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CENTRAL PLACE THEORY AND REGIONAL INPUT-OUTPUT

by

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Central place theory (CPT) and regional input-output (I-O) have long served as important though mainly independent branches of regional science. CPT and regional I-O address different facets of the regional structure. CPT explains the spatial structure of regions, the size and location of settlements in space. Regional I-O explains the structure of regional interindustry trade. CPT has advanced in a primarily formal literature. In contrast, regional I-O is a highly applied technology, with many of its more prominent advances resulting from empirical exercises.

The bridge between CPT and regional I-O has been explored in a theoretical context by Mulligan (1979), and in an empirical context by Robison and Miller (1991). The aim of this paper is to further explore the CPT/regional I-O relationship. We start by reviewing common theoretical threads, and then present a technique for constructing non-survey spatial regional I-O models. Finally, we present findings from a spatial regional I-O modeling exercise in Idaho, and conclude by considering implications of spatial regional I-O for regional economic impact assessment and economic development policy.

A Common Feature Linking CPT and Regional I-O

The link between CPT and regional I-O is found in a common feature: regional trade in goods and services. Trade is explicit in regional I-O models, tracked as sales to and purchases from the various sectors of the model. Regional I-O sectors represent industry aggregates, normally defined aspatially on the basis of more-or-less homogenous commodity outputs.

Trade in CPT is a spatial phenomenon. The regional landscape is viewed as a collection of discrete settlements in an otherwise unsettled plain. Individual settlements, or places, are ordered according to the goods and services they provide to themselves and to other places. To the extent that a particular place supplies other places, it is said to dominate those other places. The collection of dominated places, together with the unsettled regions they dominate, is referred to as the "complementary region" of the dominant place (Christaller, 1966).

The pattern of dominant places and overlapping complementary regions gives rise to a trade hierarchy, i.e., a hierarchy of central places. In the strict Christaller (1966) model, the trade hierarchy reflects trade in "central place goods and services" only. But there is balancing trade in non-central place goods and services as well.

Parr (1987) provides a complete taxonomy of goods and services in a central place hierarchy. "Central place goods and services" are items for which there is essentially ubiquitous demand, groceries, consumer durables, movies, air travel, accounting, legal and business services, and so on. In contrast, "specialized goods and services" are items for which production is unique to particular regions, agricultural products, timber, input-oriented manufacturing, military installations, federal government offices, and so on. There are also factor services, principally labor services, with trade in these reflected in the pattern of commuting.

In Christaller's theoretically ideal model, trade in central place goods and services is strictly hierarchical, i.e., central place goods and services flow down but never up the trade hierarchy. Lower-order places supply their own lower-order central place goods and services, and obtain higher-order central place goods and services from higher-order places. Higher-order places supply their own lower and higher-order central place goods and services. Trade balances are obtained through production and trade in specialized goods and services, and factor services. Lowest-order places, for example, derive their income from the export of specialized goods and services, and from outcommuting.

Central place trade is modeled in regional I-O terms by partitioning the regional I-O table according to the places of the central place hierarchy. The resulting model provides a spatial I-O analysis of the regional economy. The mathematics of the model are otherwise identical to that of the traditional interregional I-O model (Robison and Miller, 1966).

Features of Spatial I-O Analysis Anticipated by Central Place Theory

Export-Base Multipliers in Central Place Hierarchies

One of several branches of modern central place research is the city size model (Beckmann, 1958; Dacey, 1966; and Parr, 1970). According to this model, a city's population is a function of its own population, plus the population of its complementary region. Parr, Denike, and Mulligan (1975) demonstrated the manner in which city size models can be cast in simple economic-base terms. Referring to the economic-base formulation, Mulligan (1979) demonstrated that basic-nonbasic ratios decrease with higher-order centers, "... the nonbasic sector becomes increasingly significant as higher and higher levels are considered." Decreases in the basic-nonbasic ratio are matched by increases in community economic-base multipliers.

Mulligan's result is not surprising. Production at a farm located in the otherwise unsettled plain provides, at the production site, an export base multiplier of 1.0. In contrast, a lowest-order place, perhaps a hamlet with a general store and post office, will have a multiplier greater than 1.0, depending on the respending, in the form of local patronage, at the store and post office. Ascending the trade hierarchy, each center offers a wider variety of goods and services, and thereby greater opportunities for the internal capture of multiplier effects. The highest-order place offers the widest variety of goods and services, and thereby the greatest opportunities for multiplier capture. The highest-order place can be expected to exhibit the largest export-base multiplier.

Figure 1 provides a hypothetical portrayal of export-base multipliers in a central place hierarchy. The figure depicts a representative cross-section of a three-order hierarchy: a metro-area dominating a city and a town, with the city in turn dominating the town. Reflecting its relatively more developed commercial infrastructure, the metro-area exhibits the greatest export-base multiplier, 2.8, as compared to a multiplier of 2.0 for the city, and 1.4 for the town.

Production in the otherwise unsettled plain provides a multiplier at that site of 1.0. Assuming that the recipients of this income, perhaps farmers or loggers, have the same consumption propensities as other regional residents, and that the production site is located in the complementary region of the town, third-order demands are satisfied at the town, second-order demands at the city, and first-order demands at the metro-area. Accordingly, associated with isolated production are a set of what Hamilton et. al. (1990) called "spillover multipliers:" 0.40 to the town, 0.60 to the city, and 0.80 to the metro-area.

Ascending the trade hierarchy, multipliers for the various levels increase, as predicted by Mulligan (1979), while the overall spillover, i.e., the sum of all spillovers to higher-order places, diminishes. Spillovers from the metro-area leave the region, and are therefore not tracked.

A portion of the impact of an economic change at a lower-order place spills beyond the lower-order place, following a path defined by its location in the trade hierarchy, to higher-order places, eventually impacting the region's dominant place. Spillover multipliers provide a mechanism for assessing the spatial diffusion of economic impacts (Robison et. al., 1991a).

Centrality as an Element in the Community Economic-base

In describing the functional character of places, Christaller (1966) draws a distinction between "importance," or "nodality," and "centrality" (see also Preston, 1971). Nodality indicates "... the combined economic efforts of [a settlement's] inhabitants" (Christaller, 1966, p.18). Nodality might be measured by the number of employees, or gross product.

Centrality, on the other hand, indicates a settlement's relationship to its complimentary region, or trade dominated hinterland. Christaller describes centrality in terms of "surplus" and "deficit" of importance. Centrality indicates a surplus of importance, a surplus matched by a deficit of importance in the complementary region.

Centrality, or central functions, can be viewed as an element in the community economic-base. An economic-base study expresses total community income and employment as a function of export income and employment (Tiebout, 1962). A community's export industries are traditionally distinguished according to a homogeneity of outputs, wood products, agriculture, mining, and so on. In addition, it is often useful to identify a composite of industries serving a common buyer, "the tourism industry" for example (Robison et. al., 1991b). Having bifurcated industry outputs as export and non-export, total community activity is explained in terms of export activity.

Proceeding along lines of composite, common-buyer industries, it is a conceptually simple matter to define that portion of the community economic-base attributable to its role as a central place. Accordingly, places of otherwise equal size, measured for example in terms of employment or income, will differ in terms of their function as central places, i.e., differ in terms of centrality.

Inasmuch as centrality captures a complex relationship between a dominating center and its dominated complementary region, capturing centrality as an element in the community economic-base provides the first step in assessing the economic impact and economic development implications of central place trade.

