THE IMPACT OF CATTLE FEEDING OPERATIONS ON INCOME AND EMPLOYEMNT OF THE SIX HIGH-PLAINS STATES

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HIGH-PLAINS STATES

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INTRODUCTION

1.1 PROBLEM STATEMENT

The U.S. Agricultural Situation

The geographical High-Plains area of the United States has been and continues to be an important agricultural production area. Most of the economies of individual counties in the high plains area depend on agricultural production. The central High Plains area plays a crucial role in the production of food and fiber not only for U.S consumers but also for the rest of the world. According to the Economic Research Service, USDA (2000), most of the counties of the High-Plains area are farm-dependent counties and farm-important counties. Farm-dependent counties derive at least 20 percent of their total labor and proprietor income (LPI) from farming. Farm-important counties derive 10 to 19 percent of their total labor and proprietor income from farming.

The Economic Research Service, USDA (2003) reported that in the last twenty years, rural economies have changed. Farming areas have participated in the 1990's overall employment and population growth but not to the same extent as other non-metro areas. Population in many farm areas is still declining. Shrinking local economies spell continued uncertainty for communities in sparsely settled farming areas unless non-farm jobs are added. The LPI that comes from farming in non-metro economies declined substantially through the mid-1980s but has remained relatively stable in the 1990's.

The Economic Research Service, USDA (2003) also reported that increased productivity and structural change in the farming sector have contributed to the continued decline in farm employment since 1935, and this decline is expected to continue in the foreseeable future. Growth in the number of non-farm business, first in manufacturing and then in services, have greatly expanded the rural employment base. Thus, farming is no longer the dominant source of jobs or income in most rural communities as it was 50 years ago.

The Central and Southern High Plains agricultural area plays a crucial role in U.S agricultural production (Figure 1.1). For this study, the Southern and the Central High Plains study area consists of parts of Colorado, Kansas, Nebraska, New Mexico, Oklahoma, and Texas. Three (Texas, Nebraska, and Kansas) of the top five states in terms of livestock and crops products sold are in the study area. The total market value of agricultural products sold in these three states accounted for 16 percent of the U.S. total (2002 Census of Agriculture, National Agricultural Statistics, and USDA).

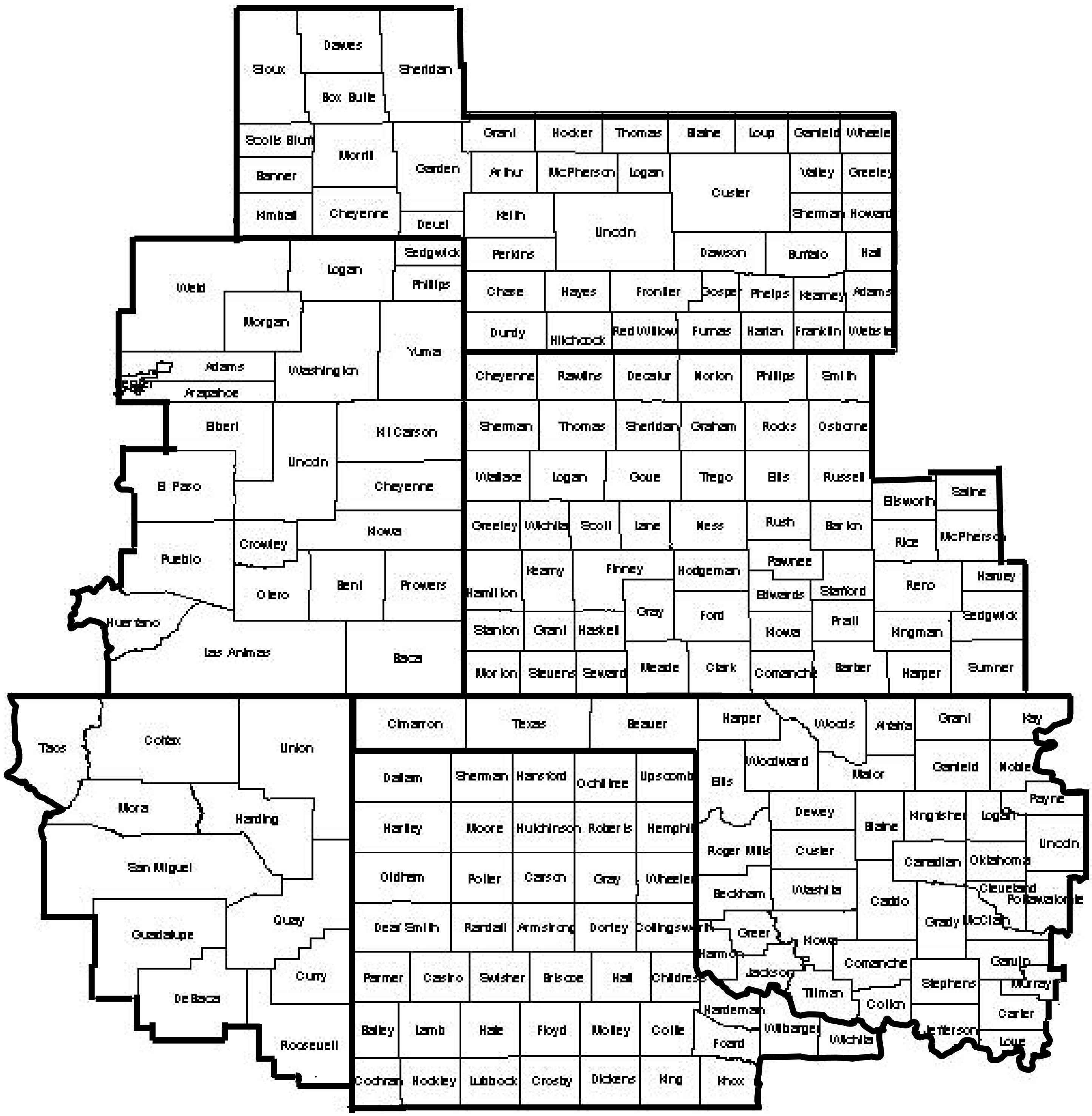
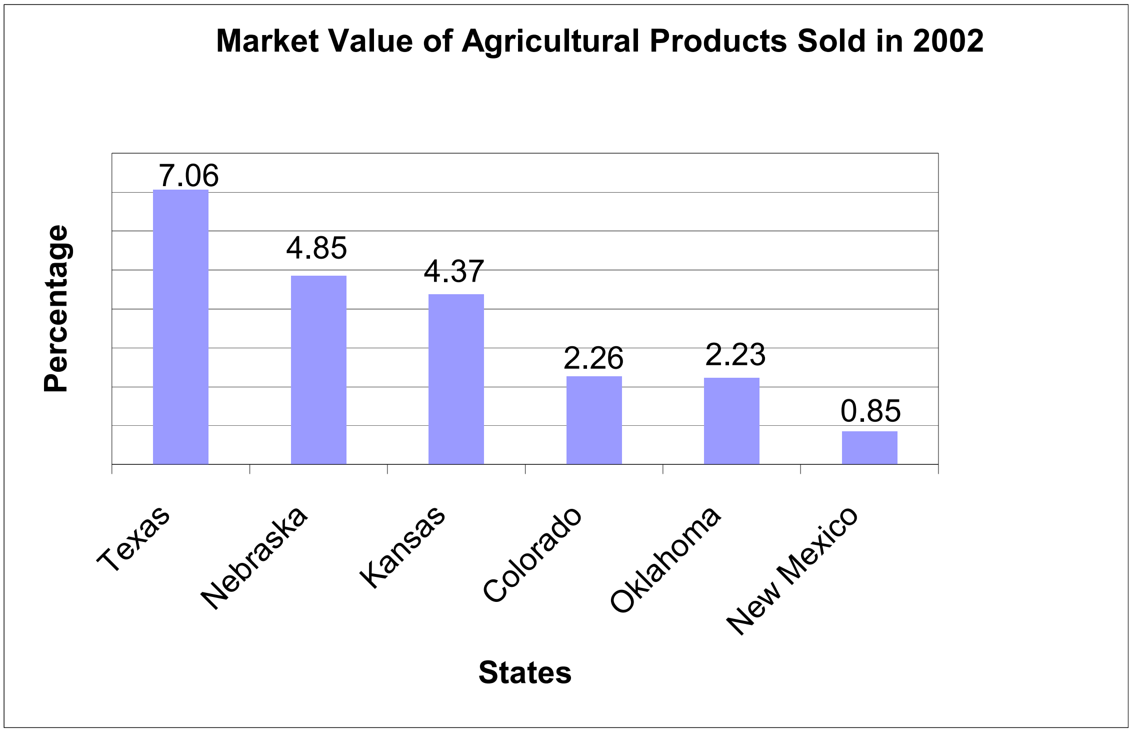


Figure 1.1 Selected Counties for the Study Area of Six High-Plains States

Most counties of Central and Southern High-Plains are defined as rural areas, farm dependent or farm important. These counties are likely to be affected the most by changes in farm financial conditions. Not only does farming have a relatively large economic presence, but the farm commodities produced are those most susceptible to price fluctuation in the international market. Federal agricultural commodity programs have historically played an important role in the farm economy of those counties. Many farming areas have not participated in the industrial diversification of America's rural economy. Therefore, they have a unique economic personality as they represent a remnant of rural America's past.



Source: 2002 Census of Agriculture, National Statistics Service, USDA

Figure 1.2 Market Value of Agricultural Products Sold 2002 from the Six States in the Central and Southern Plains as a Percent of U.S Total. (Billion of dollars)

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In this research study, the study-area covers some geographical parts of six High-Plains states: Colorado, Kansas, Nebraska, New Mexico, Oklahoma, and Texas. The total market value of agricultural products sold from livestock and crops accounted for 22 percent of the U.S total. In terms of market value of livestock and poultry products sold, five states of six states study area have long been among the top 20 leading states in the U.S since 1992. These five states are Texas, Nebraska, Kansas, Colorado, and Oklahoma (Table 1.1).

The selected counties from six High-Plains states are used as the study area. They are 23 counties from Colorado, 56 counties from Kansas, 46 counties from Nebraska, 11 counties from New Mexico, 43 counties from Oklahoma, and 43 counties from Texas.

Table 1.1 Leading States in Market Value of Livestock, Poultry and Their Products Sold in 1992, 1997, and 2002

State	Rank		
	2002	1997	1992
Texas	1	1	1
California	2	2	5
Kansas	3	4	2
Nebraska	4	3	3
Iowa	5	5	4
North Carolina	6	6	9
Minnesota	7	7	7
Wisconsin	8	8	6
Oklahoma	9	10	10
Georgia	10	12	15
Arkansas	11	9	12
Colorado	12	11	8
Missouri	13	13	13
Pennsylvania	14	14	11
Alabama	15	15	19
South Dakota	16	19	14
Idaho	17	23	21
Mississippi	18	16	26
New York	19	21	18
Kentucky	20	24	25

Source: 2002 Census of Agriculture, The National Agricultural Statistics Service, USDA.

Twenty-seven out of 222-counties in the study area were included in the list of the top 100 counties in the U.S. in terms of market value of agricultural products sold from livestock and crops in 1992, 1997, and 2002 (1997 and 2002 Census of Agriculture, National Agricultural Statistics Service, USDA) (Table 1.2) Since 1964, the market value of livestock and poultry products has been the major part of total market value of all agricultural products sold in the six High Plains states (Table 1.3). The market value of livestock and poultry products sold varies from 60 to 80 percent of the total market value of agricultural products sold in these states.

Table 1.2. Counties in the Study Area that were Included in the Top 100 U.S Counties in Terms of Value of Agricultural Products Sold in 2002, 1997, and 1992.

County, State	2002Rank	1997Rank	1992Rank
Weld Co., Colorado	8	5	5
Deaf Smith Co., Texas	15	23	15
Texas Co., Oklahoma	25	20	19
Parmer Co., Texas	28	27	24
Castro Co., Texas	29	19	21
Yuma Co., Colorado	33	32	31
Finney Co., Kansas	34	33	38
Haskell Co., Kansas	35	38	34
Morgan Co., Colorado	37	40	37
Hartley Co., Texas	38	47	51
Dawson Co., Nebraska	49	41	42
Dallam Co., Texas	50	46	48
Hansford Co., Texas	51	48	44
Gray Co., Kansas	54	42	59
Logan Co., Colorado	57	69	54
Phelps Co., Nebraska	59	53	71
Scott Co., Nebraska	62	35	29
Grant Co., Kansas	66	70	45
Wichita Co., Kansas	68	80	39
Moore Co., Texas	71	68	57
Swisher Co., Texas	72	43	63
Sherman Co., Texas	73	66	77
Lincoln Co., Nebraska	76	**	**
Custer Co., Nebraska	83	71	75
Seward Co., Kansas	90	82	76
Randall Co., Texas	98	**	**
Lamb Co., Texas	100	84	86

**Counties were not included in 1997 and 1992 top 100 U.S.A
Source: 1997 and 2002 Census of Agriculture, National Agricultural Statistics Service, USDA

Table 1.3. Values of Livestock, Poultry and Their Products as a Percentage of the Total Market Value of Agricultural Products Sold in Each State

State	Year								
	1964	1969	1974	1978	1982	1987	1992	1997	2002
Colorado	69.9	80.2	65.3	77.9	71.2	75.1	74.8	70.7	73.1
Kansas	61.8	68.1	51.3	71.2	65.4	73.8	72.7	65.0	72.4
Nebraska	72.2	75.0	58.1	66.6	64.1	67.9	67.7	61.4	65.1
New Mexico	59.9	78.2	69.6	76.3	72.7	75.3	70.2	71.4	76.6
Oklahoma	57.3	72.3	57.9	73.5	67.3	77.5	78.1	78.1	81.6
Texas	46.1	69.4	61.4	67.3	66.2	71.9	72.2	68.8	73.6

Source: Calculated from 1992, 1997, and 2002 Census of Agriculture, Volume 1 Geographic Area Series, National Statistics Services, USDA

The structure of agricultural production and markets for livestock, poultry and their products has changed over the past 15 years. Output of livestock and poultry products has increased while the number of farms producing livestock has decreased As a result, Animal Feeding Operations (AFOs) have increased in size. AFOs have become the hub of livestock and poultry operations. Ikerd (1992), Seidl and Davis (1999), and Ahmed (2000) argue that livestock could be considered as the engine of rural economics development.

The establishment of AFOs is one strategy for community economic development. The AFO is usually related to the county economic base of agricultural products. Moreover, an AFO contains linkages to other economic activities, which can be a part of long-term economic development. This study will examine the impact of AFOs on income and employment as a means of economic development.

In terms of rural development, rural communities must decide whether to allow AFOs and if so, how to manage them. Common issues surrounding the potential of an

AFO as an engine of economic development include employment and income, infrastructure and public utilities and real estate. The focus of this study is to estimate the impact of Central and Southern High-Plains AFOs on income and employment in the study area.

United States Department of Agriculture defined Animal Feeding Operations (AFOs) as:

> "Animal Feeding Operations are agricultural operations where animals are housed, fed, and cared for in barn, and or other confined space."
> "In contrast to animal operations that use only pasture or free-range production practices, AFOs, by definition, confine animals more than 45 days in a 12-month period. Furthermore, the area of confinement such as barns, or open lots, does not sustain natural vegetation, row crops, or forage crops during the normal growing season. These operations trend to congregate animals, feed, manure, and other waste into small areas. These confinement facilities usually employ mechanical material handling systems to deriver feed to animals and remove waste."

By United States Department of Agriculture's definition, AFOs include cattle on feed, milk cows, hogs, chicken and sheep. This study focuses mainly on the impact of fed cattle operations on income and employment in the study area.

Table 1.4 Cattle on Feed as Percentage of Total Animal Feeding Operations (AFOs) in each of the six states.

State	Percentage
Texas	18.6
Kansas	33.9
Nebraska	33.8
Oklahoma	7.4
Colorado	35.8
New Mexico	8.6

Source: National Agricultural Statistics, United States Department of Agriculture, 2000

Table 1.4 displays cattle on feed as percentage of numbers of total animal feeding operations in each state. There is high percentage of fed cattle in the study area in three of the six states, Colorado, Kansas, and Nebraska, followed by Texas New Mexico and Oklahoma. The recent study of United States Department of Agriculture exhibited cattle on feed sold as percentage of cattle and calf sold in 2002 shown in Figure 1.3. The six-state study area has many counties where fed cattle represent 50 to 80 percent of all cattle sold. Thus fed cattle operations would appear to be a major source of income and employment in the study area. Demand for animal feed or feed purchases would create the jobs in the animal feed manufacturing while the numbers of fed cattle slaughtered would create the jobs in meat product manufacturing, (animal slaughtering, meat processing, and meat products).

In the six-state study area, wheat is one of the other main sources of crop income. A recent USDA study found the area of wheat harvested for gain varied from 150,000 to 299,999 acres in the six study area (Figure 1.4).

In this research study, income from crops was assumed to have the impact on manufacturing at the county level. Crops products are the raw materials for grain and oil seed milling, starch and vegetable, fats and oil manufacturing as well as animal feeding.

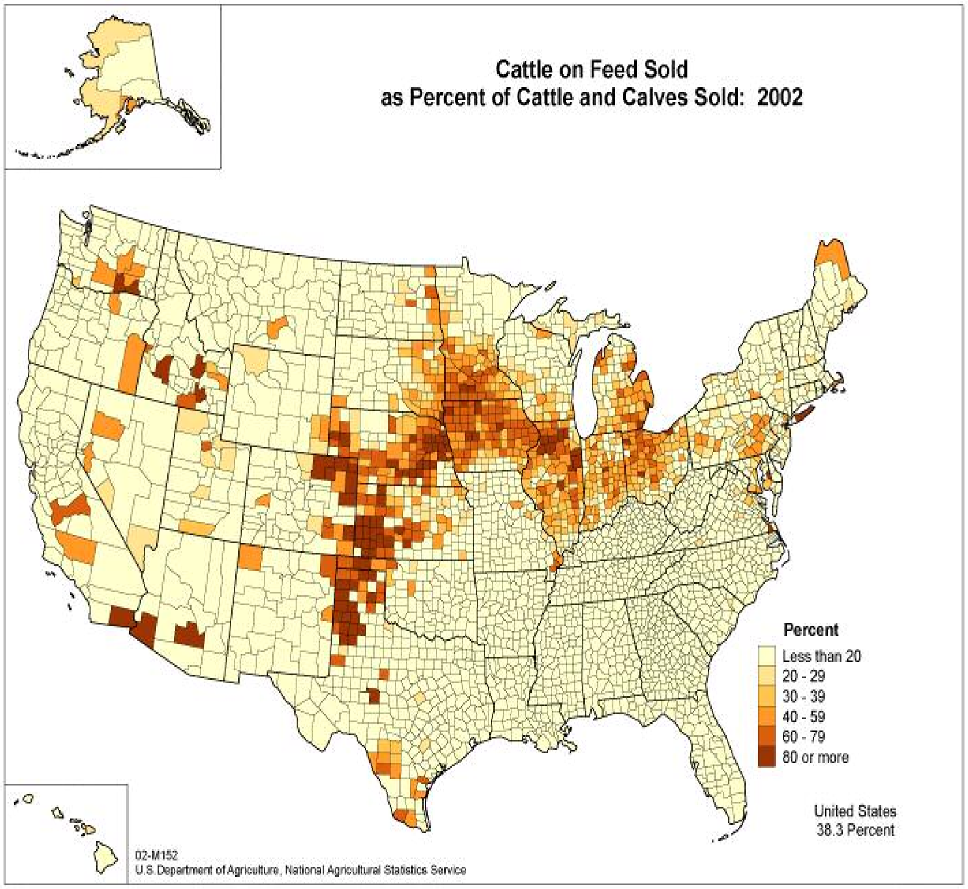

Figure 1.3 Cattle on Feed Sold as Percentage of Cattle and Calves Sold in 2002

Source: United States Department of Agriculture, 2002.

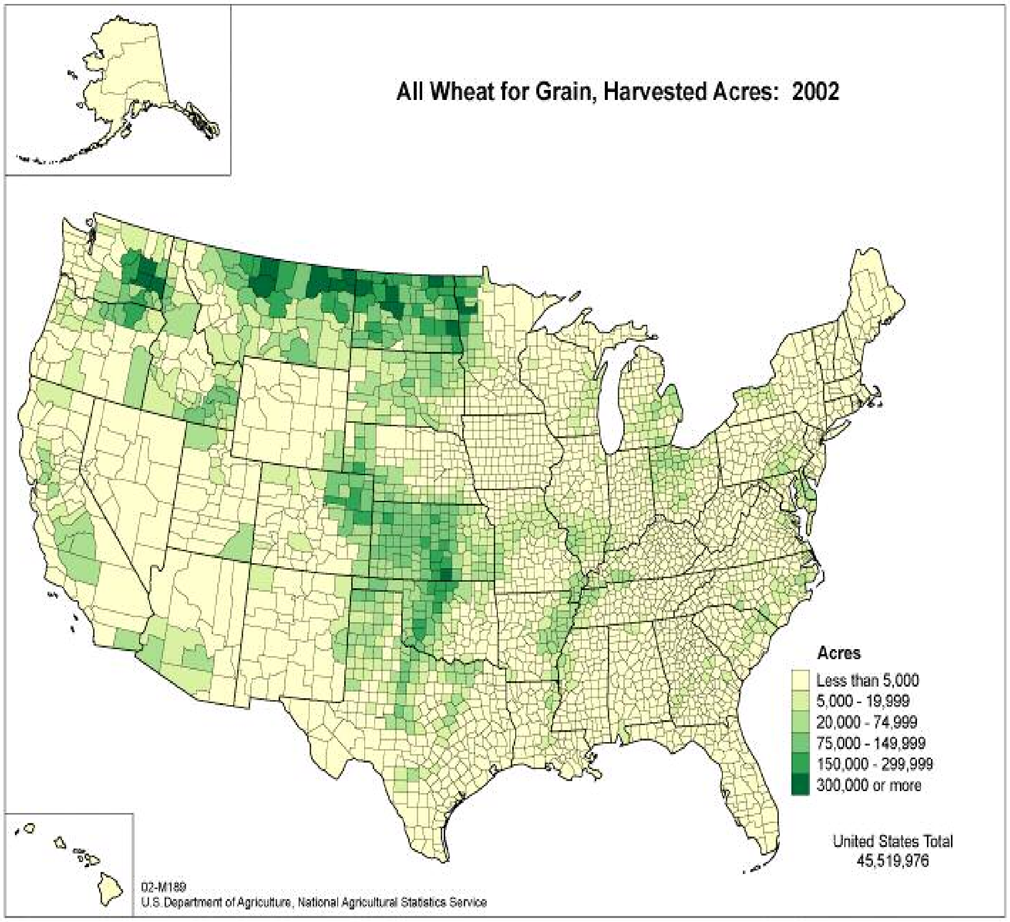

Figure 1.4 All Wheat for Grain, Harvested Acres in 2002.

Source: United States Department of Agriculture, 2002.

1.2 OBJECTIVES

The major objective is to measure the impact of agricultural output and animal feeding operations on county income and employment in the study portion of a six-state area. Specific objectives are to:

1) Estimate the county level direct and indirect employment and income multipliers from agricultural production in the study area

2) Estimate the differential impact of crop and livestock on income and employment in counties where production occurs.

3) Measure the impact of Cattle Feeding Operations on income and employment in the counties where they are produced.

4) Measure the impact of fed cattle slaughtered on food manufacturing and other sectors in counties with large slaughter plants.

5) Measure the impact of the rest of the U.S. manufacturing employment on the six-state study area on manufacturing employment at the county level.

6) Measure the spatial impact of changes in the real output of the basic sectors (agriculture, mining, and manufacturing) on employment in the non-basic (trade, transportation, finance, services and government), in the six-state study area.

7) Measure the spatial linkage between retail trade and wholesale trade employment in the large population centers and the smaller outlying counties in the six-state study area.

CHAPTER II

LITERATURE REVIEW

2.1 LITERATURE REVIEW

Aldrich and Kusmin (1997) used an econometric model to find factors that were consistently associated with rural growth in the 1980s. The factors included low initial labor cost, retirement county status, high educational spending, and the presence of a passenger service airport within 50 miles. Other factors were consistently associated with lagging growth. These were relatively large transfer payments to county residents and the relative size of the African-American population. Other factors positively associated with rural growth included state right-to-work laws, the percentage of adults who had completed high school, and access to the interstate highway system. The factors considered in the study accounted for about 40 percent of variation in earnings growth among counties. They concluded that overall, rural economies in the first half of the 1990s fared much better than they did during the 1980s. While a majority of non-metro counties experienced real earning declines during 1979-89, more than 80 percent saw real earnings growth during the 1989-1994 period. They also reported that earnings in the median rural county grew at an annual rate of about 2 percent over the latter period.

