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Return on Investments for Community Infrastructure Projects? A Foundation for Rural Development Strategy

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Abstract

With decreasing populations and declining resources, rural governments are finding it challenging determining how to make investments in their infrastructure. This paper defines the problem confronting rural governments and develops a process for making infrastructure decisions to maximize community welfare.

Key Words: Infrastructure, Public Goods, Rural Development, Social Welfare Economics

Introduction

Economies are built on people and declining populations create significant challenges for small towns and rural communities. These challenges include viable workforce, leadership depth, tax base and maintenance of infrastructure. These challenges are exacerbated when the communities are remote and distant from large population centers and have few physical amenities (Deller et al., 2001; McGranahan and Beale, 2002). Policy makers have been working hard to ameliorate some of these challenges through various policy initiatives. For example, the U.S. Department of Agriculture, which is the lead federal government agency charged with rural development, as designated by the Rural Development Policy Act of 1980, invested more than $25 billion in 2005/2006 for rural housing, infrastructure, community facilities and business development. Other agencies with rural development responsibilities include the Small Business Administration, the Environmental Protection Agency, and the Departments of Housing and Urban Development, Labor, Commerce, Health and Human Services, and Homeland Security. Each of these departments and agencies has significant expenditures on rural development initiatives aimed at addressing specific economic

and/or social challenges confronting rural communities. In addition to these federal agencies and departments, state and local governments also dedicate resources towards rural development. These expenditures go to education, recreation, safety and emergency services, housing, etc. The underlying assumption for these government expenditures on these services and infrastructures is that the well-being of rural citizens matters. However, recent studies on the effectiveness of these investments are not complementary. For example, Porter et al. (2001, p.3), assessing the economic performance of rural communities in comparison to urban communities, observe that:

> Current policies to improve the disappointing economic performance of rural regions are, by and large, not working. This is increasingly the consensus among policy makers across political parties, not only in the United States but also in many other countries around the globe. Not only is the performance of rural regions lagging, but the gap in performance levels between rural and urban areas seems to be widening. This state of affairs exists despite significant efforts to boost rural regions through a wide variety of policies with budgets of billions of dollars in the United States alone.

They go on to note, in their conclusion, that:

> Overall, many participants in the research debate lament the disconnect between what is advocated in the literature and current U.S. rural economic development policy. Policy does not seem to drive rural development, but responds to special interests. The many sensible ideas proposed by experts are not acted upon. . . . Without a strong conceptual foundation, it is not surprising that economic development efforts for rural regions have been particularly vulnerable to political pork battles between small but well organized interest groups, frequent institutional redesigns without lasting effect, and the re-invention of old policies under new names. (p. 61)

While this conclusion may be harsh, it is, we believe, made with a genuine desire to enhance the competitiveness of small towns and rural communities. This implies that policies targeting economic development solutions must focus on strategies that create effective outcomes for the communities and improve citizen well being. It challenges policy makers and researchers with interest in rural and small town economies to develop tools and strategies that enhance the effectiveness of investments made to achieve

economic development outcomes. It creates an opportunity for researchers to develop decision tools to help community leaders and government officials responsible for executing rural economic development policies make better decisions.

In the light of the foregoing, the overall objective of this paper is to develop the economic foundations of a decision tool for infrastructure investments in small towns and rural communities. While we believe the tool is applicable in all communities regardless of size and location, we have structured the conversation with small towns and rural communities in mind because of the population pressure that creates complex economic and social challenges for these communities. We are also cognizant of the opportunities that the changing demographics present to these communities and therefore offer this tool with a forward looking perspective.

In achieving the objective, we draw on the economics of decision-making and capital investment models. We review the literature on public finance with particular focus on the estimation of value in relation to public goods. We argue that the challenge confronting the academy is to provide some simple, clear and compelling methods for conducting subjective evaluation of public goods to come up with objective estimates in public decision making. We acknowledge that these challenges are daunting but with dedication and marshalling of the right resources, it can be solved, creating significant opportunities for small towns and rural communities to enhance their competitiveness in the evolving global economy.

Infrastructure in Small Towns and Rural Communities

Modern communities need some basic infrastructures to sustain quality of life. These include good roads, bridges, water and sewage, electricity, telephone and information technology services, schools, emergency services and recreation facilities. In making location decisions, many people are influenced by the availability and state of these infrastructures. Thus, there is a strong correlation between the existence of quality infrastructure and the economic and social vibrancy of a community (Dissart and Deller, 2000; Halstead and Deller, 1997; Gottlieb, 1994). The responsibility of providing these infrastructures usually fall on governments because they are consumed by the public and presented as public goods. We may define public goods as goods consumed simultaneously by a particular populace (Boadway and Wildasin, 1984). Public goods may be described as pure public goods or mixed public goods. Pure public goods fail the rivalry theorem of competitive market economy which states that the use of a good or factor by any one economic agent precludes its use entirely by any other economic agent. Thus, the use of a pure public good by an economic agent has no effect on its availability for use by other economic agents. Examples of pure public goods may include emergency weather warning systems, radio and television signals and knowledge. A large number of public goods fall under the mixed category. This category captures goods that are neither purely rival nor purely public. They are subject to "congestion costs as the number of users increases" (Boadway and Bruce, 1984, p. 120). Mixed public goods include such goods as parks and recreation facilities, roads and bridges, public transportation, schools and information technology facilities. For these mixed public goods, at some point the addition of another consumer reduces the utility of other consumers by altering the "quality" of the good rather than its quantity. For example, at

some point, class sizes become too large for effective teacher-student interaction even though the "quantity" of education students are receiving may not change.