Modeling Central Place Trade: A Spatial Extension of the Supply-Demand-Pool Technique

In this section we describe a technique for incorporating central place trade into the framework of a non-survey regional I-O model. The technique was first proposed by Robison and Miller (1991) in an empirical exercise that assumed strictly hierarchical trade. We start by reviewing the strictly hierarchical trade approach, and then generalize the technique to modeling unrestricted trade. While our presentation is limited to a three-order hierarchy, it is easily generalized to trade hierarchies of any order.

Christaller described centrality as "an excess of importance" in trade dominating places, matched by "a deficit of importance" in trade dominated complementary regions. The popular supply-demand-pool (SDP) non-survey regional I-O modeling technique (Schaffer and Chu, 1969) compares regional supply to regional demand. Excess supply indicates export, excess demand indicates import. Similarities between Christaller's notion of centrality and the mechanics of the SDP technique suggest a spatial extension of the SDP technique.

A Non-Survey Approach for Estimating Central Place Trade: A Three-Order Strictly Hierarchical Case

Consider a three-order hierarchy, a metro-area, denoted by 'M,' dominating a city, 'C', and a town 'T.' The city in turn dominates the town. For simplicity, communities are defined broadly, to include the community itself, and a surrounding but non-overlapping hinterland of dominated hamlets and isolated homesteads. The three-order hierarchy might be thought of as but a cross-section of a more complex hierarchy, with the metro-area dominating a number of cities, who in turn dominate a larger number of towns and sparsely populated hinterlands.

Assuming strictly hierarchical trade, intra and intercommunity I-O coefficients appear as follows:

$$(1) \qquad \left\{ \begin{matrix} A_{MM} & A_{MC} & A_{MT} \\ 0 & A_{CC} & A_{CT} \\ 0 & 0 & A_{TT} \end{matrix} \right\}$$

Elements along the principal diagonal indicate intracommunity trade, and are assumed to be estimated through a standard SDP application. Off-diagonal elements indicate intercommunity trade. Null elements in the lower diagonal reflect our strictly hierarchical trade assumption.

Given a three-order trade hierarchy, intercommunity trade is estimated in a two-stage fashion, first trade between the city and town, $\boldsymbol{A}_{CT}$, and then trade between the metro-area and the city, $\boldsymbol{A}_{MC}$, and the metro-area and the town $\boldsymbol{A}_{MT}$.

CITY-TOWN TRADE

Trade between city and town, $\boldsymbol{A}_{CT}$, is estimated by first forming a matrix of coefficients, $\boldsymbol{G}_{CT}$, indicating the demand by the town for commodities available at the city in excess of that satisfied by town industries. The matrix recalls Christaller's notion of a deficit of importance in complementary regions.

Let $\boldsymbol{N}_{CT}$ be an array of national model input-output coefficients with the same row and column structure as $\boldsymbol{A}_{CT}$. Let $\boldsymbol{H}_{CT}$ be a matrix with this same row and column structure, but consisting solely of unit and null vectors. For industries present in both city and town, columns of $\boldsymbol{H}_{CT}$ contain a one in the row of that industry, zeros otherwise. For industries present at the town but not present at the city, corresponding columns of $\boldsymbol{H}_{CT}$ contain all zeros.

$\boldsymbol{G}_{CT}$ indicates the demand for commodities in the town in excess of that satisfied by town industries. Given its row dimension, $\boldsymbol{G}_{CT}$ tracks only commodities produced at the city. Assuming borrowed, e.g., national technology throughout, an estimate of matrix $\boldsymbol{G}_{CT}$ is obtained as follows:

$$(2) \qquad \boldsymbol{G}_{CT} = \{ \boldsymbol{N}_{CT} - \boldsymbol{H}_{CT}\boldsymbol{A}_{TT} \} \qquad .$$

The right-side of (2) takes gross demands for city commodities by the town, $\boldsymbol{N}_{CT}$, and subtracts from these demands satisfied by town industries $\boldsymbol{H}_{CT}\boldsymbol{A}_{TT}$.

On the basis of (2), an estimate of the town's total import demand for city commodities is given as follows:

$$(3) \qquad \boldsymbol{R}_{CT} = \boldsymbol{G}_{CT}\boldsymbol{X}_{T}$$

where $\boldsymbol{X}_{T}$ is the vector of total gross outputs for the town. Vector (3) is reminiscent, in an intercommunity context, of Isard's (1953) notion of "regional requirements." In a manner with obvious parallels to the standard SDP technique, vector (3) now serves to form a vector of scalars ρ_{CT} as follows:

$$(4) \qquad \rho_{CT_i} = \begin{cases} E_{C_i}/R_{CT_i} \ \mathit{if} \ E_{C_i} < R_{CT_i} \\ 1.0 \ \mathit{otherwise} \end{cases}$$

Arrayed in a diagonal matrix, scalars (4) premultiply (2) yielding our estimate of city to town intercommunity input-output coefficients:

(5) $$A_{CT} = \{ \hat{\rho}_{CT} \} G_{CT}$$

METRO-CITY AND METRO-TOWN TRADE

The metro-area dominates both the city and the town. Metro to city trade estimation follows the same procedure as city to town trade, through formation of the matrix:

(6) $$G_{MC} = \{ N_{MC} - H_{MC}A_{CC} \}$$

Metro to town trade is more complicated. Metro to town trade must take into account the city's dominance of the town, i.e., town demands satisfied from the city. The metro-town estimating matrix that accounts for city-town trade appears as follows:

(7) $$G_{MT} = \{ N_{MT} - H_{MT}A_{TT} - H_{MC}A_{CT} \}$$

where A_{CT} is estimated in (5) above.

The city and town's combined import demand for commodities of the metro-area is now given as follows:

(8) $$R_{M,C+T} = G_{MC}X_C + G_{MT}X_T$$

and vector (8) serves to form a vector of scalars $\rho_{M,C+T}$:

$$\rho_{M,+C+T_i} = \begin{cases} E_{M_i}/R_{M,C+T_i} \; if \; E_{M_i} < R_{M,C+T_i} \\ 1.0 \; otherwise \end{cases} \tag{9}$$

A diagonalized vector of scalars (9) serves to estimate metro to city interregional coefficients:

$$\boldsymbol{A}_{MC} = \{ \hat{\rho}_{M,C+T} \} \boldsymbol{G}_{MC} \tag{10}$$

and metro to town interregional coefficients:

$$\boldsymbol{A}_{MT} = \{ \hat{\rho}_{M,C+T} \} \boldsymbol{G}_{MT} \tag{11}$$

The Case of Three-Order Unrestricted Trade

We next consider a three-order trade hierarchy with unrestricted trade, i.e., lower-order places supplying specialized goods and services, and factor services, to higher-order places without restriction. Three-order intra and intercommunity I-O coefficients now appear as follows:

$$(12) \qquad \left\{\begin{matrix} \boldsymbol{A}_{MM} & \boldsymbol{A}_{MC} & \boldsymbol{A}_{MT} \\ \boldsymbol{A}_{CM} & \boldsymbol{A}_{CC} & \boldsymbol{A}_{CT} \\ \boldsymbol{A}_{TM} & \boldsymbol{A}_{TC} & \boldsymbol{A}_{TT} \end{matrix}\right\}$$

where matrices $\boldsymbol{A}_{CM}$, $\boldsymbol{A}_{TM}$, and $\boldsymbol{A}_{TC}$ track lower to higher-order non-hierarchical trade, and other terms are as defined in (1).

