# THE INFLUENCE OF INPUT SUPPLY AND OUTPUT DEMAND ON INDUSTRIAL GROWTH IN RURAL COMMUNITIES

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An important concept in location theory is the availability of intermediate inputs. This paper presents a conceptualization of intermediate input supply and suggests a variable to operationalize this concept. The variable is empirically implemented to test the relationship between the availability of intermediate inputs, market access and industrial growth in rural communities.

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## Introduction

The spatial distribution of employment opportunities in rural communities continues to be a relevant policy issue. Given the recent reversal in the traditional rural to urban migration of jobs and people, many rural communities have an improved opportunity to attract additional employment opportunities. However, the mechanisms for communities to use in order to encourage plants to locate in their communities are as yet not well understood. There is relatively little information concerning how a community can either encourage or discourage plant locations in their boundaries.

In general, location theory is designed to address such questions. However, despite substantial empirical literature in industrial location, variables have not been defined and measured that adequately reflect many of the important concepts of location theory. One of the important concepts that has not been adequately treated in the empirical literature is the availability of intermediate inputs. This paper will present a brief conceptualization of intermediate input supply and suggest an alternative variable to operationalize this concept. A commonly used measure of output demand will be presented. The proposed variables will be empirically implemented and will be used in a statistical analysis to test the hypothesized relationship between the supply of intermediate inputs, the demand for output, and industrial growth.

## Components of the Concepts

In location theory, [Hoover, 1948; Greenhut, 1956; and Isard, 1956] the concepts of input supply and output demand exhibit important components or characteristics (for brevity, only the components of input supply will be discussed). A simple spatial price equilibrium model, can be used to illustrate the components.

The spatial model, presented in Figure 1, shows the local supply and demand for commodity 1 (an input or output) that exist in two spatially separated communities, A and B. The prices and quantities established in the two areas in the absence of trade are $P_A$ and $P_B$, and $Q_A$ and $Q_B$. $TC_{AB}$ equals the per unit transportation costs for the commodity 1 between area B and area A. If $P_A - P_B > TC_{AB}$, exchange or trade between the areas will occur, and the commodity will be transported from area B to area A. At equilibrium, $P_{A1} = P_{B1} + TC_{AB}$ and the excess quantity demanded at the price $P_{A1}$ in area A equals the excess quantity supplied at the price $P_{B1}$ in area B.

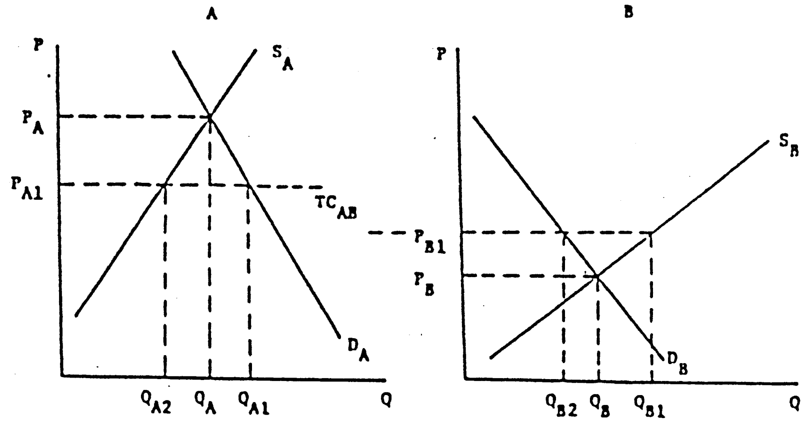


Figure 1. Spatial Equilibrium in Two Communities, A and B

Conceptually, input supply has a spatial component. The theories recognize that the production of inputs is not uniformly distributed over space, but occur at a limited number of points. Thus, input supply (as perceived by a firm) at a location has a spatial component in that it includes the production at other points and varies as the distance to points of production varies. In Figure 1, the supply of the input 1 in A has a spatial component in that it includes the production in B and varies as the distance to B varies.

An additional component of the concept of input supply is the effect of the demand of other users of an input on input supply. It is reasonable to expect that the demand of other users influences the quantity available to a firm and/or the price of the input. Thus, input supply is influenced by the spatial location of other firms which use the input. A greater demand in B would imply a lesser excess quantity supplied in B.

Another component of the concept of input supply implicit in location theory, is the industry specific nature of this concept. At a location, a firm is concerned with the supply of the specific inputs that the firm uses, not with the supply of other inputs. Thus, input supply must be considered at a very detailed industrial level.

