NORTHERN ARIZONA UNIVERSITY
The W. A. Franke College of Business

The Economic Contributions of Northern Arizona University to the State of Arizona in 2010

November 2010

The Arizona Rural Policy Institute

A Unit of the Center for Business Outreach

Prepared by:

Wayne R. Fox, Director

Thomas E. Combrink, Senior Researcher

John D. Eastwood, Lecturer in Economics

Ronald J. Gunderson, Professor of Economics

Jeffrey V. Peterson, Research Associate

This report was prepared in part with funding from Northern Arizona University, the City of Flagstaff, Coconino County, and the United States Economic Development Administration.

The Economic Contributions of Northern Arizona University to the State of Arizona in 2010

Thomas E. Combrink, John D. Eastwood, Wayne R. Fox
Ronald J. Gunderson, and Jeffrey V. Peterson

Executive Summary

- This impact analysis estimates the economic contributions of Northern Arizona University (NAU) to the State of Arizona and its counties for Fiscal Year 2010. Separate models were developed to demonstrate the economic impact of NAU on the entire state as well as the impacts on Coconino, Maricopa and Yuma counties, and on the Balance of State (the remaining twelve counties.)

- The Minnesota IMPLAN Group model was used to generate the economic impacts analyzed in this report. This widely acclaimed model provides measures for both the direct impact and the ensuing multiplier impacts resulting from NAU operations in each location.

- This study provides information on the total expenditures, employment, employee compensation and labor income associated with NAU operations throughout the state.

- The total impact is further divided to show the contributions classified by type of spender arising from the following five subgroups related to NAU activities: University (including employees), students, visitors to campus, NAU retirees, and NAU graduates in Fiscal 2010.

- Total expenditure in FY 2010 by all parties related to NAU was almost $1.5 billion dollars -- $1.461 billion dollars. The direct expenditure by these groups was $806 million while the remaining $655 million is the result of indirect and induced expenditures associated with the multiplier. These numbers can be interpreted to mean that for each $1000 of spending that occurs to directly support NAU, an additional $810 is spent elsewhere within the state as a result of the multiplier impacts on the economy. (i.e. the spending multiplier is 1.81).

- Overall, these numbers are relatively conservative since they do not include intangible impacts of the spillover benefits that a more highly-educated population generate in the form of increased productivity and earnings that benefit all the residents in an area in the form of better public health, reduced levels of crime, and the attraction of increased amounts of business activity as a result of business enterprises that choose to locate within the region simply because the University also is located here.

- The total spending impact in Coconino County in FY 2010 was $644 million. The impact in Maricopa County was $145 million. In Yuma, the impact was over $20 million, and in the Balance of State, this impact was $65 million.

- Total employment generated in Arizona by NAU and all its affiliated activities during FY 2010 was 14,750 positions (full-time equivalent). Of this amount 9,770 positions were attributed to direct employment, and the remaining 4,981 positions are due to the multiplier impact. This suggests that for each 100 persons employed at NAU and at other businesses and organizations

as a direct result of NAU's operations, another 51 positions are generated due to the multiplier effects on the State's economy.

- Total employment at each of the county levels -- including direct employment at NAU plus other positions created in each county in support of NAU, was 8,269 in Coconino, 1,330 in Maricopa, 244 in Yuma and 900 in the Balance of State.

- Total direct, indirect and induced expenditures in Arizona resulting from NAU operations and faculty and staff spending in 2010 were almost $540 million.

- Total direct, indirect and induced expenditures in Arizona resulting from NAU student spending in 2010 exceeded $603 million.

- Total direct, indirect and induced expenditures in Arizona generated by visitors to NAU campuses and to NAU students in 2010, were $119 million.

- Total direct, indirect and induced expenditures made by NAU retirees living in Arizona were almost $43 million in 2010.

- NAU graduates earn incremental income above what they would earn if they had not completed a college degree. The spending associated with the incremental income earned each year by graduates who continue to reside in Arizona after graduation also contributes to the state's economy. Over their working lifetimes it is estimated that the approximately 80,000 NAU graduates residing in Arizona will earn significantly more income due to their educational attainment. Their extra earnings have an estimated present value of $37 billion over what they would have earned without their NAU degree. This higher earning power also generates significant state tax revenue. It is estimated that NAU alumni paid approximately $73 million in Arizona personal income taxes in 2009 in excess of what they would have paid with only a high school educational attainment.

- NAU operations generated in excess of $96 million of local and state tax revenues during FY 2010.

- For FY 2010, NAU overall funding sources were $379 million excluding investment and auxiliary revenue. These funds generated 3.85 times that amount in total state spending. However, if we focus solely on NAU's state appropriation of $128 million in Fiscal 2010, the total state spending impact generates a return of $11 for each $1 of state funded allocations to NAU.

- Direct employment associated with NAU in Coconino County accounts for 10.1% of total employment in the County. This figure rises to 11.9% once the multiplier impacts are included. Directly or indirectly, one of every 8 ½ jobs in the county exists due to NAU's presence.

Acknowledgements

The preparation of this study would not be possible without the assistance of numerous individuals from Northern Arizona University and other persons throughout the state. The authors would like to thank the many individuals who provided information needed in order to determine the impacts generated by the IMPLAN model used for this project.

Among the individuals from the NAU community who deserve special thanks include Patricia Haeuser, Diane Verkest, Laura Huenneke, Winnie Ennenga, Robert Norton and Neil Goodell along with others who provided valuable information. We also wish to recognize Richard Bowen who coordinated the information solicitations among the campus units. We are grateful to Melinda Bradford who reviewed the final draft, and Theresa Stacy-Ryan, W. A. Franke College of Business Graphic Designer Sr., who provided valued assistance with the project and who produced the final report.

The Economic Contributions of Northern Arizona University to the State of Arizona in 2010

Thomas E. Combrink, John D. Eastwood, Wayne R. Fox,
Ronald J. Gunderson, and Jeffrey V. Peterson

Introduction

This analysis is the latest in a series of similar reports over several years designed to measure the economic contributions of Northern Arizona University (NAU) to the State of Arizona as well as the separate contributions that NAU has made to Coconino, Maricopa and Yuma counties and to the Balance of State (the remaining twelve counties). This study reports these impacts for Fiscal Year 2010. Universities such as Northern Arizona University serve as centers for learning and research; however, they also act as major contributors to the economic development of the regions where they exist.

The economic well-being of the residents of Flagstaff and other communities throughout Arizona is enhanced by the purchases of goods and services and the number of jobs created as a result of the daily activities on NAU's campuses. The influx of outside monies and the ongoing research and development activities also contribute to an enhanced quality of life for Arizona citizens. Thus it is important from time to time for the university to quantify its impacts in order to provide a measure of the return on the investment of public funds spent in support of higher education.

At present, nearly 70 percent of NAU students are enrolled at the Flagstaff campus; however, given NAU's role as a significant provider of education throughout Arizona, the impact of the university is extensive throughout the State and is not confined to Coconino County. This study, therefore, is designed to measure these contributions on a statewide level. Separate models were produced to demonstrate the impacts occurring on several distinct regions within Arizona as well as on the overall state.

In this study, we isolate the quantifiable impacts of the operational expenditures of NAU. We examine the impacts of annual operations and construction spending at NAU, as well as the impacts resulting from the expenditures by employees, students, visitors to the campuses, retirees and alumni.

The overall impact on the state and on each of the individual counties greatly exceeds the initial impact created by the direct expenditures made by the individuals described in the preceding paragraph. As these dollars are spent and re-spent within each county, a multiplier effect is created which generates additional dollars in the local economies. Therefore, two sets of impacts are provided – the direct or initial impacts, and the total or overall impacts. We also estimate the number of jobs created in each location as well as the amount of wages, salaries and personal income generated as a result of these activities in Fiscal 2010.

Although studies of this type only examine the monetary effects of these expenditures, the full impact of NAU extends far beyond the dollars and cents associated with daily spending activities. The additional effects are called non-monetary impacts; however these typically are not included in economic impact studies because their impacts are difficult to assess. We do not estimate, for example, the dollar impact associated with increased levels of cultural and sports activities occurring in Flagstaff due to NAU's presence in the community. Furthermore, the population of Coconino

County is clearly influenced by the presence of Northern Arizona University in the area. Migration of residents and businesses into the region is due, in part, to the existence of NAU and the job and research opportunities associated with such a large employer.

We begin with a history of NAU's changing role in providing higher education services to the residents of Arizona. This is followed by a description of the methodology employed to measure the expenditure, employment, and income impacts associated with the university activities across the state. We include sections on the impacts of alumni and retirees in addition to the traditional impacts associated with spending by employees, students and visitors. The remaining sections of the study examine the fiscal impact that NAU and its activities exert on the budgets of all governments -- federal, state and local. We provide tables that show the number of dollars collected by each type of government as a result of the spending and re-spending that occurs from NAU activities.

History of Northern Arizona University

NAU's origins are traced to 1899 when the Arizona Territorial Legislature established the forerunner of Northern Arizona University (NAU). Twenty-three students were enrolled in the first class at the Northern Arizona Normal School in September 1899.

Growth of the Normal School, both in enrollment and in its importance to the State, eventually led to changes in the institution's status and name. In 1925, the state legislature changed the school's status to that of a four-year degree-conferring college and authorized the initial Bachelor of Education degree program. In the same year, the name of the school was changed to Northern Arizona State Teachers College, and in 1929, the name was changed once again to Arizona State Teachers College at Flagstaff.

In 1937, the legislature authorized the first Master of Arts in Education program. In 1945 the school's name was changed to Arizona State College at Flagstaff. The Bachelor of Science in Forestry was authorized in 1958.

Arizona State College became Northern Arizona University on May 1, 1966. Two years later, the Arizona Board of Regents approved the authorization of the first doctoral programs at NAU in the areas of Biological Science and in Education.

Northern Arizona University's role in higher education in Arizona has expanded in numerous ways since becoming a university in 1966. Student enrollment at all NAU campuses in the Fall semester FY 2010 was 23,600, and by Fall FY 2011, this number has exceeded 25,200. NAU and staff make significant contributions to community and public service across the state. Numerous curricular changes have been implemented that focus on the global society emphasizing the international, sustainable and diverse environments that our students encounter in the 21st century. The citizens of Arizona also benefit from ongoing initiatives in education, environmental and ecological research, business, nursing and hotel/restaurant management as well as from outreach activity undertaken by university centers and institutes. The impacts include a growing and significant amount of externally funded research conducted by university faculty.

The NAU main campus (The Mountain Campus) is located on approximately 740 acres of land in Flagstaff. The university also operates a campus in Yuma in concert with Arizona Western College, and has recently moved into a new building in Yavapai County on the Prescott Valley Campus.

Students also can enroll at one of over thirty NAU Statewide campuses as part of NAU Extended Learning programs, and others enroll in classes and earn their degrees online.

Since graduating its first students in 1901, over 110,000 students have graduated from Northern Arizona University. Many of these alumni continue to participate in university-sponsored events and activities in Flagstaff and throughout Arizona.

The Role of Universities in Economic Development

Faculty members at universities are responsible for generating significant numbers of ideas that have been used by economic developers across the nation. Business incubators such as the Northern Arizona Center for Emerging Technologies (NACET) exist in locations where universities increasingly assume a leadership role in providing technical assistance to businesses as well as instituting applied research and facilitating technology transfer to enhance economic development in local communities.

Over time, the missions of universities have evolved to include activities that promote economic growth within the state. NAU is an active participant in the promotion of economic development across Arizona. Faculty members working at NAU provide leadership at both national and state levels in fields as diverse as biological research, natural resource and conservation efforts, tourism research and Native American and rural policy programs and initiatives.

