Measuring Rural-Urban Economic Linkages in the Monroe Louisiana Trading Area Through a Multiregional Input-Output Model (Bulletin #856)

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INTRODUCTION

Many questions regarding economic development and structural change in rural areas are best viewed in terms of a larger regional economy that includes the urban region to which the rural region is economically related. A deeper understanding of the linkages between rural and urban economies is expected to aid policy makers in addressing interrelated problems, such as declining economic opportunity in certain rural regions and losses in quality of life in urban areas with high rates of economic growth (Harrison and Sieb 1990). A better assessment of the impact of agriculture and other rural-based sectors on urban economies may also be provided.

Many writers have pointed out that a functional regional economy will typically consist of a central urban core and a surrounding rural periphery. This study integrates regional economic theory with empirical analysis through the construction of an interregional core-periphery input-output (I-O) model of the 10- parish Monroe, Louisiana Functional Economic Area economy. The model is used to estimate trade relationships and resulting economic linkages between the core and periphery economies. Model results also provide a starting point for comparing the importance of positive (spread) and negative (backwash) effects from the urban core subregion of Ouachita Parish to the region's rural periphery.

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THEORETICAL DEVELOPMENT

Core-periphery economic models are based on a number of different underlying theoretical concepts. These theories are used to make certain predictions about the structure of core and periphery economies and about economic linkages between the two. Core economies are generally more urban in nature with an economic structure more dependent on services. Periphery economies are more rural in nature with economic activity more dependent on natural resources and inexpensive labor. In this study, the tantamount concern is the relationship between an urban core and the surrounding, completely rural (nonmetropolitan), periphery.[1]

Location, Central Place, Core-Periphery, Nodal Response, and Growth-Pole Theories

As suggested by firm location theory (Richardson 1979), many periphery regions specialize in the production of goods in which they have a comparative advantage. Comparative advantage may be due to local natural resources or to inexpensive labor used in routine low-tech manufacturing. One could surmise that food processing and other industries that are dependent on local agriculture or other natural resource-based industries for inputs may locate in the core.[2] Trade in such goods may flow from the periphery to the core (Parr 1987) or to other national and international markets. For example, agricultural commodities might be shipped from a periphery to its urban core or exported out of the region entirely. Hence, a testable hypothesis is whether core sectors dependent on agricultural products, such as food processing, have strong linkages with the periphery economy. Results could be important to development planners, because if these linkages are strong, the expansion of such core sectors could imply growth in the periphery economy as well.

Advocates of central place theory (Christaller 1966) argue that within a region communities can be ordered based on the effective demand for goods and services. This ordering ranges from villages and towns, where only the lowest-order economic activity exists, up to primary cities that are the main suppliers of higher-order services to the region, such as specialized health facilities and financial services. Based on central place theory, an urban central place is expected to have an economy that is more heavily weighted towards so-called higher-ordered services. An urban core surrounded by a peripheral rural region is an extension of the central place concept. The surrounding rural periphery is largely dependent on the central place for its supply of higher-order goods and services.

Partly because of previously mentioned trade relationships, growth in the core region influences economic activity in the periphery through positive spread effects and negative backwash effects. Spread effects include the diffusion of investment, innovation, and growth attitudes from core to periphery areas. A more concrete spread effect is the backward linkages between sectors of the core economy and those industries that function as their input suppliers in the periphery. Input suppliers from a rural area are likely to be industries, such as agriculture, that are oriented toward the natural resource base or the inexpensive labor supply of the periphery region.

Backwash effects refer to the unfavorable effect of core economic growth on periphery economic development. Some backwash effects result from the migration of labor and financial capital from the periphery to the core, with the attendant problems of depopulation and capital shortages in the periphery. Core service sectors may also displace their counterparts in the periphery. For example, core-based facilities specializing in more advanced and complex procedures in legal and health services may draw an increasing proportion of total regional business.

Economists tend to disagree about the predominance of spread versus backwash effects and even about whether core growth drives growth in the periphery, or if the converse is true. In growth-pole analysis, dynamic economic growth in an urban center positively influences economic activity in the surrounding periphery (Richardson, 1979). A growth pole will probably also be a dominant central place in that it may supply a higher-order service, such as financial services, to the periphery (Richardson, 1979). A reversal of core and periphery roles is found in the concept of a nodal response, where core economic growth is based on increasing demand by a growing periphery economy for products primarily found in the core central place (Parr 1973). The nodal response implies a relatively fixed pattern of trade between the core and periphery economies.

Others have accepted the notion of core dominance, but disagree over the prevalence of spread versus backwash effects. Myrdal (1957) argued that backwash effects generally dominate. Hirschman (1958), on the other hand, felt that backwash effects are initially high as resources are pulled into the urban core. However, over time, backwash effects diminish and decentralization characterizes the spatial structure of economic activity in the region.

Krugman (1991) asserts that the interaction of growing consumer demand and increasing returns in the production of manufactured goods and in transportation systems drives a cumulative process that may result in a core-periphery economy. He emphasizes the role of accident and history in determining how the core obtains an early start in the production of manufactured commodities for national or international markets. Scale economies accentuate this early advantage, while workers attracted to the core serve as markets for the local production of other so-called nontradable goods. Once a critical mass is obtained, a cumulative process of growth may ensue in the core at the expense of the periphery. On the other hand, Krugman has argued that a core-periphery economic structure may exist for a number of years, but that under the proper conditions, seemingly small changes in economic structure can set off a rapid, cumulative process of import substitution and growth in the periphery. In this case, the previously disadvantaged periphery can itself become a core. Krugman cites the post-World War Two California economy as an example of the transformation of a periphery into a core.

Like Krugman, we also assert that no one pattern characterizes the relationship between the core and its periphery. This assertion applies to situations where the core is an urban center and the periphery is a completely nonmetropolitan area as found in the Monroe, Louisiana FEA.

The previous theoretical discussion leads to a number of testable hypotheses that are examined in this study. First, do central place and location theories hold, that is, does the core tend to provide the periphery with higher-ordered services, and does the periphery provide the core with natural resource-oriented commodities? A second, related hypothesis is whether growth pole or nodal response tendencies can be expected to dominate. If so, growth in the core economy provides greater benefits to the periphery than is provided to the core by periphery growth. Hughes and Holland (1994) indicated that periphery growth tended to spill over into the core from the periphery at a greater level than the converse. However, as compared to the region used in this study, their model of the Washington State economy had a larger urban center (Seattle) as the core. The periphery (the rest of the state) used in their study also contained a number of smaller urban centers, unlike the periphery in the Monroe, Louisiana FEA. Third, previous research (Hughes and Holland 1994, Hamilton, et al., 1991, Robison and Miller 1991) has implied that the strength of core-periphery linkages may vary across different types of rural areas and urban centers. That is, smaller urban centers may have stronger economic linkages with surrounding rural areas than do larger cities. This is true because larger urban cities may have especially strong linkages with urban areas in the rest of the country. By comparing results from this study to those for other core-periphery economies in which the core was a larger urban area, such as in the Hughes and Holland study, results can be used to indicate if the strength of core-periphery linkages varies across the size of the urban core. Fourth, the theoretical discussion suggests that certain core sectors, such as food processing, could be expected to have strong links with the periphery and that demand for certain higher-ordered services in the periphery, such as medical services, could influence economic activity in the core. Further, if rural-urban linkages are strong, growth in key periphery sectors, such as production agriculture, could spill over into the core. Therefore, economic impact analysis is used to indicate the level of spillover effect to the other subregion for changes in economic activity in key core and periphery industries. Such information may be especially useful for economic development planners in using a key industry in the core (or periphery) to induce economic growth in the periphery (or core).

Delineation and Economic Structure of the Region

There is variation in the definition of regions and the variables that are used to define regions. However, the previous theoretical discussion provides some indication of the delineation of a region and of the core-periphery subregions that may be found within a given region. In central place theory, the influence of the core extends outward over the periphery as a hexagonal area. The core area is identified as a regional growth center in growth pole theory, but no geometric structure or limitation is imposed on its area of influence. Advocates of location theory focus on firm location decisions to help explain the overall structure of a regional economy, including core-periphery linkages.

The area of study here is 10 parishes in the northeastern delta region of Louisiana known as the Monroe, Louisiana Functional Economic Area (FEA) (Figure 1). A region outlined in the Rand-McNally rating system of Principal Business Centers served as the starting point for the region and its core and periphery (Rand-McNally Company, 1993). This rating is based on commuter, trading, and shopping patterns. The city of Monroe, which is located in Ouachita Parish, has been assigned a 3-AA rating. The city was seen as a significant business and trading center for 10 adjacent or nearby parishes in Louisiana and Ashley County in Arkansas.

The original FEA was evaluated based on knowledge of the regional economy and journey to work data (U.S. Department of Commerce 1993). Based on journey to work data, Ashley County was determined to have stronger economic linkages with El Dorado, Arkansas, a nearby regional trading center in south central Arkansas, than with Monroe. Also based on journey to work data, Catahoula Parish, in the southern most portion of the original FEA, was determined to have stronger ties to Natchez, Mississippi and Alexandria, Louisiana than to Monroe.

Two adjacent parishes to the west of Monroe, Jackson and Lincoln, were excluded from the original FEA, but were evaluated for inclusion in the revised Monroe FEA. Both parishes were part of the Shreveport-Bossier City urban area. Shreveport-Bossier City is a larger regional business center located less than two hours west on Interstate Highway 20 with a combined population of 250,755 in 1990 (over four and one-half times greater than the 1990 population of Monroe). Journey to work data for 1980 indicated more commuting in dollar terms from Jackson Parish to Caddo Parish (Shreveport) and Bossier Parish (Bossier City) than to Ouachita Parish (Monroe). Further, based on central place theory, the Shreveport-Bossier City economy was assumed to provide a number of goods and services not found in Monroe. As a result, the Shreveport-Bossier City economy was assumed to exert a stronger pull on the economies of Jackson and Lincoln parishes.

The Monroe FEA was chosen as the area of study for several reasons. First, Monroe is the only metropolitan community in the region. The nine other parishes in the FEA are defined as nonmetropolitan (U.S. Depart-

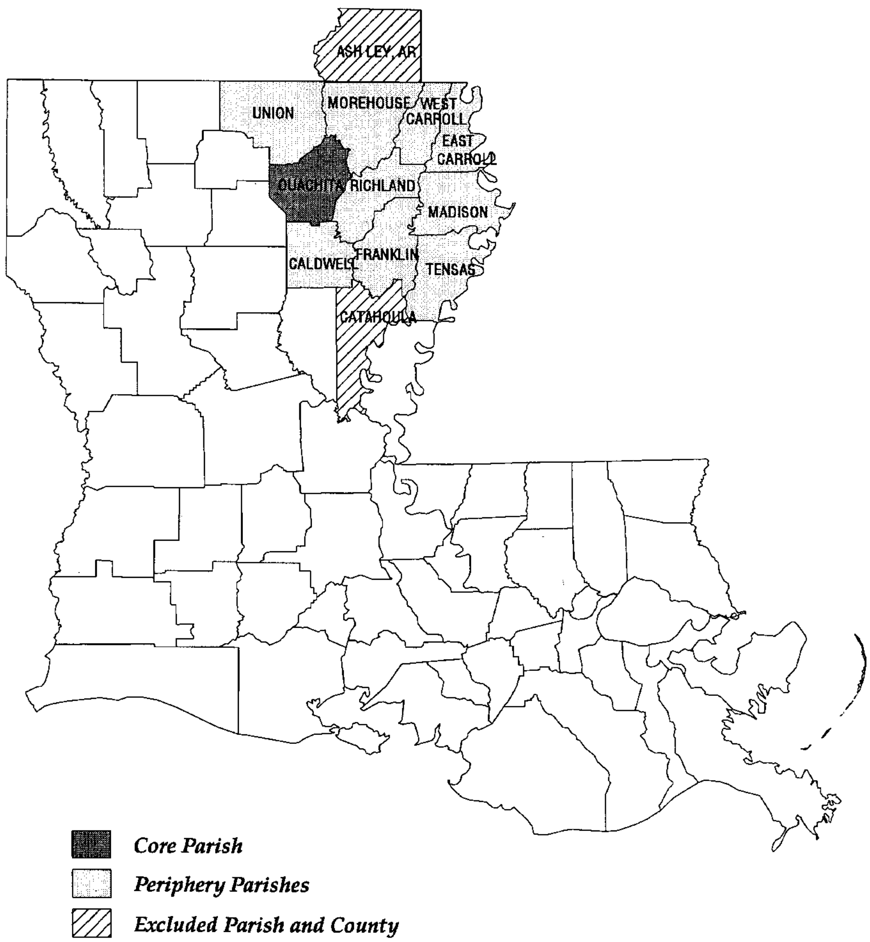


Figure 1. Map of Parishes in Multiregional I—O Model of the Monroe, Louisiana FEA.

ment of Commerce, 1989) with economies that are dependent on agriculture and forestry. Hence, the region provided a laboratory for assessing the contribution of rural based industries such as agriculture to an urban economy.

