

Economic Impacts of RSA-Owned Investments on Alabama



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THE UNIVERSITY OF ALABAMA

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Executive Summary

- This study presents the economic and fiscal impacts on the state of Alabama of the 2007 operating and 2002-2008 construction activities of The Retirement Systems of Alabama (RSA)-owned investments in the state. RSA provides pension benefits to retirees through the Employees' Retirement System (ERS), the Judicial Retirement Fund (JRF), and the Teachers' Retirement System (TRS). Contributions from the state and members are invested in various financial instruments and assets in order to provide benefits.
- The economic impacts focus on output, earnings, and employment. Output refers to the gross domestic product (the value of goods and services produced in Alabama [ALGDP]) for the region of focus, the state of Alabama in this case. Fiscal impacts presented are conservative because they comprise income and sales taxes only; other taxes and fees (e.g., property, utilities, rental/leasing, alcoholic beverages, cigarette and tobacco, insurance premium, lodgings, driver's license fees, and auto title and license fees, and other personal property taxes) are not covered.
- The RSA-owned investments in Alabama are diverse, involving at least 14 primary recipient companies in various manufacturing and service sector industries, with activities in many different parts of the state for the period considered in this report. Capital expenditures over the 2002-2008 period totaled \$854.3 million. Operating expenditures in 2007 by the companies were nearly \$1.6 billion and included a \$245.4 million payroll for 5,836 workers.
- The 2002-2008 \$854.3 million capital expenditures had statewide impacts of \$1.947 billion in output, \$620.9 million in earnings to Alabama households, 19,225 direct and indirect jobs, and \$42.9 million in income and sales taxes; \$20.4 million in state income taxes, \$10 million in state sales taxes, and \$12.5 million local (county and city) sales taxes.
- The 2007 operating activities yielded statewide impacts of \$3.3 billion in output (2 percent of the \$165.8 billion 2007 Alabama GDP), \$578.1 million in earnings, and 14,056 jobs (0.7 percent of the state's 2007 nonagricultural employment). The associated fiscal impacts summed up to nearly \$40 million; \$19 million in state income taxes, \$9.3 million in state sales taxes, and \$11.6 million local sales tax receipts.
- The only publicly available retirement systems investment impact study was conducted by the Applied Research Center at California State University, Sacramento in 2007 and showed that investments made by retirement systems in their home states can have considerable economic and fiscal impacts on those economies.
- The economic and fiscal impacts presented in this report are statewide. All 67 Alabama counties, in one way or another, benefit from the above-mentioned RSA investments and other RSA economic development efforts. Impacts of benefit payments made by RSA are not considered in this report.
- As part of its community and economic development activities, RSA has provided more than \$670 million in advertisement benefits that have contributed to growing Alabama tourism into a \$9.3 billion industry from \$1.8 billion. The ad benefits comprise \$30 million per year in TV for 13 years, \$25.4 million per year in print for 11 years, and \$362,400 per year in billboards for the last 3 or 4 years.

Economic Impacts of RSA-Owned Investments on Alabama

Introduction

This report presents the economic and fiscal impacts of The Retirement System of Alabama (RSA)-owned investments' operating and construction activities in Alabama on the state's economy. Operating activity impacts focus on 2007, while construction activity impacts cover 2002 through 2008. The economic impacts focus on output, earnings, and employment. Output refers to the gross domestic product (the value of goods and services produced in Alabama [ALGDP]) for the region of focus, the state of Alabama in this case. The fiscal impacts presented comprise income and sales taxes derived from the earnings impacts.

