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Rural-Urban Economic Linkages for Agriculture and Food Processing in the Monroe, Louisiana, Functional Economic Area

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ABSTRACT

An interregional input-output model of the Monroe, Louisiana, Functional Economic Area constructed with IMPLAN is used to assess economic linkages between a small urban core and a surrounding rural periphery. The contribution of agriculture, especially in the rural periphery, to the urban core (Ouachita Parish) economy is demonstrated. Also assessed is the possibility of using the core's food processing sector to facilitate periphery economic growth. While results demonstrated stronger rural-urban linkages than have been found in other regions, growth in the urban food processing industry, as currently structured, did not imply rapid growth in the periphery.

Key Words: economic linkages, food processing, Functional Economic Area, IMPLAN, interregional input-output model, rural periphery, urban core.

A recent article in the *American Journal of Agricultural Economics* discussed a number of studies that have examined the role of agriculture in regional economies in recent years (Leones, Schluter, and Goldman). Several approaches to the study of the contribution of agriculture to regional economies, especially at the state level, were discussed.

Especially popular was the use of input-output models for economic impact analysis of the contribution of agriculture to state economies. Leones, Schluter, and Goldman identified 14 states where input-output models were used to assess the contribution of agriculture to the economy. In 11 of the studies, the IMPLAN (IMpact PLANning) input-output model building procedure (see Alward et al.) was used to calculate the contribution of agriculture to state economic activity.

While the number of studies examining the contribution of agriculture was impressive, no studies were cited that discussed the contribution of agriculture to urban as opposed to rural economies. The absence of such studies is somewhat surprising. The majority of residents in most states live in urban communities. If educating the public about the importance of agriculture is the goal of these studies, then the contribution of agriculture to urban economies would be expected to be an important finding. For example, Robison and Meyer discussed the importance of spillover from rural areas into urban communities in Idaho. The authors made no effort, however, to quantify the contribution of agriculture to the economy of an urban area. Such studies have been very

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limited in number because in an input-output framework, discerning the urban versus rural location of economic impacts requires the construction of multiregion versus single-region models.

This deficiency in the literature is partly addressed here through the use of an interregional input-output model based on the Monroe, Louisiana, Functional Economic Area (FEA). The region contains rural parishes (counties) that have agriculture as an important part of the economic base.[1] A procedure pioneered by Hughes and Holland was used to construct an interregional input-output model based on the Monroe FEA. Results from the model were used to demonstrate the contribution of agriculture, especially in the outlying rural parishes, to economic activity in Ouachita Parish, in which the city of Monroe is located.[2] The rural parishes in the region suffer from high rates of poverty and unemployment and a general lack of development. Hence, model results were also used to assess the possibility of using food processing sectors in the core as a means of facilitating economic growth in the periphery.

Central Place Core-Periphery and Growth Pole Analysis

Advocates of central place theory (Christaller) 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.

An urban core surrounded by a peripheral rural region is an extension of the central place concept. A core is defined as an area within a region that determines the structure of the economy in the surrounding region (the periphery). The surrounding rural periphery is largely dependent on the central place for its supply of higher-order goods and services. As suggested by firm location theory, many periphery regions specialize in the production of goods in which they have a competitive advantage. Competitive 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.[3] But trade may also flow from the periphery to the core (Parr 1987), or from the periphery to other national and international markets. For example, agricultural commodities might be shipped from a periphery to its urban core for further processing or consumption, or might be 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. If these linkages are strong, the expansion of such sectors could imply growth in the periphery economy as well.

A theoretical construct related to central place theory is growth pole analysis, in which dynamic economic growth in an urban center positively influences economic activity in the surrounding periphery (Richardson). A growth pole will usually be a dominant central place, in that it may supply a higher-order service, such as financial services, to the periphery (Richardson). Growth in the periphery drives growth in the core by the concept of a nodal response (a reversal of core and periphery

[1] Parishes in Louisiana are the same unit of government as counties in other parts of the U.S.

[2] The term "nonmetropolitan" is equivalent to rural and the term "metropolitan" is equivalent to urban in this discussion. Counties are designated as nonmetropolitan versus metropolitan based on census population and commuting data (U.S. Department of Commerce 1989, 1993).

[3] A natural resource-based industry, such as an 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.

roles in growth pole analysis). In the nodal response, 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. A testable hypothesis is whether growth pole or nodal response tendencies can be expected to dominate. That is, does growth in the core economy provide greater benefits to the periphery than is provided to the core by periphery growth? Hughes and Holland found 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 examined 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.

There is variation in the definition of regions and the variables that are used to define regions. 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.

Model Construction

Delineation and Economic Structure of the Region

The area of study here is comprised of 10 parishes in the northeastern delta region of Louisiana known as the Monroe, Louisiana, Functional Economic Area (FEA). 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). 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.[4]

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 (Arkansas) 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 southernmost portion of the original FEA, was determined to have stronger ties to Natchez, Mississippi, and to Alexandra, 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 as-

[4] The Rand McNally rating system utilizes commuter patterns, total retail sales volume, shopping goods volume, and volume of wholesale activity in helping to determine FEAs. The number of major corporate headquarters is used in the rating system as well as total banking deposits. Sunday circulation of the local newspaper versus circulation of newspapers from other cities, and the amount of hospital services provided in the city are also used. For example, cities with a 3-AA rating have annual sales in general merchandise and apparel stores of at least $100 million and a daily newspaper with a minimum circulation of at least 25,000. Because of the wide range of information on which it is based, the rating system was used as a starting point for determining the Monroe FEA.