Coefficients along the principal diagonal, and in the upper triangle of (12) are estimated as in the previous section. Coefficients below the principal diagonal are estimated in a two-step process beginning with city sales to the metro, $\boldsymbol{A}_{CM}$.

First form a matrix of coefficients, $\boldsymbol{G}_{CM}$, indicating the demand by metro industries for commodities available from city industries in excess of that satisfied by metro industries:

$$(13) \qquad \boldsymbol{G}_{CM} = \{ \boldsymbol{N}_{CM} - \boldsymbol{H}_{CM}\mathbf{A}_{MM} \} \quad .$$

To the extent that national technology is representative of our regional economy, and trade in central place goods is hierarchical, we would expect matrix (13) to exclusively reflect specialized goods and services, e.g., raw agricultural commodities and timber demanded by food and wood products producers located in the metro, and labor services, reflecting a demand for labor in the metro in excess of supply. The metro's total import demand for commodities of the city is given by:

$$(14) \qquad R_{CM} = G_{CM}X_M$$

Import demand (14) serves to form a vector of scalars ρ_{CM}.

In forming scalars ρ_{CM}, we must slightly deviate from the procedure used to model strictly hierarchical trade. In particular, rather than employing a gross measure of city exports as the measure of goods available for absorption by metro industries, we are compelled to employ a net measure that accounts for city exports previously identified as city sales to the town -- see expression (5). The procedure gives preference to the town vis-à-vis the metro-area in obtaining city exports. In defence of this preference, we note that given the structure of trade predicted by CPT, the metro-area and the town should demand a different mix of city commodities, with city-town trade reflecting central place goods and services, and city-metro trade reflecting specialized goods and services, and factor services. With this caveat in mind, scalars ρ_{CM} are formed as follows:

$$(15) \qquad \rho_{CM_i} = \begin{cases} (E_{C_i} - E_{CT_i})/R_{CM_i} \ \mathit{if} \ (E_{C_i} - E_{CT_i}) < R_{CM_i} \\ 1.0 \ \mathit{otherwise} \end{cases}$$

Capturing Hierarchical Trade in Uniform Region Models: The Core-Periphery Functional Economic Area

Geographers recognize two types of regions, uniform and punctiform (Whittlesey, 1954). Uniform regions abstract from spatial features, with boundaries drawn according to shared features of the landscape. Agricultural, industrial, and climatic regions are examples of uniform regions. Political regions, states and counties for example, are uniform regions by virtue of a common political authority. Regional I-O models are normally constructed for uniform regions.

In contrast, punctiform regions are explicitly drawn on the basis of spatial features, the areal dispersion of focused activity, settlements for example. CPT has generally evolved on a punctiform region definition.

Data are routinely collected for political regions, counties, states, and the nation. In comparison, data at the individual community level are scarce. The punctiform region, intercommunity I-O analysis of Robison and Miller (1991) notwithstanding, the utility of spatial regional I-O is limited if the modeling approach is restricted to punctiform regions.

The Functional Economic Area

Inspired by central place principles, Philbrick (1957), and Fox and Kumar (1965) introduced the notion of the "functional economic area" (FEA). With minimal spatial disaggregation, the FEA concept provides some of the spatial flavor of a punctiform central place model, in a model based on linked uniform regions.

As the name suggests, a FEA functions as a regional economy, i.e., it reflects in some measure closed markets for labor, and the goods and services available in the area. CPT plays a role: the internal structure of the FEA is recognized as reflecting a central place hierarchy, often with a single trading core dominating a surrounding hinterland of smaller dominated subcenters, each with its own dominated hinterland.

The BEA Economic Areas

The U.S. Department of Commerce, Bureau of Economic Analysis (BEA) mapped the principal trade areas, "BEA Economic Areas," of the United States (U.S. Department of Commerce, Bureau of Economic Analysis, 1975). "Each economic area consists of a standard metropolitan statistical area, or similar area that serves as a center of trade, and surrounding counties that are economically related to the center." "To the extent possible, each area includes the place-of-work and place-of-residence of its labor force." The BEA's mapping is clearly based on the FEA concept (Robison and Miller, 1988).

The Core-Periphery Model

In an applied context, the simplest central place hierarchy is conveyed by a core-periphery model, where the core is the trade center, and the periphery is the dominated complementary region of a FEA. In the next section we report on a core-periphery spatial regional I-O modeling exercise for Idaho. While BEA economic areas serve as our point of departure, we dissect one BEA economic area into finer areas, and model overlapping dominance of still another area. Our exercise provides an analysis of centrality in Idaho, and spillover estimates to neighboring regions. The exercise serves as an application of spatial economic impact analysis in a three-order trade hierarchy.

Application of Central Place-Based Regional I-O: The Role of Rural Industry in Idaho's Urban Places

Idaho is a state rich in rural industry, agriculture, timber, mining, and recreation and tourism. Rural industry in Idaho is routinely impacted by decisions of the federal government, decisions involving water, public grazing, and timber harvesting for example. What impact do these decisions have on Idaho's economy, urban as well as rural? Or more generally, what role does rural industry play in Idaho's urban places?

To answer these questions we developed a set of core-periphery models for the Idaho economy. The models reflect important rural-urban areas, and include economically linked portions of neighboring Oregon, Utah, and Washington.

Our models are constructed to indicate the economic-base of regions. Accordingly, we close the models with respect to state and local government, and endogenous investment, as well as household spending. Additional details on our procedures for constructing individual region models can be found in Robison et. al. (1991a).

Trade between the various subregions of our modeling exercise is estimated according to the spatial SDP technique discussed above. We assume trade is strictly hierarchical, recognizing that this understates the urban role of rural industry to the degree that there are feedback linkages. We are encouraged by the literature on interregional feedbacks indicating that these are likely small in magnitude (Miller, 1966; Miller, 1967; and Robison and Miller, 1991).

The Structure of Idaho's Trade Hierarchy

Idahoans are fond of saying that their state has three capitols only one of which is located in Idaho. The saying mirrors perhaps the most basic feature of Idaho's trade hierarchy: the trade dominance of Salt Lake City, Utah in southeastern and southcentral Idaho; and of Spokane, Washington in northern Idaho. Boise's dominance is largely limited to southwestern Idaho, and a portion of southeastern Oregon.

Figure 2 shows Idaho's three economic capitols. Complementary regions are based on BEA economic areas shown in Figure 3 (U.S. Department of Commerce, Bureau of Economic Analysis, 1975). Figure 2's Salt Lake City region is drawn as the combined BEA Salt Lake City and Idaho Falls economic areas.

We are justified in forming a Salt Lake City FEA from the BEA's Salt Lake City and Idaho Falls economic areas. The BEA's mapping of U.S. trade areas is limited by its implicit two-order core-periphery structure. For example, Idaho Falls is clearly locally dominant, in a manner consistent with the BEA's Idaho

Falls economic area (Figure 3). However, the common perception in Idaho is that Idaho Falls is in turn dominated by Salt Lake City.

The common perception is corroborated by television market areas. While Idaho Falls has its own television stations, with broadcast areas that generally match the Idaho Falls BEA economic area, Salt Lake City television is also available throughout southeastern Idaho. Our Figure 2 boundaries for the Salt Lake City FEA suggest a three-order trade hierarchy, with Salt Lake City at the top of the hierarchy, followed by Idaho Falls at the top of its own two-order trade hierarchy. The bottom of the hierarchy consists of the relatively less settled areas of both northern Utah and southeastern Idaho.

