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## INFRASTRUCTURE AND LOCAL ECONOMIC DEVELOPMENT

*Janet M. Rives and Michael T. Heaney\**

This study examines the relationship between infrastructure and the level of community economic development. Research using state and national level data has found that infrastructure is a significant, positive determinant of economic performance. This research seeks to establish whether there is a similar link at the community level using cross-sectional data for one state. Examining this relationship at the community level is important because, as Fox and Smith (1990) note, infrastructure investment decisions often are made locally, regardless of the source of funding. Immergluck (1993, 311) observes, however, that the recent economics literature does not provide a sufficient basis for establishing "strategic infrastructure-related economic development policy" at state and local levels. The paucity of local studies is underscored by their absence in recent reviews of infrastructure research by Gramlich (1994) and Gillen (1994).

The goal of this research is to develop a model that explains variations in the level of community economic development using selected variables relating to infrastructure and other community characteristics. After clarifying the meanings of economic development (as used in this study) and infrastructure, the nature of the relationship between them is examined. Empirical issues regarding the measurement of variables are explored, and regression analysis is applied to test the hypothesized relationship.

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\* Janet M. Rives is professor of economics at the University of Northern Iowa, Cedar Falls, Iowa. Michael T. Heaney is a Ph.D. student and associate instructor in the department of political science at Indiana University, Bloomington, Indiana.

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## Economic Development, Infrastructure, and the Links Between Them

### *What is Economic Development?*

Because economic development is an amorphous and vaguely defined concept, the effectiveness of local economic development efforts cannot be directly measured. Consequently, researchers have employed a myriad of different approaches to obtain a proxy for economic development. Blakely (1989, p. 58) defines local economic development as "a process by which local government and/or community-based groups manage their existing resources and enter into new partnership arrangements with the private sector, or with each other, to create new jobs and stimulate economic activity ..." Though *economic activity* is not precisely defined, the number of new jobs is a quantifiable measure of economic development and one that has been used to assess the effectiveness of local development programs.

The Council of State Planners stresses a broader view of development, defining it as "the process of creating wealth ... Development is more than the creation of jobs ..." (Eisenger 1988, p. 39) Another view, suggested by the National League of Cities (1982), includes a city's tax base along with jobs and income as indicators of development. Fox and Smith (1990, p. 53) recognize that there are multiple measures of economic development, including per capita personal income, employment, and value added. The process of economic development may be even more complex, involving changes in income distribution, the wage and skill levels of new jobs, and factor use in growing industries.<sup>1</sup>

The model presented in this paper follows a multidimensional view of economic development by incorporating several variables into a single index measure. Limitations on data available for communities mean that the index measures the level of development across communities rather than the dynamic development process. This issue is addressed in more detail later in the paper.

### *What is Infrastructure?*

While the issue of providing infrastructure has been important in the United States since the construction of the Pennsylvania and Lancaster turnpikes in 1792, the term *infrastructure* was not used until the construction of the federal highway system in the 1950s (Cain 1994). Gillen (1994) and Cain (1994) point out that although a consensus is lacking, most empirical studies concentrate on highways, water systems, sewer systems, and public buildings as the major components of infrastructure.

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<sup>1</sup> We wish to thank an anonymous referee for noting this more complex view of the economic development process.

This study examines the effects of two kinds of infrastructure: point infrastructure and network infrastructure.<sup>2</sup> *Point infrastructure* consists of the underlying core amenities within a particular community that support the basic processes of the social-economic system within that community. Water systems, local roads, and public buildings meet this definition. One community may share in the point infrastructure of another community. *Network infrastructure* consists of systems designed to facilitate linkages between economic units across space, such as highways, railroads, and canals. Network infrastructure may or may not be located within a particular community; it is distance from or access to the network that is the relevant factor.