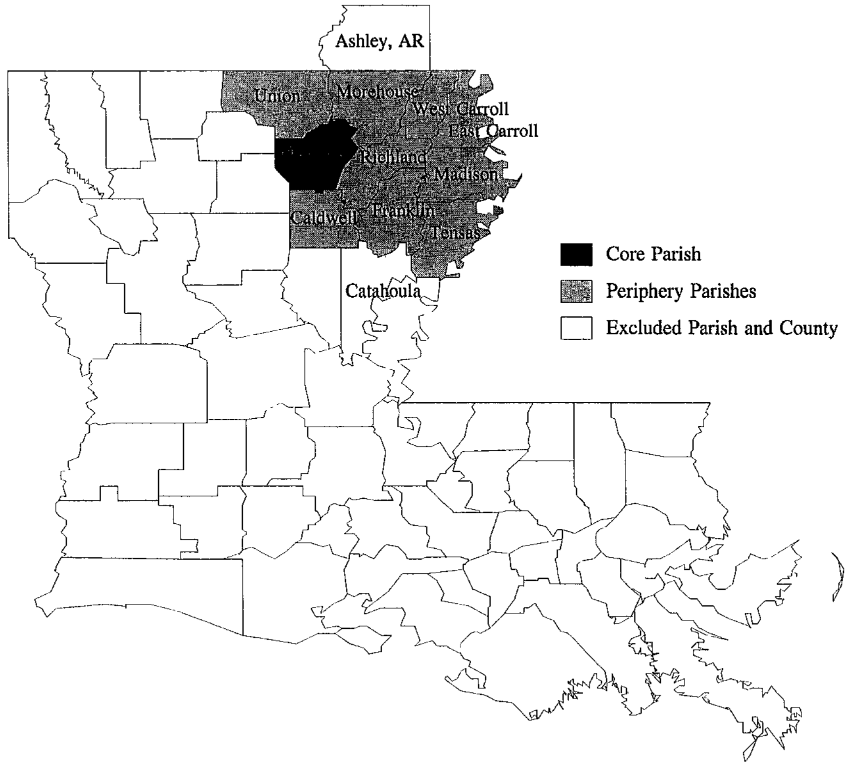

Figure 1. Map of parishes in core-periphery I-O model of the Monroe, Louisiana, FEA

sumed 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 resulting FEA is a 10-parish area in northeastern Louisiana (figure 1). The core is Ouachita Parish. The peripheral parishes are Caldwell, East Carroll, Franklin, Morehouse, Madison, Richland, Tensas, Union, and West Carroll. These nine parishes surround Ouachita in northern, southern, and easterly directions.

The Monroe FEA was chosen as the area of study because of the importance of agriculture and the nature of core-periphery linkages in the region. Monroe is the only metropolitan community in the region. The nine other parishes in the FEA have been defined as nonmetropolitan (U.S. Department of Commerce 1989), with economies that are dependent on agriculture, forestry, and some routine manufacturing.

Agriculture forms a significant part of the economic base of the nine rural parishes. Six of the nine rural parishes in the region were designated as nonmetropolitan farming-dependent counties in 1988. This designation was based on the criterion that at least 20% of total parish earnings (labor plus proprietor income) came from farm income. Only 22% of all nonmetropolitan counties (516 out of 2,349) in the contiguous U.S. received the same designation in 1988 (U.S. General Accounting Office). Further, total farm commodity program payments from the federal government equaled or exceeded $1 million in 1987 in each of the parishes in the region, including Ouachita. Farmers in Union Parish received total farm program payments in excess of $10 million in the same year (U.S. Department of Commerce 1989).

It is well known that many rural counties have an economic base of routine manufacturing, tourism, or other activity that often is not tied to agriculture. But a number of rural areas, especially in the Midwest and the Mississippi Delta regions, are still dependent on agriculture. Central place theory and observation suggest that such rural areas often rely on nearby urban communities for a number of goods and services. The importance of agriculture to the region and the nature of core and periphery relationships indicate that the region under study here would provide a laboratory for such areas in assessing the contribution of agriculture to an urban economy.

The nine rural parishes in the region tend to be characterized by high unemployment, low educational attainment levels, and high poverty rates. The decline of agriculture and other area industries has led to a decrease 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 (DED)]. This fact suggests that former residents of adjacent parishes may have moved closer to the core or migrated out of the region. Unemployment figures in the area suggest a disparity between the core and periphery regions. In 1991, the unemployment rate in Ouachita Parish was 5.9%. In comparison, for the same period, the nine rural parishes experienced unemployment levels ranging from a low of 8.1% in Union Parish (a parish adjacent to Ouachita) to a high of 23.2% in West Carroll Parish (Louisiana DED). Employment in the rural parishes is concentrated in agriculture or routine manufacturing. In contrast, five of the major employers (more than 500 employees) in Ouachita Parish are service sector firms (Louisiana DED).

An interregional core-periphery 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. A core-periphery I-O model of the FEA would give policy makers a device for analyzing the utility of different approaches to facilitating rural development in the region. Such a model would also allow policy makers to assess the impact of changes in agricultural policy not only on the rural parishes in the area, but also on the urban area by assessing the indirect contribution of agriculture to the urban economy. 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 show the economic relationship between the core and its periphery.

The IMPLAN model 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.). 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 was comprised of the remaining nine parishes in the region, and the regional model included all 10 parishes. The three models were used to build an aggregate interregional I-O model with intraregional and interregional trade.

The interregional model represents trade between industries within the region and is comprised of eight blocks, as shown in figure 2. The first block is the core IMPLAN single-region I-O model for Ouachita Parish and contains the usual fixed-proportion, regional input coefficients (Miller and Blair) representing core industry use of core industry production. The fourth block 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. Both the first and the fourth (diagonal) blocks were derived from IMPLAN models of the core and periphery economies. Each block was generated separately in the appropriate IMPLAN model, and then read into the Matrix Transformation Systems (MATS) software program.

The second and third (off-diagonal) blocks are the industrial interregional trade matrices. The second block depicts periphery industry use of core industry production as fixed-proportion import coefficients. The third block represents core industry use of periphery industry production as fixed-proportion import coefficients. The fifth block shows sales by core industries to periphery final demand. The sixth block shows sales by periphery industries to core final demand. The core model,

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

Figure 2. Diagram of core-periphery I-O model of the Monroe, Louisiana, FEA

periphery model, and regional model together are used in estimating the second and third blocks as well as the fifth and sixth blocks in a process described in the next section.

