ECONOMIC IMPACT MODEL
FOR LINCOLN COUNTY
Economic Impact Model

for Lincoln County

Study Conducted by
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ECONOMIC IMPACT MODEL FOR LINCOLN COUNTY

EXECUTIVE SUMMARY

This study was commissioned by the Lincoln County Commissioners. This paper addresses impact models and development of such a model for Lincoln County. The model can be used to analyze the impacts to the Lincoln County economy from changes to the Lincoln County economy.

BASELINE

- Population in Lincoln County increased from 3,732 in 1980 to 3,775 in 1990 or a population increase of 1.15 percent during the decade.

- Population in the city of Caliente increased from 982 in 1980 to 1,111 in 1990 or a population increase of 13.13 percent during the decade.

- Nominal taxable sales for Lincoln County have steadily increased from 1988 to 1994. Nominal taxable sales have increased by 38.2 percent during this seven year time period.

- When taxable sales are deflated, real taxable sales from 1988 to 1994 only increased by 11.4 percent during this seven year time period.

IMPACT MODEL

- The Lincoln County input-output model was derived to estimate the economic interlinkages between local economic sectors.

- The Lincoln County impact model derives the impacts to overall economic activity, income, employment, population and housing dwelling in Lincoln County from exogenous changes.

- Exogenous changes considered in this model are changes in final demand sales (expansion of export sales caused by tourism); changes in sectoral output (changes in agricultural sector output from changes in public lands policies); changes in sectoral employment (increased employment from the opening of a mine); and changes in income (a new industry will pay a given payroll).

- Impact model results give local decision makers an idea of potential socio-economic impacts from either increases or decreases in local economic activity.
ECONOMIC IMPACT MODEL FOR LINCOLN COUNTY

The overall objective of this bulletin is to develop an economic impact model which estimates overall Lincoln County economic impacts from exogenous changes; such as, changes in tourism, decreases in sectoral output from alternative public lands management policies, etc. An input-output model for Lincoln County was developed to estimate the economic interrelationships, or more commonly called linkages, between economic sectors in the county economy. These linkages are then used to estimate impacts on economic activity, employment and income in Lincoln County from given changes in the Lincoln County economy. Specific objectives are to:

1. Review the basic concept of community economics;
2. Investigate socioeconomic trends in Lincoln County;
3. Discuss interindustry or input-output modeling; and
4. Develop and discuss an impact model for Lincoln County.

The organization of this report follows the sequence of the above stated specific objectives.
BASIC CONCEPT OF COMMUNITY ECONOMICS

Community economics is an applied field of economics that investigates the interrelationships, more commonly called linkages, that exist among economic sectors within a local economy. An overview of a community economic system is presented in Figure 1. Economic sectors shown are basic industries, households and service firms. The linkages that exist among these sectors are depicted by Figure 1.

Basic industries are those industries which produce goods and services primarily for sale outside the economy. These industries are usually involved in agriculture, mining, manufacturing, casino gaming or federal government activities, such as the Test Site. Household and service firms support basic industries. Labor is purchased from households and inputs are purchased from service firms. Service firms also provide goods and services to households (consumers). Of course, each of these three sectors purchase products, inputs and labor from outside the community borders. Local transactions determine the relationship that exists among the various types of firms in an economy. These three sectors are also linked with the rest of the economy through inflow and outflow of income, inputs and labor, goods and services and finished products.

The total impact of any basic industry on an economy consists of direct, indirect and induced impacts. Direct impacts are the activities or changes in production level of the impacted industry. Indirect impacts occur in the local business sector as a result of providing inputs to the impacted industry. For example, the increased output of local firms providing inputs for a local mining operation represent the indirect impacts of a basic industry. Induced impacts consist of the economic activity caused by household consumption in a local economy from the direct and indirect effects.