#### *Local Links Between Economic Development and Infrastructure*

The relationship between infrastructure and economic development has been well-established at the national and international levels. Aschauer (1989a, 1989b, 1991) presents empirical evidence to demonstrate that declining productivity growth in the United States and other nations can be explained by a shortfall in infrastructure investment. The academic community has responded to Aschauer's work with a plethora of studies that, although differing in their parametric estimates, generally support the conclusion that public capital is an important input in the production function of private firms. These studies include Munnell (1990), Fox and Smith (1990), Eberts (1990), Hulten and Schwab (1991), Lynde (1992), and Carlino (1993).

Little research has been undertaken to establish links between infrastructure and private economic activity at the local level and for rural areas. Smith (1992), one of few to pursue this issue, uses data for rural counties in seven midwestern states to estimate growth in employment and growth in real personal income. Among Smith's independent variables are physical infrastructure (interstate highway miles) and several social overhead capital measures (hospital and nursing home beds, colleges, and educational expenditures). Smith finds mixed results concerning the effects of these factors on the two measures of economic development.

Two other studies use local infrastructure data for metropolitan areas. Eberts and Fogarty (1987) examine private and public capital stocks for 52 SMSAs from 1958 to 1978 to determine whether the formation of public investment precedes the formation of private investment. They find this pattern in about one-half of the cities examined and suggest that infrastructure plays a larger role in regional growth than

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<sup>2</sup> This distinction was suggested by Andrew F. Haughwout in discussion at a conference sponsored by the Institute for Government and Public Affairs, University of Illinois, on The Role of Infrastructure in Economic Development, Chicago, Illinois, September 27, 1994.

had been recognized previously. Deno (1988) analyzes the impact of public capital on manufacturing activity using metropolitan data for 36 SMSAs from 1970 to 1978. He finds that all types of public capital had a positive effect on the supply of manufacturing output and that public capital could be used to promote employment growth in manufacturing as well as to expand the private capital stock.

As Fox and Smith (1990) note, the impact of infrastructure on metropolitan areas cannot be extended automatically to smaller cities but must be tested empirically. Also, results of national level studies cannot be generalized to specific states or regions, because national level infrastructure spending data in relation to economic development may mask the effects of infrastructure in certain areas. We agree with their conclusion that studies should focus on specific localities in order to shed light on infrastructure-development relationships at the local level.

## **Measuring Economic Development and Infrastructure**

### *Economic Development*

Because it is impossible to observe the economic development of a community directly, variables that reflect development indirectly must be examined. Four alternative indicators of the level of economic development suggested in previous studies are used here: median household income (INCOME), percent of the labor force employed (EMPLOY), population change (POPCHG), and assessed valuation per capita (VALUE). Table 1 reports the means and standard deviations for these variables and other measures used in this study of 178 Iowa communities with populations between 1,000 and 35,000. Data for INCOME and EMPLOY are obtained from the *1990 Census* (1992), and data for POPCHG come from the Iowa State Data Center (1994).

The fourth measure, VALUE, attempts to measure community wealth, an attribute identified in several previous studies. Information on assessed property value, infrastructure, and other community characteristics are obtained from *Community Quick Reference* (CQR) reports published by the Iowa Department of Economic Development. Because CQR reports are not available for each community for every year, the latest CQR report available (from 1990 to 1992) was used for each community.

Each of these measures reveals something unique about economic development. VALUE is, perhaps, the most inclusive measure. Property values are a proxy for the overall health of the local economy. If ample employment opportunities and expansion of industry are present in a community, then property owners will bid up the price of land in order to take advantage of these opportunities. Conversely, if these opportunities are not present, then lesser demand in the market will drive the price down.