Given these conponents of the concepts of input supply and output demand, it is reasonable to expect that the empirical treatment of these concepts reflect these components. However, a review of empirical studies revealed that the variables often used to operationalize these concepts often do not reflect these components.

## Operationalization of Concepts

To empirically investigate the influence of the supply of inputs and demand for output on manufacturing activity in rural communities, it is necessary to operationalize the concepts of input supply, output demand, and industry growth.

The operationalization of the supply of an input in a community used in this study is defined as:

$$1) \qquad PNIA_{ij} = \sum_{k=1}^{p} \frac{P_{ik} - C_{ik} - \sum_{m=1}^{p} C_{im}}{TRC_{ijk}}.$$

where, $PNIA_{ij}$ = Potential net input availability of input i in community j.

$P_{ik}$ = Quantity of input i supplied in community k,

$C_{ik}$ = Quantity of input i demanded in community k,

$C_{im}$ = Quantity of input i demanded in community m, a surrounding community for which community k is the closest source of the input i,

$TRC_{ijk}$ = Transportation cost for input i from community j to community k.

For a community, Potential Net Input Availability (PNIA) increases as the quantity of an input supplied in surrounding communities increases, just as conceptually, the supply of an input increases (in that more of the input is available). It decreases as the quantity of the input demanded in surrounding communities increases, just as conceptually, the supply of an input decreases (in that less of the input is available). Also, PNIA decreases as the transportation costs for an input from surrounding surrounding communities increase, just as conceptually, the supply of an input decreases (in that higher transportation costs imply higher prices). Thus, this variable operationalizes the supply of an input in a community.

The merit of this operationalization of input supply is that it includes the important components of the concept. The spatial component is included by considering the quantity of the input supplied in other communities and the transportation costs to these communities. The "demand" component is included by considering the quantity demanded in surrounding communities. The industry specific nature of input supply is accounted for by measuring PNIA at a detailed level.

The operationalization of the demand for an output in a community that is used in this study is defined as:

$$2) \qquad PMA_{1j} = \sum_{k=1}^{p} \frac{M_k}{TRC_{1jk}}$$

where, $PMA_{1j}$ = Potential market access for output 1 in community j,

$M_k$ = Market for output 1 in community k, and

$TRC_{1jk}$ = Transportation costs for output 1 from community j to community k.

Potential Market Access (PNIA) has been widely used to operationalize the concept of output demand. The spatial component of output demand is included by considering the market for the output in other communities and the transportation costs to these communities. The "supply" component of this concept, the effect of other producers of the output, is not considered in this variable.

The growth of an industry in a community is an indication of the response of the industry to the relative locational advantages of the community. A variable which operationalizes the growth of an industry in a community is Relative Community Industry Growth (RCIG). This variable is defined as:

$$3)\qquad RCIG_{1j} = \frac{E_{1jt}}{E_{1t}} - \frac{E_{1jt-1}}{E_{1t-1}} + X_{1j}$$

where, $RCIG_{1j}$ = Community industry growth of industry 1 in community j,

$E_{1j}$ = Employment in industry 1 in community j,

$E_{1}$ = Employment in industry 1 in all communities

t, t-1 = Time

$X_{1j}$ = 1 if the industry is present in the community, and 0 if the industry is not present in the community.

If an industry grows more rapidly (or declines less) in a community than it did in all communities, RCIG is greater than one. If an industry grows less rapidly (or declines more) in a community than it did in all communities, then RCIG is less than one. If an industry is not present in a community in each of the time periods then community industry growth is zero. The range of possible values for this varible is from zero to two.

## Measurement of Variables

The decision was made to calculate PNIA and PMA for 1965, and to relate those to RCIG for the time period 1965 to 1973. In this study, the communities within Pennsylvania are 177 "central place areas," combinations of Pennsylvania minor civil divisions, delineated on the basis of 1960 population. The communities outside Pennsylvania are the counties of the fourteen northeastern states. Twenty Standard Classification Industries (or aggregations there of) were selected for study, based on the incidence rate in rural Pennsylvania communities. The input-providing industries considered were the three manufacturing industries that were the major suppliers based on the direct requirement coefficients in the 1967 Input-Output Study.