While universities are becoming more actively engaged in statewide economic activities, the share of state appropriations accruing to higher education has been diminishing in many states. In Arizona, this is no exception. From data prepared by the State's Joint Legislative Budget Committee, the agency share of statewide funding for the universities has declined from 12.3 percent to 10.5 percent of the state's total general funds budget over the past ten years.

Measuring the Economic Impacts of a University

The traditional approach used to estimate the economic impact of a university is to measure the dollar impact of the additional economic activities which accrue to a region but which would then disappear if the university were to close down or if the university were not located in that area. Economic impacts occur whenever the university spends dollars for capital and operations items. In addition, spending by university employees and students, as well as by visitors to the campus, also contributes to the impact. In this study, we also have included spending that was made by NAU retirees and by NAU alumni on an annual basis.

Local economies across Arizona would be influenced if these expenditures were to end. For example, receipts at local hotels and other lodging facilities would decline with the reduction of out-of-town visitors to the campus and to its students. Local restaurant and entertainment enterprises also would feel the negative impacts. Banking, insurance and other business and personal services firms would experience a reduction in their sales and service activities.

The closure of a university also impacts the region's supply of available labor. Many businesses depend on university students and employees as primary sources of labor and technical expertise. The decreased availability of student workers and interns would increase operating costs for local firms when they were compelled to increase wages to replace relatively inexpensive laborers with more expensive workers.

A host of quality-of-life activities also are associated with a university, and these would be negatively impacted if the university was not present in the region. Most obvious, perhaps, are the athletic and

cultural events held at university locations. Local public radio programming would disappear, numerous seminars and workshops conducted by university personnel would decline, and the overall physical and cultural infrastructure of the region typically shrinks in a smaller environment.

The Multiplier Effect

When the level of direct expenditures increases in a region, these dollars are spent and re-spent in the local economy, creating additional incomes and jobs. This generates a magnified impact on the region called the "multiplier." The process also works in reverse when the level of expenditure in an area declines instead of increases. In these instances, the reduced levels of spending generate additional cutbacks elsewhere in the region as well as further reduce employment. This begins a negative chain of events that result in a decline in local economic activity.

The value of the multiplier varies based upon the types and amounts of spending and re-spending that occur within each community. Therefore, every location has its own multiplier. For example, if a local area has a multiplier of 2.00, a $1 million of direct spending in that area will also generate an additional $1 million in spending, and the total impact on the area will be $2 million. Similarly, a decline in spending by $1 million dollars would cause a $2 million drop in overall spending in that area.

Underestimation of the Overall Impact

This approach to measuring impacts focuses only on the amount of spending that is attributed to the presence of the university in a region. As such, the true impact of the university on the local economy is underestimated. As an example, the existence of a university may increase home values in an area. Rental costs for local houses and apartments may rise due to the higher demand resulting from the presence of hundreds or thousands of students and faculty who live in the area because of the university. Although the impacts of higher housing costs are not measured by the model, the demand for housing exhibited by these residents, particularly in the areas adjacent to the university, is very often responsible for the elevated cost of housing in many university towns.

The typical economic impact model also ignores the impacts on state and local areas associated with the benefits arising from the discovery and application of significant scientific and technological research outcomes stemming from faculty and student activities. These outcomes can greatly influence the life and well-being of millions of citizens, yet the direct tie-in to the university is often too nebulous to permit an analysis that measures the cause and effect of these activities. Furthermore, we have not considered enhancements and improvements in the local community resulting from the increase in worker productivity associated with completing a college degree, nor the general attractiveness of a region as a desirable place to work and live due to the presence of the university in the area. While these factors impact local living conditions, their measurement is extremely difficult and their impacts are not incorporated into this study.

Costs vs. Benefits of a University

Although a university brings numerous and significant benefits to a local area that region also incurs increased costs due to the university's presence in the region. One example of these costs is the revenue foregone from tax-exempt property owned by the university. Since the land and infrastructure occupied by most state universities is removed from the local tax rolls, the assessment on remaining property in the region is likely to be higher to make up for lost revenues. A lack of adequate levels of parking and increased congestion in and around the university often occurs. Additional costs are imposed on the city water and sewer infrastructure, as well as increased costs of enhanced police and fire forces needed for

protection. The increased rental costs in the region were already mentioned above. Finally, the demands on local school systems are often impacted due to the existence and enrollment of increased numbers of school-age children of the university employees and students. However, any large-scale level of economic activity will impose similar costs on a community, and these items must be considered as part of the overall cost-benefit picture that emerges in a growing community.

The following section describes the methodology employed to estimate the economic impact of Northern Arizona University on the State of Arizona and the local communities where NAU provides educational opportunities.

Methodology

The period of analysis for this study is the 2010 Fiscal Year which began July 1, 2009 and ended on June 30, 2010. The output, income, jobs and tax impacts associated with the activities of NAU are presented for the entire state as well as for Coconino, Maricopa and Yuma counties and for the remaining twelve counties which are referred to in this study as the Balance of the State.

The specific model used for this study was originally developed in 1985 by the Minnesota IMPLAN Group Inc. IMPLAN refers to IMpact Analysis for PLANning. The model has been updated several times over the years, and employs a sophisticated computer program which adapts the national input - output tables to county and state levels. This procedure permits computations generated for the national economy to be uniquely broken out and designed for use at state and local levels. The smallest geographic region that IMPLAN uses is at the county level. Therefore, the local region is synonymous with the county. In this analysis, we estimate the impact of NAU at the state level, but we also provide the impacts on selected Arizona counties since NAU activities are present in numerous locations throughout the state.

The IMPLAN methodology estimates the impacts on a state or county that stem from a given event or the elimination of a set of economic activities. The model therefore analyzes impacts resulting from the changes in demand that would occur if NAU were to cease to exist. The model is discussed in detail in Appendix A at the conclusion of this report.

Input-output models identify three distinct effects on a region – direct, indirect and induced – and the magnitudes of these impacts are the same size regardless of whether the initial change in spending is positive or negative. Only the direction of the change will vary. The impacts are primarily grouped into output, income, employment and tax arenas. The magnitude of the impact in each community is a function of university spending in the region as well as expenditures made by NAU employees, students, visitors to the university and others associated with NAU.

When NAU or its students, employees, visitors and others related to NAU increase their spending, this action is called the *direct* effect. These expenditures immediately increase local sales activity and generate increases in local employment and income levels.

This increase in demand for local inputs generates a ripple or multiplier effect in the local economy. This action is the *indirect* effect, which occurs when local businesses gear up to replace and expand the level of these inputs. To meet these demands, the firms also must increase their purchase of inputs from other producers, some of whom may be local. As a result of these secondary purchases, this set of producers also will increase hiring of labor inputs required to produce the desired goods and services.

The chain of events does not stop here. Increases in employment resulting from higher direct and indirect spending will increase the incomes of local households. These households, in turn, will spend a portion of their new incomes in the local economy. This spending stimulates even more demand for output and creates additional employment opportunities in the local region. This tertiary increase in economic activity is the *induced* effect, and is a reflection of the changes that occur due to higher household incomes in a region.

Therefore, the *total* effect of changes in spending by the university or anyone associated with NAU, will be the sum of the direct, indirect, and induced effects described above.

The proprietors' income and the wages and salaries flowing to employees in the affected businesses provide a measure of the *income effect.* The *employment effect* is gauged by the number of jobs that exist as a result of the increased initial sales activities and the higher business-to-business transactions that occur to meet the demands of increased economic activity in the state and counties. The *tax impact* is a measure of the fiscal change resulting from the operations at NAU. The tax impact is shown for the Arizona state government as well as for various counties influenced by NAU's presence.

IMPLAN recognizes that a portion of the expenditures resulting from changes in demand in any given region will occur outside the physical boundaries of that region. This effect is called *leakage*, and refers to the impacts felt in areas outside the region being measured. Therefore, the leakage must be subtracted from the local budget in order to provide an accurate measure of the total impact. To demonstrate this point, assume NAU Transportation Services purchases gasoline from local distributors in order to operate its fleet of State-owned vehicles. Only a portion of the proceeds from these gasoline sales remains in the local area. The crude oil is pumped at the source and refined at facilities throughout the world. The transportation of the gasoline to Flagstaff is often undertaken by individuals living outside the region, and for firms whose owners reside elsewhere. The local gas stations are impacted only by the dollar amount of the increased sales which remain in the local economy. Most of the value spent for a gallon of gasoline is used to fund the activities of entities that produce and transport the gasoline to the local service stations and is not counted as part of the impact on the region.

The Impact of Northern Arizona University on Arizona including Coconino, Maricopa and Yuma Counties as well as the Balance of the State

The impacts of Northern Arizona University are analyzed for Arizona overall and separately for Coconino, Maricopa and Yuma Counties as well as for the Balance of the State. The impacts are separated into five distinct components. The first and largest impact is generated by expenditures made by students attending NAU campuses throughout Arizona. Over the past several years, NAU enrollments have increased dramatically in Flagstaff as well as in locations throughout Arizona. As a result, the impact of student spending has become more widely dispersed and generates a substantial economic impact in regions outside Coconino County.

The second largest impact results from the day-to-day activities undertaken at NAU as well as spending by NAU employees. These figures include spending from all sources for construction, operations and wages and salaries at NAU. The numbers used in this study were obtained from appropriate NAU departments and offices throughout the campus network.

An additional impact is attributed to the spending by visitors to NAU campuses as well as to those persons who visit students who are attending NAU. Spending by visitors is included in the overall

impact in order to account for dollars spent at athletic, music, cultural and other events occurring on the campuses as well as by friends and family who visit or conduct business at the university. Some stay overnight, others do not; still others spend several days on campus for retreats, camps, Road Scholar events and other activities that span several days. Their impacts are measured by the amount of money spent during the time they visited the campus.

Spending by NAU retirees also was considered when determining the overall impact of NAU on the state and county economies. Expenditures made by these persons are considered as part of the impact associated with NAU since their presence in the state can be partly attributed to their prior employment at the university. In line with the methodology presented earlier, these individuals may not have a reason to reside in Arizona if NAU had not been here to provide them employment. Their continued residence in Arizona in their post-employment years can; therefore, be counted as part of NAU's contribution to the state and county-level impacts.

Finally, NAU presently confers approximately 5,400 degrees each year to graduates at the bachelor, master and doctoral levels. These students will earn greater salaries over the course of their working lives compared to what they would earn without their degrees. Therefore, the incremental spending that results from the higher incomes earned by NAU alumni also contributes to the NAU impact on the state economy. Since this study is designed to measure the impact attributed to NAU on an annual basis, we have included numbers that capture alumni spending due to their higher incomes on a one-year basis.

A case could be made for including all of NAU's living alumni that live and work in Arizona. During each year of their working lives, these graduates earn more than they would have had they not completed their degrees. This earnings differential tends to increase during their careers and results in substantial increases in lifetime incomes. A separate review of the impact of all NAU alumni is presented at the end of this study to highlight this contribution.

The impacts of each of these activities are discussed and presented in the following sections of this report. The overall impact in each region was compiled by summing the impacts generated by each of the five spending groups. Comparable analyses are presented here for the State of Arizona as well as for the four separate county models (Coconino, Maricopa, Yuma, Balance of State).

