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SPATIAL INTERDEPENDENCE IN A METROPOLITAN SETTING

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Spatial Interdependence in a Metropolitan Setting

Running title: metropolitan spatial interdependence

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Abstract Consideration is given to the spatial structure of the metropolitan area, and to the tendency for this to be generalized in terms of the stark dichotomy of city and suburbs. Focusing on a four-zone metropolitan area, a model of spatial interaction is outlined, the components of which are based on intersectoral trade, labor mobility, and consumption-expenditure patterns. These components are drawn together as layers in an organized sequence of processes. The linked components are shown to give rise to intricate patterns of spatial interdependence. These have the effect of blurring the city-suburbs distinction, and are fundamentally different from comparable patterns at other spatial scales.

JEL Classification: R12, R15, R22, R29

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1. Introduction

Three important issues underlie this paper. First, the growth of metropolitan areas, particularly in North America, has been accompanied by a perception of increased economic separation between the central city (the *de jure* city) and its suburbs, sometimes to the point where these are seen as independent economic entities. Second, drawing on this perception, it has been frequently asserted that attempts to promote economic development in one part of the metropolitan area are necessarily at the expense of the rest of the area. This zero-sum-gain view of development is influenced (at least in part) by the fact that spillover and feedback effects among regions in multi-regional input-output models tend to be of modest proportions, as shown in the early work of Miller (1966, 1969, 1986) and in the consideration of spatial-aggregation problems (Miller and Blair, 1981; Blair and Miller, 1983). Third, while the new economic geography (NEG) has highlighted the interdependencies in development over space, the metropolitan context presents some additional challenges to understanding the nature and extent of these interdependencies. More specifically, the general arguments of NEG may need to be qualified and/or extended for each particular scale of analysis: the macro-regional, the regional, the sub-regional, the metropolitan. And as will be revealed, the role of labor mobility and consumption-expenditure patterns at this last level generates a dynamic that causes the character of spatial interaction to be different from that normally observed at the interregional level.

A recognition of the role of space and an appreciation of the subtleties of spatial structure have been important features in the development of urban economics over the last 50 years (Alonso, 1964; Mills, 1972; Wingo, 1966). This has been especially true in those studies concerned with population distribution and the operation of land and housing markets, where the

analysis has reached high levels of sophistication. It is all the more surprising, therefore, that in other areas of urban economics the role of space has been neglected or seriously under-emphasized, as exemplified by studies dealing with interaction and interdependence within the urban economy. For example, in the case of intermediate trade, where the focus is typically on interindustry transactions, relatively little attention is given to the intraurban distribution of this trade. This has also been true of studies of the labour market (the interaction between households and the various sectors of economic activity), where the bulk of attention has been on such aggregates as labor supply, labor demand, unemployment levels, participation rates, etc, and not on how these aggregates are interrelated spatially. A similar disregard of space has been present in the treatment of the income-generating effects of consumption (the interaction between households and the retail and service sectors). This general state of affairs has arisen because of the willingness to treat the metropolitan economy as a dimensionless unit. Such an approach (no doubt justifiable on grounds of technical convenience) is incomplete, inasmuch as it effectively causes certain kinds of economic interaction to be eliminated entirely. The issue of interdependence within the urban economy thus becomes seriously obscured.

An attempt is made in the discussion to follow to examine certain facets of interaction in the economy of a major metropolitan area, using Chicago as a case study, a metropolitan area for which detailed data on employment, income, commuting and consumption are available. The metropolitan area of Chicago (the former SMSA) is composed of Cook, Du Page, Kane, Lake, McHenry and Will Counties, as shown in Figure 1, where the four-zone structure used throughout the paper is also indicated. The numbered zones are as follows: central area or CBD (1); rest of the City of Chicago (2); suburbs (3); and outer suburbs or exurban areas (4), comprising Lake, McHenry, Kane and Will Counties. The question of spatial interdependence is

approached in terms of a series of layers of interaction, and we demonstrate the manner in which these are sequentially linked. However, in order to provide a setting to the subsequent analysis, we first discuss various aspects of metropolitan spatial structure.