Further, the nine rural parishes in the region are characterized by high unemployment and poverty rates, an economy dominated by natural-resource based industries, and a possible imbalance in economic linkages with the core. For example, 41.8 percent of the population of West Carroll Parish lives below the poverty level, which is one of the highest county-level poverty rates in the United States (University of New Orleans, 1993). The decline of agriculture and other area industries has led to a decline in population for all parishes in the FEA during the 1980s with the exception of the urban core, Ouachita Parish (Louisiana Department of Economic Development, 1992). This fact suggests that former residents of adjacent parishes have moved closer to the core or migrated out of the region. In 1991, the unemployment rate in Ouachita Parish was 5.9%, while 1991 unemployment levels in the nine rural parishes periphery ranged from 8.1% in Union Parish (adjacent to Ouachita) to a high of 23.2% in West Carroll Parish (Louisiana Department of Economic Development, 1992). Employment in the rural parishes is concentrated in low-pay and low-skill jobs in technologically mature agriculture or routine manufacturing. Therefore, they offer little incentive for attracting a more highly skilled work force. In contrast, five of the major employers (more than 500 employees) in Ouachita Parish are service sector industries. Three of these five major employers are hospitals (Louisiana Department of Economic Development, 1992).

The lack of development in the rural periphery and the inequities between the core and periphery provide two further justifications for studying the area. First, one view of core-periphery theory suggests that economic inequities may exist between core and periphery areas. Such economic imbalances are present within the Monroe, Louisiana FEA. The analysis of economic relationships between the urban core and rural periphery would help address the issue of whether core dominance of the periphery contributed to this asymmetry. Second, the underdevelopment of the rural parishes presents a challenge to policy makers to break the cycle of rural poverty. A core-periphery model of the FEA would give policy makers a device for analyzing the utility of different approaches to facilitating rural development in the region.

An I-O analysis of the area would enable researchers to draw more decisive and categorical conclusions about the area and the relationship of interdependency that exists within the region. Through the use of I-O analysis and certain primary and secondary data, a model of the regional economy in the Monroe, Louisiana FEA was constructed to help show the economic relationship between the core and its periphery.

THE MULTIREGIONAL I-O

The Impact PLANning (IMPLAN) model building system was developed by researchers at the U.S. Forest Service to facilitate construction of regional input-output models starting at the parish level (Alward et al., 1989). Models constructed with IMPLAN draw on data from a variety of sources including the national I-O model, parish level state employment data, and various other sources. Using IMPLAN, one model was constructed for the core, a separate model was constructed for the periphery, and a third model represented the region as a whole. The core model consisted of Ouachita Parish, the periphery model comprised the remaining nine parishes in the region, and the regional model included all 10 parishes. The three models were used to build an aggregate multiregional I-O model of the Monroe FEA with intraregional and interregional trade.

The multiregional model represents trade between industries within the region and comprises of eight blocks as shown in Figure 2. Block 1 is the core IMPLAN single region I-O model for Ouachita Parish. It contains fixed proportion input coefficients (Miller and Blair 1985), repre-

Figure 2. Diagram of Core-Periphery Input-Output Model of Monroe, LA Functional Economic Area.

Core to Core Sales (Block 1)	Core Sales to Periphery Industry (Block 2)	Cores Sales to Final Demand in Periphery (Block 5)	Other Core Final Demand Sales
Periphery Sales to Core Industry (Block 3)	Periphery to Periphery Sales (Block 4)	Periphery Sales to Final Demand in Core (Block 6)	Other Periphery Final Demand Sales
Core Firms Payments to: 1) Core Workers 2) Periphery Workers 3) Outside Workers (Block 7)	Periphery Firms Payments to: 1) Core Workers 2) Periphery Workers 3) Outside Workers (Block 8)		
Other Core Value Added and Other Core Imports	Other Periphery Value Added and Other Periphery Imports		

senting core industry use of core industry production as would be found in a single region I-O model of the core. For example, the cell at the intersection of the second row and the first column would show purchases by core industry one from core industry two per dollar of output of core industry one. Block 4 is the periphery single region I-O IMPLAN model for the nine rural parishes in the Monroe FEA where the fixed input coefficients represent periphery industry use of periphery industry production. Block 2 and Block 3 (off-diagonal blocks) are the industrial interregional trade matrices. Block 2 depicts periphery industry use of core industry production as a fixed proportion input coefficient. For example, the cell at the intersection of the second row and the first column in Block 2 would show purchases by periphery industry one from core industry two per dollar of output of periphery industry one. Block 3 represents core industry use of periphery industry production as a fixed proportion input coefficient. Blocks 5 and 6 show sales by core industries to periphery final demand and sales by periphery industries to core final demand. The core model, periphery model, and regional model together are used in estimating blocks 3-6. Block 7 shows labor purchases by core industries. Contained in the block are purchases by core industries of labor from workers residing in the core and workers residing in the periphery (periphery to core commuters). Block 8 shows labor purchases by periphery industries from periphery residents and from workers living in the core (core to periphery commuters).[3]

Construction of Interregional Trade Matrices

Supply Demand Pool (SDP) values and Regional Purchasing Coefficients (RPC) are key in estimating core-periphery trade in IMPLAN. The SDP is the maximum amount of regional supply that is available to meet regional demand. It is the ratio of regionally produced net commodity supply to gross regional commodity demand.[4] A SDP of one or more implies that regional supply is at least equal to regional demand for the commodity in question. A SDP of less than one implies that the commodity will have to be imported even if none of the regional supply is exported domestically (Alward, et. al., 1989).

The RPC is a measure of the actual amount of local demand that is satisfied by local production. For a given commodity, it represents the ratio between regional purchases of regional output and the total net regional supply of the commodity. An RPC of .9 means that 10% of the commodity consumed is imported into the area. RPCs for all nonservice commodities in IMPLAN (commodities 1 through 445) are estimated through an econometrically based procedure. RPC estimates for IMPLAN service commodities (commodities 446 through 528) are calculated on the basis of observed 1977 values for state supply, exports, and imports. Because the SDP is the maximum amount of regional supply available to meet regional demand, it is an upper bound for the RPC values that are actually used in IMPLAN models (Alward, et. al., 1989).

Crosshauling is defined as the simultaneous exporting and importing of the same commodity and occurs when the RPC and SDP values are unequal. Crosshauling is often encountered in I-O analysis due to the lack of disaggregated sectors used for analysis. Assume, for example, that the forest products sector contains all types of wood products. Also assume that the region specializes in the production of plywood for the export market and imports other wood products to meet local demand. The simultaneous export of plywood and import of other wood products would show up as crosshauling in the I-O model. Brand differentiation, vertical corporate linkages, and seasonality of production may also contribute to the existence of crosshauling (Begg, 1986). If crosshauling is not accounted for in the I-O model, the study in question will probably overestimate regional impacts of a given change in final demand. Crosshauling is also important in this study because it effects the calculation of trade flows between the core and periphery economies.

Calculation of Trade Flows

Commodity trade plays an important role in determining the coefficients in the core-periphery trade blocks 2 and 5 and blocks 3 and 6 in Figure 2. That is, because commodity trade estimates are control totals for the coefficients in each block, such estimates determine the strength of core-periphery linkages in the model. For example, if core to periphery trade for a particular commodity was zero, then the appropriate row in blocks 2 and 5 would be all zeros and, *ceteris paribus*, linkages between the two economies would be weaker than if trade did exist (and the rows contained positive valued elements).

For any region, domestic trade with the rest of the United States will consist of imports and exports. For the type of multiregional model examined in this study, domestic trade can exist between three regions, i.e., the core, the periphery, and the rest of the United States. This information can be used to estimate core-periphery commodity trade. That is, trade of individual commodities between the core and periphery, between the two subregions and the rest of the U.S., and between the entire region and the rest of the U.S. can be represented by:

$$(1) \quad I_R = X_{uc} + X_{up}$$
$$(2) \quad I_P = X_{up} + X_{cp}$$
$$(3) \quad I_C = X_{uc} + X_{pc}$$
$$(4) \quad X_R = X_{cu} + X_{pu}$$
$$(5) \quad X_P = X_{pc} + X_{pu}$$
$$(6) \quad X_C = X_{cu} + X_{cp}$$

where the known, left-hand side variables are defined as follows: I_R represents regional imports, I_P represents periphery imports, I_C represents core imports, X_R represents regional exports, X_P represents periphery exports and X_C represents regional exports. For the unknown right-hand side trade variables, X_{cp} represents core exports to the periphery, X_{pc} represents periphery exports to the core, X_{pu} represents periphery domestic exports outside of the region, X_{cu} represents core domestic exports out of the region, and X_{uc} and X_{up} each represent imports from out of the region to the core and periphery (Hughes and Holland, 1994).

Simultaneously solving the system of six unknown variables in six equations would yield unique estimates of commodity trade between the core and periphery. But because the system is linearly dependent, a unique solution does not exist. However, the rank of the matrix of the unknown variables is five and the vector of known variables is a linear combination of that matrix. Therefore, a one-parameter family of an infinite number of solutions exists for the system of equations. That is, the equations solve for a unique solution if any one of the trade variables, such as core shipments to the periphery, can be set to any known value. Because negative trade flows are ruled out, if one of the left-hand side variables equals zero in any of the six equations, two of the unknown trade variables must equal the known value zero. The system of equations would then solve for unique values of the remaining four unknown variables.

Trade within the region is uniquely determined for a commodity when one of the known import or export values in equations 1 through 6 is zero. Such a situation exists when the SDP and RPC values are equal for the commodity in at least one of the three models. If the two values both equal one, then commodity imports for that particular region are equal to zero because all local demand is met locally. Two of the trade variables can be set equal to zero by use of the appropriate regional import equation, and the system of equations is solved. If the RPC and SDP values are equal and less than one, commodity exports from the region in question equal zero or all local commodity production is consumed by local demand. Two of the trade variables can be set equal to zero through the appropriate regional export equation and the system of equations is solved. Hence, if crosshauling does not exist for the commodity in question in at least one of the three regions (i.e., the RPC equals SDP in at least one region), the trade variables can be uniquely determined (Hughes and Holland, 1994). Using the six equations discussed previously, 289 of the 528 commodity trade flows were solved. Trade flows for 276 commodities were solved because either core exports or periphery exports equaled zero. Additionally, seven commodity trade flows were solved because regional exports were equal to zero, and six commodity trade flows were solved because core imports equaled zero.

The remaining 239 commodities had crosshauling in all three models and trade flows could not be determined uniquely with the six-equation system. An additional equation can be established to solve for unknown trade relationships with the new lefthandside variable, T_{pc} (Hughes and Holland 1994). This value is determined by subtracting the region import equations from the core plus periphery import equations:

$$
\begin{aligned}
&= I_c + I_p - I_r \\
&= (X_{uc} + X_{pc}) + (X_{up} + X_{cp}) - (X_{up} + X_{uc}) \\
T_{pc} &= X_{pc} + X_{cp}
\end{aligned}
$$

or by subtracting the region export equations from the core plus periphery export equations:

$$= E_c + E_p - E_r$$
$$= (X_{cu} + X_{cp}) + (X_{pu} + X_{pc}) - (X_{cu} + X_{pu})$$
$$(7) \quad T_{pc} = X_{cp} + X_{pc}$$

where T_{pc} is total core-periphery trade.