A more focused look at Idaho's trade hierarchy reveals a number of smaller, locally dominant centers. One of the more prominent of these is Twin Falls, Idaho. Twin Falls dominates an eight-county subregion, "Magic Valley," shown in Figure 4. Magic Valley otherwise appears as a portion of the BEA's Idaho Falls economic area.

Twin Falls has its own television station, and the eight-county Magic Valley subregion mirrors the market area of that television station. Magic Valley also receives television from Idaho Falls, Salt Lake City, and Boise. Magic Valley yellow page listings, newspaper readership, and local knowledge suggest substantial market reach from these three larger centers, Boise, Idaho Falls, and Salt Lake City. We therefore identify Magic

Valley as a separate, lower-order subregional economy, and model it as occupying overlapping market shadows of Boise, Idaho Falls and Salt Lake City.

Idaho's Gross Product by Principal Trade Region

We estimate Idaho's gross state product in 1987 at $13.7 billion. Our estimate is based on the BEA's 1986 estimate (Renshaw et. al., 1988), adjusted to 1987 on the basis of Idaho job growth. Figure 4 indicates the breakdown of Idaho's 1987 gross state product by economic trade region. With the exception of the eight-county lower-order Magic Valley FEA, Figure 4 regions appear as political subdivisions of the broader multistate trade regions of Figure 2.

In its present generational form, our Idaho economic models permit a still finer geographic breakdown of southwestern and southeastern Idaho. Figure 5 provides a more detailed look at southeastern and southwestern Idaho, indicating a further breakdown of gross product as urban and rural.

Our labels "urban" and "rural" are to some extent misnomers. By "urban" we mean urban trade center. In the case of southwestern Idaho, urban refers to the more-or-less continuous urban-suburban southwestern Idaho trading core, Boise-Nampa-Caldwell. Boise, Nampa, and Caldwell are located in Ada and Canyon Counties, Idaho; two counties otherwise noted for substantial production-agriculture. In assembling our model, we assume that all Ada and Canyon County production-agriculture lies outside the urban core, and define this as part of southwestern

Idaho's "rural" economy. Conversely, we assume all non-agricultural Ada and Canyon County economic activity lies within urban Boise-Nampa-Caldwell.

Southeastern Idaho's trading core consists of another more-or-less continuous urban-suburban complex including the cities of Pocatello, Blackfoot, Idaho Falls, Rigby, and Rexburg, Idaho. These cities are located in the upper Snake River Plain, in Bannock, Bingham, Bonneville, Jefferson, and Madison Counties, Idaho. These counties are also otherwise noted for substantial production-agriculture. In defining the gross product of this region's urban core, we again assume that all production-agriculture lies outside the urban core, and all non-agricultural economic activity lies within the several urban places.

Central Functions as an Element in the Urban Economic-base

Figure 6 is constructed to indicate the role of central place trade in the economic-base of Idaho and neighboring state urban core areas. The Spokane urban core is defined as Spokane County, Washington. Utah's Wasatch Front trading core is defined as Weber, Davis, Salt Lake, and Utah Counties, Utah, a four-county region that encompasses the urban-suburban complex of Ogden, Salt Lake City, and Provo, Utah.

Urban centers in Figure 6 appear partially shaded. Shaded areas indicate the portion of urban gross product linked to economic activity in the complementary region. For any one center, the sum of all shaded portions indicate central functions as an element in the economic-base of that center. Accordingly, central functions in the case of the Idaho Falls trade center (i.e., urban Pocatello, Blackfoot, Idaho Falls, Rigby, and Rexburg) accounts for 38% of that center's economic-base. The comparable figure for Boise-Nampa-Caldwell's economic-base is 19%; 13% for Utah's Wasatch Front; and 12% for Spokane, Washington.

Figure 6 shows considerable variation in the importance of central place trade in the economic-base of our four urban centers. Much of the variation stems from the relative presence of stand-alone export industries, i.e., industries with sales beyond the boundaries of the complementary region. For example, Spokane Washington has notable sources of stand-alone export income including Fairchild Air Force Base, Alcoa Aluminum, a diverse collection of high and medium-tech manufacturing, and others. Utah's Wasatch Front is similarly endowed with stand-alone export industry including Hill Air Force Base, Geneva Steel, Kennecott Copper, MacDonald-Douglas Aircraft, and others.

Stand-alone export industries are less easily identified in southern Idaho, particularly in southeastern Idaho. The relative lack of stand-alone export income explains much of southern Idaho's greater urban dependence on central place trade. But there is more to it than this.

Factors Determining the Centrality of Trade Centers

Centrality describes a relationship between trade center and complementary region (Christaller, 1966). Let us now focus on centrality as a function of economic activity in the trade dominated complementary region.

The top panel in Table 1 presents information from Figure 6 for the Spokane FEA. Spokane's gross product, $5,692 million, is divided into three portions, a portion linked to stand-alone export industry, $4,988 million, and portions attributable to central place dominance of northern Idaho and non-urban eastern Washington, respectively $296 million and $407 million. Also shown is the gross product for northern Idaho, $2,690 million, and for non-urban eastern Washington, $1,516 million.

The bottom panel in Table 1 looks at central place trade from the perspective of the complementary regions. The bottom panel shows top panel elements as a percent of top panel column sums. Column sums indicate total economic activity, at both core and complementary region, generated by economic activity in the various subregions. Accordingly, off-diagonal elements indicate spillovers from complementary region to trading core, as a percent of the overall economic effect of complementary region activity.

Economic activity in northern Idaho generates $2,986 million in gross product in the Spokane FEA. Of this, 90.1% accrues to residents and businesses located in northern Idaho, while 9.9%, or $296 million, spills beyond northern Idaho, to the Spokane trading core. In the case of non-urban Eastern Washington, overall gross product generated is $1,924 million, with 21.2%, or $407 million, spilling to the Spokane trading core.

Table 1 might appear puzzling. In particular, why does non-urban eastern Washington, with a gross product 45% (=($2,690-$1,516)/$2,690) less than northern Idaho's, explain urban Spokane income nearly 40% (=$407/$296) greater than that explained by northern Idaho? The simple answer, as indicated in the bottom panel of Table 1, is that compared to northern Idaho, a far greater portion of non-urban Eastern Washington's overall economic impact spills to the urban core, 21.2% for non-urban Eastern Washington versus 9.9% for northern Idaho. This answer, however, begs the more penetrating question: what determines the magnitude of complementary-to-urban center spillover?

Robison et. al. (1991a) examined spillovers in an eight core-complementary region breakdown of the Salt Lake City FEA otherwise shown in Figure 2. Focusing on summary measures of intra and interregional interconnectedness, Robison et. al. (1991a) found that the most significant factor in determining the magnitude of complementary-to-urban center spillover is the degree of commercial infrastructure development in the complementary region. Where commercial infrastructure development is slight, there is little opportunity for multiplier capture -- a large share of the multiplier effect is fugitive, spilling up the trade hierarchy to higher-order places.

The finding of Robison et. al. (1991a) explains the disparate spillovers to Spokane from northern Idaho and non-urban eastern Washington. Northern Idaho has significant urban development of its own, with three rather large cities, Lewiston, Couer d'Alene, and Sandpoint, and a large collection of smaller cities and towns. In contrast, non-urban Eastern Washington is mainly dispersed agriculture, with a few small towns. Multiplier effects that are intercepted by other industry in northern Idaho cities and towns, spill over to Spokane in the case of relatively less-developed non-urban Eastern Washington.

