PROCEEDINGS 1967

WESTERN FARM ECONOMICS ASSOCIATION

Fortieth Annual Meeting
July 19-21, 1967
Las Cruces, New Mexico

ESTIMATION OF THE LEAKAGE OF OUTPUT AND INCOME FROM A REGIONAL ECONOMY USING INPUT-OUTPUT ANALYSIS

by
Gerald A. Doeksen and Charles H. Little*
Oklahoma State University

Introduction

Interest in economic development, especially at the regional, state and local level, has increased during the past several years. From this interest, a need for some measure of the level of economic activity or rate of economic growth has become evident. One of the tools of regional analysis is the input-output model, which can be used to trace through the change in each sector of the economy resulting from some initial impetus. The impact of various stimuli for economic growth can be measured by the input-output multipliers.

Generally, as economic activity in a region expands, more goods and services are imported from other regions. Income is exported from the region to pay for the goods and services. Thus less income is circulated in the immediate region, which may dampen the total impact of an induced change. A measure of this dampening effect, referred to as leakage, is needed to assess the total effect on the regional economy of an induced change. The intent of this paper is to demonstrate the use of input-output analysis to estimate leakage.

Definition and Computation of Leakage

The multiplier effect, as measured by a regional input-output model, is the total change in the economy due to some stimulus; that is, the sum of the direct effect and secondary or indirect effects. Leakage refers to the change in economic activity in other regions due to the change in a particular region. The amount of leakage depends on the goods and services imported from other regions to the regions receiving the initial impetus.

Estimation of the amount of leakage using an input-output analysis involves two separate flow tables for the economy.[1/] The original flow table includes an import row and an export column. Output and income multipliers are obtained from the technical and interdependent coefficients derived from this flow table. Next, the original flow table is modified by adding the figures in the import row into the set of figures in the endogenous sectors of the model. The method is illustrated in Table I and Table II. As shown in Table I, the model has three producing sectors (agriculture, manufacturing and service) two final demand sectors (export and final consumption), a primary input sector and an import row.

The imports are distributed as follows: (1) Of the three units imported by agriculture, two units are manufactured products and one unit is obtained from

---

* Regional Economist, United States Department of Agriculture, Economic Research Service, Economic Development Division and Assistant Professor, Department of Agricultural Economics, respectively, Oklahoma State University, Stillwater, Oklahoma, Agricultural Economics Paper AE 6718.

1/ For a description of the basic input-output model and computation procedure, see Harold O. Carter, "Input-Output Uses and Problems in Regional Analysis for Agriculture," Regional Economic Development, Proceedings of Great Plains Agricultural Council, Denver, Colorado, May 4, 1966, (Compiled by Department of Agricultural Economics, Oklahoma State University, Stillwater), pp. 56-83.

service establishments; (2) Of the four units imported by the manufacturing sector, three units are acquired from manufacturing industries and one unit from service establishments. Adding these figures to the inputs of the producing sectors yields the Modified Flow Table (Table II).

Table I. Original Flow Table

				Final Demand		
	Agric.	Manf.	Services	Export	Final Consumption	Total Output
Producing Sectors						
Agriculture	2	2	4	4	3	15
Manufacturing	4	2	3	5	1	15
Services	4	2	1	3	1	11
Primary Inputs	2	5	3	0	0	
Imports	3	4	0	0	0	
Total Input	15	15	11			

Table II. Modified Flow Table

				Final Demand		
	Agric.	Manf.	Services	Export	Final Consumption	Total Output
Producing Sectors						
Agriculture	2	2	4	4	3	15
Manufacturing	6	5	3	0	1	15
Services	5	3	1	1	1	11
Primary Inputs	2	5	3	0	0	
Total Inputs	15	15	11			

The export column remains in the flow table; however, the figure for each sector is reduced by the amount of imports added to the sector. Again, the column and row totals are equal for the endogenous sectors.

The technical and interdependent coefficients are computed from the modified flow table, and multipliers are computed from these coefficients. These multipliers measure the total effect generated by some initial change in the economy, assuming no goods and services are imported from the other regions. An estimate of leakage is obtained by taking the difference between the multipliers computed from technical and interdependent coefficients of the two flow tables. The multiplier obtained from the original flow table is subtracted from the multiplier derived from the modified flow table to determine the leakage coefficient. The multiplier computed under the assumption of no imports is always the largest, so the leakage coefficient is positive.

The Empirical Example

There are several multipliers that can be computed from the input-output model. Only two will be discussed here--the output multiplier and the income multiplier. A leakage coefficient associated with each multiplier can be computed from the data used in an input-output study. The data for an input-output study for Oklahoma will be used to illustrate the computation of a leakage coefficient.

