

# **Samford University 2016-2017 Economic and Fiscal Impacts on Alabama and the Birmingham- Hoover Metropolitan Area**



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Culverhouse College of Business  
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# The Samford University 2016-2017 Economic and Fiscal Impacts on Alabama and the Birmingham-Hoover Metropolitan Area

## Executive Summary

- This report presents the economic and fiscal impacts of Samford University on both the State of Alabama and the seven-county Birmingham-Hoover metropolitan area for the 2016-2017 academic year. The focus is on output, employment, and fiscal (income and sales tax) impacts of Samford University on the state and metro area. Output refers to total or gross business sales and contains value-added, which is the contribution to gross domestic product (GDP). The fiscal impacts focus on income and sales taxes and are conservative because just income and sales taxes are considered; other relatively small taxes and fees (e.g., utility taxes, car tags and fees, rental/leasing, alcoholic beverages, cigarettes and tobacco, insurance premiums, lodgings, auto title, and other personal property taxes) are not.
- For the 2016-2017 academic year, the economic and fiscal impacts of Samford University on Alabama were \$424.8 million, 2,424 jobs, and \$16.1 million in income and sales taxes (more than \$10.1 million for the state and slightly less than \$6.0 million for local jurisdictions).
- Most of the Samford University impacts were in the Birmingham-Hoover metro area—especially the City of Homewood, where the campus is located and the vast majority of Samford students as well as many Samford employees reside. The university’s impacts on the metro area were \$384.1 million, 2,172 jobs, and about \$5.2 million in local sales tax.
- Alabama will realize even more gains as the 2016-2017 Samford University graduating class will over their careers pay \$258.7 million additional income and sales taxes (\$181.5 million state and \$77.2 million local) than they would have without the Samford education.
- Samford University is also an attractive investment for its graduates. From a private investment perspective, the real annual return on investment (ROI) of the Samford education for the 2016-2017 graduating class ranges from 7.1 percent to 8.8 percent depending on the degree attained when compared to a high school graduate. Comparing the Samford degree to the prior educational attainment level provides a marginal real annual ROI range of 7.1 percent to 15.7 percent.
- Samford University is truly an asset to the State of Alabama and the Birmingham-Hoover metro area. In addition to the above mentioned impacts, Samford provides many other public and private benefits some of which are difficult to fully quantify.

# The Samford University 2016-2017 Economic and Fiscal Impacts on Alabama and the Birmingham-Hoover Metropolitan Area

## Introduction

This report presents the economic and fiscal impacts of Samford University (also referred to herein as Samford) on the State of Alabama and the seven-county Birmingham-Hoover metropolitan area for the 2016-2017 academic year. Expenditure and employment impacts are presented as well as a private return on investment (ROI) analysis of the Samford education since tuition and other attendance costs can be considered as investments by the students. The results show that a Samford education is a prudent investment and also that the university had significant impacts on the state and metro area economies.

The focus in this economic report is on output, employment, and fiscal (income and sales tax) impacts of Samford University on the state and metro area. Output refers to total or gross business sales and contains value-added (the contribution to gross domestic product (GDP) or the value of goods and services produced on a value-added basis within a specific region or state), which in turn contains earnings impacts (the wages and salaries of the workers recognized by the employment impact). The fiscal impacts focus on income and sales taxes and are derived from earnings impacts, but are conservative because just income and sales taxes are considered in this report; other taxes and fees are not. Omitted taxes and fees include utility taxes, car tags and fees, rental/leasing, alcoholic beverages, cigarettes and tobacco, insurance premiums, lodgings, auto title, and other personal property taxes; these are relatively small tax revenues.

The mission of Samford University is to nurture persons in their development of intellect, creativity, faith and personhood. As a Christian university, the community fosters academic, career and ethical competency while encouraging social and civic responsibility, and service to others. Samford University was chartered in 1841 as Howard College in Marion, Alabama, about 55 miles southwest of Birmingham. It was originally named for the British penal reformer, John Howard (1726–1790), who had no connection with the college, but was an international personality of Christian charity. Howard died in Russia, strongly advocating more humane prisons, and his statue was one of the first installed in St. Paul's Cathedral, London. The college was moved to Birmingham in 1887 to a site near the present-day airport in the East Lake section. In 1957, it moved to its present campus in the municipality of Homewood. In 1965, having added the Cumberland School of Law in 1961, the institution reorganized as a university and took the name of a prominent Alabama family as Samford University. Samford currently has 10 schools and colleges.

