THE IMPACT OF THE COLLEGE OF ENGINEERING AT THE UNIVERSITY OF NEVADA, RENO ON THE ECONOMY OF THE STATE OF NEVADA
The Impact of the College of Engineering at the University of Nevada, Reno on the Economy of the State of Nevada

Study Conducted by

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Executive Summary

This report provides an analysis of economic impacts of the University of Nevada, Reno College of Engineering (UNR-COE) on the state of Nevada economy. Highlights of the study are stated below:

Review of Backward and Forward Impacts of UNR-COE

- The impacts of the College of Engineering can be split between backward (demand-sided) impacts and forward (supply-sided) impacts.
- Backward (demand-sided) impacts are characterized as the economic impacts from purchases by UNR-COE and expenditures by UNR-COE faculty and staff.
- Forward (supply-sided) impacts are the knowledge spillovers to the Nevada economy from UNR-COE.
- Forward (supply-sided) impacts to the state are long-run impacts to the state’s human capital.
- Human capital for this paper is divided into two types, which are creative and social capital.
- Creative capital was popularized by Richard Florida in his analysis of economic growth by the creative class.
- As Florida states, universities and specifically colleges of engineering provide education to produce local and statewide creative class.
- Social capital is a product of investment strategies, individual or collective, consciously or unconsciously aimed at establishing or reproducing social relationships that are directly useable in the short or long run.
- Colleges of engineering provide networks for creative individuals to interact and through interaction, increase local industrial productivity and provide the basis for future local and state economic growth.
- For this paper, the forward (supply-sided) effects will not be pursued. The backward (demand-sided) effects will be estimated.

Methodology

- Export sales bring dollars to the state economy that provide for future economic growth.
- Import sales act as a leakage from the state economy.
- Expenditures by UNR-COE and its faculty and staff impact the economic activity of the state’s economy through the multiplier effect.
- To derive the multiplier effect and state level value of output, employment, and labor income levels, the Minnesota IMPLAN Group, Inc. input-output model was used.
Economic Impacts of UNR-COE on the State of Nevada

- In 2010, the UNR-COE direct expenditures, employment, and household income made in the state of Nevada were estimated to be $19.9 million, 327.4 jobs, and $15.9 million, respectively.
- Given the economic inter-linkage and multiplier effect, total output impacts to the state of Nevada was estimated to be $34.9 million. Total employment and labor income impacts in the state of Nevada economy from activity by UNR-COE is estimated to be 437.1 jobs and $20.6 million, respectively.
The Impact of the College of Engineering at the University of Nevada, Reno on the Economy of the State of Nevada

Introduction

This report provides an analysis of the economic impacts of the University of Nevada, Reno College of Engineering (UNR-COE) on the economy of the state of Nevada. This study includes an analysis of the demand-sided and supply-sided impacts of UNR-COE. The demand-sided impacts are characterized as the economic impacts from purchases by UNR-COE and expenditures of UNR-COE faculty and staff. The supply-sided impacts are the knowledge spillovers to the Nevada economy from UNR-COE.

Stokes and Coomes (1998) state that in the short run, expenditure impacts will be greater than knowledge impacts. However, in the long run, knowledge impacts will impact the state economy more than expenditure impacts.

The Impact of College of Engineering at the University of Nevada, Reno on the economy of the state of Nevada is divided into three sections. The first section discusses the demand-sided effects of UNR-COE related to expenditures and its multiplier effect on the state’s economy and the supply-sided effects of UNR-COE related to the state’s human capital and research. The second section provides a review of input-output analysis for estimation of impacts. The third section shows the multiplier impacts of UNR-COE on output, jobs, and household income in the state of Nevada. Utilizing the input-output model, this report provides estimates of the direct economic contribution of UNR-COE as well as the indirect and induced output, employment, and household income impacts.