Table 2 shows spillovers for the Boise FEA. Comparison of Tables 1 and 2 indicate striking differences between the Spokane and Boise trade centers both in terms of the role of central place trade, and the magnitude of spillovers. Note in particular that over 38% of the overall economic effect of industry located in non-urban southwestern Idaho spills to the urban Boise-Nampa-Caldwell core.

Non-urban southwestern Idaho is at the same time rich in rural industry, principally production-agriculture and timber, and poor in terms of residentiary and other industry, or commercial infrastructure development. With relatively few opportunities for spending in non-urban southwestern Idaho, a larger share (38%) of the overall multiplier effect of rural industry spills into the urban southwestern Idaho trading core.

Table 3 shows spillovers for the Salt Lake and Idaho Falls FEA's. Reflecting the three-order trade hierarchy, note that two levels of spillovers are tracked, spillovers to the Idaho Falls core, and spillovers to the Wasatch Front core, including spillovers from the Idaho Falls core. Spillovers from the complementary regions of Idaho Falls are, in percentage terms, less than the spillover from non-urban southwestern Idaho to Boise. This suggests a greater level of commercial infrastructure development in the Idaho Falls complementary region as compared to non-urban southwestern Idaho. A clearer reflection of the degree of commercial infrastructure development is the relatively small (4.5%) spillover from Idaho Falls to the Wasatch Front.

Table 3 indicates several three-order spillovers, from non-urban southeastern Idaho, Teton County, Wyoming, and Magic Valley to Idaho Falls, and beyond Idaho Falls to the Wasatch Front. Inspection of these three-order spillovers suggest that the degree of commercial infrastructure development in lower-order regions is a complex notion that hinges partly on industry mixes at both lower and higher-order regions.

In the case of non-urban southeastern Idaho, spillovers to Idaho Falls and the Wasatch Front are respectively 23.1% and 14.5%. In contrast, the comparable spillovers from Teton County, Wyoming are respectively 11.4% and 12.8%. Given the mix of industries present in the various subregions, both core and complementary, Teton County, Wyoming finds more of its needs satisfied in the Wasatch Front relative to Idaho Falls than does non-urban southeastern Idaho. More work on the particulars of spillovers in terms of industry mix at core and complementary regions is warranted.

Concluding Comment: Implications of Spatial I-O Analysis for Economic Impact Assessment and Economic Development Policy

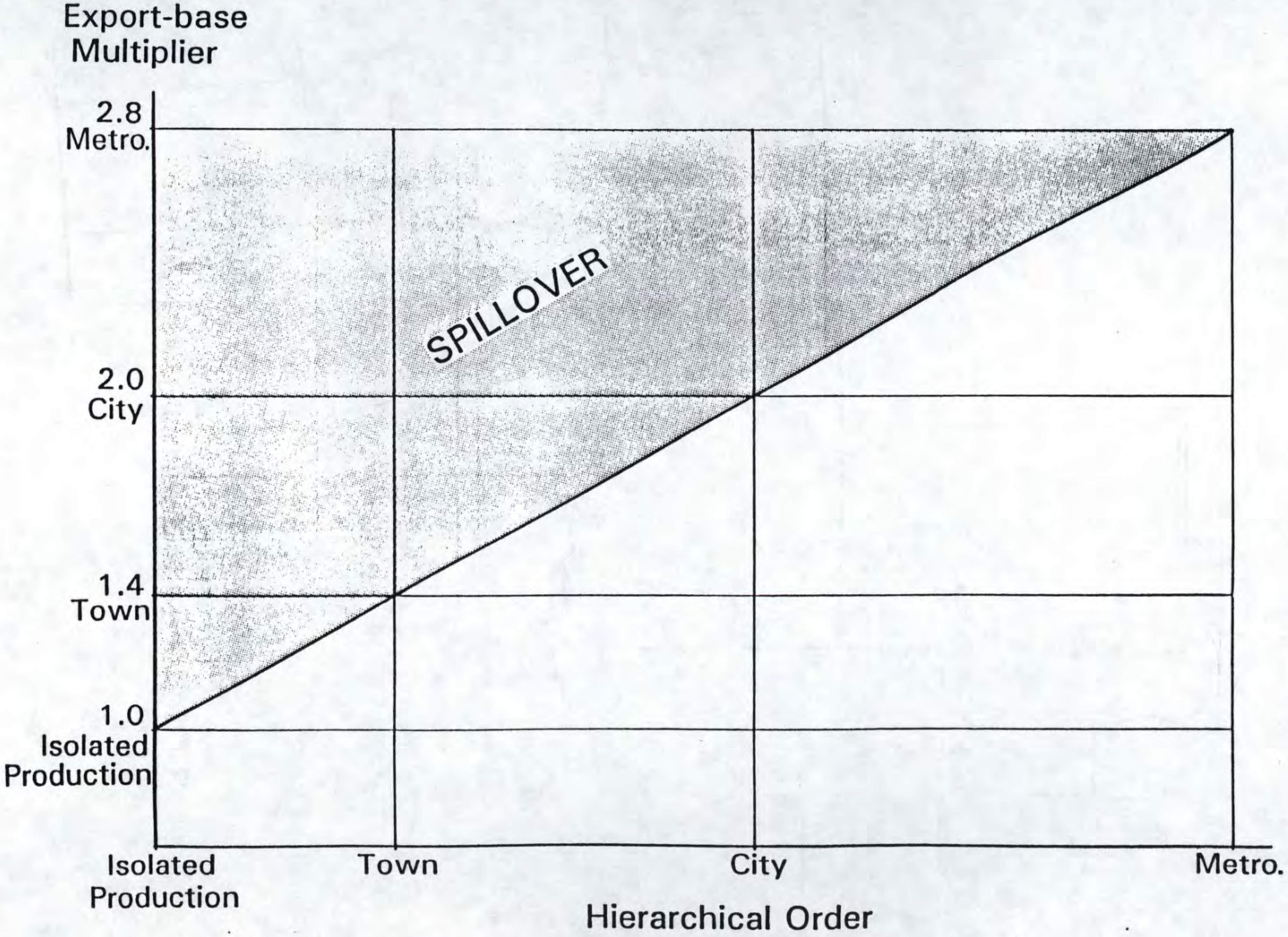
Capturing central place trade in regional I-O models opens issues with important implications for regional economic impact assessment and economic development policy. The implications for economic impact assessment are perhaps obvious. As suggested in Table 2, some 38% of the economic impact of a change in non-urban southwestern Idaho spills over to the urban Boise-Nampa-Caldwell trading core. Clearly urban Boise-Nampa-Caldwell decision makers are justified in their concern for economic changes in the rural hinterland.

Implications for economic development policy stem from the finding that centrality varies inversely with the degree of commercial infrastructure development in complementary regions. Centrality is greatest where substantial economic activity in the complementary region is accompanied by a modest level of complementary region commercial infrastructure development.

Anticipating threshold and import substitution effects, regional economic development policies often aim at deepening the economic infrastructure of targeted regions. Through spillover effects, increased economic activity in complementary regions generates economic activity in trade centers. However, as complementary region infrastructure development proceeds, a larger share of the multiplier effect will be captured in the complementary region, and spillovers can be expected to decline. In the longer run, other things equal, we might expect an overall leveling effect from development in lower-order regions.

Improvements in transportation and communication, and technological change in agriculture and other predominantly extractive rural industries has led to greater spatial concentration in many regions of the rural west. At the same time, however, other rural regions have grown and deepened their infrastructures, thus lessening their dependence on larger dominating regions. Incorporating centrality and its determinants into the regional I-O model helps explain these countervailing trends, and provides a framework where economic development policies, aimed at differential growth targets between regions, might be more appropriately framed.