We used the following measures to demonstrate NAU's impact in various ways. Information is presented and analyzed at the statewide level and for each of the county areas listed above for the following variables:

- Total Expenditure or Output
- Employment
- Employee Compensation
- Labor Income

Overall NAU Impact on Arizona

Northern Arizona University's overall impact on the State's economy in Fiscal 2010 was $1,461,285,000. This number represents the total spending (direct, indirect and induced) by all of the sectors mentioned above (NAU and its employees, students, visitors, retirees and incremental alumni expenditures.) The spending impact along with the impacts related to employment, employee compensation and labor income are shown in Table 1. (Note: In input-output analysis, government

services are valued at their production costs, because these services are not sold at market prices. As a result total output and total expenditure are the same amounts.) As shown in Table 1, over $806 million of the $1,461 million in total expenditure is a result of direct spending by these sectors. An additional $214 million resulted from indirect expenditures by Arizona businesses whose operations were positively influenced by the increased levels of initial spending in the state. Furthermore, almost $441 million in induced spending resulted from increased household spending that was generated by increased household incomes made possible by the greater numbers of jobs and the higher levels of wages and salaries paid as a result of the increased levels of direct and indirect expenditures across the state. The difference between the $1,461 million in overall spending and the $806 million in direct spending is referred to as the multiplier effect. In this study, the multiplier is 1.81 which means that every $1 million dollars of expenditure made by NAU generates an additional $810,000 in spending somewhere else in Arizona.

Table 1:

The Statewide Impact of the Operations of NAU for Fiscal Year 2010

Impact	Direct	Indirect	Induced	Total
Total Output	$806,477,500	$214,117,900	$440,690,000	**$1,461,285,400**
Employment	9,770	1,501	3,480	**14,751**
Employee Compensation	$366,185,000	$58,271,900	$125,319,300	**$549,776,200**
Labor Income	$394,518,800	$68,626,500	$141,239,800	**$604,385,100**

The overall effects of these spending activities associated with NAU also generated a significant increase in statewide employment. Full-time equivalent direct employment at NAU averaged 3,550 in Fiscal 2010. In addition another 6,220 full-time equivalent workers were employed as a result of spending by students, visitors, retirees and alumni. Overall, 9,770 jobholders in the state directly owe their positions to spending by NAU and these groups of individuals. This, in turn, stimulated additional employment within the state that added 1,501 jobs in the indirect sector. The increase in household incomes that resulted from more persons being employed in both the direct and indirect sectors created an additional 3,480 jobs in the induced sector. In total, 14,750 jobs are created throughout Arizona as a result of NAU's presence. Therefore, the jobs or employment multiplier is 1.51, which means that each 100 full-time jobs at NAU will generate another 51 positions elsewhere in the state.

NAU's direct contribution to employee compensation was $366 million. This includes all wages and salaries paid to employees at NAU as well as the salaries paid to workers employed in other sectors across the state that were initially impacted by the spending of NAU faculty, staff, students and other spending groups. As these dollars were spent and re-spent in the state, they generated additional compensation to workers employed in the indirect and induced sectors. This additional spending increased NAU's contribution to total employee compensation in the state to almost $550 million. The multiplier effect related to employee compensation is 1.50. This means that for each $1 paid to employees at NAU, another 50 cents in employee payments also occurred somewhere else in Arizona.

The final impact shown in Table 1 addresses the amount of labor income generated in the state as a result of NAU and its activities. Labor income reflects the salaries and benefits paid to employees at NAU and to workers in other businesses that immediately benefited from spending by NAU and its employees and others. However, labor income also includes proprietors' income as well as other property income received by local landlords. In FY 2010, the amount of labor income directly associated with NAU's presence exceeded $394 million. This direct labor income was further supplemented by additions to income generated in the indirect and induced sectors and eventually

resulted in an increase in total labor income of $604 million in the state. These increases generated a labor income multiplier equal to 1.53. This suggests that for each $1 million in labor income generated at NAU, another $530,000 in labor income was created in the state.

Overall NAU Contribution to Arizona Counties

A series of similar analyses were prepared to measure NAU's economic impact on Arizona counties. These results appear in Table 2 and the interpretations are similar to what was described for the state impact in the previous section. NAU's contribution to output, employment, employee compensation and labor income are reported separately for Coconino, Maricopa and Yuma counties as well as for the Balance of the State. These impacts vary considerably, with approximately 73 percent of the spending impact occurring in Coconino County, which is home to the Mountain Campus, and 27 percent of the impact occurring in the remaining counties.

Table 2:
The Countywide Impact of the Operations of NAU on Coconino County for Fiscal Year 2010

Coconino	Direct	Indirect	Induced	Total
Total Output	$496,738,100	$25,036,800	$121,790,800	$643,565,700
Employment	6,994	213	1,062	8,269
Employee Compensation	$295,527,400	$6,561,700	$32,580,700	$334,669,800
Labor Income	$309,578,600	$8,308,700	$37,064,700	$354,952,000

Note: Row numbers may not add to total due to rounding

The Countywide Impact of the Operations of NAU on Maricopa County for Fiscal Year 2010

Maricopa County	Direct	Indirect	Induced	Total
Total Output	$80,038,200	$32,318,800	$33,023,600	$145,380,700
Employment	853	224	253	1330
Employee Compensation	$25,428,900	$9,336,300	$9,548,200	$44,313,400
Labor Income	$27,488,800	$10,895,200	$10,722,400	$49,106,400

Note: Row numbers may not add to total due to rounding

The Countywide Impact of the Operations of NAU on Yuma County for Fiscal Year 2010

Yuma County	Direct	Indirect	Induced	Total
Total Output	$15,627,800	$1,307,700	$3,152,000	$20,087,500
Employment	199	12	33	244
Employee Compensation	$5,572,000	$369,400	$1,358,900	$7,300,300
Labor Income	$6,152,100	$435,900	$1,435,700	$8,023,700

Note: Row numbers may not add to total due to rounding

The Countywide Impact of the Operations of NAU on Balance of the State for Fiscal Year 2010

Balance of State	Direct	Indirect	Induced	Total
Total Output	$47,869,500	$8,697,100	$8,407,100	$64,973,700
Employment	700	100	100	900
Employee Compensation	$13,977,200	$2,276,600	$2,313,600	$18,567,400
Labor Income	$15,502,300	$2,678,600	$2,596,700	$20,777,600

Note: Row numbers may not add to total due to rounding

Overall Impacts in Coconino County

The various county impacts are highlighted in Table 2. Coconino County is the recipient of the largest impact and is the first county appearing in the table.

Total direct expenditures by NAU and its related spenders (employees, students, visitors, retirees and incremental alumni spending) was over $496 million in 2010. Additional rounds of expenditures boosted this total to nearly $644 million once the impacts of the multiplier were considered.

Direct employment in the county was 6,994 and an additional 1,275 persons were hired in support of these workers elsewhere in the county for a total of 8,269 total jobs. Thus, for every 100 NAU employees, another 18 persons are hired elsewhere in the county due to the indirect and induced expenditures. Total employment in Coconino County averaged 69,500 during the January – June period in 2010. ***Based on our results, direct employment associated with NAU accounts for almost 10.1% of total county employment. This figure increases to almost 12% once the multiplier impacts are included. In other words, one of every eight jobs in the county directly or indirectly, exists due to NAU's presence.***

Employee compensation in the county was directly enhanced by $295 million reflecting NAU payroll as well as payments made to others in direct support of the university. Overall, this compensation exceeded $334.6 million after accounting for the multiplier impacts.

Labor income of county residents rose by almost $310 million as a direct result of NAU operations and by $355 million once all the side impacts are included. ***The $355 million is over 8.1% of total personal income in the county.*** (This figure is based upon a 2010 adjusted update of the official 2008 Personal Income figures for the county provided by the U.S. Bureau of Economic Analysis.)

Overall Impacts in Maricopa County

Northern Arizona University also has increased its economic influence in Maricopa County. The amount of these impacts is shown in Table 2. Total direct expenditures by NAU and others directly affiliated with the university in Maricopa County exceeded $80 million in Fiscal 2010. Once these dollars were spent and re-spent in the county, NAU's total contribution to spending rose to $145 million in Maricopa County.

NAU-related employment in Maricopa County was 853 and 1,330 jobs existed in the county after accounting for the jobs multiplier. In Maricopa, every 100 NAU jobs, generates another 56 jobs elsewhere in the county.

NAU presence in Maricopa County also directly added over $25 million in employee compensation in the State's largest county. NAU's employee compensation impact rose to $44.3 million after the multiplier effects were added to the total.

Labor income in Maricopa County was higher by $27.5 million as a direct result of NAU operations occurring there, and overall labor income in Maricopa County increased by $49.1 million after adding the indirect and induced impacts to the direct operations.

Overall Impacts in Yuma County

The overall Yuma County impacts also appear in Table 2. Total direct expenditures by NAU and its related spenders (employees, students, visitors, retirees and incremental alumni spending) in Yuma County exceeded $15.6 million in 2010. Additional rounds of expenditures boosted this total to $20.1 million once the impact of the multiplier is considered.

Direct NAU-related employment in the county was 199 persons and an additional 45 persons were hired in support of these workers elsewhere in the county for a total of 244 jobs. Thus, for every 100 NAU employees, another 23 persons are hired elsewhere in Yuma County due to the indirect and induced expenditures.

NAU employees and students and others directly employed as a result of NAU operations received slightly more than $5.5 million in employee compensation in Yuma County during 2010. This figure rises to $7.3 million once the multiplier effects are added to the total.

Labor income of Yuma county residents rose by $6.2 million as a direct result of NAU operations and by $8.0 million once all the indirect and induced impacts are included.

Overall Impacts in the Balance of the State

Northern Arizona University's impacts on the remaining counties in the state are included at the end of Table 2. NAU also exerts a considerable economic influence in these regions of the State as a result of its increased educational presence in these counties. Direct expenditures by NAU and others affiliated with the university in these counties exceeded $47.8 million in 2010. After spending and re-spending, total spending in the Balance of State increased by almost $65 million due to NAU's presence in these areas.

NAU-related employment in the Balance of the State was 700; however, 900 jobs exist in these areas after accounting for the jobs multiplier of 1.29, or 29 jobs for every 100 NAU jobs.

NAU directly added close to $14 million in employee compensation in these counties, and over $18.5 million after the multiplier effects are added to this total.

Labor income added to the Balance of State was $15.5 million as a direct result of NAU operations. Labor income increased by $20.8 million overall.

The overall impacts presented here illustrate the magnitude of the impact that NAU generates outside Coconino County in regions throughout the state. Once the multiplier effects have been included, NAU's Extended Campus operations located outside Coconino County are responsible for 6,481 jobs and $818 million in expenditures which created $249 million of new income in these regions in addition to the economic impacts generated in Coconino County. (Note: These numbers were found

by subtracting the impacts in Coconino County from the statewide impacts shown in Table 1. These numbers differ from the sum of the impacts shown for the other counties in Table 2 because of the differences in the multipliers that were used in the state versus the county models.)

Analysis of Impacts by Type of Spender

This section of the report reviews the impacts generated by type of spender. The levels of expenditure and employment in the State and in each county are summarized here to reflect the highlights of the spending generated by each of the five separate groups analyzed in this report. These spending groups are NAU and its employees, students, visitors to the campuses, NAU retirees living in Arizona, and NAU graduates residing in Arizona.

Student spending numbers were obtained from a questionnaire sent to all NAU students in 2010 which asked for information regarding their monthly expenditures. Almost 5,000 students returned the questionnaire which generated a rich source of expenditure patterns. Spending information for NAU and its employees, visitors to the campuses, retirees and alumni, was generated from multiple sources including NAU offices along with local, state and national sources that publish data pertinent to these demographic groups.

The highlights presented here are generated from Tables 3 through 12 which provide more detailed information on the overall expenditure and employment impacts associated with the spending levels made by each of these five groups. These tables show the impacts occurring at the State level as well as for Coconino, Maricopa and Yuma counties and the Balance of the State. These numbers reflect activity for Fiscal 2010, and as in the previous section, the expenditures made by the alumni are based solely on the incremental income received by NAU alumni as a result of obtaining their degrees from NAU, not on their total income. For purposes of internal consistency, this study is designed to measure the estimated annual spending for only the most recent year's graduates, and does not include spending by all NAU alumni residing in Arizona.