**Table 1—Descriptive Statistics and Variable Definitions**

Variable Name	Mean	Standard Deviation	Definition
INCOME	24,442	4,924	1990 median household income (\$)
EMPLOY	95.6	1.90	Percent of labor force employed
POPCHG	0.825	3.807	1990-92 percent population change
VALUE	16.937	5.880	Assessed value per capita (\$1000s)
DEVELOP	0.000	1.000	Index measure from factor analysis (using INCOME, EMPLOY, POPCHG, VALUE)
SEWER	1246	3891	Average sewer capacity (millions of gallons per day)
WATER	3352	10694	Total water plant capacity (millions of gallons per day)
USHWY	1.258	1.485	Number of U.S. highways in town
IAHWY	1.573	1.759	Number of Iowa highways in town
INFRAS	0.000	1.000	Index measure from factor analysis (using SEWER, WATER, USHWY, IAHWY)
DSINT	24.94	20.13	Miles to interstate highway
DSCITY	101.47	52.17	Miles to nearest regional center
TOTAX	30.88	4.83	Total tax rate (\$ per \$1000 assessed value)
MANEMP	0.19	0.08	Proportion employed in manufacturing
POP	5036	6334	1990 population
COLLEGE	0.143	0.060	Proportion of population 25 years and older with at least a bachelor's degree
HSGRAD	0.769	0.066	Proportion of population 25 years and older with at least a high school diploma
EDUCATE	0.000	1.000	Index measure from factor analysis (using COLLEGE, HSGRAD)

POPCHG measures a similar phenomenon, but in a dynamic sense, by looking at population change over a short (two year) period. This variable essentially captures a community's growth at a point in time. If population increase is positive, then it is reasonable to assume that the community is creating new jobs and other economic opportunities for its residents. If population change is zero or negative, then it seems likely that there are insufficient economic opportunities for the local population or that the community is not expanding its capacity to house those who may seek new opportunities.

Information about the distribution of benefits in the local economy is provided by EMPLOY. For example, a community may be growing quickly and providing opportunities for highly-educated residents; however, less-educated residents may not benefit from the economic success of others. Thus, the percent of the labor force employed gives some indication of what percent of the population is benefiting from economic success or hurting from economic failure.

Finally, INCOME provides a measure of the relative well-being of the average family in one community as opposed to another. Waller (1991, p. 202) cautions against the use of income as a measure of development because income does not account for spatial differences in the cost of living. INCOME ideally would be adjusted to account for such differences, but the unavailability of these data for nonmetropolitan areas in Iowa makes this impossible. As Heaney and Abraham (1994) have argued, however, the relatively low variance of cost of living within a state makes it meaningful to discuss a single cost of living for the entire state. In other words, a given income level will be able to purchase a relatively equal basket of goods and services anywhere in the state of Iowa.

The construction of an index measure of development is desirable, as each measure of development has its strengths and weaknesses. Rather than attempt to select one measure and accept its limitations, we have chosen to analyze the commonality among the four measures. This approach may provide more insight into the level of economic development in the community. The community's level of economic well-being is captured by measures of income and assessed value; its level of economic performance at a point in time is identified by employment and short-term population growth. Because our composite measure omits factors that would be included in a more comprehensive and dynamic measure of the economic development process, we stress the point that it is a community's *level* of economic development that is being measured.

Factor analysis is used to construct an index of economic development. It is hypothesized that INCOME, EMPLOY, POPCHG, and VALUE are components of a single factor, economic development (DEVELOP). Factor analysis is conducted using extraction by the prin-

ciple components procedure, with the criterion to extract each factor with an eigenvalue greater than or equal to one. This criterion is consistent with Kim and Mueller (1983).

The results of the initial factor analysis confirm the hypothesis that only a single factor (DEVELOP) can be extracted from INCOME, EMPLOY, POPCHG, and VALUE. DEVELOP accounts for 64.5 percent of the covariance among INCOME, EMPLOY, POPCHG, and VALUE and is estimated as the following index of standardized variables:

$$(1) \text{ DEVELOP} = .897 \text{ INCOME} + .528 \text{ EMPLOY} + .798 \text{ POPCHG} \\ + .587 \text{ VALUE.}$$

### *Community Infrastructure*

Studies conducted at the state, national, and international levels have used dollar expenditures as a measure of the level of infrastructure. Such data are not broadly available at the local level, particularly for rural areas; thus, this study uses stock and proximity measures of infrastructure.<sup>3</sup> Two categories of infrastructure are considered: physical infrastructure and location with respect to both network and point infrastructure.

