

1-1-1985

Spatial clustering of sector linked industry in an urban economy

Colleen Greer Acres
Portland State University

Follow this and additional works at: https://pdxscholar.library.pdx.edu/open_access_etds

Let us know how access to this document benefits you.

Recommended Citation

Acres, Colleen Greer, "Spatial clustering of sector linked industry in an urban economy" (1985).
Dissertations and Theses. Paper 356.
<https://doi.org/10.15760/etd.356>

This Dissertation is brought to you for free and open access. It has been accepted for inclusion in Dissertations and Theses by an authorized administrator of PDXScholar. Please contact us if we can make this document more accessible: pdxscholar@pdx.edu.

SPATIAL CLUSTERING OF SECTOR LINKED INDUSTRY
IN AN URBAN ECONOMY

by
COLLEEN GREER ACRES

A dissertation submitted in partial fulfillment of the
requirements for the degree of

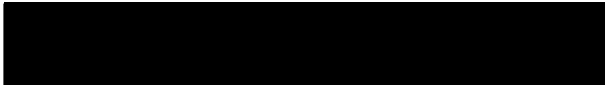
DOCTOR OF PHILOSOPHY
in
URBAN STUDIES

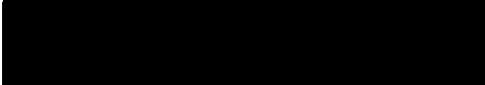
Portland State University

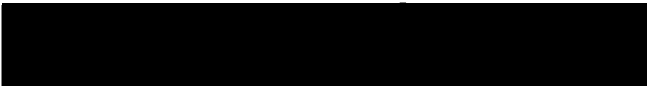
1985

TO THE OFFICE OF GRADUATE STUDIES AND RESEARCH:

The members of the Committee approve the dissertation
of Colleen Greer Acres presented May 23, 1985.


James Strathman, Chairman



Sumner Sharpe

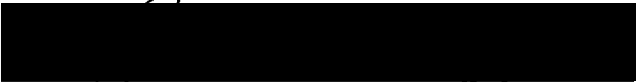

Morton Paglin


E. Kimbark MacColl


Abdul Qayum

APPROVED:


Kenneth Dueker, Acting Dean, School of Urban and Public
Affairs


James Heath, Dean of Graduate Studies and Research

ACKNOWLEDGEMENTS

Behind this dissertation lie the efforts of a perceptive committee, a sacrificing family, and understanding friends.

Thank you all

TABLE OF CONTENTS

	PAGE
ACKNOWLEDGEMENTS	iii
LIST OF TABLES	vi
CHAPTER	
I INTRODUCTION	1
II REVIEW OF THE LITERATURE	6
Relevant Theoretical Literature	6
Relevant Empirical Literature	13
Summary of Relevant Literature	18
III METHODOLOGY	20
Conceptual Model	20
Research Hypotheses	23
Operational Model	24
Measurement of Spatial Proximity	27
Cut-off of Linkage Analysis	30
Area Selection	39
Variable Measurement	45
Spatial Proximity	45
Linkages	47
Transportation and Utility Costs	50
Supply and Market Orientation	51
Industry Average Firm Size	51
Conclusion	52
IV FINDINGS	53
Summary of Regression Findings	54

CHAPTER	PAGE
Regression Findings and the Research Hypotheses	73
Discussion	75
Conclusion	82
V CONCLUSION	84
BIBLIOGRAPHY	90
APPENDIX	100

LIST OF TABLES

TABLE		PAGE
I	Spatial Concentration Information	31
II	List of Variables	46
III	Regression of Intra-Industry Linkage With Covariates Including Manufacturing Purchases.	55
IV	Regression of Intra-Industry Linkage With Covariates Including Manufacturing Sales	56
V	Regression of First Backward Linkage With Covariates	57
VI	Regressions of Second Backward and Third Backward Linkages With Covariates. . . .	58
VII	Regressions of Fourth Backward and Fifth Backward Linkages With Covariates. . . .	59
VIII	Regressions of First and Second Backward and First, Second, and Third Backward Linkages with Covariates.	60
IX	Regression of First Forward Linkage With Covariates	61
X	Regressions of Second Forward and Third Forward Linkages With Covariates.	62
XI	Regressions of Fourth Forward and Fifth Forward Linkages With Covariates.	63

TABLE		PAGE
XII	Regressions of First and Second Forward and First, Second, and Third Forward Linkages With Covariates	64
XIII	Regressions of One Backward and One Forward Linkages and One Backward and Two Forward Linkages With Covariates	65
XIV	Regressions of One Backward and Three Forward Linkages and Two Backward and One Forward Linkages With Covariates	66
XV	Regression of Two Backward and Two Forward Linkages and Two Backward and Three Forward Linkages With Covariates	67
XVI	Regressions of Three Backward and One Forward and Linkages and Three Backward and Two Forward Linkages With Covariates.	68
XVII	Regression of Three Backward and Three Forward Linkages With Covariates	69
XVIII	Status of Industries With One Firm	101
XIX	Industry Revisions	103
XX	Identification of Manufacturing Industries.	115

AN ABSTRACT OF THE DISSERTATION OF Colleen Greer Acres for
the Doctor of Philosophy in Urban Studies presented
May 23, 1985.

Title: Spatial Clustering of Sector Linked Industry in an
Urban Economy.

APPROVED BY MEMBERS OF THE DISSERTATION COMMITTEE:

[REDACTED]
(James Strathman, Chairman

[REDACTED]
Sumner Sharpe

[REDACTED]
Morton Paglin

[REDACTED]
E. Kimbark MacColl

[REDACTED]
Abdul Qayum

The influence of economies of agglomeration on
location decisions has been debated since it was advanced
by Alfred Weber in 1909. Empirical findings at the inter-
national, national, and regional levels do not definitely
support the efficacy of such economies. No study has been
done at a local level, the one inherently appropriate to

the Weber premise. Further, most studies have used highly generalized manufacturing groupings.

The importance of intra-industry and inter-industry determinants of spatial proximity in the Portland, Oregon metropolitan area was investigated in this study. The data base included 220 industries with 2,111 firms employing 108,295 workers. National input-output transaction tables were used to generate measures of intra-industry and inter-industry technological linkage at the 4 digit Standard Industrial Code classification level.

Nearest neighbor statistics were employed to measure the spatial proximity of firms within an industry. A spatial association measure, the local concentration coefficient, was devised to calculate spatial proximity among manufacturing firm pairs in various linkage relationships. Then, multiple linear regression was used to examine the relationships of intra- and inter-industry linkages to spatial proximity. Average firm size, material and market orientations, and transportation and utility cost intensities were treated as covariates in the analysis. A total of 25 models involving the covariates and various combinations of forward and backward linkages were executed.

In 23 cases, the models and effects of linkages were insignificant. The observed influence of the covariates was generally insignificant. Clearly,

economies of agglomeration have no effect on industrial patterns in this analysis. Further, the poor performance of the covariates suggest that application of existing theory to localized manufacturing plan selection processes may be misplaced. While these factors may function at the regional or national level, they do not on an intrametro-politan level, at least in this case. Seeking the specific factor of manufacturing linkage based economies of agglomeration or external economies may be a rare exception in location behavior in general and particularly inoperative at a local level. Local development policies which are premised on maximizing such economies are, accordingly, not supported by this research.

CHAPTER I

INTRODUCTION

The seminal micro-theory of manufacturing location advanced by Alfred Weber (1909) had as a major component the effects of economies of agglomeration on the location decisions of firms. Later theorists such as Hoover (1937, 1948) extended this notion to include cost savings associated with close spatial proximity to complementary as well as similar firms under the concept of economies of concentration. For Vernon (1960), Lichtenberg (1960) and Hoover (1967) cost savings achieved by individual firms through their locational choices were referred to as external economies. In contrast, Isard (1960) separated cost reducing factors generated by inter-industry linkages from economies of agglomeration, scale, urbanization, and localization. Regardless of the label applied common to all of these theorists was the contention that spatial proximity to similar firms and transactionally linked firms is an important consideration in the firm site selection process.

Empirical findings have not consistently supported this hypothesis. Alonso (1964) and Smith (1981) found that external economies of agglomeration and inter-industry

linkages were important determinants of plant location in advanced industrial nations while external economies were more important in underdeveloped nations where firms must compensate for comparatively higher costs of transportation and other factors of production.

Conversely, Lausen (1969) in a comparative study of industrial growth patterns in England and the European economic community found that major firms in England were footloose while European counterparts as extensions of existing plants were classified as relatively immobile.

Studies at the regional level have also led to inconclusive results. Inter-regional linkages rather than intra-industry linkages are more important in understanding the behavior of the Pacific Northwest steel industry and manufacturing plant and industry growth in the Seattle regional economy according to Schmidt (1973) and Beyers (1975). North (1955), however, attributed the development of the Pacific Northwest to natural resource export market demand. Bell, Lieber, and Rushton (1974) contend that some firms will depart from agglomeration principles when local conditions favor a centrally situated site. Recently Tauchen and Witte (1982) note that firm proximity and interaction produce cost savings and revenue generation accruing directly from economies of agglomeration.

Awareness of the impacts of governmental attitudes

and actions beginning with Hoover in 1940 has been a consistent theme and related subject of debate. The interplay of community political attitudes, community amenities, and executive personal choices in the search for new plant locations was brought into focus by the work of Greenhut in 1963. Holland (1976) advised communities seeking to lessen their vulnerability to economic fluctuations to develop a self-sustaining economic base composed of firms large enough to stimulate linked development through subcontracting and purchasing of materials and components of production. Smith (1981), on the other hand, tells communities seeking growth and diversification to create planned growth points, supplied with public services necessary to attract industry capable of siting within the community. Tomer (1980) stressed the importance of understanding intra-industry and inter-industry transactional patterns in the site selection process regardless of the approach taken by the community. The result has been the development of local economic development programs built on the enhancement of industrial external economies and/or economies of agglomeration.

However, this association between industrial transaction linkage and spatial concentration has never been conclusively substantiated. Even such studies as

exist are at broad regional levels for grossly aggregated classification levels. The purpose of this investigation was to see if this basically micro-economic concept pertains in micro-circumstances of space and disaggregation. The basic research hypothesis was that spatial proximity of firms is not related to the magnitude of intra-industry, primary forward and backward, or composite inter-industry linkages. The study was conducted at a metropolitan geographic scale and industry linkages were disaggregated to the 4 digit Standard Industrial Classification level.

The Oregon portion of the Portland-Vancouver Standard Metropolitan Statistical Area (SMSA) was chosen as the field area for this research. It is varied in topographical features, diverse in economic base and mix of transportation modes, contains a substantial inventory of buildable industrial sites, has available necessary levels of physical and community infrastructure to support industrial growth, and shows a history of supporting industrial growth and diversification. Only recently have studies by the Stanford Research Institute (1982) questioned whether the greater Portland area now contains an adequate inventory of buildable industrial sites capable of meeting the diverse area and site locational requirements of a full range of industries. Confining the

study to the Oregon portion of the metropolitan area limits the heterogeneity produced among subareas by differences created in crossing State political borders.

A covariance application of the multiple regression model was used to test the explanatory power of intra-industry and inter-industry technological linkages in the spatial clustering of manufacturing firms. Spatial proximity, the dependent variable, was measured by the nearest neighbor statistic for firms within an industry. A comparable local concentration measure was developed to calculate spatial arrangements for firms across industries as the nearest neighbor's mathematical properties precluded its use in the latter case. The potential influences of firm size, transportation and utility costs, and supply and market orientation were controlled by their treatment as covariates within the model. The experimental variables--within industry, forward and backward technological linkages--were measured at the 4 digit Standard Industrial Classification level using the 1972 national input-output commodity/industry transactions table.

CHAPTER II

REVIEW OF THE LITERATURE

Statements on the influence of intra-industry and inter-industry linkages on the growth and composition of spatial agglomerations are a consistent theme in the development of industrial location theory. Viewed originally as cost minimizing factors, later theorists recognized both cost reducing and/or revenue generating variables in discussions of the determinants of industrial spatial patterns. Lacking in the theoretical literature is a direct and explicit evaluation of the pull which these interdependencies could exert in competition with other determinants of spatial form, e.g. traditional cost variables.

RELEVANT THEORETICAL LITERATURE

Economies of agglomeration were first defined in 1909 by Weber (1929) as cost savings of firms directly attributable to the presence of similar industries in close spatial proximity. Resultant cost savings were viewed as separate and distinct from economies of scale produced by increasing levels of production or external economies generated by minimizing costs of factors external to production such as transportation.

The search for other cost minimizing factors continued with the work of Hoover (1937, 1948) in his study of the shoe and leather industry and later theoretical formulations. Building on Weber's earlier contributions Hoover noted that cost savings could also be realized by material and market oriented firms locating in close spatial proximity to complementary as well as similar firms. These savings are classified as economies of concentration. Later, Greenhut (1956) extended the analysis of cost and demand factors of location to include revenue-generating as well as cost-reducing factors associated with agglomeration and deglomeration. For example, marketing products or services in an area familiar with a firm's reputation lowers advertising costs relative to competitor cost outlays while increasing sales revenues. Agglomerative economies were seen as a necessary prerequisite for the maximization of possible industrial expansion.

The examination of different input price combinations on areal variations in production costs led Isard (1960) to explain observed firm spatial agglomerations with the use of two types of economies--urbanization and localization. The former arise from city characteristics of size and composition and clustering of complementary firms. The latter, also referred to as external economies, are achieved by spatial clusters of similar establishments. These are

viewed as separate and distinct from economies of scale, economies of agglomeration and cost reductions produced by inter-industry linkages. From this classification of economic factors linkages emerge as a competitive determinant whose influence must be independently assessed and then evaluated in conjunction with other factors of location (Isard and Kuenne 1953).

For Perroux (1970) linkage as a concept applied to the economic interdependencies of industries and regions. Growth within a spatially bounded growth pole is attributed to the presence of key industries and input-output related non-competitive industries and the occurrence of territorial agglomeration. These active poles in turn induce growth in other areas with relatively passive industries. These latter areas do not possess propulsive industries or the benefits of agglomeration. Input-output industry transactions are recognized as one of the primary factors in the economic growth of regions and nations.

Inter-industry linkages are seen as increasingly important by Stabler (1968) as the number of stages in the production process grows and the number of industries directly connected to natural resource inputs or final markets decreases. The establishment and growth of industrial complexes is attributed to industries seeking to minimize inter-industry transfer costs and maximize

accessibility to both suppliers and buyers.

Rather than being industry wide Romanoff (1984) argues that a need for spatial proximity is tied to the nature of an industry's production process. Manufacturers who produce goods in response to orders are seen as more dependent upon close contact with markets than those who produce goods for mass consumption and in anticipation of demand.

Other theorists use firm size and/or corporate organizational structure to account for differences in economically linked inter-industry spatial patterns. Small firms are characterized as more vulnerable to external market forces (Galbraith 1975; Holland 1976). At the same time these firms are also more likely to be dependent upon the local economy for their orders (O'Farrell 1985). Therefore a location in close proximity to trading partners is used to minimize market uncertainties and increase accessibility to trading partners (Moomaw 1985). Conversely, large firms are seen as having the power necessary to control their environment. If not, an option open to large firms is the vertical integration of product stages as cost factors subject to economies of scale are internalized (Hakanson 1979).

The influence of inter-industry linkages, firm size, and other factors in the selection of plant location

was examined by the above theorists within varying spatial scales ranging from the micro to macro levels of development. While distinctions were generally made between areas the applicability of the variables to the selection of a specific site among alternatives within an area was not addressed.

The selection of a plant location is a two tier decision-making process according to Greenhut (1964). Distinction is made between demand as an area-determining and site determining locational factor. While market proximity is a factor in the selection of an area locations of competitors and interdependence of firms are seen as the operational aspects of demand at the site level.

A similar but more inconclusive distinction is made by Thomas (1975) in the typology of environments within which the firm conducts business and decisions are made. Constraints and opportunities for growth are seen as influenced by the characteristics of the firm, the industry, the geographic area, and the socio-economic-political system. Adding to this base are the works of network and informational theorists who challenge the economic assumption of complete knowledge and suggest that a firm is further constrained by the a firm's planning space, informational space, and decision space (Taylor 1979;

Moses and Williamson 1967; Mathur 1981; Kipnis 1984).

The integration of these two viewpoints raises the question of whether equivalence exists between the definition of space as used by the researcher and that used by the individual firm or industry in the site selection process. Clearly, there is a need for the examination of firm interviews or other primary data a comprehensive theory of the plant location selection process can be developed.

Finally, no treatment of interdependencies among input/output linked firms and industries could be considered complete without a discussion of transportation and inventory factors. Isard (1951) called attention to the the substitution principle whereby labor or transportation cost savings could be used to counterbalance increased costs of other inputs at a given location. Hakimi (1964) in his modeling of transportation factors suggests that the optimal plant location will be at the market. Louveaux, Thisse, and Beguin (1982) argue that the optimal location for plant location will be at inter-modal transshipment nodes rather than at the market unless large fixed transportation costs are evident. Even here, a market location may not be the optimal location if, according to these authors, the firm is dependent upon a number of markets. Inventory costs can be treated in the same way as transportation costs according to Louveau et al

(1982). The second and third theorems are viewed as applicable to the determination of the effect of inventory costs and management practices on plant location choices.

Empirical studies in the next section of this chapter examine the importance of transportation costs in the site selection process within metropolitan areas. Each of the theorists reviewed above investigated the possible influence transportation costs within a regional context or, as in the case of Isard, at the individual firm level. No agreement has been reached at the theoretical level.

To sum, Weber (1909) called attention to the notion that cost savings could be generated by locating in close spatial proximity to similar firms. Hoover (1937) extended this premise to include cost savings generated by firms locating in close spatial proximity to complementary firms. These savings were variously referred to as economies of agglomeration (Weber 1929), concentration (Hoover 1937), territorial agglomeration (Perroux 1970), external economies (Vernon 1960), and demand factors of location (Greenhut 1964). For other theorists, inter-industry linkages are a competitive factor in the plant selection process and distinct from each of the above economies (Isard 1951). Mitigating the influence of inter-industry linkage on firm spatial proximity are the characteristics of firms, industries, geographic

areas, and socio-economic-political systems according to Thomas (1975). Need to differentiate area and site determining factors is suggested by Greenhut (1964).

In each of these cases, inter-industry linkages receive secondary treatment as a component within a broader theoretical framework. Trade relationships among firms within an industry are ignored entirely. It can be argued, however, that inter-industry linkages include intra-industry linkages as the latter are an artifact of the use of highly aggregated industrial categories. By this argument intra-industry linkages become a surrogate for a set of linkages which are beyond the precision of a given transactions table and common definitions pertain.

This lack of theoretical focus suggests that either inter-industry linkages are a minor locational factor or that their influence may be easily diluted by other locational factors. However, there is no concensus about the importance of other locational factors such as labor and transportation costs within a regional economy. The purpose of this study is to directly examine the influence of input-output linkages on spatial proximity of manufacturing firms within an urban economy.

RELEVANT EMPIRICAL LITERATURE

Empirical studies can be classified according to

whether their focus is on the the existence of linkages or the influence of linkages on the attractiveness of an area for growth and diversification. These studies may be international, national, regional, or local in their scope. While findings are able to document the presence of linkages they do not definitively support postulates which associate linkages with area attractiveness or the spatial proximity of similar or complementary firms.