The seventh block shows labor purchases by core industries. Contained in block 7 are three rows. The first row shows the level of purchases by core industries of labor from workers residing in the core. The second row shows purchases by core industries of labor from workers residing in the periphery (periphery-to-core commuters). The eighth block shows both labor purchases by periphery industries from periphery residents and from workers living in the core (core-to-periphery commuters). The third row in both blocks 7 and 8 shows payments by core or periphery firms to workers residing outside of the Monroe FEA. Such payments are properly characterized as leakages outside of the Monroe FEA economy.

Construction of Interregional Trade Matrices

Aggregate commodity trade flows played an important role in determining the coefficients in the core-periphery trade blocks 2 and 5 and blocks 3 and 6 in figure 2. Commodity trade between the core and the periphery was estimated based on a procedure involving the construction of three regional models. As discussed in the appendix, estimates of domestic exports and domestic imports from IMPLAN models of the core economy, the periphery economy, and the entire Monroe FEA were used to estimate core-to-periphery and periphery-to-core commodity trade flows.

The estimates of core-to-periphery and periphery-to-core trade by commodity formed control totals for the model blocks 2 and 5, and for the model blocks 3 and 6 in figure 2. It was necessary to translate commodity trade into industry trade because IMPLAN produced industry-by-industry input-output models for the core-to-core (block 1) and periphery-to-periphery (block 4) portions of the model. The industry × commodity market share matrix in the shipping region was used to change commodity trade values into industry terms using the MATS software package. Or, by letting **M** represent the industry × commodity market share matrix (IMPLAN Report .104) in the shipping region, and **C** the vector of commodity trade values, we obtain

$$\text{(1)} \qquad \mathbf{T} = \mathbf{MC},$$

where **T** is the vector of interregional trade as industry values.[5]

[5] The make matrix is an industry × commodity matrix, and shows the level of commodity production by each industry. (Refer to the appendix for a discussion of the distinction between commodities and industries,

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, was 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 follow 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 was row-normalized, resulting in the matrix **R** that showed the percentage distribution of consumption of traded goods among all industries and consumers in the receiving region. The vector **T** was diagonalized to form $\hat{\mathbf{T}}$ to maintain the proper dimensions. Multiplying $\hat{\mathbf{T}}$ and **R** yielded

$$(2) \quad \mathbf{B} = \hat{\mathbf{T}}\mathbf{R},$$

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 6 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 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 (1%) 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 revealed 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.

Accounting for Commuting

Similar to commodity trade, workers may also commute 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 on CD-ROM (U.S. Department of Commerce 1993). 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 (SIC) code. For each one-digit SIC category, the total wage bill for periphery residents commuting to core jobs was calculated by multiplying the number of periphery-to-core commuters times the average salary. The total wage bill for periphery-to-core commuters was then divided by the estimate of total core place of work labor compensation for each one-digit SIC category. The result was an estimate, for core industries in each of the one-digit SIC categories, of core-to-periphery labor payments as a percentage of total labor payments. The percentages were then applied to all IMPLAN industries in the appropriate one-digit SIC category to provide an estimate of payments to periphery workers by all core industries in the model. These values were normalized by core total industry output to obtain fixed periphery-to-core labor input coefficients (row 2 in block 7, figure 2). The method is based on the assumption that commuting patterns by workers in all industries in a given one-digit SIC category were the same. For example, core fer-

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or see Miller and Blair, chapter 5.) Normalizing the matrix by its row total results in the industry × commodity market share matrix (Miller and Blair), which shows the distribution of commodity production by industries in percentage terms. Hence, multiplying the vector of trade variables by the market share matrix in the producing region translates commodities trade into industry trade. The vector of trade values **C** from the core to the periphery was made to conform to the core market share matrix. Hence, the vector was a 457 × 1 vector, with 68 positive-valued elements and all other elements valued at zero. For periphery shipments to the core, the **C** matrix was a 433 × 1 vector, with 53 positive-valued elements.

tilizer manufacturing and electronic equipment manufacturing were assumed to have the same percentage of labor payments to periphery workers. The same method was used to estimate payments by periphery industries to workers residing in the core on a per unit basis (row 1 in block 8, figure 2).

The method was also used to calculate payments to core and periphery workers residing outside of the Monroe FEA (row 3 in block 7 and block 8, figure 2). As Rose and Stevens argued, payments to workers not living in a region should be treated as leakages of income outside of the region. Therefore, wages paid by core and periphery industries to workers residing outside of the Monroe FEA were assumed to support household spending elsewhere. That is, worker spending was assumed to be concentrated where they lived (outside the Monroe FEA) rather than where they worked (inside the Monroe FEA). As a result, payments to individuals working in the Monroe FEA but living elsewhere were excluded when the model was closed with respect to households (i.e., row 3 in block 7 and block 8 was excluded).

All elements in the core and periphery regional household demand vectors were uniformly adjusted downward by the appropriate percentages 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 households and 1.78% across all periphery households. Therefore, the household consumption vector for the core was multiplied by 1 minus .0176, while the periphery household consumption vector was multiplied by 1 minus .0178. The resulting household consumption vectors were based on the assumption that the reduction in the estimate of purchases by regional households was proportional across industries.

Model Results

Central place theory, growth pole analysis, and nodal response analysis all suggest an inherent interdependence in the core-periphery relationship. The basis of this interdependency is manifested in the types of goods and services traded between the two subregions. A core area should provide higher-order services to its periphery area. The periphery, in turn, may supply natural resource-oriented goods and other commodities to the core. Such an interrelationship is important for determining the strength and the nature of direct and indirect linkages between agriculture in the periphery and the overall core economy.

Interregional Trade Estimates

Total core domestic commodity export (both to the periphery and the rest of the U.S.) was $1,969.262 million, while total periphery domestic export was $1,011.243 million. A total of 180 core industries produced 457 commodities, while 140 periphery industries made 433 commodities. The core exported 341 commodities, while the periphery exported 297 commodities.