A measure of physical infrastructure is developed using factor analysis. The variable INFRAS is computed with four measures of physical infrastructure: average sewer capacity (SEWER) and water plant capacity (WATER), both measured in thousands of gallons per day, and the numbers of U.S. highways (USHWY) and Iowa highways (IAHWY) passing through the community. Data to compute INFRAS are obtained from CQR reports.<sup>4</sup> The results of the factor analysis confirm that only one factor (INFRAS) can be extracted from the variables defined above. The following index of standardized variables explains 61.3 percent of the variance among the variables defined above:

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<sup>3</sup> Using information on public fiscal expenditures is the approach taken in a number of studies on infrastructure conducted on larger geographic areas. But in the case of small communities, this approach is problematic. Fiscal resources are applied by various levels of government (federal, state, local), and it is difficult to determine the actual amount of dollars devoted to infrastructure for a specific community. Moreover, the expenditures approach does not work well when network infrastructure (such as highways) is considered.

<sup>4</sup> We thank an anonymous referee for pointing out that information on the provision of energy (natural gas, electricity) to communities also is relevant to a measure of infrastructure. Though we examine privately owned as well as publicly owned infrastructure items, data on energy consumption by community are not available.



$$(2) \text{ INFRAS} = .756 \text{ SEWER} + .774 \text{ WATER} + .764 \text{ USHWY} + .834 \text{ IAHWY}.$$

Two variables that capture dimensions of location are included in the analysis. Distance to an interstate (DSINT) measures access of a community to network infrastructure. Shortest distance to the nearest regional center (DSCITY) measures the degree to which a community shares in the infrastructure of larger areas. This variable also reflects non-infrastructure dimensions of development, as proximity to a major metropolitan area provides firms access to large markets and individuals access to good jobs. Cities used in the calculation of DSCITY are Des Moines, Omaha, Kansas City, Minneapolis, Chicago, and St. Louis. Data for DSINT and DSCITY are provided in CQR reports.<sup>5</sup>

## The Regression Model and Results

### *The Model*

Ordinary least squares (OLS) regression is applied to explain variations in economic development across communities using DEVELOP as the dependent variable. The hypothesized equation takes the following form:

$$(3) \text{ DEVELOP} = \alpha + \beta_1 \text{ INFRAS} + \beta_2 \ln \text{ DSCITY} + \beta_3 \ln \text{ DSINT} + \beta_4 \text{ TOTAX} \\ + \beta_5 \text{ EDUCATE} + \beta_6 \text{ MANEMP} + \beta_7 \ln \text{ POP} + \epsilon,$$

with the expectation  $\beta_1, \beta_5, \beta_6, \beta_7 > 0$  and  $\beta_2, \beta_3, \beta_4 < 0$ .

In addition to infrastructure and location variables discussed in the previous section, several control variables are included in the estimated equation. MANEMP, a measure of agglomeration, is the proportion employed in manufacturing. TOTAX represents the community's property tax rate (provided in CQR reports). EDUCATE is an index measure, obtained through factor analysis, of the percent of high school (HSGRAD) and college graduates (COLLEGE).<sup>6</sup> POP represents community population in 1990. Data are obtained from the *1990 Census*

<sup>5</sup> It would be desirable to include observations across time, as well as across space, to construct a pooled cross-sectional time-series regression model. The pooled approach would provide greater support to the causal implications of the model. Data unavailability at earlier points in time, however, prevent this approach. Data obtained from the census is, of course, only available at ten year intervals. Moreover, the Iowa Department of Economic Development does not keep historical records of CQR reports, so a complete data set is not available for past census years.

<sup>6</sup> EDUCATE = .902 COLLEGE + .902 HSGRAD. Eighty-one percent of the covariance between these two variables is accounted for by EDUCATE.