Duncan, M.R., et al (1997) concluded that cattle feeding in the Northern Plains and Western Lakes States was profitable. The profit level depended on the price of fed cattle and size of feedlot. However, during the last 20 years, cattle feeding in five states (North Dakota, Wisconsin, Montana, Minnesota, and South Dakota) has declined. Duncan (et al) gave the following reasons for the decline in cattle feeding: 1) the relative price of cash grain during the early and latter parts of the period, 2) the lack of nearby packing plants, and 3) the expansion of cattle feeding in Nebraska, Kansas, other Southern Plains and Rocky Mountain states. Kansas led the nation in the number of cattle slaughtered, followed by Nebraska, Texas, and Colorado (USDA). Ducan (et al) stated that labor was a substantial cost to feedlots. The labor requirements for 5,000 and 20,000 head feedlots are 6 and 21 workers respectively. They estimated the labor cost per head in a 5,000, and 20,000 head feedlot was $28.83, and $23.38. Most feedlot workers stayed in their jobs for several years and lived on the worksite (house or mobile home hookups on the farm). Cattle feeding created forward linkages through related businesses such as trucking companies, cardboard box factories, and packing plants. Generally, packing plants stimulate new employment and population growth. They usually recruited workers from outside the communities where they are located. Packing plant workers are young and are likely to have young families. Packing plants also face a high rate of worker turnover.

Hamed (2000) studied alternative public policies for land use related to livestock production in Saline County, Missouri. Hamed developed and implemented a multi-dimensional framework for public decision-making. The integrated framework included an input-output analysis, a labor force model, fiscal impact analysis, hedonic price analysis, and multiple objective decision-making. The framework was used to evaluate alternatives for reducing negative impacts of livestock waste from Confined Animal Feeding Operations (CAFOs) in Saline County, Missouri. Three groups of strategies or alternatives were considered. These were land application of manure, dietary change for livestock, and changes in farm size and structure. Results revealed that the local economic benefits of CAFO exceed any loss in property tax receipts. However the average loss in land value within 3 miles of 640 acre CAFO was approximately $112 per acre. Ahmed argued that increasing the distance from residential housing to a CAFO was crucial in reducing pollution damages from CAFOs. His study also found that small CAFOs dominated large and medium CAFOs in terms of economic and environmental criteria. His results indicated that building the public decision-making capacity of a community was crucial. Addressing community issues requires a multi-disciplinary approach incorporating different assessment models.

Ikerd (1992) found that the swine production in Missouri statewide had decreased over the previous 10 years because a large number of small producers retired from swine industry. As a result, Missouri declined from the fourth place in 1982 to the seventh place in 1992 in swine production. (Census of Agriculture, USDA). Ikerd estimated the direct and indirect linkages from swine production in Missouri to both agricultural and non-agricultural business in the state and to the region. His 1992 study found that an average 600 sow contract-farrowing unit created 2.5 new jobs at the site, and cost $550,000. The average 1,250 head contract-finishing unit created 0.5 jobs at the site and cost $130,000. Ikerd also concluded that “for every job created at the site, approximately 0.56 new jobs were created in industries having direct link to the unit (such as feed business, construction, pharmaceutical, veterinary, suppliers, etc). In addition, 0.66 jobs are created in the rest of the Missouri economy as purchases of other goods increased (primary retail purchases of goods and services by new employees).” He also found that each $5,000,000 invested in contract swine production facilities created 40 to 44 jobs in Missouri.

Kusmin (1994) examined the factors that may affect rural economic growth by focusing on policy and economic factors. The policy factors included taxation, public spending, and public capital stocks, branch banking laws and availability of industrial-revenue bond financing. The second set of factors included wage levels, unionization levels, unemployment levels, labor force quality measured by education, and proximity to higher education institutes. Transportation factors included access to highways, airports, and other transportation, and proximity to metropolitan areas. Socioeconomic factors included per capita or family income, population size and density, urbanization, minority population concentration. Still other factors included temperature and precipitation, energy prices, industrial mix or concentration, availability and price of land, labor productivity, local fire protection ratings, small business activity measures, and measures of the age distributed of population.

Lawrence, Schroeter, and Hayenga (1998) studied Iowa’s pork processing industry. They found that from 1994 to 1996, Iowa’s share of national hog processing had fell from 32 to 28 percent. There are 11 packing plants in Iowa that process at least 2,500 hogs per day, with a combined capacity of 95,000 hogs per day. These facilities and other smaller meat processors accounted for approximately seven percent of all Iowa's manufacturing jobs. The plants were generally located near a large supply of hogs. In addition, Iowa packers have located in south Minnesota, eastern Nebraska, northwest Illinois and Indiana. New plants have been built in North Carolina and Oklahoma where rapid hog expansion has occurred. The supply of hogs is the most significant factor in plant site selection, but the packers also prefer to locate in communities that can support a labor force.

Musser and Mallinson (1996) studied the economic impact of a potential avian influenza outbreak in the Delmarva region. They derived an economic multiplier for broiler income and employment in Maryland using a 1991 input-output model. They found each one million dollars of processed broilers directly generated 8.22 full time jobs per year, and indirectly generated another 8.66 jobs. For each one million dollars of broilers included an additional 12.48 employees.

Otto, Orazam, and Huffman (1998) examined the economic impacts of the Iowa hog industry. They found that an estimated 89,000 Iowa jobs were directly or indirectly related to the hog industry. These jobs included those directly involved in hog production and processing, as well as jobs generated by the indirect linkages to feed grain production and other inputs. It also included the effects of expenditures by farmers and workers in the Iowa hog industry. They also estimated $700 million of income was earned by farmers and workers directly employed in hog production and processing, while additional $1.4 billion of personal income was indirectly linked to Iowa's hog industry. The importance of their study has raised awareness of economic, social and environmental issues. Their research examined the potential impacts of new 150 to 3,400 sow farrow-to-finish operations. They found that a new 3,400 sow, farrow-to-finish facility employed 21 new workers directly, provided 19 additional indirect jobs, and generated nearly $1 million of new income for workers and proprietors in region. If the facility was locally owned and financed, all of the impacts were retained locally.

Seidl and Davis (1999**)** studied animal feeding operations in rural Colorado communities. They found that "livestock are a traditional and important part of rural Colorado. Recently, Colorado has had an increase in livestock numbers and a decrease in the number of livestock operations. While both of these categories are dominated by beef cattle operations, large-scale swine operations are primarily fueling these state level growth and concentration trends. Colorado's pig production increased 25 percent from 1996 to 1997 and 92 percent from 1992 to 1997 to about one million hogs, but the number of farms producing pigs have decreased. Like the rest of the U.S, Colorado hog production is in transition from an industry dominated by many small and diversified farms to one dominated by a few large concentrated and integrated operations".

The study of Iowa's Pork Industry by department of Economics, Iowa State University (1998) reported, "Nationwide 55 percent of all hogs are produced on farms with more than 2,000 animals and 33 percent of all hogs are on farms with 5,000 or more hogs.

From 1992 to 1996, while almost all eastern states saw declines in hog production, production in western states increased. Hog production in Wyoming increased by 134 percent, in Utah by 270 percent, and in Arizona by 42 percent. Breeding hogs increased by 567 percent in Utah and by 33 percent in Arizona. Oklahoma experienced a 450 percent increase in total hog and pig numbers”. They also argued, “The emergence of corporate hog farming is both a reaction to federal, state, and local steps to regulate these operations and a catalyst for past and future regulation changes”.

2.2 CONCEPTUAL FRAMEWORK

Rural economies of six High-Plains regions of Colorado, Kansas, Nebraska, New Mexico Oklahoma, and Texas rely strongly on agricultural production. The study area is comprised of 222 counties mostly farming-dependent counties in portions of these six states. The local economies depend heavily upon agricultural production sector.

The research study focuses on fed cattle because they are the main part of animal feeding operations in the six-state study area. More specifically, the study focuses economic impact of cattle on feed on local and regional non-durable manufacturing employment. Cattle feeding would create local backward linkages through feed purchases and regional forward linkage such as meat processing. Demand for animal feed would create the jobs in animal food manufacturing within the six-state study area while meat processing manufacturing would create additional employment in transportation and public utilities, wholesale trade, retail trade, and service sectors. The main hypotheses of cattle on feed's impact on income and employment are:

2.1) Cattle on feed will have a positive impact on non durable manufacturing employment at the county level of the six-state study area.

2.2) Cattle on feed will create both forward and backward linkages which have a positive impact on manufacturing employment at the county level.

The research study also focuses on factors affecting on agricultural services employment in each county level. Agricultural services employees also serve urban consumers through greenhouses and nurseraies. .The main hypotheses are that agricultural services employment is affected by:

2.3) Income from crops and livestock

2.4) Personal income of all residents

The hypotheses about wholesale trade employment are:

2.5) Wholesale trade employment is affected intermediate production in the basic and non-basic sector

2.6) Wholesale trade employment is also dependent upon retail trade employment. An increase in retail trade employment would have increase wholesale trade employment.

The hypotheses about retail trade employment are:

2.7) Retai trade employment is affected by the employment in all sectors of the county's economy.

2.8) An increase in the personal income of residents will increase retail employment.

The hypotheses about Finance, Insurance, and Real Estate (F.I.R.E) employment are:

2.9) FIRE employment will increase with the real output of trade and non-trade sector in county

2.10) FIRE employment will increase the personal income of a county

The hypotheses of Services employment are:

2.11) Services employment will increase with the real output of trade and non-trade sectors.

2.12) Services employment will increase with population in each county

The hypotheses about construction employment are:

2.13) Construction employment will increase with the real value-added by the economy in each county..

2.14) Construction employment will increase with the personal income of residents in each county.

The hypotheses about mining employment are that mining employment will increase with:

2.15) An increase in real value-added in a county

2.16) With mining employment in the rest of the United States

2.17) With an increase in the price of crude oil

The hypotheses about transportation and public utilities are that employment would increase with::

2.18) The real value-added by the economy in a county

2.19) With an increase in population of a county

The hypotheses about government employment are that government employment increases with:

2.20) The real value-added in a county

2.21) An increase in population of a county

CHAPTER III

METHODOLOGY

3.1 PROCEDURE

3.1.1 Data Sets

The study required data on variables such as income earned, employment, and value added by each two-digit SIC sector in each county in the study area. The available secondary data were collected from the period of 1977 to 2000 for each of the 222 counties in the High-Plains states of Colorado, Kansas, Nebraska, New Mexico, Oklahoma and Texas. The two-digit Standard Industrial Classifications (SIC), sectors are agricultural services, mining, construction, manufacturing, transportation and public utilities, wholesale trade, retail trade, finance, insurance and real estate, services, and government sectors. These data were obtained from the Bureau of Economic Analysis (BEA), Regional Economic Accounts. Also data from the County Business Patterns (CBP) series were collected from the U.S.Census Bureau. Gross Domestic Product (GDP) deflators and Producer Price Index (PPI) were collected from the U.S.department of Labor. The interest rates from 1977 to 2000 were collected from Economic Research, Federal Reserve Bank of St.Louis. A mileage matrix measuring the distance from the major city from one county to the major city in another county such as the distance from Stillwater in Payne County to Oklahoma City in Oklahoma County was constructed. The mileage data were obtained from Rand McNally-Maps, Driving Directions, and Travel Store. It is also available on line at www.randmcnally.com .

The mileage matrix was used to determine the closest county of the next largest population or employee size. It was also used to locate the closest meat packing plant for fed cattle production in surrounding counties.

3.1.2 THE METHODOLOGY FOR DATA DISCLOSURE PROBLEMS

Some data were not available at the county level and must be estimated. This is because of the U.S law that prevents disclosure of data on individual firms. For instance, if a county has only one or a few firms in a specific sector, then the data are not disclosed to public. However since state and county totals are available, the missing data were estimated by the RAS or bi-proportional methodology. In this research, the RAS technique was used to estimate the data with held because of disclosure limitation in the BEA income and employment in the two-digit SIC series.

The RAS or bi-proportional technique is commonly used in variety of modeling frameworks and in areas as diverse as demography, transportation research, and economic analysis. The particular form of bi-proportional analysis was developed and introduced to the literature by Stone (1961) and Stone and Brown (1962). The objective was to devise a procedure that could be used to update a given input-output (IO) table without having to generate a completely new set of inter-industry data. The method they devised, which has come to be known as the RAS method, generates new IO coefficients for a target year using a prior year table in conjunction with a target year's row and column totals for intermediate industry inputs and outputs (Jackson and Murray 2004).

The objective of applying the RAS technique in this study was to estimate missing and withheld BEA employment and income data for each two-digit sector within each county from 1977 to 2000 in the six-state study area. The RAS uses the basic concept of a location quotient to estimate missing and withheld data. The RAS technique can be described by introducing the basic concept of location quotient.

The location quotient is one of the most frequently used tools in economic geography and local regional economic analysis. The location quotient is a measure of an industry's concentration in area relative to a reference area, which is usually at the state or national level. It compares an industry's share of local employment with its share of state or national employment. It is very quick and useful tool in determining a region's key industries (Mustafa, 2002). The location quotient is formulated as,

$$LQ = \left({E_{i,r,t}}/{E_{r,t}} \right) \Big/ \left({E_{i,n,t}}/{E_{n,t}} \right). \qquad (3.1)$$

In equation (3.1), $E_{i,r,t}$ is the employment of sector i, in region r, and in year t. The term $E_{r,t}$ is the employment of region r in year t. The term $E_{i,n,t}$ is the employment at the national level in year t, and $E_{n,t}$ is the employment at the national level in year t.

A location quotient is simply an industry's share of employment at the local level divided by the industry's share of national employment. If the location quotient is equal to one then the industry's share of local employment is the same as the industry's share nationally. A location quotient greater than one means the industry employs a greater share of the local workforce than it does nationally, which also implies that the industry is producing more goods and services than are consumed locally. Thus, the industry is exporting the goods or services and bringing money into local area, which helps the local economic growth. A location quotient less than one implies that the industry share of local employment is smaller than its share of national employment (Mustafa, 2002).

Basically, the location quotient can be applied in sub-region such as county using the state as the reference area. By applying the idea of the location quotient at the county level, we can re-arrange (3.1) by using the state level as the reference area. A location quotient at the county level can be expressed as,

$$LQ = \left(E_{i,c,t} \Big/ E_{c,t} \right) \Big/ \left(E_{i,s,t} \Big/ E_{s,t} \right). \tag{3.2}$$

In equation (3.2), $E_{i,c,t}$ is the employment of sector i, in county c, in year t. The term $E_{n,t}$ is the total employment of county c, in year t, and $E_{i,s,t}$ is the employment of sector i, in state s, in year t. The variable $E_{s,t}$ is the employment in state s, in year t.

Equation (3.2) shows the location quotient of a county by using state level as the reference.. It compares an industry's share of county employment with the share of state employment. If the location quotient is equal to one then the industry's share of county employees is the same as the state industry share. A location quotient greater than one means the industry employment employs a greater share of local workforce in a given sector than it does in the state as a whole. Compared with other counties in state, if a county location quotient is greater than one then county produces more goods or services than its consumed. This implies the county is exporting goods or services to other counties, states, or international markets. The income from exports adds to the county's growth. If a county's location quotient is less than one then this implies the county imports goods or services from other counties, states, or international markets.

Suppose the industry's share of county employment is the same as the state industry share so, the location quotient is equal to one. Then equation (3.2) becomes (3.3) which can be expressed as:

$$1 = \left(E_{i,c,t} / E_{c,t} \right) \Big/ \left(E_{i,s,t} / E_{s,t} \right). \tag{3.3}$$

Equation (3.3) is re-arranged, then (3.3) becomes (3.4):

$$\left(E_{i,c,t} / E_{c,t} \right) = \left(E_{i,s,t} / E_{s,t} \right). \tag{3.4}$$

Equation (3.4) is further re-arranged, then (3.4) becomes (3.5):

$$\left(E_{i,c,t} \right) = \left(E_{i,s,t} / E_{s,t} \right) x \left(E_{c,t} \right)., \tag{3.5}$$

Equation (3.5) then gives county $c's$ the expected share of employment of sector i, in year t. This value can always (in this study at least) be generated from the BEA data series.

3.1.3 METHODS TO OVERCOME LIMITATIONS OF DATA AND ESTIMATION METHODS

The RAS method described above requires an initial estimate of the withheld or missing two-digit employment or earning value in each county for each year the data are missing. The more accurate the initial estimate, the more accurate are the final results of the RAS method. Two different annual two-digit SIC data series of income and employment estimates are available at the county level. These are the annual employment and earning series from the Bureau of Economic Analysis (BEA) and the County Business Pattern (CBP) series. The latter series provides data on employment, salary, and number of firms by size class. Both series are subject to disclosure problems. The BEA series is considered the most reliable and consistent. However when the data are withheld from a sector in the BEA series, it might be difficult if not impossible to determine weather the missing value represents 25 or 25,000 employees. However the CBP always provides an estimate of the number of firms in each employment size class. This allows construction of lower bounds and sometimes upper bounds on the number of employees in a sector in a county in a given year. When the two series are compared one finds the two series are significantly correlated though the correlation is much less than perfect. In this study the CBP series was completed first. This was done by the RAS method using class midpoints as starting values to first to complete the CBP data series. Then the completed CBP series was used as an independent variable in a regression to obtain preliminary estimates for missing BEA data that were then adjusted by the RAS method. **Completion of the CBP series.** The LQ method described above was used to provide an estimate of employment or earnings for each two-digit sector in the county total employment (or earnings) from all sectors was available for each county and the total state employment (or earnings) were available for each sector. That is the LQ method provides estimates of expected employment in each sector based on the total employment in that county. However in many counties the data for a sector may be completely or partially available. The available or actual employment estimates may vary widely from LQ estimates. Thus the first step was to use regression to establish a relationship between the actual or published CBP estimates and the LQ estimates by sector for each county. The next step was to use regression to estimate missing or withheld employment and salary estimates by sector for each county. The RAS method was then used to adjust these estimates so they summed to the published county and state totals.

Use of the CBP series to aid in completing the BEA data series. In this step the available county level BEA employment or earnings data in each two-digit SIC sector were regressed against the LQ estimates from BEA data and the available CBP estimates for that sector and year. The regression coefficients were then used to estimate the missing or withheld BEA data. These estimates were then adjusted by the RAS method so they summed to the proper county and state values for each year.

The LQ concept was used to create independent variables used in estimating non-disclosed BEA income and employment at the county level. The method begins by calculating the LQ equation (3.5) and adding a county dummy variable to form a regression equation. The regression equation related the reported data to the natural logarithm of the LQ coefficient, which can be expressed as,

$$(3.6) \qquad \ln\left(Ebea_{i,c,t}\right) = a + b\ln\left(\left(\frac{Ebea_{i,s,t}}{Ebea_{s,t}}\right)x\left(Ebea_{c,t}\right)\right) + \sum c\, DC_n\ .$$

In equation (3.6), $Ebea_{i,c,t}$ is the BEA series value of employment of sector i, in county c, in year t. $\left(\frac{Ebea_{i,s,t}}{Ebea_{s,t}}\right)x\left(Ebea_{c,t}\right)$ is the expected share of employment. The term $Ebea_{i,s,t}$ is the BEA series data of employment in sector i, in state s, in year t. $Ebea_{s,t}$ is the BEA series data of employment in total state s and in year t. The term $Ebea_{c,t}$ is the BEA series value for employment in total county' c and year t. DC_c is a county dummy variable. DC_c is equal to one if the observation is from county c, zero otherwise.

Equation (3.6) was modified by adding the CBP estimate of employment and the county employment dummy variables. This equation can be expressed as,

$$(3.7) \qquad \begin{aligned} \ln\left(Ebea_{i,c,t}\right) &= a + b\ln\left(EXP_{i,c,t}\right) + e\ln(Ecbp_{i,c,t}) \\ &+ g\left(cu*\ln(Ecbp_{i,c,t})\right) + \sum c_c\, DC_c + \sum d_t D_t + \sum h\, cu \end{aligned} .$$

In equation (3.7), $Ebea_{i,c,t}$ is the BEA employment in sector i, in county c and in year t. The term $EXP_{i,c,t}$ is the expected employment given by the ratio of

$\left({Ebea_{i,s,t}}/{Ebea_{s,t}} \right) x \left(Ebea_{c,t} \right)$ from equation (3.6). The term $Ecbp_{i,c,t}$ is the CBP employment in sector i, in county c and in year t. The term cu is a dummy variable for counties with a low employment. The variable cu is equal to one if the total county employment was less than 10,000, and zero otherwise. The term $cu * \ln(Ecbp_{i,c,t})$ is the county employment dummy variable multiplied by the natural logarithm of CBP employment in sector i, in county c, and in year t. DC_c is a county dummy variable. DC_c is equal to one if the observation is from county n, zero otherwise. D_t is a time dummy variable. If the observation is from year t then D_t is equal to one, zero otherwise.

A 2-Step Method of Estimating Missing Data:

Step1: The SAS GLM procedure was used to estimate the coefficients and predicted employment variable from equation (3.7). The GLM procedure provides the results of coefficients and predicted values of two-digit standard classification (SIC) at county level. The SAS GLM procedure has the following features as documented in SAS version 8:

> "*The GLM procedure can create an output dataset in addition to predicted values, residual and other diagnostic measures. GLM procedure can be used interactively after specifie*d *and running a model, a variety of statements can be executed without re-computing the model parameters. Moreover, for analysis involving multiple dependent variables, a missing value in one dependent variable*

does not eliminate the observation from the analysis for other dependent variable. GLM procedure automatically groups together variables that have the same pattern of missing values within the dataset or within group. This ensures that the analysis for each dependent variable brings into use all possible observations."

In step 2, the estimates of the predicted values were further refined by regressing the predicted values of the BEA two-digit SIC employment at the county level against the predicted employment value of equation (3.7). The refined regression was expressed in form of quadratic equation as:

$$(3.8) \qquad EMPbea_{i,c,t} = a + b\,EMPbeapred_{i,c,t} + c\left(EMPbeapred_{i,c,t}\right)^2 .$$

In equation (3.8), $EMPbea_{i,c,t}$ stands for the BEA actual data series of employment of sector i, county c, and year t, $EMPbeapred_{i,c,t}$ stands for the predicted values of BEA employment of sector i, county c, and year t, which were obtained from step 1 by estimating equation (3.7). The term $\left(EMPbeapred_{i,c,t}\right)^2$ stands for the square term of the predicted values of BEA employment of sector i, county c, and year t.

3.1.4 The Allocation of Employment and Real Value Added of the Six-State Study Area Classified by Two-Digit SIC.

Table 3.1 displays the allocation of employment of the six-state study area study area from 1977 to 2000.