Lausen in his comparative study of Britain and the European Economic Community found that firm site choices could not be explained by inter-industry linkage arrangements. Manufacturing firms in England were found to be relatively footloose. As extensions of existing manufacturing facilities new European plants, on the other hand, were found to be relatively immobile. Similar results were found by Peschel (1982) in the study of European economic integration. The presence of agglomeration areas with clusters of linked industries were not found to help or hurt the attraction of new firms or to reduce opportunities for growth at the periphery. Auty (1975) in a study of sugar industries in Carribean countries found that plant size was the critical factor in the relationships which firms established with other firms. Small firms were also seen as embodying different technologies than large firms.

Streit (1969) found weak relationships between spatial association and economic alliance in his study of industries in the United Kingdom. Linkages were not found to be a binding force among transactionally related firms. Similar results were found by Harrigan (1982) in a study of industrial linkages and distributions in England using clustering algorithms designed to generate industrial and spatial clusters. External economies based on information/communication and amenities were used to explain concentrations of high technology industries. For others such as aerospace, timber and lumber, and shipbuilding labor costs and/or port proximity were used to account for spatial clusters identified in the study. Comparable results were found by Czamanski and Czamanski (1977) in their study of manufacturing clusters in the United States. Conversely, strong local linkages were found in a study of metal industries in West Midlands, England by Taylor and Wood (1975). These linkages were found to be important to small firms with less than 50 employees but not for plants with 90 or more employees. The presence of linkages was confirmed by O'Farrell (1985) in the study of surviving plants in Ireland. However, the presence of intra-national linkages which tied firms to domestic demand slowed the growth of plants relative to that observed in export linked firms.

The driving force for the growth of steel industries in the Pacific Northwest was attributed to inter-regional or export linkages by Schmidt (1973). In this same region Beyers (1975) in a study of Puget Sound, Washington as a growth center found weak linkages between industries within the region. In studies of Joinville, Brazil and 12 growth centers in Israel, Kipnis (1984) found the strongest within area linkages among small and medium firms. Multiplier effects could be traced to the growth of these firms and their forward linkages in particular. Among large plants only textile industries were found to have relatively strong local linkages.

Vernon in his New York Study (1960) found that spatial proximity was more important to small firms taking advantage of external economies generated by sharing the costs of support services. The clustering of firms within the central city was attributed to firm needs for communication/information, reduction in the costs of uncertainty, and opportunities to take advantage of economies not inter-industry linkages. No significant differences were observed between the central city and outlying areas on available space, transportation costs, or taxes.

Birch (1970)) in a comparative study of American metropolitan areas found that manufacturing firms were

moving to the suburbs. Linkages could not be used to explain their relocations. The attraction of manufacturing firms to the young cities was attributed to the availability of large open spaces and relatively new transportation systems. However, a recent study by Walker (1977) in England using analysis of variance found that spatial clusters of industries and complementary activities existed and that inter-sectoral linkages were important to the formation and growth of these spatial concentrations. Less important were the inter-industry linkages within manufacturing.

These apparent contradictions in the literature are attributed by Wood (1969) in his study of industrial location and linkages as the inadequacy of traditional theory which "...regards as awkward exceptions the complex agglomerations that are supposed to be based on principles of external economies of scale and close functional linkage." More than ten years later Smith (1981) following a comprehensive review of industrial location theory and research concludes that economies of agglomeration and inter-industry linkages will become more important in the future for industries and firms within advanced industrial societies. Present problems with the concepts are dismissed essentially as problems of measurement.

SUMMARY OF RELEVANT LITERATURE

Intra-industry and inter-industry linkages represent the transactional relationships which firms establish through their purchase of inputs (backward linkages) and sale of outputs (forward linkages). Plant location theory postulates that cost-reducing and revenue-generating opportunities exist for firms who locate in close spatial proximity to suppliers and markets. Economic development practitioners use these concepts to shape community development and target industry programs at each level of government. While the desired network of new firms and economic opportunities include all sectors of the economy the emphasis is usually placed upon the manufacturing industries as drivers of the economy which will create the largest impacts through the basic multiplier effect.

In actuality, evidence on manufacturing linkage impacts at the regional, national, and international levels does not substantiate the importance of linkages at the metropolitan or community level. Nor does research which focuses on the total economy, manufacturing industry serving, or consumer oriented sectors test the attributed ability of manufacturing linkages to influence the spatial patterns of production.

Assuming that a decision has been made to build a

new facility rather than utilize other options available such as expansion of an existing plant, choices must be made between competing areas and sites. The existing industrial mix is a product of characteristics of both area and site environs. If technological linkages are important locational determinants for firms, clustering should be observable in the landscape as linked firms choose locations which minimize distance with respect to the strength of linkages.

CHAPTER III

METHODOLOGY

This research tested hypotheses about the influence of linkages as determinants of close spatial proximity within a local urban economy. Variability in locational concentration patterns associated with other factors was controlled for by the use of a covariance model of multiple regression. Formalization of the research hypotheses, research design, area definition, measurement, and data collection are addressed below.

CONCEPTUAL MODEL

The patterns of spatial proximity among firms in the urban economy can be seen as a function of the strength of intra-industry and inter-industry linkages, factor of supply and market orientation, firm size, transportation costs, and utility costs. Stated as a conceptual model:

$$SP=f(IL, BL, FL, SO, MO, FS, TC, UC, CA)$$

WHERE: SP=Spatial Proximity

IL=Intra-industry Linkages

BL= Inter-industry Backward Linkages

FL=Inter-industry Forward Linkages

SO=Supply Orientation

MO=Market Orientation

FS=Firm Size

TC=Transportation Costs

UC=Utility Costs

CA=A Vector of Community Attributes

Firms differ in the number and magnitude of their transactional relationships with similar firms (IL) and other manufacturing firms (BL/FL). Trade relationships may be occasional, temporary, or routine. It has been assumed that in general the greater the frequency and magnitude of exchanges among given firms the more likely close spatial proximity (SP) will produce cost reducing savings and/or revenue generation at levels considered important to the firm. Spatial proximity (SP) is said to facilitate the timely exchange of goods and services, the possibility for the externalization of inventory costs (Samuelson 1957; Louveau, Thisse, and Beguin 1982), and establishment and development of informational flows and relationships (Moses and Williamson 1967) and the minimization of uncertainty (Webber 1972). The validity of these premises at the metropolitan level is questionable where limited transportation costs are involved.

The pull exerted by suppliers or markets will depend upon the types of inputs required in the production process (SP), the nature and composition of firm markets (MO), and the transportation costs (TC) involved in the movement of

goods and services. Obviously the greater the areal variation in these factors both individually and in combination, the steeper will be the cost and revenue surfaces and the more likely firms will be to seek locations in close proximity to firms which provide the factors to which they are most cost or revenue sensitive. The sensitivity of firms to these factors will also be dependent upon the size of the firm (FS), with smaller firms having more limited sets of options.

Traditional factors of production--land, labor, and capital--may constrain or enhance the availability of locational choices (Smith, 1981). The availability of an inventory of buildable industrially zoned sites supplied with adequate types and levels of social and physical infrastructure is necessary for the community seeking economic growth and diversification. Availability and costs of delivered services (UC) such as electricity, gas, water, and sanitary sewer and appropriate transportation modes for freight and passenger movement (TC)--roads, railroad, air, water, and pipeline--may be critical factors in the selection of areas and sites. Social infrastructure availability and cost is likely to be important to firm owners, executives, and line workers as costs will directly impact both the firm and its labor force.

Finally, the attitudes, policies, and programs of the community may increase or decrease area attractiveness.

The pursuit of business and industry is a highly competitive process (CEDO 1983). Public infrastructure and plant investments are the result of decisions with long term consequences for the community and the industry. Community attitudes, politics, and programs are a barometer of the receptivity of the community to the industry both now and in the future. As such they bear directly on the present and future costs of doing business in the area and at that site in a longitudinal framework. Unlike other costs previously mentioned, many of the variables important to the assessment of the community may not be amenable to quantification in monetary terms. But, the importance of this evaluation is well substantiated in the literature and the practical experience of communities seeking economic development. Through study design, variable selection and measurement, and use of statistical procedures address each of the elements presented in the conceptual model as elaborated here must be addressed.

RESEARCH HYPOTHESES

Derivable from the above discussion are statements which describe the hypothesized types and directions of relationships expected among identified variables. Current practice, which has accepted intrinsically micro level theoretical statements and inferred empirical findings at the macro level about the importance of linkages at the

metropolitan level. This research directly addresses the influence of linkages in a metropolitan setting. The research hypotheses are:

1. The spatial proximity of firms in an industry is not related to the magnitude of intra-industry technological linkages.
2. The spatial proximity of firms is not related to the magnitude of their primary forward and backward linkages.
3. The spatial proximity of firms is not related to the magnitude of their composite forward and backward linkages.

The expected aggregate impact of firm size, supply and market orientation, transportation costs, and utility costs will be controlled by the use of a covariance application of multiple regression. The extraction of the variability in the dependent variable, spatial proximity, with these covariates will allow the measurement of effects directly attributable to the active or experimental variables--intra-industry and inter-industry linkages.

OPERATIONAL MODEL

The model takes the following linear form:

$$Y = a + b_1X_{C1} + \dots + b_kX_{CK} + bX_{E1} + e$$

WHERE a, b_i = empirically estimated parameters

$X_{C1} \dots X_{CK}$ = Covariates

X_{E1} = Experimental Variable

e = Error Term

Independent variables identified as covariate candidates include firm size, supply and market orientation, transportation costs, utility costs, and community attributes. The former will be included in the model as covariates. The latter, as discussed earlier, are not readily amenable to quantification. Variability in the dependent variable attributable to differences among area geographic subunits will be controlled by the selection of an area where differences among geographic subunits are minimized.

Intra-industry and inter-industry linkages are the experimental variables in the design. The contribution of each linkage to variability in the dependent variable will be examined individually and in linear combination. No relationship is expected between the experimental variables, intra- and inter-industry linkages and the dependent variable. In order to test the research hypotheses the regression model will take the following general form:

$$Y_{IJK} = a + b_{1IF}X_{1F} + b_{2IS}X_{2IS} + b_{3IM}X_{3IM} \\ + b_{4IT}X_{4IT} + b_{5IU}X_{5IU} + b_{6IJK}X_{6IJK} \\ + e$$

WHERE: $Y_{IJK} = R_{NIJK}$ and

$$R_{NI} = \frac{2d_{IJK}}{A_R} N_{IJK} \quad (\text{Clark and Evans 1954})$$

WHERE:

d_{IJK} = the average of the nearest neighbor
distances for each firm in industry I

N_{IN} = the number of firms in industry I

A_R = the area of the region under
investigation

a, b_i = empirically derived parameters

$F_{1IF} \dots X_{5IU}$ are covariates

and

X_{IF} = industry I average firm size

X_{2S} = manufacturing purchases as a percentage
of total purchases in the industry

X_{3M} = manufacturing sales as a percentage
of total industry sales

X_{4IT} = transportation purchases as a percentage
of total industry purchases

X_{5IU} = utility purchases as a percentage
of total industry purchases

X_{6IJK} = percent of intra-industry purchases
among all firms in industry I to
total manufacturing purchases

Consideration of the variability in inter-industry
spatial proximity attributable to an inter-industry backward

or forward linkage results in substitutions in the above equation for the dependent and experimental variables. Combinations are treated in similar fashion.

MEASUREMENT OF SPATIAL PROXIMITY

Spatial proximity of firms within an industry is measured by the use of nearest neighbor analysis. Spatial proximity of subject industry firms to forward and backward linkage firms is measured by the use of a new and comparable technique devised to work with inter-industry linkages--the local concentration coefficient.

Developed by Clark and Evans (1954) the nearest neighbor technique calculates the mean of the distances between all firms within an industry and their nearest neighbor. Divided by the expected mean nearest neighbor distance for a random arrangement the index provides a concise measure of pattern in terms of a single value (Ebdon 1981). The index can take a value between 0.0 (a clustered pattern) and 2.12 (a dispersed pattern). A value of 1.00 indicates a random arrangement of points.

Criticisms of nearest neighbor analysis have focused on the sensitivity of the index as a direct statistic to differences in the shape of a bounded region under investigation (Hsu and Tiedemann 1968) and modifications made to the two-dimensional Poisson model in its application to the nearest neighbor analysis (Ingram 1978). Hsu and

Tiedemann (1968) using a hypothetical metropolitan area as an example that a pattern identified as random within the central city needed to be reclassified as clustered in the area of measurement included the surrounding suburban and urban fringe areas. Later Hsu and Mason (1972) suggested that this problem could be handled by development of alternative probability models.

These are reasonable concerns for its use as a statistic. However, in this investigation nearest neighbor is used only as a measurement of point array. All scores are based on the same geographical unit.

Thus the design of this research, which focuses on a bounded urban area with an integrated economic base and a fixed size and shape, circumvents the need to consider alternatives to the measurement of points in a region originally suggested by Clark and Evans (1954).

Continued use of nearest neighbor analysis seems, at first glance, appropriate. However, this technique requires the use of all points within the plane. Matching of inter-industry nearest neighbor pairs means that all subject firms as origins or destinations of goods will be included in the analysis. But linkage firms exist on a separate plan and will be excluded from the analysis if they are not the nearest neighbor of their type to subject firms and some linked firms. Therefore, the nearest neighbor technique cannot be used.

Cluster algorithms as used by Harrigan (1982) to identify integrated industry spatial clusters or by Walker (1977) to determine general spatial associations among establishment groupings do not measure nearest neighbor pair distances. What is needed is a measure which is comparable in formulation to the nearest neighbor technique and results in the a single index of the correlation among given pairs of points. A measurement called the Local Concentration Coefficient (LC) is advanced to measure of general spatial proximity of linked pairs.

The LC calculates the average length of lines between point pairs in the 2 industry pattern and compares this to the longest distance that could be expected to occur between 2 linked firms within the Oregon portion of the Portland-Vancouver SMSA.

Stated formally:

$${}^{kl}LC_{ILJ} = \frac{\sum_{nB} b_{ij}}{nB}$$

WHERE: b_{ij} = the distance from the i th firm of the k th industry to its nearest firm, j , of linked industry l .

n = the number of i th firms

B = the greatest possible distance from an i th firm to an l th partner.

The use of a referent line (B) in the equation's denominator which is the longest distance that could be

expected between any two linked firms in the Oregon portion of the Portland-Vancouver SMSA establishes a benchmark against which measured distances among pairs can be contrasted. The measure ranges from 0.0 indicating complete clustering to 1.00 which indicates a completely dispersed pattern of points within the bounded area. Again, both the nearest neighbor technique and the local concentration coefficient are used here strictly as measures of the dependent variable, spatial proximity. Industry scores are presented in Table I to allow an inspection of concentration patterns.

CUT-OFF OF LINKAGE ANALYSIS

Linkage data are expressed as percentages of total purchases and sales from a given k th base industry. All industries which supplied 5 percent or more of the value of the value of total manufacturing sales were included in the analysis. This resulted in the identification of up to 8 backward and 9 forward linkages for a given base (k). LC's for all paired patterns up to 17 for a single base industry were calculated. However, there were so few industries with more than 5 backward or forward inter-industry linkages that the analysis of 6th, 7th, 8th, and 9th inter-industry linkages was technically impractical by multiple linear regression.

Combinatorial concentrations were represented by

TABLE I

SPATIAL CONCENTRATION INFORMATION

SIC CODE	FIRMS	EMPLOYEES	SELF NEAREST NEIGHBOR	NUMBER OF LINKAGES		FIRST BACKWARD LINKAGE		FIRST FORWARD LINKAGE	
				BACKWARD	FORWARD	SIC	LC	SIC	LC
2011	11	452	.49245	3	3	2011	.15458	2013	.11838
2013	8	282	.44581	2	2	2011	.11889	2013	.16410
2017	6	230	.26034	4	3	2651	.13957	2051	.08833
2021	2	23	.40439	1	2	2017	.03751	2026	.11742
2026	8	740	.15928	2	2	2026	.05862	2026	.05862
2032	5	112	.10765	3	1	3411	.12638	2032	.05011
2033	5	97	.17475	4	6	3411	.17650	2033	.08132
2034	2	33	.07283	2	4	2034	.05361	2034	.05361
2035	5	516	.28247	4	2	2079	.18890	2035	.13152
2037	8	715	.14699	5	2	2651	.15260	2037	.05411
2041	3	171	.13061	4	4	2041	.07851	2051	.05002
2047	2	246	.34041	3	1	2011	.07391	2047	.25060
2048	8	252	.06841	5	1	2048	.02518	2048	.02518
2051	19	1,399	.14555	4	4	2041	.10416	2051	.03470
2052	5	1,030	.20801	4	2	2041	.10452	2099	.04327
2065	7	211	.38953	0	1	-	-	2065	.15331
2077	4	35	.24070	2	5	2077	.12530	2048	.13061
2084	6	33	.33174	4	1	2084	.14100	2084	.14100
2086	6	456	.05051	3	5	3411	.18559	2086	.02147
2087	2	58	.04374	4	3	2087	.03220	2086	.01396
2091	3	106	.07599	5	3	3411	.16490	2047	.04785
2095	2	167	.36949	3	1	3411	.05995	2095	.27201
2097	5	72	.06085	3	1	2643	.07629	2097	.02833
2098	2	74	.06399	3	2	2041	.04925	2032	.02467
2099	9	576	.15361	6	6	3079	.02120	2051	.01504
2231	7	277	.15086	1	2	2231	.05937	2231	.05937
2253	5	1,153	.04150	2	1	2293	.05272	2253	.01932
2321	18	1,382	.13681	2	1	2231	.06405	2321	.03357

TABLE I (CON'T)

SIC CODE	FIRMS	EMPLOYEES	SELF NEAREST NEIGHBOR	NUMBER OF LINKAGES		FIRST BACKWARD LINKAGE		FIRST FORWARD LINKAGE	
				BACKWARD	FORWARD	SIC	LC	SIC	LC
2391	19	201	.16853	2	3	2231	.07599	2391	.04025
2392	5	161	.15091	1	2	2231	.05831	2392	.07026
2393	5	632	.26216	2	5	2299	.13148	2041	.11055
2394	9	95	.09543	3	4	2293	.06024	3732	.05118
2399	6	41	.17148	2	2	2231	.06715	3711	.05503
2411	67	984	.33125	3	3	3496	.35751	2421	.05503
2421	39	2,696	.35430	2	4	2411	.05816	2431	.10717
2426	2	22	.15427	3	5	2421	.01722	2511	.07717
2429	7	92	.31951	3	5	2411	.07716	2499	.19610
2431	24	879	.20799	3	3	2421	.03315	2452	.06803
2434	51	642	.28630	6	3	2435	.10115	2431	.06373
2435	10	592	.35780	2	2	2411	.04287	2435	.11951
2439	7	289	.13233	1	2	2421	.03768	3732	.07040
2448	8	177	.40073	2	4	2421	.04342	3079	.05972
2452	9	108	.35390	3	1	2421	.04122	2452	.12282
2491	5	188	.41116	3	7	2421	.05660	3079	.03128
2499	15	339	.29541	4	4	2421	.03558	2499	.07941
2511	10	281	.27585	5	2	2421	.04114	3792	.05272
2512	11	348	.36218	5	2	2231	.12948	3792	.10865
2515	11	195	.14773	5	2	3496	.04947	2515	.04637
2521	3	69	.17944	4	1	2421	.02792	2521	.10786
2531	2	59	.38974	5	2	3312	.20024	3711	.20880
2541	22	503	.21239	5	2	3079	.02876	3732	.06365
2542	2	34	.16869	3	3	3312	.10492	3312	.10492
2591	5	86	.02678	4	1	3079	.00774	2591	.01247
2599	6	120	.32583	4	2	3312	.16918	3731	.09318
2621	5	1,261	.12516	3	6	2411	.05146	2752	.03477
2641	4	757	.18115	4	2	2621	.08941	2751	.03430
2642	3	538	.09167	3	3	2621	.08639	2721	.02855
2643	5	429	.20337	4	2	2621	.04900	2051	.05827