Review of Backward and Forward Impacts of UNR-COE

From the demand side, the expenditure activities of UNR-COE generate economic activity for the state’s economy. When UNR-COE, as a college, purchases inputs to generate an output such as education and research, UNR-COE has a noticeable impact on the state’s economy. UNR-COE, in its operations, demands goods and services from local providers; hires employees, which generates an increase in local income; sponsors outreach activities such as conferences, workshops, etc. that in turn, increase demand for local hotels, restaurants, etc. All of the UNR-COE activities impact the state’s economy and are described as “backward effects” or “backward linkages.”
In the supply-sided analysis, universities in the long run impact the state’s human capital, which in the new economy increases current economic activity and provides inputs for future economic growth. Batabyal and Nijkamp (2010) denote two types of capital that researchers have investigated to study economic growth in cities and regions. These two capital types are creative and social capital.

Creative capital has been popularized by Florida (2002) in his analysis of the creative class. According to Florida (2002), the creative class comprising of professionals such as doctors, engineers, lawyers, scientists, and university professors possess creative capital and this group produces ideas, information, and technology that increases industrial production and economic growth in the community. As Florida (2002) states, universities and specifically colleges of engineering provide education to produce the local creative class but also, colleges of engineering provide on-going education and networks to continue formulation and development of local creative capital.

Social capital has several meanings but this paper follows the definition proposed by Bourdieu (1986), Coleman (1988), and Putnam (2000). Social capital as defined in this paper is a product of investment strategies, individual or collective, consciously or unconsciously aimed at establishing or reproducing social relationships that are directly usable in the short or long term (Bourdieu, 1986). Colleges of engineering provide networks for creative individuals to interact and through this interaction increase local industrial productivity and provide a basis for future state economic growth. Since the basic objective of this study is to estimate the economic impacts by the College of Engineering on the state’s economy, the “forward effects” approach will not be pursued.

**Methodology**

This study will estimate the economic impacts of the College of Engineering at the University of Nevada, Reno on the economy of the state of Nevada. Basic multipliers and the economic models used for this study will be discussed in this section.
Some Basic Concepts of State Economics and Income and Employment Multipliers

Figure 1 illustrates the major dollar flows of goods and services in any economy. The foundation of a state’s economy is those businesses which sell some or all of their goods and services to buyers outside the state. Such a business is a basic industry. The flow of products out of, and dollars into, a state is represented by the two arrows in the upper right portion of Figure 1. To produce these goods and services for “export” outside the state, the basic industry purchases inputs from outside of the state (upper left portion of Figure 1), labor from the residents or “households” of the state (left side of Figure 1), and inputs from service industries located within the state (right side of Figure 1). The flow of labor, goods, and services in the state is completed by households using their earnings to purchase goods and services from the state’s service industries (bottom of Figure 1). It is evident from the interrelationships illustrated in Figure 1 that a change in any one segment of a state’s economy will have reverberations throughout the entire economic system of the state.

Consider, for instance the University of Nevada, Reno College of Engineering and its impact on the state of Nevada economy. The expenditures of UNR-COE could be considered a basic industry as it draws dollars from outside the area. These dollars may hire people from the household sector such as administrative personnel or professors/researchers employed at UNR-COE. However, most of the local economic linkages are from UNR-COE purchasing goods and services from the local Service Sectors. These include businesses such as restaurants, gas stations, hotels, and other retail businesses. As earnings increase in these businesses, they will hire additional people and buy more inputs from other businesses. Thus the change in the economic base works its way throughout the entire state economy.
Economic Model

The regional impacts for this study were estimated using IMPLAN (Impact Analysis for Planning), an economic input-output model (Minnesota IMPLAN Group, Inc., 2004). Input-output models are constructed based on the concept that all industries within an economy are linked together: the output of one industry becomes the input of another industry until all final goods and services are produced. Input-output models can be used to analyze the structure of a regional economy and/or to estimate economic impacts of a new business or industry, loss of a business or industry, or changes in governmental policies. For this analysis, an economic model for the state of Nevada was constructed using the IMPLAN software and data, and used to derive the economic impacts of the College of Engineering at the University of Nevada, Reno. Because the estimated linkages between economic sectors are fixed to the relationships at a particular point in time, input-output models are static and do not account for changes in technology or the entrepreneurial adaptations of the local economy to meet the demands of UNR-COE.