2. Perceptions of the Spatial Structure of Metropolitan Areas

Over a given interval extending beyond the short run, the spatial structure of a metropolitan area can be expected to undergo a change. Different locational requirements on the part of firms, changing relative factor prices, new production and transportation techniques, and emerging housing and amenity preferences (influences that are usually interrelated) are all likely to shape this evolution of metropolitan spatial structure. For the last half century, and probably longer, such change has been viewed in the US though the prism of local-government structure, leading to a familiar dichotomy, namely, the central city and the suburbs, i.e., the core city of the metropolitan area and the myriad of suburbs, with its accompanying pattern of local governments and special districts. This dichotomy, which has probably more substance in the northern and eastern sections of the US than elsewhere, has given rise to generalizations of the following type, which are convenient, if not entirely accurate. On the one hand there is the central city, an area of slow or sometimes negative economic growth, high unemployment, low per capita incomes, a disproportionately large share of social problems, and below-average quality of public services. By contrast, the suburbs have emerged as areas of superior economic performance, relatively low unemployment rates, high income levels, and above-average quality of services. In fact, it is possible to argue that in certain cases the relative differences between the two parts of the metropolitan area become hightened by the processes of cumulative causation, unintentionally reinforced by various federal-government policies relating to transportation and housing finance (Swanstrom, 1996).

What has been the academic response to this general situation? For many years there appeared to be a general contentment with the view espoused by Tiebout (1956) that the balkanized pattern of local government (which underlay the dichotomous structure of the metropolitan area, referred to above) was essentially a rational one, i.e., in terms of public-choice theory, mobile consumer-voters were revealing their true preferences for local public goods. Imaginative as Tiebout's argument undoubtedly was, it is as well to bear in mind that it depended on a number of powerful assumptions: complete mobility of consumer-voters; full knowledge of differing revenue and expenditure patterns; a large number of independent jurisdictions; the non-sensitivity of residence to access to employment; the absence of interjurisdictional spillovers; the possibility of substantial economies of scale in the provision of certain local public goods.

More recently, opinion has been divided. Certain authors (Fishman, 1987; Muller, 1986; Pascal, 1987) have seen the suburbs in a particularly favorable light. This view, epitomized by Garreau (1991) in his celebration of the "edge city," argued that the suburbs have caught up with the central city in terms of population, employment, retailing, the provision of other consumer services, and the availability of many types of business services, etc. The suburbs, so it was claimed, no longer need the central city, in the sense that their economic fortunes do not depend on it. This argument that suburbs are economically separate from the central city has led to what amount to "declarations of independence" by suburban residents and officials, or at least the reluctance to display solidarity or co-operate closely with the central city. Such attitudes are fuelled by the belief that since many suburban dwellers do not have occasion to go the central city (for employment, consumption or for any other purpose), there is therefore little economic reliance by the suburbs on the central city. We hope to demonstrate otherwise.

Not all opinion adheres to this harsh view, of course. Various counterarguments have been put forward, including those based on equity considerations (Summers, 2000), and serious doubts have been raised about the economic separation between the suburbs from the central city (Ihlanfelt, 1995; Voith, 1992). While it is possible to observe a continuing competition between the two parts of metropolitan area (by which the central city may be losing out to the suburbs in the field of employment, for example), interdependence continues to be important. Intermediate trade among firms, commuter linkages (to and from the central city), consumption flows, and capital movements represent some of the more important means by which interaction occurs between the two parts of the metropolitan area. Absent from this list are direct government transfers between the two parts, these generally being seen as falling within the purview of state and federal government.

Downs (1994) has argued persuasively in favor of metropolitan government (now ambiguously termed "regionalization"), and has provided an admirable summary of some of the more important economic linkages between the central city and the suburbs, focusing on why the latter need the former (Downs, 1996). *First*, the performance and reputation of the central city can be a major influence on business decisions to locate within its suburbs rather than in some alternative metropolitan area. *Second*, the central city accommodates a pool of labor (often with low skills), which is employed in service activities in the suburbs, but which cannot afford to live there. *Third*, the nodal functions of the central city (not only with respect to transportation terminals and infrastructure systems, but also in terms of cultural and sport facilities) are heavily used by the suburbs, but are not feasibly relocated there. *Fourth*, the central city continues to make substantial labor demands on the suburbs, particularly in the semi-skilled and skilled occupational sectors, thus providing a major source of income to suburban households. *Fifth*,

there is considerable reliance of suburban firms on specialized business-service firms located in the central city. These firms are typically concentrated in the central city (particularly its CBD) because of various kinds of agglomeration economies, but their location suggests the supply of important central-place functions serving the entire metropolitan area.