If the total core-periphery trade variable equals zero, there is no interregional trade of that particular commodity between the core and the periphery. The core to periphery trade variable (X_{cp}) and the periphery to core trade variable (X_{pc}) must both equal zero. Under this condition, a unique solution for the four remaining unknown trade variables can be found. Commodity trade variables were determined for 104 of the remaining 239 commodities under this condition. Trade variables for the remaining 135 commodities were still not uniquely determined by the use of equations (1) through (7). Most of these commodities (126) either had import (X) or export (I) values for one of the three models that were relatively small, ($100,000 or less) or a total core-periphery trade value (Tpc) equal to or less than $100,000. For such commodities, crosshauling occurred, but it was very slight. Unique solutions for the trade flow variable for these 126 commodities were obtained by assuming that the appropriate import, export, or total core-periphery trade value equaled zero.

Solutions for the unknown trade variables for the nine remaining commodities could not be obtained by rounding imports, exports, or the total core-periphery trade variable to zero. For these commodities, the known interregional trade variable (T_{pc}) from equation (7) was used to directly solve for the interregional trade values, X_{pc} and X_{cp}, in one of three ways. Because these nine commodities represented only 1.2% of total core-periphery trade, the method of allocating trade flows was not expected to have much effect on model structure and results.

Based on central place and location theory, interregional trade was assumed to flow solely in one direction for four of these commodities. For the remaining five commodities, theory provided no clear indication of the direction of core-periphery trade. Therefore, interregional trade was assumed to consist of core to periphery and periphery to core shipments. That is, X_{pc} and X_{cp} were both assumed to be positive values. Trade flows for the five commodities were estimated by multiplying the ratio of subregion imports to total region imports by T_{pc}, the total interregional trade variable.

Estimated trade flows were examined for conformity with accepted notions of location theory and central place theory. Trade flow estimates for Banking (commodity 464), Insurance Agents and Brokers (commodity 468), Colleges and Universities (commodity 508), and Gas Production and Distribution (commodity 457) were not consistent with theory. Counter to central place theory, the higher order services of Banking, Insurance Agents, and Colleges and Universities were shipped from the periphery to the core rather than from the core to the periphery. Further, there was no interregional trade between the core and periphery in Gas Production and Distribution (commodity 457). This result was at odds with location theory, which suggested that two subregions producing a particular commodity on a large scale would probably experience crosshauling of that commodity within the region.

The periphery to core trade for Banking (464), Insurance Agents and Brokers (468), and Colleges and Universities (508) resulted from a lack of commodity supply in the core. New core supply estimates for each of these commodities were obtained through unpublished employment data for Ouachita Parish and the state, obtained from the Louisiana Department of Employment Security, and through the use of a hybrid IMPLAN model of the Louisiana state economy (Hughes, 1995). Hybrid models are I-O models that have been generated with the use of software packages such as IMPLAN but have been modified with the use of primary and secondary data. New core supply estimates for each commodity were obtained by multiplying the ratio of employment in Ouachita Parish to state employment in the appropriate industry by commodity supply in the state IMPLAN model. The new supply estimates were incorporated into both the core and the regional models resulting in core to periphery trade for Banking (464) and Colleges and Universities (508) and two-way core-periphery trade in Gas Production and Distribution (457).[5]

Trade Block Construction

The estimates of core to periphery and periphery to core trade by commodity formed control totals for Block 2 and Block 5, and Block 3 and Block 6 in Figure 2. Commodity trade had to be translated into industry trade because IMPLAN produces industry by industry input-output models.[6] The industry by commodity market share matrix in the shipping region is used to change commodity trade values into industry terms. By letting **M** represent the market share matrix in the shipping region and **C** the vector of trade values we obtain

(8) $\mathbf{T} = \mathbf{MC}$

where **T** is the vector of interregional trade as industry values. For the subregion receiving the trade, the industry by industry flow table (IMPLAN Report *.402), augmented by the set of final demand vectors excluding all exports, is used to distribute the industry trade values in **T** among all industry and non-industry users. For periphery to core trade, this distribution requires the assumption that core use of commodities imported from the periphery follows the same pattern as consumption of commodities produced in the core. For example, assume the periphery shipped electricity to the core. If 10% of core generated electricity was consumed by core food processing, then 10% of periphery electricity traded with the core would also be consumed by core food processing. The augmented flows matrix is row normalized resulting in the matrix **R** that shows the distribution of consumption of traded goods between all industries and consumers in the receiving region. The vector **T** is diagonalized to form $\hat{\mathbf{T}}$ to maintain the proper dimensions. Multiplying $\hat{\mathbf{T}}$ and **R** yields

(9) $\mathbf{B} = \hat{\mathbf{T}}\,\mathbf{R}$

where **B** represents industry trade Block 2 and consumer trade Block 5 in Figure 2 for core to periphery sales and industry trade Block 3 and consumer trade Block 5 for periphery to core sales.

Validity of model results is dependent on the accuracy and stability over time of the fixed trade coefficients in both of the off-diagonal blocks. For example, assume a particular core industry purchases one cent's worth of output from a given periphery industry per dollar of production. An increase in output by the core industry is predicted to result in a proportional (one percent) increase in sales by the periphery industry to the core industry.

Several years of data on trade between the core and periphery for hospital services indicated that trade in this important commodity was stable over time (University of New Orleans). Hence, the model was assumed to be a reasonably accurate portrayal of core and periphery economic linkages in the Monroe, Louisiana FEA.

Calculation of Commuting

Labor is another commodity that can be traded between a core and its periphery. Cross regional commuting was calculated based on journey to work data for 1980 and 1990 provided by the Regional Economic Information System CD-ROM (U.S. Department of Commerce, Bureau of Economic Analysis, 1994). For workers in all parishes in the Monroe FEA, the data contained the parish of residence, number of workers, and average salaries by one-digit Standard Industrial Classification Code. Periphery residents commuting to core jobs was accounted for by first computing the labor bill for core workers residing in the periphery as a percentage of total core payments to labor within the given SIC Category. The percentages were then applied to all IMPLAN industries in the one-digit SIC Category to provide an estimate of payments to periphery workers by all core industries in the model. These values were then normalized by core total industry output to obtain fixed periphery to core labor input coefficients (part of Block 7 in Figure 2). The same procedure was also applied to payments to labor by periphery firms in obtaining payments by periphery industries to workers residing in the core on a per unit basis (part of Block 8 in Figure 2).

The procedure was also used to calculate payments to core and periphery workers residing outside of the Monroe FEA. As Rose and Stevens (1991) argue, payments to workers not living in a region should be treated as leakages of income outside of the region. Wages paid by core and periphery industries to workers residing outside of the Monroe FEA were assumed, therefore, to support household spending elsewhere. As a result, payments to individuals working in the Monroe FEA but living elsewhere were not included when the model was closed with respect to households. All elements in the core and periphery regional household demand vectors were also adjusted downward to account for the estimated total leakage of labor income in the core and the periphery. The estimated total leakage of labor income was 1.76% across all core industries and 1.78% across all periphery industries.

MODEL RESULTS

Theory suggests an inherent interdependence in the core-periphery relationship. The basis of this interdependency is manifested in the type of goods and services traded between the two subregions. A core area should provide higher-order services to its periphery area. The periphery may supply natural resource oriented goods and other commodities to the core. Such an interdependency is important for determining the strength and the nature of direct and indirect linkages between agriculture in the periphery and the overall core economy. This relationship may be examined in a multiregional input-output model through the evaluation of core-periphery trade, through total interregional and intraregional multipliers, and through regional impact analysis.

Composition of Core and Periphery Commodity Production

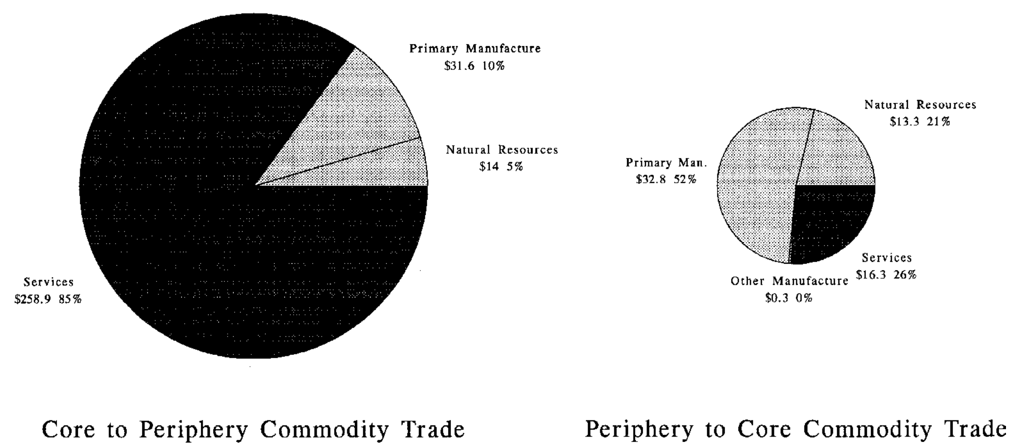
The breakdown of periphery commodity production was based on net commodity supply estimates generated in IMPLAN. IMPLAN net supply estimates were consistent with *a priori* expectations that agriculture and natural resource oriented primary manufacturing formed much of the economic base of the periphery regional economy. For example, important periphery industries included Cotton (10), with $114.6 million, and Paper Mills (188), with $177.3 million worth of commodity supply. Services, such as Retail Trade (463), were an important part of the economy but were expected to be sold in local markets and to not form a major portion of periphery exports.

Natural resource based manufacturing, such as Nitrogenous and Phosphatic Fertilizers (216), with $141.6 million of commodity supply, and Paperboard Mills (189) were important to the core. But health, finance, and trade services also formed important components of the core economy. Major service industries included Retail Trade (463), with a commodity supply of $283.8 million, and Wholesale Trade (461), with $243.5 million worth of commodity supply, and Hospitals (504), with $115.6 million worth of core commodity supply.

Interregional Trade Estimates

Interregional trade between the core and the periphery economies was estimated by the previously described three-region model method. Commodity trade from the periphery to the core was less in total number of commodities and total value than the converse. Core to periphery trade was $304.5 million, or almost five times greater than periphery to core trade at $62.6 million (Figure 3). Core to periphery trade consisted of 86 commodities, while periphery to core trade comprised 53 commodities. The core shipped 27 commodities to the periphery in excess of $1 million in value whereas the periphery shipped only 11 commodities in excess of $1 million in value. Further, 11 of the com-

Figure 3. Multiregional Input-Output Model Estimates of Core-Periphery Trade in the Monroe Louisiana FEA in 1985.



Millions of 1985 Dollars.
Total Core to Periphery Commodity Trade was $304.5 million.
Total Periphery to Core Commodity Trade was $62.6 million.

Figure 3. Multiregional Input-Output Model Estimates of core-Periphery Trade in the Monroe Louisiana FEA in 1985.

modities shipped from the core to the periphery exceeded $10 million in value, whereas only two commodities shipped from the periphery to the core exceeded $10 million in value.

Advocates of central place theory posit that higher order services within the region, such as financial and health services, will be provided by the core. Examination of core to periphery trade in specific commodities confirmed the *a priori* notions of central place theory. The majority of trade from the core to the periphery was concentrated in service commodities, with total trade of $258.9 million, or 85% of all shipments as shown in Figure 3. For example, the core was estimated to provide $47.7 million worth of Insurance Carriers (467) and $40.6 million worth of Hospital Services (504) (Table 1). Other Wholesale Trade (461) at $15.4 million, Other Retail Trade (463), and Eating and Drinking Places (491) were also important elements in core to periphery trade.

Primary manufacturing commodities were $31.6 million, or 10% of total core to periphery trade (Figure 3). Over half of the core to periphery trade in primary manufacturing was in the sale of Fluid Milk (90) and Fertilizer Manufacturing (216) (Table 1). Given the importance of agriculture to the periphery economy, shipments of fertilizer (an important agricultural input) from the core to the periphery indicated regional economic interdependence.

