Regional General Equilibrium Analysis of Reduced Trip Demand at Lake Texoma

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Executive Summary and Conclusions

An earlier study showed that regional impacts associated with angler expenditures at Lake Texoma equaled $14,602,000 gross regional product (GRP) (aggregate value added) and 654 jobs. The impact region is five counties in Oklahoma (Bryan, Carter, Marshall, Love, and Johnston) and two counties in Texas (Grayson and Cooke). This impact is approximately 0.58 percent of total regional employment and 0.38 percent of gross regional product.

The earlier study is a fixed-price multiplier analysis where the angler expenditures create a multiplier effect on impact regional output, income, GRP, and employment. That type of analysis has two major limitations. (1) The implication is a with and without condition for angler expenditures. The with implies that Lake Texoma anglers make trips to the lake, find conditions as expected, and carryout their trip objectives. The without condition implies that trips were not made and thus angler expenditures did not occur. The analysis does not explain why the number of trips would go from the existing level to no trips, implying the with and without conditions. (2) The fixed-price multiplier analysis assumes no regional opportunity costs to resources used in regional production of goods and services purchased by anglers. If the goods and services are not purchased by anglers, those resources used in their production and the production of associated goods and services are assumed lost to the region. Resources do have regional opportunity costs. If they are not used in the production of goods and services associated with angler expenditures, they may be used in the production of other goods and services demanded within the region or for production of goods exported. Fixed prices for commodities and resources are a restrictive assumption of this type of impact analysis.

The objective of the current study is to assess the potential impact of changing water quality (removal of salts by the Red River Chloride project) of Lake Texoma on the demand for angler trips and thus on the region's economy using regional computable general equilibrium (CGE) methods. It is based on the premise that reducing the salt content of Lake Texoma reduces the striped bass fish population, thus reducing the quality of the trip and the number of trips demanded. A reduction in trips demanded reduces total resident and nonresident angler expenditures. A reduction in angler expenditures reduces aggregate regional demand with region-wide economic impacts.

The actual reduction in trip demand from a change in water quality at Lake Texoma is not known. This study has hypothetically posed a quality tax on angler trips that, if assessed, anglers would have to stay longer and spend more to catch the same number of fish and thus have the same level of trip satisfaction. At a higher cost per trip, anglers would demand fewer trips. Using a price elasticity of demand for trips of -0.5775, the reduction in trip demand can be estimated for a given

quality tax. Even though the quality tax is not actually assessed, the effect of a reduced quality of trip on trip demand is thus estimated. Two levels of quality tax per trip price (expenditure) were evaluated: (1) 25 percent and (2) 50 percent. The two levels of quality tax were evaluated with respect to impacts on (1) trip demands, (2) regional commodity markets, (3) regional factor markets, and (4) regional welfare. The regional general equilibrium model was specified to evaluate short run and long run effects. Short run effects are defined to allow labor mobility between sectors of the economy and between the impact region and the rest of the U.S. A labor migration elasticity of 0.92 was assumed. Capital and land are assumed fixed by sector and region for the short run. Long run effects allow labor and capital to be mobile between sectors and regions but land is fixed. The capital migration elasticity is specified also at 0.92.

Summary results of the study include the following:

(1) The number of resident angler trips decreased from 55,744 to 49,976 (10.3 percent) with the 25 percent quality tax and to 46,120 (17.3 percent) with the 50 percent quality tax. The short run and long run results are almost the same. Nonresident trips decreased from 56,285 to 49,481 (12.1 percent) with the 25 percent quality tax and to 44,538 (20.9 percent) with the 50 percent quality tax.

(2) Aggregate regional demand (sectoral output) decreased from 0.018 percent to 0.044 percent depending on level of quality tax and whether the results measure short run or long run effects. The 50 percent quality tax had a greater reduced aggregate regional demand compared to the 25 percent tax and, in general, the short run result was marginally greater than the long run result. Reductions in aggregate export demand were marginally greater than reductions in aggregate regional demand for the 25 percent quality tax.

(3) Regional wage rate decreases were from 0.004 percent to 0.031 percent depending on level of quality tax and whether results are short run or long run. The higher level of tax reduced wage rate more compared to the lower level of tax, and the short run wage rate was marginally lower than the long run wage rate. About seven jobs were lost through migration with the 25 percent quality tax, and about 30 jobs were lost to migration with the 50 percent quality tax. Industry demand for labor decreased in trade, services, and agriculture but increased in all other sectors when the quality tax was imposed.

(4) Aggregate capital rent increased with the 25 percent quality tax and decreased with the 50 percent quality tax. This resulted in

capital in-migration with the 25 percent quality tax and capital out-migration with the 50 percent quality tax. This occurred only in the long run analysis because capital is fixed in the short run analysis.

(5) Land rent (in agriculture) decreases were from 0.027 percent to 0.048 percent depending on level of quality tax and whether results are short run or long run. Land rents were marginally lower for short run analysis compared to long run analysis. The level of land use remains the same because full capacity of resource use is assumed with adjustments occurring in market equilibrium price (rent).

(6) Lake Texoma anglers show considerable consumer surplus losses from imposing the quality tax ranging from $1,097,270 to $2,114,410 for resident anglers and from $3,890,470 to $7,413,780 for nonresident anglers depending on level of tax. For all anglers, the consumer surplus loss in the long run with the 50 percent quality tax is $9,528,190. This represents a consumer surplus loss of about $85 per trip when based on the initial number of trips.

(7) The loss in gross regional product (GRP) ranged from zero to $1,643,789 depending on whether short run or long run effects are considered and on the level of quality tax imposed. With the 25 percent quality tax, the long run result shows no change in GRP. The higher capital rent and the returns to in-migration of capital off-set the losses due to lower wage and lower land rent and the loss of compensation of out-migrating labor. With the 50 percent quality tax, the loss in GRP is $1,642,789 for the short run analysis. This loss is attributed to lower returns to labor, capital, and land and to loss in compensation to out-migration of labor. The loss in total GRP is minimal. However, the distribution among sectors shows that some lose and others gain. The trade and services sectors are the principal losers because of their direct linkages to the loss of angler expenditures. Manufacturing, transportation, and mining are the principal gainers because of the diversion of regional resources into those sectors for export production.

(8) Households remaining in the region show welfare losses and income losses because of the quality tax. Welfare loss for all household groups ranged from $1,112,136 (short run with 25 percent quality tax) to $2,255,290 (long run with 50 percent quality tax). The major part of this loss is attributed to the loss by resident anglers who are part of the regional households and suffer the loss in quality of angler trips. Household income losses for all household groups range from $20,234 for the 25 percent quality tax long run result to $434,378 for the 50 percent quality tax short run result. Income losses are due to lower wage rates and lower capital and land rents. The medium income household group shows the

greatest welfare and income losses whereas the low income household group shows the lowest welfare and income loses. Resource ownership is assumed to be unchanged in analysis of the various scenarios.

Major conclusions of the study may be stated as the following:

(1) Lake Texoma anglers are the principal losers with a change in trip demand because of a change in quality of trip. Over 70 percent of angler losses are associated with nonresident anglers.

(2) The loss in GRP because of the reduced trip demands is minimal, less than two million dollars for the 50 percent quality tax on angler trips. Alternative uses of resources in the production of other goods and services replaces to a considerable extent the losses from reduced angler expenditures.

(3) Welfare losses of households remaining in the region are mainly attributed to losses of resident anglers from fewer trips and higher prices per trip associated with the quality tax. Marginally lower incomes by households are partially offset by lower composite commodity prices in computing welfare losses.

(4) Fixed-price multiplier analysis overestimates employment and GRP losses because of reduced trip demands at Lake Texoma. For a 19.1 percent reduction in trip demand the CGE results estimate a reduction of GRP by $1,179,424 in the long run. A similar reduction in trip expenditures under the fixed-price multiplier analysis gives a reduction in GRP of $2,788,982. Similarly, CGE results for labor migration is 30 jobs versus a loss of jobs under fixed-price multiplier analysis of 125.

(5) Distribution effects are important when considering the impact of reduced trip demands at Lake Texoma. Firms and businesses associated with trade (retail and wholesale), services, and transportation are major losers. Firms able to expand output because of lower wage rates are gainers including manufacturing, mining, and construction.

(6) General equilibrium models are operational at regional levels but require considerable data. Many of the parameters used in regional CGE models have not been verified. However, fixed-price multiplier models implicitly assume many of the same parameters but at more extreme levels.

Regional General Equilibrium Analysis of Reduced Trip Demand at Lake Texoma

Introduction

This study is an extension of a fixed-price multiplier analysis of the economic impact of Lake Texoma fishing activities (Amera et al., 1995). The study region covers five counties in Oklahoma (Bryan, Carter, Marshall, Love, and Johnston) and two counties in Texas (Grayson and Cooke). In the multiplier analysis, the aggregate economic effects of angler expenditures are expressed through Type I and Type III multiplier impacts (see Olson, 1993). Total angler hours of fishing at Lake Texoma estimated from the Oklahoma and Texas Cooperative Creel Survey were 1,328,815 for 1990. Total number of angler trips was estimated at 112,029 using the estimated number of angler hours and number of hours per trip estimated from an angler survey (Amera et al.).

Results of the angler survey reported in the multiplier analysis study indicate that regional anglers in 1990 spent about $85 per trip per angler with all of the expenditures occurring within the impact region. Non-regional anglers spent about $350 per trip per angler with about 85 percent of the expenditures occurring within the impact region. Regional anglers associated about 51 percent of their expenditures with striped bass fishing versus 87 percent for non-regional anglers.

Total expenditures by Lake Texoma anglers occurring within the impact region was estimated in the multiplier analysis study at $21,350,000. Of this amount, $16,721,000 (78 percent) was associated with non-regional anglers and $4,629,000 (22 percent) was associated with regional anglers. Striped bass fishing was associated with about $16,908,060 of expenditures and all other specie fishing was associated with about $4,442,000 of expenditures (79 percent and 21 percent, respectively, of the total).

Problem Statement

Direct impact on region business transactions (outputs), income (employee compensation, proprietary income, and other property income), value-added (regional income plus indirect business taxes), and employment (number of jobs) associated with Lake Texoma angler expenditures is shown in Table 1. The aggregate economic effects of angler expenditures were expressed through the Type I and Type III multiplier impacts. Impact on region business transactions (outputs)

associated with angler expenditures ranged from $11,973,000 for Type I impact (direct and indirect) to $24,332,000 for Type III impact (direct, indirect and induced). Regional income associated with angler expenditures was $5,685,000 for direct purchases by anglers, $6,347,000 for Type I income impact, and $12,771,000 for Type III income impact. These results imply that the effect of angler expenditures on impact region income ranged from about $6,000,000 to $13,000,000 depending on the degree of associated linkages or multiplier effects included in the analysis. The lower end of the income range captures the direct income associated with angler expenditures while the higher end of the income range captures direct, indirect, and induced income associated with angler expenditures. Value added includes indirect business taxes with regional income estimates as presented above and thus the range of value added was from $6,468,000 to $14,602,000 depending on the degree of associated linkages included in the analysis. Impact region employment (number of jobs) associated with Lake Texoma angler expenditures was 377 direct jobs, 402 jobs for Type I employment impact, and 654 jobs for Type III employment impact.

Table 1. Aggregate Effect of Lake Texoma Angler Expenditures on Impact Region, 1991.

Angler Expenditures Associated With	*Direct Effects*	*Indirect Effects*	*Induced Effects*	*Total Effects*
Output ($1,000)				
Resident anglers	1,806	274	2,146	4,226
Nonresident anglers	8,747	1,147	10,211	20,106
Total	10,553	1,421	12,357	24,332
Income ($1,000)				
Resident anglers	928	125	1,115	2,168
Nonresident anglers	4,757	537	5,306	10,600
Total	5,685	662	6,421	12,768
Value-Added ($1,000)				
Resident anglers	1,050	137	1,285	2,472
Nonresident anglers	5,418	594	6,116	12,128
Total	6,468	731	7,401	14,600
Employment (Number of jobs)				
Resident anglers	65	5	44	114
Nonresident anglers	312	21	208	541
Total	377	26	252	655

Source: Amera et al., (1995).

The fixed-price multiplier analysis is a method frequently used to show the associated regional effects of a set of economic activities. In this case, the economic activities are expenditures by Lake Texoma anglers. Such an analysis has two major limitations. (1) When left with the results as presented in Table 1, the implication is a with and without condition. The with condition implies that Lake Texoma anglers make trips to the lake, find conditions at the lake as expected, and carryout their trip objectives. In the process, the anglers make direct expenditures in the region as estimated. The without condition implies that if no trips were made by anglers to Lake Texoma, no direct expenditures occur, and, hence, regional output decreases by $24,332,000, regional income decreases by $12,771,000, regional value-added decreases by $14,602,000, and regional employment decreases by 654 jobs. The analysis does not explain why the number of trips would go from the existing level to no trips, implying the with and without conditions. The analysis only shows associated regional impacts of existing angler expenditures.