Figure 1. Community-Intercommunity Multipliers in a Central Place Hierarchy



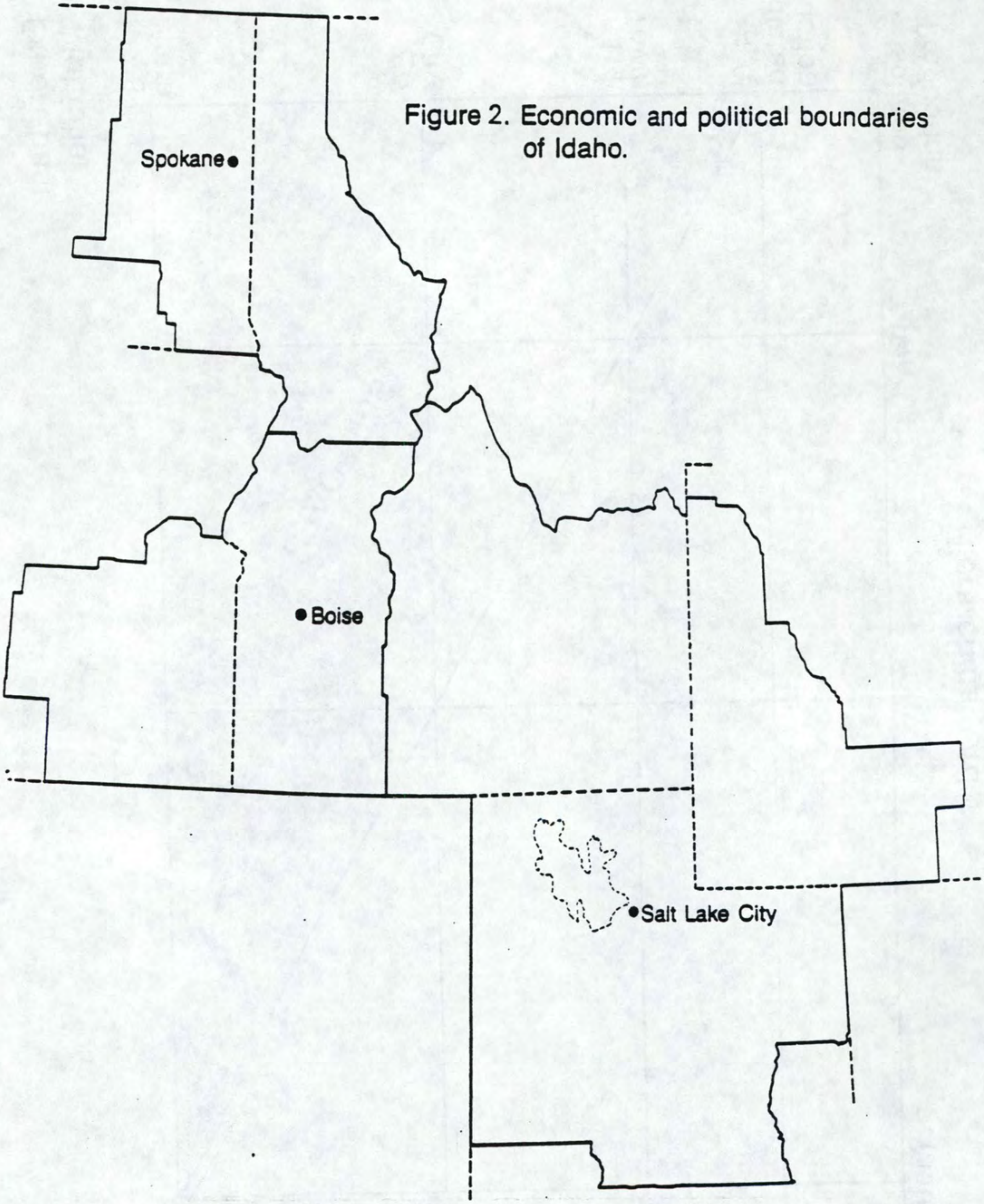


Figure 2. Economic and political boundaries of Idaho.