The concentration of periphery to core trade in agriculture and primary manufacturing was consistent with *a priori* expectations based on location theory. Periphery to core trade flows were concentrated in primary manufacturing sectors with $32.8 million, or 52% of all periphery to core trade (Figure 3). For example, Sawmills, Planing Mills (161) and Logging Camps and Logging Contractors (160) accounted for 31%, or $19.2 million of the commodities shipped from the periphery to the core region (Table 1). Commodities shipped from the periphery to the core also included specialized resource-based commodities such as Ranch Fed Cattle (3) and Natural Gas Liquids (43). However, periphery agricultural production was concentrated in cotton and oilseed crops. Neither one of these commodities was shipped from the periphery to the core. Rather, both were produced for national and international markets.

Multiplier Analysis

The core-periphery input-output model of the Monroe, Louisiana FEA used in this study and presented in Figure 2 was aggregated to form 57 industries in the core and 57 industries in the periphery or a 114 by 114 A Matrix. Including household spending and payments to labor increased the size of the matrix to 116 by 116. Type II earnings-based output multipliers are derived from the Leontief Inverse Matrix $(I-A)^{-1}$ where A represents the eight blocks of the multiregional I-O matrix depicting intraregional and interindustry trade in Figure 2. The coefficients may be used to measure the direct, indirect, and induced effects of a dollar change in output for a particular industry. Direct effects refer to the actual exogenous dollar change in output for the particular industry.

Table 1. Core to Periphery and Periphery to Core Commodity Shipments in Multiregional I-O Model of the Monroe, Louisiana FEA.

Core Commodity Number	Core Commodity Name	Core to Periphery Trade (1985 million $)	Periphery Commodity Number	Periphery Commodity Name	Periphery to Core Trade (1985 million $)
467	INSURANCE CARRIERS	47.750	161	SAWMILLS/PLANING MILLS	10.097
504	HOSPITALS	40.609	43	NATURAL GAS LIQUIDS	10.048
491	EATING/DRINKING PLACES	35.313	151	BOUGHT MATERIAL APPAREL	9.186
463	OTHER RETAIL TRADE	25.106	160	LOGGING CAMPS	9.117
469	OWNER-OCCUPIED HOUSING	18.271	468	INSURANCE AGENTS/BROKERS	5.733
503	DOCTORS AND DENTISTS	17.346	448	MOTOR FREIGHT TRANSPORT	3.653
461	OTHER WHOLESALE TRADE	15.437	3	RANCH FED CATTLE	2.392
41	NATURAL GAS	13.205	457	GAS DISTRIBUTION	2.014
508	COLLEGES, UNIVERSITIES	12.827	515	SOCIAL SERVICES, N.E.C.	1.850
489	ENGINEER/ARCHITECT SRVCS	12.593	451	PIPELINES, NOT NATURAL GAS	1.674
454	COMMUNICATIONS SERVICES	12.509	215	INDUSTRIAL CHEMICALS	1.149
216	FERTILIZER MANUFACTURING	8.607	188	PAPER MILLS	0.899
90	FLUID MILK	7.930	507	PRECOLLEGE EDUCATION	0.805
487	ADVERTISING	3.181	169	WOOD PRESERVING	0.517
462	RECREATIONAL RETAIL TRADE	3.063	172	WOOD PRODUCTS, N.E.C	0.480
464	BANKING	2.902	225	PLASTICS MATERIALS/RESINS	0.407
479	SERVICES TO BUILDINGS	2.850	2	POULTRY AND EGGS	0.311
177	HOUSEHOLD FURNITURE	2.493	518	OTHER U.S. GOVERNMENT	0.262
446	RAILROAD SERVICES	2.416	237	PETROLEUM N.E.C.	0.232
512	RELIGIOUS ORGANIZATIONS	1.903	4	RANGE FED CATTLE	0.207
230	SOAP & OTHER DETERGENTS	1.837	164	MILLWORK	0.190
106	BREAD AND CAKE	1.743	449	WATER TRANSPORTATION	0.144
238	PAVING MIXTURES AND BLOC	1.490	40	BITUMINOUS/LIGNITE MINING	0.126
475	ELECTRICAL REPAIR SERVICES	1.350	232	SURFACE ACTIVE AGENTS	0.111
459	SANITARY SERVICES	1.233	171	PARTICLEBOARD	0.106
457	GAS DISTRIBUTION	1.063	296	ALUMINUM PRODUCTION	0.105
493	AUTOMOBILE REPAIR	1.023	8	MEAT ANIMAL PRODUCTS	0.103
392	COMMUNICATIONS EQUIPMENT	0.816	254	LEATHER GOODS, N.E.C	0.102
118	COTTONSEED OIL MILLS	0.768	480	PERSONNEL SUPPLY SERVICE	0.101
131	BROADWOVEN FABRIC MILLS	0.752	1	DAIRY FARM PRODUCTS	0.101
215	INDUSTRIAL CHEMICALS	0.661			
26	AGRICULTURAL SERVICES	0.627			
155	CANVAS PRODUCTS	0.558			
116	SOFT DRINKS	0.520			

Note: Only core commodities with at least $500,000 and periphery commodities with at least $100,000 in trade are shown.

Indirect effects refer to the secondary change in all industries as a result of the dollar change in output. Induced effects are caused by changes in payments to labor and changes in regional household spending resulting from a dollar increase in output for a particular industry (Miller and Blair, 1985). Type II Earnings Multipliers are based on the assumption that employee compensation and proprietors' income support household consumption of regional production while returns to capital and others components of value added do not.

Total Multiplier Effects

Each column of the Leontief Inverse closed with respect to households was summed to derive the Total Type II Multiplier (direct, indirect, and induced) effect of a change in output for each core and periphery industry on the entire regional economy. The range of Total Type II Multipliers for the entire region for core industries was from 1.761 to 4.350. The unweighted average of Total Type II Multipliers across all core industries was 2.93, while the standard deviation was 0.59. In contrast, the range of Total Type II Multipliers for the entire region for periphery industries was from 1.748 to 4.274. The unweighted average of periphery industry Total Type II Multipliers was 3.10 and the standard deviation was 0.57. The size of the Total Type II Multipliers was compared across all industries with production in both regions. Eighteen industries in the core had larger total multipliers than their periphery counterparts, while the converse was true for 26 industries.

Interregional Multiplier Effects

The Leontief Inverse matrix $(I-A)^{-1}$ of the multiregional I-O for the Monroe FEA contained two intraregional sections and two interregional sections. The intraregional (within regional) sections are represented by blocks 1 and 4 in Figure 2, and the interregional trade sections are represented by blocks 2 and 3 in Figure 2. The coefficients in Block 1 represent the total intraregional change in output for the core industry represented in the row for a dollar change in sales for the core industry represented in the column. The coefficients in Block 4 represent the intraregional multiplier effects between periphery industries.

The other two sections of the Leontief Inverse matrix represent interregional core-periphery linkages. For the section with core industries in the column and periphery industries in the row (Block 3, Figure 2), coefficients indicate the total change in output for the periphery industry given a dollar change in sales for the core industry. In the other interregional block (Block 2, Figure 2), the roles are reversed with coefficients showing the total change in output for core industries from a dollar change in periphery industry sales. Any given column in the Leontief Inverse matrix can be divided into a core and a periphery section. That is, the total multiplier can be divided into the intraregional and interregional multipliers. Interregional earnings-based Type II

Multipliers were calculated by summing each industry column within the core to periphery and the periphery to core trade blocks of the Leontief matrix.[7]

A related concept is the spillover coefficient, which is the portion of secondary effects that spillover into another region from the region of origin (Hamilton and Jensen, 1983). It is calculated as the impact on all industries in the secondary subregion (the interregional multiplier) from a change in final demand in an industry located in the primary subregion divided by the total indirect regional impact (the total multiplier across both subregions minus the one dollar direct change in output). For example, a dollar increase in final demand for products for the core Livestock and Products (1) Industry impacted the entire region by $1.90 with $1.80 of the effect in core and $0.10 of the effect in the periphery (Table 2). The spillover coefficient in this case is the interregional multiplier ($0.10) divided by the total secondary effect ($0.90), or 0.1075. This value suggested that 10.8% of all regional indirect impacts from the core Livestock Products Industry (1) was predicted to spillover into the periphery economy. Thus, the spillover coefficient provided a relative measure of interconnection between the core and periphery economies. That is, the larger the core to periphery spillover coefficient, for example, the more economic activity in the core would effect the periphery economy.

Spillover coefficients and interregional multipliers were used to test the relative size of core to periphery versus periphery to core economic linkages. Both variables were also used to see if core-periphery linkages were consistent with central place and location theories, to see if core growth benefited the periphery more than periphery growth benefited the core, and to test the hypothesis that core-periphery linkages tend to be stronger in a smaller urban center, such as the Monroe FEA, than when the core is a larger metropolitan area.

Spillover coefficients confirmed the hypothesis that interregional effects from the core to the periphery were generally less than interregional effects from the periphery to the core per dollar change in sectoral output (Table 2 and Table 3). That is, on a per unit basis, growth in the periphery provided greater benefits to the core than the converse. Of the 44 industrial groups existing in both the core and the periphery, only two core industries, Sawmills and Planing Mills (14) and Lumber and Wood Products (15), had a larger coefficient than their counterpart industries in the periphery. Spillover effects from the core to the periphery ranged from 0.066 to 0.405, whereas spillover effects from the periphery to the core ranged from 0.308 to 0.524.

The relationship between core food processing and the periphery economy was also examined for consistency with a hypothesis based on firm location theory. That is, core food processing industries could have strong backward linkages with the periphery, if the large agricultural base in the periphery had attracted firms to the core. If such backward linkages are strong, the core food processing sector could serve as a device for facilitating economic growth in the periphery.

Analysis of interregional multipliers for the four core food and fiber processing sectors provided mixed results as to their potential for core food processing sectors to serve as a device for facilitating economic growth in the periphery. On the one hand, larger than average spillover coefficients for core Other Food Products (7) and Fluid Milk (8) indicated strong backward linkages to the periphery as a percentage of the total effect of a dollar change in output (Table 2). But because all of the food processing industries had small total output multipliers, changes in output did not translate into large changes in output in the periphery economy as measured by the interregional multiplier. For example, core Food and Kindred Products (7) had an interregional multiplier of only $0.108, which ranked twenty-eighth among all core industries. Core Fluid Milk (8) had the largest interregional multiplier among all core food processing sectors at $0.114.

But periphery to core economic linkages were consistent with location and central place theories both in general and for important periphery industries. Cotton (2), one of the most important periphery sectors, had an interregional multiplier of $0.481, which was the thirtieth largest interregional multiplier among all periphery industries (Table 3). Consistent with location theory, part of this effect was concentrated in core Fertilizer Manufacturer (23) and core Crude Oil and Natural Gas (5). Consistent with central place theory, the majority of interregional impacts for cotton were felt in core service sectors such as Finance and Insurance (46) and Business Services (47) or in core consumer oriented services such as Retail Trade (45), Eating and Drinking Establishments (50) and Hospitals (54). Strong interregional linkages to core sectors such as Finance and Insurance (46) were partly due to direct links from periphery Cotton (2) to such business services in the core. But the majority of interregional impacts from periphery cotton production were based on the induced effects of household spending.

In general, model results were also consistent with central place theory, in that core industries provided higher order services such as Finance and Insurance (46), to the periphery. The larger components of the periphery interregional multipliers were usually found in core service sectors. For example, a dollar increase in final demand in periphery Finance and Insurance (46) was predicted to generate $0.91 in activity across all core industries (Table 3). Examination of the Leontief Inverse showed that this activity was concentrated in core service sectors. Core Retail Trade (45) was predicted to experience an increase in output of $0.10, core Real Estate (47) an output increase of $0.10, and core Finance and Insurance (46) an output increase of $0.21 because of the increase in periphery demand.

Thirty-six out of 47 periphery industries (77%) had spillover coefficients that were greater than 0.40, suggesting strong direct and indirect linkages with the core. Further, although the spillover effects were significantly less from the core to the periphery than from the periphery to the core, core spillover effects to the periphery were generally not

TABLE 2. Total Type II Multipliers With and Without Labor Rows and Spillover Coefficients Levels and Ranking for all Core Industries in the Multiregional I-O Model of the Monroe, Louisiana FEA.