(2) The fixed-price multiplier analysis assumes no regional opportunity costs to resources associated directly and indirectly with the goods and services purchased by the anglers (see Koh, Schreiner, and Shin for the limitations of fixed-price multiplier analysis). If the goods and services are not purchased by anglers, those resources used in their production and the production of associated goods and services are assumed lost to the region. This assumption is very restrictive. Resources do have opportunity costs. If they are not used in the production of goods and services associated with angler expenditures, they may be used in the production of other goods and services demanded within the impact region or for production of goods exported. Some resources may be bid away from the region if people and capital are willing to migrate. Fixed-prices for commodities and resources are thus a very restrictive assumption of any impact analysis.

Assumptions of fixed prices and no regional opportunity costs to resources are relaxed in computable general equilibrium (CGE) analysis. Han-Sung Lee and Rini Budiyanti have developed regional general equilibrium models to assess the impacts of sport fishing activities in Oklahoma. Lee (1993) analyzed the general equilibrium impacts of establishing a trout fishery in McCurtain County, Oklahoma and concluded that the existence of the trout fishery resulted in a total welfare gain of about $608,537 to all households in the county. Non-resident anglers contributed about 92 percent ($558,080) of the total household welfare gain. Budiyanti (1995) studied measures of welfare change and regional equilibrium results from a reduction of sport fishing trips due to a quality change in trips because of a hypothetical water pollution problem. The Lake Texoma fishery is similar in nature and requires an analysis of the impacts of a change in trip demand.

Objective of the Study

The objective of this study is to assess the potential impact of changing water quality (removal of salts by the Red River Chloride (RRC) project) of Lake Texoma on the demand for fishing trips and thus on the region's economy using regional computable general equilibrium (CGE) methods. It is based on the premise that reducing the salt content of Lake Texoma reduces the striped bass fish population and thus the number of trips demanded (decrease in quality of fishing trips to Lake Texoma). A reduction in trips demanded reduces total resident and nonresident angler expenditures. A reduction in aggregate regional demand will have region-wide economic impacts. The objective of this study is carried out by simulating the effects of reduced trip demands by means of a price increase in trips. Price increases are proposed through a quality tax which increases the price of a trip and thus reduces trip demand. Two quality tax scenarios on resident and nonresident trips are considered; (1) a 25 percent and (2) a 50 percent quality tax on resident and nonresident trips. In the regional general equilibrium model, the quality tax on Lake Texoma fishing trips has the effect of reducing trip demand. Resident angler households shift their consumption expenditures to other goods and services. Non-resident anglers reduce their demand for Lake Texoma trips.

Data and Methods

The procedure of analysis included the following: (1) trip expenditure profiles were estimated for resident and nonresident anglers using 1990 data from the angler expenditure survey reported in Amera et al.; (2) estimation of a social accounting matrix (SAM) for the impact region using the IMPLAN Database and other data sources; (3) specification and calibration of a regional computable general equilibrium (CGE) model including the non-market goods of resident and nonresident angler trips; and (4) simulation of the impacts of trip reduction through imposing a quality tax on trip demand.

Trip Expenditure Profiles

Because of limited information gathered on angler expenditures, modified spending profiles and bridge tables developed by Stynes and Propst to match spending categories of Lake Texoma anglers and IMPLAN's 528 sectors were used. The spending profiles were developed by Stynes and Propst for the U.S. Army Corps of Engineers and are assumed generalizable across regions, sites, and types of anglers. The degree to which the spending profiles are generalizable, however, was not tested. The spending profiles are based on visitations to the Upper Mississippi River system (1989-90) and measure trip spending in eight major and 32 detailed categories. In the current study, survey data were

used to modify the percentage expenditures in the major categories, but the Stynes and Propst percentages were used for disaggregation within the detailed categories.

The modified spending profiles were multiplied by a bridge table to allocate the expenditures among the 528 IMPLAN sectors. In the bridge table, margin industries (retail trade, wholesale trade, and transportation) convert purchaser values to producer values.

The use of percentage expenditure distributions and bridge tables of Stynes and Propst assumes the following:

1. The expenditure behavior of anglers in the Lake Texoma impact region is similar to the anglers in the Upper Mississippi River System.
2. Definitions of broad spending categories between the Lake Texoma survey questionnaire and the Stynes and Propst study are similar.

Two modifications were made to the Stynes and Propst data for the current study. First, the amounts in the broad spending categories (eight categories) were changed to results obtained in the Lake Texoma survey. Percentage distribution within the broad categories, however, are from Stynes and Propst. Second, the percent purchased locally reflects the Lake Texoma survey results rather than the Stynes and Propst results. The latter study reflects purchases within a 30 mile radius of the recreation site. The current study bases results on a survey question of whether purchases were made within the impact region or outside the region. The modified spending profiles are presented in Table 2.

This analysis is based on the 1991 IMPLAN Database and thus the 1990 survey results are inflated to the 1991 price level. The IMPLAN 528 sectors were aggregated into 38 industries corresponding to the 1987 Standard Industrial Classification (SIC) code and following the aggregation of Regional Input-Output Modeling Systems (RIMS) II (U.S. Department of Commerce, 1992) (Appendix 1). These sectors were further aggregated into eight sectors to reduce the size of the model. These sectors are: (1) agriculture, forestry, fishery products and services; (2) mining; (3) construction; (4) manufacturing; (5) transport, communication, and utilities; (6) trade; (7) finance, insurance, and real estate; and (8) other services (Appendix 2). Resident and nonresident angler expenditures in producer's value and 1991 price level for the eight major and 38 RIMS sectors are presented in Table 3. The data in Table 3 differ from the results in Table 2 because (1) the price level is 1991 rather than 1990 and (2) nonresident angler expenditures are adjusted to include only expenditures within the impact region.

Social Accounting Matrix (SAM)

A social accounting matrix (SAM) was developed using the information from IMPLAN and the Bureau of Economic Analysis (BEA) for the

Table 2. Trip Expenditure Profiles (in 1990 Purchaser's Value) for Anglers at Lake Texoma, 1990.

Trip Spending Categories	*Resident Anglers*		*Nonresident Anglers*		*All Anglers*	
	$	*(%)*	*$*	*(%)*	*$*	*(%)*
(1) Lodging Expenses						
Hotel	70,032		2,640,885		2,710,917	
Camp Grounds	13,617		518,392		532,009	
	83,649	1.8	3,159,277	15.1	3,242,927	12.6
(2) Food and Beverages						
Grocery	452,938		3,619,376		4,072,315	
Restaurant	257,108		1,531,235		1,788,343	
	710,047	15.0	5,150,611	24.6	5,860,657	22.9
(3) Auto & RV Expenses						
Auto/RV gas & oil	155,302		2,239,079		2,394,382	
Auto/RV rental	9,402		134,282		143,685	
Auto/RV repairs	6,160		87,440		93,600	
Auto/RV tires	12,969		189,453		202,421	
Auto/RV parts	3,891		55,170		59,061	
Auto/RV parking & tolls	2,270		35,392		37,662	
	189,994	4.0	2,740,816	13.1	2,930,810	11.4
(4) Boat Gas & Oil						
Boat gas & oil	391,336		933,730		1,325,067	
	391,336	8.3	933,730	4.5	1,325,067	5.2
(5) Boat Rental, Repair & Fees						
Boat rental	49,606		13,532		63,138	
Boat repairs	502,544		137,405		639,950	
Boat parts	1,093,277		297,711		1,390,988	
Boat launch fees	588,463		159,265		747,728	
Boat fares	29,504		7,287		36,791	
	2,263,395	47.8	615,200	2.9	2,878,595	11.2
(6) Fishing Expenses						
Bait and fishing tackle	78,138		394,519		472,657	
	78,138	1.6	394,519	1.9	472,657	1.8
(7) Activity Fees						
Equipment rental	81,704		1,074,258		1,155,962	
Guide fees	30,153		394,519		424,672	
Spectator sports fees	30,153		394,519		424,672	
Tourist attraction fees	174,432		2,292,167		2,466,599	
Other recreation fees	108,939		1,432,344		1,541,283	
	425,380	9.0	5,587,809	26.7	6,013,188	23.4
(8) Other Expenses						
Film purchase	84,298		328,940		413,237	
Film developing	50,903		198,821		249,724	
Souvenirs	116,720		454,894		571,614	
Footwear	64,844		252,950		317,795	
Men's clothing	67,762		262,319		330,081	
Women's clothing	116,720		454,894		571,614	
All other	9,694		373,700		469,994	
	597,542	12.6	2,326,519	11.1	2,924,060	11.4
Total	4,739,480	100.0	20,08,482	100.0	25,647,962	100.0

Source: Broad expenditure categories were from the telephone survey.
Allocations within the broad categories were from Stynes and Propst.

Note: Nonresident angler expenditures are not adjusted for within region expenditure of 85.3%.

Table 3. Resident and Nonresident Angler Expenditures Spent Within Lake Texoma Region by Industry, 1991.

Sector	*Total Angler Expenditures ($)*		
	Resident Anglers	*Nonresident Anglers*	*Total Anglers*
Agriculture, forestry, and fisheries:			
1. Agricultural products and Agricultural, forestry, and fisheries services	37,838	340,058	377,896
2. Forestry and fishery products	13,327	145418	158,745
Mining:			
3. Coal mining			
4. Crude petroleum and natural gas			
5. Miscellaneous mining			
Construction:			
6. New construction			
7. Maintenance and repair construction			
Manufacturing:			
8. Food and kindred products and tobacco	273,687	1,853,161	2,126,849
9. Textile mill products	6,500	21,479	27,978
10. Apparel	81,912	270,554	352,467
11. Paper and allied products	8,153	32,041	40,194
12. Printing and publishing	3,164	11,634	14798
13. Chemicals and petroleum refining	327802	1,616,011	1,943,813
14. Rubber and leather products	51,463	225,391	276,854
15. Lumber and wood products and furniture			
16. Stone, clay, and glass products	4,814	20,875	25,689
17. Primary metal industries			
18. Fabricated metal products	6,402	2,227	8,629
19. Machinery, except electrical	61,921	15,152	77,072
20. Electric and electronic equipment	13,437	49,545	62,982
21. Motor vehicles and equipment	622	7,430	8,053
22. Transportation equipment, except motor veh.	1,281,588	296,477	1,578,064
23. Instruments and related products	31,701	105,000	136,701
24. Miscellaneous manufacturing industries	77,345	274,613	351,958
Transportation and public utilities:			
25. Transportation	141,133	318,455	459,587
26. Communication	52	167	218
27. Electric, gas, water, and sanitary services			
Wholesale and retail trade:			
28. Wholesale	217,861	933,626	1,151,487
29. Retail trade	646,060	1,976,653	2,622,713
Finance, insurance, and real estate:			
30. Finance			
31. Insurance			
32. Real estate			
Services:			
33. Hotels and lodging places and amusements	941,535	6,274,888	7,216,423
34. Personal services	96,617	319,298	415,915
35. Business services	50,147	166,501	216,648
36. Eating and drinking places	230,216	1165,208	1,395,424
37. Health services			
38. Miscellaneous services	23,704	279,140	302,843
Total	4,629,000	16,721,001	21,350,000

Table 4: Social Accounting Matrix for Lake Texoma Region, 1991 ($1,000).