Table 3.1. Employment of the Six State Study Area Classified by Two-Digit SIC (Number of Jobs)

Year	Agricultural Services	Mining	Construction	Manufacturing	Transportation And Public Utilities
1977	21,854	73,607	137,351	285,337	118,953
1978	23,890	83,311	152,185	306,042	126,270
1979	25,199	97,056	159,008	331,954	132,184
1980	25,617	120,848	152,226	336,669	137,147
1981	26,062	166,958	153,316	342,977	138,821
1982	25,458	181,733	157,818	314,296	141,726
1983	26,674	163,610	158,045	304,251	137,660
1984	28,899	164,334	167,866	321,800	139,463
1985	30,573	161,446	159,813	315,692	137,114
1986	31,022	125,238	146,640	306,515	133,365
1987	40,846	118,657	132,567	308,054	135,358
1988	39,946	112,360	130,941	317,586	135,628
1989	37,913	106,451	127,337	321,778	138,572
1990	39,905	102,709	129,987	323,444	142,931
1991	42,066	98,883	133,588	320,029	145,171
1992	40,707	88,594	145,538	316,874	145,676
1993	45,933	93,380	157,798	324,212	152,708
1994	49,044	93,101	170,159	335,508	158,868
1995	49,410	83,467	179,022	341,021	165,182
1996	51,501	72,709	189,879	350,926	171,705
1997	53,998	77,361	197,440	365,734	174,293
1998	54,101	73,913	209,084	376,340	180,306
1999	55,208	71,659	219,590	372,319	187,121
2000	56,328	70,513	226,021	370,802	192,163
Average	38,423	108,412	162,218	329,590	148,683

Table 3.1 (Cont). Employment of the Six State Study Area Classified by Two-Digit SIC (Number of Jobs)

Year	Wholesale Trade	Retail Trade	F.I.R.E	Services	Government	Total
1977	119,647	419,188	172,465	467,066	484,893	2,300,361
1978	126,734	438,087	176,563	490,995	490,699	2,414,776
1979	131,711	450,172	182,645	506,954	500,930	2,517,813
1980	137,977	455,114	193,619	525,100	511,850	2,596,167
1981	143,056	464,940	199,788	540,936	513,279	2,690,133
1982	143,097	480,099	203,393	572,611	523,057	2,743,288
1983	134,826	483,475	206,234	593,650	525,101	2,733,528
1984	137,490	499,478	213,361	615,467	532,460	2,820,619
1985	138,067	505,710	214,268	636,683	540,467	2,839,833
1986	131,007	494,787	215,591	652,858	545,098	2,782,121
1987	130,976	504,495	209,774	693,148	548,702	2,822,577
1988	133,327	509,418	207,235	732,649	551,385	2,870,475
1989	137,754	516,181	203,665	752,745	561,381	2,903,777
1990	140,942	523,019	202,556	774,131	568,461	2,948,085
1991	143,931	532,441	198,817	805,960	568,974	2,989,860
1992	146,186	543,302	196,696	819,224	581,803	3,024,599
1993	144,224	556,671	203,405	847,702	585,221	3,111,254
1994	146,366	589,237	203,317	876,843	594,106	3,216,549
1995	151,748	610,420	218,385	912,784	598,471	3,309,909
1996	153,357	632,146	229,320	952,230	596,058	3,399,832
1997	157,565	638,054	248,295	988,566	595,410	3,496,716
1998	160,335	639,622	271,783	1,029,477	599,327	3,594,288
1999	164,242	645,533	277,060	1,049,678	604,487	3,646,899
2000	165,952	658,492	292,805	1,075,149	615,564	3,723,789
Average	142,522	532,920	214,210	746,359	555,716	2,979,052

Table 3.2. Real Value Added of the Six State Study Area Classified by Two-Digit SIC (Million of Constant Dollars)

Year	Agricultural services	Mining	Construction	Manufacturing	Transportation And Public Utilities
1977	5,837.35	9,475.72	5,616.35	15,071.68	9,577.54
1978	5,764.21	9,387.09	5,975.58	14,939.06	9,674.34
1979	7,122.25	9,735.23	6,035.27	16,139.33	9,558.56
1980	5,141.87	15,386.28	5,758.68	16,211.36	10,137.50
1981	6,118.47	19,764.41	5,252.36	16,291.75	10,423.77
1982	5,341.18	18,958.32	5,399.30	15,796.26	11,174.29
1983	3,761.76	14,896.61	5,011.12	14,764.79	11,078.87
1984	4,606.96	13,671.94	4,955.37	14,767.84	10,624.39
1985	4,456.15	12,497.44	4,520.69	14,661.18	10,077.12
1986	3,864.63	6,788.18	4,010.18	13,626.76	9,588.40
1987	3,845.81	6,567.54	3,392.13	13,894.67	9,442.47
1988	3,887.84	6,848.08	3,211.02	14,519.86	9,238.04
1989	3,833.78	5,942.37	2,997.90	13,844.37	8,954.44
1990	4,109.36	6,350.17	2,963.56	13,794.48	8,856.89
1991	3,569.17	5,150.00	3,016.37	13,850.30	9,236.13
1992	3,761.81	4,334.08	3,278.43	13,745.92	8,959.05
1993	3,430.27	4,601.10	3,526.44	13,785.36	9,310.00
1994	3,433.07	4,142.83	3,762.01	13,829.20	9,531.68
1995	2,729.10	4,021.54	3,751.68	13,784.15	9,853.47
1996	3,201.16	4,587.00	3,971.82	13,695.25	10,053.42
1997	3,041.76	4,720.95	3,934.17	13,891.20	9,834.96
1998	2,591.64	3,507.75	4,297.38	13,548.17	9,876.99
1999	2,306.08	3,207.72	4,557.20	13,280.33	10,161.97
2000	2,150.64	4,112.30	4,712.19	12,864.22	10,251.48
Average	4,079.43	8,277.28	4,329.47	14,358.23	9,811.49

Table 3.2 (Cont). Real Value Added of the Six State Study Area Classified by Two-Digit SIC (Million of Constant Dollars)

Year	Wholesale Trade	Retail Trade	F.I.R.E	Services	Government	Total
1977	7,248.90	10,858.29	11,679.11	11,591.36	16,265.48	103,221.78
1978	7,408.84	10,877.02	12,005.91	11,785.62	15,571.97	103,389.63
1979	7,596.85	10,688.12	12,531.07	11,964.17	15,323.58	106,694.43
1980	7,815.76	10,420.96	13,287.92	12,633.92	15,690.68	112,484.92
1981	7,915.43	10,538.10	13,737.97	12,737.95	15,894.76	118,674.98
1982	7,943.66	11,185.23	14,183.04	13,864.94	17,046.25	120,892.45
1983	7,205.72	11,138.31	14,252.50	13,753.79	16,796.04	112,659.52
1984	7,098.79	11,076.40	13,906.23	13,628.90	16,130.42	110,467.24
1985	6,887.85	10,925.59	13,621.70	13,668.71	16,174.64	107,491.06
1986	6,348.83	10,195.79	12,943.31	13,695.42	15,975.89	97,037.39
1987	5,789.44	9,547.01	12,316.55	13,945.21	15,615.16	94,355.98
1988	5,969.16	9,172.39	11,447.22	14,264.13	15,078.42	93,636.15
1989	5,831.02	8,876.81	11,237.03	14,468.46	14,922.10	90,908.30
1990	5,817.57	8,708.73	11,256.40	14,755.90	14,858.20	91,471.26
1991	6,164.64	8,992.87	11,698.22	15,277.41	15,260.88	92,215.98
1992	6,123.07	8,943.31	11,894.10	15,610.92	15,357.74	92,008.43
1993	6,044.46	9,056.24	12,077.20	15,912.34	15,275.38	93,018.77
1994	6,332.98	9,266.30	11,878.32	15,974.82	15,002.65	93,153.85
1995	6,321.89	9,267.69	12,162.08	16,499.42	14,999.21	93,390.25
1996	6,382.40	9,375.86	12,215.83	16,690.89	14,605.66	94,779.29
1997	6,503.92	9,544.83	12,889.10	17,298.22	14,381.20	96,040.32
1998	6,575.68	9,594.75	13,485.96	17,878.39	14,042.69	95,399.40
1999	6,666.96	9,466.88	13,579.83	18,168.60	13,901.85	95,297.40
2000	6,869.20	9,475.61	14,157.48	18,376.09	13,938.46	96,907.68
Average	6,702.63	9,883.05	12,685.17	14,768.57	15,337.89	100,233.19

Table 3.2 displays the real value added of the six-state study area classified by two-digit SIC from 1977 to 2000.

3.1.5 THE DATA CODING FOR AGRICULTURAL SERVICES EMPLOYMENT DEMAND

It is important to describe the methods by which the data were coded to capture the spatial interaction between counties with large, medium and small populations. As a result there is some repetition in the development of the regression models in this chapter and their semi final form in Chapter IV. The hypothesis was that increasingly more specialized products and services could be found in counties with larger populations. Firms and residents in smaller counties would purchase part of goods and services from the nearest larger counties. Initially, counties were divided into population size groups of 1-500, 5001 to 10,000, 10,001 to 25,000, 25001 to 50,000, 50,001 to 100,000 and over 100,000. Regression analysis was used to determine which size groupings were significant. The non-significant designations were dropped. Only the significant size groupings are discussed in the employment equations for each sector.

Demand for agricultural services employment was to be estimated by using a time-series and cross sectional procedure. Counties in the six-state study area were classified by size of population. It was determined that counties with a population of less than 10,000 could be considered as small while counties with a population size more than 10,000 could be considered as large. The agricultural services sector does include greenhouse and services which are in demand by an urban population. However,there are more than the expected number of agricultural services employees in the larger counties. The hypothesis to be tested is that part of the demand for the Agricultural Services employees in the large counties is from producers and residents who live in the smaller surrounding counties. In this case the dependent variable would be the agricultural services employment for the given county and year. The independent variables are agricultural receipts and personal income earned each year in each county. The concept that the large central county serves as a trade center is shown in the diagram below:

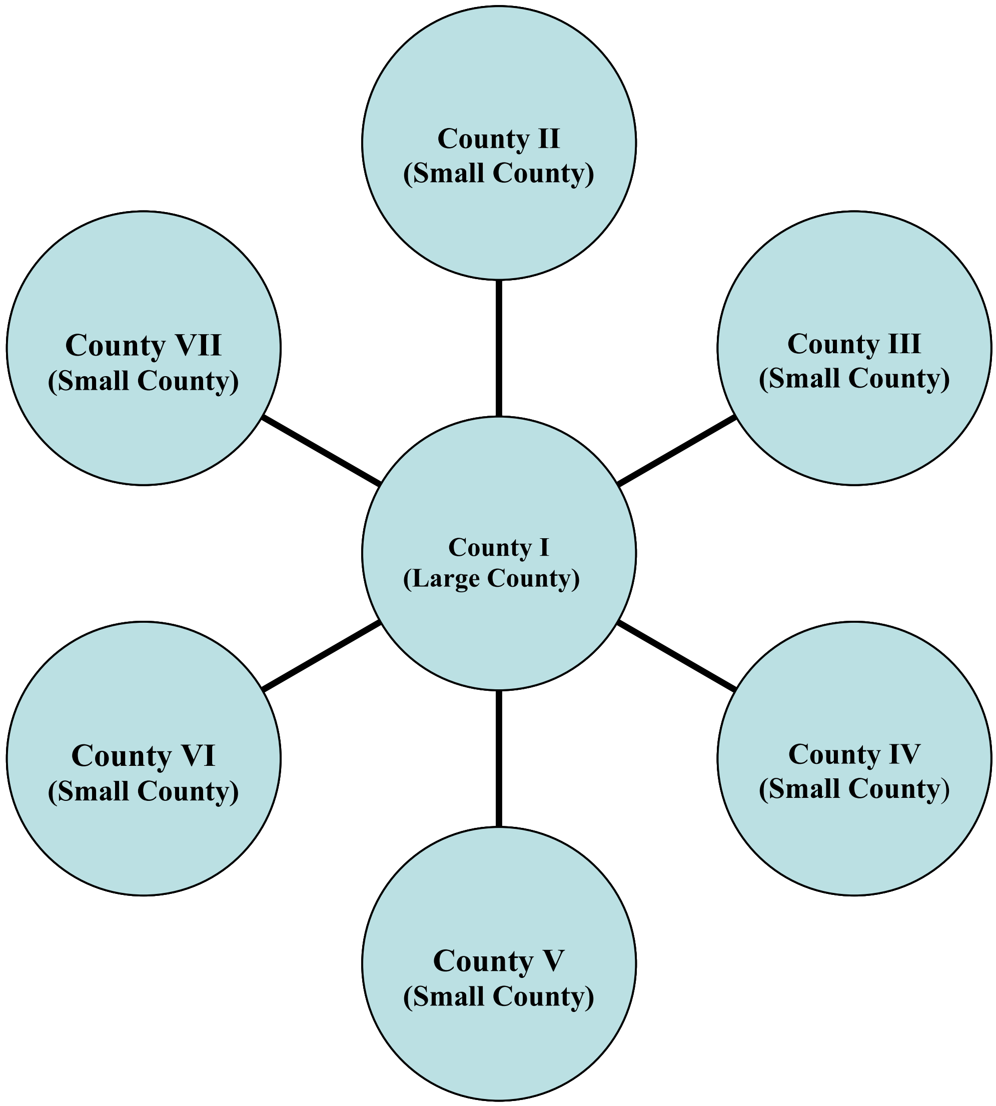

Figure 3.1 Schematic Diagram to Illustrate the Hypothesis that Demand for Agricultural Services Employment in the Large Central County Results From Agricultural Cash Receipts and Personal Income From the Large County and from Close Surrounding Smaller Counties.

Figure 3.1 displays a seven county diagram with a central trade county. The hypothesis to be tested is that part of the demand for agricultural services employment in the large central county results from agricultural cash receipts and personal income earned in the smaller surrounding counties. In Figure 3.1 and Table 3.3 county one is a large county that serves as a trade center for the surrounding smaller counties (Counties II, III, IV, V, VI, and VII). The coding format for agricultural services employment demand is shown in Table 3.3.

Table 3.3 Data Coding to Estimate Agricultural Services Employment Impacts from Agricultural Cash Receipts and Personal Income in the Close Surrounding Small Size Counties and in a County with a Central Trade Center

County	County Code	Year	AgrSerEmp	Agricultural Cash Receipts		Personal Income	
				TCS	TCL	PerIncS	PerIncL
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	40109	1977	894	12,069	165,318	4,322,461	6,246,491
2	40119	1977	104	16,546	0	306,283	0
3	40125	1977	87	14,409	0	315,357	0
4	40027	1977	214	10,078	0	763,877	0
5	40073	1977	73	52,064	0	76,720	0
6	40017	1977	160	41,084	0	321,560	0
7	40083	1977	34	19,068	0	140,233	0
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1	40109	2000	3,934	18,030	326,193	18,731,373	30,037,649
2	40119	2000	620	23,304	0	1,434,174	0
3	40125	2000	255	43,500	0	1,328,159	0
4	40027	2000	1,170	14,060	0	5,236,009	0
5	40073	2000	234	11,908	0	336,383	0
6	40017	2000	527	7,611	0	2,210,092	0
7	40083	2000	212	38,580	0	761,459	0

The first three columns of the data set contain data on the county identification number and year. The fourth column of the data set is the supply or total number of agricultural services employees in each county and in each year. The fifth column contains the agricultural cash receipts in each county. The hypothesis to be tested is that the number of employees in the large county exceeds the number to serve agricultural producers and residents of that county. The entries in the sixth column are zero except for the large county. The entry in the sixth column is the sum of agricultural cash receipts in the large county plus the sum of agricultural cash receipts from all surrounding smaller counties. The seventh column of data set contains the personal income of residents in each county in each year. The eighth column of the data set is similar to the sixth column. The entries in the eighth column are zero for the smaller counties. The entry for the large county is the sum of personal income of residents in the large county plus the personal income of residents of all the close surrounding smaller counties. With this information,

the regression model for agricultural services employment demand can be expressed as:

$$(3.9) \quad AgsEmp_{i,t} = \alpha_1 TCS_{i,t} + \alpha_2 TCL_{i,t} + \alpha_3 PerIncS_{i,t} + \alpha_4 PerIncL_{i,t}.$$

In equation (3.9), the dependent variable in each county is the number of agricultural services workers, $AgsEmp_{i,t}$, in that county. It is assumed the basic types of agricultural services in the small surrounding counties are also found in the large county. However that is assumed there are specialized services found only in larger counties. The demand for the basic service workers found in all counties for each one million dollars cash receipts will be given by the coefficient of variable TCS in Table 3.3 The total agricultural cash receipts for all counties is shown in column six (TCL) in Table 3.3. The demand for the type of agricultural services sought by those who come to the large county or the central county will be estimated by the coefficient for variable TCL in Table 3.3. The coefficient of TCL or α_2 will be significant only if the number of agricultural services workers in the large county is greater than those that can be expressed by cash receipts in the large county.

Similarly, the demand for the basic agricultural services workers found in all counties for each one million dollars of personal income of residents in each county will be given by the coefficient of PerIncS, (column seven) in Table 3.3 or α_3. The aggregate personal income of residents of the large county and the small surrounding counties is shown in PerIncL (column eight) in Table 3.3. The demand for agricultural services employment created by the personal income of residents in small surrounding counties who purchase from firms in the large county is measured by the coefficient of PerIncL, α_4. The coefficient of PerIncL will be significant only if the number of agricultural services employees in large counties are greater than those justified by the level of personal income in large counties.

3.1.6 THE DATA CODING FOR MANUFACTURING EMPLOYMENT MODEL

Employment in manufacturing may be broadly divided into durable and nondurable categories. The problem is that this breakdown is only published in counties with several hundred employees. In many counties of the study area the manufacturing employment was too small for the breakdown to be published. In fact as described previously it was often necessary to use the RAS method to complete the manufacturing employment series in the smaller counties. In the study area, counties with 500 or more manufacturing employees had complete or nearly complete data series on manufacturing employment by durable and non durable categories. Food and feed manufacturing are major subcomponents of the nondurable manufacturing in the study area. Livestock slaughter and meat production is a major component of food manufacturing. In this study, number of fed cattle slaughtered in the six-state study area was expressed in Table 3.4. The expansion of the fed cattle industry over the past 60 years has been matched by the establishment of large slaughter plants in selected counties of the study area.

Nondurable employment was assumed to be influenced by cattle slaughtered cattle on feed, and crop production. Durable employment was assumed to be determined by valued added by other sectors in the county and by manufacturing trends in the rest of the United States. The estimated data for nondurable manufacturing employment is displayed in Table 3.5.

The manufacturing employment model was also to be estimated with the time-series and cross-sectional procedure. The regression methodology and data coding can be illustrated by the following example shown in Figure 3.2 and Table 3.6.

Table 3.4 The Average Number of Fed Cattle Slaughtered from 1977-2000 in Six State Study Area

State	County	City*	1,000 Head
Colorado	Denver	Denver	524
Colorado	Weld	Greeley	1,629
Colorado	Logan	Sterling	401
Kansas	Lyon	Emporia	356
Kansas	Finney	Garden City	1,725
Kansas	Ford	Dodge City	1,113
Kansas	Barton	Great Bend	171
Kansas	Seward	Liberal	936
Nebraska	Douglas	Omaha	36
Nebraska	Colfax	Schuyler	1,620
Oklahoma	Ellis	Shattuck	60
Oklahoma	Custer	Clinton	36
Oklahoma	Garfield	Enid	367
Texas	Parmer	Friona	790
Texas	Hale	Plainview	416
Texas	Deaf Smith	Hereford	60
Texas	Potter	Amarillo	1,123
Texas	Moore	Dumas	944
Average			12,307

*The City where the Major Meat Packing Plant is located.

Table 3.5 Total and Average Number of Non Durable Manufacturing Employment in the Six State Study Area from 1977 To 2000*

Year	Total Nondurable Manufacturing Employees**
1977	101,495
1978	102,092
1979	103,969
1980	105,345
1981	104,738
1982	102,807
1983	101,225
1984	106,128
1985	106,982
1986	106,137
1987	107,994
1988	110,837
1989	107,584
1990	107,323
1991	109,752
1992	112,780
1993	116,810
1994	119,323
1995	118,227
1996	123,889
1997	124,975
1998	123,993
1999	120,535
2000	127,003
Average	111,331

*Total for published and estimated nonduarable manufacturing employment in counties with more than 500 manufacturing employees.

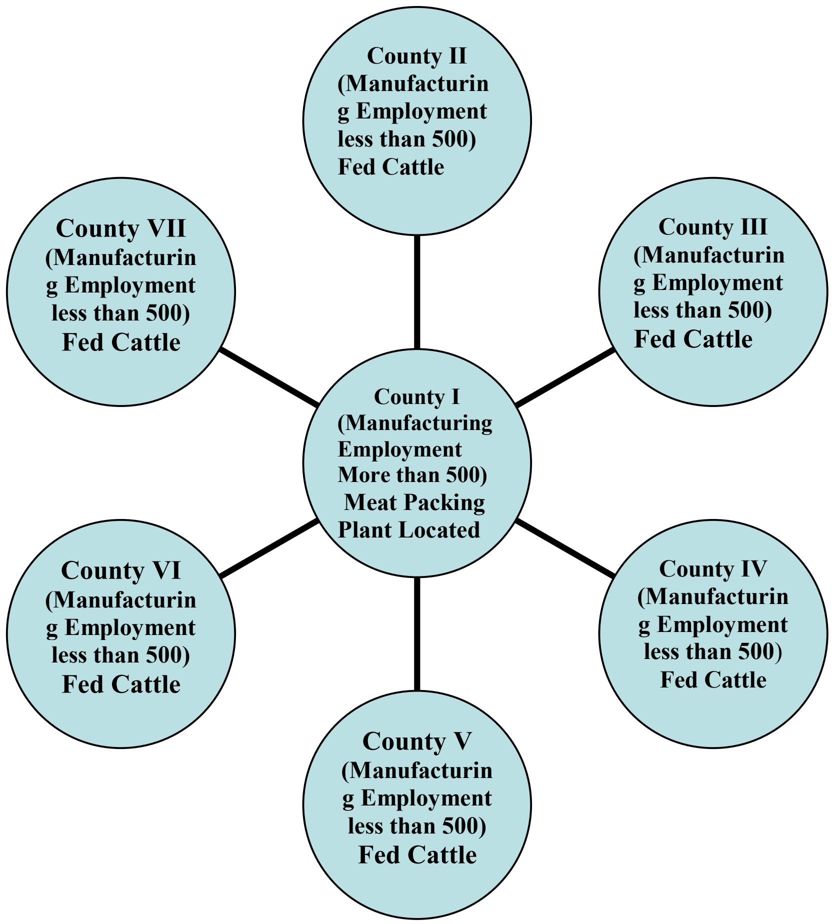

Figure 3.2 Schematic Diagram to Estimate Manufacturing Employment Impacts from Cash Receipts from Crops, Feed Purchases, the Real Output, the Number of Fed Cattle Slaughtered of a Major Meat Packing Plant

Figure 3.2 contains a schematic diagram with a large county with a slaughter plant surrounded by smaller counties. Counties with more than 500 manufacturing employees were considered large. The cattle slaughtered are drawn from all counties in the diagram. A single regression model was used for all counties but a coding method was developed to take advantage of availability of durable and nondurable employment data for large counties.

Table 3.6 Data Coding to Estimate Manufacturing Employment Impacts from Cash Receipts from Crops, Feed Purchases, the Real Output, the Number of Fed Cattle Slaughtered in a Major Meat Packing Plant

County	County Code	Year	Manufacturing Employment		CropCash Receipts ($1000)	Feed Purchase ($1000)	Total Vadd (Million)	Fed Cattle (1000 Head)	Rest UsMnf
				Total Manf (5)					
(1)	(2)	(3)	(4)		(6)	(7)	(8)	(9)	(10)
1	40109	1977	NDME[a]	15,714	3,859	1,603	0	460	0
1	40109	1977	DME[b]	22,613	0	0	14,736		18547840
2	40119	1977	TME[c]	346	3,210	2,515	1,021		18547840
3	40125	1977	TME	259	3,781	2,333	1,125		18547840
4	40027	1977	TME	446	1,417	1,466	1,317		18547840
5	40073	1977	TME	332	11,576	5,210	303		18547840
6	40017	1977	TME	448	10,147	4,829	646		18547840
7	40083	1977	TME	410	61,69	2,126	273		18547840
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1	40109	2000	NDE	14,842	9,004	1,067	0	378	0
1	40109	2000	DME	27,204	0	0	11576		17188758
2	40119	2000	TME	498	3,983	2,905	981		17188758
3	40125	2000	TME	442	5,172	4,793	1015		17188758
4	40027	2000	TME	225	4,350	1,296	1904		17188758
5	40073	2000	TME	339	20,074	10,928	208		17188758
6	40017	2000	TME	338	20,407	4,204	831		17188758
7	40083	2000	TME	339	10,460	2,851	284		17188758

[a] Nondurable Manfacturing Employment
[b] Durable Manfacrturing Employment
[c]. Total Manfacturing Employment

The regression model and data coding can be illustrated by Table 3.6. The first three columns of Table 3.6 show the county identification and year. Column 4 shows the type of data (Total manufacturing employment, durable manufacturing employment, or nondurable manufacturing employment). County one is a large county and durable and non durable employment are entered as separate observations. Nondurable manufacturing is explained by feed purchases and crop production in county one plus the sum of all fed cattle produced in county one and the surrounding counties. Durable manufacturing is explained by real value added in county one and by US manufacturing trends. In the remaining counties, there is only one observation per county where total manufacturing employment is entered for the value of the dependent variable. In the single observation, total manufacturing employment is explained by the same variables that were used to explain durable and nondurable employment in the large county. That is the single observation in the smaller counties represents the sum of the two equations (durable and nondurable) used in the large counties. The manufacturing model can be expressed as:

$$(3.10) \quad MnftEmp_{i,t} = \alpha_5 CropCashRect_{i,t} + \alpha_6 FeedPurchase_{i,t} + \alpha_7 FedCattle_{i,t}. + \alpha_8 TotVadd_{i,t} + \alpha_9 RestUsMnf_{i,t}$$

In equation (3.10), the dependent variable is manufacturing employment in county i in year t. In small counties $MnftEmp_{i,t}$, is the total manufacturing employment in county one in year t. In a large county, $MnftEmp_{i,t}$ will be one observation where durable manufacturing employment will be entered and a second observation where nondurable manufacturing employment will be entered for year t. The variable $CropCashRect_{i,t}$ is crop cash receipts in million constant dollars from county i in year t. The coefficient α_5 is the demand for nondurable manufacturing employment for each one million dollars of cash receipts from crops. The variable $FeedPurchase_{i,t}$ is feed purchased in millions of constant dollars in county i in year t. The coefficient α_6 is the number of nondurable manufacturing employees demanded for each one million dollars of feed purchases. The variable $FedCattle_{i,t}$ is the thousands of fed cattle slaughtered in the large counties where a meat packing plant is located. The coefficient α_7 is the demand for manufacturing employment for each one thousand fed cattle slaughtered in the large county where a meat packing plant is located. The variable $TotVadd_{i,t}$ is millions of total real value-added in the county i each year. The coefficient α_8 is demand for durable manufacturing employment for each one million dollars of total real value-added. The variable $RestUsMnf_{i,t}$ is the rest of the U.S manufacturing employment for each year. The coefficient α_9 is demand for durable manufacturing employment in county i in year t because of a increase one job increase in the rest of U.S manufacturing employment.

