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ESTIMATING THE LONG-RUN BENEFITS FROM PRIVATE INVESTMENT ON REGIONAL INCOME BY INDUSTRY CATEGORIES*/

Gerald A. Doeksen and Dean F. Schreiner
Economic Development Division, Economic Research Service, U.S. Department of Agriculture and Oklahoma State University

Decentralization of manufacturing activity has rapidly occurred in the 1960's. Not only have industrial plants been locating in suburban and satellite communities of metropolitan complexes, but also in rural areas. Decentralization is expected to continue into the 70's [2]. Furthermore, the trend in the shift has been away from the traditional Northern industrial centers to the less industrialized Southern states. Regional planners and economists are concerned with measuring the economic impact of private investment on regional income. Input-output models [4] and from-to analysis [3] are two interindustry models which are often used to quantify secondary benefits. These models are short-run forecasting tools, but frequently regional planners and economists are more interested in the long-run influences of potential investments. A dynamic model that measures the short, intermediate, and long-run impacts of potential investment would be of value.

The objective of this paper is to present such a dynamic model and to provide an analysis of the income impact in Oklahoma of investment in various sectors. The paper is presented in three sections. First, the Oklahoma social accounting system and simulation model are outlined. Second, the procedure used to estimate the short, intermediate, and long-run effects is discussed. Third, the income impact analysis is presented.

The Oklahoma Social Accounting System and Simulation Model1/

Economic activity within the state was classified into 12 endogenous sectors and five exogenous sectors. The Oklahoma social accounting system presents data for these sectors in three main accounts: (1) the interindustry account, (2) the capital account, and (3) the human resource account. The interindustry account consists of three basic parts: a transaction or flow table, a direct coefficient table, and a direct and indirect coefficient table. The capital account includes the following parts: a capital coefficient matrix, capital-output ratios, capital stock matrix, capital unit matrix, capacity estimates, inventory coefficients, investment matrix, and depreciation coefficients. The human resource account contains income and employment data.

The simulation model was formulated around the basic Leontief input-output system. The complete multiple sector recursive model consists of 51 major equations. Many of the 51 major equations were disaggregated into sub-equations with one sub-equation for each endogenous sector in the Oklahoma economy. Thus, the entire system includes over 300 equations. The model incorporates economic growth and development into the analysis through capital investment (capital-output ratios and changes in capital-output ratios), through human resource productivity (labor-output ratios, changes in labor-output ratios, and changes in wage rates), and through current activity (changes in population, government expenditures, and exports). The simulation model was used to project economic variables from 1963 to 1980. To evaluate the simulation model, projected values were compared with published data for 1963 to 1969 [2].

Methodogy Used to Measure the Short, Intermediate, and Long-Run Income Effects

Many alternative strategies exist for planning state economic development. A strategy may be to maximize direct and indirect income from investment in a given sector. Alternatively, a strategy may be to maximize total income per dollar of income directly generated, i.e., select those sectors with high income multipliers. For whatever development strategy, it is useful to know the impact on income from investment in any one of the industry categories. In this section, the effect of industry sector investment on income is determined for the short, intermediate, and long-run.

The procedure for this analysis was to assume a one-million-dollar investment in each industry sector in 1970. A separate simulation run was made for each sector to determine

the impact of the million-dollar investment.[2/] The impact of that investment was measured in terms of new income generated from 1970 and through 1980.

The growth process leads to short, intermediate, and long-run impacts. The economic effects from a million-dollar investment created during each period are specified as follows:

Short-Run Effects	Intermediate-Run Effects	Long-Run Effects
1. Direct Effect	1. Direct Effect	1. Direct Effect
2. Indirect Effect	2. Indirect Effect	2. Indirect Effect
3. Capital Formation Effect	3. Induced Consumption Effect	3. Induced Consumption Effect
	4. Induced Capacity Effect	

During the first year, three effects arise due to the million-dollar sector investment. The direct effect measures the economic activity generated directly in the sector due to increased production. The indirect effects arise as the sector which increases production demands additional goods and services from all other sectors. In turn these sectors will increase their demands for goods from other industries. The reverberations will continue until the economy completely adjusts. All repercussions of the increased production are included in the indirect effects. Another economic effect arises during the first year and is referred to as the capital formation effect. This effect includes the economic activity that is generated as a result of the one-million-dollar capital investment in a sector. Economic activity created by capital formation is heavily associated with the construction and durable goods sectors.