Expenditures	*Agriculture*	*Mining*	*Construction*	*Manufacturing*	*Transport*	*Trade*	*Finance*	*Services*	*Resident Trips*	*Nonresident Trips*	*TOTAL*
COMMODITY											
Agriculture	66,517	3	2,627	57,767	307	151	824	3,636	43	413	132,294
Mining	1,149	2,049	2,409	18,090	5,976	367	214	4,232			34,491
Construction	3,641	92,368	495	5,6703	12,365	834	1,094	26,638			143,110
Manufacturing	13,102	381	50,566	292,954	23,151	4,837	8,833	31,758	1,337	2,877	429,800
Transport	16,251	687	22,714	139,339	41,726	11,159	11,332	44,306	89	202	287,809
Trade	6,264	108	24,490	50,449	2,591	509	2,519	8,986	580	1,956	98,454
Finance	12,741	231	10,003	28,415	10,067	6,248	81,439	16,447			165,596
Services	23,018	623	58,786	49,651	20,742	15,588	21,028	88,700	904	5,532	284,576
Resident Trips											
Nonresident Trips											
Total	142,686	96,454	172,093	642,338,986	116,929	39,695	127,286	224,705	2,955	10,982	1,576,128
FACTORS											
Labor	26,235	35,029	141,049	604,120	134,770	243,858	98,306	529,629			1,813,000
Capital	37,194	141,215	48,321	391,605	144,456	58,450	279,364	154,258			1,254,867
Land	46,148										46,148
Total	109,578	176,244	189,370	995,726	279,227	302,309	377,671	683,888			3,114,016
INSTITUTIONS											
ENTERPRISE											
HOUSEHOLD											
low											
medium											
high											
Sub Total											
GOVERNMENT	5,983	124,690	2,077	49,726	26,593	84,219	103,093	17,941			414,324,900
CAPITAL											
IMPORTS											
Agriculture	43,084	648	1,061	15,570	87	70	844	2,751	7		63,478
Mining	646	37,285	11,691	308,459	45,717	15	.017	794			404,611
Construction	1,231	15	125	2,061	4,433	305	1,386	9,950			19,510
Manufacturing	45,731	773	219,976	853,565	29,667	6,414	3,114	160,385	893		1,320,522
Transport	7,677	171	19,862	81,604	30,377	5,455	3,104	33,970	51		182,275
Trade	8,161	81	23,595	73,671	3,404	626	170	13,230	283		123,225
Finance	35,252	570	8,038	20,190	14,225	12,621	25,345	90,582			206,829
Services	10,067	254	25,121	109,567	31,127	22,381	13,026	113,088	437		325,072
Resident Trips											
Nonresident Trips											
Total	151,852	39,153	309,472	1,464,691	159,041	47,890	46,991	424,755	1,673		2,645,522
TOTAL	410,101	436,542	673,014	3,152,483	581,792	474,114	655,041	1,351,290	4,629	10,982	7,749,992

Table 4 (Continued)

Expenditures	*Labor*	*Capital*	*Land*	*Total*	*Enterprises*	*Hh-Low*	*Hh-Med*	*Hh-High*	*Sub-Tot*	*Government*	*Capital*	*Exports*	*Total*
COMMODITY													
Agriculture						5,143	5,300	2,701	13,145	1,200		263,460	410,101
Mining										4	715	401,333	436,542
Construction										107,187	281,742	140,977	673,014
Manufacturing						55,028	93,774	43,976	192,780	18,816	154,987	2,356,100	3,152,483
Transport						63,230	68,02	33,380	164,633	1,724	4,069	123,555	581,791
Trade						91,559	151,164	73,431	316,154	3,495	8,560	47,449	474,114
Finance						133,712	204,221	91,205	429,139	1,812	660	57,832	655,041
Services						254,568	302,465	163,496	720,530	32,179	1,865	312,138	1,351,290
Resident Trips						1,203	2,221	1,203	4,629				4,629
Nonresident Trips												10,982	10,982
Total						604,448	827,169	409,395	1,841,013	166,420	452,598	3,713,830	7,749,991
FACTORS													
Labor								5,140	5,140	261,725			2,079,865
Capital													1,254,867
Land													46,148
Total								5,140	5,140	261,725			3,380,881
INSTITUTIONS													
ENTERPRISE		1,086,841		1,086,841									1,086,841
HOUSEHOLD													
low	174,172		1,163	175,335	22,710	1,500	4,245	1,722	7,468	401,133		125,550	732,199
medium	539,592		17,448	557,040	38,974					221,620		827,149	1,644,785
high	1,087,398		20,162	1,107,560	110,235					115,981		(278,224)	1,055,553
Sub Total	1,801,163		38,773	1,839,937	171,921	1,500	4,245	1,722	7,468	738,735		674,475	3,432,537
GOVERNMENT	278,701	168,026	7,374	454,103		27,091	152,965	185,777	365,833	321,408			1,555,670
CAPITAL					914,919	(338,684)	80,115	159,927	(98,641)	(229,357)		(43,154)	543,767
IMPORTS													
Agriculture						2,829	3,260	1,749	7,839	628			71,946
Mining						107	71	38	217	308	11,332		416,469
Construction										8,232	5,756		33,497
Manufacturing						194,206	270,700	129,691	594,598	131,620	63,386		2,110,127
Transport						46,19	51,643	28,844	126,680	21,8140	2,597		333,367
Trade						30,441	43,037	21,530	95,010	7,074	6,051		231,361
Finance						74,688	94,212	46,491	215,392	70,824	1,725		494,771
Services						89,377	117,362	65,242	271,982	56,236	318		653,609
Resident Trips													
Nonresident Trips													
Sub Total						437,843	580,289	293,589	131,172	296,738	91,168,		4,345,151
TOTAL	2,079,865	1,254,867	46,148	3,380,881	1,086,841	732,199	1,644,785	1,055,553	3,432	1,555,670	543,767	4,345,151	22,094,838

seven counties for the year 1991. In this study, employee compensation, proprietary income, and other property income were distributed to factors of labor, capital, and land. Indirect business taxes were allocated to government following procedures in Koh (1991), Lee (1993) and Budiyanti (1995). Income by income source for the three household income levels was estimated using sources of data in Budiyanti and Lee.

The estimated social accounting matrix (SAM) for the impact region is presented in Table 4. Total commodity output was $7,750 million of which total exports account for about 48 percent ($3,714 million). Total commodity final demand in the region was $12,095 million of which $4,345 million (35.9 percent) was fulfilled by imports. The intermediate inputs used and produced in the region account for about 37 percent ($1,576 million) of the total intermediate inputs used. Share of labor from the total gross regional product (value added plus indirect business taxes) of $3,795 million was 54.8 percent, capital 33.1 percent, and land 1.2 percent.

The resident and nonresident trips were treated as sectors of nonmarket goods making market good purchases from other sectors in the social accounting matrix. The nonresident trips were considered as an export of goods. About 30 percent of nonresident angler expenditures were spent on imported commodities, and hence excluded from the SAM. The remaining expenditures by sector were considered as inputs for the production of exportable nonmarket goods. The resident expenditures by sector were treated as inputs of a resident trip production function while the output is consumed by household groups.

Specification of Regional CGE Model

General equilibrium models have four essential ingredients: endowments of consumers (households), production technology, demand functions, and the conditions for equilibrium (Ballard et al, 1985). In our model, households possess endowments of labor, land, and capital. The model is built based on the assumptions of competitive markets with full information, and profit or utility maximizing behavior of producers and consumers. A sector is an aggregation of many producers, but the sector is treated as a single firm in the model. Household groups are an aggregation of many similar households within each income group, but each income group is treated as a single household. Variable and parameter descriptions, model equations, endogenous and exogenous variables are listed in Appendices 3 and 4. Exogenous parameter estimates and their sources are presented in Appendix 5.

Under the Walrasian general equilibrium framework, relative prices are assumed to be the only force that determines the flow of commodities and factors. Therefore, all prices are expressed in terms of relative value with respect to a base price of one. The regional market price of the composite good is a weighted average of the imported and domestic good prices. Import prices are exogenous to the region whereas regional

prices are endogenous except for the sectors to which shocks are given.

Production functions are characterized at two (nested) levels. At the first level, each production sector produces only one homogeneous commodity using intermediate and primary inputs (Figure 1). Technology assumes no substitution between composite intermediate inputs and composite primary factors nor between intermediate inputs produced by different sectors. This is the Leontief input-output production function technology. At the second level, substitution among primary factors of labor, capital, and land is represented by a constant returns to scale Cobb-Douglas (C-D) production function. It is assumed that there exists only one type of each factor.

Demand for the composite and individual intermediate inputs is derived from the Leontief input-output production relationship whereas primary factor demand is determined from the (C-D) production rela-

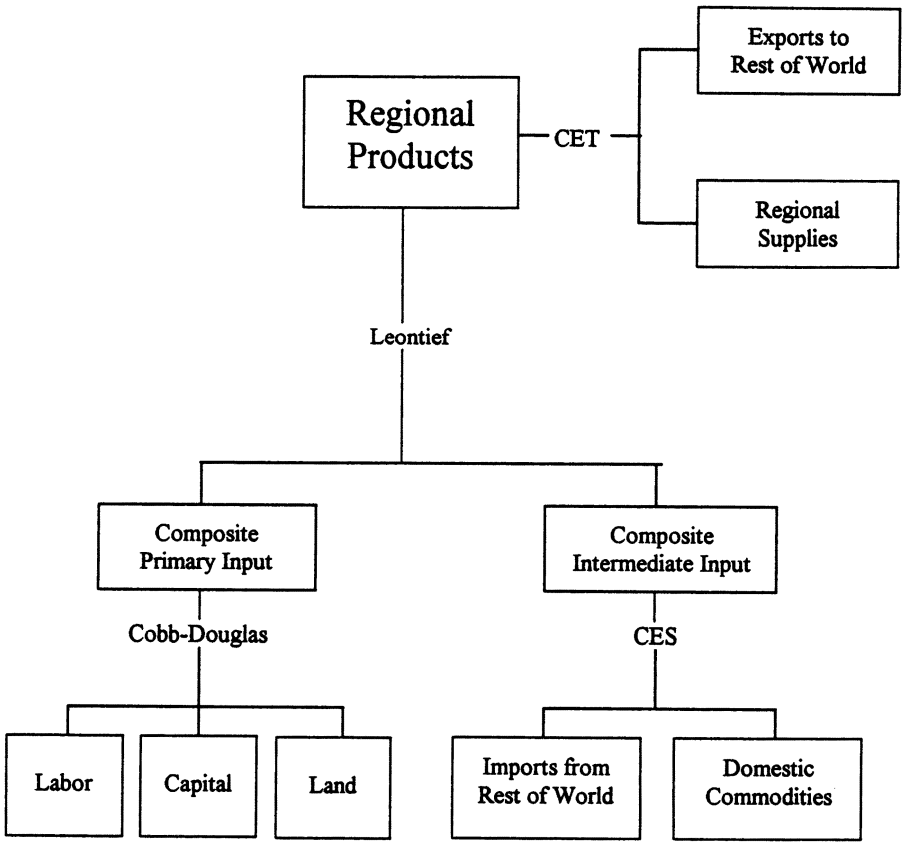

Figure 1. Production and Distribution Structure of the Model.

tionship by profit maximizing for each sector. The first order conditions for profit maximization are included in the CGE model. The model assumes that full employment is always attained by adjustment of the wage rate and the rates of return to land and capital for a given time period. Land is used only in agriculture and is assumed fixed in supply. Capital is assumed fixed in supply by sector in the short run. Both intersectoral and interregional mobility of capital are allowed in the long run analysis. Labor supply from regional households is part of the household expenditure system and is derived from the labor-leisure choice. Labor migration is defined as a function of the ratio of regional and out-of-region wage rate and an assumed labor migration elasticity.

Intermediate inputs are treated as a mix of regional and imported products (Figure 1). Quantity of the intermediate input demanded is described by a constant elasticity of substitution (CES) function between regional and imported components. The elasticity of substitution parameters are exogenously specified. The regional intermediate input demand is obtained from first order conditions of cost minimization subject to a given level of composite intermediate input defined by the CES function. Relative prices of regionally produced and imported inputs and the elasticity of substitution parameter determine regional intermediate input demand.

Similarly, each sector producing market goods transforms its output for export or a product used by the region. A constant elasticity of transformation (CET) function describes this transformation process for the market good sectors. The regional supply function for market goods is derived from the first order conditions for maximizing revenue subject to a given output level with the CET function. Relative prices of regional goods to exported goods and the constant elasticity of transformation parameter determine regional supply and export supply for market goods. For nonmarket goods, Texoma resident fishing trips are only consumed in the region (no exports) and Texoma nonresident fishing trips are consumed in the region but considered as exports. The export demand for nonresident trips is a function of regional price and a price elasticity of export demand.

Three household annual income groups are considered in this study: low income (< $20,000 income), medium income ($20,000 to $ 40,000), and high income (>$40,000). Income for each household group is determined by the level of ownership of the primary factors (labor, land, and capital), factor prices, government transfers, and inter-household transfers. Government and inter-household transfers are assumed fixed in this analysis. It is assumed that resource ownership structure remains unchanged. Quantity of labor supplied by household is endogenous and determined by wage rate and the labor-leisure choice.

Consumer demand functions are derived from maximization of utility. The Stone-Geary utility function is used which results in a linear expenditure system (LES) and satisfies the assumption of a diminishing

marginal rate of substitution. The Stone-Geary utility function is given as:

$$U_h = \sum_i \beta_{ih} \log (Q_{ih} - \gamma_{ih})$$

where, U_h = utility of household group h
Q_{ih} = amount of commodity i consumed by household group h
γ_{ih} = minimum subsistence consumption requirement for commodity i by household group h
β_{ih} = average budget share for commodity i of household group h.

The demand system derived from this utility function satisfies the general properties required; homogeneity of degree zero in all prices and income, symmetry of cross-substitution effects, adding up condition, and negativity of direct substitution effects. Household consumption is modeled at two levels. The first level determines consumption of the composite market goods, nonmarket goods, and the demand for leisure (or supply of labor) derived from maximizing utility subject to prices and full income. The average budget shares are calculated from the SAM data. Income elasticity of demand for market and nonmarket goods, income elasticity of labor supply, and a Frisch parameter are exogenously assigned to allow calibration of the minimum subsistence consumption parameters. A backward bending labor supply curve is assumed and hence the income elasticity of labor supply is greater in absolute value for high income (-0.24) than for low income (-0.12) household groups (Appendix 5).