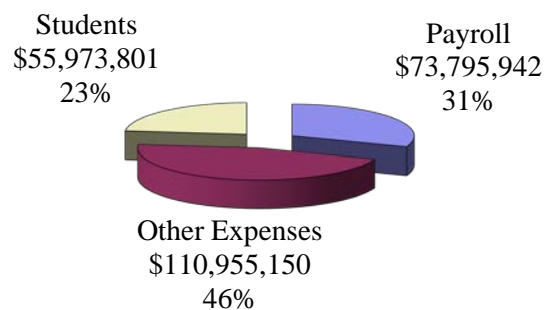
Samford is accredited by the Commission on Colleges of the Southern Association of Colleges and Schools to award the associate's, bachelor's, master's, educational specialist's and doctor's degrees. The university holds accreditation by numerous special accrediting groups.

Samford University contributes to economic development through its teaching, research, and service activities. The university provides numerous benefits that have lasting impacts on its graduates as well as the general public through service and outreach programs with links to communities, business, industry, government, and individuals. Samford provides jobs, generates significant tax revenues, promotes innovation, assists in business creation and growth, and facilitates economic development by making the Birmingham-Hoover metro area and the state attractive for the startup, location, and expansion of business and industry. These benefits lead to improvement of workforce skills and the general quality of life in the Birmingham-Hoover metro area, particularly the City of Homewood, as well as the state and the nation. Samford enhances graduate's learning abilities and intellectual growth, enabling them to earn higher incomes, and contribute significantly in various ways to society. Higher incomes generate more tax revenues for the state and other tax jurisdictions. The university provides many other public and private benefits some of which are difficult to fully quantify.

To determine the total economic and fiscal impacts of Samford University, two types of economic impacts are estimated. The first type, household impacts, deals with the economic and fiscal impacts derived from Samford spending that affect households (i.e., jobs and earnings to households). The second focuses on broad economy-wide impacts that take all expenditures into consideration, i.e. gross business sales and its components. Data provided by the university for the 2016-2017 academic year showed enrollment of 5,471 students and employment of 1,649. Of the faculty and staff 1,544 are Alabama residents and 1,458 live in the metro area. Direct Samford spending for the year was about \$241 million; \$74 million on payroll, \$111 million on purchases, and \$56 million students' off-campus spending on housing, food, clothing, etc.

### Samford University Direct 2016-2017 Expenditures

Total: \$240,724,893



Visitors to the University also make additional expenditures that must be incorporated in the spending impact. Samford visitors include parents, friends and relatives, event spectators, other institutions' academic personnel, business representatives, vendors, research sponsors, and candidates for faculty and staff positions, media representatives, civic and political leaders, government officials, and others. Visitors are drawn to activities such as commencement, alumni weekends and reunions, conferences, seminars, lectures, other educational programs, athletic events, arts and entertainment programs, and various other events.

The \$241 million Samford expenditures generate rounds of spending in the metro area and the state that is captured by multipliers determined from the Regional Input-Output Modeling System (RIMS II). RIMS II is an input-output model developed and maintained by the U.S. Department of Commerce's Bureau of Economic Analysis; the model is available for states, metro areas and county groupings, and counties in the nation. An economic and fiscal impacts model that uses RIMS II multipliers for Alabama and the Birmingham-Hoover metro area was developed and used in this study to determine the impacts. Fiscal impacts are derived from earnings impacts taking into consideration that (i) spending on sales taxable items generally constitute 42.4 percent of total household earnings and (ii) state taxable income (net income) is about 66 percent of earnings. The state income tax rate is 5.0 percent on net income. Sales tax rates used in this study were 4.0 percent for the state and 5.0 percent combined for Birmingham-Hoover metro area and its cities. Combined county and city sales tax rates in the state vary between 3.0 to 7.0 percent among the 67 Alabama counties, but are most frequently around 5.0 percent.