The relationships discussed above indicate how basic industries serve as the foundation of an economy and how households and service firms are necessary to make the economy function. Service industries account for a substantial part of the output of most economies, but, as shown in Figure 1, much of service industry output goes to support local basic industries and households. Mathematical techniques, such as input-output analysis, can be used to measure the relationships between basic industries, households and service firms.
Figure 1: Overview of Community Economic System
Socioeconomic Trends in Lincoln County

Basic socioeconomic data for Lincoln County are presented in Tables 1 through 7. This information will help decision-makers in Lincoln County as they attempt to evaluate impacts in Lincoln County. Lincoln County population was 3,732 in 1980 and increased to 3,775 in 1990. (Table 1). The population of Caliente was 982 in 1980 and increased to 1,111 in 1990.

Population by age and sex for Lincoln County is shown in Table 2. The unemployment rate from 1988 to 1993 increased from 4.7 percent in January 1989 to 13.7 percent in January 1993. Since January 1993, unemployment in Lincoln County has fluctuated between 10.4 percent in June 1993 to 12.5 percent in June 1994.

Table 4 shows sectoral employment in Lincoln County from 1988 to 1993.¹ From 1988 to 1993, employment in the Service Sector is not disclosed but this is the largest sector of employment. Persons employed in the Test Site are allocated to the Service Sector.

Table 5 shows that per capita income in Lincoln County has increased from $15,709 in 1988 to $19,189 in 1993. Of interest is the change in proportionate share of total personal income from dividend, interest and rents; and transfer payments from 29 percent in 1988 to 38 percent in 1993. Dividends, interests and rents; and transfer payments are primarily sources of income for the retired population. Table 5 shows the growing importance of the “Silver Haired” economy in Lincoln County. Therefore an area for potential economic development focus for Lincoln County would be meeting the demands of the growing elderly population.

Nominal taxable sales for Lincoln County have shown a somewhat steady increase from 1988 to 1994. (Table 6). Nominal taxable sales for Lincoln County increased from $10,078,253 in 1988 to $13,926,923 in 1994 or a 38.2 percentage increase. However, when inflation is discounted, real taxable sales in Lincoln County only increased by 11.4 percent.

¹ Labor data from Tables 3 and 4 differ because Table 3 shows monthly data while Table 4 shows an annual average. Also employment data may differ because Table 3 is Bureau of Labor Statistic data while Table 4 is Bureau of Economic Analysis data which includes proprietor employment.
Table 1. Population Estimates by Community for Lincoln County, Nevada, 1980 and 1990.

<table>
<thead>
<tr>
<th></th>
<th>1980</th>
<th>1990</th>
<th>Percent Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caliente</td>
<td>982</td>
<td>1,111</td>
<td>13.14</td>
</tr>
<tr>
<td>Remainder of County</td>
<td>2,750</td>
<td>2,664</td>
<td>-3.13</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>3,732</td>
<td>3,775</td>
<td>1.15</td>
</tr>
</tbody>
</table>

Source: 1980 and 1990 Census of Population
Table 2. Population Estimates by Age and Sex for Lincoln County, Nevada, 1990.