Highlights of Impacts by Type of Spender (Summary of Tables 3-12)

State of Arizona:

The total impact in Arizona generated by the following groups in FY 2010 was:

NAU & Employees	$539.8 million and 6,696 jobs
Students	$603.4 million and 5,217 jobs
Visitors	$119.2 million and 1,211 jobs
Retirees	$42.7 million and 358 jobs
Alumni	$156.1 million and 1,269 jobs
Total Statewide impact:	**$1,461.3 million and 14,750 jobs**

Coconino County:

The total impact in Coconino County generated by the following groups in FY 2010 was:

NAU & Employees	$326.3 million and 4,729 jobs
Students	$221.2 million and 2,420 jobs
Visitors	$78.3 million and 955 jobs
Retirees	$9.0 million and 87 jobs
Alumni	$8.7 million and 78 jobs
Total impact in Coconino County:	**$643.6 million and 8,269 jobs**

Maricopa County:

The total impact in Maricopa County generated by the following groups in FY 2010 was:

NAU & Employees	$3.5 million and 200 jobs
Students	$57.7 million and 466 jobs
Visitors	$168,800 and 2 jobs
Retirees	$7.9 million and 64 jobs
Alumni	$76.1 million and 597 jobs
Total impact in Maricopa County:	**$145.4 million and 1,330 jobs**

Yuma County:

The total impact in Yuma County generated by the following groups in FY 2010 was:

NAU & Employees	$3.1 million and 69 jobs
Students	$13.1 million and 129 jobs
Visitors	$1.4 million and 20 jobs
Retirees	$0.2 million and 3 jobs
Alumni	$2.3 million and 24 jobs
Total impact in Yuma County:	**$20.1 million and 244 jobs**

Balance of State:

The total impact in the Balance of the State generated by the following groups in FY 2010 was:

NAU & Employees	$3.1 million and 255 jobs
Students	$32.3 million and 278 jobs
Visitors	$1.6 million and 19 jobs
Retirees	$5.7 million and 53 jobs
Alumni	$22.4 million and 198 jobs
Total impact in Balance of State:	**$65.0 million and 803 jobs**

Table 3:

Expenditures Made in Arizona Classified by Type of Spender in Fiscal Year 2010

Output	Direct	Indirect	Induced	Total
NAU & Employees	$281,407,300	$20,356,400	$238,041,600	$539,805,300
Students	$353,642,000	$121,935,700	$127,790,500	$603,368,200
Visitors	$65,060,900	$26,270,200	$27,895,100	$119,226,200
Retirees	$23,324,600	$9,065,600	$10,345,900	$42,736,100
Alumni	$83,042,638	$36,490,000	$36,616,900	$156,149,600
Total Expenditure	**$806,477,500**	**$214,117,900**	**$440,690,000**	**$1,461,285,400**

Note: Column numbers may not add to total due to rounding

Table 4:

The Employment Impact Generated in Arizona Classified by Type of Spender in Fiscal Year 2010

Employment	Direct	Indirect	Induced	Total
NAU & Employees	4,675	142	1,878	6,696
Students	3,359	848	1,010	5,217
Visitors	807	184	220	1,211
Retirees	211	65	82	358
Alumni	718	262	289	1,269
Total Employment	**9,770**	**1,500**	**3,480**	**14,750**

Note: Column numbers may not add to total due to rounding

Table 5:

Expenditures Made in Coconino County Classified by Type of Spender in Fiscal Year 2010

Output	Direct	Indirect	Induced	Total
NAU & Employees	$240,594,038	$1,615,605	$84,140,203	$326,349,846
Students	$178,361,696	$15,996,227	$26,869,157	$221,227,081
Visitors	$63,279,200	$5,976,899	$8,996,367	$78,252,465
Retirees	$7,344,172	$707,929	$979,911	$9,032,012
Alumni	$7,159,027	$740,094	$805,148	$8,704,269
Total Expenditure	**$496,738,133**	**$25,036,754**	**$121,790,786**	**$643,565,673**

Table 6:

The Employment Impact Generated in Coconino County Classified by Type of Spender in Fiscal Year 2010

Employment	Direct	Indirect	Induced	Total
NAU & Employees	3,982	13	734	4,729
Students	2,052	133	235	2,420
Visitors	822	54	79	955
Retirees	72	6	9	87
Alumni	65	6	7	78
Total Employment	**6,994**	**213**	**1,062**	**8,269**

Table 7:

Expenditures Made in Maricopa County Classified by Type of Spender in Fiscal Year 2010

Output	Direct	Indirect	Induced	Total
NAU & Employees	$1,889,470	$121,017	$1,483,834	$3,494,321
Students	$31,975,516	$12,473,124	$13,225,675	$57,674,315
Visitors	$95,488	$36,285	$37,017	$168,790
Retirees	$4,478,264	$1,694,621	$1,775,181	$7,948,066
Alumni	$41,599,454	$17,993,785	$16,501,930	$76,095,169
Total Expenditure	**$80,038,192**	**$32,318,832**	**$33,023,637**	**$145,380,661**

Note: Column numbers may not add to total due to rounding.

Table 8:

The Employment Impact Generated in Maricopa County Classified by Type of Spender in Fiscal Year 2010

Employment	Direct	Indirect	Induced	Total
NAU & Employees	188	1	11	200
Students	279	86	101	466
Visitors	1	0	0	2
Retirees	39	12	14	64
Alumni	346	125	126	597
Total Employment	**853**	**224**	**253**	**1,330**

Note: Column numbers may not add to total due to rounding.

Table 9:

Expenditures Made in Yuma County Classified by Type of Spender in Fiscal Year 2010

Output	Direct	Indirect	Induced	Total
NAU & Employees	$2,302,401	$14,726	$764,430	$3,081,557
Students	$10,269,481	$968,680	$1,816,970	$13,055,131
Visitors	$1,104,837	$125,838	$190,032	$1,420,707
Retirees	$175,326	$17,389	$36,001	$228,716
Alumni	$1,775,748	$181,048	$344,539	$2,301,335
Total Expenditure	**$15,627,793**	**$1,307,681**	**$3,151,972**	**$20,087,446**

Note: Column numbers may not add to total due to rounding.

Table 10:

The Employment Impact Generated in Yuma County Classified by Type of Spender in Fiscal Year 2010

Employment	Direct	Indirect	Induced	Total
NAU & Employees	61	0	7	69
Students	101	9	20	129
Visitors	17	1	2	20
Retirees	2	0	0	3
Alumni	19	2	4	24
Total Employment	**199**	**12**	**33**	**244**

Note: Column numbers may not add to total due to rounding.

Table 11:

Expenditures Made in the Balance of State Classified by Type of Spender in Fiscal Year 2010

Output	Direct	Indirect	Induced	Total
NAU & Employees	$2,124,093	$56,073	$907,492	$3,087,658
Students	$24,053,331	$4,499,587	$3,710,672	$32,263,590
Visitors	$1,153,069	$232,019	$203,646	$1,588,734
Retirees	$4,170,466	$744,334	$768,762	$5,683,562
Alumni	$16,368,566	$3,165,099	$2,816,487	$22,350,152
Total Expenditure	**$47,869,525**	**$8,697,112**	**$8,407,059**	**$64,973,696**

Note: Column numbers may not add to total due to rounding.

Table 12:

The Employment Impact Generated in the Balance of State Classified by Type of Spender in Fiscal Year 2010

Employment	Direct	Indirect	Induced	Total
NAU & Employees	247	0	8	255
Students	211	34	33	278
Visitors	15	2	2	19
Retirees	40	6	7	53
Alumni	148	25	25	198
Total Employment	**662**	**67**	**74**	**803**

Note: Column numbers may not add to total due to rounding.

Return on Investment

NAU operations generate a significant economic impact on the state. One approach to evaluating that impact is to compare the overall dollar value of the resources the institution receives each year to the annual expenditure impact it generates. NAU received $379,309,000 from all sources during FY

2010 excluding investment income and revenues from internal auxiliary enterprises (*Northern Arizona University 2009-2010 Financial Report, Combined Sources and Uses of Funds,* p. 12). The total expenditure by all parties related to NAU which was discussed previously was estimated to be $1,461 billion for FY 2010. Under this approach, the ratio of total expenditures generated in Arizona compared to the total funds received, generates a return of $3.85 on each dollar of funding received by NAU. However, a more appropriate measure may be to compare the total expenditures generated across Arizona to the amount of state funding received by NAU. Using this comparison, the return on state dollars invested at NAU increases to $11 per dollar of state support.

Impacts Expected from Future Construction Activity at NAU

Construction activity is continuing at NAU campuses and contributes significantly to the level of economic activity in Flagstaff and other regions.

Construction projects typically vary in size and over time, which makes an annual contribution somewhat arbitrary. In fiscal years 2006 through 2010, construction expense was $58 million, $73 million, $64 million, $53 million, and $52 million, respectively. The impacts from construction projects on Coconino County in fiscal year 2010 are shown in Table 13. Future construction over the FY 2011 though FY 2014 period is shown in Table 14 and is projected to reach $217 million in direct spending in Coconino County, or an average of $54 million per year in 2010 prices.

While construction activity will generate $217 million in direct expenditures in Coconino County over this period, the total impact expected from new construction once the multiplier impacts are considered will approach $265 million in current dollars.

The employment impact of the construction activity also occurs over multiple years. Increases in direct employment for this period as a result of the construction will generate 1,459 jobs or an average of 365 jobs per year. The overall increase in employment after accounting for the indirect and induced effects will generate 1,877 jobs or an average of 469 jobs, as shown in Table 14.

Table 13:
Construction Impact 2010

Impact Construction 2010	Direct	Indirect	Induced	Total
Output	$52,000,000	$4,607,178	$6,990,316	$63,597,493
Employment	337	39	61	438
Employee Compensation	$11,093,711	$1,212,866	$1,859,533	$14,166,110
Labor Income	**$16,473,872**	**$1,712,294**	**$2,115,415**	**$20,301,582**

Table 14:
Construction Impact FY 2011 – 2014

Impact of Future Construction	Direct	Indirect	Induced	Total
Output	$216,865,872	$19,214,223	$29,153,095	$265,233,190
Employment	1,459	164	255	1,877
Employee Compensation	$68,704,240	$7,141,119	$8,822,335	$84,667,694
Labor Income	$77,808,224	$10,017,424	$17,859,065	$105,684,713

Fiscal Impacts

The IMPLAN model also provides a means to calculate the impact that NAU exerts on government revenues, both at the national and at state and local levels. Even though NAU commands a tax exempt status, the spending that occurs in the state and local economies that can be traced to NAU's presence generates tax revenues that are paid by entities in those economic sectors that are subject to taxes. Estimates were generated by the IMPLAN model to determine the levels of taxes and other government revenues collected as a result of the direct, indirect and induced spending attributed to NAU and its constituents. These estimates are reported separately for the federal government and for state and local governments.

Table 15 summarizes the federal, state and local tax impacts from the state model. A short description of each of the tax impacts provided in the model is presented here.

- Corporate profits tax: Federal and state corporate income taxes.
- Dividends: Corporate dividends paid on stock held by government entities including employee retirement funds or trust accounts.
- Indirect Business Taxes**:** The taxes exist at all levels of government and include sales taxes, excise taxes (e.g., gasoline), and estate and gift taxes. Non-taxes include fees, forfeitures and fines.
- Personal taxes: Personal taxes are primarily levied against income and property, motor vehicles, and customs duties.
- Personal non-taxes include user fees (e.g., hunting & fishing licenses), and other fees, forfeitures and fines.
- Social Insurance Tax: This is the Social Security program and includes employee and employer contributions as well as other social insurance taxes (Medicare, unemployment).