RSA provides pension benefits to retirees through three major trust/investment funds: Employees' Retirement System (ERS); Judicial Retirement Fund (JRF); and Teachers' Retirement System (TRS). RSA administers and manages these funds to provide a secure and sound retirement at the end of the careers of employee members of these three public organizations. RSA manages and invests the retirement assets for its members and beneficiaries, both active and retired. RSA also provides healthcare benefits for public education employees and retirees through the Public Education Employees' Health Insurance Plan (PEEHIP). The State Employees' Insurance Board (SEIB) provides healthcare benefits to state and local government employees and retirees. Most healthcare benefit payments are made by PEEHIP and SEIB to providers and facilities. The economic and fiscal impacts covered in this report are separate from those of the benefit payments mentioned in this paragraph.

RSA is also involved in various community and economic development activities, including a focus on statewide economic development initiatives to attract various industries and businesses, promoting and funding tourism through a series of golf courses known as the Robert Trent Jones Golf Trail and other resort and hotel properties, major construction projects, and other investments. RSA's development activities, specifically annual advertisement contributions, have been significant to growth of Alabama's tourism industry from \$1.8 billion to \$9.3 billion. The total value of these RSA ads over the past 13 years exceeds \$670 million and comprises \$30 million TV ads per year for 13 years, \$25.4 million print ads per year for 11 years, and \$362,400 billboard ads per year for the past 3 or 4 years.

RSA assets of about \$32 billion in 2007 comprised 61 percent public equities, 25 percent fixed income, 9 percent in private placements including RSA's real estate investments and Robert Trent Jones Golf Trail, and 5.0 percent in cash. The investments and expenditures made by RSA provide

jobs and stimulate business activity in various sectors of the Alabama economy. This spending also generates taxes for the state and other taxing jurisdictions.

For the 2007 operating and 2002-2008 construction periods, RSA investments in the Alabama economy have been through diverse goods-producing and service-providing industries. Manufacturing industries represented include aircraft and motor vehicle parts, wood products, and metals production. Other direct RSA investment industries include newspaper publishing, radio and TV broadcasting, advertising, real estate, offshore oil and gas support services, computer and technology services, hotels and resorts, and recreational sports. Companies that are the primary recipients of the RSA investments for the periods of interest are shown in Table 1. They have activities in many different parts of the state. Not all the companies were operating in 2007 and not all of them reported capital expenditures for the 2002-2008 period.

Table 1. 2007 Primary RSA Investment Receiving Companies

Alabama River Group, Inc.
Bell Microproducts
Community Newspaper Holdings, Inc.
Daniel Corporation
GKN Aerospace Services Alabama
Magic Media
National Alabama Corporation/National Steel Car
Navistar Diesel of Alabama, LLC
Navistar Big Bore Diesels, LLC
PCH Hotels and Resorts
Raycom Media
Sunbelt Golf Corporation
Signal International
Wise Metals

Source: The Retirement Systems of Alabama.

Capital expenditures in Alabama by the companies totaled \$854.3 million over the 2002-2008 period (Table 2). For their 2007 operations, the companies employed 5,836 workers in the state with a \$245.4 million payroll for an average per worker of \$42,046 which is 14.4 percent more than the average of \$36,751 per Alabama worker in 2007. Nonpayroll expenses of \$1.3 billion plus payroll resulted in total 2007 operating expenses of almost \$1.6 billion. Taxes paid by the companies (e.g., for sales, use, property, and privilege taxes) and collected for remission (e.g., lodging, sales, use, and beverage taxes) totaled \$23 million in 2007. About half of this amount was collected for remission.

Table 2. RSA-Owned Investments in Alabama Operating and Construction Data

Input Parameters	Operating 2007	Construction (2002-2008)
Capital expenditures		\$854,342,181
Operating Alabama employment (jobs)	5,836	
Operating Alabama wages	\$245,383,213	
Average earnings per employee	\$42,046	
Operating nonpayroll Alabama expenses	\$1,327,306,806	
Total Operating Alabama Expenses	\$1,572,690,019	
Alabama taxes paid and collected	\$23,039,774	

Source: The Retirement Systems of Alabama and Center for Business and Economic Research, The University of Alabama.