A substantial literature has accumulated on the statistical testing of the interrelationships between the central city and the suburbs, and on the interdependence between the two parts (Bradbury *et al*.,1980; Chang and Coulson, 2001; Gottlieb, 2000; Leichenko, 2001; Voith, 1998). The predominant approach involves correlation analysis, using such variables as growth of population and employment, income levels, and house prices, the variables in one area being related to those in the other, sometimes in terms of cross elasticities (Hollar, 2003). Analyses of this kind tend to be complicated by such factors as the direction of the relationship, the possibility of a bi-directional relationship, the fact that a relationship may change over different time intervals and with city size, and annexations by the central city. Clearly, the inferences drawn from the results are constrained by the fact that relationships between the central city and suburbs are associational rather than casual. The broad conclusion of these studies is that there are significant linkages between the two parts of the metropolitan area, and (less strongly perhaps) that the reliance of the suburbs on the central city has not come to an end. While these approaches provide valuable insights on intra-metropolitan relations, the concern is necessarily with how the two parts are linked in terms of outcomes. The broad objective of this paper is to trace through the various processes by which these outcomes actually occur, and to do this, using actual data.

3. Background to the Analysis

The changing spatial structure of metropolitan areas has posed difficult theoretical challenges. As Fujita and Thisse (2002) have noted, the spatial organization of a metropolitan area becomes much more complex to model, when a spatially-discounted accessibility formulation is employed. The possibility of several employment centers emerges, and the stylized journey-to-work patterns, themselves, become more complex, with workers by-passing secondary centers for jobs in the primary center (CBD). This complexity within the theory appears to have considerable empirical support from the analysis of journey-to-work flows. These observations reflect, in part, the changing home-work location preferences of household members, and in part the increasing preponderance of households with more than one member in the employed labor force. Furthermore, these theoretical formulations might be enriched with the adoption of some of the approaches embodied in the Lowry-Garin model (Lowry 1964; Garin, 1966) and the subsequent set of extensions and modifications (Chan, 2005). Starting with an exogenously-given location of basic employment by zone in the metropolitan area, the Lowry-Garin model explores the way in which employment in non-basic activities is allocated. This is initially determined by the expenditures of households receiving wages and salaries from employment in the basic activities. Through familiar multiplier effects, the expenditures, in turn, generate further indirect (non-basic) activities, creating a new set of home-work flows, yet further non-basic activity, and so on.

The models described by Fujita and Thisse (2002) have more to say about the initial locations of activity, but take only a limited view of the resulting interactions that originate at these locations and their concomitant impact in terms of the creation of additional employment within firms supplying intermediate goods and services to other firms, and also within firms

supplying goods and services to households. The formulation presented here accords more with a stylized Lowry-Garin view of a metropolitan economy, although it does not attempt to locate activities within the metropolitan space. Rather, the approach analyzes the implicit interdependencies, and explores the ways in which income received from employment is translated into consumption that itself generates further impacts in the zones of the metropolitan area. In essence, the approach may be viewed as an attempt to develop a set of spatial accounts for the metropolitan area, the set being compiled through the interactions among zones, initially through journey-to-work movements and then through consumption expenditures.

The accounts may be seen as a series of layers, reflecting a systematic sequence of processes, generated by the initial distribution of employment and household locations. This sequence is illustrated in Figure 2. We start with an exogenous impact on the Chicago economy, e.g, an increase in interstate or international exports. Since firms within the metropolitan area buy from and sell to each other, such an exogenous impact will generate the usual interindustry-interzonal effects through a multi-zonal Leontief system, shown as layer A in Figure 2 (imports and exports are considered but their efforts are not modeled explicitly). This first layer in the set of accounts describes an intrametropolitan system of the trade, in which the flows represent an aggregation to a single composite sector of all the specific sector-to-sector and zone-to-zone interactions. Naturally, firms also make payments to factors of production, although in this analysis only factor payments to labor are considered. These payments are then “transported” (by workers) from place of work to place of residence. This creates a second layer of interaction (shown as layer B in Figure 2), since income is assumed to move from zone to another. Note that a varying proportion of incomes remains within the zone of work, and is associated with non-commuters. This second layer of interaction is derived using journey-to-work data. In the

next stage of the sequence, households spend their income within the various zones of the metropolitan area, in a manner that reflects their preferences for variety and their sensitivity to spatial accessibility, as well as the costs of travel. These consumption expenditures thus form a third layer in the set of accounts, shown as layer C in Figure 2.

There is, in effect, a "fourth layer" which represents an integration of the three networks of flows. The consumption expenditures in layer C generate a new signal for producers (this time an endogenous form of demand) which will then loop through the networks of flows (layers A through C), generating further demands for goods and services, creating a new stimulus to local production, additional employment, additional income and thus additional consumption. This multiplier process will eventually play itself out, and the total impact on the economy will be ascertained, revealing the overall structure of interzonal interconnections. While this will be more complete than the structure revealed by the interzonal interdependencies in the first and subsequent layers, it obviously does not include all potential interactions. For example, it does not consider the distribution of other factor returns (profits, dividends, rents, etc.), transfers, and other exogenous non-wage/salary income nor the impacts of investment and government spending. Further, it does not include the effects on the labor market that Persky *et al*. (2004) refer to as vertical multiplier effects generated by vacancy-chain mechanisms. Hence, the interdependence described in this paper may be seen as an intermediate step in generating a more complete picture of metropolitan interdependence.