3.1.7 DATA CODING FOR WHOLESALE TRADE EMPLOYMENT MODEL

The demand for wholesale trade employment was estimated with the times-series and cross-sectional procedure in the form of geometric distributed lag. The regression methodology and data coding can be expressed by the following example:

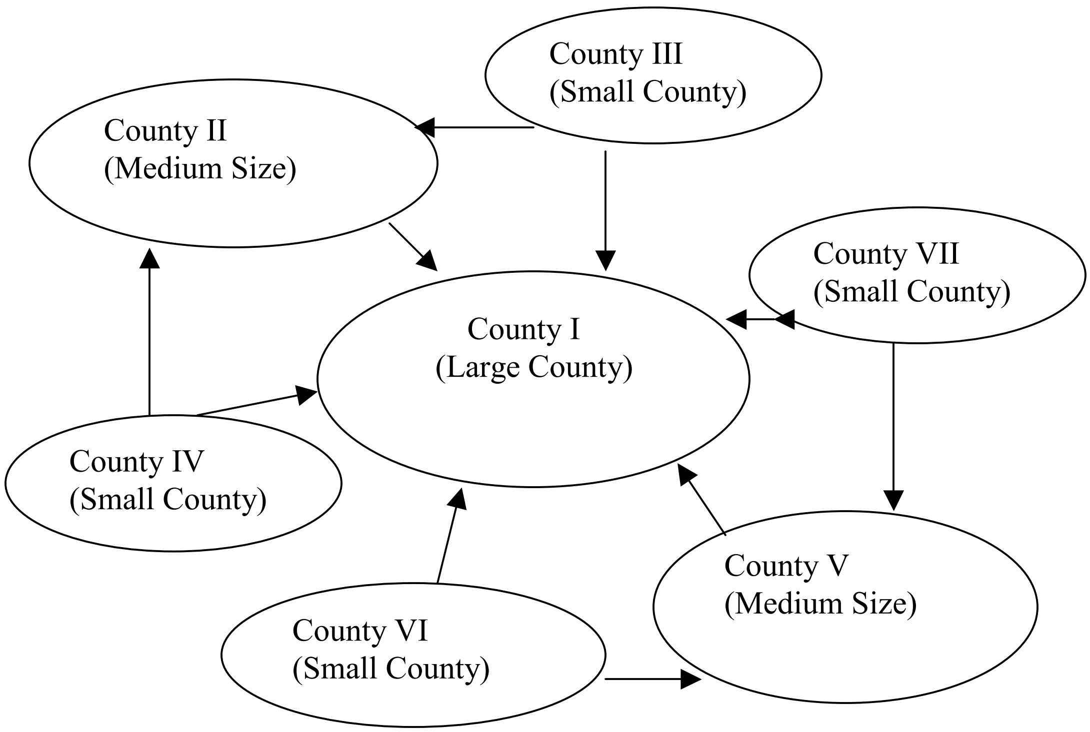

Figure 3.3 Schematic Diagram to Estimate Wholesale Trade Employment Impacts from the Real Output of Basic Sectors, the Real Output of Non-Basic Sectors and Retail Trade Employment.

The hypothesis is that wholesale trade firms in large counties serve retail establishments in large, medium and small counties. Wholesale firms in medium size counties serve retail firms in medium and small counties. Wholesale firms in small counties only serve firms that same county.

Table 3.7 Data Coding to Estimate Wholesale Trade Employment Impacts from the Real Output of Basic Sectors, the Real Output of Non-Basic Sectors, and Retail Trade Employment

County	County Code	Year	Wholesale Emp	Size Class	BaseReal Vadd	NonBase Real Vadd	Retail Trade Emp		
							Small	Medium	Large
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1	40109	1977	5500	Large	200	300	5600	5600	12825
2	40119	1977	2500	Medium	35	45	2800	5000	0
3	40125	1977	1000	Small	22	42	1500	0	0
4	40027	1977	500	Small	10	30	700	0	0
5	40073	1977	1500	Medium	30	50	1550	2225	0
6	40017	1977	300	Small	15	40	450	0	0
7	40083	1977	125	Small	15	25	225	0	0
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---	---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---	---
1	40109	2000	8250	Large	300	450	8400	8400	19237.5
2	40119	2000	3750	Medium	52.5	67.5	4200	7500	0
3	40125	2000	1500	Small	33	63	2250	0	0
4	40027	2000	750	Small	15	45	1050	0	0
5	40073	2000	2250	Medium	45	75	2325	3337.5	0
6	40017	2000	450	Small	22.5	60	675	0	0
7	40083	2000	187.5	Small	22.5	37.5	337.5	0	0

There are three categories of the size classes for wholesale trade employment model. Counties with than 5,000 retail trade employees more were classified as large. Counties with 1,000 to 5,000 retail trade employees were classified as medium. Counties with 1000 or fewer retail trade employees were classified as small. Figure 3.3 displays an example for seven counties. County one was classified as a large county. Counties two and five were classified as medium counties. Counties three, four, six, and seven were classified as small counties. Data coding is shown in Table 3.7. The first column displays the county number. The second column displays FIPS code classified by Bureau of Economic Analysis (BEA). The third column displays years from 1977 to 2000. The fourth column displays wholesale trade employment in each county in each year. The fifth column displays the size classes of each county. The sixth column displays the real output of basic sectors for each county each year. The seventh column displays the real output of non-basic sectors for each county in each year. The eighth column displays the retail trade employees for each county in each year. The entry in the ninth column is zero for small counties. The entry in column nine is the number of retail employees in the medium or large county plus the sum of all retail trade employees from the closest surrounding small size counties. For the above example, counties three and four are the smallest counties closest to medium size county two. Similarly small counties six and seven are closest to medium county five. In column ten entries are zero for all counties except for the large county. The sum of the retail employees in all seven counties for the year is entered for that observation. That is the entry in the tenth column for the large county is the sum of number of all retail trade employees in counties one through seven. The wholesale trade employment model can be expressed as:

$$(3.11)\quad \begin{aligned} WhsEmp_{i,t} = \omega_1\, & WhsEmp_{i,t-1} + \alpha_{10} BaseVadd_{i,t} \\ & + \alpha_{11} NonBaseVadd_{i,t} + \alpha_{12} \mathrm{Re}\,tailEmpS_{i,t}\ . \\ & + \alpha_{13} \mathrm{Re}\,tailEmpM_{i,t} + \alpha_{14} \mathrm{Re}\,tailEmpL_{i,t} \end{aligned}$$

In equation (3.11), $WhsEmp_{i,t}$ is the number of wholesale trade employees of county i, and year t. $WhsEmp_{i,t-1}$ is the one year lagged wholesale trade employment in county i. The variable $BaseVadd_{i,t}$ is millions of real value-added by the basic sectors in county I in year t. The coefficient α_{10} is demand for wholesale trade employment created by each one million dollars of real value-added by the basic sectors. The variable $NonBaseVadd_{i,t}$ is millions of real value-added by the non-basic sectors in county i in year t. The coefficient α_{11} is demand for wholesale trade employment created by each one million dollars of real value-added by the non-basic sectors. The variable $\mathrm{Re}\,tailEmpS_{i,t}$ is the number of retail trade employees in county i in year t. The coefficient α_{12} is demand for wholesale trade employment in each county created by each job in retail trade sector. The variable $\mathrm{Re}\,tailEmpM_{i,t}$ is the number of retail trade employees in the medium size county plus retail trade employees all the close surrounding small counties. The coefficient α_{13} is demand for wholesale trade employment in a medium or larger county created by for each retail trade job in the medium plus all the close surrounding small counties. For example, retail firms from small size counties come to closest medium size county to purchase wholesale items which are not found in the smaller county such as electronics or machinery. So, the demand for wholesale trade employment in the medium size county includes part of demand for wholesale trade from all the closest surrounding small size counties. The variable $\mathrm{Re}\,tailEmpL_{i,t}$ is the number of retail trade employees in the large size county plus all retail trade employees in the closest surrounding small and medium size counties. The coefficient α_{14} is the demand for wholesale trade employment in the large county created by a one job in retail trade employment in the large county and in the closest surrounding small and medium size counties. For example, retailers from small and medium size counties come to the closest large county to purchase goods not found in their county

The data coding for the regression models for FIRE (finance, insurance and real estate), services, construction, mining, transportation and public utilities, as well as government employment model was done in the same fashion.

CHAPTER IV

ECONOMETRIC MODEL

4.1 THE DERIVATION OF GEOMETRIC DISTRIBUTED LAG MODEL

A geometric distributed lag model was used to estimate demand for agricultural services employment, manufacturing employment, wholesale trade employment, retail trade employment, finance, insurance, and real estate (F.I.R.E) employment as well as services employment in the six-state study area. The geometric distributed lag model has been used by several economists such as Pindyck, Daniel and Rubinfeld (1976) and Greene (2000). The Geometric lag model has been used in regional analysis and economic development to estimate the income and employment multipliers of economic changes. For instance, Blair (2003) applied a geometric distributed lag in his study on the retail development in rural counties from the Upper Midwest.

Following Pindyck (1976), the geometric lag assumes that the weights of the lagged explanatory variables are all positive and declined geometrically with time as follows:

(4.1) $$y_t = \alpha + \beta\left(x_t + w\,x_{t-1} + w^2 x_{t-2} + w^3 x_{t-3} + w^4 x_{t-4} + \ldots + w^n x_{t-n}\right) + \varepsilon_t,$$

where y_t is dependent variable at time period t, α is a constant term intercept, β is the coefficient for the sum of geometric lag series of independent variables, w is the weight of geometric lag series of dependent variables, and ε_t is the error term of time t.

Equation (4.1) can be re-written as:

(4.2) $$y_t = \alpha + \beta \sum_{s=0}^{\infty} w^s x_{t-s} + \varepsilon_t ..$$

The weights of geometric lag model never become zero, but they diminish so that beyond a reasonable time period the effect of the explanatory variable becomes negligible.

In its present form in equations (4.1) and (4.2), the Koyck geometric lag model appears quite difficult to estimate, since it involves an infinite number of regressors. However, the parametric form of lag weights allow for a substantial simplification of the model. Re-write the original equation (4.1) with all observations lagged one period, then equation (4.1) becomes (4.3):

(4.3) $$y_{t-1} = \alpha + \beta\left(x_{t-1} + w\,x_{t-2} + w^2 x_{t-3} + w^3 x_{t-4} + ...\right) + \varepsilon_{t-1}.$$

Multiply both sides of equation (4.3) by w to get:

(4.4) $$wy_{t-1} = w\alpha + \beta\left(w\,x_{t-1} + w^2 x_{t-2} + w^3 x_{t-3} + ...\right) + w\,\varepsilon_{t-1}.$$

To consider the change in the dependent variable between two different periods of time t, and $t-1$ subtract (4.4) from (4.3):

(4.5) $$y_t - wy_{t-1} = \alpha(1-w) + \beta x_t + \mu_t,$$

where $\mu_t = w_t - w\varepsilon_{t-1}$. Re-write equation (4.5) and to get (4.6):

(4.6) $$y_t = \alpha(1-w) + wy_{t-1} + \beta x_t + \mu_t.$$

Equation (4.6) is more easily estimated since only three parameters are unknown.

Generally, equation (4.6) is used to describe the structure of the distributed lag model in terms of its mean or average lag, and in terms of the long-term response of the dependent variable to a permanent change in one of the explanatory variables. Mathematically, the mean lag of geometric series can be calculated as,

(4.7) $S_n = \left\{1 + w^1 + w^2 + w^3 + ... + w^n\right\}$, or

(4.8) $Sn = \sum_{s=0}^{n} w^s$.

Multiply both sides of (4.8) by w which is the weight of geometric series (the same as equation (4.4)) then (4.4) becomes (4.9):

(4.9) $wS_n = \left\{w + w^2 + w^3 + w^4 + ... + w^{n+1}\right\}$.

Subtracting (4.7) from (4.8), the result becomes (4.10):

(4.10) $S_n - wS_n = \left\{1 + w^1 + w^2 + w^3 + w^4 + ... + w^n\right\} - \left\{w + w^2 + w^3 + w^4 + ... + w^{n+1}\right\}$

(4.11) $(1-w)S_n = 1 - w^{n+1}$

(4.12) $Sn = \dfrac{1 - w^{n+1}}{(1-w)}$;

For all $0 \prec w \prec 1$ the summation converges as $n \to \infty$, in which case S_n becomes (4.13).

(4.13) $S_n = \dfrac{1}{(1-w)}$, thus

(4.14) $S = S_n = \sum_{s=0}^{\infty} w^s = \dfrac{1}{(1-w)}$.

The long-term response of the dependent variable to a permanent change in one of the explanatory variables in the geometric lag model is simply the parameter β multiplied by the sum of the lag weights, which can be expressed as $\frac{\beta}{(1-w)}$.

From equation (4.11) if s varies from one to infinity then S becomes (4.15):

$$(4.15) \quad S_n = \sum_{s=1}^{n} w^s = \frac{w\left(1-w^n\right)}{(1-w)}.$$

In case $n \to \infty$, so (4.15) becomes (4.16):

$$(4.16) \quad S_n = \sum_{s=1}^{\infty} w^s = \frac{w}{(1-w)}.$$

If w = 1/2, then a mean lag of one suggests that half the impact of a change in y will be felt during the first time period. To modify the original form of geometric distributed lag model, equation (4.3) can be re-explained as:

$$(4.17) \quad y_t = \alpha + \beta\left(x_t + w\,x_{t-1} + w^2 x_{t-2} + w^3 x_{t-3} + w^4 x_{t-4} + \ldots + w^n x_{t-n}\right) + \varepsilon_t.$$

It is common to consider base and none-base sectors in regional economic analysis. The sectors in the economic base are assumed to be the drivers for the non-base sector. The output of the base sectors is weakly connected to the output of non-base sectors. The econometric model of demand for agricultural services employment, manufacturing employment, wholesale trade employment, retail trade employment, finance, insurance, and real estate (F.I.R.E), services, construction, mining, transportation and public utilities, as well as government employment would be expressed in section 4.2-4.11.

4.2 THE ECONOMETRIC DISTRIBUTED LAG MODEL FOR AGRICULTURAL SERVICES EMPLOYMENT

Demand for Agricultural Service Employment

The demand for agricultural service employment of the six-state study area was assumed to depend on a one year lag of agricultural services employment, total cash receipts from livestock and crops and personal income. The demand for agricultural service employment can be expressed as:

$$(4.18) \quad AgsEmp_{i,t} = \omega_1 AgsEmp_{i,t-1} + \alpha_1 TCS_{i,t} + \alpha_2 TCL_{i,t} + \alpha_3 PerIncS_{i,t} + \alpha_4 PerIncL_{i,t}.$$

In equation (4.18), $AgsEmp_{i,t}$ is the total agricultural services employment of county i in year t. $AgsEmp_{i,t-1}$ is a one year lag of agricultural employment. $TCS_{i,t}$ is the total income from livestock and crops from all counties. The term α_1 represents the number of agricultural services employees required by each one million dollars of cash receipts from livestock and crops in any size of county. The term α_2 represents the demand for the type of agricultural services provided by firms that are located in counties with more than 10,000 population. The term $TCL_{i,t}$ represents the sum of agricultural cash receipts from the large county plus the receipts from all surrounding counties with a population of 10,000 population or less that are closest to the larger county. That is each one million dollars of agricultural cash receipts is assumed to require $\alpha_1 + \alpha_2$ agricultural service employees. The α_1 employees can be found in any county while the α_2 employees are located in the larger counties. This represents the share of total demand for agricultural services purchased by the agricultural producers in a county with a population size 10,000 or less. $TCL_{i,t}$ is total cash receipts from livestock and crops in the large county plus all total cash receipts from livestock and crops in the closest surrounding small size counties. This demand is from producers in that county and by producers in surrounding counties with a population size of 10,000 or less by increase a million dollars of total cash receipts from livestock and crops. Counties with a population of more than 10,000 were considered as large. The variable $PerIncS_{i,t}$ is personal income of residents in all counties. The variable $PerIncL_{i,t}$ is personal income in the large county plus all personal income in the closest surrounding small counties. The coefficient α_3 is demand for agricultural services which found in all counties by each one million dollars of personal income. The coefficient α_4 is demand for agricultural services of the large county plus the closest surrounding small counties.

The long-term impact on agricultural services employment from a unit change in of the independent variables can be expressed as shown below.

(4.19) $LTIP_1 = \left(\alpha_1 / 1 - \omega_1 \right).$

(4.20) $LTIP_2 = \left(\alpha_2 / 1 - \omega_1 \right).$

(4.21) $LTIP_3 = \left(\alpha_3 / 1 - \omega_1 \right).$

(4.22) $LTIP_4 = \left(\alpha_4 / 1 - \omega_1 \right).$

In equation (4.19), $LTIP_1$ is the long-term impact by each one million dollars of cash receipts from livestock and crops in any size of county on agricultural services employment. The coefficient α_1 is the one period effect of a change in cash receipts from livestock and crops in any size of county. The coefficient ω_1 is the time weighted geometric distributed lag.

In equation (4.20), $LTIP_2$ is the long-term impact by one million dollars of cash receipts from livestock and crops from the large county plus the closest surrounding small size counties on agricultural services employment. The coefficient α_2 is the coefficient of cash receipts from livestock and crops from the large county plus the closest surrounding small counties. The coefficient ω_1 is the time weighted geometric distributed lag.

In equation (4.21), $LTIP_3$ is the long-term impact by one million dollars of personal income of residents in any county on agricultural services employment. The coefficient α_3 is the coefficient of the personal income of residents in any county. The coefficient ω_1 is the time weighted geometric distributed lag.

In equation (4.22), $LTIP_4$ is the long-term impact by one million dollars of personal income of residents in the large county plus the closest surrounding small size counties on agricultural services employment. The coefficient α_4 is the coefficient of personal income of residents in the large county plus the closest surrounding small size counties. The coefficient ω_1 is the time weighted geometric distributed lag.

4.3 THE ECONOMETRIC DISTRIBUTED LAG MODEL FOR MANUFACTURING EMPLOYMENT

Manufacturing employment was assumed to depend on a one year lag of manufacturing employment, crop cash receipt, feed purchase, and numbers of fed cattle slaughtered, total real value-added, and the rest of the U.S manufacturing employment. Manufacturing employment model can be expressed as:

$$(4.23)\quad MnftEmp_{i,t} = \omega_2\, MnftEmp_{i,t-1} + \alpha_5 CropCashRect_{i,t} + \alpha_6 FeedPurchase_{i,t} + \alpha_7\, FedCattle_{i,t} + \alpha_8\, TotVadd_{i,t} + \alpha_9\, RestUsMnf_{i,t}$$

In equation (4.23), $MnftEmp_{i,t}$ is manufacturing employment of county i in year t. The variable $MnftEmp_{i,t-1}$ is a one year lag of manufacturing employment, $CropCashRect_{i,t}$ is crop cash receipts in terms of one million of constant dollars of county i in year t. The variable $FeedPurchase_{i,t}$ is millions of real feed purchases in county i in year t. The variable, $FedCattle_{i,t}$ is the thousands of fed cattle slaughtered in the county where a meat packing plant / or slaughtered house is located. The variable $TotVadd_{i,t}$ is total real value-added in terms of one million of constant dollars of county i in year t. The coefficient α_5 is demand for manufacturing employment for each million dollars of crop cash receipts. The coefficient α_6 is the demand for manufacturing employment created by each million dollars of feed purchased. The coefficient α_7 is demand for manufacturing employment created by each one thousand head of fed cattle slaughtered. The coefficient α_8 is demand for manufacturing employment for each one million dollars of real value-added. The coefficient α_9 is demand for manufacturing employment created by each manufacturing job in the rest of the U.S.

The long-term impact of crops cash receipts, feed purchases, number of fed cattle slaughtered, total real value-added , and the rest of the U.S manufacturing employment on manufacturing employment can be expressed as shown below.

(4.24) $$LTIP_5 = \left(\alpha_5 / 1 - \omega_2 \right).$$

(4.25) $$LTIP_6 = \left(\alpha_6 / 1 - \omega_2 \right).$$

(4.26) $$LTIP_7 = \left(\alpha_7 / 1 - \omega_2 \right).$$

(4.27) $$LTIP_8 = \left(\alpha_8 / 1 - \omega_2 \right).$$

In equation (4.24), $LTIP_5$ is the long-term impact by one million dollars of crops cash receipts on manufacturing employment. The coefficient α_5 is the coefficient of crops cash receipts. The coefficient ω_2 is the time weighted geometric distributed lag.

In equation (4.25), $LTIP_6$ is the long-term impact by one million dollars of feed purchases on manufacturing employment. The coefficient α_6 is the coefficient of feed purchases. The coefficient ω_2 is the time weighted geometric distributed lag.

In equation (4.26), $LTIP_7$ is the long-term impact by one thousand head of fed cattle slaughtered on manufacturing employment. The coefficient α_7 is the coefficient of number of fed cattle slaughtered. The coefficient ω_2 is the time weighted geometric distributed lag.

In equation (4.27), $LTIP_8$ is the long-term impact of the rest of the U.S manufacturing employment on the manufacturing employment of the six-state study area. The coefficient α_8 is the coefficient of the rest of the U.S manufacturing employment. The coefficient ω_2 is the time weighted geometric distributed lag.

In the manufacturing employment model, counties in the six-state study area were classified into 2 categories: 1) Counties with manufacturing employment more than 500 were considered as large, 2) Counties with manufacturing employment less than 500 were considered as small.

Assumptions of Demand for manufacturing Employment:

1) In the large counties two observations are entered for each year, one for nondurable employment and one for durable employment. Crop cash receipts, feed purchases and number of fed cattle slaughtered are used to explain non-durable manufacturing employment. The real value of Gross State Product (GSP) in the county and manufacturing employment in the rest of the U.S are used to explain durable manufacturing employment. For small counties only the observation for total manufacturing employment is entered. Crop cash receipts, feed purchases, real GSP added in that county and total manufacturing in the rest of the US were assumed to determine total manufacturing employment. Fed cattle slaughtered are entered as a zero in the small counties.
2) The major firms that slaughtered fed cattle were located in counties with more than 500 manufacturing employees.
3) It was assumed the fed cattle from each county would be shipped to the nearest slaughter plant with the capacity to accept them. A standard capacitated transportation model was solved for each year of the study period to make this allocation. As explained above the number of fed cattle slaughtered in a county with a slaughter plant are assumed to have a significant impact on non-durable manufacturing employment in that county.

4.4 THE ECONOMETRIC DISTRIBUTED LAG MODEL FOR WHOLESALE TRADE EMPLOYMENT

The employment in the wholesale trade sector in each county of the study area was assumed to depend on a one year-lag of wholesale trade employment, the real GSP value-added by the basic sectors, the real GSP value added by the non-basic sectors, and the retail trade employment in that and in surrounding smaller counties. Counties in the six-state study were classified by the number of employees in retail trade sector. There were 3 categories as defined in the previous chapter: 1) counties with 1,000 or fewer retail trade employees were considered as small, 2) counties with 1,001 to 50,000 retail trade employees were considered as medium, and 3) counties with more than 50,000 retail trade employees were considered as large.

The lagged wholesale trade employment model can be expressed as:

$$(4.28)\quad \begin{aligned} WhsEmp_{i,t} = \omega_3\, WhsEmp_{i,t-1} &+ \alpha_{10} BaseVadd_{i,t} \\ &+ \alpha_{11} NonBaseVadd_{i,t} + \alpha_{12} RetailEmpS_{i,t} \\ &+ \alpha_{13} RetailEmpM_{i,t} + \alpha_{14} RetailEmpL_{i,t} \end{aligned} .$$

In equation (4.28), $WhsEmp_{i,t}$ is the wholesale trade employment of county i in year t. The variable $WhsEmp_{i,t-1}$ is a one year lag of wholesale trade employment of county i. The variable $BaseVadd_{i,t}$ is the real value-added of basic sectors in terms of millions of constant dollars in county i in year t. The variable $NonBaseVadd_{i,t}$ is millions of real value-added in the non-basic sectors in county i in year t. The variable,

$\mathrm{Re}\, tailEmpS_{i,t}$ is the number of retail trade employees in county i in year t. The variable $\mathrm{Re}\, tailEmpM_{i,t}$ is the number of retail trade employees in the medium size county plus retail trade employees from all closest surrounding small counties. The variable $\mathrm{Re}\, tailEmpL_{i,t}$ is the number of retail employees in a large county plus all retail trade employees in the closest surrounding small and medium size counties. The coefficient α_{10} is demand for wholesale trade employment created in county i for each one million dollars of real value-added by all sectors in county i. The coefficient α_{11} is demand for wholesale trade employment created in all counties by a one million dollar increase in real value-added of the non-trade sectors. The coefficient α_{12} is demand for wholesale trade employment found in each county by an increase of one job in retail trade sector. The coefficient α_{13} is the additional demand for wholesale trade employment created in a medium size county by each one job increase in retail trade in the medium county and the closest surrounding smaller counties. The coefficient α_{14} is the additional demand for wholesale trade employment in a large county created each by an increase one job in the retail trade sector in closest surrounding small and medium size counties. Further assume, $\alpha_{14} \angle \alpha_{13} \angle \alpha_{12}$, meaning the share of demand for wholesale trade employment is declining while the size class is increased.

According to the geometric distributed lag model, the long term impact of the real value added by the basic sectors, non-basic sectors, and the number of retail trade employees classified by the size classes can be expressed as:

(4.29) $$LTIPC_1 = \left(\alpha_{10} \big/ 1 - \omega_3 \right).$$

In equation (4.29), $LTIPC_1$ is the long-term impact of the real value-added of basic sectors on wholesale trade employment. The coefficient α_{10} is coefficient of the real value added of basic sectors, and ω_1 is the coefficient of a one year lag of wholesale trade employment.

(4.30) $$LTIPC_2 = \left(\alpha_{11} \big/ 1 - \omega_3 \right).$$

In equation (4.30), $LTIPC_2$ is the long-term impact of real value added of non-basic sectors on wholesale trade employment. The coefficient α_{11} is the coefficient of real value added of non-basic sectors and ω_1 is the coefficient of a one year lag of wholesale trade employment or the time weighted distributed lag.

(4.31) $$LTIPC_3 = \left(\alpha_{12} \big/ 1 - \omega_3 \right).$$

In equation (4.31), $LTIPC_3$ is the long-term impact of retail trade employment of the small size class on wholesale trade employment. The coefficient α_{12} is the coefficient of retail trade employment of small size class and ω_1 is the coefficient of a one year lag of wholesale trade employment or time weighted distributed lag.