IMPLAN input-output models provide three economic measures that describe the economy: value of output, labor income, and employment. Value of output is the total value of goods and services produced by businesses in the study area. Labor income is the sum of employee compensation (including all payroll costs and benefits) and proprietor income. Employment represents the annual average number of employees, whether full or part-time, of the businesses or industry producing outputs.

Total economic effects include direct effects attributed to the activity being analyzed, as well as the additional indirect and induced effects resulting from money circulating throughout the economy.¹ The total impact of a change in the economy consists of direct, indirect, and induced impacts. Direct impacts are the changes in the activities of the impacting industry, such as the operation of UNR-COE. The impacting business, such as UNR-COE, changes its purchases of inputs as a result of the direct impact. This produces an indirect impact in the business sectors. Both the direct and indirect impacts change the flow of dollars to the community’s households. The local households alter their consumption accordingly. The effect of this change in local household consumption upon businesses in the study area

¹ Effects are not the same as economic benefits because effects are generated with inputs that would have an economic value in other uses. These opportunity costs must be deducted from effects to derive the net economic benefits to society (or net change in social welfare) that are used in benefit-cost analysis.
is referred to as an induced impact. A measure is needed that yields the effects created by an increase or decrease in economic activity. In economics, this measure is called multiplier effect. The IMPLAN input-output software will be employed to derive the economic, labor income, and employment impacts of the College of Engineering at the University of Nevada, Reno (Minnesota IMPLAN Group, Inc., 2004).

**Economic Impacts of UNR-COE on the State of Nevada**

*Overview of UNR-COE*

The University of Nevada, Reno College of Engineering is home to five departments: Department of Chemical and Metallurgical Engineering, Department of Civil and Environmental Engineering, Department of Computer Science and Engineering, Department of Electrical and Biomedical Engineering, and Department of Mechanical Engineering. There are thirteen disciplines within the five departments that together offer eight Bachelor of Science degrees, seven Master of Science degrees, and six Doctoral degrees.

The average undergraduate enrollment for fiscal year 2008 (FY 08) was 1,272 representing 10.5 percent of all UNR undergraduate enrollment. UNR-COE graduate enrollment averaged 280 for the same fiscal year, representing 8.7 percent of all UNR graduate enrollments. UNR-COE faculty reported 59 faculty full time teaching equivalents (FTE) incorporated by the 67 departmental faculty members. There are fourteen research labs that employ a combined total of 102 faculty and students. The department is supported administratively by a staff of thirteen.

*UNR-COE Expenditures*

The total FY 08 operating expenses for UNR-COE totaled $24.7 million of which $13.8 million was funded by grants and the $10.9 million balance was funded by the state. An expense breakdown is shown in Table 1.
Table 1. Breakdown of FY 08 UNR-COE Expenditures.