The second level determines the optimal combination of imported and regional consumer goods (market goods and Texoma resident fishing trips). The optimal combination is the result of first order conditions for cost minimization subject to the level of composite commodity obtained from the first level which is expressed as a CES function of imported and regionally produced components. The optimal combination is determined by relative prices and the elasticity of substitution.

Federal and state and local government revenues include indirect business taxes, factor taxes, intergovernmental transfers, and household and corporate income taxes. Their expenditures include commodity consumption, transfers to households and governments, and payment to labor. Quantity of commodity consumption is held constant but as regional prices change total government expenditure changes. The proportion of regional relative to imported commodities specified by a CES function changes as discussed above for households.

Total saving is composed of household savings, retained earnings for enterprises, and net transfers (saving) from rest-of-world. Capital expenditures are for investment demand and include regional produced and imported components as specified through a CES function. Capital

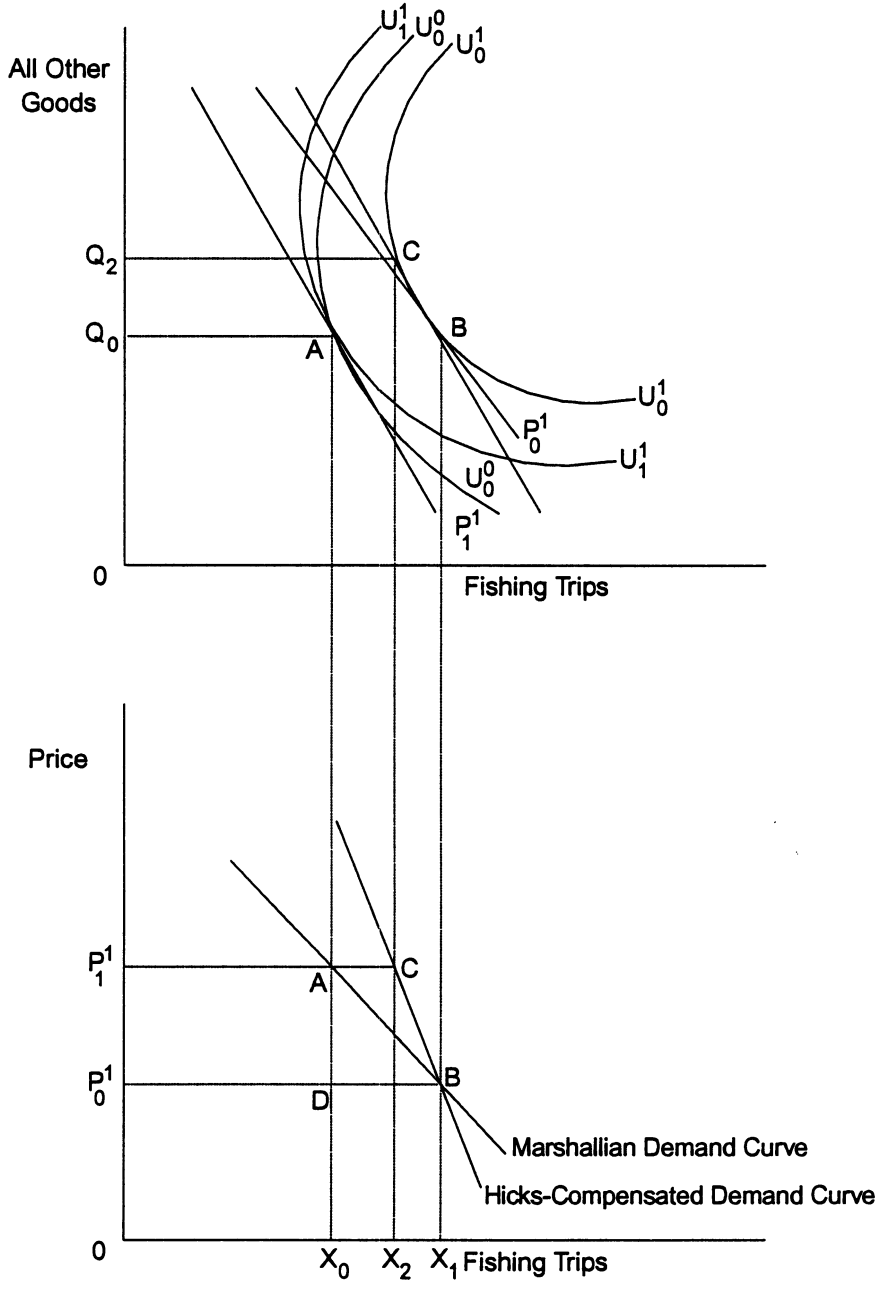

Figure 2. Marshallian Demand, Hicks-Compensated Demand, and Compensating Variation Relationships for a Quality Change in Fishing Trips.

expenditures are the result of a fixed quantity (exogenous) and a regionally determined composite price.

Gross regional product is estimated by before tax factor income generated from the production activities of the region plus indirect business taxes. Welfare changes measured by compensating variation (CV) were computed outside of the model for each household income group.

Quality Tax on Trip Demand

As the water quality decreases, the number of fish caught per trip for a given period of time decreases. Anglers have to stay longer and spend more to catch the same number of fish. This is illustrated in Figure 2. Utility for anglers shifts from U_0^0 to U_0^1. U_0^1 after a decrease in water quality represents the same level of utility as U_0^0. The shape of the utility curve changes. After the quality is reduced, the utility curve becomes flatter because it takes more trips than before to achieve one unit of utility. In other words, the trade off between one unit of all other commodities and fishing trips increases. To remain as well off as before, anglers consume more fishing trips (X_1) for the same level of all other commodities (Q_0). P_0^1 is the iso-cost line tangent to U_0^1 at point B. Because U_0^0 is equivalent to U_0^1 the following analysis is relative to U_0^1.

For a given level of expenditure anglers are limited to Q_0 and X_0. This shifts the utility curve from U_0^1 to U_1^1. This is equivalent to a shift from B to point D in the lower graph, that is, fishing trips decrease from X_1 to X_0. The iso-cost line at point A is tangent to Q_1^1, that is, P_1^1 is steeper than P_0^1 indicating an increase in the price of fishing trips.

To remain as well off as before, the compensating variation (CV) in the upper graph is the amount of money required to leave anglers as well off as before. Point C is obtained by shifting the iso-cost line P_1^1 to the right until it is tangent to U_0^1. This corresponds to point C on the Hicks-Compensated demand curve in the lower graph. The price increase from P_0^1 to P_1^1 is considered as a quality tax in our analysis.

Simulation Results

Commodity Market

Short run and long run changes in commodity markets of the impact region from imposing a quality tax (reduced trip demand) of 25 percent and 50 percent are presented in Table 5. Most changes are expressed in terms of indices with the base value equal to one. A 25 percent quality tax increases unit price of resident trips by the same amount. The marginally lower price in the short run analyses is because of a slightly lower aggregate regional price level. Budiyanti (1995) found a less than proportional increase in composite price of fishing trips for a quality tax for the State of Oklahoma (a 7.3 percent increase in composite price for

a 10 percent quality tax and a 30 percent increase for a 50 percent quality tax). The results in this model are different because the model does not consider alternative out-of-region fishing trips for resident anglers. The assumption is that Lake Texoma represents a unique fishery with the striped bass fishing that is not available elsewhere. Hence, stripe bass trips are not a substitute for other fishing trips but stripe bass trips are substitutes for other goods and services.

With capital fixed and labor mobile, an increase in the unit price of fishing trips from 1 to 1.25 reduced resident trips from 55,744 to 49,976 (10.3 percent), and nonresident trips from 56,285 to 49,481 (12.1 percent). With a quality tax of 50 percent, resident trips decreased by about 17.3 percent and nonresident trips by 20.9 percent. In the long run, where both capital and labor are allowed to move freely among sectors, resident trips decreased marginally less in the long run than in the short run. The trip demand levels at higher prices correspond to the trip levels that would have been obtained from a shift in the demand curve to the left at the original cost per trip (Figure 2). The quality tax (even though not assessed) has the effect of shifting the demand curve because anglers are on a lower indifference curve.

Most market good regional and composite prices in the short run decreased because of the reduced aggregate regional demand. The exceptions are mining and manufacturing with the 25 percent quality tax. Services, trade, and finance show the greatest decrease in prices because of their direct linkages with trip demands. The long run composite prices of market goods are the same or higher than the short run levels. This is due to the mobility of capital in the long run. The regional prices are less than the composite prices in the short run for each sector except mining. This is because of the fixed nature of external prices and the effect of reduced aggregate demand on regional prices. The exception for mining and manufacturing may be due to shifting of resources out of other sectors into mining. In the long run analyses, regional agriculture, manufacturing, and trade prices are lower than the composite price with the 25 percent quality tax. With the 50 percent quality tax, all regional prices are lower than the composite prices.

Changes in output by sector are net results of changes in regional and composite prices, changes in factor prices, substitutions between factor inputs, elasticity of substitution between regionally produced and imported intermediate goods, and elasticity of transformation between regional supply and export. In both the short run and long run analysis, the overall output level decreased. The overall decrease for market goods is less than the percentage decrease for nonmarket goods which are directly affected by the quality tax. The changes in output by sector show mixed results. Output decreased in agriculture, trade, and services and increased for all other market goods with the 25 percent quality tax and short run. This means labor resources were shifting from the output decreasing sectors to the output increasing sectors. In the long

Table 5. Impacts of a Quality Tax on Fishing Trips and Commodity Markets, 1991.

Items	Base	Quality Tax (25%)		Quality Tax (50%)	
		Short Run	Long Run	Short Run	Long Run
Resident Trips					
Composite Price (index)	1.00000	1.24998	1.24999	1.49988	1.49993
Number of Regional Trips	55,744	49,976	49,977	46,120	46,121
Expenditure/Trip ($)	83.04	103.80	103.80	124.55	124.55
Non-Resident Trips					
Regional Price (index)	1.00000	1.25000	1.25000	1.50000	1.50000
No. of Trips	56,285	49,481	49,481	44,538	44,537
Expenditure/Trip	297.08	371.35	371.35	445.62	445.62
Regional Price (index)					
Agriculture	1.00000	0.99992	0.99996	0.99982	0.99986
Mining	1.00000	1.00002	1.00000	0.99903	0.99989
Construction	1.00000	0.99997	0.99999	0.99985	0.99989
Manufacturing	1.00000	1.00001	0.99999	0.99991	0.99990
Transport, Comm., & Utilities	1.00000	0.99999	1.00000	0.99986	0.99987
Trade	1.00000	0.99994	0.99998	0.99964	0.99979
Finance, Insurance, R. Est.	1.00000	0.99996	1.00001	0.99978	0.99987
Services	1.00000	0.99992	0.99999	0.99968	0.99984
Resident Fishing	1.00000	1.24998	1.24999	1.49988	1.49993
Non-resident trips	1.00000	1.25000	1.25000	1.50000	1.50000
Composite Price (index)					
Agriculture	1.00000	0.99994	0.99997	0.99988	0.99991
Mining	1.00000	1.00000	1.00000	0.99992	0.99999
Construction	1.00000	0.99998	0.99999	0.99986	0.99990
Manufacturing	1.00000	1.00000	1.00000	0.99998	0.99997
Transport, Comm., & Utilities	1.00000	0.99999	1.00000	0.99992	0.99993
Trade	1.00000	0.99996	0.99999	0.99977	0.99986
Finance, Insurance, R. Est.	1.00000	0.99998	1.00000	0.99988	0.99993
Services	1.00000	0.99995	0.99999	0.99980	0.99990
Resident trips	1.00000	1.24998	1.24999	1.49988	1.49993
Sectoral Output (index)					
Agriculture	1.00000	0.99995	0.99983	0.99999	0.99982
Mining	1.00000	1.00003	1.00013	0.99967	1.00045
Construction	1.00000	1.00001	1.00002	1.00003	1.00012
Manufacturing	1.00000	1.00016	1.00031	1.00028	1.00034
Transport, Comm., & Utilities	1.00000	1.00005	1.00008	1.00012	1.00008
Trade	1.00000	0.99995	0.99993	0.99955	0.99940
Finance, Insurance, R. Est.	1.00000	1.00001	0.99997	1.00002	0.99989
Services	1.00000	0.99972	0.99962	0.99931	0.99905
Resident Fishing	1.00000	0.89652	0.89653	0.82735	0.82736
Non-resident Fishing	1.00000	0.87911	0.87910	0.79128	0.79126
Total	1.00000	0.99979	0.99982	0.99956	0.99956
Exports (index)					
Agriculture	1.00000	1.00007	0.99989	1.00023	1.00002
Mining	1.00000	1.00002	1.00013	0.99990	1.00048
Construction	1.00000	1.00007	1.00004	1.00037	1.00037
Manufacturing	1.00000	1.00016	1.00031	1.00034	1.00041
Transport, Comm., & Utilities	1.00000	1.00008	1.00009	1.00056	1.00046
Trade	1.00000	1.00011	0.99998	1.00048	0.99995
Finance, Insurance, R. Est.	1.00000	1.00010	0.99995	1.00061	1.00023
Services	1.00000	0.99991	0.99965	1.00002	0.99940
Non-resident Fishing	1.00000	0.87911	0.87910	0.79128	0.79126
Total	1.00000	0.99975	0.99982	0.99966	0.99968

run analysis, output decreased in agriculture, trade, finance, and services and increased for all other sectors. In general, the changes in output with the 50 percent quality tax are in the same direction as with the 25 percent tax but at a higher level of magnitude.

