bid rent. Rents and transportation costs are decreasing function of access or distance from the CBD. In other words, travel costs increase with distance from the CBD, households prefer for more accessible locations. Therefore, the bid-rent function must be negatively sloped that is shown in Fig. 2.1. Rents are lower away from CBD because transportation costs residents there are high. The bid rent theory is popular in urban economics to show the relationship between the distance from the city center and house prices to analyze the urban externalities.

2.2 Bid-Rent Model

The behavioral model in this study has been developed based on the previous models proposed in a number of articles and books on bid rent function (Courant and Yinder 1977; Yellin 1974; Kanemoto 1980, 1996; Kern 1981; Fujita 1996). The literature suggested that conventional economic theory may not be readily applied in urban externalities. The model started with a basic theory of consumer behavior, for example, utility maximization subject to budget constraint; however, utility not only depends on consumption of housing services or location but also on other commodities. Many types of externalities such as traffic congestion, water and sanitation, pollution, noises, and neighborhood features among others are found in the urban areas. Externalities arise when the production or consumption behavior of an agent affects the activities of another agent. The consequences of these effects from two possibilities: more benefits or more costs. Negative externalities create additional cost; however, positive externalities produce additional benefits. On the other hand, externalities can be classified based on types of agents such as externalities among

Fig. 2.1 Bid rent function

firms, externalities among transportation, and externalities among households etc. This study primarily focuses on externalities among households.

As suggested by consumer behavior theory, the household maximizes its utility subject to a budget constraint. The household utility depends upon composite good (z) and consumption of land or housing services (h).

$$U = U(z, h) \quad (2.1)$$

Given the household income, prices of composite commodity, and residential location, the household spends the income so as to achieve highest possible utility. The composite good is chosen as the numeraire, so its price is one. The price of the composite good is independent of location. The household is located at distance r from CBD. $T(r)$ is the transportation cost at distance r . $R(r)$ is the price of housing services or unit land rent distance r from CBD. Therefore, the budget constraint can be written as

$$z + R(r)h = Y - T(r) \quad (2.2)$$

The household is in equilibrium when the household maximizes the total utility from its expenditure. Therefore, residential choice of the household can be written as

$$\max U(z, h), \text{ subject to } z + R(r)h = Y - T(r) \quad (2.3)$$

The Eq. (2.3) gives us the basic model of residential choice. The utility function satisfies the basic characteristics of indifference curves. It is assumed that the marginal transportation cost is always positive. The land is a normal good. It means

income effect on ordinary demand for land is positive. The indifference curve with utility level, u can be expressed as $u = U(z, h)$. Solving $u = U(z, h)$ for Z , the equation of indifference curve is $z = Z(u, h)$. It means the amount of composite good that is necessary to achieve utility level u when household services h . We use the concept of bid rent function to show the optimum decision of household on the choice of location. A bid rent function is a tool that describes the ability of household to pay for land when the utility is constant. The bid rent $[\Psi(r, u)]$ is the maximum rent per unit of land that the household can pay for residing at distance r while enjoying a given level of utility u . The bid rent function suggests that the slope of the indifference curve is equal to the slope of the budget line at distance r . As per definition, the household residing at distance r and selecting consumption bundle is (u, h) . The money available for rent is $Y - T(r) - z$. The rent per unit of land at r is $(Y - T(r) - z)/h$. Then the bid rent can be written as

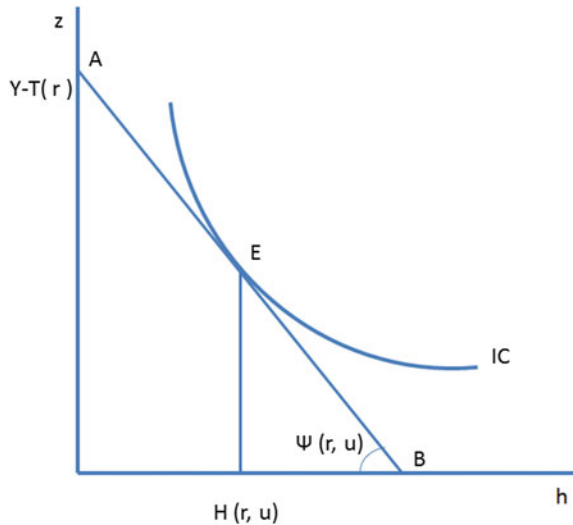
$$\Psi(r, u) = \max \left\{ \frac{Y - T(r) - z}{h} \mid U(z, h) = u \right\} \quad (2.4)$$