<table>
<thead>
<tr>
<th>Age in Years</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-4</td>
<td>148</td>
<td>156</td>
</tr>
<tr>
<td>5-9</td>
<td>159</td>
<td>156</td>
</tr>
<tr>
<td>10-14</td>
<td>212</td>
<td>144</td>
</tr>
<tr>
<td>15-19</td>
<td>195</td>
<td>180</td>
</tr>
<tr>
<td>20-24</td>
<td>94</td>
<td>48</td>
</tr>
<tr>
<td>25-29</td>
<td>118</td>
<td>107</td>
</tr>
<tr>
<td>30-34</td>
<td>133</td>
<td>118</td>
</tr>
<tr>
<td>35-39</td>
<td>120</td>
<td>119</td>
</tr>
<tr>
<td>40-44</td>
<td>111</td>
<td>90</td>
</tr>
<tr>
<td>45-49</td>
<td>83</td>
<td>117</td>
</tr>
<tr>
<td>50-54</td>
<td>107</td>
<td>92</td>
</tr>
<tr>
<td>55-59</td>
<td>112</td>
<td>87</td>
</tr>
<tr>
<td>60-64</td>
<td>84</td>
<td>86</td>
</tr>
<tr>
<td>65-69</td>
<td>109</td>
<td>93</td>
</tr>
<tr>
<td>70-74</td>
<td>74</td>
<td>78</td>
</tr>
<tr>
<td>75-79</td>
<td>63</td>
<td>77</td>
</tr>
<tr>
<td>80-84</td>
<td>27</td>
<td>77</td>
</tr>
<tr>
<td>85+</td>
<td>15</td>
<td>22</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>1,964</td>
<td>1,811</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Employment</th>
<th>Unemployment</th>
<th>Labor Force</th>
<th>Unemployment Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 1988</td>
<td>1,940</td>
<td>120</td>
<td>2,060</td>
<td>5.0%</td>
</tr>
<tr>
<td>June 1988</td>
<td>2,180</td>
<td>140</td>
<td>2,320</td>
<td>7.0%</td>
</tr>
<tr>
<td>January 1989</td>
<td>2,000</td>
<td>120</td>
<td>2,120</td>
<td>4.7%</td>
</tr>
<tr>
<td>June 1989</td>
<td>2,060</td>
<td>100</td>
<td>2,160</td>
<td>5.7%</td>
</tr>
<tr>
<td>January 1990</td>
<td>1,350</td>
<td>130</td>
<td>1,480</td>
<td>8.5%</td>
</tr>
<tr>
<td>June 1990</td>
<td>1,400</td>
<td>110</td>
<td>1,510</td>
<td>7.5%</td>
</tr>
<tr>
<td>January 1991</td>
<td>1,360</td>
<td>140</td>
<td>1,500</td>
<td>9.5%</td>
</tr>
<tr>
<td>June 1991</td>
<td>1,420</td>
<td>120</td>
<td>1,540</td>
<td>7.9%</td>
</tr>
<tr>
<td>January 1992</td>
<td>1,310</td>
<td>140</td>
<td>1,450</td>
<td>7.9%</td>
</tr>
<tr>
<td>June 1992</td>
<td>1,340</td>
<td>130</td>
<td>1,470</td>
<td>9.0%</td>
</tr>
<tr>
<td>January 1993</td>
<td>1,290</td>
<td>210</td>
<td>1,500</td>
<td>13.7%</td>
</tr>
<tr>
<td>June 1993</td>
<td>1,340</td>
<td>160</td>
<td>1,500</td>
<td>10.4%</td>
</tr>
<tr>
<td>January 1994</td>
<td>1,300</td>
<td>160</td>
<td>1,460</td>
<td>10.8%</td>
</tr>
<tr>
<td>June 1994</td>
<td>1,330</td>
<td>190</td>
<td>1,520</td>
<td>12.5%</td>
</tr>
</tbody>
</table>