Core Industry Number and Name		Total Type II Multiplier		Interregional Multiplier		Spillover Coefficient to Periphery	
		Value	Rank	Value	Rank	Value	Rank
1	LIVESTOCK PRODUCTS	1.900	46	0.097	35	0.107	15
2	COTTON	2.198	22	0.085	46	0.071	52
3	OTHER AGRICULTURE	2.372	16	0.132	16	0.097	21
4	OTHER MINING	2.185	24	0.116	24	0.098	19
5	OIL AND NATURAL GAS	1.902	45	0.083	47	0.092	30
6	CONSTRUCTION	2.402	15	0.151	8	0.108	14
7	FOOD, KINDRED PRODUCTS	1.972	42	0.108	28	0.111	12
8	FLUID MILK	1.675	51	0.114	26	0.168	4
9	SOFT DRINKS	1.796	50	0.066	52	0.083	40
10	COTTONSEED OILMILLS	1.652	52	0.043	53	0.066	54
11	FABRICS AND TEXTILES	1.882	47	0.082	49	0.093	28
12	APPAREL	2.152	27	0.165	7	0.143	5
13	LOGGING CAMPS	1.574	53	0.080	50	0.140	6
14	SAWMILLS, PLANING MILLS	2.737	7	0.703	1	0.405	1
15	LUMBER, WOOD PRODUCTS	2.623	10	0.504	2	0.311	2
17	FURNITURE AND FIXTURES	2.074	31	0.132	17	0.123	7
18	PAPER, PAPERBOARD MILLS	2.268	20	0.250	3	0.197	3
19	PAPER, ALLIED PRODUCTS	1.979	41	0.106	30	0.109	13
20	PAPERBAGS	1.963	43	0.092	41	0.095	25
21	PRINTING, PUBLISHING	2.167	26	0.111	27	0.095	27
22	CHEMICALS MANUFACTURE	1.999	38	0.092	42	0.092	32
23	FERTILIZER MANUFACTURE	2.057	33	0.085	45	0.081	42
24	AGRICULTURAL CHEMICALS	1.876	48	0.074	51	0.084	39
25	PLASTICS PRODUCTS	2.150	28	0.097	34	0.084	38
26	PETROLEUM REFINING	1.951	44	0.091	43	0.096	24
27	RUBBER, LEATHER, CLASS, CLAY	1.995	40	0.097	36	0.097	20
28	PRIMARY METALS MANUFACTURE	2.003	37	0.088	44	0.088	35

Table 2 Continued

30	FABRICATED STRUCTURAL METAL	1.998	39	0.096	38	0.096	22
31	HEATING, PLUMBING EQUIPMENT	2.066	32	0.098	33	0.092	31
32	ENGINES, INDUSTRY MACHINERY	2.197	23	0.114	25	0.096	23
33	PUMPS AND COMPRESSORS	2.040	35	0.099	32	0.095	26
34	ELECTRONIC EQUIPMENT	2.029	36	0.096	37	0.093	29
36	ELECTRONIC MACHINERY	2.526	13	0.137	14	0.090	33
37	TRANSPORTATION EQUIPMENT	1.865	49	0.092	40	0.107	16
38	MISCELLANEOUS MANUFACTURE	2.175	25	0.100	31	0.085	37
39	RAILROADS SERVICES	2.520	14	0.183	5	0.120	8
40	MOTOR FREIGHT TRANSPORT	2.292	18	0.149	9	0.115	10
41	TRANSPORTATION SERVICES	2.747	4	0.204	4	0.117	9
42	COMMUNICATIONS	2.128	29	0.129	19	0.115	11
43	UTILITIES	2.240	21	0.129	20	0.104	17
44	WHOLESALE TRADE	2.362	17	0.116	23	0.085	36
45	RETAIL TRADE	2.619	11	0.131	18	0.081	43
46	FINANCE AND INSURANCE	2.746	5	0.139	13	0.080	46
47	REAL ESTATE	1.495	54	0.034	54	0.068	53
48	PERSONAL SERVICES	2.561	12	0.126	21	0.081	44
49	BUSINESS SERVICES	2.821	2	0.145	11	0.079	47
50	EATING, DRINKING PLACES	2.052	34	0.083	48	0.079	48
51	AUTO REPAIR, SERVICE	2.282	19	0.094	39	0.074	51
52	AMUSEMENTS	2.645	9	0.123	22	0.075	50
53	DOCTORS AND DENTISTS	2.798	3	0.146	10	0.081	41
54	HOSPITALS	2.743	6	0.140	12	0.080	45
55	OTHER MEDICAL SERVICES	2.705	8	0.135	15	0.079	49
56	SCHOOLS, SOCIAL SERVICES	2.955	1	0.175	6	0.090	34
57	GOVERNMENT, SPECIAL INDUSTRY	2.086	30	0.108	29	0.099	18

Note: Total Type II Multipliers include only industry production effects (i.e., labor income effects are excluded). Interregional multipliers are the total effect of a dollar change in output by the core industry on the periphery economy. Industry groups with no production in the core are not reported.

TABLE 3. Total Type II Multipliers and Spillover Coefficients Levels and Ranking for all Periphery Industries in the Multiregional I-O Model of the Monroe, Louisiana FEA.

Periphery Industry Number and Name	Total Type II Multiplier		Interregional Multiplier		Spillover Coefficient to Core	
	Value	Rank	Value	Rank	Value	Rank
1 LIVESTOCK PRODUCTS	1.9395	42	0.3555	42	0.3784	42
2 COTTON	2.3102	21	0.4811	30	0.3672	44
3 OTHER AGRICULTURE	2.3377	17	0.5546	22	0.4146	31
4 OTHER MINING	2.0487	37	0.4525	36	0.4315	16
5 OIL AND NATURAL GAS	2.1815	33	0.5594	21	0.4734	3
6 CONSTRUCTION	2.1846	31	0.5185	28	0.4377	11
7 FOOD, KINDRED PRODUCTS	1.8874	43	0.2764	45	0.3115	46
12 APPAREL	2.2355	27	0.5014	29	0.4058	33
13 LOGGING CAMPS	1.6529	46	0.2735	46	0.4190	29
14 SAWMILLS, PLANING MILLS	2.7855	4	0.5495	23	0.3078	47
15 LUMBER, WOOD PRODUCTS	2.6602	10	0.5738	17	0.3456	45
16 PARTICLEBOARD	2.1481	34	0.4319	39	0.3762	43
17 FURNITURE AND FIXTURES	2.5269	14	0.6172	15	0.4042	35
18 PAPER, PAPERBOARD MILLS	2.2050	28	0.4627	34	0.3840	40
19 PAPER, ALLIED PRODUCTS	1.8769	44	0.3358	43	0.3830	41
21 PRINTING, PUBLISHING	2.2526	26	0.5626	18	0.4491	7
22 CHEMICALS MANUFACTURE	2.3204	18	0.5838	16	0.4422	9
23 FERTILIZER MANUFACTURER	2.3141	20	0.6882	12	0.5237	1
24 AGRICULTURAL CHEMICALS	2.0023	40	0.4044	40	0.4035	36
26 PETROLEUM REFINING	2.3907	16	0.7177	9	0.5160	2
27 RUBBER, LEATHER, GLASS, CLAY	2.2046	29	0.4729	31	0.3926	39
28 PRIMARY METALS MANUFACTURE	2.2828	23	0.5395	25	0.4206	28
29 ALUMINUM ROLLING	1.7830	45	0.3118	44	0.3982	38

Table 3 Continued

30 FABRICATED STRUCTURAL METAL	2.0123	39	0.4352	38	0.4299	18
32 ENGINES, INDUSTRY MACHINERY	2.0422	38	0.4393	37	0.4215	27
35 COMMUNICATIONS EQUIPMENT	2.2751	24	0.5426	24	0.4255	25
37 TRANSPORTATION EQUIPMENT	1.9871	41	0.3993	41	0.4045	34
38 MISCELLANEOUS MANUFACTURE	2.2885	22	0.5601	20	0.4347	14
39 RAILROADS SERVICES	2.6761	9	0.7701	4	0.4595	5
40 MOTOR FREIGHT TRANSPORT	2.3171	19	0.5608	19	0.4258	24
41 TRANSPORTATION SERVICES	2.8481	3	0.7903	3	0.4277	21
42 COMMUNICATIONS	2.1864	30	0.5350	26	0.4510	6
43 UTILITIES	2.1823	32	0.4721	32	0.3993	37
44 WHOLESALE TRADE	2.4356	15	0.6351	14	0.4424	8
45 RETAIL TRADE	2.6346	11	0.7120	10	0.4356	13
46 FINANCE AND INSURANCE	2.9186	1	0.9051	1	0.4717	4
47 REAL ESTATE	1.4754	47	0.2041	47	0.4293	19
48 PERSONAL SERVICES	2.6082	13	0.6895	11	0.4287	20
49 BUSINESS SERVICES	2.8948	2	0.8295	2	0.4378	10
50 EATING, DRINKING PLACES	2.0590	36	0.4622	35	0.4365	12
51 AUTO REPAIR, SERVICE	2.2598	25	0.5218	27	0.4142	32
52 AMUSEMENTS	2.6098	12	0.6709	13	0.4167	30
53 DOCTORS AND DENTISTS	2.7483	6	0.7581	5	0.4336	15
54 HOSPITALS	2.7383	7	0.7476	6	0.4301	17
55 OTHER MEDICAL SERVICES	2.7321	8	0.7377	8	0.4259	23
56 SCHOOLS, SOCIAL SERVICES	2.7491	5	0.7422	7	0.4244	26
57 GOVERNMENT, SPECIAL INDUSTRY	2.1073	35	0.4719	33	0.4261	22

Note: Total Type II Multipliers include only industry production effects (i.e., labor income effects are excluded). Interregional multipliers are the total effect of a dollar change in output by the periphery industry on the core economy. Industry groups with no production in the periphery are not reported.

insignificant. These results suggest a great deal of interdependence between the industries located in the Monroe FEA.

Further, the spillover coefficients for both the core and the periphery economies exceeded the estimates made in two previous studies using the same method, but for larger areas. Hughes and Holland (1994) calculated spillover coefficients for 75 sectors in a core-periphery model of Washington State with Seattle-Tacoma as the core and the rest of Washington State as the periphery. Reported spillover coefficients from periphery sectors to the core ranged from 0.13 to 0.37. Reported spillover coefficients from core industries to the periphery ranged from 0.06 to 0.48. Using the same method, Waters, Holland, and Weber (1994) reported similar spillover coefficient values for a Portland, Oregon core and a western Oregon, southwestern Washington periphery.

Using a different method but also covering a large area, Hamilton, et al. (1991) reported the spillover coefficients to the California Economy for 26 mostly agricultural Arizona industries. Using an unweighted average, 20.7% of the secondary impacts of spending originating in the Arizona sectors would be predicted to occur in California.

In contrast, Robison and Miller (1991) presented data that we used to calculate the spillover coefficients for a smaller region, specifically, five small communities in West-Central Idaho. Based on the employment multiplier for each of the communities, overall spillover coefficients between the communities were as large as 0.764, and the mean of the five spillover coefficients was 0.477. The results from other studies and the model results from the Monroe FEA suggested that greater independence may exist between the core and the periphery when the Functional Economic Area was relatively small and when the core region was a smaller, lower-ordered, central place.

Regression analysis was also performed with the interregional multiplier as a function of the intraregional multiplier as shown in Table 4. The regression analysis was used to test the hypothesis that core and periphery industries with relatively large intraregional (within region) impacts also tended to have relatively large cross(inter)-regional effects as well. For the periphery, regression analysis indicated a strong, statistically significant, and positive relationship between the size of the intraregional Type II multiplier (measuring backward linkages from a given periphery industry to all other periphery industries) and interregional Type II multiplier showing the impact of the sector on the core. Important periphery service sectors that tended to have strong impacts in the periphery (large intraregional multipliers) such as Business Services (49) possessed strong direct and indirect linkages with the core. The correlation between intraregional and interregional multipliers in the periphery were stronger than those found by Hughes and Holland (1994) in an earlier study of the larger Washington economy.