### **Samford University 2016-2017 Economic Impacts on Alabama**

Of the \$241 million total 2016-2017 Samford direct spending, about \$211 million was made in Alabama (Table 1). In addition, there is a visitor impact of \$18.5 million. The economic impacts of Samford University on the state for the academic year were \$424.8 million (including a contribution to gross domestic product or GDP of \$250.7 million) and 2,424 jobs. Fiscal impacts totaled \$16.1 million statewide and comprised roughly \$10.2 million in state tax revenues (\$4.8 million sales and \$5.4 million income) and about \$6.0 million in local sales taxes.

The 2016-2017 economic and fiscal impacts on the state are only part of what Alabama gets. Many public benefits of education and healthcare are hard to measure—innovation promotion, direct and indirect new business development and job creation, general improvements in quality of life, public service, etc. Many of these benefits occur over time and are long-lasting. Other benefits such as additional tax receipts from the higher income that the Samford education enables alumni to receive can be determined. To do so, we assume that sales and income taxes stay at current rates and use a Samford provided estimate of 52 percent of alumni residing in the state. Over the working life of the 2016-2017 graduating class, the Samford education will provide higher income that enables generation of \$258.7 million additional income and sales taxes; \$181.5 million in state sales and

income tax collections and \$77.2 million local sales taxes. This is in excess of the \$16.1 million 2016-2017 fiscal impact.

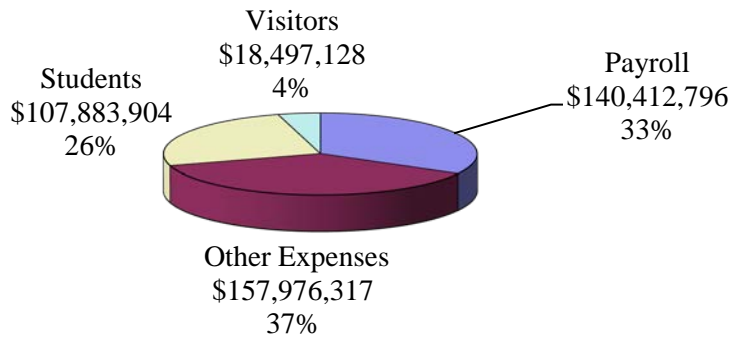
**Table 1. The Samford University 2016-2017 Expenditure Impacts on Alabama**

	Total Amount	Alabama Amount	Indirect Impact	Total Impact
Payroll (Millions)	\$73.8	\$72.9	\$67.6	\$140.4
Purchases (Millions)	\$111.0	\$82.0	\$76.0	\$158.0
<b>Subtotal</b>	<b>\$184.8</b>	<b>\$154.8</b>	<b>\$143.6</b>	<b>\$298.4</b>
Student Expenditures (Millions)	\$56.0	\$56.0	\$51.9	\$107.9
Visitor Expenditures (Millions)				\$18.5
<b>Sum</b>	<b>\$240.7</b>	<b>\$210.8</b>	<b>\$195.5</b>	<b>\$424.8</b>
Contribution to GDP (Millions)				\$250.7
Employment Impact (Jobs)				2,424
Statewide Fiscal Impact (Millions)				\$16.1
State Sales Tax (Millions)				\$4.8
State Income Tax (Millions)				\$5.4
Local (City and County) Sales Tax (Millions)				\$6.0

Note: Rounding effects may be present.

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

**Samford University 2016-2017 Economic Impact on Alabama**  
 Employment Impact: 2,424 Jobs      Expenditure Impact: \$424.8 million



**Samford University 2016-2017 Economic Impacts on Birmingham-Hoover Metro Area**

Of the total Samford University expenditure, \$184.6 million was spent in the Birmingham-Hoover Metro Area from portions of payroll, purchases, and student expenditures (Table 2). This resulted in economic impacts of \$384.1 million (including a visitor spending impact of \$17.6 million) and 2,172 jobs for the metro area. About \$5.2 million in local sales tax revenues for the area's counties and cities were generated.