Estimated interregional trade between the core and the periphery economies fit a priori expectations based on central place and location theories. Commodity trade from the periphery to the core was less in number 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). Core-to-periphery trade consisted of 86 commodities, while periphery-to-core trade was comprised of 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 to the core. Further, 11 of the commodities 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.

The majority of trade from the core to the periphery was concentrated in services, as shown in table 1. For example, the core was estimated to provide $47.7 million in services of insurance carriers (467), and $40.6 million in hospital services (504) to the periphery. Other wholesale trade (461) at $15.4 million, other retail trade (463) at $25.1 million, and eating and drinking places (491) at $35.3 mil-

Table 1. Core-to-Periphery and Periphery-to-Core Commodity Shipments from Core-Periphery I-O Model of the Monroe, Louisiana, FEA (millions 1985 $)

CORE-TO-PERIPHERY TRADE			PERIPHERY-TO-CORE TRADE		
Core Commodity by No.	Name	$ mil.	Periphery Commodity by No.	Name	$ mil.
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/Contractors	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 Production/Distribution	2.014
508	Colleges, Universities	12.827	515	Social Services, N.E.C.	1.850
489	Engineers/Architects	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 and Other Detergents	1.837	164	Mill Work	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	Bottled/Canned 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.

lion were also important elements in core-to-periphery trade. Other types of shipments from the core to the periphery were not notable with the exception of selected commodities. Trade in natural resources was almost entirely concentrated in natural gas (41), representing $13.2 million in core-to-periphery shipments. Core-to-periphery trade in manufactured goods was concentrated in the sale of fluid milk (90) at $7.9 million, and fertilizer manufacturing (216) at $8.6 million (table 1). Given the importance of agriculture in the periphery economy, core-to-periphery shipments of fertilizer were indicative of regional economic interdependence.

In contrast, periphery-to-core trade was primarily concentrated in manufacturing, oriented toward local natural resources, or in the natural resource-based products themselves (table 1). The concentration of this trade in agriculture and natural resource-oriented manufacturing was consistent with a priori expectations based on location theory. Commodities shipped from the periphery to the core included specialized resource-based commodities such as ranch fed cattle (3) at $2.4 million, and natural gas liquids (43) at $10.05 million. One should note, however, that periphery agricultural production was concentrated in cotton and oilseed crops. Neither of these commodities was shipped from the periphery to the core. Rather, both were produced for national and international markets. Sawmills and planing mills (161) at $10.1 million, and logging camps and logging contractors (160) at $9.1 million represented major portions of periphery-to-core trade. The two natural resource-oriented manufactured commodities accounted for 31% (or $19.2 million) of the commodities shipped from the periphery to the core region. Even periphery-to-core trade in the service-oriented commodities tended to have a natural resource orientation, such as trade in gas production and distribution (457) at $2.01 million, and pipelines/not natural gas (451) at $1.7 million.

Multiplier Analysis

The core-periphery input-output model of the Monroe, Louisiana, FEA (presented in figure 2) was aggregated to form 57 industries in the core and 57 industries in the periphery in a 114 × 114 A (regional input) matrix. The model was then closed with respect to households by including the two household spending column vectors and the two payments to labor row vectors. Type II, earnings-based output multipliers were derived from the Leontief inverse matrix $(I-A)^{-1}$, where A represents the eight blocks of the interregional I-O matrix depicting intraregional and interindustry trade in figure 2. The multipliers were used to measure the direct, indirect, and induced effects of a dollar change in output for a particular industry (Miller and Blair). Type II multipliers were based on the assumption that employee compensation and proprietor income support household consumption of regional production, while returns to capital and other components of value added do not.

Each column of the Leontief inverse that was closed with respect to households was summed to derive the total multiplier (direct, indirect, and induced) effect of a change in output for each core and periphery industry on the entire regional economy. The total type II multipliers for selected industries in the core and in the periphery are reported in tables 2 and 3.[6]

The range of total output multipliers for the entire Monroe FEA for core industries was from $1.495 to $2.955. In contrast, the range of total output multipliers for the Monroe FEA for periphery industries was from $1.475 to $2.919.

Regional output multipliers for the three production agriculture sectors [livestock products (1), cotton (2), and other agriculture (3)] and the four food processing sectors [other food products (7), fluid milk (8), soft drinks (9), and cottonseed oil mills (10)] were not especially large in either the core or the periphery. For example, fluid milk (8) in the core had the third smallest output multiplier among all core industries. An exception was found in the core's other agriculture (3) sector, which had a larger than average output multiplier of $2.372. The periphery sectors of cotton (2) and other agriculture (3) both had output multipliers that were larger than the average across all periphery industries.

Some natural resource-oriented manufacturing industries in both the periphery and the core displayed strong backward linkages in the Monroe FEA (as seen in tables 2 and 3). For example, the core sector of sawmills and planing mills (14) had the seventh largest output multiplier among all core industries. Likewise, the periphery's lumber and wood products (15) generated $2.660, and sawmills and planing mills (14) generated $2.785 within the

[6] Multipliers provided in tables 2 and 3 are purely output multipliers; that is, both labor income rows in the Leontief inverse were excluded in summing the columns of the Leontief inverse. Multipliers for all core and periphery industries are provided in Hughes and Litz.

Table 2. Total Type II Multipliers, Interregional Multipliers, and Spillover Coefficients for Selected Core Industries in the Interregional I-O Model of the Monroe, Louisiana, FEA

Core Industry by No./Name		Total Type II Multiplier		Interregional Multiplier		Spillover Coeff. to Periphery	
		Value	Rank	Value	Rank	Value	Rank
1	Livestock Products	1.900	46	0.079	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
5	Crude Oil/Natural Gas	1.902	45	0.083	47	0.092	30
6	Construction	2.402	15	0.151	8	0.108	14
7	Other Food 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 Oil Mills	1.652	52	0.043	53	0.066	54
12	Apparels	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
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
23	Fertilizer Manufacture	2.057	33	0.085	45	0.081	42
34	Electronic Equipment	2.029	36	0.096	37	0.093	29
41	Transportation Services	2.747	4	0.204	4	0.117	9
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/Insurance	2.746	5	0.139	13	0.080	46
49	Business Services	2.821	2	0.145	11	0.079	47
53	Doctors/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
57	Government/Special Ind.	2.086	30	0.108	29	0.099	18

Monroe FEA for every additional dollar in output.