The bid rent is obtained when $(Y - T(r) - z)/h$ is maximized subject to utility constraint $(z, h) = u$. Again, as mentioned above, the equation of indifference curve $z = Z(u, h)$; when the utility constraint $U(z, h) = u$ for z . The bid rent function can be redefined in terms of unconstrained maximization problem as

$$\Psi(r, u) = \max \frac{Y - T(r) - z(h, u)}{h} \quad (2.5)$$

By solving the Eqs. (2.4), and (2.5), we obtain the optimal lot size $H(r, u)$ that is called bid max lot size. Graphically, bid rent function is shown as the slope of

Fig. 2.2 Bid rent function and bid max size



indifference curve (IC) which is equal to the slope of a budget line (AB) at distance r in Fig. 2.2.

The bid rent is maximum willingness to pay (WTP) by the household for a piece of land for a given level utility. In a competitive land market, households are assumed to compete for residential locations through the bidding process. Landowners would rent land to the highest bidders. This competitive process continues until an urban equilibrium occurs. In this case, no household has an incentive to change its location.

2.3 Externalities Among Households

Households generate externalities which affect other households. Externalities arise when activities of one group's residential affect the well-being of another group. Residential externalities result when the members of one residential area may feel that their well-being is adversely affected by the members of another residential area. In this study, the urban area is divided into two residential areas: squatter settlements and nonsquatter settlements. There are two types of residents: residents of squatter settlements (S) and residents of nonsquatter settlements (N). Within a given residential group, the utility function is the same for all households. Residents of nonsquatter settlements may receive negative externalities from the residents of squatter settlements. Residents of squatter settlements may or may not obtain the negative externalities. The neighborhood quality at location (r) will be $e^i(r)$ where $i = S, N$. The income of two types of households are fixed at Y^i . The lot size is exogenously determined. Given the distribution of residential group, the household's utility maximization problem is to maximize the utility function,

$$U^i\{z, h, e^i(r)\} \text{ subject to } Y^i = z + T(r)h + K(r) \quad (2.6)$$

The bid rent function will be,

$$R^i[Y^i - \{z + T(r)h + K(r)\}, u^i] \quad (2.7)$$

Three types of the specification of spatial externalities are primarily developed to explain the racial problem (Kanemoto 1996). These models can apply to capture the externalities of squatter settlement. The first one is the border model which assumes that the strength of externalities depends only on distance from the S - N border. All residents of squatter settlements are identical. Similarly, all residents of squatter nonsettlements are identical. The neighborhood quality function may be written as:

$$e^i(r) = e^i(r - b)$$

where b denotes border of squatter and nonsquatter settlements $r - b \geq 0$.

The utility function is $U^i\{z, h, e^i(r - b)\}$.

This model assumes that all households of squatter settlements have lower income than the households of nonsquatter settlements. The first model is criticized by Courant and Yinder (1977). The second model focuses on the composition of residents of squatter or nonsquatter settlements. The second model, the local externality model, assumes that the externalities at radius x depend only on the composition of SS and NSS at their radius. In this model, the quality function depends upon the percentage of the population at squatter settlements out of the total population at that location. The neighborhood quality function may be written as:

$$e^i(r) = e^i(N^j(x)/N(x)); \quad j \neq i$$

In the second model, residents of nonsquatter settlements will get (negative) externalities only from the residents of squatter settlements. It does not capture (negative) externalities faced by the residents of squatter settlements from their own neighborhood. The third that is called the global externality model combines the elements of both the border model and the local externality model. It assumes that the level of externalities received by a household at x is the weighted sum of residents of the other type with weights being a decreasing function of a radial distance between households. The neighborhood quality function may be written as:

$$e^i(r) = \int_0^{\infty} e^i(r - b)N^j(x); \quad j \neq i$$

In practice, a global model may be difficult to operationalize the influence of residents of squatter settlements on the bid. Therefore, the specifications of the border model and the local externality model only are more popular for the empirical estimation. Spatial equilibrium based on these models emerges only with passive discrimination (Kanemoto 1996).

As mentioned above, bid rent is the hypothetical price that the households pay for a piece of land for a given level of utility. Residential bid rent function indicates how many residents are willing to pay for the land at different locations in the city. Monocentric models predict that households choose their residential location as a trade-off between access cost and land costs. Above model is based on residential locations in a monocentric model where all urban jobs and business activities take place at the CBD. However, in reality, some firms maximize their profits by locating their activities and jobs outside the CBD. Some of the households engage in home production and self-employment. Various attributes of the residential location determine accessibility of jobs. Residential locations differ with the various public facilities such as electricity, water and sanitation, quality of the road, among others. Housing is a heterogeneous and indivisible commodity in both SS and NSS. Housing has several characteristics such as structure, quality, lot size, land size, and durability among others. Housing is a durable commodity for NSS, but it may or may not be durable commodity for SS because houses may not be built on legally

permitted area. The houses within SS, due to nondurability characteristic have same prices. Indifference prices indicate the residential equilibrium. The externalities within SS and NSS due to activities in SS are different. Externality situations depend on the type of action taken. Positive externalities provide gains for society while negative externalities produce losses. There may be various types of negative externalities as mentioned in the previous chapter due to an inadequacy of public facilities, lack of water and sanitation, and behavior of the households or individual.

WTP to remove these externalities is the price of negative externalities. WTP indicates the incidence and intensity of externalities. Net economic benefits of reducing the negative externalities, in simple terms, are estimated as the difference between the consumers' maximum WTP for better situation or reduction of negative externalities and the actual cost paid due to negative externalities. In addition to this, the technique in this study is carefully designed to measure (negative) externalities of various activities and several actors. The innovative idea is to measure the incidence and intensity of externalities of various components of individual, household, and community activities and to estimate their costs to the society. The incidence of externalities indicates the coverage of negative externalities; however, intensity specifies the degree of negative externalities.

The WTP concept generally refers to the economic value of externalities to a person (or a household) under given conditions. Net economic benefits of reducing the negative externalities, in simple terms, are estimated as the difference between the consumers' maximum WTP for better situation or reduction of negative externalities and the actual cost paid due to negative externalities. The negative and positive externalities are actually a mirror reflection of each other because if the negative externality is corrected or reduced, there will be positive externalities among the households. Strong dominance of negative externalities invites the effective public interventions.

Usually, the WTP of the squatter settlements to avoid the negative externalities produced by them is higher than the WTP of the nonsquatter settlements; however, if the opposite is found there is a negative impact on urbanization since such a response would imply that the costs of urbanization (squatter settlements) would be greater than their benefits. This is supported by further analysis of underlying factors determining the squatters' choices and responsibilities of squatters for a better life. This approach used for the study is the standard practice for analysis in health economics.

When there are externalities, there is a potential for a policy intervention. An externality includes two aspects: (a) the impact of an action on others and (b) that those others are not compensated for or do not pay for this impact. Negative externalities occur when the action imposes costs on others, such as increasing incidence diseases, violent and destructive activities. Positive externalities occur when the action provides benefits for others, such as reduced air pollution, improved space and greenery of the cities. Negative externalities impose direct costs on society. Solutions to a negative externality focus on ways to force the producer to internalize the costs it imposes on others, through decreasing the

activity or forcing the producer to pay for it inflicting burdens on the producer. Negative externalities, therefore, are generally public issues.