**Table 2. Samford 2016-2017 Expenditure Impacts on Birmingham-Hoover Metro Area**

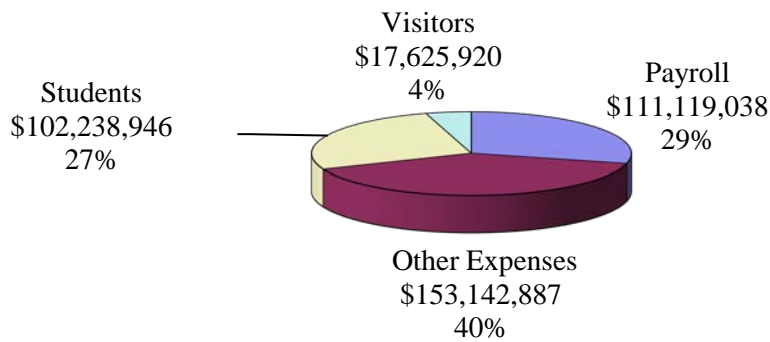
	Total Amount	MSA Amount	Indirect Impact	Total Impact
Payroll (Millions)	\$73.8	\$54.8	\$56.4	\$111.1
Purchases (Millions)	\$111.0	\$79.5	\$73.7	\$153.1
<b>Subtotal</b>	<b>\$184.8</b>	<b>\$134.2</b>	<b>\$130.1</b>	<b>\$264.3</b>
Student Expenditures (Millions)	\$56.0	\$50.4	\$51.9	\$102.2
Visitor Expenditures (Millions)				\$17.6
<b>Sum</b>	<b>\$240.7</b>	<b>\$184.6</b>	<b>\$181.9</b>	<b>\$384.1</b>
Employment Impact (Jobs)				2,172
Local (City and County) Sales Tax (Millions)				\$5.2

Note: Rounding effects may be present.

Source: Center for Business and Economic Research, and Samford University.

### Samford University 2016-2017 Economic Impact on Birmingham-Hoover Metro Area

Employment Impact: 2,172 Jobs      Expenditure Impact: \$384.1 million



### Samford University Education as Private Investment

A university education is also an investment by the students who enroll in the degree programs. There are many benefits for these students from getting a Samford education including the fact that education is its own reward. The ability to learn and grow intellectually greatly increases graduates' earning potential. However, a college degree comes at a cost that includes the obvious cost of the education (tuition, room and board, books, etc.), as well as forgone earnings while in school.

The forgone earnings, often called the opportunity cost, is derived from the earnings potential of the educational attainment level immediately below the graduate's highest Samford degree. For example, the opportunity cost of getting a master's degree is the earnings potential of a bachelor's degree holder. The cost of the Samford education is therefore the opportunity cost plus the direct expenditure to obtain the degree. This cost is the actual marginal cost of pursuing the degree, which can be compared to the marginal benefit or addition to value (called value added) for the graduate, to determine whether the decision to obtain the degree is prudent. Value added in this case is the

difference in salaries of a particular degree graduate with that of a specified reference. High school graduation is used as general reference, but for marginal value added the reference is the prior degree level.

Only half the opportunity cost is included in the marginal cost of the Samford degree since many students work while pursuing their education. A category of people with “some college” is included in the analysis to capture individuals who began college but did not complete a bachelor’s degree requirements. These individuals will earn more income in their working lives than high school graduates will without college experience.

In the marginal analysis, the average doctoral degree salary is compared to that of the master’s degree, a master’s is compared to a bachelor’s, and a bachelor’s to a high school graduate with some college experience. The value added of people with some college is obtained by comparing their income to that of high school graduates. Table 3 shows the results of the private investment analysis with the assumption that graduates will retire at age 67. The table also shows lifetime earnings in both current and real (year 2016) dollars. Expected lifetime earnings increase from about \$3.1 million for a high school graduate to \$8.8 million for the doctoral degree; the corresponding real lifetime earnings range is \$1.4 million to \$4.6 million.