Core and periphery industries with large total multipliers were generally service industries. As shown in table 2, business services (49), the three medical care sectors, and other service sectors were all among core industries with the 10 largest type II output multipliers. Likewise, nine of the 10 largest output multipliers in the periphery were for service industries (table 3). Two business service sectors—finance and insurance (46) and business services (49)—had the largest output multipliers among all periphery industries. Other periphery industries with larger than average output multipliers were oriented toward consumer spending, including retail trade (45) and all three industries involved in medical care.

Core-Periphery Interregional Linkages

The Leontief inverse matrix $(I-A)^{-1}$ of the interregional I-O for the Monroe FEA contained two intraregional sections and two interregional sections. These sections correspond to the blocks depicted in figure 2. The intra- (within) regional sections are represented by blocks 1 and 4 in figure 2, and the inter- (between) regional trade sections are depicted by blocks 2 and 3. The coefficients in block 1 denote the total intraregional change in output for the core industry represented in the row for a dol-

Table 3. Total Type II Multipliers, Interregional Multipliers, and Spillover Coefficients for Selected Periphery Sectors in the Interregional I-O Model of the Monroe, Louisiana, FEA

		Total Type II Multiplier		Interregional Multiplier		Spillover Coeff. to Core	
Periphery Industry by No./Name		Value	Rank	Value	Rank	Value	Rank
1	Livestock Products	1.939	42	0.356	42	0.378	42
2	Cotton	2.310	21	0.481	30	0.367	44
3	Other Agriculture	2.338	17	0.555	22	0.415	31
6	Construction	2.185	31	0.518	28	0.438	11
7	Other Food Products	1.887	43	0.276	45	0.311	46
12	Apparels	2.235	27	0.501	29	0.406	33
13	Logging Camps	1.653	46	0.274	46	0.419	29
14	Sawmills/Planing Mills	2.785	4	0.549	23	0.308	47
15	Lumber/Wood Products	2.660	10	0.574	17	0.346	45
18	Paper/Paperboard Mills	2.205	28	0.463	34	0.384	40
22	Chemicals Manufacture	2.320	18	0.584	16	0.442	9
23	Fertilizer Manufacture	2.314	20	0.688	12	0.524	1
30	Fabricated Structural Metal	2.012	39	0.435	38	0.430	18
41	Transportation Services	2.848	3	0.790	3	0.428	21
44	Wholesale Trade	2.436	15	0.635	14	0.442	8
45	Retail Trade	2.635	11	0.712	10	0.436	13
46	Finance/Insurance	2.919	1	0.905	1	0.472	4
49	Business Services	2.895	2	0.830	2	0.438	10
51	Auto Repair Services	2.260	25	0.522	27	0.414	32
52	Amusements	2.610	12	0.671	13	0.417	30
53	Doctors/Dentists	2.748	6	0.758	5	0.434	15
54	Hospitals	2.738	7	0.748	6	0.430	17
55	Other Medical Services	2.732	8	0.738	8	0.426	23
56	Schools/Social Services	2.749	5	0.742	7	0.424	26
57	Government/Special Ind.	2.107	35	0.472	33	0.426	22

Note: Other Food Products (7) was the only food processing sector in the periphery.

lar 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 final demand 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 final demand. Any given column in the Leontief inverse matrix can be divided into a core section and a periphery section that are both summed to obtain the intraregional and interregional multipliers.

A related concept is the spillover coefficient, which is the portion of secondary effects that spill over into another region from the region of origin (Hamilton and Jensen). 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's livestock products (1) industry impacted the entire region by $1.90, with $1.80 of the effect in the 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 suggests that 10.8% of all regional indirect impacts from the core's livestock products (1) industry was predicted to spill over into the periphery economy. Thus, the spillover coefficient provided a measure of interconnection between the core and periphery economies.

Spillover coefficients were calculated between the core and periphery for selected sectors (as reported in tables 2 and 3). These results 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. 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. Thirty-six of the 47 periphery industries (77%) had spillover coefficients that were greater than 0.40, suggesting strong direct and indirect linkages with the core.

The nature of backward linkages from the periphery to the core for the three periphery agricultural production sectors was analyzed because these sectors were important to the periphery economy. Cotton (2) had an interregional multiplier of $0.481, which was the thirtieth largest interregional multiplier among all periphery industries. Part of this effect was concentrated in core fertilizer manufacture (23) and core crude oil and natural gas (5). But the majority of interregional impacts for cotton were felt in core service sectors such as finance and insurance (46) and business services (49), or in core consumer-oriented services such as retail trade (45), eating and drinking places (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 business services in the core. But the majority of interregional impacts from periphery cotton production were based on the induced effects of household spending.

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 the core sectors of 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. 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 other food 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.

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.

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. 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. The indirect effect measures the increase in economic activity required to support that change when the effect of household spending is excluded. 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.

To assess the contribution of agriculture to an urban economy, a 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 is reported in table 4. Included in the table are estimates of the change in total gross output, labor payments, and jobs for selected sectors in the core and in the periphery. 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 was predicted to increase by $52.06 million. Changes of $18.446 million in labor income and an increase of 1,285 jobs were also predicted. These changes would represent a 2.1% increase in total periphery labor income and a 3% 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 $10.360 million in labor payments, in the three agriculture industries alone (table 4). 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.

The impact analysis indicated that agriculture made a substantial contribution to the Monroe economy. Total changes in the core economy from the periphery agriculture shock were 290 jobs, $6.660 million in labor income, and $14.254 million in gross output (table 4). 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 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.