During the intermediate period four effects occur throughout the state economy. Direct and indirect effects resulting from sector production remain as production continues in the intermediate period. The induced consumption effect arises as the increased production yields a greater amount of regional personal income. The increased income is spent on consumer goods and services thus increasing their demand. Another effect arises during the intermediate period and is called the induced capacity effect. This effect is created from the increased demand for additional goods from all other sectors. In order to produce the additional goods, other sectors need to increase their capacity. The induced capacity effect is largest during the first and second years following the initial change in production and eventually tapers off to zero over a period of years.

With the capital formation effect reduced to zero in the short run and the induced capacity effect reaching zero after a period of years, all that remains in the long run are the direct and indirect production effects and the induced consumption effects. The long-run effects indicate the economic activity generated over a period of years from the initial production increase. The effects can be converted into impact measures or multipliers.

Results of the Oklahoma Analysis

Table 1 contains the income impact effects and multipliers. Direct income effects for each sector are listed in column (1). The direct income effect is the amount of income going to households as wages and salaries and proprietor income as a result of increased production from a million-dollar capital investment in that sector. The service and wholesale and retail trade sectors have the largest direct income effects. For the service sector, $1,050,000 of income is directly generated, while $927,000 is directly generated by the wholesale and retail trade sector. Sectors with the lowest direct effect are petroleum; livestock; and transportation, communication, and public utilities.

Direct and indirect income effects are listed in column (2) of Table 1. These effects are determined by considering all the repercussions on income in all sectors as a result of the initial change in sector production. Construction, agricultural processing, and services have the largest direct and indirect income effects at $1,889,000, $1,776,000, and $1,388,000, respectively. The smallest direct and indirect effects are in transportation, communication and public utilities and crops. Short-run production income multipliers are contained in column (8). Each multiplier indicates the change in income generated throughout the Oklahoma economy by a one-unit change in production income from delivery to final demand for the specified sector. Petroleum, agricultural processing, and livestock have the largest short-run income multipliers at $5.27, $4.10, and $2.89, respectively. The

TABLE 1

SHORT, INTERMEDIATE, AND LONG-RUN INCOME IMPACTS AND MULTIPLIERS FROM A MILLION DOLLAR INVESTMENT IN INDUSTRY CAPACITY, OKLAHOMA, 1970

	Direct Income Effect (000) (1)	Direct and Indirect Income Effect (000) (2)	Capital Formation Effect (000) (3)	Total Short-Run Effect (000) (4)	Total Second Year Income Effect (000) (5)	Total Third Year Income Effect (000) (6)	Total Long-Run Effect (000) (7)	Short-Run Income Multiplier (8) a	Short-Run Total Income Multiplier (9) b	Intermediate-Run Income Multiplier (Second Year) (10) c	Intermediate-Run Income Multiplier (Third Year) (11) c	Long-Run Income Multiplier (12) d
Livestock	125	361	363	724	1,450	1,137	410	2.89	5.79	11.60	9.09	3.28
Crops	236	352	396	748	1,264	929	260	1.49	3.17	5.36	3.94	1.10
Agricultural Processing	429	1,776	357	2,133	4,516	4,213	2,380	4.10	4.97	10.53	9.82	5.55
Petroleum	102	538	349	887	1,853	1,519	590	5.27	8.69	18.17	14.89	5.78
Machinery	409	875	359	1,234	2,000	1,727	1,390	1.86	2.63	4.26	3.68	2.94
Other Manufacturing	495	886	361	1,247	2,010	1,778	1,870	1.79	2.52	4.06	3.59	3.78
Mining	223	418	413	831	1,430	1,072	450	1.87	3.73	6.41	4.81	2.02
Transportation, Communication and Public Utilities	156	222	324	546	997	695	220	1.42	3.50	6.39	4.45	1.41
Real Estate, Finance and Insurance	378	536	352	888	1,417	1,109	640	1.42	2.35	3.85	2.93	1.69
Services	1,050	1,388	340	1,728	2,513	2,312	2,090	1.32	1.65	2.39	2.20	1.99
Wholesale and Retail Trade	927	1,241	364	1,605	2,375	2,130	1,840	1.34	1.73	2.56	2.30	1.98
Construction	843	1,889	337	2,226	3,611	3,414	2,690	2.24	2.64	4.28	4.05	3.19