The Mean Lag of wholesale trade employment (ML) can be expressed as:

$$(4.32) \quad ML = \left(\omega_3 \big/ 1 - \omega_3 \right).$$

In equation (4.32), ML is the mean lag of wholesale trade employment, ω_3 is the coefficient of a one year lag of wholesale trade employment.

4.5 THE ECONOMETRIC DISTRIBUTED LAG MODEL FOR RETAIL TRADE EMPLOYMENT

The employment in retail trade was assumed to depend on a one year lag of retail trade employment, the total real value-added, and personal income. Counties in the six-state study area were divided into three population sizes (small, population 10,000 or less; medium, 10,001 to 50,000; and large, 50,001 or more)

The retail trade employment can be expressed as:

$$(4.33) \quad RetEmp_{i,t} = \omega_4 \ RetEmp_{i,t-1} + \alpha_{15} TotVadd_{i,t} + \alpha_{16} PerIncS_{i,t} + \alpha_{17} PerIncM_{i,t} + \alpha_{18} PerIncL_{i,t}.$$

In equation (4.33), $RetEmp_{i,t}$ is total retail trade employment for county i in year t, $RetEmp_{i,t-1}$ is a one year lag of retail trade employment of county i. $TotVadd_{i,t}$ is the real added in millions of constant dollars. $PerIncS_{i,t}$ is the personal income of residents in county i in year t. If the county is of medium size, then $PerIncM_{i,t}$ is the personal income of residents in that county plus the personal income of all the closest surrounding small sized counties. If the county is large, then $PerIncL_{i,t}$ is personal income of residents in that county plus the income of all residents in the closest surrounding small and medium size counties. The coefficient α_{15} is demand for retail employment created by each one million dollars of real value-added in county i. The coefficient α_{16} is demand for retail trade employment created by each one million dollars of personal income in each county. The coefficient α_{17} is demand for retail trade employment created in a medium size county by for each one million dollars of personal income by residents in the medium size county plus all the close surrounding small counties. The coefficient α_{18} is retail trade employment by created for each one million dollars of personal income in the large county plus that from all closest surrounding small and medium size counties. It is assumed that the share of total retail demand satisfied by specialized retail firms employment declines as the size class is increased, so $\alpha_{18} \angle \alpha_{17} \angle \alpha_{16}$.

The long-term impact of total real value added, an increase in personal income of the residents of small size class, medium size class, and large size class can be expressed as:

$$(4.34)\quad LTIP_9 = \left(\alpha_{15} \big/ 1-\omega_4 \right).$$

$$(4.35)\quad LTIP_{10} = \left(\alpha_{16} \big/ 1-\omega_4 \right).$$

$$(4.36)\quad LTIP_{11} = \left(\alpha_{17} \big/ 1-\omega_4 \right).$$

$$(4.37)\quad LTIP_{12} = \left(\alpha_{18} \big/ 1-\omega_4 \right).$$

In equation (4.34), $LTIP_9$ is the long-term impact of total real value added on retail trade employment, α_{15} is the coefficient of total real value added, ω_4 is the coefficient of a one year lag of retail trade employment or the time weighted distributed lag of retail trade geometric distributed lag model.

In equation (4.35), $LTIP_{10}$ is the long-term retail employment impact from each one million dollars of personal income of residents in given county, the coefficient α_{16} is the retail employment for each million dollars of real personal income in any county. The coefficient ω_4 is the time weighted geometric distributed lag.

In equation (4.36), $LTIP_{11}$ is the long-term retail employment created in a medium county by each one million dollars of personal income earned by residents in the medium and closest surrounding small counties. The coefficient α_{17} is the number of retail employees created in the medium size county for each one million of personal income in the medium and closest surrounding small counties. The coefficient ω_4 is the time weighted geometric distributed lag.

In equation (4.37), $LTIP_{12}$ is the long-term retail employment created in large counties for each one million in personal income earned in the large and closest surrounding medium and small counties. The coefficient ω_4 is the time weighted geometric distributed lag.

It is assumed the time-weighted geometric distributed lags of all independent variables are the same ω_4. Thus the mean geometric distributed lag can be expressed as:

$$(4.38) \quad ML = \left(\omega_4 / 1 - \omega_4 \right).$$

In equation (4.38), ML is the mean lag of retail trade employment and ω_4 is the time weighted distributed lag of retail trade employment.

4.6 THE ECONOMETRIC DISTRIBUTED LAG MODEL FOR FINANCE, INSURANCE AND REAL ESTATE (F.I.R.E) EMPLOYMENT

Finance, Insurance and Real Estate (F.I.R.E.) employment was assumed to depend on a one year lag of F.I.R.E. employment, the real value added of trade sectors, the real value added of non-trade sectors, and personal income. The Finance, Insurance, and Real Estate (F.I.R.E) can be expressed as:

$$(4.39) \quad Fire_{i,t} = \omega_5 Fire_{i,t-1} + \alpha_{19} TradeVadd_{i,t} + \alpha_{20} NonTradeVadd_{i,t} + \alpha_{21} PerInc_{1,t}.$$

In equation (4.39), $Fire_{i,t}$ is total employment in the Finance, Insurance and Real Estate sector, (F.I.R.E.) of county i in year t and $Fire_{i,t-1}$ its one year lag.

The variable $TradeVadd_{i,t}$ is real value-added by the trade sectors, $NonTradeVadd_{i,t}$ is real value-added of non-trade sectors in county i in year t. The variable $PerInc_{1,t}$ is the personal income of residents in the same county. The coefficient α_{19} is the demand for F.I.R.E employment created by a one million dollar increase in real value-added by the trade sectors. The coefficient α_{20} is demand for F.I.R.E. employment by each one million dollars of real value-added by the non-trade sectors. The coefficient α_{21} is demand for F.I.R.E. employment created for each one million dollars of personal income of residents in counties with a population size 50,000 or less.

The long-term impact by an increase in a one million of real value-added in trade sectors, non-trade sectors, and increase in one million dollars of personal income of residents in counties with a population size 50,000 or less on FIRE employment can be expressed as:

(4.40) $$LTIP_{15} = \left(\alpha_{19} / 1 - \omega_5 \right).$$

(4.41) $$LTIP_{16} = \left(\alpha_{20} / 1 - \omega_5 \right).$$

(4.42) $$LTIP_{17} = \left(\alpha_{21} / 1 - \omega_5 \right).$$

In equation (4.40), $LTIP_{15}$ is the long-term FIRE employment created by each one million dollars of real value added by the trade sectors. In equation (4.41), $LTIP_{16}$ is the long-term FIRE employment created by each one million dollars of real value-added by the non-trade sectors. In equation (4.42), $LTIP_{17}$ is the long-term FIRE employment created by each one million dollars of personal income of residents in counties with a population size 50,000 or less. All other terms are as described above.

Again, the time weighted geometric distributed lag, ω_5 is assumed to be the same for all independent variables. The mean lag of Finance, Insurance and Real Estate employment can be expressed as:

(4.43) $ML = \left(\omega_5 / 1 - \omega_5 \right)$. The term ω_5 is the time weighted geometric distributed lag.

4.7 THE ECONOMETRIC DISTRIBUTED LAG MODEL FOR SERVICES EMPLOYMENT

Services employment was assumed to depend on a one year lag of services employment, the real value added of trade sectors, the real value added of non trade sectors and population size classes. Counties in six-state study areas were classified by population size. There were two size classes: 1). counties with a population size of 50,000 or less were considered as small, 2) counties with a population size greater than 50,000 were considered as large.

The services employment model can be expressed as:

$$(4.44) \quad SerEmp_{i,t} = \omega_6\, SerEmp_{i,t-1} + \alpha_{22} TradeVadd_{i,t} + \alpha_{23}\, NonTradeVadd_{i,t} + \alpha_{24}\, PopS_{i,t} + \alpha_{25}\, PopL_{i,t}.$$

In equation (4.44), $SerEmp_{i,t}$ is the total services employment of county i in year t and $SerEmp_{i,t-1}$ is its one year lag. The variable $TradeVadd_{i,t}$ is the real value-added by the trade sectors and $NonTradeVadd_{i,t}$ is real value-added by the non-trade sectors. The variable $PopS_{i,t}$ is population of county i in year t and $PopL_{i,t}$ is the population in the large size county plus the population all the closest surrounding counties. The coefficient α_{22} is number of service employees in each county created by each one million dollars of real value-added by the trade sectors in that county. The coefficient α_{23} is the services employment created by each one million dollars of real value-added by the non-trade sectors. The coefficient α_{24} is the services employment created by each one thousand population. The coefficient α_{25} is the additional services employment created in large counties by each one thousand population in the large county plus the population of all the closest surrounding small counties.

The long-term impact of a unit change in each of the above independent variables on services employment can be expressed as:

(4.45) $LTIP_{20} = \left(\alpha_{22} / 1 - \omega_6 \right).$

(4.46) $LTIP_{21} = \left(\alpha_{23} / 1 - \omega_6 \right).$

(4.47) $LTIP_{22} = \left(\alpha_{24} / 1 - \omega_6 \right).$

(4.48) $LTIP_{23} = \left(\alpha_{25} / 1 - \omega_6 \right).$

In equation (4.45), $LTIP_{20}$ is the long-term change in service employment from a one million dollar increase in real value added by the trade sectors. In equation (4.46),

$LTIP_{21}$ is the long-term change in service employment from a one-million dollar change in real value added in the non trade sector. In equation (4.47), $LTIP_{22}$ is the long-term change a one thousand person change in the population. In equation (4.48), $LTIP_{23}$ is the long-term service employment in the large county caused by a one-thousand person population change in the large county or in the close surrounding smaller counties.

The mean lag of services employment can be expressed as:

$$(4.49) \quad ML = \left(\omega_6 \big/ 1 - \omega_6 \right).$$

In equation (4.49), ML is the mean geometric distributed lag of services employment.

4.8 THE ECONOMETRIC DISTRIBUTED LAG MODEL FOR CONSTRUCTION EMPLOYMENT

Construction employment was assumed to depend on a one year lag of construction employment, the real value of Gross State Product (GSP) and personal income classified by county population size. Counties with a population size 25,000 or less were considered as small. Counties with a population size greater than 25,001 were classified as large. Mathematically, construction employment model can be express as:

$$\begin{aligned}(4.50) \quad ConstEmp_{i,t} &= \omega_7 ConstEmp_{i,t-1} + \alpha_{26} TotalVadd_{i,t} \\ &+ \alpha_{27} PerIncS_{i,t} + \alpha_{28} PerIncL_{i,t}.\end{aligned}$$

In equation (4.50), $ConstEmp_{i,t}$ is the construction employment of county i, in year t and $ConstEmp_{i,t-1}$ is its one year lag. The variable $TotalVadd_{i,t}$ is the real value-added of county i, in year t. The variable $PerIncS_{i,t}$ is the personal income of county i, in year t. The variable $PerIncL_{i,t}$ is personal income of residents in the large county plus the closet surrounding small counties. The coefficient α_{26} is the number of construction employees in each county created by each one million dollars of real value-added. The coefficient α_{27} is the number of construction employees in each county created by one million dollars of personal income of the residents. The coefficient α_{28} is the number of construction employees created by one million dollars of personal income by residents in the large county plus the closest surrounding small counties.

The long term impact of a unit change in each of the above independent variables on construction employment can be expressed as:

$$(4.51) \qquad LTIP_{24} = \left(\alpha_{26} / 1 - \omega_7 \right).$$

$$(4.52) \qquad LTIP_{25} = \left(\alpha_{27} / 1 - \omega_7 \right).$$

$$(4.53) \qquad LTIP_{26} = \left(\alpha_{28} / 1 - \omega_7 \right).$$

In equation (4.51) $LTIP_{24}$ is the long-term impact of a change in construction employment from a one million dollar increase in real value-added. In equation (4.52) $LTIP_{25}$ is the long-term impact of a change in construction employment from a one million dollar change in personal income. In equation (4.53) $LTIP_{26}$ is the long-term impact change in construction employment from a one million dollar change in the large county plus the all the closest surrounding small counties.

The mean lag of construction employment can be expressed as:

(4.54) $$ML = \left(\omega_7 / 1 - \omega_7 \right).$$

In equation (4.54), ML is the mean lag of the geometric distributed lag of construction employment. The value ω_7 is the coefficient of a one year lag of construction employment.

4.9 THE ECONOMETRIC DISTRIBUTED LAG MODEL FOR MINING EMPLOYMENT

Mining employment was assumed to depend on a one year lag of mining employment, real value-added of the basic sectors, real value added of non-basic sectors, county population, the rest of the U.S manufacturing employment, and crude oil prices in term of dollars per barrel. The counties population was classified into three categories by population. Counties with a population size of 50,000 or less were considered as small. Counties with a population size greater than 50,000 were considered as large. The mining employment can be expressed as:

(4.55) $$\begin{aligned} MinEmp_{i,t} &= \omega_8 MinEmp_{i,t-1} + \alpha_{29} BaseVadd_{i,t} + \alpha_{30} NonBaseVadd_{i,t} \\ &+ \alpha_{31} RestUs + \alpha_{32} CrudeOilPrice_t + \alpha_{33} PopS_{i,t} + \alpha_{34} PopL_{i,t}. \end{aligned}$$

In equation (4.55), $MinEmp_{i,t}$ is the total mining employment of county i, in year t and $MinEmp_{i,t-1}$ is its one year lag. The variable $BaseVadd_{i,t}$ is real value-added by the basic sectors of county i in year t. The variable $NonBaseVadd_{i,t}$ is real value-added of non basic sectors of county i in year t. The variable $RestUs$ is the rest of the U.S mining employment. The variable $CrudeOilPrice_t$ is crude oil price in terms of dollars per barrel. The variable $PopS_{i,t}$ is population of county i in year t. The variable $PopL_{i,t}$ is population in the large size county plus population all the closest surrounding small counties. The coefficient α_{29} is number of mining employees in each county created by each one million dollars of real value-added of the basic sectors. The coefficient α_{30} is number of mining employees in each county created by each one million dollars of real value-added by the non-basic sectors. The coefficient α_{31} is number of mining employees in each county created by each mining job in the rest of the U.S. The coefficient α_{32} is number of mining employees in each county created by an increase of one dollar of crude oil price. The coefficient α_{33} is number of mining employees in each county created by each one thousand population. The coefficient α_{34} is the additional mining employment created in large counties by each one thousand population of the large county plus all the closest surrounding small counties.

The long term impact of a unit change in each of the above independent variables on mining employment can be expressed as:

(4.56) $$LTIP_{27} = \left(\alpha_{29} \big/ 1 - \omega_8 \right).$$

(4.57) $$LTIP_{28} = \left(\alpha_{30} \big/ 1 - \omega_8 \right).$$

(4.58) $$LTIP_{29} = \left(\alpha_{31} \big/ 1 - \omega_8 \right).$$

(4.59) $$LTIP_{30} = \left(\alpha_{32} \big/ 1 - \omega_8 \right).$$

(4.60) $$LTIP_{31} = \left(\alpha_{33} \big/ 1 - \omega_8 \right).$$

(4.61) $$LTIP_{32} = \left(\alpha_{34} \big/ 1 - \omega_8 \right)$$

In equation (4.56), $LTIP_{27}$ is the long-term impact of a change in mining employment from a one million dollar increase in the real value-added by the basic sectors. In equation (4.57), $LTIP_{28}$ is the long-term impact of a change in mining employment from a one million dollar increase in the real value-added by the non-basic sectors. In equation (4.58), $LTIP_{29}$ is the long-term impact of a change in mining employment created by each mining job in the rest of the U.S. In equation (4.59), $LTIP_{30}$ is the long-term impact of a change in mining employment from one dollar per barrel change in the price of crude oil. In equation (4.60), $LTIP_{31}$ is the long-term impact of a one thousand person change in population. In equation (4.61), $LTIP_{32}$ is the long-term mining employment in the large county caused by a one-thousand person population change in the large county or in the close surrounding smaller counties.

The mean lag of mining employment can be expressed as:

(4.62) $$ML = \left(\omega_8 \big/ 1 - \omega_8 \right).$$

In equation (4.62), ML is the mean lag of the geometric distributed lag of mining employment. The value ω_8 is the coefficient of a one year lag of mining employment.

4.10 THE ECONOMETRIC DISTRIBUTED LAG MODEL FOR TRANSPORTATION AND PUBLIC UTILITIES EMPLOYMENT

Transportation and public utilities employment was assumed to depend on a one year lag in transportation and public utilities, the real value-added, and population. Counties in the six-state study area were classified by population size. Counties with a population 5,000 or less were classified as small. Counties with a population size greater than 5,001 were classified as large. The transportation employment model can be expressed as:

(4.63) $$TranstEmp_{i,t} = \omega_9 TranstEmp_{i,t-1} + \alpha_{35} TotalVadd + \alpha_{36} PopS_{i,t} + \alpha_{37} PopL_{i,t}.$$

In equation (4.63), $TranstEmp_{i,t}$ is the total transportation and pubic utilities employment of county i, in year t and $TranstEmp_{i,t-1}$ is its one year lag. The variable $TotalVadd$ is the real value-added of county i in year t. The variable $PopS_{i,t}$ is the population of county i in year t. $PopL_{i,t}$ is the population in the large size county plus population all the close surrounding counties. The coefficient α_{35} is number of transportation and public utilities employees in each county created by each one million dollars of real value-added. The coefficient α_{36} is the transportation and public utilities employment created by each one thousand population. The coefficient α_{37} is the additional transportation and public utilities employment created in large counties by each thousand population of the large county plus the population of all the closest surrounding small counties.

The long-term impact of a unit change in each of above independent variables on transportation and public utilities employment can be expressed as:

(4.64) $LTIP_{33} = \left(\alpha_{35} \big/ 1 - \omega_9 \right).$

(4.65) $LTIP_{34} = \left(\alpha_{36} \big/ 1 - \omega_9 \right).$

(4.66) $LTIP_{35} = \left(\alpha_{37} \big/ 1 - \omega_9 \right).$

In equation (4.64), $LTIP_{33}$ is the long-term change in transportation and pubic utilities employment from a one million dollars increase in real value-added. In equation (4.65), $LTIP_{34}$ is the long-term change a one thousand person change in the population. In equation (4.66), $LTIP_{35}$ the long term transportation and public utilities employment in the large county caused by a one-thousand person population change in the large county or in the close surrounding smaller counties.

The mean lag of transportation and public utilities employment can be expressed as:

(4.67) $ML = \left(\omega_9 \big/ 1 - \omega_9 \right).$

In equation (4.67), ML is the mean lag of the geometric distributed lag of transportation and public utilities employment. The value ω_9 is the coefficient of a one year lag of transportation and public utilities employment.

4.11 THE ECONOMETRIC DISTRIBUTED LAG MODEL FOR GOVERNMENT EMPLOYMENT

Government employment was assumed to depend on a one year lag of government employment, the real value added, and population. In the six-state study area, counties with a population size 25,000 or less were considered as small. Counties with a population size greater than 25,000 were considered as large. The government employment model can be expressed as:

(4.68) $$GovtEmp_{i,t} = \omega_{10} GovtEmp_{i,t-1} + \alpha_{38} TotalVadd_{i,t} + \alpha_{39} PopS_{i,t} + \alpha_{40} PopL_{i,t}.$$

In equation (4.68), $GovtEmp_{i,t}$ is the total government employment of county i in year t and $GovtEmp_{i,t-1}$ is its one year lag. The variable $TotalVadd_{i,t}$ is real value-added of county i in year t. The variable $PopS_{i,t}$ is the population of county i in year t. The variable $PopL_{i,t}$ is the population in the large size county plus the population in all the close surrounding counties. The coefficient α_{38} is number of government employees in each county created by each one million dollars of real value-added. The coefficient α_{39} is government employment created by each one thousand population. The coefficient

α_{40} is the additional government employment created in large counties by each one thousand population of the large county plus all the closest surrounding small counties.

The long-term impact of a unit change in each of above independent variables on government employment can be expressed as:

$$(4.69)\qquad LTIP_{36} = \left(\alpha_{38} \middle/ 1-\omega_{10} \right).$$

$$(4.70)\qquad LTIP_{37} = \left(\alpha_{39} \middle/ 1-\omega_{10} \right).$$

$$(4.71)\qquad LTIP_{38} = \left(\alpha_{40} \middle/ 1-\omega_{10} \right).$$

In equation (4.69), $LTIP_{36}$ is the long-term change in government employment from a one million dollar increase in real value-added. In equation (4.70), $LTIP_{37}$ is the long term change caused by a one thousand person change in the population. In equation (4.71), $LTIP_{38}$ is the long term government employment in the large county caused by a one-thousand person population change in the large county or in the close surrounding smaller counties.

The mean lag of government employment can be expressed as:

$$(4.72)\quad ML = \left(\omega_{10} \middle/ 1-\omega_{10} \right).$$

In equation (4.72), ML is the mean lag of the geometric distributed lag of government employment. The value ω_{10} is the coefficient of a one year lag of transportation and public utilities employment.

CHAPTER V

RESULTS AND DISCUSSION

5.1 DEMAND FOR AGRICULTURAL SERVICES EMPLOYMENT

Table 5.1 displays the results of the pooled time-series cross-section regression demand for agricultural services employment in the 222 counties of the six-state study area over the 24-year period from 1977 through 2000.

Table 5.1 The Estimated Regression for Agricultural Services Employment Demand Classified by the Size Classes of County Population. Model Included A One Year Lag of Dependent Variable.

	Dependent Variable	
	Agricultural Services Employment	
Variable	Coefficient	T Value
AgserEmp t-1	0.568577	(77.5)***
TCS	0.087	(16.5)***
TCL	0.009	(6.1)***
PerIncS	0.047	(34.6)***
PerIncL	0.0003	(0.8)
R-square		0.92
Number of Observations		5,327

*** Indicated Coefficient is Statistically Significant at 99 % Level

AgserEmp t-1 represents a one year lag of agricultural services employment.

TCS represents total cash receipts from livestock and crops of all counties in millions of constant dollars.

TCL represents total cash receipts from livestock and crops in the large county (more than 10,000 population) plus all total cash receipts in the closest surrounding small size counties.

PerIncS represents personal income of residents in all counties in terms of one million of constant dollars.

PerIncL represents personal income of residents in the large county plus all personal income in the closest surrounding small counties. Counties with a population size more than 10,000 were considered as large.

Table 5.1 displays the results of agricultural services employment demand following the geometric distributed lag form of equation 4.18. The R-square was 0.92 and all estimated coefficients were statistically significant at the 99 percent level except for the coefficient of PerIncL which represents personal income of residents in the large county plus all personal income in the closest surrounding small counties. It is possible to consider of the multicollinearity between a one year lag of agricultural services employment and personal income of residents in the large county plus the closest surrounding small counties. The SAS 9.1 version of PROC CORR, gave a Pearson correlation coefficient of .79 between the one year lag in agricultural services employment and the variable PerIncL. This was interpreted as multicollinearity between those variables.

Table 5.2 Pearson Correlation Coefficients Matrix of a One Year Lag of Agricultural Services Employment and Personal Income of residents in the Large County Plus the Closest Surrounding Counties

	AgserEmpt-1	PerIncL
AgserEmpt-1	1.00	0.794
PerIncL	0.794	1.000

The authors Greene (2003), Studenmund (1996), Gujarati (1988), Gujarati (1999), and Pindyck (1976), suggested testing the severity of multicollinearity by evaluating the size of Variance Inflation factors. Studenmund stated that:

> "One measure of severity of multicollinearity that is easy to use and that is gaining in popularity is the variance inflation factor. The variance inflation factor (VIF) is a method of detecting the severity of multicollinearity by looking at the extent to which a given explanatory variable can be explained by all other explanatory variables in equation"

Following Studenmund (1996), the auxiliary regression of agricultural services employment model in order to calculate the variance inflation factor was estimated from the following regression:

$$(5.1) \quad AgsEmp_{i,t-1} = \alpha_1 TCS_{i,t} + \alpha_2 TCL_{i,t} + \alpha_3 PerIncS_{i,t} + \alpha_4 PerIncL_{i,t}.$$

The coefficient of determination (the unadjusted R-square) of equation (5.1) was used to calculate the variance inflation factor by the following formula:

$$(5.2) \qquad VIFs = 1 / \left(1 - R^2\right).$$

In equation (5.2) the coefficient of determination was given by equation (5.1). The results of equation (5.1) were shown in Table 5.3 with the coefficient of determination 0.724. The calculated variance inflation factor was 3.57. Following Studenmund (1996), a common rule of thumb is that if the variance inflation factor is greater than 5 then the multicollinearity is severe.

The calculated variance inflation factor (resulted from equation 5.2) was 3.5 meaning that the multicollinearity is "not" severe. Economists have suggested several ways to remedy the multicollinearity problem for example:

- Do nothing
- Drop one or more of the multicollinearity variables
- Transform the multicollinearity variables
- Increase the size of sample

Gujarati (1999) stated that "collinearity per se may not be bad". He also stated that:

> "Multicollinearity happened because most of economic data are not obtained in controlled laboratory experiments. Data on variable such as the gross national product (GNP), prices, employment, unemployment, profits, dividends, ect. are usually observed as they occur and not obtained experimentally. If data could be obtained experimentally, to begin with, we would not allow collinearity to exist. Since data are usually obtained nonexperimentally, and if there is near collinearity in two or more explanatory variables, often we are in the statistical position of not being able to make bricks without straw."