Contingent valuation (CV) is a method developed to provide the monetary valuation of these externalities. As many low-income countries have less-developed market structures and prices for goods and services, the use of a technique such as CV in these countries may lead to less-robust estimates of the benefit than other methods. On the other hand, however, CV may be a more acceptable technique to provide the monetary valuation of the externality. CV studies in developing countries are increasingly being used to value health and environment-related goods and services since more than three decades, for example, Gertler and Glewwe (1992), Altaf et al. (1992), Foreit and Foreit (2003), Shrestha et al. (2004), Bhatia (2005), McNamee et al. (2010) few of them. WTP reflects the price that someone who does not have a good would be willing to pay to buy it.

Different CV elicitation methods are found in the literature, for example, open-ended WTP method, closed-ended iterative bidding method, contingent ranking method (Ordinal ranking), and dichotomous choice method ("Take it or leave it" choices). Each method has its strength and weakness. The bidding game (BG) method of CV is one way to increase the precision of WTP estimates relative to other methods such as the single dichotomous choice approach (Bhatia 2005; McNamee et al. 2010). BG provides "thinking time" to elicit maximum WTP as desired.

The prices of many goods and services in Kathmandu, similar to other cities of developing countries, are not fixed. This suggests that the iterative BG method of obtaining WTP estimates may be better than noniterative methods. The feasibility and validity of the method are partly determined by the extent to which respondents are familiar with paying for good or services. Most of the studies, therefore, are based on iterative BG methods.

In a bidding format, respondents are exposed to a starting bid and further bidding depending upon their response (yes/no). BG begins with an interviewer postulating an initial bid to a respondent. Further bidding depends upon their response "Yes" or "No". If the respondent is willing to pay the initial bid, the interviewer revises the bid upward until a negative response is obtained. A negative response to the initial bid results in the interviewer revising the bid downward until an acceptable amount is found. The final bid is a measure of the respondents Hicksian compensating or equivalent surplus for the item being valued (Boyle et al. 1985). BG is sensitive to the starting value, which is one of the major weaknesses of the method. The starting point bias arises when the initial starting bid influences the respondent's final valuation. Initiating the bidding process should not affect the respondent's final bids (Boyle et al. 1985) while conducting a study on WTP.

The empirical evidence produced conflicting results on the starting point bias. Some of the studies, for example, Ternent et al. (2010), Bhatia (2005), Frew et al. (2004), Phillips et al. (1997), Stalhammer (1996), found starting point bias; however, other studies for example, O'Brien and Viramontes (1994), O'Brien et al. (1998), Onwujekwe and Nwagbo (2002) did not find starting point bias. However, the possibility of a starting point bias has been a concern of researchers.

A possible solution to the starting point bias has been mentioned in Boyle et al. (1985). Respondents are allowed to state their initial bid without prompting any amount. This type of modified game can reduce the starting point bias (Ternent et al. 2010). A few studies suggest developing closed-ended questions because closed-ended BG questions may have a very small starting point bias (Gunatilake et al. 2007). A positive relationship between final bids and starting values was found; therefore, some of the studies encouraged the use of a range of starting values within a single survey (Samples 1985; Ternent et al. 2010). Some of the studies based on their findings suggested that such biases may not be a major problem for applications of the CV method (Onwujekwe and Nwagbo 2002; Brookshire et al. 1981).

The WTP responses are determined by the variety of considerations, particularly, the respondents construct their values at the time they are asked, rather than reporting a more well-defined value (Schkade and Payne 1994). Alternative techniques such as verbal-protocol analysis (a psychological technique in which respondents are given time to think during their responses to surveys) might well be explored (Smith 2000). A systematic review of qualitative evidence on WTP suggested that the use of qualitative techniques improves the validity and reliability in WTP studies. It is clear that WTP questions must be properly piloted; the contingent market adequately set up by the researcher and understood by the respondent. The proper study design will necessarily be able to overcome problems including starting point bias inherent in WTP studies (Baker et al. 2008).

Economics of Urban Externalities

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