Five core service sectors were predicted to experience changes of over $1 million in gross output, as shown in table 4. These sectors included retail trade (45), with a change in gross output of $1.527 million; finance and insurance services (46), with the largest change in gross output of $2.060 million; real estate and rentals (47), reflecting a change of $1.779 million; eating and drinking places (50), with a change of $1.043 million; and hospitals (54), with a notable $1.048 million increase in gross output and the creation of 27 jobs and $0.742 million in labor income.

A number of core service sectors—including the previously mentioned finance 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 4). Gross output in these core service sectors exceeded gross output in the same periphery service sectors by 104%, 84%, and 122%, respectively. 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 10% increase in final demand for the

Table 4. Effect of Periphery Agriculture Shock on Regional Industry Output, Labor Payments, and Jobs as Estimated by the Interregional I-O Model of the Monroe, Louisiana, FEA

Industry by No./Name		CORE			PERIPHERY		
		Industry Output ($ mil.)	Labor Payments ($ mil.)	No. Jobs Created	Industry Output ($ mil.)	Labor Payments ($ mil.)	No. Jobs Created
1	Livestock Products	0.028	0.006	0.6	4.75	1.092	94.8
2	Cotton	0.004	0.001	0.1	16.41	4.559	489.9
3	Other Agriculture	0.087	0.046	3.1	12.19	4.709	321.9
5	Crude Oil/Natural Gas	0.392	0.130	2.2	0.17	0.064	1.1
6	Construction	0.133	0.061	2.4	0.49	0.204	8.0
7	Other Food Products	0.123	0.031	1.5	0.11	0.013	0.9
8	Fluid Milk	0.143	0.020	0.9	0.00	0.000	0.0
9	Soft Drinks	0.015	0.003	0.1	0.00	0.000	0.0
10	Cottonseed Oil Mills	0.020	0.002	0.1	0.00	0.000	0.0
23	Fertilizer Manufacture	0.778	0.147	3.1	0.05	0.009	0.2
24	Agricultural Chemicals	0.003	0.001	0.0	0.20	0.038	0.8
42	Communications	0.545	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	0.769	0.404	14.6	1.93	0.961	34.7
45	Retail Trade	1.527	0.929	51.6	3.25	1.822	100.7
46	Finance/Insurance	2.060	1.180	42.7	1.01	0.563	24.2
47	Real Estate/Rentals	1.779	0.200	6.3	2.78	0.297	9.4
48	Personal Services	0.229	0.139	8.9	0.73	0.419	26.5
49	Business Services	0.704	0.530	18.8	0.76	0.564	20.2
50	Eating/Drinking Places	1.043	0.332	31.8	0.57	0.168	16.1
52	Amusements	0.028	0.016	1.4	0.07	0.035	3.0
53	Doctors/Dentists	0.612	0.456	9.9	0.55	0.382	8.3
54	Hospitals	1.048	0.742	27.4	0.47	0.311	11.5
55	Other Medical Services	0.157	0.109	7.2	0.44	0.293	22.5
56	Schools/Social Services	0.465	0.392	26.3	0.46	0.305	20.2
57	Government/Special Ind.	0.209	0.096	4.2	0.58	0.262	12.8
	Total	14.254	6.660	289.6	52.06	18.446	1,285.0

Notes: All monetary values are in millions of 1985 dollars. Totals include values for industries not reported in the table.

three production agriculture industries in the core was also examined. The total direct effect on the core economy of the agriculture scenario was $2.492 million, $1.049 million in labor income, and 82 jobs. The total indirect effect in the core economy was $2.846 million in gross output, $1.267 million in labor income, and 58 jobs. The spillover coefficient to the periphery of the core agricultural scenario was 0.0901. Total, purely secondary changes in the periphery were $0.282 million in gross output, $0.123 million in labor income, and six jobs. The total effect of the 10% increase in demand for core agriculture products on the entire Monroe FEA economy was $5.620 million in gross output, $2.439 million in labor income, and 147 jobs.

Total changes in gross output, labor income, and jobs under the core agriculture shock were added to the same totals for the periphery agriculture shock to provide an estimate of the total contribution of production agriculture to the entire Monroe FEA. Projected changes in the entire Monroe FEA economy were $71.931 million in gross output, $27.545 million in labor income, and 1,722 jobs. The projected percentage increase in total gross output in the Monroe FEA economy was 1.1%, the percentage change in Monroe FEA total labor income was 1.2%, and the projected percentage change in total employment in the Monroe FEA was 1.7%. To place these numbers in perspective, total unemployment for the entire region was 8.7% in 1991 (Louisiana DED). If all jobs were to go to regional residents, a 10% increase in final demand for primary agricultural products would be projected to reduce regional unemployment by 19.2%.

Comparisons were also made on the distribution between the core and the periphery of the total effect of the two agricultural shocks without distinguishing between direct and indirect effects. Model results showed that despite the much smaller direct impact in the core of the combined effect of the two agricultural shocks, total impact in the core was still substantial. Total change in gross output in the core economy was $19.592 million, or 27.2% of the total Monroe FEA change in output. Total change in labor income in the core was 32.6% of the total change in the Monroe FEA, or $8.976 million. Total change in core employment was 430 jobs, or 25% of the total change in employment in the Monroe FEA. For the nine-parish periphery economy, total change in gross output was $52.339 million, which was 72.8% of the total Monroe FEA change in output. Total change in periphery labor income was 67.4% of the total change in the Monroe FEA, or $18.569 million. Total change in employment in the periphery was 1,292 jobs, which translated into 75% of the total change in employment in the Monroe FEA.