TABLE I (CON'T)

SIC CODE	FIRMS	EMPLOYEES	SELF NEAREST NEIGHBOR	NUMBER OF LINKAGES		FIRST BACKWARD LINKAGE		FIRST FORWARD LINKAGE	
				BACKWARD	FORWARD	SIC	LC	SIC	LC
2646	2	62	.67198	2	1	3079	.04822	3312	.24949
2649	3	87	.19473	3	4	2621	.07714	3079	.05316
2651	11	716	.09192	1	1	2621	.05533	2026	.05103
2711	32	2,115	.25970	2	1	2621	.10442	2711	.04780
2721	20	110	.25642	2	2	2751	.01986	2711	.02305
2731	9	51	.12087	3	1	2621	.05761	2731	.04195
2741	8	53	.12448	3	4	2789	.05076	2741	.04582
2751	171	1,878	.13610	4	4	2621	.06505	2721	.03541
2753	5	110	.13708	3	3	2621	.06084	2752	.00394
2761	7	258	.22785	3	2	2621	.07987	3622	.06827
2782	7	390	.12434	3	1	2721	.04806	2782	.05601
2789	6	101	.06818	3	4	2621	.06818	2731	.02644
2791	23	141	.11301	2	4	3861	.04894	2751	.00630
2793	5	54	.05805	4	1	3356	.04498	2751	.00391
2795	5	53	.03414	6	2	3354	.03429	2751	.00305
2812	7	608	.16255	1	4	2812	.06397	2812	.06397
2821	4	81	.08365	3	2	2812	.02518	3079	.03803
2831	12	330	.21577	5	2	2831	.06485	2831	.06485
2841	5	80	.12884	3	2	2812	.05701	2011	.14049
2842	7	86	.20378	5	2	2819	.05694	2842	.08019
2851	12	324	.20679	3	4	2812	.06803	3711	.10388
2875	2	14	.42766	2	1	2873	.30404	2875	.31483
2879	7	275	.21000	3	3	2812	.06272	2879	.08264
2891	6	133	.12849	4	5	2812	.04037	3714	.06429
2893	7	99	.16100	4	4	2812	.04588	2751	.01348
2899	5	133	.09028	5	2	2812	.02662	2851	.01888
2911	5	84	.11236	2	4	2911	.05234	2991	.05234
2952	6	490	.09739	2	2	2911	.02868	3711	.04856
3011	2	80	.00023	1	2	2819	.01936	3711	.04711
3041	3	30	.06545	3	1	2262	.02575	3711	.05499

TABLE I (CON'T)

SIC CODE	FIRMS	EMPLOYEES	SELF NEAREST NEIGHBOR	NUMBER OF LINKAGES		FIRST BACKWARD LINKAGE		FIRST FORWARD LINKAGE	
				BACKWARD	FORWARD	SIC	LC	SIC	LC
3069	7	409	.23941	4	3	2812	.09394	3711	.15267
3079	55	1,386	.21772	4	1	2821	.19220	3079	.03056
3111	2	50	.41882	3	3	2011	.06535	3143	.14671
3143	2	55	.20359	3	1	3111	.08890	3143	.14988
3151	2	37	.00303	2	0	3111	.00223	-	-
3199	6	80	.13870	5	4	3111	.07997	3143	.04608
3221	2	538	.07810	4	6	2651	.06218	2086	.12427
3211	5	84	.24656	4	3	3211	.11480	3711	.15762
3241	2	192	.18917	4	3	2812	.05139	3273	.01499
3251	3	68	.84076	5	0	3499	.18060	-	-
3259	2	16	.36367	6	1	2421	.11888	3259	.26773
3269	5	126	.18593	5	3	2812	.08225	3211	.08911
3271	2	38	.25013	4	3	3241	.11674	3272	.02467
3272	21	403	.20655	6	1	3241	.13780	3272	.10749
3273	18	576	.35065	1	3	3241	.02385	3272	.07854
3274	2	36	.15427	7	3	2643	.08248	3312	.01182
3281	4	47	.15852	5	3	2643	.04282	3949	.04980
3291	3	46	.03325	5	3	3291	.01998	3291	.01998
3292	3	17	.10211	5	2	2812	.02575	3714	.01433
3293	4	77	.11830	1	1	2499	.02737	3714	.02522
3295	14	672	.30024	4	8	3312	.20741	2952	.15879
3296	3	60	.17934	4	5	2891	.07565	3079	.01079
3299	3	124	.40969	5	5	3299	.24626	3299	.24626
3312	3	709	.07970	2	2	3312	.04791	3312	.04791
3313	2	216	.58169	5	1	3334	.56852	3312	.23878
3317	3	433	.28146	2	2	3312	.10426	3321	.06932
3321	12	4,046	.28507	4	2	3312	.17685	3312	.17685
3341	2	235	.08446	2	4	2812	.03649	3312	.08136
3356	2	6	.13379	0	4	-	-	3861	.06963
3361	9	506	.26747	2	1	3334	.37926	3714	.06856

TABLE I (CON'T)

SIC CODE	FIRMS	EMPLOYEES	SELF NEAREST NEIGHBOR	NUMBER OF LINKAGES		FIRST BACKWARD LINKAGE		FIRST FORWARD LINKAGE	
				BACKWARD	FORWARD	SIC	LC	SIC	LC
3362	8	171	.18992	2	5	3565	.05064	3494	.02171
3369	5	201	.26687	2	2	3544	.03258	3494	.05015
3398	3	48	.18409	4	2	3312	.16347	3312	.16347
3411	4	398	.29837	3	4	3312	.15365	2082	.22217
3412	4	148	.16247	2	5	3312	.08355	2992	.03965
3421	2	249	.20080	7	3	3312	.14774	2013	.07820
3423	5	488	.22817	5	6	3312	.17750	2431	.08784
3425	6	1,590	.26887	3	3	3312	.27110	2411	.09749
3429	11	1,088	.16385	4	1	3312	.17484	3711	.18747
3432	3	17	.15436	4	5	3362	.04642	2451	.46825
3433	12	897	.25842	4	4	3312	.23361	3433	.07767
3441	16	999	.25720	2	7	3312	.15625	3731	.09920
3442	28	835	.19685	5	4	3354	.15993	3792	.06144
3443	22	565	.30356	2	5	3312	.24441	3443	.06738
3444	53	1,017	.22435	3	6	3312	.19331	3792	.08285
3446	17	147	.34393	5	2	3312	.19313	3731	.12926
3448	3	59	.16386	4	1	3312	.09570	3448	.09849
3451	8	273	.15130	3	3	3312	.15523	3711	.16624
3462	3	139	.13907	1	1	3312	.05424	3714	.05715
3469	6	142	.10841	2	2	3312	.10960	3079	.00754
3471	17	604	.10946	2	2	2899	.06213	3677	.02019
3479	11	273	.14341	6	2	2851	.04519	3711	.10768
3484	4	44	.46701	2	7	3484	.24311	3312	.22542
3493	6	113	.18646	4	1	3312	.12676	3711	.11171
3494	14	795	.19484	4	4	3312	.15068	3585	.06825
3496	8	229	.12588	2	4	3312	.13892	2411	.04100
3499	5	25	.22920	3	2	3312	.15290	3312	.15290
3523	11	604	.36099	4	1	3312	.18457	3523	.11332
3524	2	17	.29387	4	3	3312	.15631	3524	.21634
3531	16	321	.22022	5	2	3312	.12246	3531	.05732

TABLE I (CON'T)

SIC CODE	FIRMS	EMPLOYEES	SELF NEAREST NEIGHBOR	NUMBER OF LINKAGES		FIRST BACKWARD LINKAGE		FIRST FORWARD LINKAGE	
				BACKWARD	FORWARD	SIC	LC	SIC	LC
3532	3	625	.25410	4	4	3312	.17489	3732	.15724
3534	2	29	.12787	3	4	3312	.07391	3731	.02363
3535	9	314	.18509	3	3	3312	.18937	3531	.06425
3536	5	218	.18490	4	4	3312	.24245	3731	.16060
3537	15	1,907	.20408	4	5	3312	.16363	3537	.05486
3541	4	71	.08638	6	5	3531	.04496	3541	.04496
3544	19	173	.21058	5	1	3312	.19279	3544	.05030
3546	4	210	.37340	4	4	3544	.04980	2411	.02843
3551	4	32	.13985	4	1	3312	.11297	3551	.07280
3553	34	1,635	.15307	4	7	3544	.05911	2411	.05571
3554	5	187	.23648	6	3	3554	.11011	3554	.11011
3555	2	80	.13100	5	5	3555	.09644	3555	.09644
3559	8	342	.18405	6	4	3312	.17692	2812	.08141
3561	6	1,097	.06059	3	5	3324	.02290	3312	.09926
3564	6	822	.23610	2	7	3312	.18774	3585	.06783
3565	12	134	.13850	5	3	2421	.03716	3324	.04377
3566	3	33	.19008	5	3	3312	.10637	3531	.07497
3567	5	136	.18674	3	4	3312	.15889	3567	.08695
3569	5	94	.20801	4	2	3312	.13837	2812	.06557
3573	5	1,904	.25576	3	1	3573	.11908	3573	.11908
3576	2	14	.13379	6	3	3079	.03751	3576	.09849
3579	2	5	.29387	4	2	3312	.20778	3579	.21634
3581	2	18	.25013	7	3	3312	.14029	3581	.18414
3585	5	156	.17850	3	2	3585	.08311	3585	.08311
3589	7	190	.25981	3	5	3312	.23709	3589	.10224
3592	2	201	.45372	6	3	3312	.25266	3711	.20983
3599	103	1,821	.18825	3	2	3599	.01948	3599	.01948
3612	4	435	.28908	2	2	3312	.16328	3646	.08620
3613	8	412	.26985	2	3	3622	.07714	3743	.11327
3622	9	135	.25579	5	4	3622	.08877	3585	.10831

TABLE I (CON'T)

SIC CODE	FIRMS	EMPLOYEES	SELF NEAREST NEIGHBOR	NUMBER OF LINKAGES		FIRST BACKWARD LINKAGE		FIRST FORWARD LINKAGE	
				BACKWARD	FORWARD	SIC	LC	SIC	LC
3643	4	150	.24375	3	6	3312	.20773	3661	.10385
3645	7	79	.13843	6	3	3612	.06428	3711	.10099
3691	9	318	.20643	3	2	3672	.12898	3711	.12993
3661	3	465	.32183	4	1	3661	.19345	3661	.19345
3662	11	333	.22953	3	3	3667	.02591	3662	.07205
3674	4	2,812	.17284	5	5	3677	.03374	3662	.04235
3677	16	1,184	.23207	4	6	3677	.06040	3662	.06360
3691	6	379	.25027	4	2	2819	.10178	3711	.19379
3693	6	203	.18821	5	9	3672	.14600	3693	.07999
3694	7	176	.23407	2	3	3694	.09211	3711	.16185
3713	7	170	.30409	6	4	3711	.11658	3711	.11658
3714	33	972	.19645	4	2	3312	.17795	3711	.18950
3715	16	619	.23355	4	2	3714	.05183	3713	.04836
3728	4	1,634	.46997	5	1	3728	.24465	3728	.24465
3731	13	2,493	.09660	2	1	3312	.09411	3731	.02789
3732	17	84	.23316	2	1	3211	.10054	3732	.05887
3743	3	1,430	.19359	3	2	3743	.11636	3743	.11636
3751	5	127	.24105	5	1	3731	.11223	3751	.11223
3792	13	166	.30879	5	1	3714	.07152	3792	.08916
3799	4	60	.08136	4	6	3312	.21202	3799	.04235
3811	6	141	.30897	4	3	3677	.04893	3811	.12561
3822	2	284	.02327	4	2	3079	.03109	3585	.11674
3823	3	368	.28744	2	3	3679	.04785	3711	.16061
3825	6	15,562	.15543	5	3	3679	.04499	3825	.06606
3832	3	19	.08445	5	2	3832	.05076	3832	.05076
3841	10	609	.12700	5	3	3079	.01353	3842	.21708
3842	10	89	.09459	6	1	2231	.05699	3842	.03114
3843	8	148	.23786	2	1	3356	.18902	3843	.08755
3851	8	174	.11797	5	3	3851	.04342	3851	.04342
3861	6	900	.10337	7	3	2812	.07711	3861	.04394

TABLE I (CON'T)

SIC CODE	FIRMS	EMPLOYEES	SELF NEAREST NEIGHBOR	NUMBER OF LINKAGES		FIRST BACKWARD LINKAGE		FIRST FORWARD LINKAGE	
				BACKWARD	FORWARD	SIC	LC	SIC	LC
3873	2	10	.23849	1	3	3873	.17557	3873	.17557
3911	10	47	.11228	1	2	3356	.07239	3911	.03697
3914	3	28	.10449	7	3	3312	.10135	3914	.06281
3931	4	228	.32099	4	1	3931	.16710	3931	.16710
3949	13	339	.18271	4	1	2421	.04170	3949	.05276
3953	8	81	.05247	8	0	2499	.03336	-	-
3961	2	4	.27642	2	2	3369	.10286	3961	.20349
3964	3	23	.32667	5	1	2231	.11282	2321	.04362
3991	3	234	.10221	6	7	3079	.02929	3325	.01719
3993	16	180	.13331	7	3	2821	.09318	3993	.12797
3995	3	21	.06412	6	1	3995	.03854	3995	.03854
3999	8	134	.21750	4	3	2651	.05036	3999	.08006

adding the LC's of appropriate linked sectors. Again, limitations in the number of industries with more than 5 backward or forward linkages forced the exclusion of inter-industry linkages 6, 7, 8, and 9 from inclusion in the combinatorial analysis.

AREA SELECTION

Nations, regions, metropolitan areas, and local communities compete for the siting of new manufacturing facilities. Firms begin their search at the broadest geographical levels and eventually narrow their choices to local areas and sites. Trade-offs will be evaluated as each area and site will individually and in combination offer a different bundle of opportunities and constraints. But in the end it is the local regions and communities which furnish the sites on which the new facilities will be constructed. Therefore plant location theoretical formulations and empirical studies must include an examination of the siting process at the site, local, and regional levels.

Empirical studies have investigated the site selection process at the macro and micro levels of analysis. It is clearly recognized that it is inappropriate to generalize findings from the site to area level (Stanford Research Institute 1982). The findings at the macro level have been applied to the local area level by policy-makers

and practitioners as the search goes on for propulsive or magnet industries which will stimulate development in the local economy, attract suppliers, and develop localized markets for goods and services (Oregon Economic Development Department 1977, Oregon Department of Land Conservation and Development 1973, Multnomah County 1977, and Batelle Memorial Institute 1967, 1975). The question is whether these policies and programs justified by empirical findings at the international, national and regional levels will work at the metropolitan scale. Recent findings by research/practitioners have found that the attraction of associated industry to the community may not have the magnitude of impact expected (Sommers 1984). This study focused on the relevancy of hypotheses generated in the literature through micro level theory development and empirical . studies done at various levels, with the exception of the micro one.

Most manufacturing firms prefer a site within a metropolitan area (U.S. Department of Commerce 1973). Sites selected present a picture of the end result of the locational search process. The metropolitan area chosen for study must have the following attributes if the influences of intra-industry and inter-industry linkages are to be assessed.

1. Subarea differences on influential variables

other than the linkage variables should be minimal.

2. Multi-modal transshipment nodes should be available and transportation infrastructure offer a choice of transportation modes at competitive costs
3. Utilities should be available and costs of delivered services competitive
4. An inventory of buildable sites must have been available across time.
5. A diversified manufacturing base with a relatively large number of firms capable of supporting intra-industry and inter-industry networks
6. A stable community framework which supports economic growth and diversification

The Oregon portion of the Portland-Vancouver SMSA meets these requirements. Subarea cost variations for land, labor, and capital are minimal although the usual differences between the central city and suburban fringe do exist. These differences do not, however, distinguish the Portland metropolitan area from other medium sized metropolitan areas. A full range of industrial sites with varying locational features and levels of public infrastructure have been historically available within the urban and urbanizable portions of the area (Baldwin, 1982) although a recent study (Stanford Research Institute 1982) questions the validity of this assertion in the 1980's for

the attraction of a full range of industry.

The Portland-Vancouver SMSA was credited with having the eleventh most diversified manufacturing base of all metropolitan areas in 1975 and ranked eighth in volume of tonnage shipped and received in 1977 (Multnomah County 1977). The Counties of Multnomah, Clackamas, and Washington which make-up the Oregon portion of the SMSA contains identified 220 4 digit Standard Industrial Classification manufacturing industries representing an estimated 2,111 firms with an estimated combined labor force of 108,295 in 1977.

The Portland-Vancouver SMSA serves as the State's commercial and distribution center. Its strategic location on the Columbia River fostered its development as a transshipment point for goods to and from the inland areas. Utility costs, particularly for electricity, are comparatively low (Stanford Research Institute 1982). Capital for development has been historically available although until recently natural resource oriented industries were favored by local investors over high technology economic activities (First Interstate Bank, 1977).

Historically, public land use policies and regulations have been flexible, allowing industry to locate where site requirements could be met with minimal publicly imposed constraints (Baldwin 1982). Until recently the availability of federal grants to support public infrastructure development allowed local communities to keep

pace with industries' demand for physical and social infrastructure. Differences in political policy, taxation, transportation freight rates, and utility costs required the deletion of Clark County Washington, the fourth County of the metropolitan area from this study.

The time chosen for the study was 1977. Major changes in public policies and regulations came about with the adoption of the Statewide Land Use Planning Goals and Urban Growth Boundary Strategies in 1973 and the first of the major jurisdictional comprehensive land use in compliance with new Statewide requirements. The impact of these regulations and resulting land use plans are a matter of some controversy. A study done by 1000 Friends of Oregon (1982) concludes that the inventory of buildable and industrially zoned sites increased substantially as a result of these plans. As has already been discussed the Stanford Research Institute (1982) questions the adequacy of current industrial site inventories. In addition, the current economic recession which took hold on the metropolitan area economy in 1979 and federal policy changes in the 1980's have created substantial shifts in the marketplace and availability of infrastructure capital.

The post 1977 period represents a time of changing conditions for the regional, state, and metropolitan area economies. Local governments have adopted comprehensive land use plans and implementing ordinances under the

Statewide Planning Goals and Guidelines. Demand for Oregon wood products has declined affecting the employment bases of many Oregon communities as more than 40 percent of the State's manufacturing employment is dependent upon the lumber and wood products industries (Multnomah County 1977). The majority of the growth in the high technology instruments industrial grouping has occurred in the late 1970's and 1980's. Federal funding for new infrastructure development is being severely curtailed at a time when Oregon communities are now under a 1983 legislative directive to develop long range public facilities and services plans (Oregon Legislature 1983). The national recession which hit Oregon in 1979 and still cripples much of the State's economy has led to increased efforts to develop a Statewide approach to economic development (Oregon Legislature 1983).