There are many other companies and economic activities that RSA has been involved with in Alabama besides those listed in Table 1. These companies again are located in many different parts of the state. Some notable ones are:

- CIBA-Geigy Chemical Company in Mobile
- Dole Foods in Birmingham
- Drummond Company in Birmingham
- Dynamit Nobel Chemical Company in Mobile
- EADS/Airbus in Mobile
- Gulf Coast Exploration and Science Center & IMAX in Mobile
- Kvaerner Oilfield Products in Mobile
- Mercedes Benz U.S. International in Tuscaloosa
- Southwire Company in Heflin
- Space Booster in Huntsville
- SSAB Steel in Mobile
- U.S. Steel in Fairfield
- Wal-Mart distribution center in Cullman

At the time of conducting this study, the only publicly available retirement systems investment impact study was conducted by the Applied Research Center at California State University, Sacramento in 2007. The study, “The Economic Impacts of CalPERS Investments on the California Economy,” showed a significant economic impact of investments on California’s economy, \$15.1 billion in 2006, adding approximately \$8.5 billion to California’s economy, and making CalPERS a larger entity than machinery manufacturing, oil and gas extraction, and amusements and recreation related industries in the state. The investment dollars injected by CalPERS into the California economy generated over 124,300 jobs in 2006. This job impact was larger than employment in heavy construction, civil engineering, and motion picture and video production industries. The study estimated direct, indirect, and induced economic impacts using

IMPLAN economic impact analysis software and stated that its impact estimates were conservative in the sense that not all of CalPERS investments in California were captured. For example, real estate that was built in the previous years and did not make any new contributions to the California economy in 2006 was therefore excluded, even though it still holds value and contributes both present and future retirement payments. The study considered various asset classes including:

1. Equity share of ownership in housing throughout California.
2. Ownerships of stocks and equities in U.S. headquartered companies.
3. Private equity investments in construction projects in California, including both office space and retail projects.
4. Investments in asset-backed firms having large holdings in real estate assets including office buildings, hospitals, hotels, technical centers, etc.
5. Direct private investments in existing firms, typically small firms related to buyout funds and venture capital within California.
6. Providing financing to CalPERS members for home purchases, cash-out refinances, and interest rate refinancing, including similar services to non CalPERS members.
7. Direct payments to outside consultants located in California for conducting investment management and transactions for CalPERS.
8. Loans for development and construction of affordable housing.

The California State University study shows that investments made by retirement systems in their home states can have considerable economic and fiscal impacts on those economies. These investments provide employment opportunities, increase earnings, add to the state's tax base and significantly increase the state's GDP, the total value of goods and services produced in the state.

The economic and fiscal impacts presented in this report indicate the influence that RSA's investments in Alabama have on the state through their operating and construction activities. We use the company-based approach rather than the asset-based approach used in the CalPERS study for three main reasons. The first reason is to ensure comprehensive coverage of impacts. Secondly, our approach focuses on spending of the investment activities for consistency with the methodology since impact methods are expenditure-based. The final reason is to avoid confusion by keeping investment impacts separate from benefit payment impacts. The Regional Input-Output software, RIMS II, developed by the U.S. Department of Commerce's Bureau of Economic Analysis is used to estimate the impacts. To determine the total economic and fiscal impacts, RIMS II multipliers for appropriate industries were used. The 2002-2008 construction impacts are presented first, followed by the 2007 operating impacts. The input-output methodology used in the estimation of these impacts is detailed in the Appendix.

2002-2008 Construction Economic and Fiscal Impacts

As noted earlier, the companies in Table 1 had total capital expenditures of \$854.3 million over the roughly 7-year inclusive 2002-2008 period. This capital was used for projects that included manufacturing plants, office buildings, hotels, golf courses, and a parkway. We therefore applied final demand RIMS II construction sector multipliers to this amount to determine the economic impacts. The economic and fiscal impacts of the construction activities are presented in Table 3.