The overall export level decreased in the short run and in the long run. The decrease in export demand is heavily influenced for the decrease in nonresident trip demand. The level of exports in the short run increased for all market goods except trade with the 25 percent tax and all except mining with the 50 percent tax. This increase in exports is expected because reduced aggregate demand lowers regional prices relative to out-of-region prices and induces export demand. The level of export demand in the long run for market goods has increased more with the 50 percent quality tax compared to the 25 percent quality tax.

Factor Markets

It is in the factor markets where distinction occurs between the short run and the long run. In the short, capital is fixed by sector but labor is mobile between sectors and between regions. In the long run, both labor and capital are mobile between sectors and regions. Land is fixed in both short and long run.

Both in the short run and long run, the overall wage rate decreased (Table 6). Long run wage rates are marginally higher than short run rates. This is expected because capital flows out of the region in the long run, thus increasing labor demand and increasing wage rate. In the short run, wage rate declined by 0.006 percent and 0.031 percent with a 25 percent and a 50 percent quality tax rate, respectively. Equilibrium wage rate is determined by supply of and demand for labor. In the short run, total labor demand decreased marginally with a 25 percent quality tax. The decline in labor demand is higher for a 50 percent quality tax. In the long run, labor demand increased marginally with a 25 percent quality tax rate. Labor demand, however, declined with a 50 percent tax.

Lower internal wage rate relative to a fixed out-of-region wage rate encourages outmigration. Migration of labor depends on the assumed labor migration elasticity (0.92 in this study). In the short run, labor outmigrated from the Lake Texoma region by 0.006 percent and 0.029 percent of the initial total labor supply with a 25 percent and a 50 percent quality tax rate, respectively. This is equivalent to a loss of 8 and 30 jobs, respectively. The outmigrated labor receives labor compensation at the out-of-region wage rate (1.0 base) and amounts to $114,528 and $596,077 with a 25 percent and a 50 percent quality tax, respectively. In the long run analysis, the loss of jobs and out-of-region labor compensation amounts are marginally less than that of the short run levels.

Both in the short run and long run analyses, labor demand increased in sectors where output increased: mining (except with the 50 percent quality tax), construction, manufacturing, transport, and finance. La-

Table 6: Impacts of Reduced Trips on Factor Markets.

Items	Base	Quality Tax (25%)		Quality Tax (50%)	
		Short Run	Long Run	Short Run	Long Run
Labor					
Labor Demand (index)	1.00000	0.99999	1.00001	0.99983	0.99985
Wage Rate (index)	1.00000	0.99994	0.99996	0.99969	0.99971
Migration					
No. of Jobs	0	-7.54	-6.68	-29.83	-29.18
Compensation ($)	0	-114,528	-69,282	-596,077	-545,428
Industry Demand (index)					
Agriculture	1.00000	0.99979	0.99975	0.99995	0.99980
Mining	1.00000	1.00013	1.00018	0.99836	1.00059
Construction	1.00000	1.00002	1.00003	1.00004	1.00017
Manufacturing	1.00000	1.00027	1.00033	1.00046	1.00041
Transport, Comm., & Utilities	1.00000	1.00010	1.00011	1.00024	1.00017
Trade	1.00000	0.99993	0.99994	0.99944	0.99943
Finance, Insurance, R. Est.	1.00000	1.00002	1.00001	1.00006	1.00003
Services	1.00000	0.99964	0.99964	0.99911	0.99909
Capital					
Capital Demand (index)	1.00000	1.00000	1.00002	1.00000	0.99990
Capital Rent (index)	1.00000	1.00003	1.00003	0.99955	0.99989
Capital Migration					
Rents ($)	NA	-59,843	-36,204	-311,343	-284,985
Flows ($)	NA	0.0	+29,140	0.0	-121,290
Industry Rents (index)					
Agriculture	1.00000	0.99973	1.00003	0.99964	0.99989
Mining	1.00000	1.00007	1.00003	0.99805	0.99989
Construction	1.00000	0.99996	1.00003	0.99973	0.99989
Manufacturing	1.00000	1.00021	1.00003	1.00015	0.99989
Transport, Comm., & Utilities	1.00000	1.00004	1.00003	0.99993	0.99989
Trade	1.00000	0.99987	1.00003	0.99913	0.99989
Finance, Insurance, R. Est.	1.00000	0.99996	1.00003	0.99975	0.99989
Services	1.00000	0.99958	1.00003	0.99980	0.99989
Land					
Land Demand (index)	1.00000	1.00000	1.00000	1.00000	1.00000
Land Rent (index)	1.00000	0.99973	0.99971	0.99964	0.99952
Migration					
Rents ($)	NA	-2,135	-1,291	-11,108	-10,163

bor demand decreased in agriculture, trade, and services. The decline in labor demand is the highest for the services sector in all scenarios because of its strong linkages with trip demands.

In all scenarios, the change in total labor use is less than the change in the wage rate. This result is consistent with results of Budiyanti (1995). Budiyanti attributed this result to at least three factors: (1) a slight inelasticity of labor migration which means that the change in overall wage rate leads to a smaller than proportional change in labor supply; (2) a negative income elasticity of labor supply, which means that with a lower wage rate (and subsequent income) households supply

more labor; and (3) a lower wage rate increases industry demand for labor in the region.

Labor supply, which is determined by the labor-leisure choice, increased for each household income group. The largest percentage increase was for high income households because the income elasticity of labor supply was assumed to be larger in absolute value (-0.24) when compared to low income households (-0.12). The increase in labor supply is higher with the 50 percent quality tax compared to the 25 percent quality tax. The increase in labor supply is marginally less in the long run compared to the short run because of higher wage rates in the long run.

In the short run, capital is fixed by sector and hence the total capital demand remains unchanged. In the long run, capital demand increased with the 25 percent quality tax but decreased with the 50 percent quality tax. In both the short run and the long run, the overall capital rent increased for the 25 percent quality tax but decreased for the 50 percent quality tax. The decrease in capital rent was higher in the short run than in the long run.

Out-migrating households are assumed to take their proportional capital compensation with them. This assumption is based on no changes in resource ownership. With a quality tax of 25 percent, the impact region lost $59,843 and $36,204 in the short run and long run, respectively, in the form of compensation for out-migrating household capital ownership. With a 50 percent quality tax, the amount of compensation increased to $311,343 and $284,985 in the short run and long run, respectively.

In the long run, a small amount of capital ($29,140) flows into the region with a 25 percent quality tax due to the higher overall capital rent. However, with a 50 percent quality tax rate, $121,290 of capital migrates from the region.

The capital rents by industry in the short run show mixed results. With a 25 percent quality tax, capital rents decreased for all sectors except mining, manufacturing, and transport. Capital rent in the services sector decreased by the highest percentage. With a 50 percent quality tax, capital rents decreased for all sectors except manufacturing in the short run. The highest percentage decrease in the price of capital is in the mining sector.

Land demand was assumed fixed for all scenarios. Rental price of land for agriculture decreased both in the short run and long run. The decrease in land rent is higher in the long run than in the short run. In the short run, out-migrating households received $2,135 and $11,108 for compensation of land ownership with the 25 percent and the 50 percent quality tax, respectively. Compensation to out-migrating households for land ownership is less in the long run than in the short run because of lower rent in the long run.

Welfare Impacts of Reduced Trips

Impacts of reduced trips from the imposed quality tax are discussed in terms of how it affects the welfare of (1) anglers, (2) the impact region, and (3) households remaining in the region.

Anglers. In the short run, the quality tax cost to resident anglers is equivalent to $1,037,403 at the 25 percent quality tax and $1,914,462 at the 50 percent quality tax (Table 7). The cost in the long run is marginally higher compared to the short run. The increase cost per trip for the 25 percent quality tax is $20.76 and $41.51 for the 50 percent

Table 7: Welfare Impacts of Reduced Trips.

Items	*Base*	*Quality Tax (25%)*		*Quality Tax (50%)*	
		Short Run	*Long Run*	*Short Run*	*Long Run*
Anglers					
Resident Anglers					
Quality tax ($)	0	1,037,403	1,037,488	1,914,462	1,914,663
Consumer Surplus Change ($)	NA	-1,097,270	-1,097,350	-2,114,210	-2,114,410
Non-Resident Anglers					
Quality tax ($)	0	3,674,969	3,674,924	6,615,688	6,615,519
Consumer Surplus Change ($)	NA	-3,890,490	-3,890,470	-7,413,860	-7,413,780
Total Anglers					
Quality tax ($)	0	4,712,372	4,712,412	8,530,150	8,530,182
Consumer Surplus Change ($)	NA	-4,987,760	-4,987,820	-9,528,070	-9,528,190
Impact Region					
Gross Regional Product					
Index	1.00000	0.99996	1.00000	0.99957	0.99969
Change ($)	NA	-157,548	0.00	-1,642,789	-1,179,424
Industry Value-Added (index)					
Agriculture	1.00000	1.00095	0.99983	0.99999	0.99982
Mining	1.00000	1.00003	1.00013	0.99967	1.00045
Construction	1.00000	1.00001	1.00002	1.00003	1.00012
Manufacturing	1.00000	1.00016	1.00031	1.00028	1.00034
Transport, Comm., & Utilities	1.00000	1.00005	1.00008	1.00012	1.00008
Trade	1.00000	0.99995	0.99993	0.99955	0.99940
Finance, Insurance, R. Est.	1.00000	1.00001	0.99997	1.00002	0.99989
Services	1.00000	0.99972	0.99962	0.99931	0.99905
Total	1.00000	0.99999	1.00001	0.99989	0.99986
Households Remaining					
Change in Welfare ($)					
Low Income	NA	-271,908	-288,527	-495,734	-535,727
Medium Income	NA	-521,033	-541,455	-967,840	-1,024,178
High Income	NA	-319,195	-319,857	-697,255	-695,385
Total	NA	-1,112,136	-1,149,839	-2,160,829	-2,255,290
Change in Household Income ($)					
Low Income	NA	-7,004	-2,487	-55,520	-43,328
Medium Income	NA	-16,474	-3,822	-141,849	-117,591
High Income	NA	-18,340	+4,285	-237,006	-183,486
Total	NA	-41,818	-2,024	-434,375	-343,405

quality tax. Resident anglers will have a loss in consumer surplus of $1,097,270 and $2,114,210 with the 25 percent and 50 percent quality tax, respectively.

Non-resident angler cost is the equivalent of $3,674,969 for the 25 percent tax and $6,615,688 for the 50 percent tax in the short run analysis. The cost in the long run is marginally less than in the short run. The increase cost per trip for the 25 percent quality tax is $95.23 and $148.54 for the 50 percent quality tax. Non-resident anglers will have a loss in consumer surplus of $3,890,490 and $7,413,860 with the 25 percent and a 50 percent quality tax, respectively. The total consumer surplus loss for both resident and non-resident anglers is $4,987,760 with the 25 percent quality tax and $9,528,070 with 50 percent quality tax.

Region. The gross regional product, which is the sum of factor income and indirect business taxes, decreased by $157,548 with the 25 percent tax and $1,642,789 with the 50 percent quality tax in the short run. In the long run, gross regional product remained unchanged for the 25 percent quality tax because the higher capital rent more than off-set the losses associated with migration of labor. With the 50 percent quality tax, the change in gross regional product is negative in the long run but less than in the short run. The higher wage rate and capital rents in the long run plus the lower labor migration effects in the long run more than off-set the capital migration in the long run compared to the short run.

In the short run, value-added by industry increased for all industries except trade and services at the 25 percent quality tax. These exceptions are because of close linkages with angler trips. The decrease in value-added is highest for services. Aggregate value-added, however, decreased. At the 50 percent tax, value-added increased for construction, manufacturing, transport, and finance sectors and decreased for others. Aggregate value-added by industry decreased.

In the long run analysis, aggregate value-added by industry marginally increased at the 25 percent tax but decreased at the 50 percent tax. Value-added increased for the mining, construction, manufacturing and transport sectors and decreased for all other sectors, both at the 25 percent and the 50 percent quality tax.

Households. Compensating variation for households is computed to assess the impact of simultaneous changes in prices and incomes on household welfare. Households staying in the region had a welfare loss equal to $1,112,136 and $1,149,839 for short run and long run models, respectively, with the 25 percent quality tax and a loss equal to $2,160,829 and $2,255,290 for short run and long run models, respectively, with the 50 percent quality tax. The medium income household group faced the largest loss in every scenario followed by the high income household group.