How these shifts in the marketplace, resource availability, new political approaches, and land use regulations will affect future opportunities for economic growth and diversification in the long run is not yet known. This dissertation in its investigation of the influence of intra- and inter-industry linkages on firm spatial proximity at the metropolitan level, depending on the results obtained, will suggest the continued use or reassessment of a strategy applied locally in an attempt to overcome existing economic conditions.

VARIABLE MEASUREMENT

Spatial Proximity

The intra-industry spatial proximity of firms is measured with the use of the Nearest Neighbor coefficients and inter-industry firm spatial proximity by the use of Local Concentration coefficients. The areal dimensions for both equations take into account the actual area in which manufacturing firms could site by the subtraction of subareas within the 3 Counties within federal and state national forests and recreation areas such as the Mt. Hood National Forest. The inclusion of natural resource and urban oriented manufacturing industries precluded the need for further modification of area measurements to differentiate between urban and rural areas.

Firms were mapped by industry and by plant address on millar overlays over a 1"=2000 ft. base scale map of the Portland metropolitan area. A list of firms and employment by industry is displayed in Table I. Inter-firm distance measures were made and rounded to the nearest tenth of an inch and then converted into miles and feet. A reliability check on a randomly selected 10 percent sample of measures indicated that over 99 percent of the measurements were accurate within one-tenth of an inch on the base map. Table II lists the study variables and gives definitions for each one used.

TABLE II

LIST OF VARIABLES

Dependent Variables

Spatial Proximity of Intra-industry Firms
 Spatial Proximity of Inter-industry Firms

Covariates

Industry Average Firm Size
 Manufacturing Purchases as a Percentage of Total
 Purchases in the Industry
 Manufacturing Sales as a Percentage of Total
 Industry Sales
 Transportation Purchases as a Percentage of Total
 Industry Purchases
 Utility Purchases as a Percentage of Total Industry
 Purchases

Experimental Variables

Percentage of Intra-industry Purchases Among All Firms
 in Industry I to Total Manufacturing Purchases

Percentage of First Backward Linkage Purchases to
 Total Manufacturing Purchases
 Percentage of Second Backward Linkage Purchases to
 Total Manufacturing Purchases
 Percentage of Third Backward Linkage Purchases to
 Total Manufacturing Purchases
 Percentage of Fourth Backward Linkage Purchases to
 Total Manufacturing Purchases
 Percentage of Fifth Backward Linkage Purchases to
 Total Manufacturing Purchases

Percentage of First Forward Linkage Sales to Total
 Manufacturing Sales
 Percentage of Second Forward Linkage Sales to Total
 Manufacturing Sales
 Percentage of Third Forward Linkage Sales to Total
 Manufacturing Sales
 Percentage of Fourth Forward Linkage Sales to Total
 Manufacturing Sales
 Percentage of Fifth Forward Linkage Sales to Total
 Manufacturing Sales

Linkages

To identify within and between industry trade flows theorists and researchers have traditionally used location quotients and input-output transactions tables. These tables identify inter-industry transactional flows (Leontief 1951), analyze industry interlocking dependencies and derive estimates how changes in one industry will impact other industries and sectors of the economy (Nourse 1968; Richardson 1972; Hewings 1977).

The use of input-output transactional tables at the 4 digit SIC level of disaggregation is most appropriate for this study. The problems of the use of more aggregated data are already noted and the use of a finer screen requires the grouping of firms into too great a number of categories for use at the metropolitan level of analysis. Input-output transactional tables describe the magnitude of inter-industry industry exchanges of goods and services in dollars--the information needed to develop intra-industry and inter-industry linkages. Level of product export is not relevant for this study as the focus is upon within area intra-industry and inter-industry linkage networks and participants. Industries were excluded from the firm set if no production facilities were present locally. Headquarters facilities were also excluded although any local production facilities were included in the industry set.

Inter-industry technological coefficients are used to

describe the magnitude of product and service exchanges among established inter-industry trading partners. Stability of measurement rather than fluctuations in relationships sensitive to short-term changing market conditions is the issue. Stability is an assumption on which input-output models is based although Walker (1982) notes that adjustments may be needed to apply national or regional coefficients at the local level. Tiebout (1962) suggested a questionnaire method which could be used to make these adjustments and apply this analysis technique at the local level. Ettlinger (1984) criticizes conventional Kenseyan multiplier base linkages because of the organizational factors of firms which inhibit local linkages. Gibson and Worden (1981) suggest that the minimum requirements approach gives the best estimate of census survey multipliers. Tiebout (1956) and Isard (1960) recognizing the greater stability of the national coefficients over time caution researchers using a longitudinal time frame in the research design about the compounding of measurement problems likely with the use of regional rather than national measures.

This study although using a 1977 cross-sectional data bank about plant location is using input-output locational coefficients to describe established inter-industry linkages most likely to lead to cost-reductions or revenue generation and be considered as a location factor by firms. These inter-industry measures are treated as

technological linkages rather than reflectors of actual transactional flow patterns within the Portland regional economy.

The Detailed Input-Output Structure of the U.S Economy 1972 (U.S. Department of Commerce, Bureau of Economic Analysis 1979) Use of Commodities by Industry table was used to obtain intra-industry and inter-industry records of purchases and sales. Firms are grouped into commodity/industrial classes equivalent in almost all cases to a 4 digit SIC category. Table I lists the number of industries, firms, and employment in the metropolitan area within each commodity/industry class and SIC categorical equivalences.

Industries with no plant in the region were dropped from the analysis and plants missing from the original data set were added. Table XIX in the Appendix lists by industry and employment 223 firms added to the original firm list. Total firm deletions were 106: 44 were out of area; 41 could not be located, and 21 firms were actually headquarters facilities or closed.

Additions resulted in a regional manufacturing employment estimate of 108,295 with a net increase of 3,640 due to firm list refinement. Sixteen industries with only one facility in the region were used in the analysis as a supplier of inputs or purchaser of outputs but could not be treated directly as a subject firm due to measurement

requirements of the Nearest Neighbor and Local Concentration formulations. The data base was composed of 220 industries with 2,111 firms.

Norcliffe (1975) found that the use of a modified location quotient produced scores which were roughly equivalent in their magnitude to input-output coefficients with a data base organized at the 4 digit Standard Industrial Classification level. In a similar study Isserman (1977) found that much of the unreliability of location quotients in previous research was associated, again, with the heterogeneity of industrial categories used. Input-output coefficients were used in this study at the 4 digit SIC level.

Transportation and Utility Costs

Expenditures on transportation and related services and utilities were obtained from the input-output transactions table (U. S. Department of Commerce, Bureau of Economic Analysis 1979). Total transportation costs include expenditures for passenger miles and commodity movement by highway, truck, rail, air, water, and pipeline and related transportation services. Utilities include expenditures for water, sanitary sewer, gas, and electricity. For each the subcategories were summed and defined in terms of the percentage of total industry purchases they represented.

Supply and Market Orientation

Manufacturing supply (material) orientation is the percent of total expenditures made spent for manufacturing inputs. Market orientation is the percent of total sales made to manufacturing firms. Industries vary in the proportion of their purchases and sales that are made with other manufacturing plants.

The location of other manufacturing facilities would not be expected to be important for other firms who purchase or sell a majority of their inputs and outputs outside the manufacturing sector of the economy. As with transportation and utility costs these variables are treated as covariates within the model.

Industry Average Firm Size

The prepondence of the studies in location theory which have included firm size as a variable have found effects attributable to firm size. Industry average firm size equals the total number of employers in the industry divided by the number of firms. The purpose of this variable's inclusion as a covariate is to account for the variability in the dependent variable, spatial proximity, attributable to firm size.

The smallest firm in the firm subset had 1 employee and the largest just over 9,000. The smallest subject industry had 4 employees and the largest 15,562. The largest

number of firms per industry was 171 (Table I).

CONCLUSION

To summarize, it is hypothesized that intra-industry and primary inter-industry linkages are not significant determinants of firm location within a metropolitan economy. It is also expected that spatial proximity of firms is not related to the magnitude of their composite forward and backward linkages. Failure to reject the null hypotheses will provide support for the research hypotheses as stated earlier in this chapter.

CHAPTER IV

FINDINGS

Multiple regression covariance applications were used to examine the relationships of intra-industry and inter-industry linkages to firm spatial proximity. Variation in the dependent variable attributable to inter-industry linkages was also examined for combinations of backward and forward linkages.

The treatment of average firm size, supply and market orientations, and transportation and utility industry intensities as covariates allowed their aggregate influence on the dependent variable to be controlled prior to measurement of the impacts of the experimental variables. The utility cost index is composed of water, electric, and sanitary sewer services purchases. The transportation cost composite index covers expenditures for passenger travel and movement of commodities by truck, water, air, rail, and pipeline. Colinearity between the covariates and the experimental variables was not an issue in this study. Considering all regression runs, association among covariates and experimental variables ranged from a low of $-.2606$ between the first forward linkage and market orientation in the first forward linkage model to $.37109$ between the second backward linkage and transportation

purchases in the three backward and three forward linkage model.

To reiterate, the research hypotheses of this study are:

1. The spatial proximity of firms in an industry is not related to the magnitude of intra-industry technological linkages.
2. The spatial proximity of firms is not related to the magnitude of their primary forward and backward linkages.
3. The spatial proximity of firms is not related to magnitude of their composite forward and backward linkages.

SUMMARY OF REGRESSION FINDINGS

Applications were considered for intra-industry linkages (Table III and IV), 5 backward linkages (Tables V-VII), 2 backward combinations (Table VIII), 5 forward linkages (Tables IX-XI), 2 forward combinations (Table XII), and 9 combinations of up to 3 forward and backward linkages (Tables XIII-XVII). Attrition of industries when using inter-industry linkages in combination precluded the use of 4th and 5th linkages together with the other inter-industry linkages.

Two multiple regression models had a overall F ratio significant at the .05 level: 1) intra-industry linkages when the covariate market orientation rather than supply

TABLE III

REGRESSION OF INTRA-INDUSTRY LINKAGE WITH
COVARIATES INCLUDING MANUFACTURING
PURCHASES

VARIABLE	REGRESSION COEFFICIENT	STANDARD ERROR B	F, REGRESSION COEFFICIENT
Utility Purchases	1.3495	0.5369	6.319***
Manufacturing Purchases	0.0203	0.0671	0.092
Average Firm Size	-0.0011	0.0041	0.071
Transportation Purchases	0.0439	0.3861	0.013
Intra-Industry Transactions	0.0296	0.0539	0.301
Constant	17.9119		
$R^2=0.0392$ ADJUSTED $R^2=0.0168$ $F=1.7481$ STANDARD ERROR=11.5597			

*** Significant at the .001 level

N=220

TABLE IV

REGRESSION OF INTRA-INDUSTRY LINKAGE WITH
COVARIATES INCLUDING MANUFACTURING
SALES

VARIABLE	REGRESSION COEFFICIENT	STANDARD ERROR B	F, REGRESSION COEFFICIENT
Utility Purchases	1.5190	0.5241	8.400***
Manufacturing Sales	-0.0351	0.0214	2.688*
Average Firm Size	-0.0010	0.0041	0.060
Transportation Purchases	-0.0234	0.3836	0.004
Intra-Industry Transactions	0.0430	0.0540	0.633
Constant	19.7021		
$R^2=0.0508$ ADJUSTED $R^2=0.0286$ $F=2.2884^*$ STANDARD ERROR=11.4903			

* Significant at the .05 level
*** Significant at the .001 level

N=220

TABLE V

REGRESSION OF FIRST BACKWARD LINKAGE
WITH COVARIATES

VARIABLE	REGRESSION COEFFICIENT	STANDARD ERROR B	F, REGRESSION COEFFICIENT
Utility Purchases	0.8081	0.3495	5.345***
Average Firm Size	-0.0005	0.0027	0.031
Manufacturing Purchases	0.0021	0.0440	0.002
Transportation Purchases	-0.3215	0.2495	1.660
1st Backward Linkage Purchases	-0.0024	0.0101	0.058
Constant	10.1492		

$R^2=0.0282$ ADJUSTED $R^2=0.0053$ F=1.2320
STANDARD ERROR=7.4686

*** Significant at the .001 level

N=218

TABLE VI

REGRESSIONS OF SECOND BACKWARD AND THIRD BACKWARD
LINKAGES WITH COVARIATES

VARIABLE	Y=2ND BACKWARD LINKAGE LC X=1,2,3,4,8			Y=3RD BACKWARD LINKAGE LC X=1,2,3,4,9		
	REGRESSION COEFFICIENT	STANDARD ERROR B	F,REGRESSION COEFFICIENT	REGRESSION COEFFICIENT	STANDARD ERROR B	F,REGRESSION COEFFICIENT
Utility Purchases	0.2133	0.3602	0.350	0.5395	0.3809	2.006
Average Firm Size	-0.0002	0.0026	0.006	0.0003	0.0026	0.014
Manufacturing Purchases	0.0312	0.0447	0.488	-0.0914	0.0539	2.874*
Transportation Purchases	-0.0470	0.2728	0.030	0.0398	0.3005	0.018
2nd Backward Linkage Purchases	-0.0237	0.0639	0.138			
3rd Backward Linkage Purchases				0.0886	0.1888	0.220
Constant	8.6195			10.4066		
R ²		0.0048			0.0613	
ADJUSTED R ²		-0.0200			0.0316	
F-RATIO		0.1946			2.0620	
STANDARD ERROR		7.2414			10.3014	

* Significant at the .05 level

N=206

N=164

TABLE VII

REGRESSIONS OF FOURTH BACKWARD AND FIFTH BACKWARD
LINKAGES WITH COVARIATES

VARIABLE	Y=4TH BACKWARD LINKAGE LC X=1,2,3,4,10			Y=5TH BACKWARD LINKAGE LC X=1,2,3,4,11		
	REGRESSION COEFFICIENT	STANDARD ERROR B	F, REGRESSION COEFFICIENT	REGRESSION COEFFICIENT	STANDARD ERROR B	F, REGRESSION COEFFICIENT
Utility Purchases	0.8127	0.3236	6.306***	0.5820	0.4529	1.651
Average Firm Size	-0.0002	0.0021	0.009	0.0058	0.0023	6.430***
Manufacturing Purchases	-0.0797	0.0538	2.193	0.0727	0.0805	0.816
Transportation Purchases	-0.2926	0.2469	1.405	0.2375	0.3746	0.402
4th Backward Linkage Purchases	0.1596	0.2556	0.390			
5th Backward Linkage Purchases				-1.0579	0.6027	3.080*
Constant		5.3934			10.5019	
R ²		0.0600			0.2091	
ADJUSTED R ²		0.0173			0.1359	
F-RATIO		1.4052			2.8550*	
STANDARD ERROR		5.4697			5.8843	

* Significant at the .05 level

*** Significant at the .001 level

N=116

N=60

TABLE VIII

REGRESSIONS OF FIRST AND SECOND BACKWARD AND
FIRST, SECOND, AND THIRD BACKWARD
LINKAGES WITH COVARIATES

VARIABLE	Y=1ST AND 2ND BACKWARD LINKAGE LC X=1,2,3,4,7,8			Y=1ST, 2ND AND 3RD BACKWARD LINKAGE LC X=1,2,3,4,7,8,9		
	REGRESSION COEFFICIENT	STANDARD ERROR B	F,REGRESSION COEFFICIENT	REGRESSION COEFFICIENT	STANDARD ERROR B	F,REGRESSION COEFFICIENT
Manufacturing Purchases	0.0474	0.0723	0.429	-0.0211	0.1223	0.030
Transportation Purchases	-0.3222	0.4421	0.531	0.0001	0.0059	0.000
Utility Purchases	1.0605	0.5833	3.305**	1.7140	0.8691	3.889***
Average Firm Size	-0.0009	0.0042	0.046	-0.4098	0.6981	0.345
1st Backward Linkage	-0.0139	0.0207	0.451	-0.0426	0.0808	0.278
2nd Backward Linkage	0.0374	0.1342	0.078	0.4807	0.3004	2.561*
3rd Backward Linkage				-0.6525	0.5040	1.676
Constant		17.8698			28.6571	
R ²		0.0198			0.0517	
ADJUSTED R ²		-0.0092			0.0091	
F-RATIO		0.6710			1.2140	
STANDARD ERROR		11.7244			16.4015	

* Significant at the .05 level

** Significant at the .01 level

*** Significant at the .001 level

N=206

N=164

TABLE IX

REGRESSION OF FIRST FORWARD LINKAGE
WITH COVARIATES

VARIABLE	REGRESSION COEFFICIENT	STANDARD ERROR B	F, REGRESSION COEFFICIENT
Average Firm Size	0.0002	0.0024	0.004
Manufacturing Sales	-0.0124	0.0127	0.965
Transportation Purchases	-0.0878	0.2277	0.149
Utility Purchases	0.3665	0.3350	1.197
1st Forward Linkage Sales	-0.0001	0.0003	0.127
Constant	9.2594		
$R^2=0.0082$ ADJUSTED $R^2=-0.0153$ $F=0.3499$ STANDARD ERROR=6.7763			
N=217			

TABLE X

REGRESSIONS OF SECOND FORWARD AND THIRD FORWARD
LINKAGES WITH COVARIATES

VARIABLE	Y=SECOND FORWARD LINKAGE LC X=1,2,3,4,13			Y=THIRD FORWARD LINKAGE LC X=1,2,3,4,14		
	REGRESSION COEFFICIENT	STANDARD ERROR B	F,REGRESSION COEFFICIENT	REGRESSION COEFFICIENT	STANDARD ERROR B	F,REGRESSION COEFFICIENT
Average Firm Size	-0.0021	0.0024	0.755	-0.0013	0.0035	0.134
Manufacturing Sales	-0.0062	0.0143	0.186	0.0269	0.0218	1.529
Transportation Purchases	0.2711	0.2495	1.181	0.4501	0.3937	1.307
Utility Purchases	-0.7014	0.4387	2.556*	-0.5281	0.6680	0.625
2nd Forward Linkage Sales	0.0358	0.0372	0.930			
3rd Forward Linkage Sales				-0.2520	0.2046	1.517
Constant		8.991			11.1275	
R ²		0.0357			0.0383	
ADJUSTED R ²		0.0061			-0.0067	
F-RATIO		1.2074			0.8513	
STANDARD ERROR		6.6483			8.9967	

* Significant at the .05 level

N=169

N=113

TABLE XI

REGRESSIONS OF FOURTH FORWARD AND FIFTH FORWARD
LINKAGES WITH COVARIATES

VARIABLE	Y=FOURTH FORWARD LINKAGE LC X=1,2,3,4,15			Y=FIFTH FORWARD LINKAGE LC X=1,2,3,4,16		
	REGRESSION COEFFICIENT	STANDARD ERROR B	F,REGRESSION COEFFICIENT	REGRESSION COEFFICIENT	STANDARD ERROR B	F,REGRESSION COEFFICIENT
Average Firm Size	-0.0020	0.0089	0.051	0.0012	0.0080	0.024
Manufacturing Sales	0.0316	0.0274	1.330	0.0189	0.0367	0.266
Transportation Purchases	0.1783	0.4933	0.131	0.5001	0.5094	0.964
Utility Purchases	0.4633	1.0169	0.208	-1.2752	1.1822	1.164
4th Forward Linkage Sales	0.5827	0.4063	2.057			
5th Forward Linkage Sales				0.2789	0.5981	0.217
Constant		2.7211			6.9580	
R ²		0.0747			0.0611	
ADJUSTED R ²		-0.0037			-0.1065	
F-RATIO		0.9532			0.3646	
STANDARD ERROR		6.6971			5.4893	