Table 3. 2002-2008 RSA-Owned Investments Construction Impacts on Alabama

Capital Expenditures	\$854,342,181
<u>Economic Impacts</u>	
Direct employment (jobs)	9,388
Indirect employment (jobs)	9,838
Employment Impact (jobs)	19,225
Direct earnings (wages and salaries)	\$315,184,518
Indirect earnings (wages and salaries)	\$305,665,945
Earnings Impact	\$620,850,463
Output Impact	\$1,946,618,660
<u>Fiscal Impacts</u>	
State income tax	\$20,411,452
State sales tax	\$10,003,143
State Tax Total	\$30,414,595
Local (county and city) sales tax	\$12,503,928
Total State and Local Tax Receipts *	\$42,918,523

* This total state and local tax receipts is derived from the earnings impacts of RSA-owned investment construction activities and is separate from the \$23 million taxes paid or collected by RSA-owned investment entities in 2007.

Source: The Retirement Systems of Alabama and Center for Business and Economic Research, The University of Alabama.

Statewide economic impacts of the \$854.3 million capital expenditures are \$1.9 billion in output, \$620.9 million in earnings to Alabama households, and 19,225 direct and indirect jobs. Of the total jobs impact, 9,838 jobs are indirect in other sectors resulting from the spending of the construction companies and their 9,388 direct jobs. The earnings impact generates significant tax revenues for both state and local governments. Not all of the earnings impact is taxable, expenditures on sales taxable items constitute 42.4 percent of total household earnings, and state taxable income (net income) is about 66 percent of earnings. The state income tax rate is 5.0 percent on net income.¹

¹ The first \$500 and the next \$2,500 of taxable income are taxed at 2 percent and 4 percent, respectively, for single persons, head of family, and married persons filing separately. For married persons filing joint returns the first \$1,000 and the next \$5,000 are taxed at 2 percent and 4 percent, respectively. Excess net income is taxed at the 5 percent rate. There is a sliding scale for the standard deduction that is based on filing status and adjusted gross income.

Sales tax rates used are 4.0 percent for the state and 5.0 percent for combined county and city jurisdictions statewide. Combined county and city sales tax rates vary from 3.0 to 7.0 percent among Alabama counties, but are most frequently at 5.0 percent.

The \$620.9 million earnings impact provided \$20.4 million in state income taxes and a little over \$10 million in state sales taxes for a total of \$30.4 million to state coffers. Local (county and city) sales tax receipts totaled \$12.5 million. Total income and sales taxes generated amounted to \$42.9 million. It is important to note that the fiscal impacts in this report are conservative because they cover just income and sales taxes. Other taxes and fees (e.g., property, rental/leasing, alcoholic beverages, utilities, cigarette and tobacco, insurance premium, lodgings, driver's license fees, and auto title and license fees, and other personal property taxes) are not included.

2007 Operating Economic and Fiscal Impacts

In consideration of the diverse nature of RSA investments in Alabama, we applied appropriate sector final demand and direct effect RIMS II multipliers to operating data for each of the companies in Table 1 that was operating in 2007 to determine the economic and fiscal impacts. Together, the companies had a \$245.4 million payroll for 5,836 workers and nonpayroll expenditures of \$1.327 billion. Total 2007 operating expenditures for the companies were \$1.573 billion.

Table 4 shows the aggregated input data and the resulting impacts. Statewide economic impacts of the RSA-owned investments operating activities in Alabama are about \$3.3 billion in output, \$578.1 million in earnings to Alabama households, and 14,056 direct and indirect jobs. Associated fiscal impacts derived from the earnings impact are \$19 million in state income taxes and \$9.3 million in state sales taxes for a total of \$28.3 million to state coffers. Adding local (county and city) sales tax receipts of \$11.6 million, total income and sales taxes generated was nearly \$40 million. As with the construction activities' impacts, these fiscal impacts are conservative because they cover just income and sales taxes, not other taxes and fees (e.g., property, rental/leasing, alcoholic beverages, utilities, cigarette and tobacco, insurance premium, lodgings, driver's license fees, and auto title and license fees, and other personal property taxes). Except for the possibility of a small overlap on sales and use taxes, the 2007 operating taxes are generally separate from the \$23 million paid or collected by the companies. Such overlap might occur if companies and households that are directly or indirectly affected by the 2007 operations pay sales and use taxes at RSA hotels and golf courses.