The provision of public goods by governments, pure or mixed, is geared towards advancing the quality of life in the community and increasing its attractiveness to others, including businesses. However, quality of life tends to be subjective, multidimensional and dynamic, making it difficult to measure and track if it is defined as an objective for investments in infrastructure (Wish, 1986). As observed by Liu (1975, p. 3):

> Most people approach "quality of life" with varying preconceived definitions, but it may be considered here as an output of two aggregate input factors: physical and spiritual. The physical input consists of quantifiable goods, services, material wealth, etc., while the spiritual input includes all psychological, sociological and anthropological factors such as community belongingness, esteem, self-actualization, love, affection, etc.

The subjective, multidimensional and dynamic characteristics of quality of life concept make it a difficult objective function to define, measure and track. Liu (1976) used a sample of 243 Standard Metropolitan Statistical Areas (SMSAs) in 1970 U.S. while Boyer and Savageau (1981) added another 34 urban areas classified as SMSAs by 1980 to estimate the quality of life in these communities. Liu defined quality of life to consist of five components: (1) economic; (2) political; (3) environmental; (4) social, and (5) health and educational. On the other hand, Boyer and Savageau (1981) itemized nine components: According to B&S , however, the quality of life has nine components: (1) climate; (2) housing; (3) health; (4) crime; (5) transportation; (6) recreation; (7) art; (8) economics, and (9) education. Wish (1986) argues that despite the differences in the two studies, it is expected that there would some relationships between their quality of life rankings of the SMSAs. However, her estimation of the Spearman correlation of the rankings of the two studies yielded a paltry 0.08, suggesting that the indicators or their components are poorly defined or the statistical methods used in the studies were

inadequate. She goes on to suggest that recognizing the salience of the indicators or variables can contribute to solving the problem. This involves weighting the various quality of life components because individuals exhibit a hierarchy of needs (Maslow, 1940). For example, Campbell (1976, p. 218) observes that "The social setting, including interpersonal relations and the type of housing . . . are salient factors influencing an individual's level of satisfaction with the community." Similarly, Milbrath (1979, p. 35) states that "Subjective studies of quality of life have typically shown that most people derive their greatest sense of quality from their home and family life and from the close supportive relationships they have with friends and colleagues." This may explain the apparent paradox observed among residents of larger urban areas who tend to express greater dissatisfaction with their quality of life despite having more amenities and resources (Wish, 1983).

Yet, community leaders are constantly confronted with the challenge of deciding how to allocate community resources among alternative services and infrastructures to achieve the highest quality of life in their communities. To date, our observation is that community leaders have made infrastructure investment decisions based on naïve rules, and in doing this, they do not know if they are maximizing the benefits of the investment to their communities.

Let us define the quality of life in a community, $\boldsymbol{Q}$, as dependent on the physical infrastructures, $\boldsymbol{I}$, available in the community and the psychological, social and cultural ramifications of those infrastructures on citizens, $\boldsymbol{S}$ (Equation 1):

$$Q = Q(I) + S(I) \qquad \ldots (1)$$

The transformation of these infrastructures into quality of life indicators occurs through a subjective *quality of life transformation* coefficient set defined by the matrix ***B*** while the psychological, social and cultural ramifications of quality of life occur through a *quality of life transformation coefficient* matrix ***C***. Thus, we may restate Equation 1 as follows:

$$Q = BI + CI \qquad \ldots (2)$$

For example, for school infrastructure, families with young children will be interested in such factors as availability of proximate housing to schools, class sizes, teacher experience and qualification, etc. Similarly, for roads, commuters may be interested in effectiveness of connections to major road networks, surfacing, winter maintenance, etc. For the C matrix, school infrastructure may elicit parameters such as collaboration between teachers and parents, after school activities and extracurricular enrichment while road infrastructure may elicit car pooling opportunities, for example. These subjective measures go into the quality of life transformation matrices and emerge from questions that prospective citizens ask incumbents as well as the perceptions they form from their observations of incumbents.

The challenge facing community investment decision makers is the translation of these subjective technological transformation parameters into aggregate community parameters. This may be accomplished through conducting community surveys to determine the subjective rankings of citizens for specific infrastructures within the community and developing an aggregation process to come up with community ***B*** and ***C*** matrices. In soliciting citizen's rankings of these infrastructures, it is critical that the

dynamic nature of perspectives is recognized. For example, people may not think about parks and swimming pools in the winter or snow removal in the summer even though these may have significant implications for their sense of well-being.