Secondary data were used in completing the flow table for the economy of Oklahoma presented in Table III.[2/] The most complete source of data was for the year 1959. There are nine endogenous sectors and six exogenous sectors in the model. The amount of imports and exports is a residual, and thus are net imports and export figures. The technical coefficients for the Oklahoma model are shown in Table IV. The interdependent coefficients are shown in Tables V and VI. The coefficients in Table V were obtained from the endogenous sector of the model as presented in the flow table (Table III). The coefficients in Table VI, referred to as the modified interdependent coefficients, were obtained after allocating the imports to the various endogenous sectors in each column as illustrated earlier.

Output Multiplier

The output multiplier for a sector measures the change in total output resulting from a one dollar change in final demand for the products of that sector. The sector multiplier is computed by summing the interdependent coefficients in the column for that particular sector. The output multipliers computed from the original and modified interdependent coefficients and the leakage associated with each multiplier are presented in Table VII.

The economy multiplier and the leakage figure are the average of the sector multipliers and leakage figures. The economy multiplier computed from the original interdependent coefficient table indicates that a one dollar change in final demand will change output in Oklahoma by $1.81. The output multiplier calculated from the modified interdependent coefficient table equals $2.07. This is the total output change in Oklahoma assuming that the state does not import any goods or services. Thus, the amount of net leakage as a result of the one dollar change in final demand in Oklahoma is $0.26. This is a measure of net leakage since the import and export amounts are net figures.

The agricultural processing sector has the largest output multiplier. The leakage coefficient for this sector is relatively large because of the demand for imports of manufactured products. The livestock and livestock products sector has the second largest output multiplier as computed from the original interdependent coefficient table; however, the manufacturing sector has the second largest output multiplier as computed from the modified interdependent coefficient table. The greatest amount of leakage occurs in the manufacturing sector as a result of the need for imports from manufacturing industries in other regions. The livestock and livestock sector depends on imports to a much lesser extent; therefore, the leakage coefficient is much smaller for this sector. Except for the services sector, the multiplier and leakage coefficients of the remaining sectors are somewhat similar. The demand for imports by these sectors is small and thus the leakage effects are relatively small. The larger leakage coefficient for the services sector is due to a larger demand for manufactured imports by this sector.

2/ For a more complete description of the model and for the sources of data, see Gerald A. Doeksen, "An Input-Output Analysis of the Economy of Oklahoma," (Unpub. Master's Thesis, In Process, Oklahoma State University, Stillwater, 1967).

TABLE III

INTERINDUSTRY FLOWS OF GOODS AND SERVICES, OKLAHOMA ECONOMY, 1959

(Thousands of Dollars)

	Lvsk. & Lvsk. Products	Crops	Agric. Proc.	Manf.	Trans., Comm. & Pub. Ut.	Real Est. Fin. & Ins.	Service	Wholesale and Retail	Mining	Construction		Government		Household	Export	Total
										Maintn.	New	Federal	State & Local			
Livestock and Livestock Products	83,539	-[a]	117,923	520	-	3,372	433	-	-	-	-	-	109	16,979	168,390	391,265
Crops	101,108	18,011	64,790	10,319	340	5,269	866	1,818	-	-	2,885	32,360	-	21,763	90,549	350,078
Agricultural Processing	31,427	-	68,076	2,213	913	193	19,030	5,724	-	-	192	5,663	2,952	330,709	-	467,092
Manufacturing	6,287	38,982	34,377	377,952	42,875	31,470	150,717	89,908	87,138	70,289	183,465	177,051	43,884	584,145	-	1,918,540
Transportation, Communication and Public Utilities	14,261	11,476	19,840	110,309	69,265	8,252	66,879	43,410	36,921	7,840	25,257	55,974	23,335	183,084	3,897	680,000
Real Estate, Finance and Insurance	3,705	9,856	3,473	29,340	9,694	31,260	11,223	20,097	15,281	1,132	5,317	212	16,335	154,959	39,388	351,272
Services	2,620	8,691	17,995	64,037	26,297	14,102	74,412	92,420	85,346	3,205	38,149	36,499	22,663	379,454	-	865,890
Wholesale and Retail	14,747	20,897	17,409	180,438	17,613	12,643	28,688	34,956	42,967	31,915	60,582	84,749	21,006	567,690	-	1,136,300
Mining	101	1,382	374	474,545	18,066	632	433	114	51,234	3,027	7,628	5,293	1,909	2,315	293,577	860,630
Construction																
Maintenance	1,650	2,659	1,205	2,805	25,614	7,824	957	2,630	6,518	-	64	3,322	33,634	127,999	-	216,881
New	3,739	6,024	2,011	27,015	34,955	21,284	2,605	7,155	29,109	-	-	8,139	82,395	365,542	-	589,973
Government																
Federal	837	2,161	10,308	37,510	91,757	31,392	8,055	31,772	14,706	2,600	7,072	6,135	5,213	560,349	-	809,867
State and Local	12,372	16,286	7,426	40,698	35,925	4,965	3,282	24,402	42,296	2,922	7,948	91,950	-	251,536	-	542,008
Households																
Wages and Salaries	11,047	26,953	66,000	330,000	242,000	102,000	230,000	465,000	266,000	42,739	116,261	358,000	258,000	7,000	-	2,521,000
Proprietor Income	94,031	147,968	10,000	35,000	29,000	48,000	157,000	208,000	21,000	17,203	46,797	-	-	15,955	-	829,954
Rent Income	3,458	20,642	1,602	17,884	14,439	13,946	36,903	64,202	120,000	809	2,567	3,000	12,398	189,150	-	501,000
Imports	6,336	18,090	24,283	177,955	21,247	14,668	74,407	44,692	42,114	33,202	85,788	84,655	21,389	318,590	-	967,416
Total	391,265	350,078	467,092	1,918,540	680,000	351,272	865,890	1,136,300	860,630	216,883	589,972	953,002	545,222	4,077,219	595,801	