4. The Analytical Framework

Drawing on the work of Sonis and Hewings (2003), this section outlines the analytical framework to be employed in operationalizing the schematic structure of Figure 2. The results derived are then presented and interpreted. In contrast to the Lowry-Garin model, for example,

no distinction is made here between basic and non-basic sectors. The economy is assumed to be characterized by a set of sectors that interact with each other and respond to signals from final demand in the production of goods and services. As noted earlier, only factor income paid to labor is considered in this model, so that one needs to be mindful of the distinction made by Pyatt (2000) between the role and impact of factor income (in this model) and the impact of institutional income, including non-wage/salary income.

The Miyazawa income-consumption distribution in a four-partition hierarchical model can be presented as follows:

$$M = \left[\begin{array}{cccc|c} A_{11} & A_{12} & A_{13} & A_{14} & C_1 \\ A_{21} & A_{22} & A_{23} & A_{24} & C_2 \\ A_{31} & A_{32} & A_{33} & A_{34} & C_3 \\ A_{41} & A_{42} & A_{43} & A_{44} & C_4 \\ \hline V_1 & V_2 & V_3 & V_4 & \end{array}\right] = \left[\begin{array}{c|c} \widetilde{A} & \widetilde{C} \\ \hline \widetilde{V} & \end{array}\right] \tag{1}$$

where the matrix

$$\widetilde{A} = \begin{bmatrix} A_{11} & A_{12} & A_{13} & A_{14} \\ A_{21} & A_{22} & A_{23} & A_{24} \\ A_{31} & A_{32} & A_{33} & A_{34} \\ A_{41} & A_{42} & A_{43} & A_{44} \end{bmatrix}$$

is the block matrix of direct inputs for the different metropolitan zones specified above: central area or CBD (1); rest of the City of Chicago (2); suburbs (3); and outer suburbs (4). The expression

$$\widetilde{V} = \begin{pmatrix} V_1 & V_2 & V_3 & V_4 \end{pmatrix}$$

represents the income corresponding to the different sectors in the four zones, while

$$\widetilde{C} = \begin{pmatrix} C_1 \\ C_2 \\ C_3 \\ C_4 \end{pmatrix}$$

represents zonal consumption in the metropolitan area. We may write

$$\begin{pmatrix} X \\ Y \end{pmatrix} = \left(\begin{array}{c|c} A & C \\ \hline V & 0 \end{array}\right)\begin{pmatrix} X \\ Y \end{pmatrix} + \begin{pmatrix} f \\ g \end{pmatrix} \tag{2}$$

where *X* and *Y* are block vectors of production and income by zone, *f* is final demand (excluding households), and *g* represents exogenous income, e.g., transfers from outside the region. Through matrix manipulation, a final result can be presented of the form:

$$\begin{pmatrix} X \\ Y \end{pmatrix} = \left(\begin{array}{c|c} B(I + CKVB) & BCK \\ \hline KVB & K \end{array}\right)\begin{pmatrix} f \\ g \end{pmatrix} \tag{3}$$

where $B = (I - A)^{-1}$ is the block interzonal Leontief matrix, $K = (I - L)^{-1}$ is the interrelational income multiplier matrix, and $L = VBC$ is essentially a matrix of propensities for expenditure *C* derived from labor income *VB*. Attention is directed to the assembly of the components of the matrix $B(I + CKVB)$ in (3), starting with the four-zone presentations of *B*, then *V*, and finally *C*. In the final part, all components are brought together to generate a picture of spatial interdependence in the metropolitan area. In the process, matrix *L* will be constructed and examined to gauge the role of income generation in contributing to the nature and strength of this interdependence, the various components of which are outlined in the following sub-sections.

Trade Flows of Goods and Services

Attention is first directed to flows of goods and services between sectors within the metropolitan area. The estimation of these flows involved the development of a matrix of interactions for all

53 sectors and 12 areal units, representing a matrix of enormous size that is far too large for presentation. Instead, the sectors were collapsed into a single sector for each areal unit and the 12 areal units were aggregated to form the set of four zones shown in Figure 1. Using estimates for 2005, the interzonal trade flows are shown in Table 1. It can be seen from this table that intrazonal flows dominate the production relationships in the assembly of $479 billion worth of goods and services. Accordingly, net flows (Table 2a) are modest in size, with zones 1 and 4 net importers and zones 2 and 3 net exporters. These characteristics then result in a diagonally-dominant Leontief matrix (Table 2b) that is re-worked in percentage terms in Table 2c. Somewhere between 90% and 94% of the direct and indirect effects of trade remain within the zone.