A core food processing impact scenario was used to evaluate the possibility of using food and fiber processing in the core as a means of facilitating growth and development in the periphery. The scenario consisted of a 100% increase in final demand for the four core food processing sectors.[7]

Model results provided mixed evidence concerning the use of the core food processing sector as a means of inducing economic growth in the periphery. On the one hand, the spillover coefficient for the food processing impact scenario was 0.1267 for output and 0.1406 for jobs, indicating that over 14% of the change in secondary employment occurred in the periphery. As shown in table 5, job creation in the periphery was concentrated in livestock products (1) with 12 jobs, and retail trade (45) with eight jobs. However, total changes in economic activity in the periphery as a result of the increase in food processing in the core were not pronounced. Total periphery employment was projected to increase by only 44 jobs, while total gross output in the periphery economy was projected to change by only $1.99 million. Growth in the core economy was not large because spillover from the core food processing shock tended to leak out of the entire Monroe FEA at a high rate. For example, the total indirect change in the core economy was only 267 jobs. Further, the direct change in the core food processing sectors was not especially large, even with a 100% increase in sales to final demand.

Summary and Conclusions

Many rural development issues can be addressed through the examination of linkages between rural and urban areas. An interregional, 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 were

[7] As pointed out by an anonymous reviewer, this impact scenario is based on the assumption that the composition of the core food processing sector would not undergo a significant change. This is an important limitation because a large increase in the core food processing sector could be due to a new facility, such as a swine processing plant. For a new facility, assumptions about the relevant industry's production function, linkages with the periphery, and use of local versus imported inputs would need to be closely examined.

Table 5. Effect of Core Food Processing Shock on Regional Industry Output, Labor Payments, and Jobs as Estimated by the Interregional I-O Model of the Monroe, Louisiana, FEA

		CORE			PERIPHERY		
Industry by No./Name		Industry Output ($ mil.)	Labor Payments ($ mil.)	No. Jobs Created	Industry Output ($ mil.)	Labor Payments ($ mil.)	No. Jobs Created
1	Livestock Products	0.864	0.201	17.7	0.59	0.135	11.8
2	Cotton	0.005	0.002	0.2	0.01	0.002	0.2
3	Other Agriculture	0.079	0.042	2.8	0.04	0.014	1.0
7	Other Food Products	10.429	2.642	125.9	0.01	0.001	0.1
8	Fluid Milk	7.795	1.076	48.1	0.00	0.000	0.0
9	Soft Drinks	0.328	0.066	2.8	0.00	0.000	0.0
10	Cottonseed Oil Mills	0.760	0.065	2.9	0.00	0.000	0.0
15	Lumber/Wood Products	0.005	0.002	0.1	0.00	0.001	0.0
19	Paper/Allied Products	0.340	0.105	3.6	0.00	0.000	0.0
21	Printing/Publishing	0.138	0.055	2.2	0.01	0.003	0.1
23	Fertilizer Manufacture	0.039	0.007	0.2	0.00	0.000	0.0
40	Motor Freight	0.049	0.023	1.0	0.02	0.007	0.3
42	Communications	0.486	0.197	6.3	0.04	0.016	0.5
43	Utilities	1.055	0.251	6.8	0.10	0.020	0.6
44	Wholesale Trade	1.070	0.563	20.3	0.10	0.051	1.9
45	Retail Trade	1.444	0.879	48.8	0.25	0.141	7.8
46	Finance/Insurance	1.003	0.575	20.8	0.09	0.049	2.1
47	Real Estate/Rentals	1.611	0.181	5.7	0.13	0.014	0.4
48	Personal Services	0.292	0.178	11.4	0.04	0.023	1.5
49	Business Services	0.707	0.532	18.8	0.05	0.035	1.3
50	Eating/Drinking Places	0.657	0.209	20.0	0.04	0.013	1.3
53	Doctors/Dentists	0.434	0.323	7.0	0.05	0.032	0.7
54	Hospitals	0.526	0.373	13.8	0.04	0.026	1.0
55	Other Medical Services	0.198	0.137	9.1	0.04	0.025	1.9
56	Schools/Social Services	0.309	0.260	17.5	0.06	0.037	2.4
57	Government/Special Ind.	0.301	0.139	6.0	0.04	0.019	0.9
	Total	32.135	9.616	440.6	1.99	0.774	43.6

Notes: All monetary values are in millions of 1985 dollars. Totals include values for industries not reported in the table.

used to examine core-periphery economic linkages.

Model results were consistent with central place theory and firm location theory in that the core provided mainly higher-order 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.

Model results were used to estimate the contribution of production agriculture to the Monroe FEA. Agriculture in the periphery was seen as making a substantial contribution to total economic activity in the urban core. Periphery agriculture was shown to especially contribute to economic activity in core service industries.

Development of food and fiber processing industries in the core was examined as a device for facilitating growth in periphery agriculture and in the periphery economy in general. The spillover to the periphery economy from growth in core food processing was not small in terms of the percentage of total impacts that went to the periphery as opposed to the core. But the absolute gain in periphery economic activity from growth in core food processing was not large. Increases in the periphery were limited because core food and fiber processing had small multiplier effects in the Monroe FEA as a whole, as measured by the total output multipliers. Further, core food and fiber processing was not an especially large part of the core economy. A substantial percentage growth in final demand did not translate into large changes in output in either the core or the periphery economies.

Input-output analysis only sheds light on the strength of backward linkages. In this case, an interregional input-output model was used to examine backward linkages between an urban core and its rural periphery. Input-output analysis does not include examination of the market potential and other factors influencing the profitability of a given sector. Hence, if core food and fiber processing were to be used as a means of strengthening rural-urban linkages and facilitating growth in their periphery, feasibility analysis would be required to assess potential output markets and firm profits.

The usefulness of this model as a rural development policy tool can also be extended by including an industry occupation matrix. Such a matrix would allow researchers to examine the match between growth in the demand for labor by firms in the core economy and in the periphery economy with the job skills of residents of both subregions. Projections could then be made to ascertain whether increases in employment could be expected to go to current residents, and hence help alleviate rural poverty and underemployment in the region, or whether jobs could be expected to go to commuters and in-migrants.

Finally, a model of this type could be used to examine the potential of other industries, such as forest products and oil and natural gas for the Monroe FEA, as a way to facilitate rural economic growth. A core industry that would facilitate growth in the periphery would be expected to have strong direct linkages with a primary commodity produced in the periphery.