N=65

N=34

TABLE XII

REGRESSIONS OF FIRST AND SECOND FORWARD AND
FIRST, SECOND, AND THIRD FORWARD
LINKAGES WITH COVARIATES

VARIABLE	Y=1ST AND 2ND FORWARD LINKAGE LC X=1,2,3,4,12,13			Y=1ST, 2ND AND 3RD FORWARD LINKAGE LC X=1,2,3,4,12,13,14		
	REGRESSION COEFFICIENT	STANDARD ERROR B	F, REGRESSION COEFFICIENT	REGRESSION COEFFICIENT	STANDARD ERROR B	F, REGRESSION COEFFICIENT
Utility Purchases	-0.9272	0.6630	1.956	-1.7375	1.1457	2.300*
Average Firm Size	-0.0031	0.0037	0.698	-0.0052	0.0059	0.785
Manufacturing Sales	-0.0062	0.0216	0.082	0.0352	0.0378	0.863
Transportation Purchases	0.0619	0.3765	0.027	0.8133	0.6745	1.454
1st Forward Linkage	0.0002	0.0004	0.149	0.0445	0.0823	0.292
2nd Forward Linkage	0.0242	0.0631	0.147	-0.0785	0.1523	0.266
3rd Forward Linkage				-0.0273	0.3774	0.005
Constant		18.8327			27.2431	
R ²		0.0266			0.0381	
ADJUSTED R ²		-0.0095			-0.0260	
F-RATIO		0.7364			0.5940	
STANDARD ERROR		10.0182			15.4057	

*Significant at the .05 level

N=169

N=113

TABLE XIII

REGRESSIONS OF ONE BACKWARD AND ONE FORWARD LINKAGES AND ONE
BACKWARD AND TWO FORWARD LINKAGES WITH COVARIATES

VARIABLE	Y=1ST BACKWARD AND 1ST FORWARD LINKAGE LC X=1,2,3,4,5,7,12			Y=1ST BACKWARD AND 1ST AND 2ND FORWARD LINKAGE LC X=1,2,3,4,5,7,12,13		
	REGRESSION COEFFICIENT	STANDARD ERROR B	F, REGRESSION COEFFICIENT	REGRESSION COEFFICIENT	STANDARD ERROR B	F, REGRESSION COEFFICIENT
Utility	1.1481	0.6182	3.449**	-1.1214	0.9613	1.361
Purchases						
Average Firm	-0.0004	0.0043	0.009	-0.0047	0.0052	0.804
Size						
Manufacturing	0.0535	0.0712	0.564	0.0523	0.0958	0.298
Purchases						
Manufacturing	0.0024	0.0228	0.011	0.0038	0.0313	0.015
Sales						
Transportation	-0.3508	0.4040	0.754	-0.0520	0.5394	0.009
Purchases						
1st Backward	-0.0113	0.0164	0.477	-0.0178	0.0199	0.807
Linkage						
1st Forward	-0.0001	0.0005	0.053	0.0000	0.0006	0.001
Linkage						
2nd Forward				0.0739	0.0897	0.678
Linkage						
Constant		17.2761			27.0817	
R ²		0.0223			0.0357	
ADJUSTED R ²		-0.0107			-0.0129	
F-RATIO		0.6754			0.7350	
STANDARD ERROR		11.9124			14.1956	

** Significant at the .01 level

N=215

N=168

TABLE XIV

REGRESSIONS OF ONE BACKWARD AND THREE FORWARD LINKAGES AND TWO
BACKWARD AND ONE FORWARD LINKAGES WITH COVARIATES

VARIABLE	Y=1ST BACKWARD AND 1ST, 2ND AND THIRD FORWARD LINKAGE LC X=1,2,3,4,5,7,12,13,14			Y=1ST AND 2ND BACKWARD AND 1ST FORWARD LINKAGE LC X=1,2,3,4,5,7,8,12		
	REGRESSION COEFFICIENT	STANDARD ERROR B	F, REGRESSION COEFFICIENT	REGRESSION COEFFICIENT	STANDARD ERROR B	F, REGRESSION COEFFICIENT
Utility Purchases	-2.2026	1.4911	2.182*	1.0334	0.8642	1.430
Average Firm Size	-0.0083	0.0075	1.212	-0.0010	0.0056	0.030
Manufacturing Purchases	0.0177	0.1566	0.013	0.1140	0.0985	1.339
Manufacturing Sales	0.0481	0.0493	0.954	0.0251	0.0308	0.661
Transportation Purchases	0.8440	0.8689	0.944	-0.2331	0.6020	0.150
1st Backward Linkage	-0.0206	0.0283	0.530	-0.0241	0.0282	0.728
1st Forward Linkage	0.0344	0.1050	0.107	-0.0002	0.0006	0.129
2nd Backward Linkage				0.0312	0.1806	0.030
2nd Forward Linkage	-0.0563	0.1936	0.085			
3rd Forward Linkage	0.1037	0.4837	0.046			
Constant		37.0372			24.0940	
R ²		0.0424			0.0225	
ADJUSTED R ²		-0.0421			-0.0178	
F-RATIO		0.5016			0.5589	
STANDARD ERROR		19.5740			15.7316	
* Significant at the .05 level		N=112			N=203	

TABLE XV

REGRESSIONS OF TWO BACKWARD AND TWO FORWARD LINKAGES AND TWO
BACKWARD AND THREE FORWARD LINKAGES WITH COVARIATES

VARIABLE	Y=1ST AND 2ND BACKWARD AND FORWARD LINKAGE LC X=1,2,3,4,5,7,8,12,13			Y=1ST AND 2ND BACKWARD AND 1ST 2ND AND 3RD FORWARD LINKAGE LC X=1,2,3,4,5,7,8,12,13,14		
	REGRESSION COEFFICIENT	STANDARD ERROR B	F, REGRESSION COEFFICIENT	REGRESSION COEFFICIENT	STANDARD ERROR B	F, REGRESSION COEFFICIENT
Utility	-1.7342	1.3248	1.713	-2.3910	2.0219	1.398
Purchases						
Average Firm	-0.0056	0.0067	0.715	-0.0101	0.0092	1.223
Size						
Manufacturing	0.1080	0.1286	0.706	0.0571	0.1952	0.086
Purchases						
Manufacturing	0.0275	0.0407	0.456	0.0735	0.0597	1.513
Sales						
Transportation	0.1329	0.7974	0.028	0.8156	1.3071	0.389
Purchases						
1st Backward	-0.0318	0.0353	0.812	-0.0483	0.0543	0.791
Linkage						
1st Forward	-0.0000	0.0008	0.004	0.0376	0.1296	0.084
Linkage						
2nd Backward	0.0658	0.2434	0.073	0.1908	0.4162	0.210
Linkage						
2nd Forward	0.0658	0.1166	0.318	-0.0373	0.2382	0.024
Linkage						
3rd Forward				0.1410	0.6015	0.055
Linkage						
Constant		18.1693			23.6161	
R ²		0.0375			0.0465	
ADJUSTED R ²		-0.0206			-0.0508	
F-RATIO		0.6454			0.4783	
STANDARD ERROR		18.1693			23.6161	
N=159					N=109	

TABLE XVI

REGRESSIONS OF THREE BACKWARD AND ONE FORWARD LINKAGES AND
THREE BACKWARD AND TWO FORWARD LINKAGES WITH COVARIATES

VARIABLE	Y=1ST, 2ND AND 3RD BACKWARD AND 1ST FORWARD LINKAGE LC X=1,2,3,4,5,7,8,9,12			Y=1ST, 2ND AND 3RD BACKWARD AND 1ST AND 2ND FORWARD LINKAGE LC X=1,2,3,4,5,7,8,9,12,13		
	REGRESSION COEFFICIENT	STANDARD ERROR B	F, REGRESSION COEFFICIENT	REGRESSION COEFFICIENT	STANDARD ERROR B	F, REGRESSION COEFFICIENT
Utility	1.0941	1.1948	0.839	-1.9361	1.6597	1.361
Purchases						
Average Firm Size	0.0009	0.0072	0.016	-0.0065	0.0079	0.670
Manufacturing	0.0141	0.1495	0.009	0.0444	0.1782	0.062
Purchases						
Manufacturing	0.0571	0.0546	1.092	0.0236	0.0676	0.122
Sales						
Transportation	-0.2731	0.8572	0.101	-0.0003	1.0511	0.000
Purchases						
1st Backward	-0.0968	0.1017	0.905	-0.0465	0.1176	0.156
Linkage						
1st Forward	0.0827	0.0541	2.337*	0.0056	0.0876	0.004
Linkage						
2nd Backward	0.4207	0.3680	1.3307	0.7827	0.4623	2.866**
Linkage						
2nd Forward				0.1627	0.1689	0.929
Linkage						
3rd Backward	-0.6970	0.6247	1.245	-1.0336	0.7316	1.996*
Linkage						
Constant		34.3197			43.3098	
R ²		0.0489			0.0597	
ADJUSTED R ²		-0.0074			-0.0207	
F-RATIO		0.8690			0.7430	
STANDARD ERROR		19.9027			21.2733	

* Significant at the .05 level
N=162

** Significant at the .01 level
N=128

TABLE XVII
REGRESSION OF THREE BACKWARD AND THREE FORWARD LINKAGES
WITH COVARIATES

VARIABLE	REGRESSION COEFFICIENT	STANDARD ERROR B	F, REGRESSION COEFFICIENT
Utility	-2.2396	2.3859	0.881
Purchases			
Average Firm	-0.0135	0.0103	1.713
Size			
Manufacturing	-0.0022	0.2489	0.000
Purchases			
Manufacturing	0.1553	0.0990	2.463**
Sales			
Transportation	-0.5201	1.6012	0.106
Purchases			
1st Backward	0.0006	0.1790	0.000
Linkage			
1st Forward	0.0800	0.1549	0.266
Linkage			
2nd Backward	1.6468	0.7408	4.942***
Linkage			
2nd Forward	0.1166	0.2800	0.173
Linkage			
3rd Backward	-1.3361	1.1215	1.419
Linkage			
3rd Forward	0.4478	0.7695	0.339
Linkage			
Constant	37.6609		

$R^2=0.1325$ ADJUSTED $R^2=0.0117$ F-RATIO=1.0966
 STANDARD ERROR=26.269 ** Significant at the .01 level
 *** Significant at the .001 level N=91

orientation was utilized and the inter-industry 5th backward linkage. (Tables III and VI). In the former case the experimental variable did not have a significant F ratio while in the latter the experimental variable, the 5th backward linkage, was significant at the .05 level. Little variability in the dependent variable was accounted for by the covariates and experimental variables in these two runs with multiple coefficients of determination of 0.0508 and 0.2091 respectively.

Statistically significant relationships between experimental variables and the dependent variable existed only for the 5th backward linkage when intra-industry and inter-industry linkages were considered individually (Table VII). In forward/backward inter-industry linkage combinations the 1st forward linkage was significant at the the 2nd and 3rd backward linkages in the 3 backward/2 forward run (Table XVI); and the backward linkage in the 3 backward and forward combination (Table XVII).

No consistent pattern emerged between inter-industry firm spatial proximity and the experimental variables with statistically significant regression coefficients. Increases in purchases of inputs from the 5th inter-industry linkage are associated with a more dispersed array of subject firms and suppliers (Table VII). This tendency towards randomness is also evidenced in the relationship

between the first forward linkage and firm spatial proximity when considered in combination with the first three backward linkages. As the magnitude of the third backward linkage in an array that includes three backward and two forward linkage firms increases inter-industry firm spatial proximity decreases (Tables XV and XVI). Increases in the purchases of inputs from the third largest supply source results in a more concentrated distribution of firms among the purchaser, three largest suppliers and two manufacturing industry markets (Table XVI). The second largest supply source exerts pressures towards concentration for firm groupings composed of a subject industry with its three largest suppliers and output buyers (Table XVII).

These statistically significant dependent and experimental variable relationships occurred in models with extremely small multiple coefficients of determination. The experimental variables and covariates working together could account for no more than 13 percent of the variability in the dependent variable in any of these applications. The result is statistically significant relationships among a few of the experimental variables and the dependent variable which have little explanatory power.

Among the covariates only utility costs, market orientation and average firm size were significant at the

statistically significant relationships between covariates and intra-industry or inter-industry spatial proximity appeared only in applications with extremely small overall multiple coefficients of determination.

Utility costs were positively related to firm spatial proximity for the intra-industry and individual backward linkages and significant at the .01 level or greater for the intra-industry (market orientation covariate), 1st and 4th backward and combination backward linkage runs. The direction of the industry utility intensiveness with spatial proximity for the forward and backward and forward combinations was not consistent. Percent of industry expenditures spent on utilities was significant at the .05 level or greater for the 2nd forward; 1st, 2nd and 3rd forward combination; and three forward/backward combinations. Utility costs were inversely related to spatial proximity in the 2nd forward, forward combination, and 1 backward/ 3 forward linkage combination models. Utility costs were positively related to the dependent variable in the run which used 1 backward and 1 forward linkage.

Market orientation (percent of manufacturing sales of all sales) was negatively related to spatial proximity at the .05 level of significance for the intra-industry linkage run containing the covariate and the 3rd backward linkage application (Tables IV and VI) In the model which combined

the first 3 backward and forward linkages market orientation was positively related to the dependent variable at the .01 level (TABLE XVI). Average firm size was positively related to inter-industry firm spatial proximity and significant at the .001 level for the 5th backward linkage application (Table VII). No consistent patterns were found between average firm size except as specified and transportation costs with the dependent variable for the covariance applications.

REGRESSION FINDINGS AND THE RESEARCH HYPOTHESES

The first hypothesis anticipated no relationship between intra-industry technological linkages and intra-industry firm spatial proximity. No statistically significant regression coefficients were produced in either of the intra-industry linkage models. The first model used percent of manufacturing inputs to total inputs purchased. In the second application percent of manufacturing outputs to total outputs was substituted for the former in the covariate sequence. Failure to reject the null hypothesis lends support for the research hypothesis of no relationship between intra-industry linkages and intra-industry firm spatial proximity within an urban economy.

The second research hypothesis stipulated no

association between inter-industry backward and forward linkages and related inter-industry firm spatial proximity. The research hypothesis was supported with the retention of the null hypothesis of no difference for the first four backward and all five forward inter-industry technological linkages. An inverse and statistically significant relationship was found between the 5th backward inter-industry linkage and inter-industry firm spatial proximity for the subject firm and its 5th largest supply source. As the percentage of manufacturing inputs from this supplier increased spatial distance between purchasing and supplier firms decreased. However, less than 6 percent of the variability in the dependent variable is attributable to the workings of the covariates and experimental variable in this model.

No association was predicted for the relationship between forward and backward technological linkage combinations and the appropriate combination of inter-industry firm spatial array in the third research hypothesis. Of the 9 possible combinations for 3 backward and 3 forward inter-industry linkages the null hypothesis was retained in 6 applications. In the remaining models the 1st forward linkage was positively related to the dependent variable in the 3 backward/1 forward combination. The 2nd backward linkage had a statistically significant relationship to the

dependent variable in a positive direction in the 3 backward/2 forward combination and a negative direction in the 3 backward/3 forward combination. A negative and statistically significant relationship exists between the 3rd backward technological linkage and the dependent variable in the 3 backward/2 forward linkage combination application. In each of these cases less than 14 percent of the variability in inter-industry firm spatial proximity is explained by all covariates and experimental variables in each of the combination applications.

DISCUSSION

The null hypothesis of no difference for the experimental variables was retained in twenty-one out of twenty-five of the multiple regression covariance applications. This statistical hypothesis was rejected for the 5th backward linkage in the 5th backward linkage model; 1st forward linkage in the 3 backward/1 forward combination run; 2nd and 3rd backward linkages in the 3 backward/2 forward combination; and 2nd backward linkage in the 3 backward/3 forward linkage combination application. Only for the intra-industry linkage (with the market orientation covariate) and the 5th backward linkage models were statistically significant multiple coefficients of determination produced. In neither application using intra-industry linkages were statistically significant regression

coefficients produced for the experimental variable. Even in inter-industry applications where statistically significant results were obtained the amount of variability accounted for by the covariates and experimental variabilities working in concert was inconsequential.

The interpretation of results from the applications where the appropriate null hypothesis was retained is relatively straightforward. Technological linkages within an industry and among industries are not determinants of firm location in an urban economy. For the models in which the experimental variables were statistically significant the interpretation is not as clear cut.

In these latter instances if the multiple coefficients of determination had been substantial and the contributions made by the experimental variables relatively large, then variability in the dependent variable could have been accounted for in large measure by the influence of the experimental factors. This was not the case. The multiple coefficients were so low that little variability in the dependent variable could be attributed to the influence of the covariates working in aggregate and/or the experimental variables.

For the statistically significant experimental variables the question, given their measured lack of impact,

is whether these results could have been obtained as a result of the variables or statistically procedures utilized. By extension if these factors unduly influenced the results obtained for the statistically significant experimental variables then the same forces would be in operation on the other independent variables used in this study.

The definition and operationalization of the variables in this study were commented on length in the literature review and methodology chapters. To review, input and output coefficients are standardly utilized in the study of economic systems and the inter-relationships of sectors and industries (Leontief 1951; Miernyk 1965; Smith 1981). Following the advice of Tiebout (1956) and Isard (1960) national coefficients were used because of the greater stability of these measures over regional coefficients since the study design is cross-sectional but is the result of a longitudinal decision-making process. The effects of secondary products have been controlled in the 1972 national transactional tables to provide better information on industry input requirements and input/output relationships (Ritz 1979). Finally within industry homogeneity has been enhanced while between industry heterogeneity is preserved through the use of the Standard Industry Classification/Commodity system at the 4 digit level of disaggregation (Norcliffe 1975).

Debate on the use of the nearest neighbor procedure focuses on its use as a statistic in the classification of firm spatial arrays and the effect of area size and shape on measurements obtained (Lloyd and Dicken 1972). In this study the use of nearest neighbor is limited to its use as a measure of firm spatial proximity. Area size and shape arguments are not pertinent as the area in this research is fixed and its shape conforms to the Oregon portion of the metropolitan region. It is within these fixed boundaries that the determination of firm spatial proximity is made.

The straight line distance between each firm and its nearest neighbor within the defined area is used to calculate the nearest neighbor measure. This method can be followed when investigating firm spatial arrays within an industry. When the array is composed of an industry and its trading partner(s) and the task is to determine the nearest linked industry firm to the subject industry the methodology required by nearest neighbor cannot be followed. It is likely that one or more linked firm will be a 'nearest neighbor' to any of the subject firms and will therefore be excluded from consideration. Therefore the requirement that all firms be included is violated and the technique cannot be utilized.