Journey-to-Work and Income Flows

Using data from the Chicago Area Transportation Study (CATS), it has been possible to aggregate the journey-to-work information to match the four-zone system. Information about work-home relationships and income received by place of work were then used together to generate a matrix of zone-to-zone income flows within the metropolitan area. This matrix is shown in Table 3, where each row records the source of income for the zone at the left from the other zones. Table 4a shows this in percentage terms. Given the complexity of the journey-to-work patterns, it is not surprising to find a much more diffused pattern of income flows. While entries along the principal diagonal still dominate, off-diagonal elements are large. For example, zone 2 derives 42% of its income from zone 1, and the percentage for zone 3 is almost 21%. The residents of zone 2 derive almost 62% of their income from outside the zone, while for residents of zone 1 only 34% is derived from outside. Table 4b provides a net-income flows perspective.

Zone 1 is a major "exporter" of income (in total and with each of the other zones), while the other zones are net "importers" in total, with expected declines in net volumes with distance from zone 1. Zone 4 is a net importer of income with all zones, while zone 2 enjoys this relationship only with zone 1.

Consumption Expenditures

Data available from CATS and from other sources (detailed by Hewings *et al*., 2001), together with the availability of a home-to-shop matrix, permitted the estimation of consumption expenditures, in total and by zone. The data were further adjusted through access to other sources of information that enabled the estimation of a "float" for each zone by major commodity purchased. This estimation procedure compared the surveyed household expenditures on a good with the value of sales by local businesses offering the same good. This information resulted in a more spatially dispersed pattern of expenditures, as shown in Table 5. However, as may be seen from the percentage allocations in Table 6a, household propensities to consume intrazonally varied approximately from 0.59 for zone 1 to 0.93 in zone 3. Given consumer preferences for variety, these findings are not surprising. Furthermore, the increase in the geographic extent of the zones is such that standard central-place behavior patterns can be expected to operate, with consumers in the zones more distant from zone 1 exhibiting a higher propensity to consume locally. Table 6b indicates that in contrast to the net income flows (Table 4b), zone 1 is now the beneficiary of positive net expenditure flows, while the reverse is the case for zones 2 and 4. Zone 3 enjoys positive net flows with all zones except zone 1.

Summary Measures of Spatial Interdependence

Table 7 provides the first summary measure of spatial interdependence, the various interactions and feedbacks shown in Figure 2 being summarized in terms of income. The entries in Table 7 thus indicate the direct and indirect income generated by a unit change in income in the zone at the top of the column. The row entries reveal how this income change reverberates throughout the metropolitan area, generating direct and indirect income changes in other zones that finally sum to the entries shown in this table. There is a modest variation in the overall income-generating effects (from 1.64 in zone 2 to 1.92 in zones 1 and 3). Table 8 re-computes these entries in percentage terms. Even though zones 1 and 3 generate the same total impact on the metropolitan area, the intrazonal effect is smaller in zone 3. Zone 2, on the other hand, generates the same intrazonal impact as zone 1, but the total multiplier effect on the metropolitan area is smaller. Between 13% and 15% of the total income impact generated in zones 1, 2 and 3 ends up in zone 4.

Finally, the total impact of the network interactions in Figure 2 is presented in Tables 9 and 10. When the almost-complete set of interdependencies are considered (recall that non-wage/salary income as well as transfers are not considered), then (with the exception of zone 4) less than 50% of the total production impacts can be traced, directly and indirectly, to activity that is generated within the zone. This activity is more than simply the production of goods and services, but includes the impacts of the distribution of income, the expenditures by consumers and the interzonal impacts that those allocations create. For zone 4, there is a greater degree of self-sufficiency, but even here 36% of system-wide production owes its existence to signals generated in other zones. Of particular interest is the finding that almost 14% of the impact in zone 4 (outer suburbs) can be traced to zone 1 (the central area or CBD). However, even these

summary tables do not convey the rich, complex nature of the interactions that come to be summarized here.