In the short run, each household group staying in the region showed a decrease in household income with the high income class showing the largest decrease in absolute value both at 25 percent and 50 percent tax rate ($18,340 with a 25 percent tax and $237,006 with a 50 percent tax) followed by the medium income class. In the long run with a 25 percent tax, however, high income households showed an increase in income ($4,285) whereas low and medium income households experienced a loss in income. The increase in income for high income households is associated with the increase in capital rent. At a 50 percent tax, all household groups lost income but the loss is less than that of the short run.

Comparisons of income and welfare losses for each household income group at different scenarios gave consistent results. In all scenarios, the welfare loss is greater than the income loss for all household income groups. This implies that the price effect is greater than the income effect for all household groups.

Results of the fixed-price multiplier analysis from Table 1 may be compared to the regional general equilibrium results of Table 7. In Table 1, the assumption is that angler trips go to zero and the loss in gross regional product is $14,602,000 (aggregate value-added). For Table 7, the assumption of a 50 percent quality tax on angler trips reduces trips by 19.1 percent and reduces gross regional product by $1,642,789 in the short run and $1,179,424 in the long run. The proportional amount (19.1 percent) of $14,602,000 is $2,788,982 suggesting that the fixed-price multiplier analysis tends to over estimate the impacts of reduced angler trips when compared to regional general equilibrium results.

Similarly, employment losses under fixed-price multiplier analysis when angler trips go to zero is 654 jobs (Table 1). Under regional general equilibrium analysis, for a reduction of angler trips by 19.1 percent, labor migration is equal to about 30 jobs (Table 6). The same proportional amount under fixed-price multiplier analysis would be a loss of 125 jobs. Clearly, the regional general equilibrium model identifies alternatives for employment with the region compared to the fixed-price multiplier model.

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APPENDIX

APPENDIX 1
RIMS SECTOR AGGREGATION

RIMS	*IMPLAN Database Sector Number*	*Standard Industrial Classification (SIC) 1987*
Agriculture, forestry, and fisheries:		
1. Agricultural products and agricultural, forestry, and fisheries services	1-23, 26-27	01, 02, 07, 08, 09 (exc. 074, 081, 083, 097, 091)
2. Forestry and fishery products	24-25	081, 083, 097, 091
Mining:		
3. Coal mining forestry, and fisheries services	37	12 083, 097, 091)
4. Crude petroleum and natural gas	38-39	131, 132
5. Miscellaneous mining	28-36, 40-47	10,14
Construction:		
6. New construction	48-54	Part 15, 16, 17
7. Maintenance and repair construction	55-57	138, Part 15, 16, 17
Manufacturing:		
8. Food and kindred products and tobacco	58-107	20,21
9. Textile mill products	108-123	22
10. Apparel	124-132	23
11. Paper and allied products	171-183	27
12. Printing and publishing	174-185	27
13. Chemicals and petroleum refining	186-214	28, 29
14. Rubber and leather products	215-217, 219-229	301, 302, 3052, 306, 308, 31
15. Lumber and wood products and furniture	133-142, 144-160	24 (exc. 2451), 25
16. Stone, clay, and glass products	218, 230-253	3053, 32
17. Primary metal industries	254-272, 290-291	33, 3462, 3463
18. Fabricated metal products	273-289, 292-306, 396, 398	34 (exc. 3462, 3463), 3761, 3795
19. Machinery, except electrical	307-323, 325-354, 382	35 (exc. 3548), 3695
20. Electric and electronic equipment	324, 355-381, 383, 404, 410 411	3458, 36 (exc. 3695), 3825, 3844, 3845
21. Motor vehicles and equipment	384-387	3711, 3713, 3714, 3715
22. Transportation equipment, except motor vehicles	143, 388-395, 397, 399	2451, 3716, 372-5, 3792, 3799
23. Instruments and related products	400-403,405-409, 412-414	38 (exc. 3825, 3844, 3845)
24. Miscellaneous manufacturing industries	415-432	39
Transportation and public utilities:		
25. Transportation	433-440, 513	40, 41, 42, 44, 45, 46, 47, 4311
26. Communication	441-442	48
27. Electric, gas, water, and sanitary services	443-446, 514	49
Wholesale and retail trade:		
28. Wholesale trade	447	50, 51
29. Retail trade	448-453, 455	52-7, 59
Finance, insurance, and real estate:		
30. Finance	456-458	60, 61, 62, 67 (exc. 6732)
31. Insurance	459-460	63, 64
32. Real estate	461-462	65
Services		
33. Hotels and lodging places and amusements		463, 483-489 70, 78, 79
34. Personal services	464-468, 480-481	721-9
35. Business services	469-476, 482, 494, 506-509	73, 769, 811, 87
36. Eating and drinking places	454	58
37. Health services	490-493	80, 074
38. Miscellaneous services	477-479, 495-505, 510-512, 515	6732, 75, 82-86, 8922, part of 41 & 491

* Includes Federal Government Enterprises

Sources: Regional Multipliers: A User Handbook for Regional Input-Output Modeling System (RIMS II), USDC, BEA, 1992, and Micro IMPLAN User's Guide Version 91-F, USDA Forest Service, 1994.

APPENDIX 2
SECTOR AGGREGATION FOR IMPACT REGION

Impact Region Sector	*RIMS Sector Number*	*IMPLAN Sector Number*
1. Ag, Forestry, Fishery Products and Services	1-2	1-27
2. Mining	3-5	28-47,186-214,218,230-253
3. Construction	6-7	48-57
4. Manufacturing	8-24	58-432
5. Transportation, Communication, Utilities	25-27	433-446, 513-514
6. Trade (Wholesale, Retail)	28-29	447-453, 455
7. Finance, Insurance, Real Estate	30-32	456-462
8. Other Services	33-38	454, 463-515

APPENDIX 3

TEXOMA MARKET AND NONMARKET GOODS REGIONAL GENERAL EQUILIBRIUM MODEL

	Equation	Description Equations	No. of Equations	Endogenous Variables	Exogenous Variables	Parameters
	PRODUCTION BLOCK					
1.	$LAB_i = \frac{\alpha_i^L PN_i X_i}{PL}$, $i \in M$	*Labor demand*	*m*	$LAB_i\ PN_i\ PL\ X_i$		α_i^L
2.	$CAP_i = \frac{\alpha_i^K PN_i X_i}{PK_i}$, $i \in M$	*Capital demand*	*m*	$CAP_i\ PN_i\ PK_i\ X_i$		α_i^K
3.	$LAND_i = \frac{\alpha_i^T PN_i X_i}{PT_i}$, $i \in M$	*Land demand*	*m*	$LAND_i\ PN_i\ PT_i\ X_i$		α_i^T
4.	$VA_i = a_{0i} X_i$, $i \in M$	*Value added*	*m*	$VA_i\ X_i$		a_{0i}
5.	$V_{ji} = a_{ji} X_i$, $i \in M, NM; j \in M$	*Intermediate demand*	*n* x *m*	$V_{ji}\ X_i$		a_{ji}
6.	$VA_i = \phi_i^{VA} LAB_i^{\alpha_i^L} CAP_i^{\alpha_i^K} LAND_i^{\alpha_i^T}$, $i \in M$	*Value added production function*	*m*	$VA_i\ LAB_i\ CAP_i\ LAND_i$		$\phi_i^{VA}\ \alpha_i^L\ \alpha_i^K\ \alpha_i^T$
7.	$V_{ji} = \phi_{ji}^V \left[\delta_{ji}^V VM_{ji}^{\rho_j^V} + \left(1 - \delta_{ji}^V\right) VR_{ji}^{\rho_j^V} \right]^{\frac{1}{\rho_j^V}}$, $\sigma_j^V = \frac{1}{1-\rho_j^V}$ $i \varepsilon M, NM; j \varepsilon M$	*Domestic and import substitution*	*n* x *m*	$V_{ji}\ VM_{ji}\ VR_{ji}$		$\phi_{ji}^V\ \delta_{ji}^V\ \rho_j^V\ \sigma_j^V$
8.	$TV_i = \sum_j V_{ij}$, $i \in M, NM; j \in M$	*Total intermediate demand*	*n*	$TV_i\ V_{ij}$		

APPENDIX 3 (Continued)

	Equation	Description Equations	No. of Equations	Endogenous Variables	Exogenous Variables	Parameters
9.	$VR_{ji} = VM_{ji}\left[\left(\frac{1-\delta_{ji}^{V}}{\delta_{ji}^{V}}\right)\left(\frac{PM0_j}{PR_j}\right)\right]^{\sigma_j^V}$, $i \in M,\ NR;\ j \in M$	*Intermediate regional demand*	$m^2 + (nr \times m)$	$VM_{ji}\ VR_{ji}\ PR_j$	$PM0_j$	$\delta_{ji}^{V}\ \sigma_j^{V}$
10.	$VR_{ji} = V_{ji}$, $i \in NE;\ j \in M$	*Intermediate regional demand*	$m \times ne$	$V_{ji}\ VR_{ji}$		
11.	$VM_{ji} = 0$, $i \in NE\ j \in M$	*Intermediate imported demand*	$m \times ne$	VM_{ji}		
12.	$TVR_i = \sum_j VR_{ji}$, $i \in M,\ NM;\ j \in M$	*Total intermediate regional demand*	n	$TVR_i\ VR_{ji}$		
13.	$TVM_i = \sum_j VM_{ji}$, $i \in M,\ NM;\ j \in M$	*Total intermediate imported demand*	n	$TVM_i\ VM_{ji}$		
14.	$X_i = \phi_i^x\left[\delta_i^x EXP_i^{\rho_i^x} + \left(1-\delta_i^x\right)R_i^{\rho_i^x}\right]^{\frac{1}{\rho_i^x}}$, $\sigma_i^X = \frac{1}{\rho_i^X - 1}$, $i \in M$	*Regional supply*	m	$X_i\ EXP_i\ R_i$		$\phi_i^x\ \delta_i^x\ \rho_i^x\ \sigma_i^x$
15.	$R_i = EXP_i\left[\left(\frac{1-\delta_i^x}{\delta_i^x}\right)\left(\frac{PE0_i}{PR_i}\right)\right]^{-\sigma_i^x}$, $i \in M$	*Regional supply for regional demand (market goods)*	m	$R_i\ EXP_i\ PR_i$	$PE0_i$	$\phi_i^x\ \delta_i^x\ \sigma_i^x$
16.	$R_i = X_i$, $i \in NR$	*Regional supply for regional demand (nonmarket goods for resident)*	nr	$R_i\ X_i$		

APPENDIX 3 (Continued)

	Equation	Description Equations	No. of Equations	Endogenous Variables	Exogenous Variables	Parameters
17.	$R_i = 0$, i∈NE	*Regional supply for regional demand (nonmarket good for nonresident)*	ne	R_i		
18.	$EXP_i = 0$, i∈NR	*Export (nonmarket good for resident)*	nr	EXP_i		
19.	$EXP_i = E0_i\left(P_i + q_{tax}\right)^{\varepsilon^{trip}}$, i∈NE	*Export (nonmarket good for nonresident)*	ne	EXP_i P_i	$E0_i$ qtax	ε^{trip}
	INCOME BLOCK					
20.	$YL = PL(TLAB + LHHH0 + LGOV0)$ $+ \text{PLROC0}\left(\sqrt{\text{TLMIG}^2} - \text{TLMIG}\right) 0.5$ $- PL\left(\sqrt{\text{TLMIG}^2} + \text{TLMIG}\right) 0.5$	Labor income	1	*YL PL TLMig TLAB*	*PLROC0 LHHH0 LGOV0*	
21.	$YK = \sum_i \left(CAP_i PK_i\right) + PKROCO$ $\left(\sqrt{\text{KMIG}^2} - \text{KMIG}\right) 0.5 - \text{PK(Agr)}$ $\left(\sqrt{\text{KMIG}^2} + \text{KMIG}\right) 0.5$	Capital income	1	*YK* CAP_i Pk_i KMiG	*PKROC0*	
22.	$YENT = YK - \left(1 - Ktax\right)$	Enterprise income	1	*YENT YK*		*ktax*

APPENDIX 3 (Continued)