[a] Dash indicates zero or negligible quantity.

Table IV
Technical Coefficients, Oklahoma Economy, 1959

	Lvsk. & Lvsk. Products	Crops	Agric. Proc.	Manf.	Trans., Comm. & Pub. Ut.	Real Est. Fin. & Ins.	Service	Wholesale and Retail	Mining
Livestock and Livestock Products	.2135	.0000	.2525	.0002	.0000	.0096	.0005	.0000	.0000
Crops	.2584	.0514	.1387	.0054	.0005	.0150	.0010	.0016	.0000
Agricultural Processing	.0803	.0000	.1457	.0011	.0013	.0005	.0220	.0050	.0000
Manufacturing	.0161	.1114	.0736	.1970	.0631	.0890	.1741	.0791	.1013
Transportation, Communication and Public Utilities	.0365 .0365	.0328 .0328	.0425 .0425	.0575 .0575	.1019	.0235	.0773	.0382	.0429
Real Estate, Finance and Insurance	.0095	.0281	.0074	.0153	.0143	.0896	.0130	.0177	.0178
Services	.0067	.0248	.0385	.0334	.0387	.0407	.0859	.0813	.0992
Wholesale and Retail	.0377	.0597	.0373	.0940	.0259	.0360	.0331	.0308	.0499
Mining	.0003	.0039	.0008	.2474	.0266	.0018	.0005	.0001	.0595
Construction									
Maintenance	.0042	.0076	.0026	.0015	.0377	.0223	.0011	.0023	.0076
New	.0096	.0172	.0043	.0141	.0514	.0606	.0030	.0063	.0338
Government									
Federal	.0021	.0062	.0020	.0195	.1349	.0894	.0093	.0280	.0171
State and Local	.0316	.0465	.0159	.0212	.0528	.0141	.0038	.0215	.0481
Households									
Wages and Salaries	.0282	.0070	.1413	.1720	.3559	.2904	.2656	.4092	.3091
Proprietor Income	.2403	.4227	.0214	.0182	.0426	.1366	.1813	.1831	.0244
Rent Income	.0088	.0590	.0034	.0093	.0212	.0397	.0426	.0565	.1394
Total	.2773	.5587	.1661	.1995	.4197	.4667	.4895	.6488	.4729
Imports	.0162	.0517	.0520	.0928	.0312	.0417	.0859	.0393	.0489
Total	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table V
Interdependent Coefficients, Oklahoma Economy, 1959

	Lvsk. & Lvsk. Products	Crops	Agric. Proc.	Manf.	Trans., Comm. & Pub. Ut.	Real Est. Fin. & Ins.	Service	Wholesale and Retail	Mining
Livestock and Livestock Products	1.3122	.0014	.3892	.0029	.0017	.0151	.0111	.0035	.0020
Crops	.3774	1.0569	.2851	.0103	.0028	.0234	.0110	.0055	.0031
Agricultural Processing	.1255	.0024	1.210	.0060	.0041	.0046	.0311	.0096	.0047
Manufacturing	.1259	.1838	.2092	1.3453	.1191	.1574	.2790	.1422	.1902
Transportation, Communication and Public Utilities	.0920	.0627	.1132	.1211	1.1327	.0514	.1248	.0666	.0824
Real Estate, Finance and Insurance	.0332	.0404	.0327	.0365	.0230	1.1059	.0264	.0265	.0300
Services	.0480	.0540	.0919	.1093	.0647	.0681	1.1276	.1079	.1406
Wholesale and Retail	.0986	.0909	.1100	.1582	.0486	.0646	.0762	1.0549	.045
Mining	.0379	.0547	.0607	.3574	.0634	.0451	.0776	.0395	1.1153