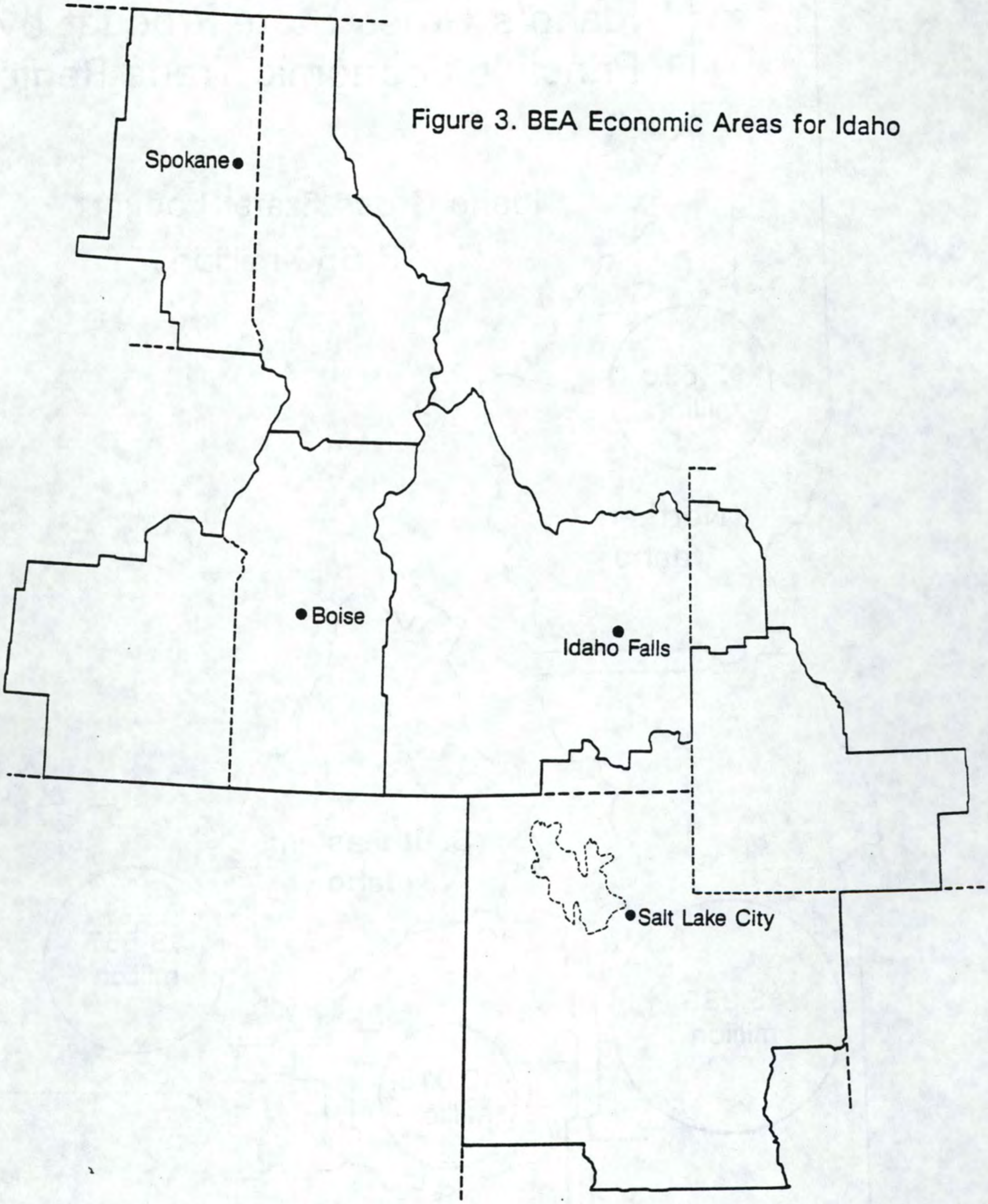
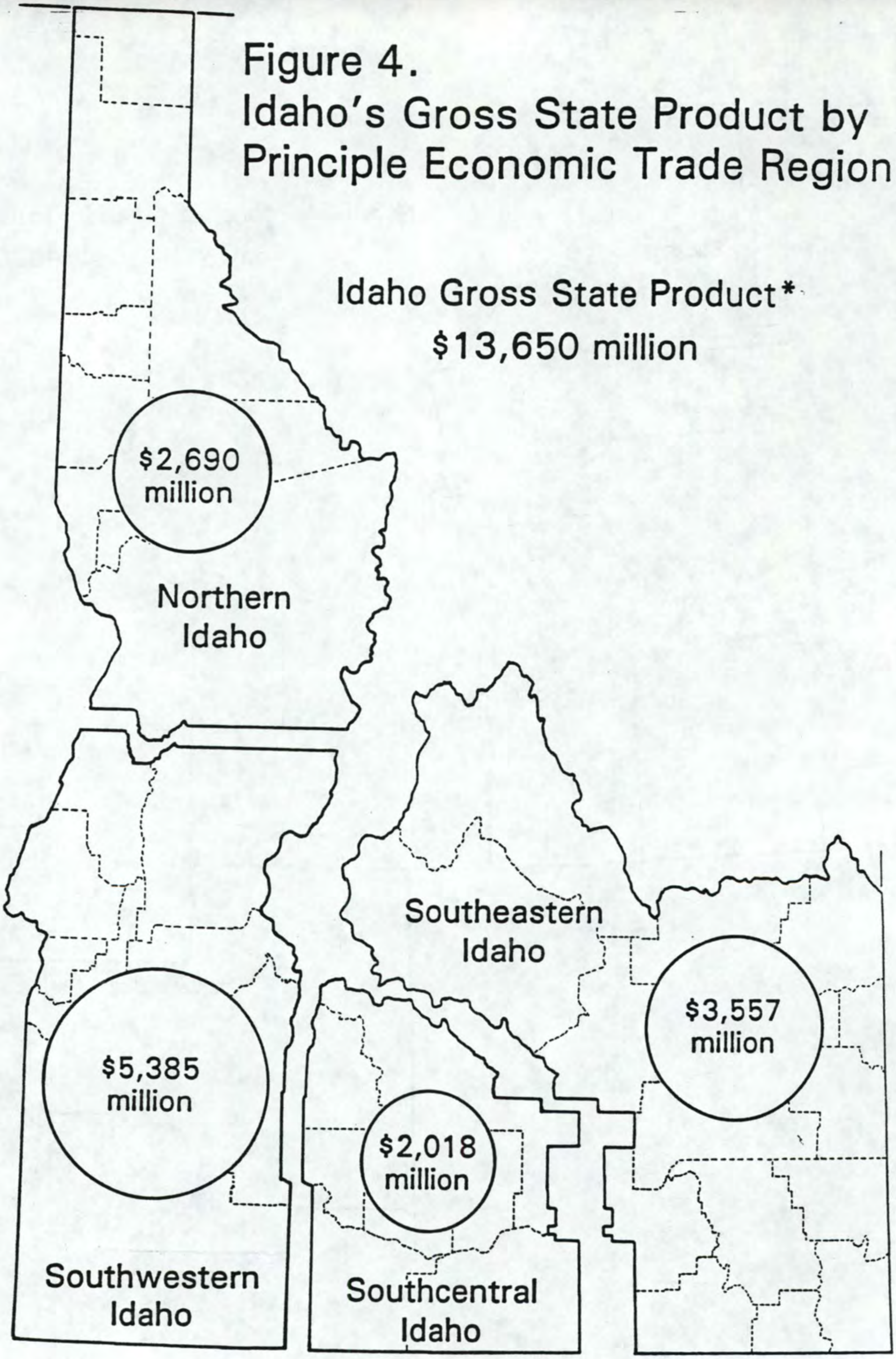


Figure 3. BEA Economic Areas for Idaho

Figure 4.
Idaho's Gross State Product by Principle Economic Trade Region



*1987

Figure 5.
Rural-Urban Breakdown of Gross Product: Southwestern and Southeastern Idaho

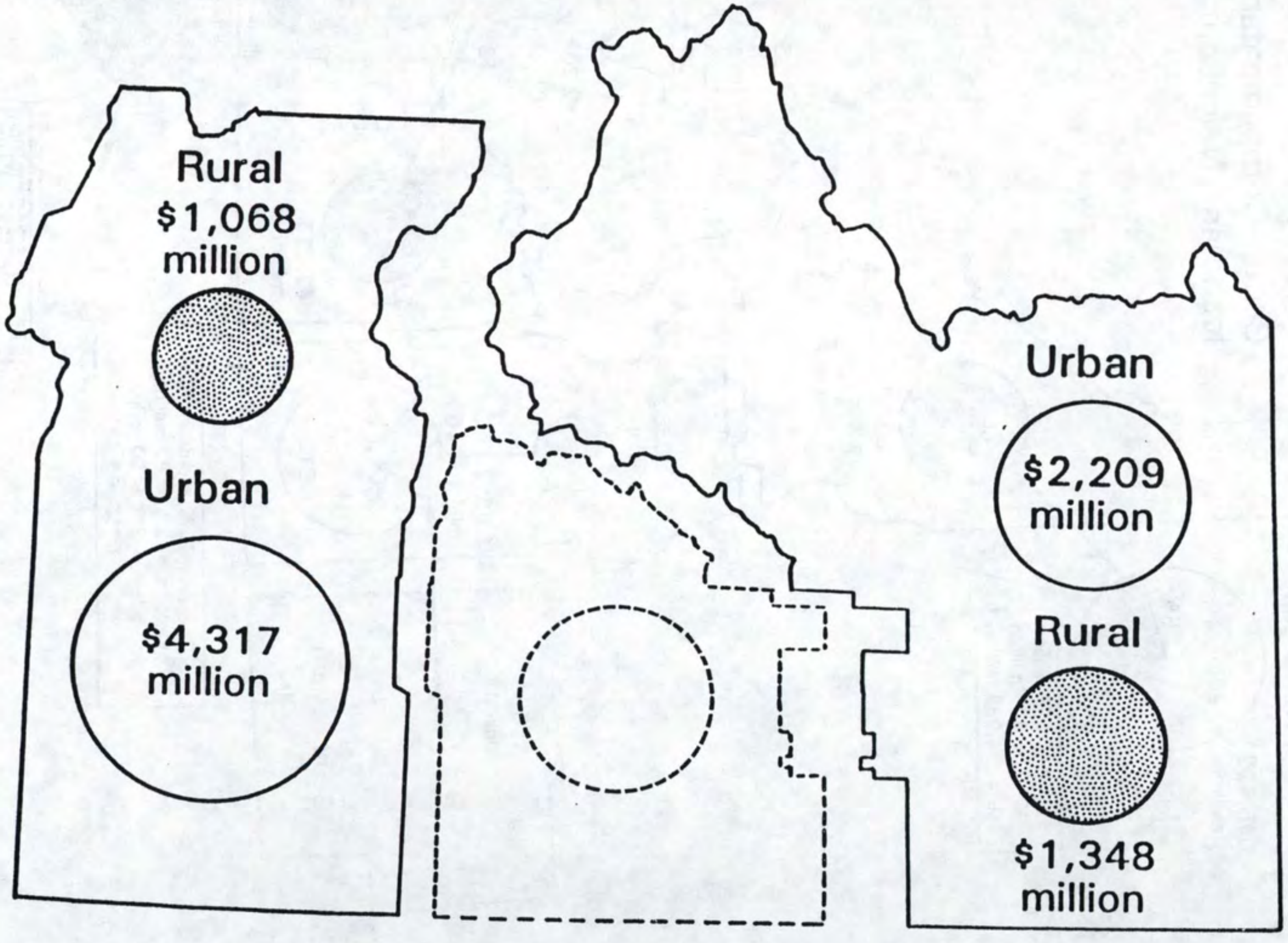


Figure 6.
Center-Complimentary Region Relationships, Idaho and Neighboring Economies