In PNIA, the quantity of an input supplied is measured with the total sales of the industry which produces the input. The quantity of the input demanded is measured with the total purchases of the input by all industries which use the input. The transportation costs of an input are measured with the motor carrier transportation costs that apply to the input and to the distance to surrounding communities. The estimation procedures and data used are detailed below.

The total sales of an industry ($P_{ik}$ in Equation 1) were estimated by the product of the employment in the industry in the community (County Industry Reports, County Business Patterns) and the average sales per employee of the industry (Dun Market Identifiers). To estimate the total purchases of an input, all industries which use an input were identified. Then, the total sales of the output of each user were determined using the procedure discussed above. The total sales of each user in a community are multiplied by the amount of the input required by the user for each dollar of output (direct requirements coefficient). These data were obtained from the 1967 Input-Output Study. This product is the purchases of the input ($C_{ik}$ and $C_{im}$ in Equation 1) by the users in the community. Transportation costs for various types of products between each pair of communities ($TRC_{ijk}$ in Equation 1) were estimated using an equation relating the distance between communities to the truck transportation costs (class rate) for alternative product classes.

In PMA, the market for an output ($M_k$ in Equation 2) was measured by the aggregate income of a community, an indication of final demand. Aggregate income was estimated by the aggregate income from the 1970

Census of Population.

The data required to measure RCIG (Equation 3) for the period 1965 to 1973, were obtained from the 1965 and 1973 Pennsylvania County Industry Reports (Pennsylvania Department of Internal Affairs, 1966 and Pennsylvania Department of Commerce, 1974).

## Model Specification

Generally, it is proposed that the growth of an industry in a community is influenced by the supply of the inputs the industry uses and the demand for the output of the industry. The general form of the model is:

$$4) \quad RCIG_{lj} = f(PNIA_{ij}, PNIA_{jj}, PNIA_{kj}, PMA_{lj})$$

where, $RCIG_{lj}$ = Relative community industry growth of industry 1 in community j,

$PNIA_{ij}$, $PNIA_{jj}$, $PNIA_{kj}$ = Potential net input availability of inputs i, j, and k, in community j, where i, j, and k are input-providing industries for 1, and

$PMA_{lj}$ = Potential market access for output 1 in community j.

The empirical analysis presented below is not designed as a detailed study of the location factors of the twenty industries. The analysis is designed to provide an indication of the efficiency of the variables and measurement techniques suggested above.

The dependent variable, RCIG, is a limited value dependent variable and assumes the limiting value for a large number of observations. That is, RCIG is zero if the industry was not present in both of the time periods (1965 and 1973). This was frequently the case. Because of this, Tobit Analysis, an alternative to the OLS estimating procedure, was employed. Following the logic of Tobit Analysis it is reasonable to expect that the supply of inputs and/or the demand for output will influence both whether an industry is present in a community or not (the probability of limit responses) and the relative growth of the industry in a community (the size of non-limit responses).

Hypotheses regarding the influence of individual independent variable on the dependent variable are tested using the Student's t test. In this study, the null hypothesis of $H_o$: $b_1=0$ is tested. The alternative hypothesis is $H_a$: $b_1 > 0$. Thus, a one-tail test is used.

For each industry, the general model specified above was estimated. If the addition of squared variables and interaction variables as independent variables improved the initial model, the variables were retained. In cases where the results of the initial model indicated the presence of multicollinearity among the independent variables. One of the correlated variables was removed.

## Results

The results of the estimation of the relationship between the growth of an industry and input supply and output demand for the twenty selected industries are presented in Table 1. The results for fourteen of the selected industries indicate that the growth of these industries in the rural communities of Pennsylvania is positively related to the supply of inputs from input-providing industries and/or the demand for the output of the industries.

For six of the selected industries, there is not a positive relationship between industry growth and either input supply or output. These industries tended to be either labor intensive and/or highly aggregated. That is, for most of the six industries labor is the dominant location factor or the industry contains such a variety of production activities that it is unlikely that they can be successfully analyzed.

## Summary and Conclusions

In this study, most effort was focused on developing improved operationalizations of the relevant concepts and then, measuring the appropriate variables. Special attention was devoted to the concepts of input supply and industry growth. The variables defined to reflect those concepts and the measurement procedures used to impliment them show promise of improving the quality of the empirical findings in industry location studies. Additional research could continue the efforts of this study in a number of ways.

## References

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Hoover, Edgar M. The Location of Economic Activity. New York: McGraw-Hill Book Company, 1948.