The same regression analysis for the core indicated a weaker but still statistically significant and positive relationship between the size of the intraregional Type II multiplier (measuring backward linkages from a

Table 4. Regression Results, Type II Interregional Multiplier As a Function of Type II Intraregional Multiplier for the Core and Periphery Regions.

	Core Regression	Periphery Regression
Interregional Multiplier	.0754 (.0445)[2]	.6381 (.0722)[1]
R-Square	.0524	.6343
F-Test	2.873	78.057

[1] Standard Error in Parenthesis. Variable is significant at the á = .005 level of significance.
[2] Standard Error in Parenthesis. Variable is significant at the á = .10 level of significance.

given core industry to all other core industries) and interregional Type II multiplier showing the impact of the sector on the periphery (Table 4). Some core sectors with large intraregional impacts such as Social Services and Schools (56) also tended to have large interregional impacts. The positive correlation between intraregional and interregional multipliers in the core were counter to those found in the earlier study of the Washington economy (Hughes and Holland 1994), where no correlation was established between within-regional and cross-regional multiplier effects for the core. The positive correlation implies that spread effects from the core to the periphery were more pronounced in this region than in larger areas studied with the same technique. As previously mentioned, larger than average core intraregional multipliers tended to be concentrated in core service sectors that were supported by household spending. The regression analysis implies, therefore, that spending by core households not only helped support the core economy, but indirectly contributed to economic activity in the periphery as well.

Impact Analysis

Impact analysis is a useful tool for determining the effect of output changes in a particular industry or set of industries on a regional economy. For this study, impact analysis was used to determine the economic relationship between the Monroe core and the nine-parish rural periphery. Impact analysis would also provide useful information to development planners by indicating core industries that could serve as a means for facilitating economic development in the periphery or the converse. Impact analysis was conducted to analyze the effect of a change in economic activity of important sectors in one subregion on economic activity in the other subregion.

The results of impact analysis were obtained by imposing a change in final demand, or a demand shock, on a particular set of industries in the economy of one of the subregions. A 10% increase in final demand for a particular set of either core or periphery industries was used as a demand shock in this study. The changes in final demand were multiplied by the Leontief Inverse matrix to calculate final output changes across all industries in both subregions. Model results were divided into direct effects and secondary effects in the core and in the periphery to assess the impacts of changes in output in the subregions where the shock occurred versus output changes in the other subregion. Changes in output were converted to employment and labor income changes for each industry by multiplying the industry total output changes by the industry job to output ratio and by multiplying the industry output changes by the industry labor income (employment compensation plus proprietors' income) to output ratio.

Total effects measure the direct, indirect, and induced effects of an economic shock to a particular industry. Direct effects are a measure of the direct change resulting from an increase in economic activity. Indirect and induced effects refer to the change in demand across all industries within the entire region when the impacts of changes in household spending are included. Spillover effects represent the percentage of industrial output that is generated within the region but outside of the subregion in which the economic shock is initiated. Therefore, spillover coefficients provide an estimate of the relative effects of the shocks on the economy of the other subregion.

Final demand shocks of 10% for three industry groups in the periphery and four industry groups in the core were used to examine linkages between the core and the periphery. These industries were chosen because of their relative importance to the regional economy or because of their potential for developing interregional linkages.

The three sets of periphery industries used in the demand shocks were Agriculture (industries 1 through 3), Consumer Services (industries 44 through 45, Industry 48, and industries 50 through 52) and Business Services (Industry 46, Industry 47, and Industry 49) (Table 5). The

Table 5. Impact Analysis for Industries in the Core-Periphery I-O Model of the Monroe, Louisiana FEA.

Industry Sets	Industry Numbers	Shock Area	Direct Effect	Indirect Core Effect	Indirect Periphery Effect	Spillover
			(1985 million $)			
Agriculture	1,2,3	Periphery	29.237	14.254	22.821	0.3845
Consumer Services	44-45,48, 50-52	Periphery	33.121	21.865	28.591	0.4333
Business Services	46-47,49	Periphery	15.191	7.925	9.501	0.4548
Wood, Paper Goods	13-15, 17-20	Core	37.979	35.606	6.408	0.1525
Fertilizers	23,24	Core	16.879	16.333	1.439	0.0810
Electronic Equip.	34	Core	10.540	9.822	1.011	0.0934
Transportation	39-41	Core	2.550	3.400	0.455	0.1181

spillover coefficient for each of the three periphery shocks was greater than 0.38. The two service shocks (Consumer Services and Business Services) had the largest spillover coefficient. The business services shock resulted in a spillover coefficient of 0.4548 while the consumer services shock spillover coefficient was 0.4333. The results were consistent with the prediction that direct spending in periphery higher-order services would tend to leak into the core.

The impact of the periphery agriculture demand shock on the core was slightly less than the effect on the core of the two periphery service shocks (Table 5). However, the spillover coefficient of 0.4251 for the periphery agricultural demand shock was larger than any of the spillover coefficients from the four core industry demand shocks. These findings suggested that a 10% ($29.237 million) increase in agricultural final demand in the periphery will result in an increase of $14.254 million in core-based industry outputs.

The four core demand shocks were Wood and Paper Products (industries 13 through 15 and industries 17 through 20) Fertilizers (industries 23 and 24), Transportation (industries 39 through 41) and Electric Lighting and Wiring (Industry 34) (Table 5). All of the industries in each demand shock contributed significantly to the core economy. The impact of a 10% increase in core final demand for these industries resulted in significant effects within the core. For example, a 10% increase in final demand in the two core fertilizer shock manufacturing sectors caused indirect increases in core total gross output of $16.333 million or 0.4%.

Spillover effects from the core to the periphery for the four core shocks ranged from 0.0810 for the Fertilizer shock to 0.1525 for the Wood and Paper Products shock (Table 5). The large spillover effect for the wood and paper products industries (industries 13 through 15 and industries 17 through 20) was partly due to direct backward linkages with producers of intermediate forest products in the periphery.

Model results for the demand shock scenarios suggested that the spread effects from the core to the periphery were not nearly as strong as the spread effects from the periphery to the core within the region in these key industries. These results were consistent with the findings of Hughes and Holland (1994) for a core-periphery model of the state of Washington and Waters, Holland and Weber (1994) for a core-periphery model of western Oregon and southwestern Washington.

Findings here indicated much stronger links between the core and the periphery than these previous studies, however. For example, Hughes and Holland (1994) found spillover coefficients of only 4.3% for the effect of a core-Boeing shock on the periphery economy and a spillover coefficient of 13.4% for a periphery based Spotted Owl shock on the core.[8] Similarly, Waters, Holland, and Weber (1994) predicted a 5% drop in employment in the Oregon-Washington periphery and a 1% drop in jobs in the Portland FEA core when timber harvesting was restricted under a periphery Spotted Owl scenario. Like multiplier analysis model results, impact analysis model results supported the hypothesis that smaller, lower-ordered central places may have stronger linkages with their periphery than larger, more developed, central places.

A more detailed breakdown of the effect on both the core and the periphery of a 10% ($29.237 million) increase in final demand for the periphery agricultural industries, including estimates of the change in labor payments and jobs, is reported in Table 6. This impact analysis was important because one of the goals of this study was to assess the contribution of agriculture to an urban economy. The 10% change in final demand for the three periphery agricultural industries of Livestock Products (1), Cotton (2), and Other Agriculture (3) caused marked effects in the periphery economy. Gross industrial output in all periphery sectors were predicted to increase by $52.057 million. Changes of $18.446 million in labor income and increases of 1285 jobs were also predicted. These changes would represent a 1.9% increase in total periphery labor income and a 3.0% increase in total periphery employment.

Periphery impacts were predicted to be concentrated in agriculture and in service industries. For example, the agriculture shock was expected to produce 907 jobs, representing $10.369 million in labor payments, in the three agriculture industries alone (Table 6). Employment creation outside of agriculture was concentrated in service industries. The 10% increase in periphery agriculture demand was predicted to create 349 jobs, $16.761 million in gross output and $7.451 million in labor payments in periphery service sectors (Industries 39 through 57).

The impact analysis indicated that agriculture made a substantial contribution to the Monroe economy. Total changes in the core economy from the agriculture shock were 290 jobs, $6.660 million in labor income, and $14.254 million in gross output (Table 6). These changes represented a 0.5% increase in total core jobs and a 0.3% increase in core gross output. Core changes in output, income, and jobs were concentrated in the service industries. Of the 290 jobs created in the core from the agriculture shock, 271 jobs, representing $6.107 million in payments to labor, were found in the core service industries (industries 39 through 57).

Five core service sectors were predicted to experience changes of over $1 million in gross output as shown in Table 6. These sectors included Retail Trade (45), with a change in gross output of $1.530 million, Financial and Insurance Services (46), with the largest change in gross output of $2.060 million; Real Estate and Rentals (47), and Eating and Drinking Places (50). Also notable was the $1.05 million increase in gross output and the creation of 27 jobs and $0.742 million in labor income in core Hospitals (54).

Several core service sectors, including the previously mentioned Financial and Insurance Services (46), Eating and Drinking Places (50), and Hospitals (54), experienced a greater change in final demand from the agriculture shock than did the same industries in the periphery (Table 6). Gross output in these core service sectors exceeded gross output in the same periphery service sectors by 104%, 84%, and 122%. Results from the periphery agriculture shock were consistent with central place theory, which predicted that smaller communities will only partially meet local demand for services.

A more detailed breakdown of the effect on both the core and the periphery of a 10% increase in final demand for core Wood and Paper Products (industries 13 through 15 and industries 17 through 20) was examined because these industries had the largest spillover effects to the periphery for all examined core sectors (Table 7). Increases in output, labor income, and employment in the core were concentrated in either the directly affected core industries of Paper and Paperboard Mills (18), Paper and Allied Products (19), and Paperbags (20) or in core service industries (industries 39 through 57). The seven directly affected core wood and paper products industries accounted for 32.5% of core job impacts. The nineteen core service industries were predicted to experience growth of 647 jobs, or 62.4% of the total change in core employment. Core Wholesale Trade (44), Retail Trade (45), Finance and Insurance (46), and Eating and Drinking Places (50) had large changes in output, labor income, and employment. The core Real Estate and Rental (47) Industry had the fourth largest increase in output of $4.560 million.

Changes in output, income, and employment in the periphery from the core Wood and Paper Products shock were concentrated in periphery Logging Camps (13) and Sawmills, Planing Mills (14) and in periphery service industries (Table 7). The two periphery wood products sectors together had 30.1% of the total periphery change in output and 29.9% of the total periphery change in jobs from the core shock. Both sectors had larger changes in output, labor income, and employment than their counterpart sectors in the core. The periphery service sectors (industries 39 through 57) had an increase in output of $3.581 million or 55.9% of the total periphery impact. The change in employment in the 19 periphery service industries was 82 jobs. This growth was partially concentrated in periphery Retail Trade (45), with the largest change in employment among all periphery sectors of 25 jobs and the second largest increase in output. Other especially impacted periphery service sectors included Utilities (43), Wholesale Trade (44), Personal Services (48), and Business Services (49).

Table 6. Effect of 10% Periphery Agriculture Shock on Regional Industry Output, Labor Payments, and Jobs as Estimated by the Multiregional I-O Model Of the Monroe, Louisiana FEA.