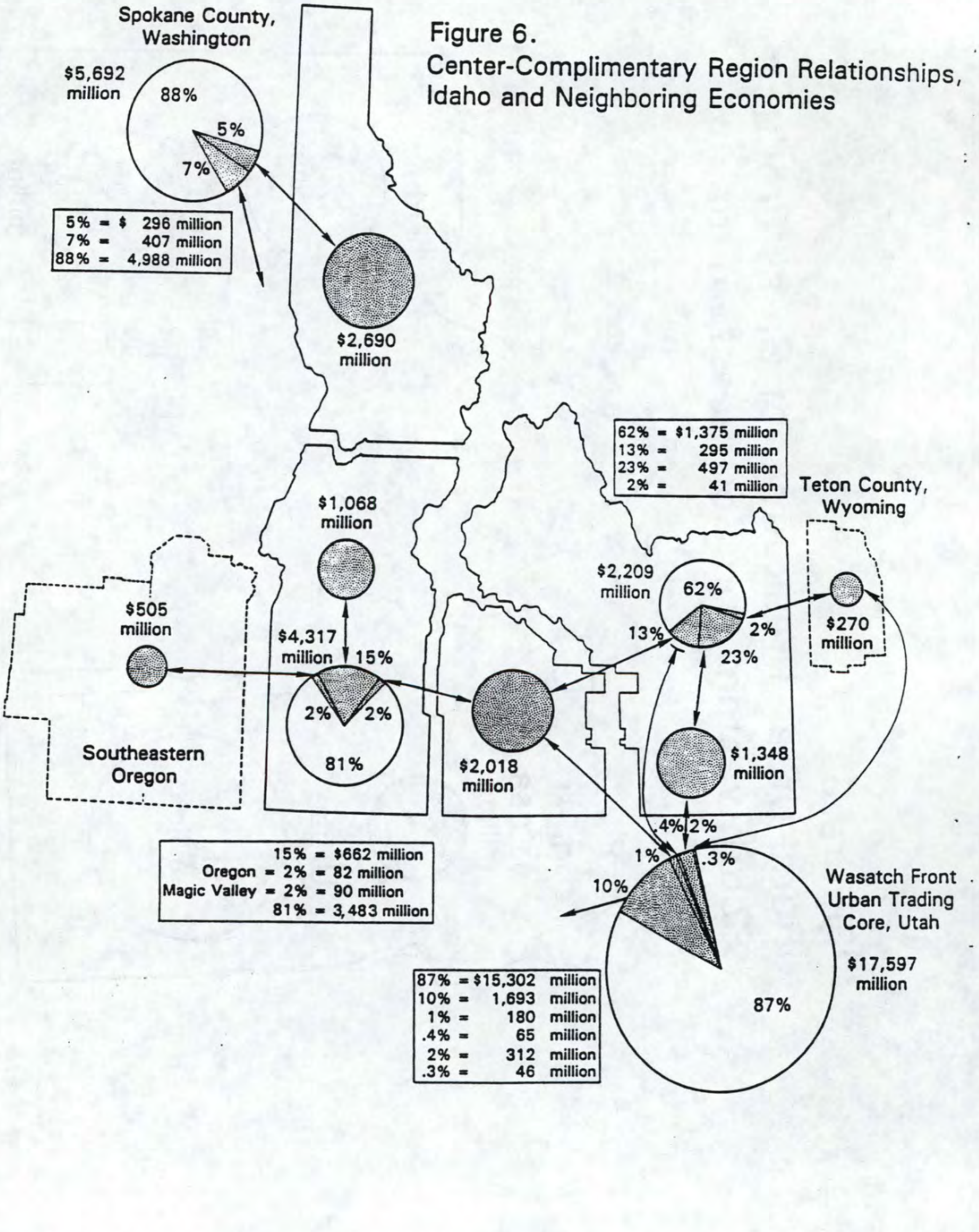


Table 1

Interregional Spillovers in the Spokane, Washington Functional Economic Area: Gross Product by Location of Originating Economic Activity

	Spokane	N.Idaho	E.Wash.	Total
		($Millions)		
Spokane	$4,988	$296	$407	$5,692
N. Idaho		$2,690		$2,690
E. Wash.			$1,516	$1,516
Total	$4,988	$2,986	$1,924	

	Spokane	N.Idaho	E.Wash.
		(Percent)	
Spokane	100.0	9.9	21.2
N. Idaho		90.1	
E. Wash.			78.8

Table 2

Interregional Spillovers in the Boise, Idaho Functional Economic Area: Gross Product by Location of Originating Economic Activity

	Boise	S.E. Oregon	S.W. Idaho	Magic Valley	Total
			($Millions)		
Boise	$3,483	$82	$662	$90	$4,317
S.E.Oregon		$505			$505
S.W.Idaho			$1,068		$1,068
Mag.Valley				$2,018	$2,018
Total	$3,483	$587	$1,730	$2,108	

	Boise	S.E. Oregon	S.W. Idaho	Magic Valley
		(Percent)		
Boise	100.0	14.0	38.3	4.3
S.E.Oregon	0.0	86.0	0.0	0.0
S.W.Idaho	0.0	0.0	61.7	0.0
Mag.Valley	0.0	0.0	0.0	95.7

Table 3

Interregional Spillovers in the Salt Lake City, Utah Functional Economic Area: Gross Product by Location of Originating Economic Activity

	S.L.C.	N.Utah	ID.Falls	S.E. Idaho	Teton Wyo.	Magic Valley	Total
	($Millions)						
S.L.C.	$15,302	$1,693	$65	$312	$46	$180	$17,597
N.Utah		$5,519					$5,519
ID.Falls			$1,375	$497	$41	$295	$2,209
S.E.Idaho				$1,348			$1,348
Teton Wyo.					$270		$270
Mag.Valley						$2,018	$2,018
Total	$15,302	$7,212	$1,440	$2,157	$356	$2,493	

	S.L.C.	N.Utah	ID.Falls	S.E. Idaho	Teton Wyo.	Magic Valley
	(Percent)					
S.L.C.	100.0	23.5	4.5	14.5	12.8	7.2
N.Utah	0.0	76.5	0.0	0.0	0.0	0.0
ID.Falls	0.0	0.0	95.5	23.1	11.4	11.8
S.E.Idaho	0.0	0.0	0.0	62.5	0.0	0.0
Teton Wyo.	0.0	0.0	0.0	0.0	75.8	0.0
Mag.Valley	0.0	0.0	0.0	0.0	0.0	80.9

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