To simplify the analysis, let us assume a two infrastructure environment, I_1 and I_2 in a community with installation cost of $\boldsymbol{\omega_1}$ and $\boldsymbol{\omega_2}$ respectively and $\boldsymbol{\rho_1}$ and $\boldsymbol{\rho_2}$ are the imputed net cash flow from the infrastructure once developed. We also assume that each infrastructure $\boldsymbol{i}$ has two component characteristics $\boldsymbol{j}$ of interest to citizens, discovered through the transformation coefficients for both the physical and psycho-socio-cultural dimensions of the infrastructure for the households in the community, defined as $\boldsymbol{b_{ij}}$ and $\boldsymbol{c_{ij}}$. Thus, $\boldsymbol{i, j = 1, 2}$ and $\boldsymbol{i \neq j}$. For now, we assumed that these transformation coefficients are fixed over time, even though we know peoples valuation of benefits change with changes in their state and situations. From the foregoing, we can define the investment decision-makers' objective function as follows:

$$\begin{aligned} &\max Q = b_{11}I_1 + b_{12}I_1 + b_{21}I_2 + b_{22}I_2 \\ &\textit{subject to}: \\ &\quad M \geq \omega_1 I_1 + \omega_2 I_2 \\ &\quad P \geq \sum_{t=0}^{T} (\rho_1 I_1 + \rho_2 I_2)/(1+r)^t \\ &\quad I, r > 0 \end{aligned} \qquad \ldots\ 3$$

where $\boldsymbol{t}$ is time and $\boldsymbol{r}$ is the discount rate. Substituting the constraints into the objective function and maximizing with respect to $\boldsymbol{I_i}$ provides the solution to the optimal levels of $\boldsymbol{I}$ to invest in to maximize $\boldsymbol{Q}$. The foregoing process allows the decision maker to solicit the preferences of community members to help develop a prioritization process to achieve solutions that offer the highest perceived quality of life. The imputed value equation forces the decision-maker to solicit information about how much citizens are

willing to pay for the infrastructure if they were going to use it on a pay-as-you-go basis. It provides a constraint to the transformation coefficients.

Operationalizing the Model

The process of identifying and ranking infrastructures to invest in has been defined as drawing on the value citizens in the community place on the different infrastructures. We have already indicated the challenges this process invokes. For example, citizens need to be capable of knowing how to identify and measure the value they place on the different dimensions of each infrastructure. Do they recognize value in class sizes and parent-teacher contact time and how much do they value it? Some of the tools available for getting to this include hedonic pricing approach (Kanemoto, 1988; Kask and Maani, 1992). The theoretical foundation of hedonic pricing has been discussed extensively in the literature (Rosen, 1974; Freeman; 1974; Polinsky and Shavell, 1976; Polinsky and Rubinfeld, 1978). A major assumption in the literature is the hedonic pricing requires a homogenous group of consumers otherwise significant challenges emerge. Thus, in using hedonic pricing to assess the value of infrastructure and its components to citizens, we have to assume that within a particular community, the citizens are homogenous.

However, Scotchmer (1985, 1986) show that the hedonic approach, even with the assumption of homogeneity, does not provide the correct benefit estimates if the characteristic is endogenous to the consumer. Since the perspective of consumers for infrastructure is dependent on the attributes of the household, it is difficult to decouple their estimates from themselves. We need to develop tools for overcoming these

challenges to improve the efficiency of using the hedonic approach in estimating consumer valuation of infrastructure.

We may use contingent valuation method to attempt to achieve the same results. The method involves the use of sample surveys (questionnaires) to elicit the willingness of respondents to pay for (generally) hypothetical projects or programs. It was first used in the estimation of the value in preventing soil erosion by Ciriacy-Wantrup (1947). It took almost two decades before it was applied by Davis (1963) in estimating the value to hunters and wilderness lovers of a particular recreational area. Although there is no standard approach to the design of contingent valuation surveys, virtually every application of the method consists of several well-defined elements. These include scenario description, mechanism for eliciting value, approaches for developing preference structures and solicitation of socio-economic characteristics of respondents (Portney, 1994).

Researchers with interest in improving decision making in the public investment arena must work directly with local government officials to develop and finesse these tools to enhance decision-making. By combining the tools and drawing on the strengths of the different tools while minimizing their weaknesses, we believe we can come up with decision tools that are a hybrid that actually creates significant value.

Conclusion

The objective of this paper was to discuss and develop the economic foundations of a decision tool for infrastructure investments in small towns and rural communities. The tool would be used by government and local leaders as the foundation to their rural

development strategies. Challenges do rise in providing a simple, clear and compelling method for conducting the subjective evaluation of public goods, which in the end would assist in determining return on infrastructure investments. The most important focus for community leaders is to allocate resources among services and infrastructure to maximize quality of life in their communities.

Pass research does indeed indicate a correlation between the quality of community infrastructure and economic and social success of a community. Because quality of life characteristics are subjective, multidimensional and dynamic, economic tools, such as subjective rankings, hedonic pricing and contingent valuation survey's to address willingness to pay factors are the best ways to transform quality of life into value. By combining each of the highlighted tools and drawing on the strengths of the different tools while minimizing their weaknesses, a tool to determine return on investments on community infrastructure can be realized. The tool will help government and communities leaders to adopt foundational strategies that will work in their individual rural communities.

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