NAU Fiscal Impact on the State—Table 15 provides the fiscal impacts identified in the statewide model resulting from NAU-related expenditures. Arizona state government and various local jurisdictions received annual revenues of nearly $96.4 million during FY 2010. Payments to the federal government exceeded $133.2 million during this period.

Table 15:
The Fiscal Impact of NAU Operations in State of Arizona in FY 2010

Arizona State and Local Tax impact	Employee Compensation	Proprietor Income	Indirect Business Tax	Households	Corporations	Total
Dividends					$5,401,300	$5,401,300
Social Ins Tax- Employee Contribution	$308,900					$308,900
Social Ins Tax- Employer Contribution	$1,328,900					$1,328,900
Indirect Bus Tax: Sales Tax			$39,881,100			$39,881,100
Indirect Bus Tax: Property Tax			$27,398,700			$27,398,700
Indirect Bus Tax: Motor Vehicle License			$336,700			$336,700
Indirect Bus Tax: Severance Tax			$329,900			$329,900
Indirect Bus Tax: Other Taxes			$2,483,100			$2,483,100
Indirect Bus Tax: S/L NonTaxes			$2,887,400			$2,887,400
Corporate Profits Tax					$3,363,100	$3,363,100
Personal Tax: Income Tax				$8,163,000		$8,163,000
Personal Tax: NonTaxes (Fines- Fees				$3,636,600		$3,636,600
Personal Tax: Motor Vehicle License				$344,400		$344,400
Personal Tax: Property Taxes				$278,600		$278,600
Personal Tax: Other Tax (Fish/Hunt)				$216,400		$216,400
Total State and Local Tax	**$1,637,800**		**$73,316,900**	**$12,639,000**	**$8,764,300**	**$96,358,100**
Arizona Fed Tax impact	**Employee Compensation**	**Proprietor Income**	**Indirect Business Tax**	**Households**	**Corporations**	**Total**
Social Ins Tax- Employee Contribution	$31,211,200	$3,406,900				$34,618,100
Social Ins Tax- Employer Contribution	$31,564,000					$31,564,000
Indirect Bus Tax: Excise Taxes			$4,641,500			$4,641,500
Indirect Bus Tax: Custom Duty			$2,161,600			$2,161,600
Indirect Bus Tax: Fed NonTaxes			$3,568,100			$3,568,100
Corporate Profits Tax					$14,388,300	$14,388,300
Personal Tax: Income Tax				$42,295,900		$42,295,900
Total Federal Tax	$62,775,300	$3,406,900	$10,371,200	$42,295,900	$14,388,300	$133,237,600
Total	**$64,413,100**	**$3,406,900**	**$83,688,100**	**$54,934,900**	**$23,152,600**	**$229,595,700**

Measuring the Impact Associated with a Hypothetical Increase of 1,000 Students

The IMPLAN model is often used to measure incremental changes associated with either real or hypothetical changes that occur in a region. In this section of the report, we present the expected annual impact on Coconino County that would occur based upon the additional enrollment of 1,000 more full-time equivalent students at the NAU Flagstaff campus.

The numbers presented here reflect expected changes based upon the results of the student survey that was conducted in connection with this study. The increased expenditure levels occur as a result of the larger number of students as well as the increase in visitor expenditures associated with the numbers of visitors to these students. The figures do not include any accompanying changes in spending by NAU or by NAU employees although these numbers would also increase over time. The impact of greater numbers of students on NAU budgets and on the number of employees changes more slowly, and these effects are not easily captured in a one-year analysis. Therefore, we have not included those changes in the hypothetical impact of more students.

Based on the results shown in Table 16, we expect that overall expenditures occurring in Coconino County from these 1,000 additional students would rise by $12.7 million in one year if 1,000 more students attended the Mountain Campus. Once the effect of this impact is expanded to include the changes in the levels of indirect and induced expenditure, the total increase in spending in the county would exceed $15.7 million each year.

Employment levels in the county also would increase. The model estimates direct employment would rise by 155 positions throughout the county while overall employment after considering the multiplier would increase by 181 positions. The larger number of jobs would initially occur on the campus as more employees would be hired in residence halls, support services and other student-oriented offices on campus. However, local businesses would also hire additional employees to account for increased sales that resulted from the larger numbers of students patronizing the businesses on a regular basis.

The model also tells us where the increases in expenditures and sales would occur. Table 17 shows us the sectors that would be most impacted by 1,000 additional students. The changes in the amount of the direct and total expenditures are shown in this table. The real estate sector would experience the largest impact with almost $2.5 million in new expenditures. Food and beverage establishments, clothing stores and miscellaneous retail businesses also would be highly impacted by the larger number of students.

Finally, in Table 18, we project the tax implications surrounding an increase of 1,000 students. Local governments within Coconino County would experience an increase in sales tax collections of $732,500 in one year based on the anticipated changes in local spending. This amount reflects heightened tax revenues accruing to both the City of Flagstaff and Coconino County along with other communities within the county that levy sales and lodging taxes on expenditures.

Property tax revenues would also increase as a result of higher market assessments associated with greater housing demand in the region as well as from the larger number of homes and apartments that would have to be built to accommodate these students. The model anticipates a net increase of $506,000 in property taxes generated within the county as a result of the larger number of students.

Table 16:

Hypothetical Impact of 1,000 Additional Students at the Flagstaff Campus

Impact of 1000 Additional Students	Direct	Indirect	Induced	Total
Output	$12,705,385	$1,130,295	$1,916,935	$15,752,615
Employment	155	10	17	182
Employee Compensation	$3,512,591	$295,212	$511,404	$4,319,207
Labor Income	$4,257,394	$373,272	$581,771	$5,212,437

Table 17:

Incremental Impact of 1,000 Students by Type of Sector

Sector	Higher Direct Expenditure	Higher Total Expenditure
Real estate establishments	2,154,800	2,448,800
Retail Stores - Food and beverage	1,816,700	1,870,300
Retail Stores - Clothing and clothing accessories	1,786,700	1,822,600
Retail Stores – Miscellaneous	1,420,200	1,433,900
Retail Stores - Gasoline stations	1,053,400	1,090,300
Water, sewage and other treatment and delivery systems	811,600	815,300
Food services and drinking places	510,300	688,800
Hotels and motels, including casino hotels	475,200	493,200
Religious organizations	401,000	419,200
Offices of physicians, dentists, and other health practitioners	392,600	549,900
Insurance agencies, brokerages, and related activities	324,400	370,700
Fitness and recreational sports centers	320,600	327,100
Other personal services	310,100	335,100
Other amusement and recreation industries	191,200	214,000
Retail Stores - Furniture and home furnishings	182,600	191,800
Personal care services	148,100	163,100
Sub Total All Other Sectors	406,000	2,518,400
Total Increase in All Sectors	**12,705,400**	**15,752,600**

Table 18:

Incremental Changes in Tax Collections from 1,000 Additional Students

Increase in Sales Tax Revenue in Coconino County	$732,474
Increase in Property Tax Revenue in Coconino County	$505,559
Total Tax Impact in Coconino County	**$1,238,033**

Estimates of Earnings Differentials of Educational Attainment

In addition to economic impacts attributable to the expenditures analyzed throughout this report, one could also put forth the concept that the overall state economy as well as the individual residents of the state benefit from earnings differentials associated with educational attainment. One of the most important contributions that NAU provides to Arizona's economy is the increased productivity and skills that a university graduate offers over a non-university graduate. The purpose of this section is to quantify and analyze incremental earnings of NAU graduates compared to the amounts of income these graduates would have earned without their NAU degree. This enables us to provide a measure of the economic impact of earnings differentials on the state's economy.

Table 19 incorporates information from the U.S. Census Bureau that shows average annual earnings correlated with educational attainment compared to a high school degree and also the incremental earnings over the prior degree for advanced degrees.

Table 19:
Average Annual Earnings by Degree

	2009 Median Earnings	Value Added Over High School	Value Added Above Prior Degree
High School	31,286		
Bachelors	57,181	25,895	25,895
Masters	70,186	38,900	13,005
Doctorate	95,565	64,279	25,379

Source: U.S. Census Bureau, Current Population Survey; *Mean Earnings by Highest Degree Earned: 2007*

Table 20 provides data on NAU's FY2010 graduates who reside in Arizona. The purpose of this table is to identify one year's "product" or "throughput" in terms of educational attainment from the university.

Table 20:
FY2010 NAU Graduates Residing in Arizona

Degree Type	FY2010 NAU Graduates Residing in Arizona
Bachelors	2,865
Masters	1,771
Doctorate	82
Total	**4,718**

Table 21 estimates the present value of the earnings differential that a recent NAU graduate can expect to earn over his or her working life above the prior degree attainment. The Census Bureau has reported the typical lifetime earnings of people according to their level of educational attainment: at 1999 prices a typical high-school graduate could expect to earn $1,037,759 between the ages of 25 to

64 years; a typical college graduate could expect $1,838,432; a typical master's degree holder could expect $2,127,947; a typical doctoral degree holder could expect $3,105,793.[1]

The difference in earnings does not, however, give a complete picture. High school graduates cannot expect much growth in their earnings, while the earnings of college graduates will be on an upward trajectory. The Census Bureau reported the earnings for each educational level according to their age. The authors have adjusted these earnings to the price level prevailing in the middle of our study period (January 2010), to match the other estimates in this report, yielding lifetime earnings estimates of: $1,379,910, $2,437,480, $2,823,355, and $4,136,571, respectively.

What is the present value of a student's education? People-skills, knowledge and experience are part of their intellectual capital. This intellectual capital is an asset that produces an annual return. These estimates are already in current dollars – that is, we do not need to discount for inflation. Nevertheless, even in the absence of inflation, anyone would rather receive $100 today than $100 one year from today, since it could either be spent now, or invested at the current interest rate to yield more than $100 in one year. Investors discount the future earnings from an asset to estimate its present value, which is the highest price they would pay for that asset. For example, $110 received one year from today has a present value of $100 if the investors discount rate is 10% (present value = future value/(1+interest rate) = $110/1.1 = $100.

What discount rate should be used? An individual will consider his own preferences and other investment opportunities when making this decision. Some people are more impatient than others and thus use a higher discount rate. When considering an investment that benefits society, economists typically use a real (above inflation) discount rate in the range of one to three percent;[2] higher rates are used when the future benefits are less certain. To err on the side of conservatism, the authors have used a rate of three percent per year.

Applying this three percent discount rate to the lifetime earnings patterns by educational attainment yields the estimates shown in Table 21. As an example, the present value of a typical bachelor's degree is $597,100 in current dollars. This represents the maximum amount that a student should be willing to invest today toward earning that degree. The present value of the real dollar differential between master's and bachelor's degrees is $218,300, and between doctoral and master's degrees it is $686,600.

[1] From Table 1: Synthetic Estimates of Work-Life Earnings by Educational Attainment, Work Experience, and Age, Based on 1997-1999 Work Experience. The Big Payoff: Educational Attainment and Synthetic Estimates of Work-Life Earnings, July 2002.

[2] Zhuang,J., Z. Liang, T. Lin and F. De Guzman. 2007. Theory and Practice in the Choice of Social Discount Rate for Cost-Benefit Analysis: A Survey. ADB. Manila.
http://www.adb.org/Documents/ERD/Working_Papers/WP094.pdf

Table 21:

Lifetime Earnings Differential - FY2010 NAU Graduates Above Prior Degree

Degree	Present Value of the Lifetime Earnings Differential
Bachelor's	$597,100
Master's	$218,300
Doctoral	$686,600

When we consider the number of degrees awarded in FY2010 to students who continue to live in Arizona as that year's "output," the value of expected lifetime earnings above prior degree attainment for that cohort can be estimated using the numbers derived in the previous table. Table 22 shows that over their lifetimes, students from the FY2010 graduating class who currently reside in Arizona can expect to earn an additional $2.2 billion resulting from their NAU degrees. The implications here are significant when viewed in terms of expenditures returned to the economy and increased taxes paid due to these higher income levels.