**Table 2—Regression Results**

Variable	Coeff	Standard Error	Normalized Coeff	t-stat
INFRAS	0.205**	0.069	0.205	2.981
ln DSCITY	-0.154*	0.073	-0.156	-2.101
ln DSINT	-0.134**	0.045	-0.181	-2.976
TOTAX	-0.041**	0.012	-0.198	-3.548
EDUCATE	0.485**	0.071	0.485	6.788
MANEMP	1.514*	0.731	0.115	2.073
ln POP	-0.053	0.073	-0.046	-0.720
CONSTANT	2.428**	0.603	0.000	4.030
R <sup>2</sup>		0.594		
Adjusted R <sup>2</sup>		0.577		
F statistic		35.481**		
Degrees of freedom		8, 169		

White's test for heteroscedasticity:  $(e^{\hat{y}})^2 - \chi^2_1 = 0.397$

Bartlett test of sphericity: 373.979\*\*

\* Significant at the .05 level

\*\* Significant at the .01 level

(1992) for MANEMP, COLLEGE, HSGRAD, and POP. Table 2 shows the results of the estimation with about 58 percent of the variation in DEVELOP explained by the set of independent variables.<sup>7</sup>

### *Physical Infrastructure*

There are several ways in which physical infrastructure promotes the economic development of a community. First, infrastructure enters the production function of firms as an unpaid input and augments the productivity of other inputs. A firm that must transport its goods with truck transport will find its drivers and trucks more productive if there is a well-built highway system in the community. This relationship is

<sup>7</sup> Heteroscedasticity is a common problem in cross-sectional analysis. Therefore, White's test of heteroscedasticity is performed to check for the existence of a linear heteroscedastic error pattern (Table 2). The test fails to reject the assumption of homoscedasticity. The Bartlett test of sphericity produces a value of 373.979, which is significant at the .01 level. This test result indicates that multicollinearity is present in the equation. The beta values, therefore, are biased toward zero and thus are underestimated.

underscored by the fact that Smith (1992) uses distance to an interstate as a proxy for transportation costs.

Second, infrastructure is an amenity that serves as a magnet in the location decisions of firms and households. Sewer and water systems are particularly important factors for industrial location decisions. A food processing plant will not consider locating in a community unless there is a sewage system sufficient to handle the capacity of its plant.

Finally, as Stover (1987) notes, infrastructure makes the construction of housing possible and thus increases the value of urban land (a measure included in DEVELOP). For these reasons INFRAS is hypothesized to have a positive effect on economic development. Table 2 indicates that the coefficient on INFRAS is positive and significant at the .01 level.

### *Location*

While a community's development depends on characteristics within that community, development also depends on the proximity of the community to other centers of economic activity. Berry and Parr (1988) argue that central place theory can be applied to control for the effects of space on development. Southwest Iowa is considered the classic example of an area that satisfies the assumptions of central place theory. This study considers the distance to the nearest regional center and distance to the nearest interstate link to account for central place characteristics. Distance to the nearest regional center is expected to be related inversely to economic development and is hypothesized to take log form, because closeness to a large city should be proportionately more of an advantage to a community than distance is a disadvantage. Table 2 shows that the coefficient of  $\ln$  DSCITY is negative, as expected, and significant at the .05 level.<sup>8</sup>

While it sometimes is implied that location advantages arise naturally, there are many ways in which the government plays a role in shaping the dimensions of the central place system. Hale and Walters (1974) and Gessaman and Sisler (1976) note that the construction of an interstate highway system has had a profound effect on the location advantages of rural communities. Because an interstate provides firms with direct access to the national economy, they tend to locate in areas that are close to an interstate. As Johnson (1994) observes, proximity to an interstate not only increases the efficiency of economic activity but also redistributes activity from areas distant from an interstate and toward areas closer to it. Thus, an inverse relationship with log form is

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<sup>8</sup> All variables hypothesized to take the form of a natural log also are tested in simple linear form. In each case, the log form exhibits a lower significance level for the variable in question and a better fit for the overall model.

expected between distance to an interstate and economic development. Table 2 reflects the expected negative coefficient on *ln DISINT*, which is significant at the .01 level.