The investment analysis was performed using real or constant year 2016 dollars. The real annual return on investment (ROI) for students with a Samford University education was determined by generating annual cost and income streams over the different working lifetimes of the degree categories. People with some college will have real lifetime earnings of about \$1.8 million, \$411,449 more than a high school graduate, which yields a 7.1 percent real annual ROI on their Samford investment. Bachelor’s and master’s degree holders will earn marginal value added of \$795,284 (a 9.2 percent ROI) and \$944,658 (a 15.7 percent ROI), respectively. A doctorate will earn \$1.1 million more than a master’s, yielding a 12.2 percent real annual ROI. Using high school graduation as a reference (i.e., attending Samford University instead of ending their education at high school graduation), the master’s degree yields the greatest real annual ROI with 8.8 percent, followed by 8.5 percent for the doctorate, 7.6 percent for the bachelor’s, and 7.1 percent for some college.

The positive real rates of return and their magnitude indicate that the decision to pursue a Samford degree is very sensible. The master’s degree has the highest marginal return on investment, but the doctoral degree earns the most, even over a shorter expected work life. These real investment returns are better than the long term returns on investment in U.S. equity markets.

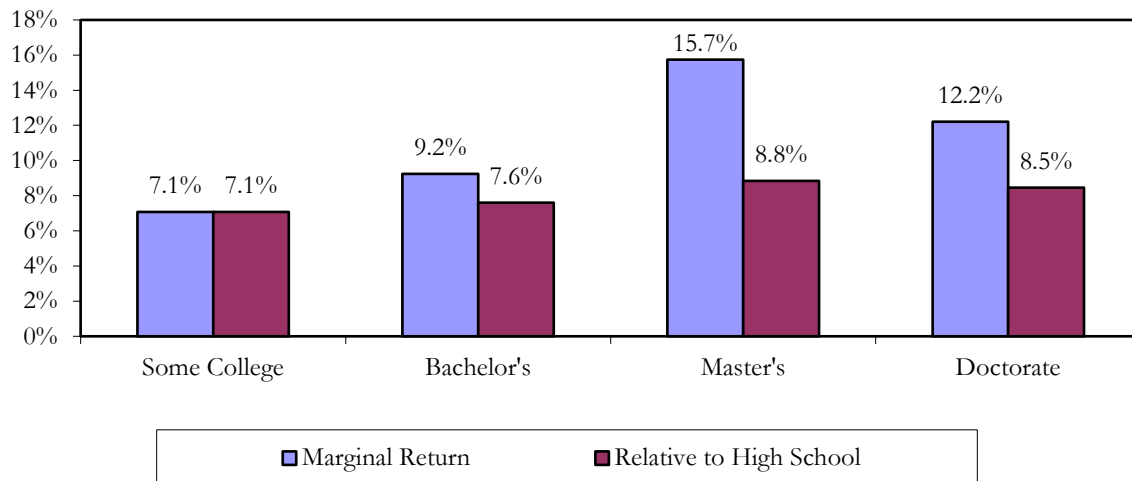
**Table 3. Samford University Education as Private Investment (Class of 2016-2017)**

	Degree/Diploma				
	High School	Some College	Bachelor's	Master's	Doctorate
Average Starting Salary (\$)	25,009	30,851	44,891	65,313	93,730
Total Cost of Degree (2016 \$)		104,231	275,182	404,295	628,598
Lifetime Earnings (2016 \$)	1,357,485	1,768,934	2,564,218	3,508,876	4,589,471
Incremental Income (2016 \$)		411,449	795,284	944,658	1,080,595
Real Annual Return on Investment		7.1%	9.2%	15.7%	13.3%
Real Return Relative to High School		7.1%	7.6%	8.8%	8.5%
Lifetime Earnings (Current \$)	3,067,908	3,918,041	5,420,328	7,126,577	8,790,779
Incremental Income (Current \$)		850,133	1,502,287	1,706,249	1,664,202

Note: Rounding effects may be present. Total cost of degree is the direct cost of the education (tuition, room and board, books, etc.), as well as forgone earnings while in school.

Source: Center for Business and Economic Research, and Samford University.