Table 22:

Present Value of Lifetime Earnings Differential
All FY2010 NAU Graduates

FY2010 Alumni	Present Value of Lifetime Earnings Beyond Prior Degree	FY2010 Graduates Living in AZ	Total Differential, FY2010 Alumni Living in AZ
Total number holding bachelor's degrees	$597,100	2,865	$1,710,692,000
Total number holding master's degrees	$218,300	1,771	$386,609,000
Total number holding doctoral degrees	$686,600	82	$56,301,000
Total		**4,718**	**$2,153,602,000**

Finally, the information in Table 23 presents an estimate of the lifetime earnings differentials applicable to degree attainment for all 80,087 NAU graduates residing in Arizona. The amounts and economic implications are again significant. Table 23 shows that all NAU graduates residing in Arizona will earn over their working lives an additional $37 billion due to academic attainment at the university.

Table 23:

Present Value of Lifetime Earnings Differential
All NAU Graduates Residing in Arizona

For All Alumni Currently Residing in Arizona	Present Value of Lifetime Earnings Beyond Prior Degree	Number of Alumni	Total Differential, All Alumni
Total number holding bachelor's degrees	$597,100	51,078	$30,498,674,000
Total number holding master's degrees	$218,300	27,928	$6,096,682,000
Total number holding doctoral degrees	$686,600	1,081	$742,215,000
Total		**80,087**	**$37,337,571,000**

There are additional economic impact analyses that can be pursued under the differential earnings hypothesis such as the number of jobs created, taxes paid and the multiplier effects attributable to

higher incomes. The purpose of this section, however, was to impart the unquestionable fact that NAU has a material effect on the state's economy that is directly attributable to educational attainment of its students while enrolled at the institution.

Arizona Personal Income Tax Differential

Another review was completed to measure the incremental personal income taxes paid on the differential incomes shown in Table 21. Arizona state personal income tax rates were applied to those increments. Table 24 presents the expected incremental Arizona personal income tax generated in calendar 2009. It is estimated that NAU alumni in the State of Arizona paid in excess of $72.6 million in Arizona personal income tax over what they would have paid had they not earned their degrees.

Table 24:
Incremental Arizona Personal Income Tax Paid by NAU Alumni in Calendar 2009

Incremental Arizona Personal Income Tax Paid - 2009					
Degree Type	**2009 Earnings over Prior Degree**	**Tax Rate (4.24%)**	**Annual Incremental Tax Paid**	**Graduates Residing in Arizona**	**Total Incremental Personal Income Tax Paid**
Bachelors	25,895	0.0424	$1,098	51,078	$56,081,000
Masters	13,005	0.0424	$551	27,928	$15,400,000
Doctoral	25,379	0.0424	$1,076	1,081	$1,163,000
		Total		**80,087**	**$72,644,000**

Source: 2009 Arizona Tax Table X For Form 140 - Single or Married Filing Separately

The Importance of Higher Education to Economic Growth

This study has highlighted many of the direct fiscal and monetary contributions that NAU and its constituents generate each year. However, the contributions of higher education to economic growth in general are both direct and indirect. Colleges prepare young people to be more productive in their first career and help older students acquire the skills needed for new careers. Economic research shows that their skills also enhance the productivity of their co-workers. As the productivity of the workforce increases, other benefits accrue to their communities. As examples, higher incomes generate greater tax revenues that contribute to building the infrastructure of a community; higher education is positively correlated with increased support for charities, increased levels of participation in local governance and higher rates of employment. The most recent unemployment data from the Bureau of Labor Statistics (October 2010) indicate that the unemployment for high school graduates was 10.1 percent of the labor force; however, the unemployment rate for persons holding a bachelor's degree or higher was only 4.7 percent, or less than half the rate for the high school graduate. Similarly, higher education is associated with generating lower rates of incarceration. In a 2006 report issued by the Alliance for Excellent Education, males in the U.S. general population were four times as likely to have some college or postsecondary education when compared to males who were incarcerated in prisons across the nation. In a parallel study, the Alliance also reported that college graduates are many times less likely to be uninsured or to require Medicaid assistance when compared to high school dropouts, and thus, less likely to depend on government support. All these characteristics help build Arizona communities and provide a positive environment where other skilled workers and employers will seek to locate. Additional details on this topic may be found by consulting the items listed in the reference section at the end of this study.

Appendix A:

An Introduction to I-O Modeling[3]

Historical Development

Input-output analysis is a branch of economic statistics, specifically, econometrics. The recent emergence of input-output analysis as a useful branch of economics dates from the development by Wassily Leontief in the 1930's of a general theory of production based on the economic interdependence of producing industries of the economy.

Early economists, notably Adam Smith, were concerned with the functioning of national economies or economies as a whole. Smith and other classical economists laid the groundwork for what is now referred to as macroeconomics. Much later, Alfred Marshall and his followers focused on the economics of the household and the firm. The method of these neoclassical economists, the founders of modern microeconomics, involved partial equilibrium analysis, that is, looking at "one thing at a time." John Maynard Keynes drew upon the work of both the classical and neoclassical economists in reviving interest in aggregative economics. While the neoclassical economists had concentrated on price theory -- examination of the forces that determine prices under given market conditions – the Keynesians were concerned with the national economic forces that determined income and employment. Keynesians were concerned with the broad aggregates of total employment, total consumption, total investment, and national income. Neither Keynes nor the neoclassical economists was directly concerned with economic interdependence, or the way individual producing industries are knitted together in the structure that is the national economy.

Any developed economy, whether national, regional, or local, is characterized by a high degree of interdependence among producing industries of the economy. Each economic industry not only produces goods or services, but is also a consumer itself, purchasing other goods and services for use in the production process. Interindustry relations were recognized long before Leontief's time. Francois Quesnay's "Tableau Economique" of 1758 developed circular flow and general equilibrium concepts. The next major economist to focus on interindustry relationships was Leon Walras, who, in the 1870's, like his neoclassical contemporaries was interested in price determination. Unlike them, however, he was interested in the simultaneous determination of all prices in the economy, that is, general equilibrium analysis rather than partial equilibrium analysis. Walras examined both the interdependence of producing industries, and what each producing industry needed from other industries to produce a unit of a finished good. Walras believed his general equilibrium model to be a purely theoretical one; the model's computational problems were formidable. Further, the kind of national economic statistics needed for the model's database were rudimentary or nonexistent in his time.

The first empirical application of the input-output model in the Anglo-American world dates from 1936, when Wassily Leontief published an input-output system of the U.S. economy. Leontief simplified Walras' generalized model so that the model's equations could be estimated empirically. He used two simplifying assumptions. First, the large number of *commodities* in the Walrasian model was aggregated into relatively few outputs, one for each *industry*[4]. Second, the supply

[3] Appendix B is quoted, with permission, from Micro IMPLAN User's Guide: Version 91-F, pages G-1 through G-15.

[4] All terms that appear in italics in the text are defined in a short glossary at the end of this appendix.

equation for labor and the demand equations for final consumption were abandoned, and the remaining production equations were expressed in the simplest linear form.

These simplifying assumptions define a sharp difference between input-output and most other conventional economic models. The assumption of linearity does not allow factor substitution or economies of scale. Time is missing, yet the purchase of inputs by one industry to make goods to sell to other industries implies a period analysis. In the "real world," the prevalence of joint products and multiproduct plants makes it impossible to aggregate only those plants with similar output and input structures; yet, the model assumes a single homogeneous output generated from the same inputs for each producing industry.

Given these assumptions, the model is starkly simple. Its key variables are the outputs of industrial categories ("industries") into which the economy is divided. Each industry's output consists of summing its sales to all other industries and to *final demand*, i.e., to ultimate consumers rather than other producing industries. The amount of each product consumed in each industry depends only on the level of output for that industry. *Equilibrium* in the economy is attained when each industry's output equals its total purchases, which are in turn determined by the output of all other industries.

Because of these simplifying assumptions, the model is empirically tractable. The implausible assumptions for the production function do not appear to restrict the model too badly. Technology changes are slow enough so that the input coefficient matrix of one year seems to be good for several years. Even out-of-date tables are useful in that they can show the maximum input requirement for each industry. Perhaps most important of all, input-output models pass the critical test: for many purposes, they predict reasonably well.

The Basic Input-Output Model

The key to input-output analysis is the construction of the input-output or *transactions table*, which shows the flow of commodities from each of a number of producing industries to all consuming industries and final demand. From these flows between economic industries, two other structural tables can be developed: (1) A table of *technical coefficients or direct requirements* (terms used interchangeably here) and (2) a table of *direct and indirect coefficients or total requirements* (also interchangeable terms). Each of these three tables and their significance is discussed below.

The Transactions Table

Given that many industries produce more than one commodity, production information is often tabulated on an industry (I) by commodity (C) basis;

1) A *Make Matrix* (CxI) contains the value of commodities produced by the different industries. Note that one particular industry may produce a variety of commodities. Normally, it is assumed that the production of multiple commodities takes the form of one principal product and one or more byproducts.

2) A *Use Matrix* (IxC) contains the value of commodities and imports used by each industry in the production process. Note that one particular type of commodity may be used by a variety of different industries.

A traditional I-0 transactions table, however, is on an industry by industry (IxI) basis. It is therefore necessary to combine the Use and Make matrices in such a way that each industry is shown buying and selling from other industries. The "Industry-Technology Assumption" presumes that any by-

products of an industrial process are technically related to the main production process, so that all commodities produced by an industry are produced with the same input structure. Therefore, since industries are classified/named based on their principal output, all individual producers within a particular industry are assumed to have the same input mix regardless of their output product mix. Thus, demand for an industry's output is in effect demand for a bundle of goods -- the principal output plus any joint production generated by the industry. This one-to-one correspondence between an industry and its "bundle of goods" output, enables the Use and Make matrices to be combined into an IxI transactions table.

Table A-1 depicts a highly simplified, aggregated version of a transactions table in which all producing industries have been aggregated into three "super-industries:" agriculture, manufacturing, and services. A transactions table portrays the dollar flows of goods and services among industries in an economy for a given accounting period. In this table, sales and purchase transactions within the economy are set forth in a matrix of rows and columns. Each row shows the output sold by each industry shown along the left-hand side of the table to each industry shown across the top of the table. Each column shows the purchases made by each industry shown along the top of the table from the industries along the left-hand side. Because this is a square table, one row corresponds to each column. The entry in each cell represents a purchase for the column industry and a sale for the row industry.

Table A-1
Illustrative Transactions Table

	Purchasing Industries				
Producing Industries	**Agriculture**	**Manufacturing**	**Services**	**Final Demand**	**Total Output**
Agriculture	10	6	2	18	36
Manufacturing	4	4	3	26	37
Services	6	2	1	35	44
Primary Inputs	16	25	38	0	79
Total Outlay	**36**	**37**	**44**	**79**	**196**

Thus, the entries in the first column show agriculture purchasing $10 worth of output from itself, $4 worth of output from manufacturing, $6 from services, and $16 from primary inputs (e.g. labor), summing to a total outlay of $36. Reading along the row, agriculture sells $10 worth of output to itself, $6 to manufacturing, $2 to services, and $18 to final demand. Summing the sales results in a total output value of $36.

The distinction commonly made in economic analysis between the production of goods and services and their final disposition is reflected by dividing the industries of the transactions table into four groups or "quadrants", each representing either intermediate transactions, primary inputs, or final demand. Figure I presents a theoretical table with the four divisions.

Quadrant I shows the intermediate transactions, that is, the flow of goods and services which are both produced and consumed in the process of current production. This quadrant can have as many or as few industries as desired. Limitations in data and processing equipment often restrict the number of industries included in a model to 100 or fewer, but some national models have well over 400 industries.