### *Control Variables*

Plaut and Pluta (1983) document empirically that taxation and private economic activity are related inversely. This relationship is particularly important for communities, as households and firms tend to migrate to areas with low tax rates. Communities are faced with a prisoner's dilemma: If all keep tax rates equally high, households and firms will make location decisions independent of tax rates. Once any given community lowers taxes (or gives tax incentives to new industry), however, others will tend to follow suit. Those communities with the lowest tax rates will attract new economic activity, while high tax communities will see firms and households migrate to other areas leaving them at a disadvantage in the recruitment of newcomers. Table 2 shows an expected negative coefficient on *TOTAX* with significance at the .01 level.<sup>9</sup>

A second control variable measures the community's human capital stock. Cheshire (1979) reports that the skill level of the labor force is important in studies of economic development. This importance is reflected by the inclusion of labor force skill level in recent infrastructure studies such as Munnell (1990). The measure of education used in this study, *EDUCATE*, controls for two human capital components. First, the percentage of high school graduates reflects the extent to which a community has a labor force trainable for employment in manufacturing and other core economic activities. Second, the percentage of college graduates reflects the community's potential for attracting highly technical and professional firms. The anticipated positive sign on the coefficient of *EDUCATE* is shown in Table 2 with significance at the .01 level.

An additional control variable is the community's level of agglomeration. As defined by Blair (1991), *agglomeration* is the advantage that accrues to firms and households when economic activity is concentrated at one point in space. Agglomeration promotes development through greater division of labor, the availability of alternative tech-

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<sup>9</sup> The dialectical nature of the relationship between taxes and development poses a problem with the specification of the equation. While the effect of lower taxes as a stimulus to private economic activity is well-documented, success in economic activity also makes a lower tax rate possible. In particular, cities with higher assessed values (which is one of the four measures in *DEVELOP*) may be able to exact lower taxes due to a higher tax base. Structural modeling techniques, such as LISREL, could be used to estimate the statistical effects of this relationship.

nologies, and cost savings from bulk purchases as well as through increased communications among managers.

Agglomeration traditionally has been measured using some index of manufacturing activity. Carlino (1980), for example, develops a diversification ratio based on data from the *Census of Manufacturers*. As data are not available in this detail at the community level, however, alternative measures such as population density (Walzer and P'ng 1995) and manufacturing density (Gruidl and Walzer 1992) have been employed. This study measures agglomeration with proportion employed in manufacturing industries. This variable has the advantage of capturing the effect of manufacturing activity within the city limits, as well as reflecting opportunities in nearby areas that are relevant to the economic development of the local community. As shown in Table 2, the coefficient of MANEMP is positive and significant at the .05 level.

The community's population is used as a final control variable. Given the large variation in the size of place used in this study, larger places may be qualitatively different than smaller places, leading to different levels of economic development. The log of community population is included in the equation to control for this possibility. The results in Table 2 indicate, however, that the coefficient of  $\ln$  POP is not significantly different from zero. This finding suggests that the effects of size on development have been controlled for adequately with other variables included in the equation.

## Conclusions

This cross-sectional study of communities in one state confirms the links identified in national level studies between infrastructure and economic development. A composite measure of the level of economic development is affected positively by physical infrastructure and location advantages. Control variables have the expected effects: high taxes discourage development; human capital enhances development; and agglomeration has a positive impact on development. There is no appreciable effect of community population size once these other variables are taken into account.

These empirical findings suggest several policy implications for state and local decision-makers seeking to promote economic development. The positive relationship between infrastructure and the level of economic development provides a compelling justification for continued infrastructure maintenance, especially for highway systems that provide smaller communities with access to central places. State and local governments should conduct research that addresses the adequacy of local infrastructure for business and industry and that also examines the effects of local taxes on development. The need for investment in human capital also should be studied.

Our findings suggest various areas for future research on the links between infrastructure and economic development. In cross-sectional research, structural modeling techniques should be considered to identify the complex, bidirectional links between infrastructure and variables such as taxation, education levels, and migration. Also, dynamic time series models of development at the community level should be tested as data become available. Finally, additional variables that present a more holistic view of development, such as measures of income distribution, should be incorporated into index measures of development.

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