	Equation	Description Equations	No. of Equations	Endogenous Variables	Exogenous Variables	Parameters
23.	$YT = \sum_i \left(LAND_i PT_i\right),\ i \in M$	*Land income*	*1*	$YT\ LAND_i\ PT_i$		
24.	$AYL = PL\left(\sum_i LAB_i + LHHH0 + LGOV0\right)$	*Adjusted labor income*	*h*	AYL, PL, LAB_i	$LHHH0$ $LGOV0$	
25.	$adjL = \frac{LS0_h + LMig_h}{TLS0}$	*Household adjustment factor*	*h*	$LMig_h$ $AdjL$	$LS0_h$ $TLS0$	
26.	$YH_h = PL\left(LS_h + LMig_h\right)\left(1 - SStax\right) + \ell_h YT_h\left(1 - ttax\right) + \ell_h\left(Yent - retrYK\right) + TRGOV_h + \ell tr_h\left[LLTRH0 + LMTRH0 + LHTRHO\right] - \left[\sqrt{Mratio^2 - Mratio}\right] 0.5 \left[t_h YT_h\left(1 - ttax\right) + e_h\left(YENT - retrYK\right)\right] + REMIT0_h + \ell tr_h\left(LLTRHO + LMTRHO + LHTRH0\right)\Big]$	*Household income*	*h*	YH_h	$TRGOV0_h$ $LHTRHO$ $LMTRH0$ $LLTRH0$	$retr$ ℓ_h, t_h e_h ltr_h $ttax$
27.	$DYH_h = YH_h\left(1 - hhtax_h\right)$	*Disposable income*	*h*	$DYH_h\ YH_h$		$hhtax_h$
28.	$HSAV_h = mps_h YH_h$	*Household saving*	*h*	$HSAV_h\ YH_h$		mps_h
29.	$GSP = YL + YK + YT + \Sigma_i ibtax_i X_i,\ i \in M$	*Gross state product*	*1*	$GSP\ YL\ YK\ YT\ X_i$		$ibtax_i$

APPENDIX 3 (Continued)

	Equation	Description Equations	No. of Equations	Endogenous Variables	Exogenous Variables	Parameters
	EXPENDITURE BLOCK					
30.	$AHEXP_h = DYH_h - HSAV_h PL * LLHH0_h - LLTRH$	*Household expenditure*	*h*	$HEXP_h$ DYH_h $HSAV_h$ PL	$LLH0_h$ $LLTRHO$	
31.	$Q_{ih} = adjL\gamma_{ih} + \left(\frac{\beta_{ih}}{(1-\beta_{0h})PX_i}\right)\left(AHEXP_h - adjL\sum_j P_j\gamma_{jh}\right),\ i, j \in M, NR$	*Composite demand for hh consumption*	h(m+nr)	Q_{ih} P_i $HEXP_h$ P_j		γ_{ih} β_{ih} β_{0h} γ_{jh}
32.	$Q_{ih} = \phi_i^Q\left[\delta_i^Q QM_{ih}^{\rho_i^Q} + (1-\delta_i^Q) QR_{ih}^{\rho_i^Q}\right]^{\frac{1}{\rho_i^Q}}, \sigma_i^Q = \frac{1}{1-\rho_i^Q},\ i \in M, NR$	*Domestic and import hh demand substitiution*	h(m+nr)	Q_{ih} QM_{ih} QR_{ih}		ϕ_i^Q δ_i^Q ρ_i^Q σ_i^Q
33.	$Q_{ih} = 0$, i∈NE	*Composite demand for hh consumption (non - market good: for nonresident)*	h x ne	Q_{ih}		
34.	$QR_{ih} = QM_{ih}\left[\left(\frac{1-\delta_i^Q}{\delta_i^Q}\right)\left(\frac{PM0_i}{PR_i}\right)\right]^{\frac{1}{1-\rho_i^Q}}$, i∈M, NR	*Regional hh demand for consumption*	h(m+nr)	QR_{ih} QM_{ih} PR_i	$PM0_j$	δ_i^Q ρ_i^Q
35.	$TQ_i = \sum_h Q_{ih}$, i∈M, NR	*Total household demand*	m+nr	TQ_i Q_{ih}		

APPENDIX 3 (Continued)

	Equation	Description Equations	No. of Equations	Endogenous Variables	Exogenous Variables	Parameters
36.	$TQR_i = \sum_h QR_{ih}$, i∈M, NR	*Total household regional demand*	m+nr	TQR$_i$ QR$_{ih}$		
37.	$TQM_i = \sum_h QM_{ih}$, $i \in M, NM$	*Total household imported demand*	*m+nr*	*TQM$_i$ QM$_{ih}$*		
38.	$LS_h = MAXHOURS0_h - \left(\frac{\beta_{0h}}{PL}\right) \left(\frac{AHEXP_h - \sum_{j=1}^{n} PX_j \gamma_{jh}}{1-\beta_{0h}}\right)$, $j \in M, NR$	*Household labor supply*	*h*	*LS$_h$ PL P$_j$ HEXP$_h$*	*MAXHOURS0$_h$*	*β_{0h} γ_{jh}*
39.	$ALS_h = LS_h$ * AdjL	*Adjusted labor supply*	*h*	*LS$_h$ ALS$_h$*		
40.	$TLS = \sum_h LS_h$	*Total Labor supply*	*1*	*TLS LS$_h$*		
41.	$YGOV = \left(\sum_i ibtax_i PR_i X_i\right) + \left(sstaxYL\right) + \left(ktaxYK\right) + \left(ttaxYT\right) + \sum_h hhtax_h * Y_h + GOVBOR0 + GOVITR0$, $i \in M$	*Government revenue*	*1*	*YGOV PR$_i$ X$_i$ YL YK YT YH$_h$*	*GOVBOR0 GOVLITRO*	*ibtax$_i$ sstax ktax ttax hhtax$_h$*
42.	$GOVEXP = \sum_i QGOV_i P_i + \sum_h adjL * TRGOV0_h + PL * LGOV0 + GOVITRO$, $i \in M$	*Government expenditures*	*1*	*QGOV$_i$ GOVEXP QGOV$_i$ P$_i$ PL*	*LGOV0 TRGOV0$_h$ GOVITR0*	

APPENDIX 3 (Continued)

	Equation	Description Equations	No. of Equations	Endogenous Variables	Exogenous Variables	Parameters
43.	$QGOV_i = QGOV0_i,\ i \in M$	*State / Local gov commodity demand*	*m*	$QGOV_i$	$QGOV0_i$	
44.	$QGOV_i = \phi_i^{GOV}\left[\delta_i^{GOV} QGOVM_i^{\rho_i^{GOV}} + \left(1-\delta_i^{GOV}\right) QGOVR_i^{GOV}\right]^{\frac{1}{\rho_i^{GOV}}},\ i \in M$	*government domestic and import demand substitution*	*m*	$QGOV_i$ $QGOVM_i$ $QGOVR_i$		ϕ_i^{GOV} δ_i^{GOV} ρ_i^{GOV} σ_i^{GOV}
45.	$QGOVR_i = QGOVM_i\left[\left(\frac{1-\delta_i^{GOV}}{\delta_i^{GOV}}\right)\left(\frac{PM0_i}{PR_i}\right)\right]^{\frac{1}{1-\rho_i^{GOV}}},\ i \in M$	*State / Local government demand for regional good*	*m*	$QGOVR_i$ $QGOVM_i$ PR_i	$PM0_i$	δ_i^{GOV} ρ_i^{GOV}
46.	$SAV = \sum_h \left(HSAV_h * AdjL\right) + retrYK + ROWSAV0$	*Total Saving*	*1*	*SAV HSAVh YK YENT*	*ROWSAV0*	*depr retr*
47.	$QINV_i = \phi_i^{INV}\left[\delta_i^{INV} QINVM_i^{\rho_i^{INV}} + \left(1-\delta_i^{INV}\right) QINVR_i^{\rho_i^{INV}}\right]^{\frac{1}{\rho_i^{INV}}},\ \sigma_i^{INV} = \frac{1}{1-\rho_i^{INV}},\ i \in M,$	*Investment demand substitution between region and import*	*m*	*QINVi QINVMi QINVRi*		ϕ_i^{INV} δ_i^{INV} ρ_i^{INV} σ_i^{INV}
48.	$QINV_i = QINV0_i,\ i \in M$	*Investment demand*	*m*	$QINV_i$	$QINV0_i$	

APPENDIX 3 (Continued)

	Equation	Description Equations	No. of Equations	Endogenous Variables	Exogenous Variables	Parameters
49.	$QINVR_i = QINVM_i \left[\left(\frac{1-\delta_i^{INV}}{\delta_i^{INV}} \right) \left(\frac{PM0_i}{PR_i} \right)^{\frac{1}{1-\rho_i^{INV}}} \right]$; $i \in M$	*Investment demand for regional good*	*m*	$QINVR_i$ $QINVM_i$ PR_i	$PM0_i$	δ_i^{INV} ρ_i^{INV}
50.	$INV = \sum_i QINV_i P_i$, $i \in M$	*Total investment*	*1*	INV $QINV_i$ P_i		
51.	$M_i = TVM_i + TQM_i + QGOVM_i + QINVM_i$, $i \in M$	*Import (market goods)*	*m*	M_i TVM_i TQM_i $QGOVM_i$ $QINVM_i$		
52.	$M_i = TVM_i + TQM_i$, $i \in NR$	*Import (nonmarket good)*	*nr*	M_i TVM_i TQM_i		
	PRICE BLOCK					
53.	$PN_i = PR_i - \sum_j a_{ji} P_j - ibtax_i PR_i$, $i \in M$; $j \in M$	*Net price*	*n*	PN_i PR_i P_i		a_{ij} $ibtax_i$
54.	$P_i = \frac{PR_i R_i + PM0_i M_i}{R_i + M_i}$, $i \in M$, NR	*Composite price*	*m+nr*	P_i PR_i R_i M_i	$PM0_i$	

APPENDIX 3 (Continued)

Equation	Description Equations	No. of Equations	Endogenous Variables	Exogenous Variables	Parameters
55. $P_i = \frac{\sum_j P_j V_{ji}}{\sum_j V_{ji}}$, $i \in NE; j \in M$	*Composite price (nonmarket good for nonresident)*	*ne*	$P_i\ V_{ji}$		
56. $PR_i = \sum_j a_{ji} * P_j$,, $i \in NR; j \in M$	*Regional price (Non - market good for residents)*	*nr*	$PR_i\ P_{ij}$		a_{ji}
57. $PRX_i = PR_i$, $i \in M$	*Regional price faced by consumer with quality tax*	*m*	$PRX_i\ PR_{ii}$		
58. $PRX_i = PR_i + \text{qtax}_{,,}$ $i \in NR$	*Regional price faced by consumer with quality tax (non - market good)*	*nr*	$PRX_i\ PR_{ii}$		
59. $PX_i = \frac{PRX_i R_i + PMO_i M_i}{R_i + M_i}$, $i \in M, NR$	*Composite price faced by conmsumer with quality tax Exogeneous variables*	*m+nr*	$PRX_i\ PX_i\ R_i$	PMO_i	

APPENDIX 3 (Continued)

	Equation	Description Equations	No. of Equations	Endogenous Variables	Exogenous Variables	Parameters
	MARKET EQUILIBRIUM					
60.	$X_i + M_i = TV_i + TQ_i + QGOD_i + QINV_i + EXP_i$, $i \in M$	*Commodity market equilibrium*	*m*	X_i Mi TV_i TQ_i $QGOV_i$ $QINV_i$ EXP_i		
61.	$X_i + M_i = TQR_i + TQM_i$, $i \in NR$	*Nonmarket good equilibrium (for resident)*	*nr*	$X_i M_i TQR_i TQM_i$		
62.	$X_i = EXP_i$, $i \in NE$	*Nonmarket good equilibrium (for nonresident)*	*ne*	$X_i EXP_i$		
63.	$\sum_i LAB_i + LLHHO + LGOV0 = \sum_h LS_h + TLMIG$, $i \in M$	*Labor market equilibrium*	*l*	$LS_h TLMIG LAB_i$	*LLHH0* *LGOV0*	
64.	$LMIG_h = \left(\frac{LS0_h}{TLS0}\right)\left[L0_i + LLHHO + LGOV0\right] log\left(\frac{PL}{PL^{ROCO}}\right)\eta^L$, $i \in M$	*Labor migration*	*h*	$LMIG_h PL$	$LS0_h PL^{ROCO}$ *L0i LLHH0* *LGOV0*	η^L
65.	$CAP_i = KS0_i$, $i \in M$	*Capital market equilibrium (short run equilibrium)*	*m*	CAP_i	$KS0_i$	
66.	$\sum_i CAP_i = \sum_i KS0_i + KMIG$, $i \in M$	*Capital market equilibrium (long run equilibrium)*	*1*	$CAP_i KMIG$	$KS0_i$	

APPENDIX 3 (Continued)

	Equation	Description Equations	No. of Equations	Endogenous Variables	Exogenous Variables	Parameters
67.	$KMIG = \sum_i K0_i \log\left(\frac{PK("Agr")}{PK^{ROC0}}\right)^{\eta^K}$, $i \in M$	*Capital migration (long run equilibrium)*	*1*	*KMIG PK*	$K0_i PK^{ROC0}$	η^K
68.	$LAND_i = TS0_i$, $i \in M$	*Land market equilibrium*	*m*	$LAND_i$	$TS0_i$	

WELFARE MEASURE

Compensating Variation:

$$CV_h = \left(\frac{1}{1-\beta_{0h}}\right)\left[\left(AHEXP_h - adjL\sum_j PX_j\gamma_{jh}\right) - \left(adjL_h HEXP0_h - adjL\sum_j P0_j\gamma_{jh}\right)\prod_i\left(\frac{PX_i}{P0_i}\right)^{\beta_{ih}}\left(\frac{PL}{PL0}\right)^{\beta_{0h}}\right]$$, $ij \in M, NR,$