Final demand, or the ultimate consumers' purchases from the producing industries, is recorded in the second quadrant. (To distinguish them from the industries in Quadrant 1, the components of final demand are called "Institutions".) The third quadrant represents the primary inputs of production. Here again, the decision as to the amount of detail to include is left to the model builder. Table A-1 has only one industry in Quadrants II and III, whereas Figure A-1 shows both final demand and primary inputs broken down into four industries each, i.e., the main industries of the national accounting system.

The fourth quadrant is sometimes omitted from published input-output tables, but it should be included if portrayal of a complete economy is desired. Quadrant IV records the primary inputs into final demand institutions, including such typical entries as income of government employees (H_G in Figure A-1) and imports consumed directly by households (M_C in Figure A-1). Note that in input-output terms, Quadrant I is endogenous to the model, while Quadrants II, III, and IV are exogenous.

Figure A-1

Structure of an Input-Output Transactions Table

		Purchasing Sectors							
		Intermediate Demand			Final Demand				Total
		Agriculture	**Manufacturing**	**Services**	**Household Consumption**	**Government Purchases**	**Capital Formation**	**Exports**	**Gross Output**
Producing Sectors		I. Intermediate Production and Consumption			II. Final Outputs of Producing Sectors				
Intermediate Inputs	Agriculture	X_{11}	X_{1j}	X_{1n}	C_1	G_1	I_1	E_1	X_1
	Manufacturing	X_{i1}	X_{ij}	X_{in}	C_i	G_i	I_i	E_i	X_i
	Services	X_{n1}	X_{nj}	X_{nn}	C_n	G_n	I_n	E_n	X_n
Primary Inputs	Payments to:	III. Primary Inputs to Production			IV. Primary Inputs to Final Demand				
	Households	H_1	H_j	H_n	H_C	H_G	H_I	H_E	H
	Government	T_1	T_j	T_n	T_C	T_G	T_I	T_E	T
	Depreciation	D_1	D_j	D_n	D_C	D_G	D_I	D_E	D
	Imports	M_1	M_j	M_n	M_C	M_G	M_I	M_E	M
Total Gross Outlays		X_1	X_j	X_n	C	G	I	E	X

In addition to summarizing basic consumption and production patterns, a transactions table can be used to describe other economic factors. For example, the following can be calculated from Figure 1:

Summing across a row, intermediate demand plus final demand measures the Total Gross Output of industry "i". Thus, in an "n"-industry model[5]:

$$X_i = \sum_{j=1}^{n} X_{ij} + (C_i+G_i+I_i+E_i)$$

Where: X_i = *Total Gross Output of Industry j*
$\sum X_{ij}$ = *Intermediate Demand for the output of Industry i*
$(C_i+G_i+I_i+E_i$ = *Final Demand for the output of Industry i*

Summing down a column, intermediate inputs plus primary inputs yields the Total Gross Outlays of industry j. Thus:

$$X_j = \sum_{ij=1}^{n} X_{ij} + (H_j+T_j+D_j+M_j)$$

Where: X_j = *Total Gross Outlays of Industry j*
$\sum X_{ij}$ = *Intermediate Inputs for Industry j*
$(H_j+T_j+D_j+M_j)$ = *Primary Inputs for Industry j*

We may also sum across the totals row or down the totals column to obtain the economy's Total Gross Output:

$$X = \sum_{i=1}^{n} X_i + (H+T+D+M)$$

$$X = \sum_{j=1}^{n} X_j + (C+G+I+E)$$

Now, since in equilibrium,

$$\sum_{i=1}^{n} X_i = \sum_{j=1}^{n} X_j$$

all intermediate flows cancel out. We then have:

(H + T + D) + M = C + G + I + E

or: Value Added + Imports = Final Demand.

[5] The definitions of C, G, etc can be found by reading Figure 1.

Transferring imports to the right-hand side of the equation gives the traditional social accounting identity of Gross Regional Income (allocations approach) and Gross Regional Product (expenditures approach)[6] that is:

H + T + D = C + G + I + E - M

or: Gross Regional Income = Gross Regional Product[7]

Thus, Gross Regional Product can be calculated both by the traditional income allocations approach and by the expenditures approach from an input-output model transactions table.

The Technical Coefficients, or Direct Requirements Table

Table A-2 is a table of direct requirements or technical coefficients for the illustrative transactions table, Table A-1. The entries in this table are to be interpreted as the minimal requirements from each of the producing industries at the left of the table in order for each industry at the top to produce one dollar's worth of output for final demand. The word "minimal" is important. If it takes 2 tons of ore to yield 1 ton of iron, no doubt the same iron could be produced from even more ore, but as long as iron ore has value, no one would be foolish enough to use more than the absolutely required 2 tons.

Table A-2
Direct Requirements Table*

	Purchasing Industries		
Producing Industries	**Agriculture**	**Manufacturing**	**Services**
Agriculture	.278	.162	.045
Manufacturing	.111	.108	.068
Services	.167	.054	.023
Primary Inputs	.444	.676	.864

* *Each entry represents the inputs that the column industry requires from the row industry to produce a dollar's worth of output.*

These direct requirements or technical coefficients are determined by dividing the column entries for agriculture, manufacturing, and services in the illustrative transactions table (Table A-1) by the total outlay of the respective column. In this example, the manufacturing industry requires 16.2 cents worth of input from agriculture ($6/$37), 10.8 cents from manufacturing industries, and 5.4 cents from services in order to produce one dollar of output. In other words, the 16.2 cents would be interpreted as the "dollar's worth of inputs from agriculture per dollar's worth of output from manufacturing. " The remaining inputs to the manufacturing industry come from the exogenous or primary inputs part of the model.

[6] Where the "expenditures approach" tracks purchases by an industry**,** while the "allocations approach" tracks sales.
[7] "Regional" refers to any functional economic unit, from national to local. The "region" is defined by the model builder.

Using standard notation (as in Figure 1), the technical coefficients, a_{ij}, shown in Table B are computed as follows:

$$a_{ij} = X_{ij}/X_j \qquad i, j = 1..... n$$

where X_{ij} is the sales by industry i to industry j, and X_j is the total purchases of industry j. By definition, $X_j = X_i$ for all endogenous industries, i.e., all producing industries within the technical coefficients matrix of Quadrant I. The computation of a_{ij} for all cells in the first quadrant of the transactions table results in a matrix of a_{ij}'s or a "direct coefficients" table. Each column of a_{ij} represents a production function for that industry. Economists define the production function as the physical relation between the value of resource inputs and the value of the output of goods and services.

The direct coefficients embody most of the simplifying assumptions of input-output analysis. Input-output economics assumes that fixed proportions exist in all production processes; thus, the direct coefficients are constants. Once the coefficients have been developed, they remain constant for as long as the model is used. Further, when output is to be increased n times, all inputs must also be increased n times. This property, called constant returns to scale, means that average cost in real terms is the same at all output levels. Once an optimal combination of input factors is chosen, any level of output is obtainable simply by adjusting all inputs proportionately to the new output level. In addition, constant coefficients imply no substitution among inputs. A third condition implied by constant coefficients is production by each industry of a single, unvarying output. An aggregated industry is assumed to continue to produce the same average or homogeneous product it did at the time the model was developed.

These conditions, in defiance of many other economic models and theory, may not be unreasonable when one examines reality. There are many ways of producing any good. Each method uses some set of fixed proportions among inputs. Among all the possible ways, one is best at any given moment; that is the method which firms use. In this case, one may think of input-output tables as reflecting the set of "best" processes existing at that moment. That is, once a production method is adopted, it will be retained for a certain period, and it may be used to attain all possible output levels. The process may well change over time; therefore, the technical coefficients in an input-output system should be reviewed from year to year.

Economists usually assume that when output increases, the input requirements may increase more or less in direct proportion to the increase in output. However, statistical evidence suggests that the average cost of goods is independent of the scale of output in a great many cases. Thus, although not totally defensible theoretically, the assumptions brought about by constant coefficients in the input-output system may not be too much out of line with available facts. The important point is that if one is willing to accept the input-output assumptions, one can present the inter-industrial technical relations of the entire economy very neatly in a single input-output table. Such a table can be made and used, whereas without such simplifying assumptions, model estimation is not possible.

The Direct and Indirect Coefficients or Total Requirements Table

One of the most important applications of the input-output model is to calculate the equilibrium output levels in each industry of the economy. Output is in equilibrium if it is just equal to the quantity demanded for all purposes, such as inputs for production, consumption, investment, and exports. Once the transactions table is balanced (X_i's equal X_j's; i=j) and aggregate final demand equals aggregate primary inputs, an equilibrium exists.

Now suppose that someone, probably in a final demand institution, would like to buy more. This starts a chain reaction of increasing production everywhere. Using the table of technical coefficients (Table B)

and given a lot of time, it is possible to calculate by hand the reaction as it ripples through all industries in the economy.

For example, suppose a foreign country would like to purchase $1 more from the agriculture industry. Using Table A-2 one can trace through the results. In order to sell an additional dollar's worth of output to final demand (in this case, exports), the agriculture industry must purchase 27.8 cents of output from itself, 11.1 cents output of output from the manufacturing industry, and 16.7 cents of output from the services industry. This is the first round. Now for agriculture to sell 27.8 cents to itself, it must again purchase 7.7 cents more output ($.278 times $.278) from itself and 3.1 cents ($.278 times $. 111) from manufacturing and 4.6 cents ($.278 times $.167) from services. The second round is not finished, because for manufacturing to sell 11.1 cents to agriculture, it must buy 1.8 cents ($.111 times $.162) from agriculture, 1.2 cents ($.111 times $.108) from itself, and 0.6 cents ($.111 times $.054) from services. Services must also purchase 0.8 cents (16.7 cents times .045) from agriculture, 1.1 cents (16.7 cents times .068) from manufacturing, and 0.4 cents (16.7 cents times .023) from itself to sell 16.7 cents to agriculture. In just the first two rounds, agriculture has produced $1 for export, 27.8 cents plus 7.7 cents for itself, 1.8 cents for manufacturing, and 0.8 cents for services, totaling $1.38. Now, if one were to follow this process ad infinitum, the total amount each industry would be required to produce could be calculated.

Leontief devised a much simpler method of determining the total output requirements resulting from a final demand change using matrix algebra techniques. The Leontief method determines total industry requirements directly. (If one desires the round-by-round effects, the cumbersome method described above would have to be used).

The Leontief method can be demonstrated using the information on final demands and total outputs from Table A-1 combined with the information contained in Table A-2. From this information, the following system of equations can be developed:

$$X_1 = .278\ X_1 + .162\ X_2 + .045\ X_3 + Y_1$$
$$X_2 = .111\ X_1 + .108\ X_2 + .068\ X_3 + Y_2$$
$$X_3 = .167\ X_1 + .054\ X_2 + .023\ X_3 + Y_3$$

where X_1, X_2, and X_3 are the total outputs of the three endogenous industries, while Y_1, Y_2, and Y_3 are the respective processing industries' sales to final demand, and the coefficients are the entries in the direct requirements table (Table A-2).

In matrix notation, the system becomes:

$$\begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} .278 & .162 & .045 \\ .111 & .108 & .068 \\ .167 & .054 & .023 \end{bmatrix} \cdot \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} + \begin{bmatrix} Y_1 \\ Y_2 \\ Y_3 \end{bmatrix}$$

or more simply stated:

$$\mathbf{X = AX + Y}$$

where **X** is the vector of total outputs, **A** is the matrix of direct coefficients, and **Y** is the vector of final demands.