There are 5,328 observations which are sufficient to remedy the multicollinearity problem and allow the estimation. It is a trade-off where one of two independent variables would be dropped out. A one year lag of agricultural services employment was dropped from the model. The variable PerIncL, which is the sum of income in the large county and the closest surrounding small counties is still in the model. The final agricultural services employment demand can be expressed by equation 5.3 and the results were shown in Table 5.4. The R-square decreased from 0.92 to 0.84. All of estimated coefficients were statistically significant at 99 percent level.

$$(5.3) \quad AgsEmp_{i,t} = \alpha_1 TCS_{i,t} + \alpha_2 TCL_{i,t} + \alpha_3 PerIncS_{i,t} + \alpha_4 PerIncL_{i,t}.$$

Table 5.3 The Estimated Regression for Agricultural Services Employment Demand Classified by the Size Classes of County Population.

	Dependent Variable	
	A One Year lag of Agricultural Services Employment	
Variable	Coefficient	T Value
TCS	0.227	(23.8)***
TCL	0.011	(3.7)***
PerIncS	0.095	(42.8)***
PerIncL	0.001	(2.3)*
R-square		0.73
Number of Observations		5,327

*** Indicated Coefficient is Statistically Significant at 99 % Level
* Indicated Coefficient is Statistically Significant at 95 % Level
AgserEmp t-1 represents a one year lag of agricultural services employment.
TCS represents millions of livestock and crop receipts in each county.
TCL represents total cash receipts from livestock and crops in the large county plus all total cash receipts in the closest surrounding small size counties. Counties with a population size more than 10,000 were considered as large.
PerIncS represents personal income of residents in all counties in terms of one million of constant dollars.
PerIncL represents personal income of residents in the large county plus all personal income in the closest surrounding small counties. Counties with a population size more than 10,000 were considered as large. This variable is zero in counties with 10,000 or fewer persons.

Table 5.4 The Estimated Regression for Agricultural Services Employment Demand Classified by the Size Classes of County Population

	Dependent Variable	
	Agricultural Services Employment	
Variable	Coefficient	T Value
TCS	0.217071	(29.1)***
TCL	0.015938	(6.9)***
PerIncS	0.102237	(58.7)***
PerIncL	0.001201	(2.3)***
R-square		0.84
Number of Observations		5,328

*** Indicated Coefficient is Statistically Significant at 99 % Level
All variables are as defined in Table 5.3

The Final Model for Agricultural Services Employment

The coefficient for TCS **(Table 5.4)** shows that each one million dollars of cash receipts from livestock and crops creates 0.22 Agricultural Service jobs of type that can be found in any county. The coefficient for TCL shows that each one million dollars in agricultural receipts creates an additional 0.02 agricultural services sector jobs of the type found in counties with a population of more than 10,000. The coefficient for PerIncS means that each one million dollars in personal income earned by rural and urban residents generates 0.102 jobs of the type that can be found in any county. The coefficient for PerIncL means that each one million dollars of personal income generates an additional demand for 0.001 agricultural service workers of the type that can be found in the large counties with a population of 10,000 or more. The demand related to the change in personal income is presumed to be for landscape and horticultural services though this cannot be verified. It is presumed the agricultural services demand by agricultural producers is for soil preparation services, crop services, and veterinary services. Personal income is one of the proxies to measure the demand for agricultural service employment for household items in counties in the study area. The t-values were statistically significant at 99 percent level. The R-square was 0.84.

5.2 MANUFACTURING EMPLOYMENT

Demand for manufacturing employment was assumed to depend on a one year lag of manufacturing employment, cash receipts from crops, feed purchases, the number of fed cattle slaughtered, the real value-added, as well as the rest of the U.S manufacturing employment. The model was estimated in form of geometric distributed lag which was expressed in equation 4.23. The results are displayed in Table 5.5.

Table 5.5 The estimated Regression for Manufacturing Employment Demand of the Six-State Study Area Included A One Year Lag of Manufacturing Employment

	Dependent Variable	
	Manufacturing Employment	
Variable	Estimated Coefficients	T-Value
MnftEmp t-1	0.3736	(50.7)***
CropCash Rect	2.4101	(1.5)
Feed Purchases	8.2054	(3.9)***
Fed Cattle	0.4174	(2.9)***
TotVdd	2.1247	(85.8)***
Rest US Mnft	0.000010065	(4.3)***
R-square		0.64
Number of Observations		5,328

***Indicated Coefficient is Statistically Significant at 99 % level
MnftEmp t-1 represents a one year lag of manufacturing employment
CropCashRect represents crops cash receipts in millions of constant dollars
Feed Purcahse represents the feed purchases in millions of constant dollars
Fed Cattle represents fed cattle slaughtered in thousands of head
TotVadd represents the total real value-added in millions of constant dollars
RestUSMnft represents the rest of the U.S manufacturing employment

All estimated coefficients were of the expected sign and statistically significant at 99 percent level except for the coefficient of cash receipts from crops. The Pearson correlation coefficient between cash receipts from crops and a one year lag in manufacturing was negative but is very small (Table 5.6), which is counter to expectations.

Table 5.6 Pearson Correlation Coefficients Matrix of a One Year Lag of Manufacturing Employment and Cash Receipts from Crops

	MnftEmpt-1	CropCashRect
MnftEmpt-1	1.00	-0.01038
CropCashRect	-0.01038	1.000

It is difficult to choose one of two independent variables (a one year lag of manufacturing employment or cash receipts from crops) in manufacturing employment demand model. Based on USDA information, the main crops are feed grains and wheat (Figure 1.4). Much of the former is used as the raw material for animal feed manufacturing. Logically, there should be an impact on manufacturing employment though most machinery is imported from other regions of the US. So, the variable a one year lag of manufacturing employment was dropped out from the model. The final model of manufacturing employment can be expressed as equation 5.4 and the results are shown in Table 5.7. All estimated coefficients are statistically significant at 99 percent level. The R-square dropped from 0.64 to 0.59.

$$(5.4)\quad MnftEmp_{i,t} = \alpha_5 CropCashRect_{i,t} + \alpha_6 FeedPurchase_{i,t} + \alpha_7 FedCattle_{i,t} + \alpha_8 TotVadd_{i,t} + \alpha_9 RestUsMnf_{i,t}$$

The Final Manufacturing Employment (Table 5.7)

Final Manufacturing employment demand was assumed to depend on cash receipts from crops, feed purchases, number of fed cattle slaughtered, the real output, rest of the U.S manufacturing employment. Counties with more than 500 manufacturing employees were considered large. Counties with less than 500 manufacturing employees were considered small.

In the large counties, the total manufacturing employment was disaggregated into non-durable manufacturing employment and durable manufacturing employment. The model assumed that cash receipts from crops, feed purchases, and the number of fed cattle slaughtered explain the demand for non-durable manufacturing employment. Real output or Gross State Product (GSP) in the county and the rest of the U.S manufacturing employment were assumed to explain the demand for durable manufacturing employment.

For the small counties, cash receipts from crops, feed purchases, real output and the rest of the U.S manufacturing were assumed to determine the demand for total manufacturing employment. Table 5.7 displays the results of regression model.

Table 5.7 displays the results of manufacturing employment regression. A one million dollar increase in crop cash receipts would create 4.53 jobs in manufacturing sector. An increase of one million dollars of feed purchases would create 7.63 jobs in manufacturing sector. An increase of one thousand fed cattle slaughtered would create 0.44 jobs in manufacturing sector. An increase of one million dollars in total real value-added would create 2.38 jobs in manufacturing sector. According to the results of the model, the rest of the U.S manufacturing employment has a tiny impact on manufacturing employment each county of the six-state study area.

Table 5.7 The Estimated Regression for Manufacturing Employment Demand of the Six-State Study Area

	Dependent Variable	
	Manufacturing Employment	
Variable	Estimated Coefficients	T-Value
CropCash Rect	4.53053	(2.5)***
Feed Purchases	7.6324	(3.2)***
Fed Cattle	0.4324	(2.5)***
TotVdd	2.3740	(83.4)***
Rest US Mnft	0.000038524	(14.4)***
R-square		0.59
Number of Observations		5,328

***Indicated Coefficient is Statistically Significant at 99 % level
CropCashRect represents crops cash receipts in millions of constant dollars
Feed Purcahses represents the feed purchases in millions of constant dollars
Fed Cattle represents fed cattle slaughtered in thousands of head
TotVadd represents the total real value-added in millions of constant dollars
RestUSMnft represents the rest of the U.S manufacturing employment

Each manufacturing job in the rest of the U.S creates 0.000038 jobs in the six-state study area. All t-values were statistically significant at 99 percent level. The R-square was 0.59.

5.3 Wholesale Trade Employment

It was assumed that counties with more than 5,000 wholesale employees also serve as major supply sources or trade centers to retail firms in the large county and to the closest medium and small counties. Counties with 1,000 to 5,000 wholesale employees serve as intermediate trade centers to smaller counties. Table 5.8 displays the results of geometric distributed lag model for wholesale trade. An increase in one job of wholesale trade in the previous year would create wholesale trade employment by 0.370 jobs in the present year.

Table 5.8 The Results of Geometric Distributed Lag Model for Wholesale Trade Employment

	Dependent Variable	
	Wholesale Trade Employment	
Variable	Estimated Coefficient	T-Value
$WholesaleEmp_{t-1}$	0.370	(52.6)***
BaseRealVadd	0.383	(11.4)***
NonBaseRealVadd	0.409	(12.7)***
RetailEmpS	0.043	(9.0)***
RetailEmpM	0.017	(13.8)***
RetailEmpL	0.012	(28.1)***
R-square		0.97
Number of Observations		5,328

***Coefficient is statistically significant at 99 %
$WholesaleEmp_{t-1}$ represents a one year lag of wholesale trade employment
BaseRealVadd represents million dollars of Real Value Added by the Basic Sectors in each county of the six-state study area. The Basic sectors include agricultural services, manufacturing and mining.
NonBaseRealVadd represents million dollars of Real Value Added by the Non-Basic Sectors in each county of the six-state study area. The Non-Basic sectors include construction, transportation and public utilities, wholesale trade, retail trade, finance, insurance and real estate and government.
RetailEmpS is the number of retail trade employees in each county and year.
RetailEmpM is the number of retail trade employees in the medium size county plus retail trade employees all the close surrounding small counties. Counties with 1,000 or fewer retail trade employees were considered as small. Counties with 1,001 to 5,000 retail trade employees were considered medium.
RetailEmpL represents the number of retail employees in the large county plus all retail employees in the closest surrounding small and medium size counties. Counties with more than 5,000 retail employees were considered as large.

An increase of one million dollars in real value added in the basic sector would create 0.383 jobs in wholesale trade sector. A one million dollars increase in real value-added of non-basic sector would create 0.409 jobs in wholesale trade sector. An increase of one hundred retail trade jobs sector in any county would create 4.30 jobs in wholesale trade sector. An increase in one hundred retail trade jobs in the medium county plus the closet surrounding small counties create would create 1.70 jobs in wholesale trade sector or the medium size county. An increase in one hundred retail trade jobs in the large county plus the closest surrounding small and medium sized counties would create 1.2 jobs in the wholesale trade sector in the large county (Table 5.8).

Table 5.9 The Long-Term Impact of Real Value of Basic Sectors, Non-Basic Sectors and The Size Classes of Retail Employees on Wholesale Trade Employment

	Dependent Variable
Variable	Wholesale Trade Employment
BaseRealVadd	0.608
NonBaseRealVadd	0.649
RetailEmpS	0.069
RetailEmpM	0.027
RetailEmpL	0.018
Mean Lag	0.587

BaseRealVadd represents million dollars of real value added by the basic sectors in each county of the six-state study area.
NonBaseRealVadd represents millions of real value added by the non-basic sectors.
RetailEmpS represents the number of retail trade employees in each county.
RetailEmpM represents the number of retail trade employees in the medium size county plus retail trade employees all the close surrounding small counties. Counties with the number of retail trade employees from 1,001 to 5,000 were considered medium.
RetailEmpL represents the number of retail employees in the large county plus all retail employees in the closest surrounding small and medium size counties. Counties with more than 5,000 retail employees were considered as large.
Mean Lag was defined as a time-weighted average of the individual lag weights, or $\omega/(1-\omega)$.

Each one hundred retail jobs in large, medium, or small counties, create 1.20 jobs in the wholesale trade sector of the large county. Each one million dollars of real value added by the non-basic sectors create 0.49 jobs in the wholesale trade sector. The coefficients were statistically significant at 99 percent level and the R square was 0.97.

The long-term impact of a one million dollar increase in real value-added by the basic sectors would create 0.61 jobs in wholesale trade sector while an increase of one million dollars in the real value-added by the non-basic sectors would create 0.65 jobs. Both the basic and non-basic sectors have almost the same long-term impact on wholesale trade sector employment. The long-term impact caused by an increase of one hundred jobs in retail trade sector of small counties, would create 6.90 jobs in wholesale trade sector. The long-term impact of a one hundred job increase in the retail trade sector of medium counties would create 2.70 wholesale trade sector jobs in the medium size counties. The long-term impact of a one hundred job increase in the retail trade sector in large counties would create 1.80 jobs in wholesale trade employment in the large counties. According to the mean lag, half of the total impact by a one million dollar increase in real value-added of basic and non basic sectors would be felt in 0.587 year, (Table 5.9).

5.4 RETAIL TRADE EMPLOYMENT

Retail trade employment was assumed to depend on a one year lag of retail trade employment, the real output as well as personal income of residents in different size counties. Table 5.10 displays the results of regression model. The time-series cross-sectional procedure was used to estimate the model. There were 5,238 observations. A one job increase in retail trade in the previous year would create 0.382 jobs in retail trade sector in the present year.

Table 5.10 The Results of The Geometric Distributed Lag Model for Retail Trade Employment

	Dependent Variable	
	Retail Trade Employment	
Variable	Estimated Coefficient	T-Value
RetailEmp $_{t-1}$	0.382	(60.2)***
TotalRealVadd	2.445	(45.4)***
PerIncS	0.450	(14.1)***
PerIncM	0.048	(3.2)***
PerIncL	0.022	(3.7)***
R-square		0.98
Number of Observations		5,238

***Coefficient is statistically significant at 99 %

RetailEmp $_{t-1}$ represents a one year lag of retail trade employment

TotalRealVadd represents the total real value added in terms of one million of constant dollars. Total real value-added was calibrated by summing the real value-added from the agricultural services, mining, construction, manufacturing, transportation and public utilities, wholesale trade, retail trade, finance, insurance and real estate and government sectors.

PerIncS represents the personal income of all residents in the county.

PerIncM represents the personal income of residents in medium size county plus income of residents all the close surrounding small size counties. Counties with a population size 10,000 or less were considered as small. Counties with a population size from 10,001 to 50,000 were considered as medium.

PerIncL represents the personal income of residents in the large size county plus all personal income of residents in the closest surrounding small and medium size counties, counties with a population size more than 50,000 were considered as large.

A one million dollar increase in the total real value added of all counties would create 2.445 jobs in retail trade sector. A one million dollar increase of personal income would create 0.45 jobs in retail trade sector in any county. A one million dollar increase in the personal income of residents in the medium size county or the close surrounding small counties would create 0.04 jobs in retail trade sector of the medium counties. It is assumed that the more basic goods are found in small and medium size counties. It is likely that consumers in surrounding small size counties come to medium size county for shopping in closest medium size county. So, demand for retail trade employment in a medium size class included part of demand for retail trade employment of the close surrounding small counties.

The demand for retail trade employment created by a one million dollar increase in personal income of residents in the large size county plus all personal income in the closest surrounding small and medium size counties would create 0.02 jobs in retail trade sector. It is assumed that the basic goods for living such as grocery stores can be found in any county. It is likely that consumers in the close surrounding medium size counties come to the large county for purchasing goods which are not found in the medium size county such as specialized machinery, jewelry, electronics, and automobiles. Similarly, consumers in the closest surrounding small size counties come to medium size counties and/or the large county. So, demand for retail trade employment of the large county included part of retail trade employment of the residents in the closest surrounding small and medium size counties. The T values were statistically significant at 99 percent level. The R-square was 0.98.

The long-term impact by an increase of one million dollars in total real value added would create about 4 jobs in retail trade sector. The long-term impact of one million dollar increase in personal income in a county would create 0.76 jobs.

Table 5.11 The Long-Term Impact of The Total Real Value Added, Personal Income by Size Classes of Retail Trade Employment*

	Dependent Variable
Variable	Retail Trade Employment
TotalRealVadd	3.956
PerIncS	0.728
PerIncM	0.078
PerIncL	0.036
Mean Lag	0.618

*The long-term impact of independent variables on retail trade employment was approached by geometric distributed lag model
TotalRealVadd is in millions of constant dollars. Total real value-added was calibrated by summing the real value-added of the following sectors: agricultural services, mining, construction, manufacturing, transportation and public utilities, wholesale trade, retail trade, finance, insurance and real estate and government sector.
PerIncS is millions of personal income of residents in each county and year.
PerIncM is millions of personal income of residents in medium size county plus income of residents all the close surrounding small size counties. Counties with a population size 10,000 or less were considered as small. Counties with a population size from 10,001 to 50,000 were considered as medium.
PerIncL is millions of personal income of residents in the large size county plus all personal income of residents in the closest surrounding small and medium size counties, counties with a population size more than 50,000 were considered as large.
Mean Lag was defined as a time-weighted average of the individual lag weights, or $\omega/(1-\omega)$, where ω is the coefficient of a one-year lag of dependent variable and it is assumed all independent variables have the same time-weight lag.

The long-term impact by an increase in one million dollars of residents in medium sized class county plus all the close surrounding small counties would create 0.078 jobs in retail trade sector. The long term impact of a one million dollars increase income of residents in the large county plus income of all the closest surrounding small and medium size counties would create 0.036 jobs in retail trade sector of the large county. According to the mean lag, half of the total impact by an increase in one million dollars of total real value added would felt in 0.618 year (Table 5.11).

5.5 FINANCE INSURANCE AND REAL ESTATE (F.I.R.E) EMPLOYMENT

Finance, insurance and Real Estate (F.I.R.E) employment was assumed to depend on a one year lag of F.I.R.E employment, real output of trade sector, real output of non-trade sector as well as personal income.

Table 5.12 The Results of The Geometric Distributed Lag Model for Finance, Insurance, and Real Estate (F.I.R.E) Employment

	Dependent Variable	
Variable	F.I.R.E Employment	
	Estimated Coefficient	T-Value
$FireEmp_{t-1}$	0.504	(68.6)***
TradeVadd	3.933	(12.2)***
NonTradeVadd	0.688	(10.4)***
PerIncS	0.00002	(4.1)***
R-square		0.94
Number of Observations		5,328

***Coefficient is statistically significant at 99 %
$FireEmp_{t-1}$ represents a one year lag of finance, insurance and real estate employment
TradeVadd represents millions of the real value added of the wholesale and retail trade sectors of each county.
NonTradeVadd is millions of real value of the non-trade sectors in each county. Non-trade value added is millions of the sum of real value added in the following sectors: agricultural services, mining, construction, transportation and public utilities, finance, insurance, and real estate, services, and government sector.
PerIncS represents the millions of personal income of residents in each county.

Table 5.12 displays the results of the finance, insurance, and real estate employment estimation by the SAS time-series and cross-sectional procedure. There were 5,328 observations. A one job increase in the F.I.R.E. sector in the previous year would create 0.5 jobs in the F.I.R.E sector in the present year. A one million dollars increase in real value added of trade sector would create about 4.0 jobs in the F.I.R.E. sector. A one million dollar increase in the real value in the non-trade sector would create 0.7 jobs in F.I.R.E sector. A one million dollar increase in personal income of residents would create 0.00002 jobs in F.I.R.E sector. The coefficients of all estimated coefficients were statistically significant at 99 percent level. The R-square was 0.94.

The independent variables where personal income was aggregated by county population were not statistically significant or gave coefficients of the wrong sign.

Table 5.13 The Long-Term Impact of Change in the Real Value Added by Trade Sectors, Non-Trade Sectors and in Personal Income on Finance, Insurance, and Real Estate (F.I.R.E) Employment*

	Dependent Variable
Variable	F.I.R.E Employment
TradVadd	7.932
NonTradeVadd	1.387
PerIncS	0.00005998
Mean Lag	1.016

*The long-term impact of independent variables on F.I.R.E employment was approached by geometric distributed lag model
TradeVadd is millions of real value added of trade sectors in each county. Trade value-added is sum of the real value added of wholesale trade and retail trade sector.
NonTradeVadd represents the millions of real value added by the non-trade sectors in each county. Non-trade value added is sum of the real value added of the following sectors: agricultural services, mining, construction, transportation and public utilities, finance, insurance, and real estate, services, and government sector.
PerIncS represents the personal income of residents in each county.
Mean Lag was defined as a time-weighted average of the individual lag weights, or $\omega/(1-\omega)$, where ω is the coefficient of a one-year lag of dependent variable.

A one million dollar increase in the real value-added in the trade sectors would create about 8 jobs in F.I.R.E sector in the long run. In the long term, a one million dollar increase in the non-trade sector would create about 1.5 jobs in F.I.R.E sector. The long term effect of a one million dollar increase in the personal income by residents in each county is the creation of .00006 jobs in the F.I.R.E sector. The mean lag indicates that half of the total impact of the above changes would felt in 1.016 year (Table 5.13)

5.6 SERVICES EMPLOYMENT

Services employment was assumed to depend on a one year lag of services employment, millions of real value-added by the trade sectors, the non-trade sectors, and the county's population. Table 5.14 displays the results of regression model for services employment.

Table 5.14 The Results of The Geometric Distributed Lag Model for Services Employment

	Dependent Variable	
	Services Employment	
Variable	Estimated Coefficient	T-Values
$ServicesEmp_{t-1}$	0.551	(80.1)***
TradeVadd	6.975	(6.9)***
NonTradeVadd	2.404	(11.7)***
PopulationS	3.059	(9.6)***
PopulationL	0.397	(2.2)***
R-square		0.94
Number of Observations		5,328

***Coefficient is statistically significant at 99 %

$ServicesEmp_{t-1}$ represents a one year lag of services employment

TradeVadd represents millions of real value added by the wholesale trade and retail trade sectors.

NonTradeVadd represents the millions of real value added by the non-trade sectors. The Non-trade sectors are agricultural services, mining, construction, manufacturing, transportation and public utilities, finance, insurance and real estate, and government sector.

PopulationS represents population in all counties for given county and year.

PopulationL represents population in the large size county plus population in all the close surrounding small counties. Counties with a population size more than 50,000 were considered as large.

The model was estimated by the time-series and cross-sectional procedure. There were 5,328 observations. An increase of one job of services sector in the previous year would create 0.55 jobs of services sector in the present year. A one million dollar increase in the real value-added by the trade sectors would create about 7 jobs in services sector. A one million dollar increase in the non-trade sector would create about 2.5 jobs in services sector.

A one thousand person increase in a county's population would create 3.059 jobs in services sector. A one thousand person increase in a county's population in the large size county plus all the close surrounding small counties would create 0.397 jobs in the services sector of the large county. The estimation assumes that the basic services in small counties such as hotels and lodging places can be found in the large counties. However there are specialized professional services which are not found in the small counties. Thus consumers in the close surrounding small counties come to the large county for these services. Thus, it is assumed that demand for services employment in the large county includes part of demand for services employment of all the close surrounding small counties. The T values of the estimated coefficients were statistically significant at 99 percent level. The R-square was 0.94.

Table 5.15 The Long-Term Impact of The Real Value Added of Trade Sectors, Non-Trade Sectors and The Size Class of Population on Services Employment*

	Dependent Variable
Variable	Services Employment
TradVadd	15.532
NonTradeVadd	5.355
PopulationS	6.813
PopulationL	0.886
Mean Lag	1.227

*The long-term impact of the independent variables on services employment was derived by geometric distributed lag model
TradeVadd represents millions real value added by the trade sector.
NonTradeVadd represents millions of real value by the non-trade sectors.
PopulationS represents population in each county and year.
PopulationL represents population in a large size county plus population all the close surrounding small size counties. Counties with a population size more than 50,000 were considered as large.
Mean Lag was defined as a time-weighted average of the individual lag weights, or $\omega/(1-\omega)$, where ω is the coefficient of a one-year lag of dependent variable.

A one million dollar increase in the real value added of the trade sectors would create about 16 jobs in services sector, while the long-term impact of a one million dollar increase in the real value added by the non-trade sector would create about 6 jobs in services sector. In the long term, a one thousand person increase in a county's population would create 7 jobs in services sector. The long term impact of an increase one thousand of residents in large size county plus all the close surrounding small counties would create one additional job in the services sector of the large county. The calculated mean lag indicates that half of the total impact would felt in 1.3 years (Table 5.15).

5.7 CONSTRUCTION EMPLOYMENT

Construction employment was assumed to depend on a one year lag in construction employment, the real value-added, as well as personal income of the residents in different size classes. Table 5.16 displays the results of regression model.

Table 5.16 The Estimated Regression For Construction Employment Demand Classified by the Size Class of County Population.

	Dependent Variable	
	Construction Employment	
Variable	Coefficient	T Value
ConstEmp t-1	0.4289	(56.4)***
TotalVadd	0.6565	(32.7)***
PerIncS	0.0975	(15.5)***
PerIncL	0.0104	(4.5)***
R-square		0.95
Number of Observations		5,328

*** Indicated coefficient is statistically significant at 99 %
ConstEmp t-1 represents a one year lag of construction employment
TotalVadd represents millions of real value added in the county.
PerIncS represents millions of personal income of residents in each county.
PerIncL represents millions of personal income of residents in the large county plus the closet surrounding small size counties. Counties with a population size 25,000 or less were considered as small.