The local concentration index was developed to provide a means for measuring the straight line distance between

subject industry firms and the closest firm within a linked industry. As with the nearest neighbor the use of the local concentration technique as a measurement circumvents the question of the influence of different area sizes and shapes upon the measurement because of the fixed areal base used in this study. The shape of the distribution of the local concentration measures is relevant to the question of its interpretation as a statistic but not to its more limited use as a measure of spatial distance among two firms within a defined space. The question asked in the study is whether intra-industry and inter-industry linkages can be used to explain tendencies to minimize distance among firms in technologically linked industries.

The performance of the covariates in the regression models suggests that the variability observed in the dependent variable can be influenced by variables constructed in the same way as the experimental variables. Inspection of the distribution of scores for the 220 industries used on the independent and dependent variables indicates that lack of score range and variability cannot be used to explain the absence of impact by the selected variables on firm spatial proximity.

The other possibility for lack of significant multiple coefficients of determination other than the research hypotheses is the violation of the assumptions of multiple

linear regression. These are the use of interval data from a population without bias where each variable is normally distributed and variances equal and the independent variables are orthogonal to each other (Rabiega 1984). Each of these aspects is examined in turn.

Clearly the data is interval level and cases were drawn from a population without bias. Variances were equalized through the conversion of variable scores into percentages for use in the model. Lack of colinearity among the independent variables was evidenced in the low coefficients exhibited in the variable correlation matrix. The highest correlation coefficient, 0.4353, was achieved by the composite transportation and utility cost variables. Association values among each other pair of independent variables was less than 0.2900.

The remaining assumption of normal distribution of variables was violated in this study. Each variable as indicated by the mean and standard deviation had a slight right skew associated with the presence of a few extreme scores. This skew was slight and consistent across all variables in the model with the greatest skew being produced by average firm size. Skews may result in the slight inflation of the F ratio. Since lack of statistically significant multiple coefficients of determination was common in this study it is clear that

the violation of this assumption was not problematic for the study's outcomes.

The final point which needs addressing in this section is the presence of statistically significant regression coefficients for variables within models without statistically significant F ratios and very low multiple coefficients of determination. While these results help to substantiate the validity of the model used their substantive importance as locational factors must continue to be questioned when so little variability in the dependent variable can be attributed to their influence. The presence of one or two statistically significant experimental variables within the more complex inter-industry combination applications suggests that more research may be needed into the spatial relationships of manufacturing firms within industrial clusters on a firm to firm basis. As an input the swing in the direction of relationship between industry utility intensiveness and inter-industry firm spatial proximity from positive in the input applications to negative in the forward linkage models is consistent with the expected operation of the model. Both in the case of utilities and transportation the contention by Norcliffe (1975) of the importance of the availability of needed types of infrastructure may be at least as important as cost differentials associated with site selection within a

metropolitan or local level urban economy.

CONCLUSION

The research hypotheses were supported in twenty-one out of twenty-five applications of the model. Intra-industry technological linkages were not found to be important determinants of within industry firm spatial proximity in a metropolitan region. Inter-industry technological linkages were likewise not found to be important locational determinants except in the case of the 5th backward linkage when considered individually. Statistically significant associations were found between the 1st forward linkage in the 3 backward/1 forward linkage application; the 2nd backward linkage in the 3 backward/2 forward and 3 backward and forward combination runs; and the 3rd backward linkage in the 3 backward/2 forward linkage model. These experimental variables were, however, able to account for little of the variability in the dependent variable when considered individually or working in concert with the covariates in the model. In these latter cases statistical significance was not associated with substantive importance.

Alternative hypotheses which would have attributed results obtained to the study's design and implementation were examined. Failure to reject the null hypotheses and lack of explanatory power of alternative hypotheses lends

support for the research hypotheses. Intra-industry and inter-industry technological linkages have not been shown to be important factors in the search for sites by manufacturing industries within a metropolitan economy.

CHAPTER V

CONCLUSION

Manufacturing intra-industry and inter-industry technological linkages are rejected as important determinants of the spatial distribution of manufacturing firms in an urban economy. Spatial proximity of firms in an industry was not found to be related to the magnitude of intra-industry linkages. The strength of primary backward and forward manufacturing linkages could also not be used to explain the degree of spatial concentration found among manufacturing industries in the metropolitan area.

There are several implications of these findings for plant location theory. Clearly economies of agglomeration and external economies have no effect on industrial patterns in this analysis. Second, that the poor performance of covariates suggest that application of existing theory to localized manufacturing plant selection processes may be misplaced. Third, that the distinction between economies of agglomeration and external economies may be easily made at the theoretical level but for empirical investigation this differentiation is elusive and questionable. Finally, that a reappraisal of the factors of manufacturing plant site selection at the metropolitan level

is needed. In this study industry spatial patterns were found to be random not only with respect to linkage variables but also to the traditionally used variables of firm size, manufacturing supply and market dependencies, and transportation and utility cost sensitivity.

The first implication is strongly supported by the current research. It is the major research hypothesis which has been confirmed. These findings do not, however, challenge the viability of linkages as explanatory factors at the larger regional, national, or international levels. Nor do these results question the importance of linkages found at the metropolitan level by studies such as Harrigan and Walker between manufacturing industries and other sectors of the economy such as commerce. They simply say in a pure manufacturing location situation at a local level that agglomeration and external economies as elaborated in this research are not operative.

Though no attempt to infer to broader geographical scales the experience here connotes the following for larger scale studies: 1) industry disaggregation to the maximum level feasible is advisable; 2) all pertinent variables need to be included in multiple variable or covariate models; and 3) there is substantial support for previous research efforts and theoretical frameworks which minimize the importance of manufacturing based linkage agglomerations at the metropolitan level. As stated earlier,

however, these results do not challenge the influence of inter-sectoral linkages on manufacturing plant location at this scale of development.

The utility of a distinction between intra-industry and inter-industry linkage patterns and the associated differentiation between linkage produced economies of agglomeration and external economies cannot be supported. Industries in this study were classified according to their 4 digit Standard Industrial Classification. Spatial proximity was measured between firms. Even at this level of disaggregation intra-industry technological patterns did not distinguish themselves in performance from inter-industry technological linkages. Ordering of intra-industry and forward and backward linkages based on magnitude of the relationship resulted in no systematic positioning of the intra-industry linkages with respect to other principals. The former concept may have utility when reserved to describe transactional patterns in a vertically integrated corporation where savings are generated through the internalization of costs associated with the acquisition of goods and services and to study the site selection process of an individual firm.

Variability in the spatial proximity of firms across manufacturers in the metropolitan area could not be accounted for by manufacturing inter-industry linkages, industrial supply and market orientations, or transportation

and utility cost sensitivity. While there can be and probably are some individual manufacturing industries where some or all of these variables may have a measurable effect the lack of positive systematic findings across industries suggests that other factors must be used to describe localized plant site patterns.

Norcliffe (1975) contends that infrastructure availability, internal and external economies, contact, and linkages are the most important site locational factors. The Standard Research Institute study of Portland (1982) stressed the need for the maintenance of an inventory of industrial zoned sites with varying mixtures and levels of physical and social infrastructure capable of meeting the needs of diverse locational needs of a multiplicity of industries if recruitment efforts were to be successful. Taken together these studies provide the basis of a list of site locational factors which need to be pursued when linkages are used to describe firm relationships across sectors of the economy. Such an approach would be consistent with the work of Greenhut (1964) and Thomas (1979) who make distinctions among firm, industry, site, geographic area, and socio-political-economic locational factors.

For economic practitioners, industrial recruiters, and planners the study findings suggest that a re-evaluation of policies which stress ties among manufacturers as a primary

tool for the creation of a new or expanded community employment base should be made. The expenditure of resources on the identification of inter-industry linkages and recruitment of identified target industries may better be spent on the preparation of adequately served developable industrial sites. Such an approach does not, however, negate the need of the community to assess its economic strengths and weaknesses and develop a local strategy likely to attract industries and firms seeking advantages which the community can afford to offer. In weighing the likely impacts of alternative industrial choices on the community careful inspection of estimates of indirect employment impact will obviously need to be made as firm candidates may or may not depend on the local economy for purchase of inputs or sale of products.

Inferred from the study can be support for the use of a joint economic development approach for the communities of a regional economic unit. Linkage relationships are not operative at the localized manufacturing plant site selection level. Spatial proximity to manufacturing linked firms is not required. For industries which are not linkage sensitive local resources can be combined to assure that within the region attractive sites are available. For industries which are linkage sensitive the limited number of sites available in close proximity to other manufacturers can be preserved. The necessary follow-up to this study for

industrial recruiters is the identification of those specific industries which are dependent upon locations in close spatial proximity to linked firms.

BIBLIOGRAPHY

BIBLIOGRAPHY

- Alonso, W., "Location Theory," Regional Development in Planning: A Reader, J. Friedman and W. Alonso, Editors, MIT Press, Cambridge, Massachusetts, 1964.
- Auty, R.M., "Small Factors and the Measurement of Internal Economies of Scale," The Professional Geographer, 1975, 315-322.
- Baldwin, Robert E., "Industrial Development in Portland," Interviews, Unpublished, 1982.
- Battelle Memorial Institute, The Pacific Northwest: A Study of Economic Growth in a Quality Environment, Addendum Report, March 1975.
- Bannock, G., The Economics of Small Firms, Basil Blackwell, Oxford, 1981.
- Bell, Thomas L., Stanley R. Lieber and Gerard Rushton, "Clustering of Services," Annals, the Association of American Geographers, 64(2), 1974, 214-225.
- Beyers, William B., "On Geographical Properties of Growth Center Linkage Systems," Unpublished Dissertation Draft, University of Washington, circa 1975.
- Birch, David L., The Economic Future of City and Suburb, New York: Committee for Economic Development, 1970, 1-15.
- Bourne, Larry S., "Private Redevelopment of the Central City," Department of Geography Research Paper, Number 112, University of Chicago, 1967.
- Bourne, Larry S., "Urban Structures and Land Use Decisions", Annals, the Association of American Geographers, Vol.66, Number 4, December 1976, 531.
- Brown, Robert C., "The Use and Mis-use of Distance Variables in Land Use Analysis," The Professional Geographer, Vol. 20, Number 5, September 1968, 337-341.
- Butler, James W., "Use of Input-Output Studies in Industrial Development," AIDC Journal, American Industrial Development Council, Vol. 11, Number 1, January 1976, 39-67.
- Chander, Parkash, "The Nonlinear Input-Output Model", Journal of Economic Theory, Vol. 30, Number 2, August 1983, 219-229.

- Clark, P.J. and F.C. Evans, "Distance to Nearest Neighbor as a Measure of Spatial Relationships in Population", Ecology, 35, 1954, 445-453.
- Collins, L. and D. F. Walker, Editors, Locational Dynamics of Manufacturing Activity, John Wiley Press, New York, 1975.
- Czamanski, Daniel and Stan Czamanski, "Industrial Complexes: Their Typology, Structure, and Relation to Economic Development", Papers, Regional Science Association, 38, 1977. 93-111.
- Council for Economic Development of Oregon, Development Reporter, Vol. 2, Number 1, 1983.
- Ebdon, David, "Spatial Statistics," Statistics in Geography, A Practical Approach, Basic Blackwell, Oxford, 1980, 106-127.
- Ettlinger, N., "Comments on the Concept of Linkages from the Perspective of Corporate Organization in the Modern Capitalist System," Tijdschrift voor Economische en Sociale Geografie, 75, 1984, 285-291.
- Evans, Alan W., "The Pure Theory of City Size in an Industrial Economy," Urban Studies, February 1972, 49-77.
- Executive Office of the President, Office of Management and Budget, Standard Industrial Classification Manual 1972, U. S. Government Printing Office, Catalogue Number PREX 2.6/2:IN27/972, 1972.
- First Interstate Bank, "Capital Availability in the Pacific Northwest," Multnomah County Economic Development Advisory Commission, Unpublished Report, Winter 1977.
- Galbraith, J. K., Economics and the Public Purpose, Penguin Press, Harmondsworth, 1975.
- Getis, Arthur, "On the Use of the Term "Random" in Spatial Analysis," The Professional Geographer, Vol. 29, Number 1, February 1977, 58-61.
- Gibson, L. J. and Marshall A. Worden, "Estimating the Economic Base Multiplier: A Test of Alternative Procedures," Economic Geography, 57, 1981, 146-159.
- Green, D. Howard, "Industrialists Information Levels of Regional Incentives," Regional Studies, Vol. 11, 1977, 7-18.

- Greenhut, Melvin L., Plant Location in Theory and Practice, University of North Carolina Press, Chapel Hill, 1956.
- Greenhut, Melvin L., Microeconomics and the Space Economy, Scott Foresman Press, Chicago, 1963.
- Greenhut, Melvin L., "When Is the Demand Factor of Location Important?", Land Economics, 40, 1964, 175-184.
- Greenhut, Melvin L., "Needed--A Return to the Classics in Regional Economic Development Theory," Kyklos, XIX, 1966, 461-478.
- Griffith, Daniel A., "A Note on Spatial Autocorrelation," The Professional Geographer, Vol. 27, Number 4, November 1975, 470-474.
- Guelke, Leonard, "Regional Geography," The Professional Geographer, Vol. 29, Number 1, February 1977, 1-7.
- Hakanson, L., "Towards a Theory of Location and Corporate Growth", Spatial Analysis, Industry, and the Industrial Environment, Vol. 1, Industrial Systems, John Wiley, 1979, 115-138.
- Hakimi, S. L., "Optimum Location of Switching Centers and the Absolute Centers and Medians of a Graph", Operations Research, 12, 1964, 450-459.
- Harrigan, F. J., "The Relationship between Industrial and Geographical Linkages: A Case Study of the United Kingdom," Journal of Regional Science, Vol. 22, Number 1, 1982, 19-31.
- Harvey, D., "The Geography of Capital Accumulation: A Reconstruction of the Marxian Theory," Antipode, Vol. 7, Number 2, 1975, 9-21.
- Herr, J. Paul, "Local Governmental Competition for Business Activity: An Urban Case Study," The Professional Geographer, Vol. 31, Number 3, August 1979, 292-298.
- Hewings, Geoffrey, "A Note on Forecasting the Economic Base," The Professional Geographer, Vol. 21, Number 5, September 1969, 315-318.
- Hewings, Geoffrey, Regional Industrial Analysis and Development, Methuen Press, London 1977.
- Hewings, Geoffrey, "The Role of Prior Information in Updating Regional Input-Output Models", Socio-Economic Planning Sciences, Vol. 18, Number 5, 1984, 319-336.

- Holland, S. K., Capital Versus the Regions, Macmillan Press, London, 1976.
- Holland, S. K., The Regional Problem, Macmillan Press, London, 1976.
- Holzner, Lutz, "Urban Geography Without a Regional System," The Professional Geographer, Vol. 18, Number 3, May 1966, 129-131.
- Hoover, E. M., Location Theory and the Shoe and Leather Industries, Harvard University Press, Cambridge, Massachusetts, 1937.
- Hoover, E. M., The Location of Economic Activity, McGraw-Hill Press, New York, 1948.
- Hoover, E. M., "Some Programmed Models for Industry Location", Land Economics, Vol. 43, 1967, 303-311.
- Hsu Shin-yi and Clifford E. Tiedemann, "A Rational Method of Delimiting Study Areas for Unevenly Distributed Point Phenomena," The Professional Geographer, Vol. 20, Number 6, November 6, 1968, 376-381.
- Hsu, Shin-yi and J. D. Mason, "Towards a Better Understanding of the Boundary Effect on the Decision-Making Process in the Poisson Model of Point Distribution in Bounded Two-Dimensional Space," Proceedings, Association of American Geographers, 4, 1972, 46-49.
- Imai, Haruo, "CBD Hypothesis and Economies of Agglomeration", Journal of Economic Theory, Vol. 28, 1982, 275-299.
- Ingram, David R., "An Evaluation of Procedures Utilized in Nearest Neighbor Analysis," Geografiska Annaler, Vol. 60, 1978, 65-70.
- Isard, W., "Distance Inputs and the Space Economy", Quarterly Journal of Economics, 65, 1951, 181-198.
- Isard, W. and Robert E. Kuenne, "The Impact of Steel Upon the Greater New York-Philadelphia Industrial Region: A Study in Agglomeration Projection", Review of Economics and Statistics, 35, 1953.
- Isard, W., Location and Space Economy, MIT Press, Cambridge, Massachusetts, 1956.
- Isard, W., Methods of Regional Analysis, MIT Press, Cambridge, Massachusetts, 1960.

- Isserman, A. M., "Regional Employment Multiplier: A New Approach: A Comment," Land Economics, Vol. 51, 1975, 290-293.
- Isserman, A. M., "The Location Quotient Approach to Measuring Regional Economic Impacts," Journal of the American Institute of Planners, 1977, 33-41.
- Isserman, A. M., "Estimating Export Activity in a Regional Economy: A Theoretical and Empirical Analysis of Alternate Methods," International Regional Science Review, Vol. 5, 1980, 155-184.
- Johnson, Harry G., "The Economic Approach to Social Questions," National Affairs, Vol. 12, 1968, 15-23.
- Kiel, Stanley, "Input/Output Approach to Predicting Comparative of Industry," Growth and Change, Vol. 11, 1980, .
- Kipnis, Baruch A., "Plant Size and Urban Development," Urban Studies, 21, 1984, 53-61.
- Lahiri, Sajal, "On Reconciling Purchases and Sales Estimates of a Regional Input-Output Table," Socio-Economic Planning Sciences, Vol. 18, Number 5, 1984, 337-342.
- Lausen, J. R., "On Growth Poles," Urban Studies, Vol. 6, 1969, 137-161.
- Lemelin, Andre, "Relatedness in the Patterns of Interindustry Diversification," The Review of Economics and Statistics, 1982, 646-656.
- Leontief, W. W., "Input-Output Economics," Scientific American, Vol. 185, 1951, 15-21.
- Lichtenberg, R. M., One-tenth of a Nation, Harvard University Press, Cambridge, Massachusetts, 1960.
- Lloyd, Peter E. and Peter Dicken, Location in Space, Harper and Row, 1972.
- Losch, A., "The Nature of Economic Regions," Southern Economic Journal, Vol. 5, 1938, 71-78.
- Louveaux, Francois, Jacques-Francois Thisse and Hubert Beguin, "Location Theory and Transportation Costs," Regional Science and Urban Economics, Vol. 12, 1982, 529-545.
- Mai, Chao-cheng, "Optimum Location and the Theory of the

- Firm Under Demand Uncertainty," Regional Science and Urban Economics, Vol. 11, 1981, 549-557.
- Mai, Chao-Cheng, "Demand Function and Location Theory of the Firm Under Price Uncertainty", Urban Studies, 21, 1984, 459-464.
- Mathur, V. K., "Location Theory of a Firm Under Price Uncertainty," Regional Science and Urban Economics, Vol. 11, 1981/82, 529-547.
- Miernyk, W., The Elements of Input-Output Analysis, Random House Press, New York, 1965.
- Moomaw, Ronald, "Firm Location and City Size: Reduced Productivity Advantages as a Factor in the Decline of Manufacturing in Urban Areas", Journal of Urban Economics, 17, 1985, 73-79.
- Moore, C. L., "A New Look at the Minimum Requirements Approach to Regional Economic Analysis", Economic Geography, 51, 1975, 350-356.
- Moses, Leon and Harold F. Williamson, Jr., "The Location of Economic Activity in Cities," American Economic Review, Papers and Proceedings, May 1967, 211-222.
- Multnomah County, Overall Economic Development Plan I, Colleen Greer Acres, Project Director, Multnomah County Department of Environmental Services, Division of Planning and Development, 1977.
- Norcliffe, G. B., "Using Location Quotients to Estimate the Economic Base and Trade Flows," Regional Studies, Vol. 17, 1983, 161-168.
- Norcliffe, G. B., "A Theory of Manufacturing Places", Locational Dynamics of Manufacturing Activity, L. Collins and D. F. Walker, Editors, John Wiley Press, New York, 1975, 19-57.
- North, Douglas D., "Location Theory and Regional Economic Growth," Journal of Political Economy, Vol. 63, 1955, 240-255.
- Nourse, H. O., Regional Economics, McGraw-Hill Press, New York, 1968.
- O'Farrell, P. N., "Employment Change in Manufacturing: The Case of Surviving Plants", Urban Studies, 22, 1985, 57-68.
- Openshaw, S., "Ecological Fallacies and the Analysis of

Areal Census Data", Environment and Planning A,
Vol. 16, 1984, 17-31.