5. Evaluation and Concluding Comments

The analysis reveals what many researchers have suspected for some time, namely, that the degree of intermetropolitan interdependence is significant and complex. The results should not be surprising to those who have examined the way in which interstate and international trade has increased, in both cases far more rapidly than gross state product and gross national product, respectively. Other work has examined the way in which the Chicago metropolitan economy has hollowed out, a process that has been characterized by the metropolitan area becoming much more dependent on other regions for sources of inputs and for markets for products (Hewings *et al*., 1998). One might have expected a corresponding pattern to have emerged within the individual zones of the metropolitan area. Unfortunately, it has not been possible to reconstruct the data base used in this paper for earlier years. We suspect, however, that any decrease in what are already modest interzonal trade flows has been more than offset by increases in the complexity of interzonal work-home, home-shop, and work-shop patterns that will have served to deepen the overall interzonal dependence.

It is worth commenting briefly on the relevance of this analysis to the spatial-econometrics debate on the appropriateness of *a priori* specification of weight matrices for dealing with problems of spatial correlation. With only four zones specified, the weight-matrix structure is not very complicated. However, as the tabular data reveal, the nature of spatial dependency does change (in certain respects rather dramatically), as one moves from consideration of one type of interaction to another. In some cases, spatial contiguity is of critical importance, while in others

this does not appear to be the case. Alternative zonal structures are possible, of course, and there is always the danger that the results of the analysis of interaction may be sensitive to the configuration of zones and particularly to their number. Moreover, with a larger number of zones (e.g., the 272 communities that make up the Chicago metropolitan area), a simple weight-matrix structure may prove to be of limited value. With more zones, however, detailed data on interzonal interactions are likely to be less readily available, generating a further challenge to integrate data at one spatial level with those at another.

The central focus of this paper has been on spatial interaction within a major metropolitan area. It has been argued that the extent of this interaction is probably greater, and certainly more intricate, than is generally imagined. There is every reason to suppose that broadly similar patterns of interaction would be revealed, if the analysis was undertaken for comparable metropolitan concentrations (these having populations in excess of around 2m) within economically developed nations. The results suggest that the common view of the metropolitan area as simply comprising the central city and the suburbs has only a limited economic significance. Admittedly, the political and sociological relevance of such a dichotomous structure may be greater. Nevertheless, the findings do strengthen the economic rationale for greater co-operation and joint action among local governments within a metropolitan area. One feature that stands out, perhaps more than any other, is that the various components of interaction (particularly labor flows, and consumption-expenditure patterns) occur with considerably more intensity among the zones of a metropolitan area than among the sub-regions of a region, or among the regions of a nation. All this reinforces the point made at the start of the paper, namely, that scale is a fundamental determinant of the nature and extent of spatial interaction, a consideration which may not have received the attention that it deserves.

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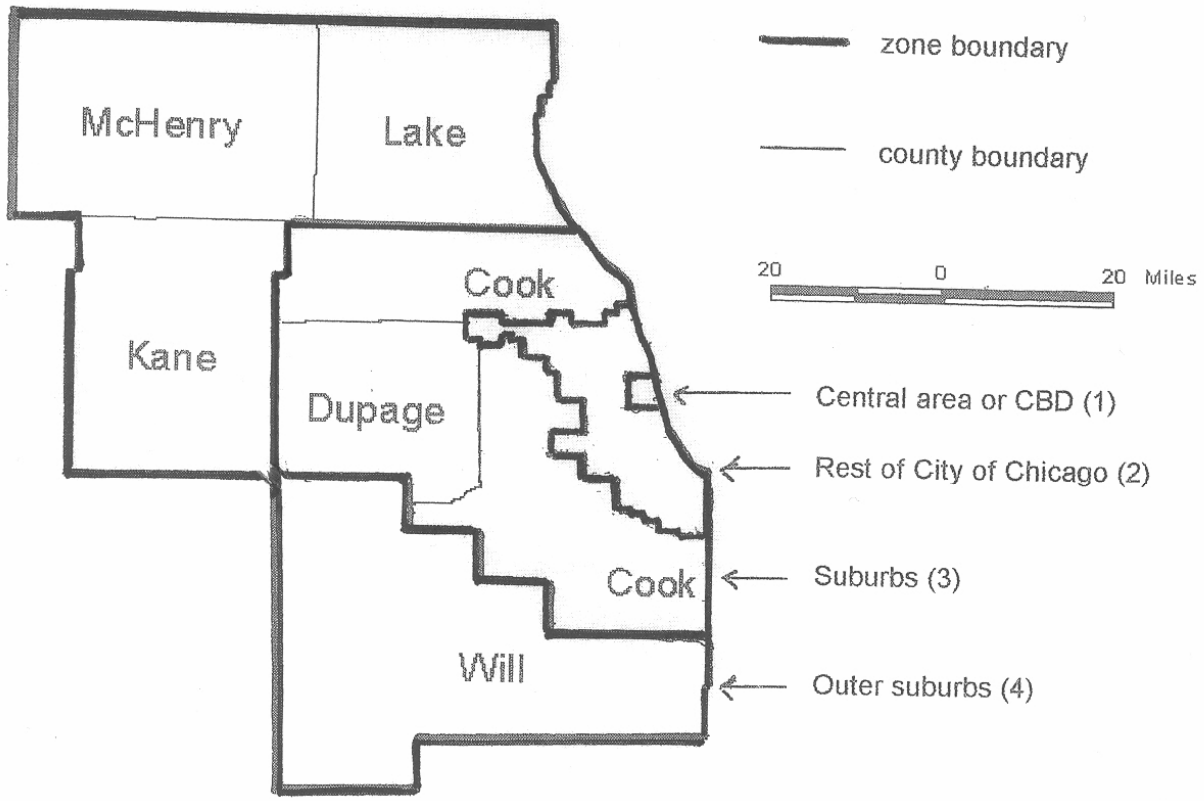