Table 4. 2007 RSA-Owned Investments Operating Impacts on Alabama

Operating Alabama employment (jobs)	5,836
Operating Alabama wages	\$245,383,213
Average earnings per employee	\$42,046
Operating nonpayroll Alabama expenses	\$1,327,306,806
Total Operating Alabama Expenses	\$1,572,690,019
Alabama taxes paid and collected	\$23,039,774
Economic Impacts	
Direct employment (jobs)	5,836
Indirect employment (jobs)	8,220
Employment Impact (jobs)	14,056
Direct earnings (wages and salaries)	\$245,383,213
Indirect earnings (wages and salaries)	\$332,708,535
Earnings Impact	\$578,091,748
Output Impact	\$3,305,926,319
Fiscal Impacts	
State income tax	\$19,005,691
State sales tax	\$9,314,214
State Tax Total	\$28,319,905
Local (county and city) sales tax	\$11,642,768
Total State and Local Tax Receipts *	\$39,962,673

* These total state and local tax receipts are derived from the earnings impacts of RSA-owned investment operating and construction activities and are generally separate from the \$23 million taxes paid or collected by RSA-owned investment entities.

Source: The Retirement Systems of Alabama and Center for Business and Economic Research, The University of Alabama.

Conclusions

This study presents the economic and fiscal impacts on the state of Alabama of the 2007 operating and 2002-2008 construction activities of RSA-owned investments in the state. The RSA-owned investments in Alabama are diverse, involving at least 14 primary recipient companies in various manufacturing and service sector industries. Capital expenditures over the 2002-2008 period totaled \$854.3 million. Total 2007 operating expenditures by the companies were nearly \$1.6 billion and included a \$245.4 million payroll for 5,836 workers.

The RSA-owned investments operating and construction activities in Alabama had significant impacts on the state. The 2002-2008 \$854.3 million capital expenditures had statewide economic impacts of \$1.947 billion in output, \$620.9 million in earnings to Alabama households, and 19,225 direct and indirect jobs. The earnings impact generated a total of \$42.9 million in income and sales taxes; \$20.4 million in state income taxes, \$10 million in state sales taxes, and \$12.5 million local (county and city) sales taxes.

The 2007 operating activities yielded statewide impacts of \$3.3 billion in output (2 percent of the \$165.8 billion 2007 Alabama GDP), \$578.1 million in earnings, and 14,056 jobs (0.7 percent of the state's 2007 nonagricultural employment). The associated fiscal impacts summed up to nearly \$40 million; \$19 million in state income taxes, \$9.3 million in state sales taxes, and \$11.6 million local sales tax receipts. It is important to note that the fiscal impacts in this report are conservative because they cover just income and sales taxes. Other taxes and fees (e.g., property, rental/leasing, alcoholic beverages, utilities, cigarette and tobacco, insurance premium, lodgings, driver's license fees, and auto title and license fees, and other personal property taxes) are not included.

APPENDIX

Methodology - Economic Impact Analysis

Economic impact analysis measures the effects of a specific economic activity or event on a specified geographic area. Examples include the economic impact on a state or county of a proposed industrial plant, an existing industry, or closing of a military installation. In some cases, federal laws, as well as state and local regulations, require economic impact studies prior to the implementation of a particular policy (relocation of an economic activity, changes in zoning ordinance, etc.). No matter what the justification, impact studies are designed to provide information for instituting policies to facilitate positive economic impacts and/or mitigate potential negative impacts. Economic impact analysis is therefore an important tool that can enhance the quality of decisions made, as well as the decision making process in both public and private sectors.