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TABLE 1
Results of Tobit Analysis

| Industry<br>Input Providing Industry | | Normalized Coefficient |
|---|---|---|
| Broadwoven Fabric Mills (2211) | | |
| Yarn Mills (2269) | | - 5.9011 |
| Synthetic Organic Fibers (2824) | | - 0.9883 |
| Cellulosic Manmade Fibers (2823) | | 0.7503 |
| Potential Market Access | | - 0.0073 |
| Constant | | -15.6068 |
| No. of Limit Observations | 143 | |
| Apparel (2311) | | |
| Broadwoven Fabric Mills (2211) | | - 3.1514 |
| Knit Outerwear Mills (2253) | | 57.9110*** |
| Knit Fabric Mills (22560) | | 0.2576 |
| Interaction[a] | | 2.9385*** |
| Potential Market Access | | - 0.0254 |
| Constant | | -33.5348 |
| No. of Limit Observations | 62 | |
| Hardwood Flooring Mills and Wood Furniture, Except Upholstered (24260) | | |
| Sawmills and Planing Mills, General (2421) | | - 0.6507 |
| Broadwoven Fabric Mills (2211) | | - 0.1129 |
| Plastics, Paints and Rubber Products (28210) | | - 0.0619 |
| Potential Market Access | | 0.0004 |
| Constant | | - 4.3788 |
| No. of Limit Observations | 133 | |
| Wood Products, Not Elsewhere Classified (24990) | | |
| Sawmills and Planing Mills, General (2421) | | - 0.0172 |
| Plastics, Paints and Rubber Products (28210) | | - 0.0471 |
| Potential Market Access | | 0.0019 |
| Constant | | - 4.0743 |
| No. of Limit Observations | 105 | |
| Millwork and Furniture, Except Upholstered (24310) | | |
| Sawmills and Planing Mills, General (2421) | | 4.0135*** |
| Veneer and Plywood Plants (24320) | | 5.2083*** |
| Potential Market Access | | 0.0122*** |
| Constant | | -13.5538 |
| No. of Limit Observations | 102 | |
| Folding Paperboard Boxes (2651) | | |
| Paperboard Mills (2631) | | 0.7034 |
| Plastics, Paints and Rubber Products (28210) | | - 0.0150 |
| Paper Mills, Except Building Paper Mills (2621) | | 1.0077** |
| Potential Market Access | | 0.0092*** |
| Constant | | -17.2292 |
| No. of Limit Observations | 141 | |
| Industrial Chemicals (28140) | | |
| Petroleum Refining and Products (29110) | | - 0.9639 |
| Plastics, Paints and Rubber Products (28210) | | 0.0166 |
| Fertilizers, Mixing Only (28720) | | 0.4428 |
| Potential Market Access | | 0.0013 |
| Constant | | - 5.6275 |
| No. of Limit Observations | 135 | |
| Footwear, Except House Slippers and Rubber Footwear (31410) | | |
| Leather Tanning and Finishing (3111) | | 5.8716*** |
| Plastics, Paints and Rubber Products (28210) | | 0.2393*** |
| Potential Market Access | | 0.0023 |
| Constant | | 2.6999 |
| No. of Limit Observations | 133 | |
| Concrete Brick and Block (3271) | | |
| Cement, Hydraulic (3241) | | - 2.0365 |
| Ready Mixed Concrete (3273) | | 1.8472 |
| Minerals and Earths, Ground or Otherwise Treated (32950) | | 21.0775*** |
| Constant | | - 7.1120 |
| No. of Limit Observations | 128 | |
| Concrete Products Except Block and Brick (3272) | | |
| Cement, Hydraulic (3241) | | 1.0044 |
| Ready Mixed Concrete (3273) | | 1.4856 |
| Blast Furnaces, Steel Works and Rolling Mills (3312) | | 0.0345* |
| Constant | | - 7.3068 |
| No. of Limit Observations | 121 | |