Oregon Legislature, Senate Bill 2295, 62nd Oregon Legislative
Assembly, 1983.

Oregon Legislature, Senate Bill 534, 62nd Oregon Legislative
Assembly, 1983.

Oregon Department of Land Conservation and Development,
Statewide Land Use Planning Goals and Guidelines,
1983 revised.

Ostrom, Vincent, Charles M. Tiebout and Robert Warren, "The
Organization of Government in Metropolitan Areas: A
Theoretical Inquiry," The Organization of
Metropolitan Government, 1960, 542-553.

Perroux, F., "Economic Space Theory and Applications,"
Quarterly Journal of Economics, Vol. 64, 1950,
89-104.

Perroux, F., "Note on the Concept of "Growth Poles","
Regional Economics, David L. McKee, Robert D. Dean,
and William H. Leahy, Editors, The Free Press, 1970,
93-103.

Peschel, Karin, "International Trade and Industrial Location",
Regional Science and Urban Economics, Vol. 12, 1982
247-269.

Rabiega, William A., Straight Talk About Statistical
Analysis, Unpublished, 1985.

Rees, J., "Decision-making: The Growth of the Firm and the
Business Environment", Spatial Perspectives on
Industrial Organization and Decision-making, F. E.
I. Hamilton, Editor, John Wiley Press, London, 189-212.

Richardson, H., Regional Economics, Weidenfeld and
Nicolson Press, London, 1969.

Richardson, H., Input-Output Analysis and Regional
Economies, John Wiley Press, 1972, pp. 85-138.

Ritz, Philip M., "The Input-Output Structure of the U. S.
Economy, 1972," Survey of Current Business, Vol.
59, Number 2, February 1979, 34-72.

Romanoff, Eliahu, "Interindustry Analysis for Regional
Growth and Development: The Dynamics of Manpower
Issues", Socio-Economic Planning Sciences, Vol. 18,
Number 5, 1984, 353-363.

- Rose, Adam, "Technological Change and Input-Output Analysis: An Appraisal", Socio-Economic Planning Sciences, Vol. 18, Number 5, 1984, 305-318.
- Samuelson, P. A., "Intertemporal Price Equilibrium: A Prologue to the Theory of Speculation", Weltwirtschaftliches Archives, Vol. 79, 1957, 181-221.
- Schmidt, C. G., "Spatial Structure of Industrial Linkages and Regional Economic Growth: An Analysis of Linkage Stability Among Pacific Northwest Steel Firms, 1963-1970, Unpublished Dissertation, University of Washington, Seattle, 1973.
- Smith, David M., Industrial Location, An Economic Geographical Analysis, Second Edition, John Wiley and Sons Inc., New York, Chichester, Brisbane, Toronto, 1981.
- Sommers, Gail, "The Effects of Economic Shifts: How a Small City Copes," Urban Affairs Annual Association Meeting Paper, Portland Oregon, March 1984.
- Stabler, J. C., "Exports and Evolution: The Process of Regional Change", Land Economics, XLIV, Number 1, 1968, 11-23.
- Stanford Research Institute, "Strengths and Weaknesses of the Portland Area as an Industrial Location", Stanford Research Institute, Phase I Report, July 1982.
- Streit, M. E., "Spatial Associations and Economic Linkages between Industries", Journal of Regional Science, 9, 1969, 177-188.
- Swoveland, C., "A Deterministic Multi-Period Production Planning Model with Piecewise Concave Production and Holding Backorder Costs," Management Science, Vol. 21, 1975, 1007-1013.
- Tauchen, Helen and Ann D. Witte, "Office Building Costs and Location," Land Economics, Vol. 59, University of Wisconsin Press, 1983, 324-336.
- Taylor, M. J., "Organizational Growth, Spatial Interaction and Location Decision-making," Regional Studies, Vol. 91, 1979, 313-323.
- Thomas, M. D., "Explanatory Frameworks for Growth and Change in Uninational and Multinational Firms," Commission of Industrial Systems, 1979 Symposium, Rotterdam, Unpublished Conference Paper.

- Thomas, Wilbur R., "Internal and External Factors in the Development of Urban Economies," Issues in Urban Economics, H. S. Perloff and L. Wingo, Editors, John Hopkins Press, Baltimore, 1975, 43-62.
- Tiebout, C. M., "Exports and Regional Economic Growth," Journal of Political Economy, Vol. 64, 1956, 256-260.
- Tiebout, C. M., "Regional and Interregional Input-Output Models; An Appraisal," Southern Economic Journal, Vol. 24, 1957, 140-147.
- Tiebout, C. M., The Community Economic Base Study, Committee for Economic Development, Supplementary Paper, Number 16, December 1962.
- Tomer, John F., "Community Control and the Theory of the Firm. Review of Social Economics, Vol. 38, 1980, 191.
- U. S. Department of Commerce, Industrial Location Detriments 1971-1975, William W. Blunt Jr., Acting Assistant Secretary for Economic Development, February 1973.
- Vernon, R., Metropolis 1985, Harvard University Press, Cambridge, Massachusetts, 1960.
- Walker, Susanne R., "Linkage Structures in an Urban Economy", Regional Studies, Vol. 11, 1977, 263-273.
- Webber, M. J., The Impact of Uncertainty on Location, MIT Press, Cambridge, Massachusetts, 1972.
- Weber, A., Alfred Weber's Theory of the Location of Industries, translated by C. J. Friedrich, from Über den Standort der Industrien 1909, University of Chicago Press, Chicago, 1929.
- White, Michelle J., "Firm Suburbanization and Urban Subcenters", Journal of Urban Economics, 3, 1976, 323-343.
- Wood, P. A., "Industrial Location and Linkage", Area, 2, 1969, 32-39.
- Wood, P. A., "Are Behavioral Approaches to Industrial Location Theory Doomed to be Descriptive?," Industrial Alternative Frameworks, D. B. Massey and W. I. Morrison Editors, Center for Environmental Studies, London, 1975, 41-48.

APPENDIX

TABLE XVIII

STATUS OF INDUSTRIES WITH ONE FIRM

A. INDUSTRIES USED AS BACKWARD AND FORWARD LINKAGES

INPUT- OUTPUT CLASS. NUMBER	STANDARD INDUSTRIAL CLASS. NUMBER	INDUSTRY TITLE	NUMBER OF EMPLOYEES
14.2500	2075	Soybean Oil Mills	2
14.2900	2079	Shortening and Cooking Oils	114
14.2101	2082	Malt Liquors	262
17.1002	2299	Textile Goods n.e.c.	45
27.0201	2873	Nitrogenous and Phosphatic Fertilizers	1
38.0400	3334	Primary Aluminum	992
38.0800	3354	Aluminum Rolling and Drawing	16
38.1000	3357	Nonferrous Wire Drawing and Insulation	15
37.0402	3399	Primary Metal Products n.e.c.	5
13.0600	3482	Small Arms Ammunition	5
54.0500	3635	Household Vacuum Cleaners	6
56.0200	3652	Phonographic Record and Tape	6
57.0100	3672	Electron Tubes	8
59.0301	3711	Motor Vehicles	3,358
64.0302	3942	Dolls	5
64.0504	3955	Carbon Paper and Inked Ribbons	26

TABLE XVIII (CON'T)

B. EXISTING SINGLE FIRM INDUSTRIES BELOW LINKAGE THRESHOLD
CUTOFF

INPUT- OUTPUT CLASS. NUMBER	STANDARD INDUSTRIAL CLASS. NUMBER	INDUSTRY TITLE	NUMBER OF EMPLOYEES
14.2104	2085	Distilled Liquor except Brandy	10
24.0300	2631	Paperboard Mills	55
34.0303	3171	Women's Handbags and Purses	58
36.1400	3275	Gypsum Products	65

TABLE XIX

INDUSTRY REVISIONS

INPUT- OUTPUT CLASS. NUMBER	INDUSTRY TITLE	REVISIONS				NUMBER OF FIRMS	NUMBER OF EMPLOYEES
		ADD	DROP	ACTION TAKEN OUT OF AREA	NOT LISTED		
14.0101	Meat Packing Plants	X				1	17
			X			1	17
				X		1	1
14.0103	Poultry and Egg Processing	X				4	9
			X			1	1
14.0200	Creamery Butter	X				1	15
14.0600	Fluid Milk			X		1	3
14.0800	Canned Specialties	X				3	23
14.1000	Dehydrated Food Products	X				1	20
14.1100	Pickles, Sauces, and Salad Dress.	X				2	84
14.1300	Frozen Fruits and Vegetables	X				2	75
14.1501	Dog, Cat, and Other Pet Food			X		1	1
14.1502	Prepared Foods, n.e.c.				X	1	1
14.1802	Cookies and Crackers	X				1	2

TABLE XIX (CON'T)

INPUT- OUTPUT CLASS. NUMBER	INDUSTRY TITLE	REVISIONS				NUMBER OF FIRMS	NUMBER OF EMPLOYEES
		ADD	DROP	ACTION TAKEN OUT OF AREA	NOT LISTED		
14.2021	Confectionery Products	X				3	11
			X			1	3
14.2700	Animal and Marine Fats and Oils	X				2	27
			X			1	17
14.2103	Wines, Brandy and Brandy Spirits	X				4	15
			X			1	3
14.2200	Bottled and Canned Soft Drinks	X				2	255
14.0700	Canned and Cured Seafoods	X				2	32
14.2800	Roasted Coffee	X				1	40
14.3000	Manufactured Ice	X				4	56
14.3100	Macaroni and Spaghetti	X				1	45
14.3200	Food Preparations	X				2	220
16.0100	Broadwoven Fabric Mills		X			1	240
19.0301	Textile Bags	X				1	8

TABLE XIX (CON'T)

INPUT- OUTPUT CLASS. NUMBER	INDUSTRY TITLE	REVISIONS				NUMBER OF FIRMS	NUMBER OF EMPLOYEES
		ADD	DROP	ACTION TAKEN OUT OF AREA	NOT LISTED		
20.0100	Logging Camps and Logging Contractors	X				6	126
			X			3	13
				X		8	50
					X	4	32
20.0200	Sawmills and Planing Mills	X				4	565
			X			3	204
				X		1	4
					X	1	1
20.0400	Special Products, Sawmills n.e.c.	X				3	27
			X			1	4
20.0502	Wood Kitchen Cabinets			X		1	1
					X	3	17
20.6000	Veneer and Plywood		X			4	1,020
				X		4	297
20.0701	Structural Wood Members n.e.c.				X	1	48
20.0901	Wood Pallets and Skids				X	1	3
20.0902	Wood Products n.e.c.				X	1	1
23.0600	Blinds, Shades and Drapery Hardware	X				3	71
				X		1	64

TABLE XIX (CON'T)

INPUT- OUTPUT CLASS. NUMBER	INDUSTRY TITLE	REVISIONS				NUMBER OF FIRMS	NUMBER OF EMPLOYEES
		ADD	DROP	ACTION TAKEN OUT OF AREA	NOT LISTED		
24.0200	Paper Mills except Building Paper	X				2	106
			X			1	354
				X		2	429
24.0701	Paper Coating and Glazing	X				1	5
24.0400	Envelopes	X				1	275
24.0702	Bags except Textile	X				1	60
24.0704	Pressed and Molded Pulp Goods	X				1	56
24.0706	Converted Paper Products	X				2	73
25.0000	Paperboard Containers			X		1	2
26.0100	Newspapers	X				6	243
					X	2	181
26.0301	Book Publishing			X		1	2
26.0400	Miscellaneous Printing			X		1	2
26.0501	Commercial Printing				X	5	45
26.0801	Engraving and Plate Printing	X				2	8
26.0601	Manifold Business Forms				X	1	28

TABLE XIX (CON'T)

INPUT- OUTPUT CLASS. NUMBER	INDUSTRY TITLE	REVISIONS				NUMBER OF FIRMS	NUMBER OF EMPLOYEES
		ADD	DROP	ACTION TAKEN OUT OF AREA	NOT LISTED		
26.0804	Photoengraving	X				2	32
26.0502	Lithographic Plate Making and	X				2	14
28.0100	Plastics Material and Resins	X				2	20
27.0202	Fertilizers	X				1	12
			X			1	20
27.0300	Agricultural Chemicals n.e.c.	X				4	116
27.0402	Adhesives and Sealants				X	1	7
27.0404	Printing Inks	X				1	1
					X	1	1
27.0406	Chemical Preparations n.e.c.	X				1	200
31.0100	Petroleum Refining and Misc. Products of Petroleum and Coal	X				1	17
32.0100	Tires and Innertubes	X				1	45
32.0500	Rubber and Pastic Hose and Belting	X				1	15
32.0400	Misc. Plastic Products				X	3	18
					X	3	8

107

TABLE XIX (CON'T)

INPUT- OUTPUT CLASS. NUMBER	INDUSTRY TITLE	REVISIONS				NUMBER OF FIRMS	NUMBER OF EMPLOYEES
		ADD	DROP	ACTION TAKEN OUT OF AREA	NOT LISTED		
33.0001	Leather Tanning and Finishing	X		X		1	2
					X	1	6
						1	3
34.0301	Leather Gloves and Mittens	X				1	28
34.0305	Leather Goods n.e.c.	X				5	78
35.0100	Glass and Glass Products except Containers			X		2	13
35.0200	Glass Containers	X				1	1
36.0200	Brick and Structural Clay Tile	X				2	63
36.0500	Structural Clay Products n.e.c.		X			1	13
				X		1	19
36.0900	Pottery Products	X				1	60
36.1000	Concrete Block and Brick				X	1	28
36.1100	Concrete Products				X	1	27
36.1200	Ready Mix Concrete	X				2	20
36.1300	Lime	X				1	12

TABLE XIX (CON'T)

INPUT- OUTPUT CLASS. NUMBER	INDUSTRY TITLE	REVISIONS				NUMBER OF FIRMS	NUMBER OF EMPLOYEES
		ADD	DROP	ACTION TAKEN OUT OF AREA	NOT LISTED		
36.1500	Cut Stone and Stone Products	X				2	8
36.1600	Abrasive Products	X				2	10
				X		1	1
36.1700	Asbestos Products	X				2	8
36.1800	Gaskets Packing and Sealing Devices	X				1	18
36.1900	Minerals, Ground or Treated	X				12	639
				X		1	3
36.2000	Mineral Wool	X				1	8
37.0101	Blast Furnace and Steel Mills	X				2	142
			X			1	156
37.0105	Steel Pipes and Tubes	X				1	120
37.0200	Iron and Steel Foundaries				X	1	1
38.0400	Primary Aluminum				X	1	4
38.0600	Secondary Nonferrous Metals	X				1	150
38.1300	Nonferrous Castings n.e.c.	X				2	125
37.0401	Metal Heat Treating	X				1	3

TABLE XIX (CON'T)

INPUT- OUTPUT CLASS. NUMBER	INDUSTRY TITLE	REVISIONS				NUMBER OF FIRMS	NUMBER OF EMPLOYEES
		ADD	DROP	ACTION TAKEN OUT OF AREA	NOT LISTED		
39.0100	Metal Cans			X		1	5
39.0200	Metal Barrels, Drums, and Pails	X				2	55
42.0201	Hand and Edge Tools n.e.c.				X	1	1
40.0200	Plumbing Fixtures, Fittings, and Trim	X				1	6
40.0300	Heating Equipment except Electrical	X		X		2	375
						1	24
					X	3	12
40.0500	Metal Doors, Sash, and Trim				X	1	6
40.0700	Sheet Metal Work	X		X		9	133
						1	3
					X	1	6
40.0901	Prefabricated Metal Buildings	X				2	6
41.0100	Screw Machine Products and Bolts, Nuts, Rivets, and Washers	X				3	90
37.0300	Iron and Steel Forgings	X				1	35
42.0402	Metal Coating and Allied Services	X				1	135

TABLE XIX (CON'T)

INPUT- OUTPUT CLASS. NUMBER	INDUSTRY TITLE	REVISIONS				NUMBER OF FIRMS	NUMBER OF EMPLOYEES
		ADD	DROP	ACTION TAKEN OUT OF AREA	NOT LISTED		
13.0500	Small Arms	X				1	1
42.0700	Steel Springs except Wire	X				1	12
42.0800	Pipe Valves and Fittings				X	1	2
42.1100	Fabricated Metal Products n.e.c.	X				2	5
44.0001	Farm Machinery and Equipment	X			X	2 1	13 2
44.0002	Lawn and Garden Equipment	X				1	5
45.0200	Mining Machinery except Oil	X				1	4
46.0100	Elevators and Moving Stairways	X				1	12
46.0300	Hoists, Cranes, and Monorails	X				2	155
46.0400	Industrial Trucks and Tractors	X				3	12
47.0100	Machine Tools, Metal Cutting Types	X				2	16
47.0401	Power Driven Hand Tools	X				1	17
48.0100	Food Products Machinery	X				1	2

TABLE XIX (CON'T)

INPUT- OUTPUT CLASS. NUMBER	INDUSTRY TITLE	REVISIONS				NUMBER OF FIRMS	NUMBER OF EMPLOYEES
		ADD	DROP	ACTION TAKEN OUT OF AREA	NOT LISTED		
48.0300	Wood Working Machinery	X				11	739
				X		1	83
					X	1	29
48.0400	Paper Industries Machinery	X				3	61
49.0300	Blowers and Fans	X				4	531
49.0500	Power Transmission Equipment	X				1	10
49.0600	Industrial Furnaces and Ovens	X				2	40
49.0700	General Industrial Machinery	X				3	79
51.0300	Scales and Balances	X				1	12
51.0400	Office Machines n.e.c.	X				1	1
52.0100	Automatic Merchandising Machines	X				1	1
50.0001	Carburetors, Pistons, Rings, Valves	X				1	200
50.0002	Machinery Except Electrical n.e.c.	X			X	2 1	20 4
53.0200	Transformers	X				2	358

TABLE XIX (CON'T)

INPUT- OUTPUT CLASS. NUMBER	INDUSTRY TITLE	REVISIONS				NUMBER OF FIRMS	NUMBER OF EMPLOYEES
		ADD	DROP	ACTION TAKEN OUT OF AREA	NOT LISTED		
53.0300	Switchgear and Switchboard Apparatus			X		1	2
55.0300	Wiring Devices	X				1	12
57.0300	Electronics Components n.e.c.			X		1	7
59.0200	Truck Trailers	X				2	60
61.0100	Ship Building and Repairing				X	1	4
61.0300	Railroad Equipment	X				1	17
61.0500	Motorcycles, Bicycles, and Equipment	X				2	8
61.0601	Travel Trailers and Campers			X		1	16
61.0700	Transportation Equipment n.e.c.	X				3	53
62.0100	Engineering and Scientific Instruments	X				2	34
62.0300	Automatic Temperature Controls	X				1	130
62.0200	Mechanical Measuring Devices	X				2	354
				X		1	4