**Real Annual Rates of Return of a Samford University Education by Degree (Class of 2016-2017)**



## Conclusions and Discussions

The 2016-2017 Samford University economic impacts on the State of Alabama were \$424.8 million expenditure impact and 2,424 jobs. Most of these impacts—\$384.1 million and 2,172 jobs—occurred in the Birmingham-Hoover metro area with many benefits going to the City of Homewood, where the campus is located and many Samford students, faculty, and staff reside. A Samford education is a very high-yielding investment for students. The real annual rate of return on some college attendance is 7.1 percent over a high school graduate. The bachelor's degree has a 9.2 percent real annual rate of return over some college attendance, and the master's degree yields a 15.7 percent return over a bachelor's degree. The doctorate provides a 12.2 percent marginal return over the master's, but has the highest lifetime earnings.

Any study of this kind has some uncertainties. The real rates of earnings growth may change and so can income and sales tax rates, share of alumni residing in the state, etc. However, under the assumptions of this report, a Samford education is a very sound investment for students (better than most stocks and stock indexes) and a better investment for the state than most bonds.

In addition, there are several intangible benefits of a Samford University education that cannot be measured. The university produces skilled and knowledgeable people; provides valuable research, adding to the stock of knowledge; enhances graduates' ability to learn and grow intellectually and to contribute in various ways to society; and facilitates economic development of Alabama and its counties and communities. Thus Samford University delivers tangible and intangible benefits to its graduates and the state's economy; since some of the graduates leave the state after completing their education at Samford, there are also benefits to the national economy that are not highlighted here.

It is important to note that there is no economic development without education. Higher education, in particular, plays a real and critical role in the modern high-tech economy. This is because economic growth is attributable mostly to the knowledge-based economy which is characterized by increasing returns, rather than the physical economy with its diminishing returns. Physical products depreciate and become obsolete. Knowledge builds on prior knowledge and does not depreciate or become obsolete. The physical products and services consumed in society are made better mainly with the gains in knowledge provided by higher education. This makes Samford University essential to the economic and community development of the metro area, the state, and the nation. The 2016-2017 economic impacts of Samford on Alabama and the Birmingham-Hoover metro area certainly exceed by far those presented in this report.

## APPENDIX

### Methodology - Model

The economic and fiscal impacts presented in this report are determined using a model that combines specific economic structure and fiscal components for Alabama and the Birmingham-Hoover metro area with multipliers from 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 (BEA). The economic impacts focus on output, employment, and fiscal (income and sales tax) impacts of Samford University on the state and metro area. Output refers to total or gross business sales and contains value-added, which is the contribution to gross domestic product (GDP) or the value of goods and services produced on a value-added basis. The fiscal impacts presented are conservative because just income and sales taxes are considered; several relatively small taxes and fees (e.g., car tags and fees, rental/leasing, cigarettes and tobacco, and insurance premiums) are not.

In this study, multipliers for the “colleges, universities, and professional schools” industry are used for the analysis. Additionally, household sector multipliers are used for visitor impacts. The four major types of multipliers—output, value-added, income or earnings, and employment—are defined as follows. Output multipliers represent the total dollar change in output that occurs in all industries for each additional dollar of output delivered to final demand (final consumption) by the industry under study. Value-added multipliers are similarly defined except that they represent the total dollar change in value-added across all industries. Earnings multipliers represent the total dollar change in earnings of households employed by all industries for each additional 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.

It is important to note that not all of the spending impacts that fiscal impacts are based on are taxable. Spending on sales taxable items constitute 42.4 percent of total earnings based on U.S. Bureau of Labor Statistics (BLS) data. State taxable income (net income) is about 65.8 percent of earnings and the applicable tax rate is essentially 5.0 percent; the first \$500 and the next \$2,500 are taxed at 2.0 percent and 4.0 percent, respectively, for single persons, head of family, and married persons filing separately while for married persons filing joint returns the first \$1,000 and the next \$5,000 are taxed at 2.0 percent and 4.0 percent, respectively, and excess net income is taxed at the 5.0 percent rate. Corporations pay at a 6.5 percent rate and corporate income tax averages about 15 percent of individual income tax. Sales tax rates used are 4.0 percent for the state and 5.0 percent for local (combined county and city) jurisdictions. Alabama Department of Revenue (ADOR) publications show that local sales tax rates vary between 3.0 to 7.0 percent statewide, but are usually at 5.0 percent.