References

Alward, G., E. Siverts, O. Olsen, J. Wagner, O. Senf, and S. Lindall. *Micro IMPLAN Users Manual.* Dept. of Agr. and Appl. Econ., University of Minnesota, St. Paul, 1989.

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

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

Hughes, D.W., and D.W. Holland. "Core-Periphery Economic Linkage: A Measure of Spread and Possible Backwash Effects for the Washington Economy." *Land Econ.* 70,3(1994):364–77.

Hughes, D.W., and V.N. Litz. "Measuring Rural-Urban Economic Linkages in the Monroe, Louisiana, Trading Area Through an Interregional Input-Output Model." Louisiana Agr. Exp. Sta., Louisiana State University, Baton Rouge, 1996 (forthcoming).

Leones, J., G. Schluter, and G. Goldman. "Redefining Agriculture in Interindustry Analysis." *Amer. J. Agr. Econ.* 75(1994):1123–29.

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

Miller, R.E., and P.D. Blair. *Input-Output Analysis: Foundations and Extensions.* Englewood Cliffs NJ: Prentice-Hall, Inc., 1985.

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

———. "Interaction in an Urban System: Aspects of Trade and Commuting." *Econ. Geography* 63(1987):223–40.

Rand McNally and Company. *Rand McNally 1993 Commercial Atlas and Marketing Guide,* 124th ed. Chicago/New York: Rand McNally, 1993.

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

Robison, M.H., and N.L. Meyer. "The Role of Rural Industry in Idaho's Cities." Idaho Economics Series No. 1-3, Coop. Ext. System, Dept. Agr. Econ. and Rural Sociol., University of Idaho, Moscow, June 1992.

Rose, A.Z., and B.H. Stevens. "Transboundary Income and Expenditure Flows in Regional Input-Output Models." *J. Regional Sci.* 31(1991): 253–72.

University of New Orleans. *1990 Statistical Abstract of Louisiana,* 8th ed. Div. Business and

Econ. Res., College of Business Administration, New Orleans, 1992.

U.S. Department of Commerce, Economic and Statistics Administration. "Journey to Work Data: Regional Economic Information System" (CD-ROM). USDC/ESA, Bureau of Economic Analysis, Regional Economic Measurement Div., Washington DC, 1993.

———. Bureau of the Census. *1987 Census of Agriculture State Data.* Pub. No. AC87-A-51. Washington DC: Government Printing Office, 1989.

U.S. General Accounting Office/Resources, Community, and Economic Development Division. "Fact Sheet for Congressional Requesters: Rural Development Profile of Rural Areas." Pub. No. GAO/RCED-93-40FS. Washington DC: Government Printing Office, April 1993.

Appendix

In IMPLAN, as well as in the U.S. I-O tables, firms are classified in a particular industry based on their primary source of revenue. But many firms make so-called secondary products that belong to other industry classifications. For example, assume that 20% of the revenue for the feed grain sector comes from the production of soybeans (an oilseed crop) as a secondary product. By constructing commodity accounts and industry accounts, secondary production is accounted for. In commodity accounts, data are compiled for a particular good based on the various industries that produce the good. In industry accounts, data are compiled based on the various goods that the industry produces. Through a process of matrix manipulation, industry and commodity accounts in both the U.S. I-O model and in IMPLAN are translated into industry-by-industry I-O models (for additional details, see Miller and Blair, chapter 5). However, before the conversion to industry terms, the import and export of goods and services, and thus trade between the core and the periphery, are expressed in commodity terms.

Commodity trade between the core and periphery, the two subregions and the rest of the U.S., and the entire Monroe FEA and the rest of the U.S. can be represented by the following:

(A1) $$I_R = X_{uc} + X_{up}$$

(A2) $$I_P = X_{up} + X_{cp}$$

(A3) $$I_C = X_{uc} + X_{pc}$$

(A4) $$E_R = X_{cu} + X_{pu}$$

(A5) $$E_P = X_{pc} + X_{pu}$$

(A6) $$E_C = X_{cu} + X_{cp},$$

where, for the known left-hand-side variables, I_R is Monroe FEA imports, I_P is periphery imports, I_C is core imports, E_R is Monroe FEA exports, E_P is periphery exports, and E_C is core exports. For the unknown right-hand-side trade variables, X_{cp} is core exports to the periphery, X_{pc} is periphery exports to the core, X_{pu} is periphery domestic exports outside of the Monroe FEA, X_{cu} is core domestic exports out of the Monroe FEA, and X_{uc} and X_{up} represent imports from out of the Monroe FEA to the core and periphery, respectively (Hughes and Holland).

The system of six unknown variables in six equations is linearly dependent with a one-parameter family of an infinite number of solutions. It solves for a unique solution if any one of the unknown trade variables equals a known value, as when one of the left-hand-side variables equals zero. This condition occurs if one of the regions does not cross-haul the commodity, that is, the commodity is not simultaneously imported or exported (the I or E variable is zero).

An additional known variable, T_{pc}, is used to solve the system when cross-hauling does exist (Hughes and Holland). It is determined from the three export equations:

(A7) $$\begin{aligned} T_{pc} &= E_c + E_p - E_r \\ &= (X_{cu} + X_{cp}) + (X_{pu} + X_{pc}) - (X_{cu} + X_{pu}) \\ &= X_{cp} + X_{pc}, \end{aligned}$$

where T_{pc} is total core-periphery trade. If T_{pc} equals zero, there is no trade of the commodity between the core and the periphery, i.e., the core-to-periphery trade variable (X_{cp}) and the periphery-to-core trade variable (X_{pc}) both equal zero. A unique solution for the four remaining unknown trade variables also exists. Trade values for 460 commodities produced in the Monroe FEA were uniquely solved with equations (A1)–(A7). Solutions for nine more regionally produced commodities were obtained by allocating T_{pc} to one or both of the trade variables, X_{pc} and X_{cp}, as explained in Hughes and Litz.