Table VI
Modified Interdependent Coefficient Table, Oklahoma Economy, 1959

	Lvsk. & Lvsk. Products	Crops	Agric. Proc.	Manf.	Trans., Comm. & Pub. Ut.	Real Est. Fin. & Ins.	Service	Wholesale and Retail	Mining
Livestock and Livestock Products	1.3181	.0018	.3992	.0039	.0021	.0157	.0131	.0043	.0026
Crops	.3823	1.0581	.2934	.0126	.0037	.0247	.0137	.0067	.0045
Agricultural Processing	.1438	.0035	1.2415	.0084	.0052	.0060	.0367	.0116	.0062
Manufacturing	.2243	.3205	.3753	1.6048	.2106	.2780	.4912	.2504	.3334
Transportation, Communication and Public Utilities	.1024	.0752	.1307	.1448	1.1411	.0629	.1446	.0768	.0957
Real Estate, Finance and Insurance	.0366	.0455	.0382	.0440	.0257	1.1187	.0326	.0298	.0343
Services	.0585	.0667	.1098	.1336	.0740	.0803	1.1486	.1196	.1560
Wholesale and Retail	.1117	.1073	.1321	.1894	.0596	.0795	.1019	1.0680	.1018
Mining	.0641	.0910	.1050	.4264	.0877	.0772	.1340	.0683	1.1539

Table VII. Output Multipliers and Leakage Coefficients, Oklahoma Economy

	Multipliers[a/]		Leakage[b/]
	I	II	
Livestock & Livestock Products	2.25	2.44	.19
Crops	1.55	1.77	.22
Agricultural Processing	2.50	2.83	.33
Manufacturing	2.15	2.57	.42
Transportation, Communication & Public Utilities	1.46	1.61	.15
Real Estate, Finance & Insurance	1.54	1.74	.20
Services	1.76	2.12	.36
Retail and Wholesale	1.46	1.64	.18
Mining	1.65	1.89	.24
Economy	1.81	2.07	.26

a/ The multipliers labeled in the column I were computed from the original flow table: the multipliers in the column labeled II were computed from the modified flow table.

b/ Difference between multipliers in column II and I.

Income Multiplier

The income multiplier for a sector measures the change in total income resulting from a one dollar change in income in that sector. The multiplier is the ratio of the sum of the direct and indirect income effect to the direct effect.[3/] The direct income effect is the amount of every dollar derived from the output of a sector which goes to the households as wages and salaries, proprietor's income and rent income. The direct effect for each sector is the sum of the three rows under Households in Table IV. The combined indirect and direct income effects are the total changes in income as a result of the one dollar change in output. These are computed from the technical and interdependent coefficients. The income multipliers computed from the original and modified interdependent coefficients and the leakage associated with each multiplier are presented in Table VIII.

The economy income multiplier and the leakage figure are computed as an average of the sector multipliers and leakage figures. They indicate that if income increases in Oklahoma by one dollar, that $2.13 of new income is generated in Oklahoma add $0.26 outside the state.

The agricultural processing sector has the largest income multiplier. This sector depends heavily on raw materials from the basic agricultural sectors as well as packaging materials and equipment from the manufacturing sector. The reliance on the manufacturing sector accounts for the high leakage figure since most of the imports in Oklahoma are manufactured products. The manufacturing sector has the second largest income multiplier and the largest amount of leakage.

3/ For a more complete description of the computation of the income multiplier, see William H. Miernyk, The Elements of Input-Output Analysis, (New York, 1965) p. 47.

Table VIII. Income Multipliers and Leakage of the Sectors in the Oklahoma Model

	Multipliers		
	I	II	Leakage
Livestock & Livestock Products	2.81	3.02	.21
Crops	1.40	1.52	.12
Agricultural Processing	4.32	4.92	.60
Manufacturing	3.35	4.01	.66
Transportation, Communication & Public Utilities	1.44	1.56	.12
Real Estate, Finance & Insurance	1.46	1.61	.15
Services	1.58	1.80	.22
Wholesale & Retail	1.28	1.37	.09
Mining	1.57	1.72	.15
Economy	2.13	2.39	.26

This is because most of the imports into the state are manufactured products used by the manufacturing sector itself. The sector with the third largest income multiplier is the livestock and livestock products sector. Leakage in this sector is small, because this sector requires only a few imported products. The multiplier and leakage of the remaining sectors are somewhat similar. The small demand for imports by these sectors determines the low leakage effect.

Summary

As an attempt to provide better decision-making information to individuals concerned with the problem of economic development and growth, this paper discusses the construction of a measurement of leakage of output and income from a regional economy. An input-output study of the economy of Oklahoma was employed to illustrate the computation of a leakage coefficient. Policy makers and planners need the information about leakage to evaluate alternatives to achieve the goal of economic growth and development. A regional input-output analysis can provide the information.