Figure 1. A Four-Zone Division of the Chicago Metropolitan Area

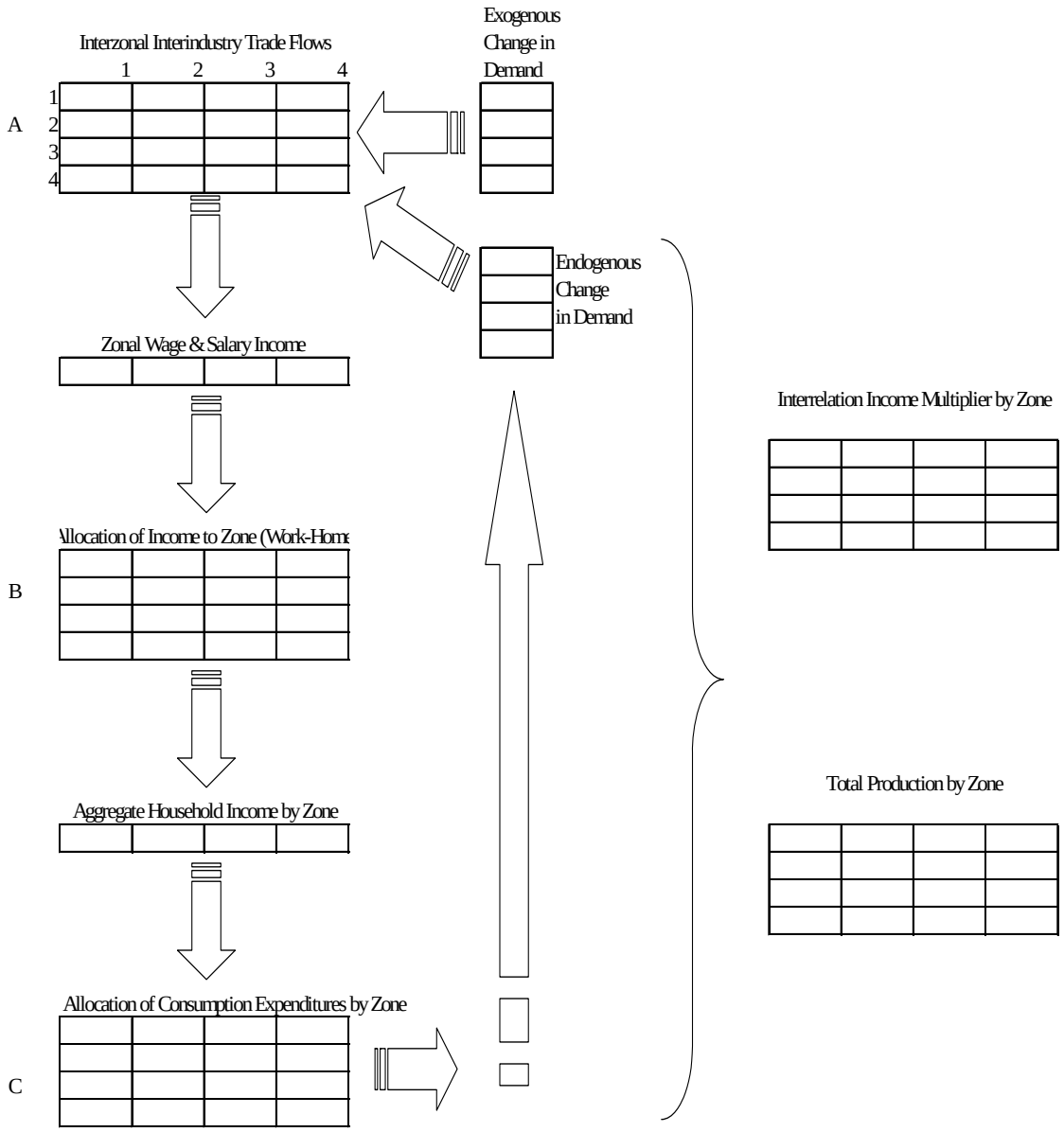

Figure 2. Schematic Flow Chart for Construction of Layers of Interaction

Table 1 Interzonal Gross Trade Flows

($ billions 2005)