The above may also be written:

$X_1 - .278\ X_1 - .162\ X_2 - .045\ X_3 = Y_1$
$X_2 - .111\ X_1 - .108\ X_2 - .068\ X_3 = Y_2$
$X_3 - .167\ X_1 - .054\ X_2 - .023\ X_3 = Y_3$

or:

$(1 - .278)\ X_1 - .162\ X_2 - .045\ X_3 = Y_1$
$-.111\ X_1 + (1 - .108)\ X_2 - .068\ X_3 = Y_2$
$-.167\ X_1 - .054\ X_2 + (1 - .023)\ X_3 = Y_3$

Again, in matrix notation:

$$\begin{bmatrix} (1-.278) & .162 & .045 \\ .111 & (1-.108) & .068 \\ .167 & .054 & (1-.023) \end{bmatrix} \cdot \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} Y_1 \\ Y_2 \\ Y_3 \end{bmatrix}$$

which may also be written:

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} - \begin{bmatrix} .278 & .162 & .045 \\ .111 & .108 & .068 \\ .167 & .054 & .023 \end{bmatrix} \cdot \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} = \begin{bmatrix} Y_1 \\ Y_2 \\ Y_3 \end{bmatrix}$$

and may be reduced to:

(I - A) X = Y

where **I** is the identity matrix, **(I - A)** is called the Leontief matrix, and **A**, **X**, **Y** are as defined previously.

The coefficients are now in the proper form to solve the Leontief system and find the vector of outputs required to sustain a given vector of final demands. The mechanical process is first to find the Leontief inverse or the inverse of the Leontief **(I-A)** matrix. Inversion techniques are available in many math books, so they will not be dwelt on here. The Leontief inverse $\mathbf{(I - A)}^{-1}$ is defined as the *total requirements matrix* and is presented in Table A-3.

Table A-3
Total Requirements Table*

	Purchasing Industries		
Producing Industries	**Agriculture**	**Manufacturing**	**Services**
Agriculture	1.4459	.2678	.0852
Manufacturing	.1996	1.1628	.0901
Services	.2582	.1100	1.0431
Primary Inputs	1.91	1.54	1.22

* *Each entry represents the output required both directly and indirectly from the row industry per dollar of deliveries to final demand by the column industry*

To develop a solution, we must pre-multiply both sides of the above equation by the Leontief inverse, as follows:

$$\mathbf{(I - A)^{-1} (I - A) X = (I - A)^{-1} Y}$$

which reduces to:

$$\mathbf{X = (I - A)^{-1} Y}$$

Using the information in table form and the above matrix, we can develop the following system of equations:

$$X_1 = 1.4459\ Y_1 + 0.2678\ Y_2 + 0.0852\ Y_3$$
$$X_2 = 0.1996\ Y_1 + 1.1628\ Y_2 + 0.0901\ Y_3$$
$$X_3 = 0.2582\ Y_1 + 0.1100\ Y_2 + 1.0431\ Y_3$$

Returning to our example, when a foreign country (or final demand institution outside of the model "region") wants to purchase $1 more from the agriculture industry, we would like to determine the total increase in output resulting from this $1 increase in final demand.

Using the above system of equations and looking at the $1 increase only, agriculture sales to final demand (Y_1) would equal 1, and manufacturing (Y_2) and services (Y_3) sales to final demand would be zero. After multiplying through, agriculture total output (X_1) equals $1.4459 (1 times the coefficient associated with Y_1), manufacturing output (X_2) equals $.1996, and services output (X_3) equals $.2582. Summing the three outputs, we find the total increase in output resulting from a $1 increase in final demand of the agriculture industry to be $1.91. We have found the total output, both direct and indirect, that this hypothetical economy is required to produce in order for the agriculture industry to sell one more dollar of output to a final demand industry. The total output requirement divided by the output sold to the final demand industry is designated as the "output multiplier. " The output multiplier is calculated by summing the appropriate column of the Leontief inverse. As presented in the total requirements table (Table A-3), by summing each column the output multipliers are 1.91, 1.54, and 1.22 for the agriculture, manufacturing, and service industries, respectively.

Multipliers

We have seen how input-output analysis is developed to tell us the effect on total output resulting from a given change in the amount of output purchased by a final demand institution. The answer is straightforward and involves only an interpretation of the Leontief inverse. The output directly sold to final demand is exogenous to the model, i.e., it must be determined outside the model. Once this "direct" change is determined, the direct and indirect outputs by industry can be calculated by premultiplying by the Leontief inverse.

The output multiplier developed in the previous subsection relates an increment of direct or final output to the resulting increment of total output -- direct and indirect combined. Although the output multiplier represents total requirements per unit of final output, it is not a particularly useful concept except as an indicator of the degree of structural interdependence between each industry and the rest of the economy. There are, however, many other multipliers that can be developed with input-output analysis, depending on the purpose of the economic study. Income and employment are the multipliers of interest in most studies, although, in recent years, water and pollution multipliers have also been frequently used. A multiplier can be developed for most any input or factor that has a determinable relationship with a industry's output. For more information, see Appendix E of the Micro IMPLAN User's Guide - "Multipliers."

IMPLAN's Glossary of Terms

Byproducts: During the production process, an industry may produce more than one output. The industry is classified according to the primary product, while secondary products are termed "*byproducts*".

Commodities: The goods and services produced by industries are classified in terms of one or more product types, or "*commodities*".

Direct and Indirect Coefficients (see also Total Requirements): The amount of output from industry i required (both directly and indirectly) to deliver one dollar's worth of industry j's output to final demand.

Direct Requirements (see also Technical Coefficients): The dollar value of industry i's output required by industry j to produce one dollar's worth of output.

Equilibrium: In the I-0 sense, equilibrium occurs when Total Gross Output equals Total Gross Outlays.

Final Demand: The ultimate consumers of commodities (goods and services).

Industry: The manufacturer or provider of goods and/or services. Industries are categorized on the basis of their primary product, though they may produce a range of commodities.

Make Matrix: The values of commodities (columns) produced by the different industries (rows). The sum of each row is that industry's Total Industry Output. The sum of each column is that commodity's Gross Commodity Production.

Technical Coefficients (see also Direct Requirements): The dollar value of industry i's production required by industry j to produce one dollar's worth of output.

Total Requirements Matrix (see also Direct and Indirect Coefficients): The amount of output from industry i required (both directly and indirectly) to deliver one dollar's worth of industry j's output to final demand.

Transactions Table: The flow of commodities from each of a number of producing industries to all consuming industries and final demand. This flow is expressed in terms of the dollar value of the commodities traded.

Use Matrix: The values of commodities and imports (rows) used in production by each industry (columns). The sum of each column is that industry's Gross Industry Commodity Demand. The sum of each row is the Intermediate Demand for that commodity.

Appendix B

Specific Terms Used in the IMPLAN Model

- *Final Demand* - the dollar value of goods and services purchased by their ultimate consumer. The tables show the change in final demand (in millions of dollars per year) due to one of the following sources of direct spending: the operations of NAU, spending by employees, students, visitors, retirees and alumni.
- *Employee Compensation Impact*- additional wages and salaries generated by NAU operations, and spending by employees, students, visitors, retirees and alumni.
- *Employment Impact* - the increase in the number of full-time jobs due to NAU operations, and spending by employees, students, visitors, retirees and alumni.
- *Indirect Business Taxes Impact* - the increase in indirect business taxes (sales and excise taxes, property taxes, etc.) due to NAU's presence and spending activity by associated parties.
- *Other Property Type Income Impact* - the increase other property-type income (e.g., rent, interest, corporate profits, surplus of government enterprises) due to NAU operations, and spending by associated parties.
- *Output Impact* - (also known as Total Industry Output, TIO) the dollar value of goods and services sold by an industry. Some of an industry's output is sold to its ultimate consumer (final demand), and some is sold to other industries for use in their production operations. The tables show how much additional output has been generated by each of the sources of direct spending analyzed in the study.
- *Proprietors' Income Impact* - the increase in proprietors' and other property owners' incomes. Since NAU is a non-profit organization, there is no direct increase in proprietors' income from its operation. However, spending by the associated parties described in the model creates additional proprietors' income.
- *Labor Income Impact* - Employee compensation plus proprietors' income and other property income.
- *Total Value Added* - value added is the income (profits and wages) generated by a firm's operations. Value added is computed as the value of a firm's output minus the value of that firm's inputs (e.g., raw materials, but not labor). The tables show the increase in value added (employee compensation, property income and indirect business taxes) as a result of the spending by NAU and associated parties.

Bibliography of Recent Economic Impact Studies

Angelou Economics, *Economic Impact of Oklahoma State University on Stillwater, OK.* Delivered to: The Stillwater Foundation. 2006.

Appleseed Economic Consultants, *The Economic Impact of the University of Notre Dame.* 2007.

Carstensen, Fred V., Stan McMillen and Murat Arik. *The Economic Impact of Continuing Operations of the University of Connecticut.* Connecticut Center for Economic Analysis. 2003.

Center for Business and Economic Research, Marshall University. *The Economic Impact of Marshall University.* 2006.

Center for Business and Economic Research, The University of Tennessee. *The Economic Impact of the University of Tennessee, Knoxville on the State of Tennessee, Academic Year 2007-2008.* 2010.

CU Office of the President. *Economic Impact: Advancing Colorado, 2010-11.* University Relations, University of Colorado. 2010

Ewing, Bradley. The *Economic Impact of Texas Tech on Lubbock County for 2009.* Commissioned by Shonrock and Eighmy. 2010.

Foote, Lynne. *The Economic Impact of the University of Delaware on Newark and the State of Delaware.* 2007.

Gittell, Ross, James R. Carter and Josh R. Stillwagon. *The University of New Hampshire: A Pillar in the New Hampshire Economy, An Economic Impact Study.* Whittemore School of Business and Economics, University of New Hampshire. 2009.

Goldstein, Harvey A. "Estimating the Regional Economic Impact of Universities: An Application of Input-Output Analysis," *Planning for Higher Education*, 18 (1)1990.

Gunderson, Ronald J., John D. Eastwood and Wayne R. Fox. *The Economic Contributions of Northern Arizona University to the State of Arizona in 2003.* Center for Business Outreach, W. A. Franke College of Business, Northern Arizona University, 2003.

Gunderson, Ronald J. *An Update of the Economic Impact of Northern Arizona University on Coconino County – 1999.* Bureau of Business and Economic Research. Northern Arizona University. 1999.

Healthier and Wealthier: Decreasing health Care Costs by Increasing Educational Attainment. Alliance for Excellent Education. Issue Brief. November 2006.

Higgenbotham, Amy, Randall Childs and Tom S. Witt. *Economic Impact of West Virginia University FY 2007.* Bureau of Business and Economics Research, West Virginia University. 2008.

Leistritz, Larry F. and Randal C. Coon. *Economic Impact of the North Dakota University System. FY 2008.* Department of Agribusiness and applied Economics, North Dakota State University, Fargo, ND. 2009.

Pavlakovich-Kochi, Vera, et al. *The University of Arizona Economic and Tax Revenue Impacts FY 2004.* Office of Economic Policy and Analysis. University of Arizona. 2005.

Saving Futures, Saving dollars: The Impact of Education on Crime Reduction and Earnings. Alliance for Excellent Education. Issue Brief. August 2006.

Shaping the Future: The Economic Impact of Public Universities. National Association of State Universities and Land-Grant Colleges. Office of Public Affairs. 2001.

Siegfried, John L, Allen Sanderson, and Peter McHenry. *The Economic Impact of Colleges and Universities, 2006.* Working Paper No. 06-W12. Department of Economics Vanderbilt University.

Simonson, John, Cathy Riedl-Farrey, and Amanda Kennedy. *Economic Impact of University of Wisconsin Platteville on Southwest Wisconsin, 2009.* Center for Applied Public Policy Project Report 09-01. 2009.

The Importance of Community Colleges to the Tenth District Economy. Economic Review, Federal Reserve Bank of Kansas City. Vol. 95-3. 2010.