Table 5.16 displays the results of the estimated regression for construction employment. The time-series and cross-sectional procedure was used for estimated model. There were 5,328 observations. A one job increase in the previous year would create 0.428 jobs in construction in the present year. A one million dollars increase in the real value-added or GSP in a county would create 0.656 jobs in construction sector. A one million dollar increase in personal income would create 0.0975 jobs in the construction sector in that county. A one million dollar increase in personal income of residents in the large size county or the close surrounding small counties would create 0.0104 jobs in construction sector of the large county. It is likely that the basic construction business such as building construction by general constructions or operative builders and always found in small counties, but the special construction operations which operate by larger construction companies are more likely to be located in a large county or Metropolitan Statistical Areas (MSAs). These companies serve customers not only in the large county but also in the close surrounding counties. All estimated coefficients were statistically significant at 99 percent level. The R-square was 0.95.

Table 5.17 The Long-Term Impact of The Real Value Added, and Personal Income Classified by The Size Class of County Population on Construction Employment*

	Dependent Variable
Variable	Construction Employment
TotalVadd	1.149
PerIncS	0.171
PerIncL	0.182
Mean Lag	0.751

*The long-term impact of independent variables on construction employment was approached by geometric distributed lag model
TotalVadd represents the real value added in terms of one million of constant dollars
PerIncS represents personal income of residents in all counties in terms of one million of constant dollars
PerIncL represents personal income of residents in the large county plus the closet surrounding small size counties. Counties with a population size 25,000 or less were considered as small. Counties with a population size greater than 25,001 were considered as large. .PerIncL is also in terms of one million of constant dollars
Mean Lag was defined as a time-weighted average of the individual lag weights, or $\omega/(1-\omega)$.

A one million dollar increase in the real value-added of any county would create 1.15 jobs in construction sector. The long-term impact of a one million dollar increase in the personal income of a county's residents would create 0.17 jobs in construction sector. The long-term impact of an increase of one million dollar in personal income of residents in the large county plus all the closest surrounding small counties would create 0.182 jobs construction sector of the large county. Given the mean lag, half of the total impact would felt in 0.75 year (Table 5.17).

5.8 MINING EMPLOYMENT

Mining employment was assumed to depend on a one year lag by itself, real value added of the basic sectors, real value-added of non-basic sectors, the rest of the U.S. mining employment, population. Table 5.18 displays the results of regression model.

Table 5.18 The Estimated Regression Results For Mining Employment Demand Classified by County Population.

	Dependent Variable	
	Mining Employment	
Variable	Coefficient	T Value
MinEmp t-1	0.775	(161.1)***
BaseRealVadd	1.4817	(46.7)***
NonBaseRealVadd	0.4911	(21.8)***
CrudeOilPrice	3.0140	(4.2)***
RestUS	-0.00000185	(-2.5)
PopS	-9.2805	(-26.4)
PopL	-0.31151	(-1.7)
R-square		0.96
Number of Observations		5,328

*** Indicated coefficient is statistically significant at 99 %
MinEmp t-1 represents a one year lag of mining employment
PopS represents thousands of population in county i and year t.
PopL represents thousands of population in the large county plus the closest surrounding small counties. Counties with a population size 50,000 or less were considered as small.
BaseRealVadd represents millions of real value added in the base sectors.
NonBaseRealVadd represents millions of real value-added by the non-base sectors.
CrudeOilPrice represents crude oil price (dollars per barrel).

The results of regression model for mining employment displays three estimated coefficients (the rest of the U.S mining employment, county population, and population in the large county plus the closest surrounding small counties) were not statistically significant. Two of variables (the rest of the U.S mining employment and population) had the wrong sign. By deleting the independent variables whose estimated coefficients were not statistically significant; the mining employment model is function of a one year lag of mining employment, the real value-added of the basic sectors, the real value added of non-trade sectors, and the crude oil prices in terms of dollars per barrel. All estimated coefficients were statistically significant at 99 percent level, and also the R-square was 0.97. Table 5.19 displays the results of the final regression model.

Table 5.19 The Final Estimated Regression For Mining Employment Demand

	Dependent Variable	
	Mining Employment	
Variable	Coefficient	T Value
MinEmp t-1	0.778	(159.1)***
BaseRealVadd	1.4817	(46.8)***
NonBaseRealVadd	0.4911	(21.8)***
CrudeOilPrice	3.1524	(4.1)***
R-square		0.97
Number of Observations		5,328

*** Indicated coefficient is statistically significant at 99 %
MinEmp t-1 represents a one year lag of mining employment
BaseRealVadd represents real value added of the base sectors in terms of one million of constant dollars.
NonBaseRealVadd represents millions of real value-added by the non-base sectors.
CrudeOilPrice represents the crude oil price (dollars per barrel).

The Final Mining Employment (Table 5.19)

Table 5.19 displays the results of the final mining employment model. The time-series and cross-sectional procedure was used for estimated model. There were 5,328 observations. A one job in the in mining employment in the previous year would create 0.78 jobs in mining sector in the present year. A one million dollar increase in the real value-added by the basic sectors of all counties would create 1.48 jobs in mining sector. A one million dollar increase in the real value-added by the non-basic sectors of all counties would create 0.49 jobs in miming sector An increase by each one dollar per barrel of crude oil price would create 3.15 jobs in mining sector.

The long-term impact by a one million dollar increase in real value-added by the basic sectors would create 6.67 jobs in mining sector. The long-term impact by a one million dollar increase in real value-added by the non-basic sectors would create 2.21 jobs in mining sector. The long-term impact of a one dollar change of the crude oil price would create 14.2 jobs in mining sector. Half of the total impact would felt in 4.5 years (Table 5.20).

Table 5.20 The Long-Term Impact of The Real Value Added, and Crude Oil Price on Mining Employment

	Dependent Variable
Variable	Mining Employment
BaseRealVadd	6.6743
NonBaseRealVadd	2.2122
CrudeOilPrice	14.2000
Mean Lag	4.5045

*The long-term impact of independent variables on mining employment was calculated from the geometric distributed lag model
BaseRealVadd represents millions of real value added by the base sectors.
NonBaseRealVadd represents millions of real value-added by the non-base sectors.
CrudeOilPrice represents crude oil price in dollars per barrel.
Mean Lag was defined as a time-weighted average of the individual lag weights, or $\omega/(1-\omega)$.

5.9 TRANSPORTATION AND PUBLIC UTILITIES EMPLOYMENT

Transportation and public utilities employment was assumed to depend one a one year lag of itself, real value added, and population. Table 5.21 displays the results of regression model.

Table 5.21 The Estimated Regression For Transportation and Public Utilities Employment Demand Classified by the Size Class of County Population.

	Dependent Variable	
	Transportation and Public Utilities Employment	
Variable	Coefficient	T Value
TranstEmp t-1	0.4987	(66.9)***
TotalVadd	0.5268	(24.4)***
PopS	4.45	(8.5)***
PopL	0.33	(4.3)***
R-square		0.94
Number of Observations		5,328

*** Indicated coefficient is statistically significant at 99 %
TranstEmp t-1 is a one year lag of transportation and public utilities employment.
TotalVadd is millions of real value added.
PopS represents the county population in thousands.
PopL represents the population of the large county plus the closet surrounding small size counties. Counties with a more than 5000 people were considered as large.

Table 5.21 displays the results of the estimated regression for transportation and public utilities employment. The time-series and cross-sectional procedure was used for estimated model. There were 5,328 observations. A one job increase in the transportation and public utilities sector in the previous year would create 0.498 jobs in transportation and public utilities sector in the present year. A one million dollar increase in the total real value-added in each county would create 0.53 jobs in the transportation and public utilities sector. A one thousand person increase in a county's population would create 4.45 jobs in transportation and public utilities sector. An increase in one thousand of county population in the large county plus all the close surrounding small counties would create 0.33 jobs in transportation and public utilities sector in the large county. The transportation and public utilities employment model assumed that the basic transportation and public utilities (electricity, gas, steam, water, or sanitary services) are found in all counties. However larger transportation and public utility firms and more specialized businesses are found in larger counties. The demand for transportation and public utilities in the large county comes in part from the close surrounding smaller counties. All estimated coefficients were statistically significant at 99 percent level. The R-square was 0.94.

The long-term impact of a one million dollar increase in the real value-added would create 1.05 jobs in transportation and public utilities sector. The long-term impact of a one thousand person increase in a county's population would create 9 jobs in transportation and public utilities sector. The long-term impact from a thousand person population increase would create 0.66 jobs in transportation and public utilities sector in the large county. Half of the impact would felt in 0.49 year (Table 5.22).

Table 5.22 The Long-Term Impact of The Real Value Added, and County Population on Transportation and Public Utilities Employment*

	Dependent Variable
Variable	Transportation and Public Utilities Employment
TotalVadd	1.0509
PopS	8.8769
PopL	0.6583
Mean Lag	0.4925

*The long-term impact of independent variables on transportation and pubic utilities employment was approached by geometric distributed lag model
TotalVadd is millions of real value added.
PopS represents the population in all counties.
PopL represents the population of the large county plus the closet surrounding small sized counties. Counties with a population size 5,000 were considered as small. Counties with a population size greater than 5,000 were considered as large.
PopS and PopL are in terms of thousand population.
Mean Lag was defined as a time-weighted average of the individual lag weights, or $\omega/(1-\omega)$, where ω is the coefficient of a one-year lag of dependent variable also assumed all independent variables have the same time-weight lag.

5.9 GOVERNMENT EMPLOYMENT

Government employment was assumed to depend on a one year lag of itself, real value-added, and population. Table 5.23 displays the results of regression model.

Table 5.23 The Estimated Regression For Government Employment Demand Classified by the Size Class of County Population.

	Dependent Variable	
	Government Employment	
Variable	Coefficient	T Value
GovtEmp t-1	0.667	(101.7)***
TotalVadd	1.552	(29.0)***
PopS	1.687	(5.8)***
PopL	0.319	(3.3)***
R-square		0.96
Number of Observations		5,328

*** Indicated coefficient is statistically significant at 99 %
GovtEmp t-1 represents a one year lag of government employment.
TotalVadd represents millions of real value added by the county's economy
PopS represents the population of the county (in thousands).
PopL represents the population of the large county plus the closet surrounding small size counties. Counties with a population greater than 25,000 were considered as large.

Table 5.23 displays the results of estimated regression for government employment. The time-series and cross-section procedure was used for estimated model. There were 3,328 observations. A one job increase in government employment sector in the previous year would create 0.667 jobs in government sector in the present year. A one million dollar increase in total real value-added of any county would create 1.55 jobs in government sector. A one thousand person increase in a county's population would create 1.69 jobs in government sector. A one thousand person increase in a county's population in the large county plus the close surrounding small size counties would create 0.32 jobs in government sector. The basic government services can be found in small counties except some government services offices which located in the large county and serve the close surrounding small size counties such as the Federal Reserve Bank. The demand for government employment in the large county included part of the demand for government employment of the closest surrounding small sized counties. All estimated coefficient were statistically significant at 99 percent level. The R-square was 0.96.

The long term impact by a one million dollar increase in real value-added would create 4.66 jobs in government sector. The long term impact of a one thousand person increase in a county's population would create 5.06 jobs in government sector. An increase of one thousand people in a large county plus the close surrounding small counties would create 0.96 jobs in government sector of the large county. Half of the long term impact would felt in 0.46 year (Table 5.24).

Table 5.24 The Long-Term Impact of The Real Value Added, and County Population on Government Employment*

	Dependent Variable
Variable	Government Employment
TotalVadd	4.6607
PopS	5.0661
PopL	0.9579
Mean Lag	0.4685

*The long-term impact of independent variables on government employment was approached by geometric distributed lag model
TotalVadd represents millions of real value added.
PopS represents the population in each county.
PopL represents the population of the large county plus the closet surrounding small counties. Counties with a population size 25,000 were considered as small. Counties with a population size greater than 25,000 were considered as large.
PopS and PopL are in terms of thousand.
Mean Lag was defined as a time-weighted average of the individual lag weights.

The Impact of an Increase in Number of Fed Cattle Slaughtered on Employment in Other sectors

In the High-Plains study area, manufacturing is one of the basic sectors which create employment in other sectors. The factors that influence manufacturing employment were found to be total real value added, feed purchases, cash receipts from crops, and the number of fed cattle slaughtered. The change in manufacturing employment was in turn found to affect jobs in retail trade, construction, transportation and public utilities, government, wholesale trade, finance, insurance and real estate, and mining. The impact of a change in number of fed cattle slaughtered was first used to estimate the change in value added from manufacturing by using the historical ratio of value added in manufacturing per unit of employment. The change in number of fed cattle slaughtered generates both forward linkage and backward linkages. For the forward linkage, the change in number of fed cattle slaughtered was added to the value added of manufacturing in the county, and then the change in value added of manufacturing was used to estimate the jobs generated in other sectors. For the backward linkage, fed cattle generate expenditures for purchased feed which then creates the jobs in manufacturing sector and increases the value added in manufacturing sector in the county in which the cattle were fed. The first step is to calculate of the ratio of real value added in meat product manufacturing per job from historical data from 1977 to 2000. This can be expressed as:

$$(5.5) \quad R_1 = \left(\sum_{i=1}^{222} \sum_{t=1977}^{2000} MeatmnfVadd_{i,t} \Big/ \sum_{i=1}^{222} \sum_{t=1977}^{2000} MeatmnfEmp_{i,t} \right).$$

In equation 5.5, the variable $MeatmnfVadd_{i,t}$ is millions of real value added in the meat product manufacturing sector in county i and year t. The variable $MeatmnfEmp_{i,t}$ is employment in meat product manufacturing sector in county i and year t. The ratio R_1 represents value added in meat product manufacturing sector per job (Million Dollars /Job). The calculated value of R_1 in equation 5.5 is \$0.03986 meaning that one job in meat product manufacturing generated \$0.043 million dollars of real value added in meat product manufacturing.

The second step is estimating demand for labor in red meat in meat product manufacturing at the state level. The estimated regression can be expressed as:

(5.6) $Emp_{s,t} = \alpha_1 redmeat_{s,t} + \alpha_2 Dtx + \varepsilon.$

In equation 5.6, $Emp_{s,t}$ is number of workers in meat product manufacturing in state s and year t in terms of one thousand production workers. The variable $redmeat_{s,t}$ is thousand pounds of total red meat produced in state s and year t. Dtx is a Texas dummy variable if the data came from Texas then Dtx is equal to one, zero otherwise. The results of equation 5.6 were shown in Table 5.25.

Table 5.25 The Estimated Demand for Labor by One Thousand Pounds of Red Meat Produced.

	Dependent Variable	
	Red Meat (1,000 LBS)	
Variable	Estimated Coefficients	T-Value
Emp	0.00000327	(38.8)***
Dtexas	14.75	(19.5)***
R-square		0.97
Number of Observations		91

***Indicated Coefficient is Statistically Significant at 99 % level
Emp represents thousands of workers in meat product manufacturing.
Dtexas represents Texas dummy variable

Table 5.25 displays the results of equation 5.6. The estimated coefficient of Emp in equation displays demand for labor by one thousand pounds of red meat in meat product manufacturing. In table 5.25 the estimated coefficient of Emp is equal to 0.00000327 meaning that an increase in one thousand pounds of red meat required 0.00000327 thousand workers or 0.0037 worker in meat product manufacturing. The ratio of processed red meat per liveweight of fed cattle slaughtered is about 0.6 meaning that 0.6 pound of processed red meat of fed cattle slaughtered came from 1 pound of live weight of fed cattle. If the processed red meat from fed cattle is equal to

1,000 pound then the live weight of fed cattle would be 1,666.667 pounds of live fed cattle (1,000/0.6 = 1,666.67). According to USDA information, the average live weight of fed cattle per head is about 1,150 pounds. So the demand for labor of live fed cattle per head is equal to 0.0022563 meaning that one head of live fed cattle required 0.0022563 workers in meat product manufacturing. So, 1,000 heads of live fed cattle required 2.23 workers in meat product manufacturing.

The third step is estimating the ratio of feed purchases per thousand heads of fed cattle sold. The 1997 and 2002 census of agriculture by USDA provided the recent information of fed cattle to calculate the ratio of feed purchases per one thousand head of fed cattle sold and the ratio of direct labor per one thousand head of fed cattle sold. The ratios were shown in Table 5.26, and 5.27.

Table 5.26 The Ratio of Direct Labor Per One Thousand Head of Fed Cattle

	Year	
State	1997	2002
Colorado	0.907	0.916
Kansas	0.891	0.706
Nebraska	1.446	1.158
New Mexico	***No Information***	***No Information***
Oklahoma	1.327	1.816
Texas	0.949	1.046
Average	1.104	1.128
The Mid Point		1.116

Source: The Author’s Calculation, The Data were Obtained from 1997,2002 Census of Agriculture USDA

Table 5.27 The Ratio of Feed Purchases Per One Thousand Head of Fed Cattle*

	Year	
State	1997	2002
Colorado	200.945	189.509
Kansas	202.002	182.625
Nebraska	169.604	178.550
New Mexico	192.045	253.532
Oklahoma	230.489	174.984
Texas	194.341	190.873
Average	198.238	195.012
The Mid Point		196.625

Source: The Author's Calculation, The Data were obtained from 1997, 2002 Census of Agriculture USDA
*Indicated one thousand dollars per one thousand head of fed cattle sold or $0.199625 million per one thousand head of fed cattle sold.

In Table 5.26, the ratio of direct labor per one thousand head of fed cattle sold displays that one thousand head of fed cattle sold required 1.12 jobs in agricultural sector. In Table 5.27, the ratio of feed purchases per one thousand head of fed cattle sold displays that one thousand head of fed cattle sold required $0.196 million in feed purchases. From table 5.26, the direct effect from one thousand head of fed cattle sold required 1.115 jobs in agricultural sector.

The fourth step is to estimate the real value added generated by one thousand head of fed cattle slaughtered. From the second step, one thousand head of fed cattle slaughtered required 2.23 jobs in meat product manufacturing. Also in the first step, one job in meat product manufacturing generated $0.039 million in real value added. Thus, 2.226 jobs in meat product generated $0.089951 (2.226*0.039867 = 0.089951) million in real value added in meat product manufacturing. From Table 5.27, one thousand head of fed cattle sold required $0.1966240 million in animal food manufacturing. The total of real value added generated by an increase in one thousand head of fed cattle slaughtered is equal to $0.286575 million in real value added in manufacturing sector. The results of equation 5.7 show that an increase in one million dollars in feed purchases required additional 7.63 jobs in manufacturing. Thus, $0.1966240 million in feed purchases required additional 1.50 (0.196624*7.63 = 1.50) jobs in animal feed manufacturing. In the fourth step, the indirect effects on employment in manufacturing sector generated by an increase in one thousand head of fed cattle slaughtered generated 2.23 jobs in meat product manufacturing and 1.50 jobs in animal feed manufacturing. The indirect effects on income in manufacturing sector by an increase in one thousand head of fed cattle slaughtered by generating $0.089 million in meat product manufacturing and $0.196 million in animal feed manufacturing.

The fifth step is to calculate the indirect impact from the real value added in the manufacturing sector from each one thousand head of fed cattle slaughtered on the remaining sectors of the study area economy. The further induced effects through changes in the total value added in each county by one thousand head increase in fed cattle slaughtered is tabulated below in Table 5.28. For example, each one million dollar change in total value added (in this case from manufacturing), was found to generate 0.699jobs in retail trade sector (Table 5.28).

Table 5.28 The Indirect and Induced Employment Effects By An increase in One Thousand Head of Fed Cattle Slaughtered

Sector (I)	Coefficient (II)	Real Value Added in Manufacturing Generated by Fed Cattle Slaughtered (Million Dollars) (III)	Number of Additional Jobs Created By Fed Cattle Slaughtered (IV)
Indirect Employment Effects			
Meat Product Mnft*			2.256
Animal Feed Mnft**			1.500
Total Indirect Employment Effects			**3.756**
Induced Employment Effects			
Retail Trade	2.440	0.287	0.699
Construction	0.656	0.287	0.188
Transportation &Public Utilities	0.527	0.287	0.151
Government	1.552	0.287	0.445
Wholesale Trade	0.792	0.287	0.227
F.I.R.E	4.621	0.287	1.324
Services	9.379	0.287	2.688
Mining	1.973	0.287	0.565
Total Induced Effects			**6.287**
Sum of Indirect and Induced Employment Effects			**10.044**

(II) The Coefficients were obtained from the Estimated Regression Models
(III) The Calculation of the Real Value Added in Manufacturing Sector Generated by One Thousand head of Fed Cattle Slaughtered was exhibited at the beginning
(IV) Column IV = Column II * Column III.
*The Indirect Impact of An Increase in One Thousand Head of Fed Cattle Slaughtered By Creating 2.256 jobs in Meat Product Manufacturing
**An Increase In One Thousand Head Fed Cattle Slaughtered required $0.196624 Million of Feed Purchases. An Increase in One Million Dollars of Feed Purchases created 7.6323 Jobs in Animal Feed Manufacturing Thus An Increase in $0.196624 Million of Feed Purchases created 1.50 Jobs In Animal Feed Manufacturing Sector (0.196624*7.632 = 1.500)

The indirect effect of a one thousand head increase in fed cattle slaughtered was the creation of 2.25 jobs in meat product manufacturing. Also, an increase in one thousand head of fed cattle slaughtered led to an increase in feed purchases by $0.196

million. The additional feed purchases of $0.196 million created 1.5 jobs in animal feed manufacturing. The total indirect effect from a one thousand head increase in fed cattle slaughtered was the creation of 3.76 jobs in the manufacturing sector (meat product manufacturing and animal feed manufacturing) (Table 5.28).

For the induced employment effects, an increase in one thousand head of fed cattle slaughtered created 0.69 jobs in retail trade sector, 0.19 jobs in the construction sector, 0.15 jobs in the transportation and public utilities sector, 0.45 jobs in the government sector, 0.23 jobs in the wholesale trade sector, 1.32 jobs in the F.I.R.E sector, 2.68 jobs in the services sector, and 0.56 jobs in the mining sector. The total number of jobs created by an increase in one thousand head of fed cattle slaughtered is about 6.29 jobs by induced effects (Table 5.28).

The Indirect and induced value added effects by an increase in one thousand head of fed cattle slaughtered were tabulated below in Table 5.29

Table 5.29 The Indirect and Induced Value Added Effects By An increase in One Thousand Head of Fed Cattle Slaughtered

Sector (I)	Number of Additional Jobs Created By One Thousand Head of Fed Cattle Slaughtered (II)	Real Value Added Per Worker (Million Per Worker) (III)	Additional Real Value Added Created By One Thousand Head of Fed Cattle Slaughtered ($Million) (IV)
Indirect Value Added Effects			
Meat Product Mnft*	2.256	0.037	0.089
Animal Feed Mnft**	1.500	0.13	0.196
Total Indirect Effects	3.756		0.285
Induced Value Added Effects			
Retail Trade	0.699	0.019	0.013
Construction	0.188	0.021	0.004
Transportation &Public Utilities	0.151	0.066	0.010
Government	0.445	0.028	0.012
Wholesale Trade	0.227	0.047	0.011
F.I.R.E	1.324	0.059	0.078
Services	2.688	0.020	0.053
Mining	0.565	0.076	0.043
Total Induced Effects			0.225
Sum of Indirect and Induced Value Added Effects			0.510

(II) The additional jobs generated from Indirect and Induced Employment Effects obtained from Column IV Table 5.28
(III) The Calculation of The Ratio of Real Value Added Per Worker in Individual Sector Using the Historical Data Across 222 Counties and Over 24 Years.
(IV) Column IV = Column II * Column III.

The data in column II was taken from Table 5.29. Column III is the ratio of real value added per worker in each sector. The number of additional jobs in column II multiplied by real value added per worker in column III gives the additional real value added in each sector. The indirect income effects generated by an increase of one thousand head of fed cattle slaughtered is about $0.089 million in real value added in meat product manufacturing as well as $0.196 million in real value added by animal feed manufacturing. The total indirect income effects were about $0.285 million in manufacturing sector. The induced income effects generated $0.013 million in real value added in retail trade sector, $0.004 million in real value added in construction sector, $0.010 million in real value added in transportation and public utilities, $0.012 million in real value added in government sector, $0.011 million in real value added in wholesale trade sector, $0.078 million in real value added in F.I.R.E sector, $0.053 million in real value added in services sector, $0.043 million in real value added in mining sector. The total induced income effects is about $0.225 million in real value added (Table 5.29).

Number of Jobs Created by an Increase 12.30 Million Head of Fed Cattle slaughtered in the Six High-Plains State Study Area

Table 3.4 in displays the average number of fed cattle slaughtered in the six High-Plains state study area. The average number of fed cattle slaughtered from 1977 to 2000 is about 12.306 million head. The average number of fed cattle slaughtered is used to calculate number of jobs generated in manufacturing sector as well as real value added in manufacturing employment which can be expressed below.

The Total Direct, Indirect and Induced Employment Effects of Fed cattle Slaughtered of the Six High-Plains State Study Area

The first step is to estimate the direct employment and labor wages effects of fed cattle slaughtered by using the average number of fed cattle slaughtered from 1977 to 2000. From Table 5.26, the direct effects by an increase in one head of fed cattle sold required 1.115 jobs in agricultural sector. Thus, the 12,306 thousand fed cattle sold would directly require 13,733 (1.115*12,306 = 13,733) jobs in agricultural sector of the six-state study area. The additional 13,733 jobs generated $219.728 (13,733*16,000 = 219,728,000,000) million in labor wages in agricultural sector.