	1	**2**	**3**	**4**
1	26706	1310	2266	824
2	658	66022	2907	1057
3	316	807	127624	507
4	1234	3153	5454	46702

Table 2a. Interzonal Net Trade Flows

($ billion, 2005)

	1	**2**	**3**	**4**
1	0	653	1951	-410
2	-653	0	2100	-2097
3	-1951	-2100	0	-4947
4	410	2097	4947	0
Total	-2193	649	8998	-7454

Table 2b. Interzonal Leontief Matrix

	1	**2**	**3**	**4**
1	2.2489	0.0599	0.0542	0.0553
2	0.0742	2.2576	0.0692	0.0707
3	0.0361	0.0373	2.2452	0.0344
4	0.1407	0.1452	0.1313	2.3396

Table 2c. Percentage Allocation of Interzonal Interdependence

	1	**2**	**3**	**4**
1	**89.96**	2.40	2.17	2.21
2	2.97	**90.30**	2.77	2.83
3	1.44	1.49	**89.81**	1.38
4	5.63	5.81	5.25	**93.58**
Total	100	100	100	100

Table 3. Interzonal Gross Income Flows

	1	**2**	**3**	**4**
1	4474	1200	851	219
2	27096	24719	11571	991
3	24117	11722	72962	6125
4	4191	1627	13669	26592

Table 4a Percentage of Income Received by Zone

	1	2	3	4	Total
1	66.34	17.80	12.62	3.25	100.00
2	42.09	38.40	17.97	1.54	100.00
3	20.98	10.20	63.49	5.33	100.00
4	9.10	3.53	29.66	57.71	100.00

Entries show receipt by total income in a zone (row) from all other zones (column)

Table 4b Interzonal Net Income Flows

	1	2	3	4	Total Net
1	0	-25,896	-23,266	-3,973	-53,134
2	25,896	0	-151	-635	25,109
3	23,266	151	0	-7,544	15,874
4	3,973	635	7,544	0	12,152

Table 5. Interzonal Gross Expenditure Flows

	1	2	3	4
1	1,362	646	300	8
2	3,445	33,835	6,185	222
3	758	3,029	67,741	1,548
4	59	93	4,185	25,640

Table 6a. Percentage Allocation of Total Expenditures by Zone

	1	2	3	4	Total
1	58.82	27.91	12.94	0.33	100.00
2	7.89	77.45	14.16	0.51	100.00
3	1.04	4.14	92.70	2.12	100.00
4	0.20	0.31	13.96	85.53	100.00

Entries show expenditure distribution from a zone (row) in all other zones (column)

Table 6b. Interzonal Net Expenditure Flows

	1	2	3	4
1	0	-2,799	-458	-51
2	2,799	0	5,427	-93
3	458	-3,156	0	-2,637
4	51	-128	2,637	0
Total	3,309	-6,084	7,606	-2,781

Table 7 Interrelational Income Multiplier

	1	2	3	4
1	1.413	0.127	0.355	0.232
2	0.055	1.215	0.051	0.068
3	0.189	0.060	1.234	0.118
4	0.259	0.241	0.275	1.427
Total	1.916	1.643	1.916	1.844

Table 8. Percentage Allocation of Interrelation Income Impacts

	1	2	3	4
1	73.78	7.71	18.55	12.58
2	2.87	73.96	2.68	3.69
3	9.86	3.64	64.42	6.38
4	13.50	14.69	14.35	77.36
Total	100.00	100.00	100.00	100.00

Table 9. Total Interzonal Impact

	1	2	3	4
1	3.7057526	0.7565764	1.3255378	1.0146311
2	0.4526461	3.1810222	0.4314928	0.4848316
3	1.4382064	0.774823	3.7818561	1.0783814
4	1.9817663	1.9883024	2.044867	4.7638856

Table 10. Interzonal Impacts as a Percentage of Total Impact

	1	2	3	4
1	**48.90**	11.29	17.48	13.82
2	5.97	**47.47**	5.69	6.60
3	18.98	11.56	**49.87**	14.69
4	26.15	29.67	26.96	**64.89**
Total	100.00	100.00	100.00	100.00