<table>
<thead>
<tr>
<th>Grant Expenditures</th>
<th>Base</th>
<th>In-state</th>
<th>Adjusted</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOA sal</td>
<td>325,460.93</td>
<td>93%</td>
<td>302,678.66</td>
</tr>
<tr>
<td>prof sal</td>
<td>2,820,975.62</td>
<td>93%</td>
<td>2,623,507.32</td>
</tr>
<tr>
<td>grad sal</td>
<td>1,804,349.18</td>
<td>93%</td>
<td>1,678,044.74</td>
</tr>
<tr>
<td>classified sal</td>
<td>235,084.42</td>
<td>93%</td>
<td>218,628.51</td>
</tr>
<tr>
<td>wages</td>
<td>377,979.25</td>
<td>93%</td>
<td>351,520.70</td>
</tr>
<tr>
<td>fringe ben</td>
<td>610,753.43</td>
<td>93%</td>
<td>568,000.69</td>
</tr>
<tr>
<td>travel</td>
<td>316,847.68</td>
<td>13%</td>
<td>41,190.20</td>
</tr>
<tr>
<td>gen operations</td>
<td>1,440,760.69</td>
<td>49%</td>
<td>705,972.74</td>
</tr>
<tr>
<td>participnt support</td>
<td>105,259.56</td>
<td>46%</td>
<td>48,419.40</td>
</tr>
<tr>
<td>sub aggree w/ ic</td>
<td>118,607.41</td>
<td>40%</td>
<td>47,442.96</td>
</tr>
<tr>
<td>sub aggree w/o ic</td>
<td>1,086,894.37</td>
<td>30%</td>
<td>326,068.31</td>
</tr>
<tr>
<td>subcontracts</td>
<td>191,795.12</td>
<td>100%</td>
<td>191,795.12</td>
</tr>
<tr>
<td>scholarships and fellowships</td>
<td>162,841.40</td>
<td>100%</td>
<td>162,841.40</td>
</tr>
<tr>
<td>equipment</td>
<td>1,574,684.76</td>
<td>5%</td>
<td>78,734.24</td>
</tr>
<tr>
<td>facilities &amp; admin cost</td>
<td>2,560,364.33</td>
<td>100%</td>
<td>2,560,364.33</td>
</tr>
<tr>
<td>vol tx out</td>
<td>69,434.84</td>
<td>0%</td>
<td>-</td>
</tr>
<tr>
<td>subtotal</td>
<td>13,802,092.96</td>
<td></td>
<td>9,905,209.31</td>
</tr>
</tbody>
</table>

State Expenditures

<table>
<thead>
<tr>
<th></th>
<th>Base</th>
<th>In-state</th>
<th>Adjusted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salary/Wages</td>
<td>8,631,978.00</td>
<td>93%</td>
<td>8,027,739.54</td>
</tr>
<tr>
<td>Fringe Benefits</td>
<td>2,072,726.00</td>
<td>93%</td>
<td>1,927,635.18</td>
</tr>
<tr>
<td>Operating</td>
<td>216,937.00</td>
<td>49%</td>
<td>106,299.13</td>
</tr>
<tr>
<td>subtotal</td>
<td>10,921,641.00</td>
<td></td>
<td>10,061,673.85</td>
</tr>
</tbody>
</table>

Total Expenditures

<table>
<thead>
<tr>
<th></th>
<th>Base</th>
<th>Adjusted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>24,723,733.96</td>
<td>19,966,883.16</td>
</tr>
</tbody>
</table>

When considering the impacts of UNR-COE on the Nevada economy, adjustments are made to account for dollars spent by UNR-COE outside the state such as wages to non-resident employees, non-resident sub contractors, and operational costs such as supplies and equipment. Table 1 reflects the in-state percentage along with the adjusted expenditure. The percentages are based on estimates of both total UNR and departmental in-state expenditure activity. State impacts were estimated using the adjusted state expenditures by UNR-COE of $19.9 million.

**Economic Impacts of UNR-COE**

Table 2 shows the output, employment, labor income, and value added impacts of UNR-COE on the state’s economy. These impacts were derived from the direct impacts of UNR-COE while the indirect and induced impacts were estimated using a state input-output model to derive impacts from linkages among other state economic sectors and households.
In 2010, UNR-COE had direct statewide expenditures of $19.9 million, employment of 327.4 employees, and labor income of $15.9 million. Applying the IMPLAN microcomputer input-output model, UNR-COE was estimated to have total value of output impacts of $34.9 million, total employment impacts of 437.1 employees, and total labor income impacts of $20.6 million. In other words, UNR-COE generated within the state of Nevada due to its economic linkages an additional $15.0 million in value of output, 109.7 employees, and $4.7 million in additional labor income.