Industry Number, Name	Core			Periphery		
	Industry Output	Labor Payments	Jobs Created	Industry Output	Labor Payments	Job Created
1 LIVESTOCK PRODUCTS	0.030	0.006	0.6	4.75	1.092	94.8
2 COTTON	0.000	0.001	0.1	16.41	4.559	489.9
3 OTHER AGRICULTURE	0.090	0.046	3.1	12.19	4.709	321.9
4 OTHER MINING	0.000	0.000	0.0	0.00	0.001	0.0
5 OIL AND NATURAL GAS	0.390	0.130	2.2	0.17	0.064	1.1
6 CONSTRUCTION	0.130	0.061	2.4	0.49	0.204	8.0
7 FOOD, KINDRED PRODUCTS	0.120	0.031	1.5	0.11	0.013	0.9
8 FLUID MILK	0.140	0.020	0.9	0.00	0.000	0.0
9 SOFT DRINKS	0.020	0.003	0.1	0.00	0.000	0.0
10 COTTONSEED OILMILLS	0.020	0.002	0.1	0.00	0.000	0.0
11 FABRICS AND TEXTILES	0.010	0.002	0.1	0.00	0.000	0.0
12 APPAREL	0.020	0.006	0.5	0.37	0.143	11.9
13 LOGGING CAMPS	0.000	0.000	0.0	0.01	0.002	0.1
14 SAWMILLS, PLANING MILLS	0.000	0.000	0.0	0.01	0.009	0.5
15 LUMBER, WOOD PRODUCTS	0.010	0.002	0.1	0.01	0.003	0.1
16 PARTICLEBOARD	0.000	0.000	0.0	0.00	0.000	0.0
17 FURNITURE AND FIXTURES	0.060	0.019	1.3	0.01	0.002	0.2
18 PAPER, PAPERBOARD MILLS	0.000	0.001	0.0	0.01	0.002	0.0
19 PAPER, ALLIED PRODUCTS	0.030	0.008	0.3	0.06	0.000	0.0
20 PAPERBAGS	0.010	0.003	0.1	0.00	0.000	0.0
21 PRINTING, PUBLISHING	0.090	0.037	1.5	0.12	0.045	1.8
22 CHEMICALS MANUFACTURE	0.010	0.002	0.1	0.13	0.034	0.8
23 FERTILIZER MANUFACTURE	0.780	0.147	3.1	0.05	0.009	0.2
24 AGRICULTURAL CHEMICALS	0.000	0.001	0.0	0.20	0.038	0.8
25 PLASTICS PRODUCTS	0.040	0.014	0.3	0.00	0.000	0.0
26 PETROLEUM REFINING	0.010	0.001	0.1	0.01	0.001	0.0
27 RUBBER, LEATHER, CLASS, CLAY	0.000	0.001	0.0	0.02	0.005	0.3
28 PRIMARY METALS MANUFACTURE	0.000	0.000	0.0	0.00	0.000	0.0

Table 6 Continued

29	ALUMINUM ROLLING	0.000	0.000	0.0	0.00	0.000	0.0
30	FABRICATED STRUCTURAL METAL	0.000	0.001	0.0	0.00	0.001	0.0
31	HEATING, PLUMBING EQUIPMENT	0.000	0.001	0.0	0.00	0.000	0.0
32	ENGINES, INDUSTRY MACHINERY	0.000	0.001	0.1	0.16	0.056	2.5
33	PUMPS AND COMPRESSORS	0.000	0.001	0.0	0.00	0.000	0.0
34	ELECTRONIC EQUIPMENT	0.010	0.005	0.2	0.00	0.000	0.0
35	COMMUNICATIONS EQUIPMENT	0.000	0.000	0.0	0.00	0.000	0.0
36	ELECTRONIC MACHINERY	0.000	0.001	0.1	0.00	0.000	0.0
37	TRANSPORTATION EQUIPMENT	0.000	0.000	0.0	0.00	0.001	0.0
38	MISCELLANEOUS MANUFACTURE	0.000	0.001	0.0	0.01	0.003	0.1
39	RAILROADS SERVICES	0.050	0.034	0.7	0.02	0.014	0.3
40	MOTOR FREIGHT TRANSPORT	0.040	0.018	0.8	0.18	0.066	2.5
41	TRANSPORTATION SERVICES	0.110	0.076	3.0	0.43	0.286	11.3
42	COMMUNICATIONS	0.540	0.221	7.0	0.55	0.217	6.9
43	UTILITIES	0.660	0.157	4.3	1.60	0.339	10.8
44	WHOLESALE TRADE	0.770	0.404	14.6	1.93	0.961	34.7
45	RETAIL TRADE	1.530	0.929	51.6	3.25	1.822	100.7
46	FINANCE AND INSURANCE	2.060	1.180	42.7	1.01	0.563	24.2
47	REAL ESTATE	1.780	0.200	6.3	2.78	0.297	9.4
48	PERSONAL SERVICES	0.230	0.139	8.9	0.73	0.419	26.5
49	BUSINESS SERVICES	0.700	0.530	18.8	0.76	0.564	20.2
50	EATING, DRINKING PLACES	1.040	0.332	31.8	0.57	0.168	16.1
51	AUTO REPAIR, SERVICE	0.180	0.076	4.0	0.38	0.147	7.4
52	AMUSEMENTS	0.030	0.016	1.4	0.07	0.035	3.0
53	DOCTORS AND DENTISTS	0.610	0.456	9.9	0.55	0.382	8.3
54	HOSPITALS	1.050	0.742	27.4	0.47	0.311	11.5
55	OTHER MEDICAL SERVICES	0.160	0.109	7.2	0.44	0.293	22.5
56	SCHOOLS, SOCIAL SERVICES	0.460	0.392	26.3	0.46	0.305	20.2
57	GOVERNMENT, SPECIAL INDUSTRY	0.210	0.096	4.2	0.58	0.262	12.8
TOTAL		**14.250**	**6.660**	**289.6**	**52.057**	**18.446**	**1285**

Note: All monetary values are in millions of 1985 dollars.

Table 7. Effect of 10% Core Wood and Paper Products Shock on Regional Industry Output, Labor Payments, and Jobs as Estimated by the Multiregional I-O Model of the Monroe, Louisiana FEA.

Industry Number, Name	Core Industry Output	Core Labor Payments	Core Jobs Created	Periphery Industry Output	Periphery Labor Payments	Periphery Job Created
1 LIVESTOCK PRODUCTS	0.05	0.012	1.0	0.05	0.012	1.0
2 COTTON	0.00	0.000	0.0	0.00	0.001	0.1
3 OTHER AGRICULTURE	0.07	0.039	2.6	0.02	0.009	0.6
4 OTHER MINING	0.00	0.000	0.0	0.00	0.000	0.0
5 OIL AND NATURAL GAS	1.14	0.377	6.5	0.17	0.062	1.1
6 CONSTRUCTION	0.59	0.271	10.6	0.05	0.020	0.8
7 FOOD, KINDRED PRODUCTS	0.27	0.069	3.3	0.03	0.003	0.2
8 FLUID MILK	0.16	0.022	1.0	0.00	0.000	0.0
9 SOFT DRINKS	0.01	0.002	0.1	0.00	0.000	0.0
10 COTTONSEED OILMILLS	0.02	0.002	0.1	0.00	0.000	0.0
11 FABRICS AND TEXTILES	0.03	0.007	0.5	0.00	0.000	0.0
12 APPAREL	0.06	0.022	1.8	0.29	0.115	9.6
13 LOGGING CAMPS	0.11	0.025	1.4	1.16	0.272	15.7
14 SAWMILLS, PLANING MILLS	0.15	0.051	2.6	0.77	0.502	25.9
15 LUMBER, WOOD PRODUCTS	0.31	0.108	5.9	0.02	0.007	0.3
16 PARTICLEBOARD	0.00	0.000	0.0	0.00	0.001	0.1
17 FURNITURE AND FIXTURES	0.99	0.323	21.6	0.00	0.001	0.1
18 PAPER, PAPERBOARD MILLS	16.67	5.497	111.8	0.08	0.025	0.6
19 PAPER, ALLIED PRODUCTS	10.94	3.376	114.6	0.01	0.000	0.0
20 PAPERBAGS	10.01	2.751	94.3	0.00	0.000	0.0
21 PRINTING, PUBLISHING	0.28	0.110	4.4	0.03	0.011	0.4
22 CHEMICALS MANUFACTURE	0.40	0.102	3.1	0.13	0.034	0.8
23 FERTILIZER MANUFACTURE	0.24	0.045	0.9	0.00	0.000	0.0
24 AGRICULTURAL CHEMICALS	0.01	0.002	0.1	0.00	0.000	0.0
25 PLASTICS PRODUCTS	0.07	0.021	0.5	0.00	0.000	0.0
26 PETROLEUM REFINING	0.01	0.001	0.1	0.00	0.000	0.0
27 RUBBER, LEATHER, GLASS, CLAY	0.03	0.009	0.4	0.01	0.004	0.2
28 PRIMARY METALS MANUFACTURE	0.01	0.004	0.1	0.00	0.000	0.0

Table 7 Continued

29	ALUMINUM ROLLING	0.00	0.000	0.0	0.00	0.001	0.0
30	FABRICATED STRUCTURAL METAL	0.01	0.003	0.1	0.00	0.000	0.0
31	HEATING, PLUMBING EQUIPMENT	0.01	0.004	0.2	0.00	0.000	0.0
32	ENGINES, INDUSTRY MACHINERY	0.01	0.007	0.2	0.00	0.001	0.0
33	PUMPS AND COMPRESSORS	0.01	0.003	0.1	0.00	0.000	0.0
34	ELECTRONIC EQUIPMENT	0.04	0.013	0.4	0.00	0.000	0.0
35	COMMUNICATIONS EQUIPMENT	0.00	0.000	0.0	0.00	0.000	0.0
36	ELECTRONIC MACHINERY	0.01	0.003	0.2	0.00	0.000	0.0
37	TRANSPORTATION EQUIPMENT	0.00	0.000	0.0	0.00	0.000	0.0
38	MISCELLANEOUS MANUFACTURE	0.01	0.003	0.1	0.00	0.001	0.0
39	RAILROADS SERVICES	0.27	0.171	3.7	0.00	0.002	0.0
40	MOTOR FREIGHT TRANSPORT	0.16	0.077	3.2	0.07	0.024	0.9
41	TRANSPORTATION SERVICES	0.81	0.558	22.2	0.13	0.090	3.6
42	COMMUNICATIONS	1.10	0.444	14.1	0.13	0.049	1.6
43	UTILITIES	3.73	0.887	24.1	0.32	0.067	2.1
44	WHOLESALE TRADE	3.11	1.636	59.0	0.30	0.147	5.3
45	RETAIL TRADE	4.15	2.527	140.2	0.80	0.447	24.7
46	FINANCE AND INSURANCE	2.72	1.556	56.3	0.24	0.134	5.8
47	REAL ESTATE	4.56	0.512	16.2	0.40	0.042	1.3
48	PERSONAL SERVICES	0.88	0.536	34.2	0.13	0.074	4.7
49	BUSINESS SERVICES	1.72	1.294	45.8	0.16	0.118	4.2
50	EATING, DRINKING PLACES	1.82	0.580	55.6	0.14	0.042	4.0
51	AUTO REPAIR, SERVICE	0.68	0.281	14.7	0.08	0.030	1.5
52	AMUSEMENTS	0.10	0.058	5.2	0.02	0.009	0.8
53	DOCTORS AND DENTISTS	1.25	0.933	20.2	0.14	0.100	2.2
54	HOSPITALS	1.53	1.083	40.0	0.12	0.081	3.0
55	OTHER MEDICAL SERVICES	0.56	0.386	25.5	0.11	0.074	5.7
56	SCHOOLS, SOCIAL SERVICES	0.89	0.754	50.6	0.17	0.113	7.5
57	GOVERNMENT, SPECIAL INDUSTRY	0.81	0.372	16.1	0.13	0.059	2.9
TOTAL		**73.58**	**27.929**	**1037.7**	**6.41**	**2.783**	**139.3**

Note: All monetary values are in millions of 1985 dollars.

SUMMARY AND CONCLUSIONS

Many rural development issues can be addressed through the examination of linkages between rural and urban areas. A multiregional, core-periphery input-output model was used to assess economic linkages between an urban core, Ouachita Parish, and a nine-parish rural periphery in the Monroe, Louisiana Functional Economic Area (FEA). The IMPLAN model-building procedure was used to estimate trade between the core and the periphery in the FEA and to construct the input-output model based on a three-region approach pioneered by Hughes and Holland. Model results in terms of trade relationships, multiplier analysis, and impact analysis was used to look at core-periphery linkages.