The analysis typically focuses on one or more of the major economic indicators; output, employment, and income. The purpose of an impact study usually determines which socioeconomic variable(s) should be monitored. In this study, the primary focus is on all three major indicators and the consequent changes in income and sales tax revenues resulting from the operations of RSA-owned investments in 2007 and construction activities undertaken by RSA from 2002 to 2008.

Economic impacts comprise direct and indirect types. Direct impacts are those that are most obvious and include the wages and salaries of the employees who work directly for an organization or industry, as well as all other expenditures of the firm or an industry, including taxes and distributed profits. Indirect economic impacts, often referred to as the “ripple” or “multiplier” effects, occur because of the additional demands arising from new income and expenditures for inputs and products related to the activity under study. New income creates demand for consumer products and services and their associated indirect impacts are often called induced impacts. Indirect and induced impacts may spark new demand for the output of the firm or industry under study. For example, RSA-owned investment activities create indirect impacts on manufacturing and wholesale and retail industries through payments made to its employees as well as for other operating expenditures. These industries and employees may in turn use the hotel and recreation facilities that are part of RSA’s investments. The total economic impacts of the organization being studied are the combined direct, indirect, and induced impacts. The ratio of the total economic impact to the direct impact is the multiplier that can be used to summarize the economic effects of the organization on the region(s) or area(s) of focus.

Economic relationships do not obey strict geographic boundaries; workers and their incomes and firms’ purchases flow across these boundaries enabled by transportation and communication. Thus a portion of the indirect effects of purchases or expenditures may occur beyond the boundaries of

the specified region. Such occurrences are called *leakages*, as opposed to *linkages* (supplier-purchaser relationships) within the region. In general a small geographic area will have a small *absolute* economic impact due to a high likelihood of leakage. A large region will have a larger absolute economic impact, but a smaller *relative* economic impact of an individual firm or industry on that area. The closure of one plant within a state, for example, may have only a small relative impact even if the plant employs thousands of workers; the absolute impact could be very large. The important point is that the effect or size of the economic impact is influenced by the size of the study area. If the area is too broadly defined, the relative impact will be small. If narrowly defined, the relative impact will be large.

Determining the Multiplier

Several methodological approaches are used in estimating economic impacts. These include the construction of econometric, economic base, computable general equilibrium (CGE), and input-output (I-O) models. Econometric and CGE models can be very costly and time-consuming to build. Economic base models require a very detailed set of information that is sometimes not available. The other methodological approaches generate slightly smaller multipliers than I-O models because of assumptions on factors such as input substitution and optimization behavior by economic agents.

The I-O modeling framework is used in this study. The technique generates multipliers for the economic activity of interest by focusing on economic interactions among all industries and all other economic transactions in the specified region. Interindustry relationships exist in both directions; backward (suppliers and other upstream linkages and leakages) and forward (distributors, retailers, customers, and other downstream linkages and leakages). The number and strength of these backward and forward linkages and leakages determine the multiplier effects of the industry. In general, products and services that require a small number of inputs and little additional processing (little value addition) will have smaller multiplier effects than complex ones that require lots of inputs and extensive processing.

The three main types of multipliers—output, income or earnings, and employment—are defined as follows. Output multipliers represent the total dollar change in all industries that results from a \$1 change in output delivered to final demand (final consumption) by the industry under study. Earnings multipliers represent the total dollar change in earnings of households employed by all industries for each dollar of payroll expenditure or each dollar of output delivered to final demand by the industry whose economic impact is being estimated. Employment multipliers represent the total change in the number of jobs in all industries for each direct job or for each million dollars of output delivered to final demand by the industry whose economic impact is being estimated.