## Methodology - Economic Impact Analysis

Economic impact analysis measures the effects of a specific economic activity or event on a specified geographic area. Examples include impacts of a proposed industrial plant, an existing industry, closing a military installation, or expanding an existing industrial facility. Federal laws and state and local regulations sometimes require economic impact studies prior to the implementation of a particular policy or action (relocation of an economic activity, change in tax policy, changes in zoning ordinance, providing economic incentives, etc.). Impact studies are designed to provide information for taking actions or instituting policies that facilitate positive economic impacts and/or mitigate potential negative impacts. Economic impact analysis is therefore an important decision making 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, value-added, 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 output, employment, and fiscal (income and sales tax) impacts of Samford University on the State of Alabama and the Birmingham-Hoover metro area.

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 a firm or industry, as well as all other expenditures of the firm or 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 demand for the output of the firm or industry under study. For example, expenditures made by Samford University create impacts on its vendors and also on consumer products and services industries purchases of products and services for the university’s own use and for its workers as consumers. These other industries and their workers in turn make purchases from other vendors in the area, and so forth, which can include Samford related education and training for the industries’ workers and their dependents. In this interconnected manner, businesses increase their production of goods and services to meet the direct and indirect demands created by Samford University. All of this results in development of the economy at both state and metro levels. The total economic impacts of the activity 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, their incomes, and industry 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(s). Such occurrences are called *leakages*, as opposed to *linkages*

(supplier-purchaser relationships) within the region. In general, small geographic areas have small *absolute* economic impacts because leakage is highly likely. Large regions have larger absolute economic impacts, but smaller *relative* economic impacts. 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 involve 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 very detailed 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 two 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 products that require lots of inputs and extensive processing.

The nature of the product (or service) 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 and destination of products or services. Inputs purchased outside the study area constitute leakage of potential impact—activities of local firms that have no economic impact—and provide opportunities for “localizing” such impact. Identifying leakage can provide valuable planning information for economic development. An activity’s maximum impact on a specific area is obtained when all interindustry linkages occur within the area. A system-wide view is required because different firms or activities have different linkages. The I-O technique permits the incorporation of such system-wide perspectives.

For the purpose of this study, linkages between Samford University activities and all related suppliers and customers must be traced. This task is greatly facilitated by BEA’s RIMS II, which provides multipliers for every state, region, county, and metropolitan area in the nation. The RIMS II I-O model provides data on each industry that reflect the value of inputs used per dollar of output

in the production of that industry's output and is represented in a tabular format. For example, data for the "colleges, universities, and professional schools" industry show the value of each input per dollar of product produced (or service provided). Since the rows (outputs) are produced by specific industries, they are also columns (inputs). I-O models are based on a table of transaction balances that ensures economy-wide accounting consistency. Total payments equal total receipts for each producing sector and aggregate final demand equals aggregate value-added. Demand for a particular input causes supply from its source industry which in turn creates demand for the materials and services that are used to produce the particular input, and so on. The round-by-round effects decrease and converge; I-O methodology captures the total effect of the rounds of spending with the multiplier. RIMS II multipliers for an economy account for all linkages in and leakages from that economy.

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 that sell and purchase goods and services to and from each other with *interindustry* flows that are key data. Sector goods and services are purchased by domestic consumers (households), international customers (exports), government (federal, state, and local), and for private investment purposes. These external to production purchases are for direct use and termed *final demand*. For an economy with  $n$  sectors, if  $X_i$  represents total output for sector  $i$ ,  $Y_i$  represents final demand for sector  $i$  products, and  $z_{ij}$  represent interindustry flows (with  $j$  representing sectors as well), then

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

If  $a_{ij}$  represents 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. This model enables determination of the output given changes in final demand levels (consumption, investment, government, or exports). The Leontief inverse,  $(I - A)^{-1}$ , provides the I-O multipliers used to determine impacts. The elements of the matrix are 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 value-added and income or earnings multipliers.