TABLE 1 Continued

| Industry / Input Providing Industry | | Normalized Coefficient |
|---|---|---|
| Metal Doors, Sash, Frames, Molding and Trim (3442) | | |
| Rolling, Drawing, and Extruding of Aluminum (33520) | | 1.9776* |
| Blast Furnaces, Steel Works, and Rolling Mills (3312) | | - 0.0088 |
| Primary Production of Aluminum (3334) | | 0.3664* |
| Potential Market Access | | 0.0049*** |
| Constant | | - 5.2431 |
| No. of Limit Observations | 145 | |
| Architectural and Miscellaneous Metal Work (34490) | | |
| Blast Furnaces, Steel Works, and Rolling Mills (3312) | | - 0.0097 |
| Fabricated Structural Steel (3441) | | - 1.1965 |
| Sheet Metal Work (3444) | | 27.6515*** |
| Potential Market Access | | - 0.0360 |
| Constant | | -19.4334 |
| No. of Limit Observations | 135 | |
| Safes, Vaults, Collapsible Tubes, and Fabricated Metal Products, Not Elsewhere Classified (34920) | | |
| Blast Furnaces, Steel Works, and Rolling Mills (3312) | | 0.1044** |
| Plastics, Paints and Rubber Products (28210) | | - 0.0211 |
| Rolling, Drawing, and Extruding of Aluminum (33520) | | - 1.6765 |
| Potential Market Access | | 0.0024 |
| Constant | | - 8.5856 |
| No. of Limit Observations | 145 | |
| Valves, Pipe, and Pipe Fittings (3494) | | |
| Blast Furnaces, Steel Works, and Rolling Mills (3312) | | 0.0637 |
| Iron and Steel Foundries (33230) | | - 0.3421 |
| Rolling, Drawing, and Extruding of Copper (3351) | | 0.7026 |
| Potential Market Access | | 0.0006 |
| Constant | | - 5.6482 |
| No. of Limit Observations | 143 | |

| Industry / Input Providing Industry | | Normalized Coefficient |
|---|---|---|
| Farm Equipment, Cycles, Trailer Coaches, and Transportation Equipment, Not Elsewhere Classified (35229) | | |
| Blast Furnaces, Steel Works, and Rolling Mills (3312) | | 0.0579* |
| Internal Combustion Engines, Not Elsewhere Classified (3519) | | 1.4815 |
| Bearings and Power Transmission Equipment (35670) | | - 0.1845 |
| Potential Market Access | | 0.0044* |
| Constant | | - 6.5745 |
| No. of Limit Observations | 127 | |
| Special Dies, Tools, and Machine Tool Accessories (3544) | | |
| Metal Stampings (34610) | | 0.0443 |
| Blast Furnaces, Steel Works, and Rolling Mills (3312) | | - 0.0078 |
| Machine Tools and Metal Working Machinery (35410) | | 0.4247 |
| Potential Market Access | | 0.0012 |
| Constant | | - 6.5872 |
| No. of Limit Observations | 123 | |
| Industrial Patterns (3565) | | |
| Iron and Steel Foundries (33230) | | - 0.1872 |
| Aluminum Castings (3361) | | 0.6954** |
| Sawmills and Planing Mills, General (2421) | | 2.5544 |
| Potential Market Access | | 0.0174** |
| Constant | | -13.0852 |
| No. of Limit Observations | 146 | |
| Semiconductors and Electronic Components (36790) | | |
| Plastics, Paints and Rubber Products (28210) | | - 0.3104 |
| Ordnance, Radio and Television Equipment, Optical Instruments (19110) | | 0.3834* |
| Metal Samplings (34610) | | 0.3087 |
| Potential Market Access | | 0.0016 |
| Constant | | - 9.5562 |
| No. of Limit Observations | 139 | |

TABLE 1 Continued

| Industry<br>Input Providing Industry | | Normalized Coefficient | Industry<br>Input Providing Industry | | Normalized Coefficient |
|---|---|---|---|---|---|
| Truck and Bus Bodies and Truck Trailers (37310) | | | Signs and Advertising Displays (3393) | | |
| Motor Vehicles and Parts (37110) | | 0.1788 | Plastics, Paints and Rubber Products (28210) | | - 0.1277 |
| Blast Furnaces, Steel Works, and Rolling Mills (3312) | | - 0.0313 | Blast Furnaces, Steel Works, and Rolling Mills (3312) | | 0.1351** |
| Rolling, Drawing, and Extruding of Aluminum (33520) | | 2.4922** | Potential Market Access | | 0.0149*** |
| Potential Market Access | | 0.0039** | Constant | | -17.1098 |
| Constant | | - 5.4243 | No. of Limit Observations | 147 | |
| No. of Limit Observations | 146 | | | | |

* Significant at the ten percent level of significance.
** Significant at the five percent level of significance.
*** Significant at the one percent level of significance.

[a] The interaction of the potential net input availability of the broadwoven fabric mills industry and the potential net input availability of the knit outerwear mills industry.