The nature of the product and technology largely determine the degree of interindustry linkages and leakages (and thus the overall impact), and the specific impact on a region depends upon the degree to which these interindustry relationships are localized. Technology determines inputs and economics determines the geographic source of supply. Inputs purchased outside the economic impact study area constitute a leakage of potential impact. Leakage represents activities of local firms that have no economic impact on the local economy; it provides opportunities for “localizing” such impact. Identifying leakage can provide valuable planning information to local economic development authorities for commercial or industrial development. An activity’s maximum impact on a specific area is obtained when all interindustry linkages occur within the area. A systemwide view is required because different firms have different linkages. The I-O technique permits the incorporation of such systemwide perspectives.

To estimate the economic impact of RSA-owned investments’ operation and construction activities on the Alabama economy, linkages between their expenditures and the rest of the economy must be traced. This task is facilitated by the Regional Input-Output Modeling System (RIMS II), an input-output model developed and maintained by the U.S. Department of Commerce’s Bureau of Economic Analysis. The model is available for every state in the nation, and also for many counties. This study uses RIMS II for the state of Alabama. As part of the analysis, another I-O software package called IMPLAN is used to check the RIMS II multipliers.

The RIMS II I-O model consists of nearly 500 industries. Data on each industry reflects the value of inputs used per dollar of output in the production of that industry’s output. For example, data for the motor vehicle, body, trailer, and parts industry show the value of each input per dollar of product produced. Since the rows (outputs) are produced by specific industries, they are also columns (inputs). Demand for a particular input will cause supply from the industry that produces it. This then creates demand for the inputs that are used to produce the particular product, and so on; the round-by-round impacts converge. The I-O model captures the total effect of these rounds of spending as the multiplier effect. RIMS II multipliers for an economy account for all linkages within and leakages from that economy. I-O models are based on a table of transaction balances, which ensures economy-wide accounting consistency. Total payments equal total receipts for each producing sector. Aggregate final demand equals aggregate value added.

Multipliers are determined mathematically from I-O tables that are constructed from observed and reported data for the economic area of interest. The economy is divided into a number of producing industries or sectors that sell and purchase goods and services to and from each other (*interindustry* or *intersectoral* flows). These interindustry flows are key data. Sector goods and services are purchased by domestic consumers (households), international customers (exports), governments (federal, state, and local), and for private investment purposes. These external to production purchases are for direct use and termed *final demand*. Assume an economy with n sectors and let X_i

represent total output for sector i , Y_i represent final demand for sector i products, z_{ij} represent interindustry flows. Then for each sector we can write

$$X_i = \sum_{j=1}^n z_{ij} + Y_i \quad (1)$$

If we let a_{ij} represent the I-O technical coefficients where $a_{ij} = z_{ij} / X_j$ so that sectors use inputs in fixed proportions (the constant returns to scale Leontief production function) then the above equation becomes

$$X_i = \sum_{j=1}^n a_{ij} X_j + Y_i \quad (2)$$

The standard formulation of the basic I-O model and its application, in matrix notation is:

$$\text{Transactions balance: } X = AX + Y \quad (3)$$

$$\text{Solving for X: } X = (I - A)^{-1}Y \quad (4)$$

$$\text{For a change in Y: } \Delta X = (I - A)^{-1}\Delta Y \quad (5)$$

where X is the gross output column vector, A is the matrix of fixed I-O coefficients, Y is the final demand column vector, and I is the identity matrix. With this basic model, the resulting output is computed given changes in final demand levels (consumption, investment, government, or exports). The Leontief inverse, $(I - A)^{-1}$, is the source of multipliers for determining impacts in the I-O methodology. The elements of the matrix are really very useful and important. Each captures in a single number an entire series of direct and indirect effects. Gross output requirements are translatable into employment coefficients in a diagonal matrix that is used together with the Leontief inverse to generate employment impacts. Similar manipulations generate income or earnings multipliers.