An urban core can influence economic activity in its rural periphery through positive spread effects and negative backwash effects. An example of a spread effect is backward linkages from urban firms to industries in the periphery. A backwash effect would be firms in the urban core gathering an increasing share of rural markets in higher ordered services over time. While there is no consensus on the predominance of spread and backwash effects, advocates of growth pole theory argue that spread effects will generally dominate. Central place theory implies that the core will provide certain higher-ordered services to the periphery. Firm location theory suggests that periphery to core shipments will be commodities oriented toward natural resources and inexpensive labor.

Based on the literature, a number of hypothesis were tested including the consistency of model results with central place and location theories and a comparison of the effect of core economic growth on the periphery versus the effect of periphery growth on the core. Also evaluated was the hypothesis that core-periphery linkages are stronger for a core-periphery economy with a smaller central place (as studied here) than when the core is a larger, more developed, city. Finally, economic impact analysis was used to compare core to periphery versus periphery to core spillover effects, to highlight the contribution of agriculture to the core economy, and to determine the core sectors that could most contribute to economic growth in the periphery.

Model results were consistent with central place theory and firm location theory in that the core provided mainly higher-ordered services to the periphery, such as medical services, while the periphery tended to provide the core with natural resource oriented commodities. Multiplier and impact analysis also confirmed expectations in that spillover effects from the periphery to the core were much larger than spillover effects from the core to the periphery. Impact and multiplier analysis both implied stronger linkages between the core and periphery economies than had been found in core-periphery studies of larger regions with higher-ordered central places. A greater potential for the core serving as a regional growth pole was found in this study as well.

One of the goals of this study was to assess the contribution of agricultural activity in the periphery to economic activity in the urban core. Impact analysis demonstrated that agriculture made a significant contribution to economic activity in the core. A 10% increase in demand for periphery agricultural production was projected to generate 290 jobs, $6.660 million in labor income, and $14.254 million in gross output in the core. Agriculture was shown to especially contribute to economic activity in core service industries. Impact analysis also demonstrated that growth in the core wood products sector may be one means of increasing economic activity in the periphery.

Future work could focus on a better assessment of the relative strength of backwash and spread effects in the region. Capital has been cited as an important element in core-periphery economic relationships. The core may serve as a source of investment for new periphery industries, or the core may pull investment capital out of the periphery.

Household spending is a driving force in the regional economy as was observed in the results of the impact analysis. Service-based industries are particularly affected by the spending patterns of individual consumers. As previously noted, the demand for service-based industries by households is of particular interest within the core-periphery framework. Reports on household consumption in IMPLAN are divided into three categories representing low, medium, and high income households. The model was closed with respect to households by summing these subtotals into two separate columns so as to correspond with core and periphery payment to labor rows. As a result, the role of consumers within the regional economy was assessed without regard to household income groups. Therefore, the model could be improved by maintaining the breakdown of consumer spending patterns based on estimates of household income groups by estimating payments to labor using the same income groups.

The Social Accounting Matrix (SAM) pioneered by Richard Stone (1986) provides a broader framework for analyzing core-periphery relationships. A SAM provides a complete accounting of income and product flows in an economy. Values are usually disaggregated by income groups in a SAM. Expanding the model to a core-periphery SAM would allow researchers to make more definitive conclusions about the core-periphery relationship by explicitly accounting for capital income flows and better assessing the effects of policies on different income groups.

The trade flows, multipliers, spillover, and impact analyses that were conducted using the model are derived from an I-O model based on the IMPLAN 1985 database. Spread and backwash effects are dynamic concepts. Therefore, no definitive conclusion can be made about the nature of spread and backwash effects over time. The estimates from the model imply that backwash effects could be occurring between the core and the periphery in the Monroe FEA. A backwash effect means that core industries are seizing increasingly larger shares of the periphery market. Such a phenomena could be expected for core higher-ordered services, such as business services. However, it is equally possible that this is indicative of a nodal response, in which case the periphery supply of core goods is static over time. Further, there was weak support for the core serving as a growth pole in the region. A growth pole is based on the requirement that spread effects outweigh backwash effects over time. Therefore, the core-periphery relationship should be examined over time so as to gain a greater understanding of the nature of the observed interdependencies.

Joined to feasibility analysis, the model presented here could also be used by policy makers. For example, the further development of certain core industries may be feasible. For a variety of reasons, such industries may prefer a location in the core (Ouachita Parish) rather than the periphery. The model presented here could help indicate if such industries could substantially enhance economic activity in the periphery. For example, the wood products industry appears to have such a potential.

REFERENCES

Alward, G., E. Siverts, O. Olsen, J. Wagner, O. Senf, and S. Linedall. 1989. *Micro Implan Users Manual*. Dept. of Agr. and Applied Econ., U. of Minnesota, St. Paul.

Begg, Robert. 1986. *Non-Survey Interregional Input-Output Modeling*. Unpublished Ph.D. dissertation, Dept. of Geography, U. of Iowa, Iowa City.

Christaller, W. 1966. *Central Places in Southern Germany*. Englewood Cliffs, NJ: Prentice Hall, translated by C. W. Baskin.

Hamilton, Joel R., Norman K. Whittlesey, M. Henry Robison, and John Ellis. 1991. "Economic Impacts, Value Added, and Benefits in Regional Project Analysis." *American Journal of Agricultural Economics*. 73 (May):334-344.

Hamilton, Joel R., and R.C. Jensen. 1983. "Summary Measures of Interconnectedness for Input-Output Models." *Environment and Planning A*. 15:55-65.

Harrison, David, and Jonathan Sieb. 1990. *Toward One Region: Strengthening Rural-Urban Economic Linkages*. Northwest Report, A Newsletter of the Northwest Area Foundation, No. 9, p. 1-12, St. Paul, MN.

Hirschman, Albert O. 1958. *The Strategy of Economic Development*. New Haven: Yale U. Press.

Hughes, David W., and David W. Holland. 1994. "Core-Periphery Economic Linkage: A Measure of Spread and Possible Backwash Effects for the Washington Economy." *Land Economics*. 70 (3):364-377.

Hughes, David W. "Measuring the Effect of Louisiana Agriculture on the State Economy Through Multiplier and Impact Analysis." Louisiana Agricultural Experiment Station Bulletin, Number 849, October 1995.

Krugman, Paul. 1991. *Geography and Trade*. Cambridge, MA: The MIT Press.

Louisiana Department of Economic Development. 1992. *Louisiana Parish Profiles 1991*. Center for Business and Economic Research, Northeastern Louisiana University, Monroe, LA. 71209-0101.

Miller, Ronald E., and Peter O. Blair. 1985. *Input-Output Analysis: Foundations and Extensions*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Myrdal, Gunner. 1957. *Economic Theory and Under-Developed Regions*. London: Gerald Duckworth & Co., Ltd.

Parr, John B. 1987. "Interaction in an Urban System: Aspect of Trade and Commuting." *Economic Geography*. 63: 223-240.

Parr, John B. 1973. "Growth Poles, Regional Development, and Central Place Theory." *Papers of the Regional Science Association*. 31: 173-212.

Rand-McNally and Company 1993. "Rand-McNally 1993 Commercial Atlas and Marketing Guide." 124 Ed.

Richardson, Harry W. 1979. *Regional Economics*. Urbana: University of Illinois Press.

Robison, M.H., and J.R. Miller. 1991. "Central Place Theory and Intercommunity Input-Output Analysis." *Papers in Regional Science*. 70 (4):399-417.

Rose, Adam Z., and Benjamin H. Stevens. 1991. "Transboundary Income and Expenditure Flows in Regional Input-Output Models." *Journal of Regional Science*. 31: 253-272.

Stone, Richard. 1986. "Nobel Memorial Lecture 1984: The Accounts of Society." *Journal of Applied Econometrics*. 1: 5-28.

University of New Orleans. 1993. "Louisiana Factbook." Division of Business and Economic Research, College of Business Administration. New Orleans

U.S. Dept. of Commerce, Economic and Statistics Administration, Bureau of Economic Analysis. 1994. *Journey to Work Data: Regional Economic Information System CD-ROM*. Regional Economic Measurement Division. Washington, DC.

U.S. Dept. of Commerce, Economic and Statistics Administration, Bureau of the Census. 1989. *1987 Census of Manufacturers, Geographic Information Series, Louisiana, MC87-A-19*. U.S. Gov. Printing Office, Washington, DC.

Waters, Edward C, David W. Holland, and Bruce A. Weber. 1994. "Inter regional Effects of Reduced Timber Harvests: The Impact of the Northern Spotted Owl Listing in Rural and Urban Oregon." *J. of Agricultural and Resource Economics*. 19 (1):141-160.

ENDNOTES

[1] Nonmetropolitan is equivalent to rural and metropolitan is equivalent to urban in this discussion. Counties are designed as nonmetropolitan versus metropolitan based on Census population and commuting data.

[2] A natural resource based industry, such as a agricultural processor, may wish to locate in an urban area that could serve as a distribution point, especially if the firm's output is more costly to transport than the agricultural input. An agricultural processing firm may also opt for an urban location because of the presence of external agglomeration economies--increases in productivity resulting from the proximity of firms to each other--that may not be found in nearby rural areas.

[3] Regional I-O models are based on the best estimates of sales between regional industries and sales by regional industries to households, various levels of government, and foreign and domestic regional exports. Also included are estimates of industry purchases of the factors of production (labor, capital, and management) and of imports. The I-O model is constructed by dividing a given industry's purchases from all other industries by its total value of output. The result is the fixed input coefficients of the type found in blocks 1-4 in the multiregional model.

[4] Commodity supply is net in IMPLAN because a portion of gross regional supply is allocated to foreign exports before the calculation of the SDP coefficient.

[5] A negative trade flow (which is impossible because negative quantities cannot exist) of $8.2681 million was estimated for Nitrogenous and Phosphatic Fertilizers (commodity 216). To correct this problem, the RPC for commodity 216 in the region model was decreased from .85439 to .63884. The new RPC increased the values of regional exports and imports by $8.6 million and yielded nonnegative estimates of all six trade variables.

[6] The calculations discussed in the this section were done with the Matrix Accounts Transformation Systems (MATS) software program.

[7] Block 5 and Block 6 also formed one core column and one periphery column where core households and periphery households were treated as industries when the model was closed with respect to household spending. The multipliers for these two columns were not reported in model results. Model closure with respect to households also meant that the labor rows could be included in output multipliers, but reported Total Type II output multipliers exclude these row values. These rows were also excluded in the calculation of the interregional multiplier and spillover coefficients.

[8] The Boeing shock indicated how an important core industry influenced economic activity in the periphery. The spotted owl shock showed how changes in a natural resource based periphery industry influenced economic activity in the core.

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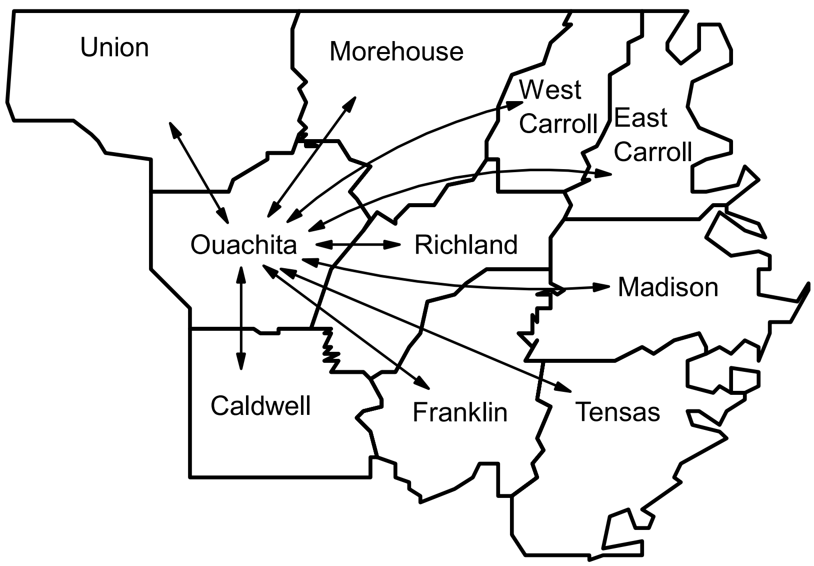

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