Changes in Compensating Variation by Household Income Group — *h*

Equivalent Variation:

$$EV_h = \left(\frac{1}{1-\beta_{0h}}\right)\left[\left(AHEXP_h - adjL\sum_j PX_j\gamma_{jh}\right)\prod_i\left(\frac{P0_i}{PX_i}\right)^{\beta_{ih}}\left(\frac{PL0}{PL}\right)^{\beta_{0h}} - \left(adjL_h HEXP0_h\right) - adjL\sum_j P0_j\gamma_j\right]$$, $ij \in M, NR,$

Changes in Equivalent Variation by Household Income Group — *h*

APPENDIX 4
DEFINITIONS OF INDICES, VARIABLES, AND PARAMETERS

Indices	Description
i,j	*Sectors: Agr, Min, Cnst, Transp, Trade, Finan, Ser, TFR and TFE*
f	*Factors of production: Lab (L), Cap (K), and Land (L)*
h	*Households: Low, Med, and High*
g	*Government*
mk,ml	*Set of market goods: Agr, Min, Cnst, Transp, Trade, Finan, Ser.*
nm	*Set of nonmarket goods: TFR and TFE*
nmr	*Nonmarket good: Resident trip (TFR)*
nme	*Nonmarket good: Nonresident trip (TFE)*
ci,cj	*Set of regional consumption goods: Agr, Min, Cons, Man, Transp, Trade, Finan, Ser, and TFR*
n	*Number of sectors = 10*
m	*Number of market good sectors = 8*
nr	*Number of nonmarket good consumed in the region = 1*
ne	*Number of nonmarket good exported = 1*
h	*Number of household income size = 3*
f	*Number of factor = 3*

Variables	Description	No. of Variables
PRODUCTION BLOCK		
L_i	*Labor demand*	*m*
K_i	*Capital demand*	*m*
T	*Land demand*	*m*
VA_i	*Value added*	*m*
V_{ji}	*Intermediate demand*	*n x m*
VM_i	*Imported intermediate input demand*	*n x m*
VR_{ji}	*Regional intermediate input demand*	*n x m*
TVM_i	*Total imported intermediate input demand*	*m*
TVR_i	*Total regional intermediate input demand*	*m*
TV_i	*Total composite intermediate input demand*	*m*
X_j	*Composite good supply*	*n*
EXP_i	*Export of regional products*	*n*
R_i	*Regional supply of regional products*	*n*
$E0_{is}$	*Initial export*	*n*
INCOME BLOCK		
LHHH0	*Labor employed by households*	*1*
LGOV0	*Labor employed by government*	*1*
LS0	*Initial stock of labor*	*1*
KS0	*Supply of private capital*	*1*
TS0	*Supply of land*	*1*
YL	*Labor income*	*1*
TYL	*Total labor income*	*1*
YK	*Capital income*	*1*
YT	*Land income*	*1*
YH_h	*Household income*	*h*
DYH_h	*Disposable household income*	*h*
$HSAV_h$	*Household saving*	*h*
$TRGOV0_h$	*gov transfer payment to households*	*h*
$REMIT0_h$	*Net remittance from rest-of-country to households*	*h*
YENT	*Enterprise income*	*h*

APPENDIX 4 (Continued)

Variables	Description	No. of Variables
GOV	*Government revenue/income*	*1*
GRP	*Gross Regional Product*	*1*
EXPENDITURE BLOCK		
$HEXP_h$	*Household expenditure*	*h*
$AHEXP_h$	*Adjusted household expenditure*	*h*
Q_{ih}	*Composite demand for private consumption*	*h(m+nr)*
QR_{ih}	*Regional demand for consumption*	*h(m+nr)*
QM_{ih}	*Imported demand for consumption*	*h(m+nr)*
TQ_i	*Total demand for composite consumption*	*m+nr*
TQR_i	*Total regional demand for consumption*	*m+nr*
TQM_i	*Total imported demand for consumption*	*m+nr*
$GOVEXP$	*Government expenditure*	*1*
$QGOVR_i$	*Government demand for regional good*	*m*
$QGOVLM_i$	*Government demand for imported good*	*m*
$QGOV0_i$	*Commodity demand by Government*	*m*
SAV	*Total savings*	*1*
INV	*Total investment*	*1*
$QINVR_i$	*Investment demand for regional good*	*m*
$QINVM_i$	*Investment demand for imported good*	*m*
$QNV0_i$	*Investment demand*	*m*
M_i	*Import*	*n*
EXP_i	*Export*	*n*
PRICE BLOCK		
PN_i	*Net price*	*n*
P_i	*Price of composite good*	*n*
PR_i	*Regional sales price*	*n*
PX_i	*Composite price faced by consumers after quality tax*	*n*
PRX_i	*Regional sales price faced by consumers after quality tax*	*n*
PE_i	*Regional price of exports*	*n*
$PM0_i$	*Import price*	*n*
PL	*Wage rate*	*1*
PL^{ROCO}	*Wage rate of rest-of country*	*1*
PK_i	*Price of a unit of capital*	*m*
PT_i	*Land rent*	*m*
M_i	*Import*	*n*
EXP_i	*Export*	*n*
PK^{ROCO}	*Out of region capital rent*	*1*
α_{ip}^L L,K and T	*Labor share parameter in production function*	*f*
α_{0i}	*Value added requirement per unit of output*	*m*
α_{ji}	*Intermediate input requirement per unit of output*	*n x m*
ϕ_i^{VA}	*Production (value added) function shift parameter*	*m*
δ_{ji}^{V}	*CES intermediate input demand function share parameter*	*m2*
σ_i^{V}	*Elasticity of substitution for intermediate demand*	*m*
ρ_i^{V}	*CES function exponent for intermediate demand*	*m*
ϕ^{X}	*Supply function shift parameter*	*m*
δ_i^{X}	*CET function share parameter*	*m*
σ_i^{X}	*Elasticity of transformation*	*m*
ρ_i^{X}	*CET function exponent*	*m*
γ_i^h	*Minimum requirement of commodity consumption*	*h(m+nr)*
β_{0h}	*Marginal budget share for leisure*	*h*

APPENDIX 4 (Continued)

Variables	Description	No. of Variables
β_{ih}	*Marginal budget share for commodity*	*h(m+nr)*
η^L	*Labor migration elasticity*	*1*
η^K	*Capital migration elasticity*	*1*
retr	*Depreciation rate and retained earnings of enterprise income*	*1*
sstax	*Social security tax rate*	*1*
ktax	*Capital tax rate*	*1*
ttax	*Land tax rate*	*1*
$htax_h$	*Household income tax rate*	*h*
$ibtax_h$	*Indirect business tax*	*m*
$htax_h$	*Household income tax rate*	*h*
$ibtax_h$	*Indirect business tax*	*h*
mps_h	*Household saving rate*	*h*
$adjL_h$	*Labor adjustment coefficient*	*h*
$ltrn_h$	*Transfer income distribution coefficient*	*h*
l_h	*Labor income distribution coefficient to household*	*h*
t_h	*Land income distribution coefficient to household groups*	*h*
e_h	*Enterprise profit distribution coefficient to household groups*	*h*
ϕ_{ih}^Q	*CES household demand function shift parameter*	*h(m+nr)*
δ_{ih}^Q	*CES household demand function share parameter*	*h(m+nr)*
σ_i^Q	*Elasticity of substitution for housheold commodity demand*	*m+nr*
ρ_i^Q	*CES household demand function exponent*	*m+nr*
ϕ_i^{GOV}	*CES gov demand function shift parameter*	*m*
δ_i^{GOV}	*CES gov demand function share parameter*	*m*
σ_i^{GOV}	*Elasticity of subs for state and local gov commodity demand*	*m*
ρ_i^{GOV}	*CES state and local gov demand function exponent*	*m*
ϕ_i^{INV}	*CES investment gov demand function shift parameter*	*m*
δ_i^{INV}	*CES investment gov demand function share parameter*	*m*
σ_i^{INV}	*Elasticity of subs for investment gov commodity demand*	*m*
ρ_i^{INV}	*CES investment gov demand function exponent*	*m*
ε^{inp}	*Fishing demand elasticity*	*1*
q^{Tax}	*Quality tax*	*1*

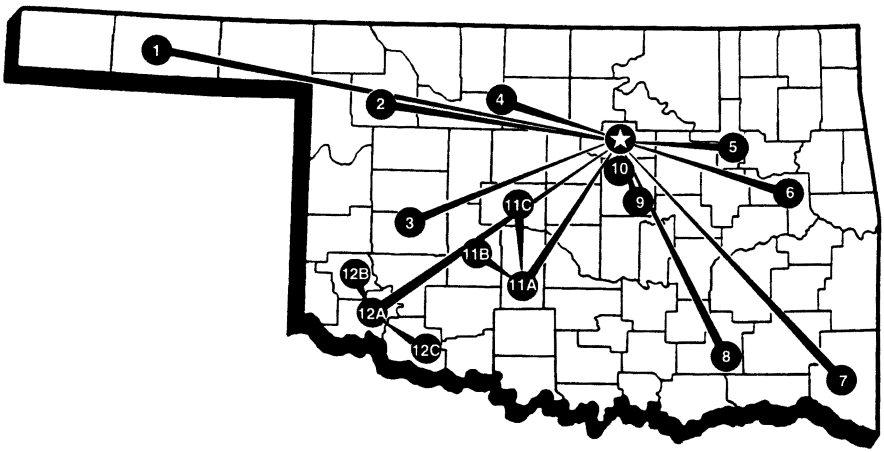
Total number of variables = 13n + 5m + 3(n x m) + 8h + 3h(m + nr) + 3(m+nr) + 17

APPENDIX 5
EXOGENOUS PARAMETER ESTIMATES AND THEIR SOURCES

Parameter	*Parameter Value*	*Source*
Elasticities of Substitution (σ^V, σ^Q, σ^{SL}, σ^{FED}, σ^{INV})		De Melo and Tarr (1992)
Agriculture	1.42	
Mining	0.50	
Construction	3.55	
Manufacturing	3.55	
Transport, communication, and utilities	2.00	
Trade	2.00	
Finance, insurance, and real estate	2.00	
Services	2.00	
Resident fishing trips (σ^Q only)	2.00	
Elasticities of Transformation (σ^X)		De Melo and Tarr (1992)
Agriculture	3.90	
Mining	2.90	
Construction	2.90	
Manufacturing	2.90	
Transport, communication, and utilities	0.70	
Trade	0.70	
Finance, insurance, and real estate	0.70	
Services	0.70	
Income Elasticities of Household Consumption		
Agriculture	0.30	De Melo and Tarr (1992)
Mining	0.89	De Melo and Tarr (1992)
Construction	1.06	De Melo and Tarr (1992)
Manufacturing	1.06	De Melo and Tarr (1992)
Transport, communication, and utilities	0.985	De Melo and Tarr (1992)
Trade	0.985	De Melo and Tarr (1992)
Finance, insurance, and real estate	0.985	De Melo and Tarr (1992)
Services	0.985	De Melo and Tarr (1992)
Resident Fishing Trips	0.82	Choi (1993)
Price Elasticity of Exported (Nonresident) Fishing Trips (ε)	-0.5775	Choi (1993)
Income Elasticities of Labor Supply		Abott and Ashenfelter (1979)
Low income Household	-0.12	
Medium Income Households	-0.18	
High Income Households	-0.24	
Frisch Parameters		Liuch, Powell, and Williams (1977)
Low Income Households	-1.80	
Medium Income Households	-1.60	
High Income Households	-1.40	
Labor Migration Elasticity (z)	0.92	Rickman (1992)
Capital Migration Elasticity (z)	0.92	Budiyanti (1995)

THE OKLAHOMA AGRICULTURAL EXPERIMENT STATION

SYSTEM COVERS THE STATE



✪ MAIN STATION—*Stillwater and adjoining areas*

1. Panhandle Research Station—*Goodwell*
2. Southern Great Plains Research Station—*Woodward*
3. Marvin Klemme Range Research Station—*Bessie*
4. North Central Research Station—*Lahoma*
5. Vegetable Research Station—*Bixby*
6. Eastern Research Station—*Haskell*
7. A. Kiamichi Forestry Research Station—*Idabel*
   B. Broken Bow Field Research Facility
8. Wes Watkins Agricultural Research and Extension Center—*Lane*
9. Pecan Research Station—*Sparks*
10. A. Agronomy Research Station—*Perkins*
    B. Fruit Research Station—*Perkins*
11. A. South Central Research Station—*Chickasha*
    B. Caddo Research Station—*Ft. Cobb*
    C. Forage and Livestock Research Laboratory—*El Reno*
12. A. Cotton Research and Extension Center—*Altus*
    B. Sandyland Research Station—*Mangum*
    C. Southwest Agronomy Research Station—*Tipton*