TABLE XIX (CON'T)

INPUT- OUTPUT CLASS. NUMBER	INDUSTRY TITLE	REVISIONS				NUMBER OF FIRMS	NUMBER OF EMPLOYEES
		ADD	DROP	ACTION TAKEN OUT OF AREA	NOT LISTED		
53.0100	Instruments to Measure Electricity				X	1	1
62.0600	Dental Equipment and Supplies	X				1	5
63.0200	Ophthalmic Goods				X	1	2
63.0300	Photographic Equipment and Supplies	X				2	41
64.0200	Musical Instruments	X				2	221
64.0400	Sporting and Athletic Goods			X		1	8
64.0503	Marking Devices	X				5	26
64.0702	Needles, Pins, and Fasteners	X				1	8
64.1000	Burial Caskets and Vaults	X				1	15
64.1200	Manufacturing Industries n.e.c.				X	1	2

TABLE XX

IDENTIFICATION OF MANUFACTURING
INDUSTRIES

INPUT- OUTPUT CLASSIF NUMBER	STANDARD INDUSTRIAL CODE NUMBER	INDUSTRY TITLE	NUMBER OF	
			FIRMS	EMPLOYEES
14.0101	2011	Meat Packing Plants	11	452
14.0102	2013	Sausages and Other Prepared Meats	8	282
14.0104	2017	Poultry and Egg Processing	6	230
14.020	2021	Creamery Butter	2	23
14.0600	2026	Fluid Milk	8	740
14.0800	2032	Canned Specialties	5	112
14.0900	2033	Canned Fruits and Vegetables	5	97
14.1000	2034	Dehydrated Food Products	2	33
14.1100	2035	Pickles, Sauces, and Salad Dressings	5	516
14.1300	2037 2038	Frozen Fruits and Vegetables	8	715
14.1401	2041	Flour and Other Grain Mill Products	3	171
14.1501	2047	Dog, Cat, and Other Pet Food	2	246
14.1502	2048	Prepared Foods, n.e.c.	8	252
14.1801	2051	Bread, Cake, and Related Products	19	1,399
14.1802	2052	Cookies and Crackers	5	1,030

TABLE XX (CON'T)

INPUT- OUTPUT CLASSIF. NUMBER	STANDARD INDUSTRIAL CODE NUMBER	INDUSTRY TITLE	NUMBER OF FIRMS	EMPLOYEES
14.2021	2065	Confectionery Prod.	7	211
14.2500	2075	Soybean Oil Mills	1	2
14.2700	2077	Animal and Marine Fats and Oils	4	35
14.2900	2079	Short. and Cooking Oils	1	114
14.2101	2082	Malt Liquors	1	262
14.2103	2084	Wines, Brandy, and Brandy Spirits	6	33
14.2200	2086	Bottled and Canned Soft Drinks	6	456
14.2300	2087	Flavoring Extracts and Syrups, n.e.c.	2	58
14.0700	2091	Canned and Cured Seafoods	3	106
14.2800	2095	Roasted Coffee	2	167
14.3000	2097	Manufactured Ice	5	72
14.3100	2098	Macaroni and Spaghetti	2	74
14.3200	2099	Food Preparations	9	576
16.0100	2231	Broadwoven Fabric Mills	7	277
	2262	and Fabric Finishing Plants		
	2241	Narrow Fabric Mills		
	2269	Yarn Mills and Finishing of Textiles		
	2293	Padding and Upholstery Filling		
18.0201	2253	Knit Outerwear	5	1,153

TABLE XX (CON'T)

INPUT- OUTPUT CLASSIF. NUMBER	STANDARD INDUSTRIAL CODE NUMBER	INDUSTRIAL TITLE	NUMBER OF FIRMS EMPLOYEES	
17.1002	2299	Textile Goods, n.e.c.	1	45
18.0400	2321 2329 2331 2337 2339 2369 2381 2385 2386	Apparel Made from Purchased Materials	8	1,382
19.0100	2391	Curtains and Draperies	19	201
19.0200	2392	House Furnishings, n.e.c.	5	161
19.0301	2393	Textile Bags	5	632
19.0302	2394	Canvas Products	9	95
19.0306	2399	Fabricated Textile Products	6	41
20.0100	2411	Logging Camps and Logging Contractors	67	984
20.0200	2421	Sawmills and Planing Mills, General	39	2,696
20.0300	2426	Hardwood Dimension and Flooring Mills	2	22
20.0400	2429	Special Products Sawmills, n.e.c.	7	92
20.0501	2431	Millwork	24	879
20.0502	2434	Wood Kitchen Cabinets	51	642
20.0600	2435 2436	Veneer and Plywood	10	592
20.0701	2439	Structural Wood Members	7	289

TABLE XX (CON'T)

INPUT- OUTPUT CLASSIF NUMBER	STANDARD INDUSTRIAL CODE NUMBER	INDUSTRY TITLE	NUMBER OF FIRMS EMPLOYEES	
20.0901	2448	Wood Pallets and Skids	8	177
20.0702	2452	Prefabricated Wood	9	108
20.0800	2491	Wood Preserving	5	188
20.0902	2499	Wood Products, n.e.c.	15	339
22.0101	2511	Wood Household Furniture	10	281
22.0200	2512	Upholstered Household Furniture	11	348
22.0400	2515	Mattress and Bedsprings	11	195
23.0100	2521	Wood Office Furniture	3	69
23.0300	2531	Public Building Furniture	2	59
23.0400	2541	Wood Partitions and Fixtures	22	503
23.0500	2542	Metal Partitions and Fixtures	2	34
23.0600	2591	Blinds, Shades, and Drapery Hardware	5	86
23.0700	2599	Furniture and Fixtures	6	120
24.0200	2621	Paper Mills Except Building Paper	5	1,261
24.0701	2641	Paper Coating and Glazing	4	757
24.0400	2642	Envelopes	3	538
24.0702	2643	Bags Except Textile	5	429

TABLE XX (CON'T)

INPUT- OUTPUT CLASSIF. NUMBER	STANDARD INDUSTRIAL CODE NUMBER	INDUSTRY TITLE	NUMBER OF	
			FIRMS	EMPLOYEES
24.0704	2646	Pressed and Molded Pulp Goods	2	62
24.0706	2649	Converted Paper Products n.e.c.	3	87
25.0000	2651 2652 2653 2654 2655	Paperboard Containers	11	716
26.0100	2711	Newspapers	32	2,115
26.0200	2721	Periodicals	20	110
26.0301	2731	Book Publishing	9	51
26.0400	2741	Miscellaneous Printing	8	53
26.0501	2751 2752	Commercial Printing	171	1,878
26.0801	2753	Engraving and Plate Printing	5	110
26.0601	2761	Manifold Business Forms	7	258
26.0602	2782	Blank Books and Loose Leaf Binders	7	390
26.0802	2789	Book Binding and Related Work	6	101
26.0803	2791	Typesetting	23	141
26.0804	2793	Photoengraving	5	54
26.0502	2795	Lithographic Plate Making and Services	5	53
27.0100	2812	Industrial Inorganic	7	608

TABLE XX (CON'T)

INPUT- OUTPUT CLASSIF. NUMBER	STANDARD INDUSTRIAL CODE NUMBER	INDUSTRY TITLE	NUMBER OF FIRMS EMPLOYEES	
	2813 2819 2865 2869	and Organic Chemicals		
28.0100	2821	Plastics Mat. and Resins	4	81
29.0100	2831 2833 2834	Drugs	12	330
29.0201	2841	Soap and Detergents	5	80
29.0202	2842	Polishes and Sanit. Goods	7	86
30.0000	2851	Paints and Allied Prod.	12	324
27.0201	2873	Nitrogenous and Phosphatic Fertilizers	1	1
27.0202	2875	Fertilizers, Mixing Only	2	14
27.0300	2879	Agricultural Chemicals	7	275
27.0402	2891	Adhesives and Sealants	6	133
27.0404	2893	Printing Inks	7	99
27.0406	2899	Chemical Preparations	5	133
31.0100	2911 2992	Petroleum Refining and Miscellaneous Products	5	84
31.0300	2952	Asphalt Felts and Coat.	6	490
32.0100	3011	Tires and Innertubes	2	80
32.0500	3041	Rubber and Plastic Hose and Belting	3	30

TABLE XX (CON'T)

INPUT- OUTPUT CLASSIF.	STANDARD INDUSTRIAL CODE	INDUSTRY TITLE	NUMBER OF FIRMS EMPLOYEES	
32.0302	3069	Fab. Rubber Prod.	7	409
32.0400	3079	Miscellaneous Plastic Products	55	1,386
33.0001	3111	Leather Tanning and Finishing	2	50
34.0201	3143 3149	Shoes Except Rubber	2	55
34.0301	3151	Leather Gloves, Mitten	2	37
34.0305	3199	Leather Goods, n.e.c.	6	80
35.0100	3211 3229 3231	Glass and Glass Products Except Containers	5	84
35.0200	3221	Glass Containers	2	538
36.0100	3241	Cement, Hydraulic	2	192
36.0200	3251	Brick and Structural Clay Tile	3	68
36.0500	3259	Structural Clay Products n.e.c.	2	16
36.0900	3269	Pottery Products	5	126
36.1000	3271	Concrete Block and Brick	2	38
36.1100	3272	Concrete Products,	21	403
36.1200	3273	Ready-Mixed Concrete	18	576
36.1300	3274	Lime	2	36
36.1500	3281	Cut Stone and Stone Products	4	47

TABLE XX (CON'T)

INPUT- OUTPUT CLASSIF. NUMBER	STANDARD INDUSTRIAL CODE NUMBER	INDUSTRY TITLE	NUMBER OF	
			FIRMS	EMPLOYEES
36.1600	3291	Abrasive Products	3	46
36.1700	3292	Asbestos Products	3	17
36.1800	3293	Gaskets, Packing and Sealing Devices	4	77
36.1900	3295	Minerals, Ground or Treated	14	672
36.2000	3296	Mineral Wool	3	60
36.2200	3299	Nonmetallic Mineral Products, n.e.c.	3	124
37.0101	3312	Blast Furnaces and Steel Mills	3	709
37.0102	3313	Electrometallurgical Products	2	216
37.0105	3317	Steel Pipes and Tubes	3	433
37.0200	3321 3324 3325	Iron and Steel Foundries	12	4,046
38.0400	3334	Primary Aluminum	1	992
38.0600	3341	Secondary Nonferrous Metals	2	235
38.0800	3354	Aluminum Rolling and Drawing	1	16
38.0900	3356	Nonferrous Rolling and Drawing, n.e.c.	2	6
38.1000	3357	Nonferrous Wire Drawing and Insulating	1	15

TABLE XX (CON'T)

INPUT- OUTPUT CLASSIF NUMBER	STANDARD INDUSTRIAL CODE NUMBER	INDUSTRY TITLE	NUMBER OF FIRMS EMPLOYEES	
38.1100	3361	Aluminum Castings	9	506
38.1200	3362	Brass, Bronze, and Copper Castings	8	171
38.1300	3369	Nonferrous Castings	5	201
37.0401	3398	Metal Heat Treating	3	48
37.0402	3399	Primary Metal Products	1	5
39.0100	3411	Metal Cans	4	396
39.0200	3412	Metal Barrels, Drums, and Pails	4	148
42.0100	3421	Cutlery	2	249
42.0201	3423	Hand and Edge Tools	5	488
42.0202	3425	Hand Saws and Saw Blades	6	1,590
42.0300	3429	Hardware, n.e.c.	11	1,088
40.0200	3432	Plumbing Fixtures Fittings and Trim	3	17
40.0300	3433	Heating Equipment-Elect.	12	897
40.0400	3441	Fab. Struct. Metal	16	999
40.0500	3442	Metal Doors, Sash, and Trim	28	835
40.0600	3443	Fabricated Plate Work (Boiler Shops)	22	563
40.0700	3444	Sheet Metal Work	53	1,017
40.0800	3446	Architectural Metal	17	147

TABLE XX (CON'T)

INPUT- OUTPUT CLASSIF. NUMBER	STANDARD INDUSTRIAL CODE NUMBER	INDUSTRY TITLE	NUMBER OF	
			FIRMS	EMPLOYEES
40.0901	3448	Prefab. Metal Bldgs.	3	59
41.0100	3451 3452	Screw Machine Products and Bolts, Nuts, Rivets, and Washers	8	273
37.0300	3462	Iron and Steel Forgings	3	139
41.0203	3469	Metal Stampings, n.e.c.	6	142
42.0401	3471	Plating and Polishing	17	604
42.0402	3479	Metal Coating and Allied Services	11	273
13.0600	3482	Small Arms Ammunition	1	5
13.0500	3484	Small Arms	4	44
42.0700	3493	Steel Springs, Except Wire	6	113
42.0800	3494 3498	Pipe Valves and Pipe Fittings	14	795
42.0500	3496	Miscellaneous Fab Wire Products	8	229
42.1100	3499	Fabricated Metal Products, n.e.c.	5	25
44.0001	3523	Farm Machinery and Equipment	11	604
44.0002	3524	Lawn and Garden Equip.	2	17
45.0100	3531	Construction Machinery and Equipment	16	321
45.0200	3532	Mining Machinery, Except Oilfield	3	625

TABLE I (CON'T)

INPUT- OUTPUT CLASSIF. NUMBER	STANDARD INDUSTRIAL CODE NUMBER	INDUSTRY CODE	FIRMS	NUMBER OF EMPLOYEES
46.0100	3534	Elevators and Moving Stairways	2	29
46.0200	3535	Conveyors and Conveying Equipment	9	314
46.0300	3536	Hoists, Cranes, and Monorails	5	218
46.0400	3537	Industrial Trucks and Tractors	15	1,907
47.0100	3541	Machine Tools, Metal Cutting Types	4	71
47.0300	3544 3545	Special Dies and Tools and Machine Tool Accessories	19	173
47.0401	3546	Power Driven Hand Tools	4	210
48.0100	3551	Food Products Machinery	4	32
48.0300	3553	Woodworking Machinery	34	1,635
48.0400	3554	Paper Industries Machinery	5	187
48.0500	3555	Printing Trades Machinery	2	80
48.0600	3559	Special Industry Machinery, n.e.c.	8	342
49.0100	3561	Pumps and Compressors	6	1,097
49.0300	3564	Blowers and Fans	6	822
49.0400	3565	Industrial Patterns	12	134
49.0500	3566 3568	Power Transmission Equipment	3	33

TABLE XX (CON'T)

INPUT- OUTPUT CLASSIF. NUMBER	STANDARD INDUSTRIAL CODE NUMBER	INDUSTRY TITLE	NUMBER OF	
			FIRMS	EMPLOYEES
49.0600	3567	Industrial Furnaces and Ovens	5	136
49.0700	3569	General Industrial Mach.	5	94
51.0100	3573	Electronic Computing Equipment	5	1,904
51.0300	3576	Scales and Balances	2	14
51.0400	3579	Office Machines, n.e.c.	2	5
52.0100	3581	Automatic Merchandising Machines	2	18
52.0300	3585	Refrigeration and Heating Equipment	5	156
52.0500	3589	Service Industry Machines, n.e.c.	7	190
50.0001	3592	Carburetors, Pistons Rings, Valves	2	201
50.0002	3599	Machinery, Except Electrical, n.e.c.	103	1,821
53.0200	3612	Transformers	4	435
53.0300	3613	Switchgear and Switchboard Apparatus	8	412
53.0500	3622	Industry Controls	9	135
54.0500	3635	Household Vacuum Cleaners	1	6
55.0300	3643 3644	Wiring Devices	4	150
55.0200	3645	Lighting Fixtures and	7	79

TABLE XX (CON'T)

INPUT- OUTPUT CLASSIF. NUMBER	STANDARD INDUSTRIAL CODE NUMBER	INDUSTRY TITLE	NUMBER OF FIRMS EMPLOYEES	
	3646 3647 3648	and Equipment		
56.0100	3651	Radio and TV Receiving Sets	9	318
56.0200	3652	Phonographic Records and Tape	1	6
56.0300	3661	Telephone and Telegraph Apparatus	3	465
56.0400	3662	Radio and TV Communication Equipment	11	333
57.0100	3672	Electron Tubes	1	8
57.0200	3674	Semiconductor and Related Devices	4	2,812
57.0300	3677 3679	Electronic Components, n.e.c.	16	1,184
58.0100	3691	Storage Batteries	6	379
58.0300	3693	X-ray Apparatus and Tubes	6	203
58.0400	3694	Engine Electrical Equipment	7	176
59.0301	3711	Motor Vehicles	1	3,358
59.0100	3713	Truck and Bus Bodies	7	170
59.0302	3714	Motor Vehicle Parts and Accessories	33	972
59.0200	3715	Truck Trailers	16	619

TABLE XX (CON'T)

INPUT- OUTPUT CLASSIF. NUMBER	STANDARD INDUSTRIAL CODE NUMBER	INDUSTRY TITLE	NUMBER OF FIRMS EMPLOYEES	
60.0400	3728	Aircraft and Missile Equipment	4	1,634
61.0100	3731	Shipbuilding and Repairing	13	2,493
61.0200	3732	Boat Building and Equipment	17	84
61.0300	3743	Railroad Equipment	3	1,430
61.0500	3751	Motorcycles, Bicycles and Parts	5	127
61.0601	3792	Travel Trailers, Campers	13	166
61.0700	3799	Transportation Equipment n.e.c.	4	60
62.0100	3811	Engineering and Scientific Instruments	6	141
62.0300	3822	Automatic Temperature Controls	2	284
62.0200	3823 3829	Mechanical Measuring Devices	3	368
53.0100	3825	Instruments to Measure Electricity	6	15,562
63.0100	3832	Optical Instruments and Lenses	3	19
62.0400	3841	Surgical and Medical Instruments	10	609
62.0500	3842	Surgical Appliances and Supplies	10	89
62.0600	3843	Dental Equip./Supplies	8	148

TABLE XX (CON'T)

INPUT- OUTPUT CLASSIF. NUMBER	STANDARD INDUSTRIAL CODE NUMBER	INDUSTRY TITLE	NUMBER OF FIRMS EMPLOYEES	
63.0200	3851	Ophthalmic Goods	8	174
63.0300	3861	Photographic Equipment and Supplies	6	900
62.0700	3873	Watches, Clocks, and Parts	2	10
64.0101	3911	Jewelry and Prec. Metals	10	47
64.0104	3914	Silverware and Plated Wear	3	28
64.0200	3931	Musical Instruments	4	228
64.0302	3942	Dolls	1	5
64.0400	3949	Sporting and Athletic Goods	13	339
64.0503	3953	Marking Devices	8	81
64.0504	3955	Carbon Paper and Inked Ribbons	1	26
64.0105	3961	Costume Jewelry	2	4
64.0702	3964	Needles, Pins, and Fasteners	3	23
64.0800	3991	Brooms and Brushes	3	234
64.1100	3993	Signs and Advertising Displays	16	180
64.1000	3995	Burial Caskets/Vaults	3	21
64.1200	3999	Manufacturing Ind. nec	8	134
TOTAL			2,111	108,295