**Patents Issued to UNR-COE Graduates**

Table 2 shows the backward effects of UNR-COE as to expenditures and inputs to the state economy. However, the long-term human capital impacts will provide the state with a base to diversify and grow the state’s economy in the future. From the U.S. Patent Office, a list of patents issued in Nevada from 1977 to 2009 was collected. The patents include the names of inventors. Using student data available from 1991 to 2009, it was possible to match issued patents with the names of University of Nevada, Reno students. Most of these patents were issued to UNR-COE students.

**Table 3. Patents Issued to UNR and Nevada Inventors.**

<table>
<thead>
<tr>
<th>Year</th>
<th>Patents Issued</th>
<th>UNR patent inventors</th>
<th>Total to UNR inventors</th>
<th>Avg UNR patent per inventor</th>
<th>All NV inventors</th>
<th>Total to all NV inventors</th>
<th>Avg all NV patent per inventor</th>
<th>% UNR patents / All patents</th>
<th>% UNR inventors / All inventors</th>
</tr>
</thead>
<tbody>
<tr>
<td>91-09</td>
<td>UNR patent inventors</td>
<td></td>
<td>183</td>
<td></td>
<td>4,965</td>
<td>12,883</td>
<td>2.59</td>
<td>7.62%</td>
<td>4.70%</td>
</tr>
<tr>
<td>91-09</td>
<td>Total to UNR inventors</td>
<td></td>
<td>843</td>
<td></td>
<td>3,895</td>
<td>11,066</td>
<td>2.84</td>
<td></td>
<td></td>
</tr>
<tr>
<td>91-09</td>
<td>Avg UNR patent per inventor</td>
<td></td>
<td>4.61</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77-09</td>
<td>All NV inventors</td>
<td></td>
<td>4,965</td>
<td></td>
<td>3,895</td>
<td>11,066</td>
<td>2.59</td>
<td>7.62%</td>
<td>4.70%</td>
</tr>
<tr>
<td>77-09</td>
<td>Total to all NV inventors</td>
<td></td>
<td>12,883</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>77-09</td>
<td>Avg all NV patent per inventor</td>
<td></td>
<td>2.59</td>
<td></td>
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</tbody>
</table>

While inventors of Nevada patents from Table 3 who are also UNR graduates seems low at 4.7 percent, it is important to realize that UNR graduates are efficient with 4.61 patents per inventor versus 2.84
patents per inventor for non-UNR graduate inventors. As the state proceeds to diversify and grow in high-technology industries, the efficiency of issued patents per inventor becomes important for the future of Nevada.

**Small Business Innovation Research Grants Awarded to Nevada Businesses**

Several federal agencies work together to award Small Business Innovation Research (SBIR) grants to small, innovative, high-tech businesses. These small businesses recruit and draw engineering students, often from local universities. From 1983 to 2007, small businesses in Nevada were awarded $66.8 million dollars in SBIR grants. The average of an individual grant was $246,422 and the average annual total was $2.7 million. Data was not available to attribute SBIR grants to UNR-COE faculty or students but it is assumed that UNR-COE faculty and students will play an important part in SBIR research grants currently and in the future.

**Conclusions**

The primary objective of this study was to estimate the economic impacts of expenditures by the College of Engineering at the University of Nevada, Reno on the state of Nevada. These impacts are usually characterized as short-run or “backward impacts.” The College of Engineering also has long-term impacts in increasing the creative and social capital of the state’s economy. These impacts, usually long-term, were not estimated in this study but will increase statewide economic sector productivity and statewide economic growth.

Lastly, a statewide state of Nevada input-output model was used to derive economic, employment, and labor income impacts on the state of Nevada economy. In 2010, the direct output, employment, and labor income impacts on the state’s economy were $19.9 million, 327.4 jobs, and $15.9 million, respectively. Including the multiplier effect and economic linkages of UNR-COE on the state’s economy, total output, employment, and labor income effects are estimated to be $34.9 million, 437.1 jobs, and $20.6 million, respectively.
References