[a]These multipliers were computed by dividing the direct effect column (1) into the direct and indirect effect column (2).
[b]These multipliers were computed by dividing the direct effect column (1) into the direct, indirect and capital formation effect column (4).
[c]These multipliers were computed by dividing the direct effect column (1) into the intermediate effects column (5) (for column 10) and column 6 (for column 11).
[d]These multipliers were computed by dividing the direct effect column (1) into the long-run effect column (7).

petroleum multiplier indicates that for each dollar of production income directly generated, a total of $5.27 is generated throughout the economy. Sectors with the smallest income multipliers are services and wholesale and retail trade.

The direct capital formation effect for each sector is listed in column (3) of Table 1. These figures indicate the income generated as the result of constructing a million-dollar increase in capital formation. The amount of income generated from capital formation varies from $324,000 in the transportation, communication, and public utilities sector to $413,000 in the mining sector. Total income generated in each sector from capital formation and increased production is listed in column (4). The total short-run income multipliers are listed in column (9). Each multiplier indicates the change in income generated throughout the Oklahoma economy by a one-unit change in production income of the specified sector. Petroleum, livestock, and agricultural processing have the largest total short-run income multipliers.

The intermediate-run impacts and multipliers are presented in columns (5), (6), (10), and (11) of Table 1. The capacity and induced consumption effects create income in addition to the direct and indirect production effects for intermediate years. Income totals generated in 1971 and 1972 are listed in columns (5) and (6). The sectors with the largest income effects are agricultural processing, construction, and services. The intermediate-run multipliers are listed in columns (10) and (11). Petroleum, agricultural processing, and livestock have the largest intermediate-run multipliers. Each multiplier indicates the total change resulting in 1971 and 1972 from a one-unit income increase in 1970.

The long-run impact data and multipliers are presented in columns (7) and (12). In 1980, only the income generated from direct and indirect production and induced consumption remains. The capital formation effect occurs only during the first year, and the capacity effect tapers off to zero during the intermediate years. The total income generated in 1980 as a result of increased production in 1970 is listed in column (7). Construction, agricultural processing, and services have the largest amount of generated income in 1980. Long-run income multipliers are listed in column (12). Each multiplier indicates the total income generated in 1980 resulting from a one unit increase in sector income in 1970. Petroleum, agricultural processing, and other manufacturing have the largest long-run income multipliers: 5.78, 5.55, and 3.78, respectively.

Summary

The objective of this paper was to derive the short, intermediate, and long-run income effects of industry investment. It was accomplished with the Oklahoma social accounting system and simulation model. The effects from industry investment on income were determined by assuming a one-million-dollar capital investment in each industrial sector. The income effects from the investment were determined for the short, intermediate, and long-run time periods. Impact measures or income multipliers for each period were derived from the income effects. The simulation model enables the researcher to determine not only the short-run effects and multipliers, but also the intermediate and long-run measures. Frequently, regional planners and economists are concerned with the effects of economic development over an extended planning horizon, and the above long-run impact data should prove useful.

FOOTNOTES

*/ Journal Article 2248 of the Agricultural Experiment Station, Oklahoma State University, Stillwater, Oklahoma.

1/ For a complete description and presentation of the social accounting system and simulation model see [1].

2/ The million-dollar capital investment was reflected in the capital equations of the simulation model. The amount of production generated in each sector from the investment was determined by the capital-output ratio. The increased production was assumed exported if the sector was a net exporter, and consumed in the state if the sector was a net importer. Both the capital investment and increased production were assumed to occur simultaneously in 1970.

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