The second step is to estimate the indirect employment and income effects from an average of 12,306 thousand head of fed cattle slaughtered. Each one thousand head of fed cattle slaughtered generated $0.089 million in real value added in meat product manufacturing. Thus 12,306 thousand head of fed cattle would generate $1,106.94 million in real value added in meat product manufacturing. Each one thousand head of fed cattle slaughtered generated $0.196 million in real value added in animal feed manufacturing. Thus 12,306 thousand head would generate $2,419.66 million in animal feed manufacturing. The total real value added by 12,306 thousand head of fed slaughtered is $3,526.59 million in the manufacturing sector. The $3,526.59 million in real value added in manufacturing then induce additional employment and value added in the remaining sectors.

Table 5.30 The Indirect and Induced Employment Effects on Employment By An increase in 12,306 Thousand Head of Fed Cattle Slaughtered

Sector (I)	Coefficient (II)	Real Value Added in Manufacturing Generated by Fed Cattle Slaughtered (Million Dollars) (III)	Number of Additional Jobs Created By Fed Cattle Slaughtered (Jobs) (IV)
Indirect Employment Effects			
Meat Product Mnft*			27,762
Animal Feed Mnft**			18,466
Total Indirect Employment Effects			46,228
Induced Employment Effects			
Retail Trade	2.440	3,526	8,603
Construction	0.656	3,526	2,313
Transportation &Public Utilities	0.527	3,526	1,858
Government	1.552	3,526	5,472
Wholesale Trade	0.792	3,526	2,792
F.I.R.E	4.621	3,526	16,293
Services	9.379	3,526	33,070
Mining	1.973	3,526	6,956
Total Induced Effects			77,360
Sum of Indirect and Induced Employment Effects			123,588

(II) The Coefficients were obtained from the Estimated Regression Models
(III) The Calculation of the Real Value Added in Manufacturing Sector Generated by One Thousand head of Fed Cattle Slaughtered was exhibited at the beginning
(IV) Column IV = Column II * Column III.
*The Indirect Impact of An Increase in 12,306 Thousand Head of Fed Cattle Slaughtered By Creating 2.256*12,306 = 27,762 jobs in Meat Product Manufacturing
**An Increase In One Thousand Head Fed Cattle Slaughtered required $0.196624 Million of Feed Purchases. An Increase in One Million Dollars of Feed Purchases created 7.6323 Jobs in Animal Feed Manufacturing Thus An Increase in 12,306 thousand Head of Fed Cattle Slaughtered generated18,466 Jobs In Animal Feed Manufacturing Sector (0.196624*7.632 *12,306 = 18,466)

Each in one thousand head of fed cattle slaughtered generated 2.256 jobs in meat product manufacturing. Thus, 12,306 thousand head of fed cattle slaughtered would generate 27,672 jobs in meat product manufacturing in the six-state study area.

Each one thousand fed cattle slaughtered generated 1.50 jobs in animal feed manufacturing. Thus, 12,306 thousand head of fed cattle slaughtered would generate 18,466 jobs in animal feed manufacturing (Table 5.30). The $3,526 million in real value added in manufacturing sector generate additional or induced effects in remaining sectors. The induced employment effects are 8,603 jobs in retail trade, 2,313 jobs in construction, 1,856 jobs in transportation and public utilities, 5,472 jobs in government, 2,792 jobs in wholesale trade, 16,293 jobs in F.I.R.E , 33,070 jobs in services, and 6,956 jobs in mining. The sum of direct, indirect and induced employment effects generated by an increase in 12,306 thousand head of fed cattle slaughtered is equal to 13,733+46,228+77,360 = 137,321 jobs. This is about 4.60 ((137,321/2,979,052)*100) = 4.60)) percent of the total employment. The 12,306 thousand head of fed cattle slaughtered generated 27,762 jobs in meat product manufacturing which accounts for 24 percent of non durable manufacturing employment. An increase in 12,306 thousand of fed cattle slaughtered generated 46,228 jobs accounted for 14 percent of the total manufacturing employment.

The direct, indirect and induced value added effects by an increase in 12,306 thousand head of fed cattle slaughtered

Table 5.31 The Indirect and Induced Value Added Effects By An increase in 12,306 Thousand Head of Fed Cattle Slaughtered

Sector (I)	Number of Additional Jobs Created By One Thousand Head of Fed Cattle Slaughtered (II)	Real Value Added Per worker (Million Per Worker) (III)	Additional Real Value Added Created By One Thousand Head of Fed Cattle Slaughtered ($Million) (IV)
Indirect Value Added Effects			
Meat Product Mnft*	27,762	0.037	1,027.194
Animal Feed Mnft**	18,466	0.13	2,400.580
Total Indirect Value Added Effects			3,427.774
Induced Value Added Effects			
Retail Trade	8,603	0.019	163.457
Construction	2,313	0.021	48.573
Transportation &Public Utilities	1,858	0.066	122.628
Government	5,472	0.028	153.216
Wholesale Trade	2,792	0.047	131.224
F.I.R.E	16,293	0.059	961.287
Services	33,070	0.020	661.400
Mining	6,956	0.076	528.656
Total Induced Effects			2,770.441
Sum of Indirect and Induced Value Added Effects			6,198.215

(II) The additional jobs generated from Indirect and Induced Employment Effects obtained from Column IV Table 5.30

(III) The Calculation of The Ratio of Real Value Added Per Worker in Individual Sector Using the Historical Data Across 222 Counties and Over 24 Years.

(IV) Column IV = Column II * Column III.

Table 5.31 displays the indirect and induced income effects accounted for by 12,306 thousand head of fed cattle slaughtered. It generated $1,027 million in real value added in meat product manufacturing, $2,400 million in real value added in animal feed manufacturing, $163 million in real value added in retail trade, $48 million in real value added in construction, $122 million in real value added in transportation and public utilities, $153 million in real value added in government, $131 million in real value added in wholesale trade, $961 million in real value added in F.I.R.E, $661 million in real value added in services, and $528 million in real value added in mining. The total value added generated by an increase of 12,306 head of fed cattle slaughtered is about $6,198 million or 6.27 percent of total real value added in the study area.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The major objective of this research was to determine the impact of AFO production on income and employment in a 222 county area of the Great Plains. This effort is unique as the area involves major portions of six states and covers a major portion of the fed cattle industry of the United States. A data set with the appropriate variables necessary to estimate county employment at the two-digit SIC level within each of the counties from 1977 to the year 2000 was constructed. Missing data techniques and multiple data sources were combined to complete the data set. An econometric time-series, cross-section approach with a lagged dependent variable was used to estimate the county level relationship between employment in one sector due to changes in employment, value added or production in other sectors. Population and personal income were also used as explanatory variables. An equation specification and a method of data coding were devised so that the relationship between larger trade center counties and surrounding smaller counties could be empirically estimated. The variables used to designate the larger center counties varied between sectors but included population or employees. The size designations used were 1-5000, 5001 to 10,000, 10,001 to 25,000, 25,000 to 50,000, 50,000 to 100,000 and greater than 100,000. The insignificant size variables were deleted in each case. The sector by sector results are summarized below.

Agricultural Services Employment

An increase in one million dollars of cash receipts from livestock and crops of any county in the six-state study area was found to create 0.22 jobs in agricultural services sector in the same county. It was noted the number of agricultural services workers in the large MSAs counties far exceeded the number that could be explained by local farms and ranches. These companies were assumed to serve customers not only in its own county but also the closest surrounding smaller counties. The hypothesis that these centrally located firms served producers in outlying counties was tested by including a variable for employment demand in the large county that was defined as the sum of agricultural cash receipts in the large county plus that in the closest surrounding smaller counties. Variations of this technique were used as explanatory variables in other sectors. It was found that an increase of one million dollars in cash receipts from livestock and crops in this "service area" of the large county create an additional 0.016 jobs in agricultural services sector in the large county. A similar coding with respect to personal income was used to explain the horticulture and landscaping portion of agricultural services employment. It was found that an increase of one million dollars of personal income created 0.102 jobs in the agricultural services sector in the same county. An increase in one million dollars of personal income of residents in the "service area" of the large county created an additional 0.001 jobs in agricultural services sector of the large county. It was expected that cash receipts from livestock and crops would have a significant agricultural services employment but personal income was also found to have a significant impact in both the large central county and in the surrounding smaller counties.. The results are consistent with the hypotheses that both income from livestock and crops and personal income have positive impact on agricultural services employment in the six-state study area.

Manufacturing Employment

The factors that were found to have a significant impact on income from and employment in the manufacturing sector at the county level were income from crop production, feed purchases, number of fed cattle slaughtered, the total real value-added in the county and manufacturing employment in the rest of the U.S.A. It was anticipated that crop cash receipts would have a significant positive impact on animal food manufacturing, grain & oilseed milling as well as bakeries and tortilla manufacturing. Feed purchases were also assumed to have a positive impact on animal food manufacturing and on grain and oilseed milling.

In the six-state study area, the main type of animal feeding is fed cattle (Table 1.4). The model attempts to measure the impact of the number of fed cattle slaughtered on non durable manufacturing employment in the counties where the meat packing plants are located. Livestock and meat processing is a sub-sector of durable manufacturing and it in turn contains the following subcategories; animal slaughtering & processing, animal slaughtering, meat processing from carcasses, and rendering &meat by product processing. The meat product manufacturing by itself accounts for only 15.30 percent of food manufacturing employment (2000 Economic Census: Manufacturing Geographic

Area Series, U.S. department of commerce). The model also measures whether manufacturing in the study area follows the trend of manufacturing in the rest of the U.S. It was found that each 1000 head of fed cattle slaughtered created 2 jobs in the county where the packing plant was located. Cattle on feed created additional jobs through feed purchases. Each million dollars of feed purchases were found to create 6.73 nondurable manufacturing jobs. A one million dollar increase in the real value in each county was found to create about 2.4 jobs in durable manufacturing. Fed cattle are also linked to other economic sectors such as transportation and public utilities, wholesale trade, retail trade, finance, insurance and real estate as well as services sector

Wholesale Trade Employment

The factors that were found to have a significant impact on wholesale trade employment were real value added in the basic sectors, real value-added in the non basic sectors and retail emplement in the six-state study area. The lagged value of wholesale trade sector employment was also significant. Each one million dollars in real value added by the basic sectors and the non-basic sectors created .38 and .41 jobs respectively. The spatial geometric distributed lag model found results that were consistent with the hypothesis that retail stores are served by a wholesale centers in a variety of locations. It was found that each retail job created.043 wholesale jobs in the same county,.017 wholesale jobs in counties with 1000 to 5000 retail employees and an additional .012 wholesale jobs in counties more than 5000 retail employees. That is the wholesale trade center located in the large county serves the retail trade sector not only in large counties but also the closet surrounding small counties for example, wholesale trade center located in Oklahoma City serve retail trade sector of the closest small surrounding small counties such as Garfield County, Custer County and Woodward County.

The real value-added of basic sectors and non-basic sectors had almost the same impact of wholesale trade employment in any county (about 0.60 jobs). For the spatial linkage between retail trade and wholesale trade employment, an increase of 100 jobs in the retail trade sector in any county would create about 7 jobs in wholesale trade sector of the same county. An increase in 100 jobs in retail trade sector in the medium county plus the closest surrounding small sized counties would create about 3 jobs in the wholesale trade sector in the medium sized county. An increase in 100 jobs in retail trade sector in the large county plus the closest surrounding small and medium sized counties would create about 2 jobs in wholesale trade sector in the large county. The results are consistent with the hypotheses that the real value added of both basic and non-basic sectors has positive impact on wholesale trade employment. Also there is positive spatial linkage between wholesale trade employment and retail trade employment in the different sized counties in the six-state study area.

Retail Trade Employment

The factors that were found to significantly drive retail trade employment were a one year lag of retail trade employment, the total real value-added, and personal income. A one million dollar increase in total real value added was found to create about 3 jobs in retail trade sector in same county. A 10 million dollar increase in the personal income was found to create about 5 retail trade jobs in same county. The same 10 million dollars increase was found to create an additional 0.5 jobs in the closest medium sized county (10,001 to 50,000) and another .2 retail jobs in the nearest large county (population greater than 50,001). The positive impact of personal income in any county on retail trade employment is expected because consumers have a propensity to spend more when their income increases. In addition, consumers in the small counties are likely to shop in the closest medium or large counties for special goods and services that are not found in small counties such as mechanics, automobiles, electronics and jewelry.

Finance, Insurance, and Real Estate (F.I.R.E) Employment

Based on the results, the significant drivers of F.I.R.E employment were the real value-added by trade and non trade sectors, as well as personal income of residents in the same county. An increase of one million dollars in trade sectors was found to create about 4 jobs in the F.I.R.E sector while an increase of one million dollars in the non-trade sectors would create only 0.68 jobs in F.I.R.E sector. An increase of one million dollars in personal income by the residents had a small (.000002) but significant impact on F.I.R.E employment. The coefficient for additional employment in the medium and large counties was not significant. That is there was no significant evidence that income increases in small counties created additional employment F.I.R.E. employment in the larger counties.

Services Employment

The factors that were found to have a significant impact on services employment were real value-added by the trade and non-trade sectors, and county population. A one million dollar increase in real value-added by the trade sector was found to create about 7 jobs in services sector such as hotels and other lodging places, business services, automotive repair, services and parking, amusement and recreation services, motion pictures, health services, engineering and management services as well as education services. The services sector is the biggest source of both of income and employment of the six-state study area. Income from services sector accounted for 30 percent of the total non-farm income (Regional Economic Account, Bureau of Economic Analysis, 2003).

A one million dollar increase in real value-added by the non-trade sectors was found to create about 3 jobs in services sector of the same county. The population of the county was found to be one of the significant drivers for services employment. A one thousand person increase in county's population was found to create about 3 jobs in the services sector. A one thousand person increase in population in the large county plus the closed surrounding small counties was found to create 0.39 jobs in services sector in the large county. Consumers can get basic services in their own counties but will travel to the larger counties for special professional services such as those in the medical area. The results of regression model were consistent with the hypotheses that population and both the real value of trade and non-trade sectors have a significant positive impact on services employment.

Construction Employment

The significant drivers for construction employment were found to be the total real value added and personal income of county residents. A one million dollar increase in real value-added was found to create 0.65 jobs in the construction sector. An increase of 10 million dollars of personal income by the residents of a county creates about 10 construction jobs in the same county. A 10 million dollar increase in personal income was found create an additional construction job in the nearest large county. The results were consistent with the hypotheses which stated that the total real value added and personal income of resident had a significant positive impact on construction employment.

Mining Employment

The main variables affecting mining employment were to be the price of crude oil and real value-added. The lagged value of mining employment was also significant. In the six-state study area the main mining sector is mainly oil and petroleum production. According to crude oil statistics by the Energy Information Administration (2003), Texas has 21 percent of the U.S oil reserve. A one dollar increase in the crude oil price was found to add about 3 mining jobs in a county. The value added by the basic and non-basic sectors probably reflects the tendency of firms to locate in larger cities.

Transportation and Public Utilities Employment

The significant variables determining employment in the transportation and public utilities sectors were found to be the county population and real value added. County population had the biggest impact on transportation and public utilities employment. Each one million of dollars of real value added 0.52 jobs in the Transportation and Public Utilities Sector. Each 1,000 population created 4.45 jobs in the same county. The same population increase was found to add 0.33 additional jobs in counties with population of 25,000 or more.

Government Employment

The main variables affecting employment in the government sector were found to be county population and real value-added. The lagged value of government employment was also significant. An increase of one thousand persons was found to create about 1.6 jobs in government sector in the same county and an additional .32 jobs in counties with more than 5000 jobs. An increase of one million dollars of real valued-added was found to create about 1.5 jobs in the government sector. The government sector by itself is not a basic sector in the six-state study area but changes in these basic sectors were found to affect employment in the government sector.

There are some military bases located in the study area for example Altus AFB, USAF, Fort Sill, USA, and Shepard, AFD USAF.(Military Base in the Continental United States, United States Department of Defense, 2005). Theses would create the jobs in counties where the military basses located in (Jackson County, Oklahoma, Comanche County, Oklahoma, and Wichita County, Texas).

The direct, indirect and induced effects by an increase in 12.36 million head of fed cattle slaughtered in the six High-Plains study area

The average number of fed cattle slaughtered in the six High-Plains study area is about 12.36 million head. The 12.36 million head of fed cattle slaughtered directly generating 13,733 jobs in agricultural sector, and $220 million dollars in labor wages. The indirect employment effects of 12.36 million head of fed cattle slaughtered were 27,766 jobs in meat product manufacturing and 18,459 jobs in animal feed manufacturing or 46,225 total manufacturing jobs. These indirect manufacturing jobs created $3,526.59 million in real value added. The 12.36 million head of fed cattle slaughtered annually induced further employment and value added in retail trade, construction, transportation and public utilities, government, wholesale trade, F.I.R.E., services and mining for a total of 77,360 jobs and $2,763 million total real value added. The total employment effects accounted for 4.6 percent of the total employment while the total real value added effects accounted for 6.3 percent of total real value added.

The Shortcoming of the study

The main shortcomings of this study are the disclosure limitations on income and employment data obtained from The Bureau of Economic Analysis (BEA), U S Department of Commerce. The RAS technique was used to estimate withhold data in this study.

Similarly, the livestock data at county level from the United States Department of Agriculture are not available in some years and some counties. Fore example, the data of sheep on feed, milk cows, hogs and hogs-breeding.

Suggestions for Further study.

Animal Feeding Operations (AFOs) are a possible way to generate income and employment. AFOs can also be a source of pollution generated from animal waste. Due to the time constraint and data limitation of the study, only cattle feeding operations were considered as a source to create income and employment at the county level. In this study, there is no issue which discusses about the impact of animal feeding operations on environment and natural resources. Further study should focus the impact of all animal feeding operations on income and employment as well as the impact on environmental caused by animal waste.

This study focuses on cattle on feed which are the main type of animal feeding operations in the six-state study area in terms of income and employment. However, animal feeding operations also include milk cows, hogs, chickens, and sheep which also impact on income and employment. Any further study should include all animal feeding operations.

REFERENCES

Abramowitz, M., and I.A Stegun. *Handbook of Mathematics with Formulas Graphs, and Mathematical Tables.* Edited by 9. New York: Dover, 1972.

Aldrich, L., and L Kusmin. *Rural Economic Development What Make Rural Communities Growth?* Washington D.C.: The United Department of Agriculture, 1997.

Bair, J. P. *Urban and Regional Economics*. Edited by 1. Irwin: Homewood, 1991.

Bair, J. P., Traynor, and M Duan. "Retail Development in Rural Counties: Evidence from the Upper Midwest." *Regional Analysis & Policy* 34, no. 1(2004): 69-84.

Bureau of Economic Analysis "Regional Economic Account: Private Earning." The US Department of Commerce. Washington D.C., 2004

---."Regional Economic Account: Cash Receipts from Market." The US Department of Commerce. Washington D.C., 2004

---."Regional Economic Account: Population." The US Department of Commerce. Washington D.C., 2004

---."Regional Economic Account: Private Employment." The US Department of Commerce. Washington D.C., 2004

Courant, P., J, and H Robin. *The Geographic Progression: An Element Approach to Ideas and Methods*. Vol. 2. Oxford: Oxford University Press, 1996.

Douglas, W. A., and Lueck Dean. *The Nature of Farm*. Vol. 1. Cambridge: The MIT Press, 2002.

Duncan, M. R., et al. "Economic Feasibility of the Cattle Feeding Industry in the North Plains and Western Lakes States." Department of Agricultural Economics, North Dakota State University.

Economic Research Service. "Economic Growth in Farming Area Lags the Rest of Rural American." *Rural Conditions and Trends: Rural Industry Issue* 10, no. 2(2002).

Energy Information Administration "Domestic First Purchase Prices of Crude Oil." The US Department of Energy, 2003.

Energy Information Administration "U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves " The US Department of Energy 2003.

Greene, W. H. *Econometric Analysis*. Edited by 4. New York: Prentice-Hall, 2000.

Gujarati, D. *Basic Econometrics*. Edited by 2. New York: McGraw-Hill, 1998.

Gujarati, D. *Essentials of Econometrics*. 2. Edited by 2. Boston: McGraw-Hill, 2000.

Hamed, M. A. "Decision-Making for Land Use: Accessing Alternative for Livestock Production in Saline County Missouri." University of Missouri-Columbia, 2000.

Hill R.C., W. E. G., and G.G Judge. *Undergraduate Econometrics*. Edited by 2. New York: John Wiley &Sons, 2001.

Hill, R. C. *Learning SAS: A Computer Handbook for Econometrics*. Edited by 1. New York: John Wiley & Sons, 1992.

Ikerd, J. E. "The Economic Impacts of Increased Contract Swine Production in Missouri." Department of Agricultural Economics, University of Missouri-Columbia.

Isard, W., et al. *Methods for Interregional and Regional Analysis*. Edited by 1. Aldershot, England: Ashgate Publishing, 1998.

Jackson, R. W., and A.T Murray. "Alternative Input-Output Matrix Updating Formulations." *Economic Systems Research* 16, no. 2(2004): 135-48.

Judge, G. G., et al. *Introduction to the Theory and Practice of Econometrics*. Edited by 2. New York: Wiley & Sons, 1988.

Kennedy, P. *A Guide to Econometrics*. Edited by 4. Cambridge: The MIT Press, 1998.

Kusmin, L. *Factors Associate with the Growth of Local and Regional Economies: A review oF Selected Empirical Literature*: Economic Research Services, USDA, 1994.

Lahr, M. L., and D.L Mesnard. "Biproportional Techniques in Input-Output Analysis: Table Updating and Structural Analysis." *Economic Systems Research* 16, no. 16(2004): 115-34.

Lawrence, J. D., et al. "Iowa's Pork Processing Industry." Department of Economics, Iowa State University.

Musser, W. N., and E.T. Mallinson. *Economic Impact of Potential Avian Influenza Outbreak in Delmarva Region*. College Park: Co-operative Extension Service, University of Maryland, 1996.

Mustafa, D. *Regional and Local Economic Analysis Tools*. Edited by 1. Washington D.C.: The World Bank, 2002.

Nerlove, M. "Lags in Economic Behavior." *Econometrica* 40, no. 1(1972): 222-51.

National Agricultural Statistics Service, *1997 Census of Agriculture*. The United States Department of Agriculture Washington D.C., 2000.

National Park Services. *Military Bases in the Continental United States*. The US Department of Interior, 2005.

Otto, D., P Orazam, and W. Huffman. "Community and Economic Impact of Iowa Hog Industry." Department of Economics, Iowa State University.

Pindyck, R. S., and D.L Rubinfield. *Econometric Models and Economic Forecasts*. Edited by 2. New York: McGraw-Hill, 1976.

Research, E. "1-Year Treasury Constant Maturity Rate." Federal Reserve Bank of St. Louis.

Seidl, A., and J Davis. *Animal Feeding Operations and Rural Colorado Communities*. Fort Collins, CO: Department of Agricultural and Resource Economics, 1999.

Stone, R. *Input-Output and National Accounts: Organization for European Economic Co-operation*. Edited by 1, 1961.

Stone, R. a. A. B. *A Computable Model of Economic Growth*. Edited by 1. London, England: Chapman & Hall, 1962.

Studenmund, A. H. *Using a Practical Econometrics*. Edited by 3. New York: Addison-Wesley, 1996.

Wheeler, J. O., et. *Economic Geography*. Edited by 3. New York: Wiley & Sons, 1998.

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Scope and Method of Study: The study area contained 222 counties from the Six High-Plains States of Colorado, Kansas, Nebraska, New Mexico, Oklahoma and Texas. County level two digit SIC data were collected for the period from 1977 to 2000. The RAS method was used to estimate missing or withheld data. The ten two-digit SIC sectors were agricultural services, manufacturing, wholesale trade, retail trade, Finance, Insurance and Real Estate (FIRE), services, construction, mining, transportation and public utilities, and government. Time-series cross-section geometric distributed lag models were used to estimate the employment multipliers. The spatial relationship between counties was also considered.

Findings and Conclusions: The main variables affecting agricultural service employment were agricultural cash receipts and personal income. Manufacturing employment was shown to be affected by crop income, fed cattle slaughter, the real value of Gross State Product (GSP) in the county and changes in manufacturing employment in the rest of the United States. Employment in the wholesale trade sector was significantly affected by the real value added by the basic and non-basic sectors in the county and by retail trade employment. Retail trade employment in small, medium, and large size counties affected by personal income. It was found the concentration of retail employment in medium and large size counties could be explained the expenditure of a proportion of income earned in smaller counties in the closest medium and larger counties. Similarly a portion of income earned in medium population counties was spent in the closest large county or SMSA. Employment in the Finance, Insurance and Real Estate sectors was best explained by real value added in the trade and non-trade sectors and personal income in the same county. Services employment was also explained by the real value-added in the trade and non-trade sectors and the population of the county. Construction employment was explained by the real value added and the personal income earned each county. Mining employment was explained by price of crude oil and the real value added by the basic and non basic sectors of the county. Employment in the transportation and public utilities sectors of a county was also explained by the real value added in the county and by the population of the county. Likewise government employment was explained by the real value added and by the population of each county.

ADVISER'S APPROVAL ______________________________