Source: Nevada Employment Security Department, Carson City, Nevada
**Table 4. Employment by Major Sector for Lincoln County, 1988-1993.**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Employment</td>
<td>2,387</td>
<td>2,386</td>
<td>2,395</td>
<td>2,319</td>
<td>2,161</td>
<td>2,224</td>
</tr>
<tr>
<td>BY TYPE:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wage and Salary</td>
<td>2,059</td>
<td>2,046</td>
<td>2,051</td>
<td>1,954</td>
<td>1,813</td>
<td>1,885</td>
</tr>
<tr>
<td>Proprietors</td>
<td>322</td>
<td>340</td>
<td>344</td>
<td>365</td>
<td>348</td>
<td>349</td>
</tr>
<tr>
<td>Farm</td>
<td>88</td>
<td>86</td>
<td>86</td>
<td>85</td>
<td>86</td>
<td>82</td>
</tr>
<tr>
<td>Nonfarm</td>
<td>234</td>
<td>254</td>
<td>258</td>
<td>280</td>
<td>262</td>
<td>267</td>
</tr>
<tr>
<td>BY INDUSTRY</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farm</td>
<td>170</td>
<td>165</td>
<td>169</td>
<td>147</td>
<td>148</td>
<td>150</td>
</tr>
<tr>
<td>Nonfarm</td>
<td>2,211</td>
<td>2,221</td>
<td>2,226</td>
<td>2,172</td>
<td>2,013</td>
<td>2,074</td>
</tr>
<tr>
<td>Private</td>
<td>1,711</td>
<td>1,702</td>
<td>1,690</td>
<td>1,624</td>
<td>1,441</td>
<td>1,496</td>
</tr>
<tr>
<td>Ag Service,</td>
<td>15</td>
<td>19</td>
<td>(D)</td>
<td>21</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>Forestry Fisheries and Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mining</td>
<td>27</td>
<td>30</td>
<td>30</td>
<td>23</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>Construction</td>
<td>44</td>
<td>41</td>
<td>43</td>
<td>35</td>
<td>22</td>
<td>23</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>(D)</td>
<td>(D)</td>
<td>17</td>
<td>(D)</td>
<td>12</td>
<td>(D)</td>
</tr>
<tr>
<td>Transportation &amp; Public Utilities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wholesale Trade</td>
<td>(D)</td>
<td>(D)</td>
<td>(L)</td>
<td>(D)</td>
<td>(D)</td>
<td>(D)</td>
</tr>
<tr>
<td>Retail Trade</td>
<td>260</td>
<td>231</td>
<td>232</td>
<td>203</td>
<td>216</td>
<td>226</td>
</tr>
<tr>
<td>Finance, Insurance &amp; Real Estate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Services</td>
<td>(D)</td>
<td>(D)</td>
<td>(D)</td>
<td>(D)</td>
<td>(D)</td>
<td>(D)</td>
</tr>
<tr>
<td>Government &amp; Gov’t Enterprises</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Federal Civilian</td>
<td>47</td>
<td>44</td>
<td>45</td>
<td>42</td>
<td>39</td>
<td>40</td>
</tr>
<tr>
<td>Military</td>
<td>12</td>
<td>11</td>
<td>12</td>
<td>11</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>State and Local</td>
<td>441</td>
<td>464</td>
<td>479</td>
<td>495</td>
<td>522</td>
<td>528</td>
</tr>
</tbody>
</table>


(D) Denotes values not shown to avoid disclosure of confidential information.

(L) Denotes less than 10 jobs. Estimates are included in totals.
Table 5. Personal Income by Major Source for Lincoln County, 1988-1993.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>($1,000)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Personal Income</td>
<td>56,568</td>
<td>62,470</td>
<td>68,908</td>
<td>72,635</td>
<td>73,550</td>
<td>72,015</td>
</tr>
<tr>
<td>Selected Categories*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net Industry Earnings</td>
<td>40,357</td>
<td>42,444</td>
<td>46,293</td>
<td>46,771</td>
<td>46,508</td>
<td>44,537</td>
</tr>
<tr>
<td>Dividends, Interest &amp; Rents</td>
<td>5,699</td>
<td>6,966</td>
<td>7,059</td>
<td>6,741</td>
<td>6,264</td>
<td>6,552</td>
</tr>
<tr>
<td>Transfer Payments</td>
<td>10,512</td>
<td>13,060</td>
<td>15,556</td>
<td>19,123</td>
<td>20,778</td>
<td>20,926</td>
</tr>
<tr>
<td>Per Capita Personal Income (Dollars)</td>
<td>15,709</td>
<td>17,031</td>
<td>18,072</td>
<td>19,313</td>
<td>19,592</td>
<td>19,189</td>
</tr>
</tbody>
</table>

* Column total will not equal Total Personal Income value because of several small income items were omitted.


<table>
<thead>
<tr>
<th>YEAR</th>
<th>NOMINAL TAXABLE SALES</th>
<th>REAL TAXABLE SALES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>10,078,253</td>
<td>9,672,028</td>
</tr>
<tr>
<td>1989</td>
<td>10,837,667</td>
<td>9,915,523</td>
</tr>
<tr>
<td>1990</td>
<td>10,805,391</td>
<td>9,404,173</td>
</tr>
<tr>
<td>1991</td>
<td>11,070,868</td>
<td>9,248,845</td>
</tr>
<tr>
<td>1992</td>
<td>11,948,770</td>
<td>9,675,117</td>
</tr>
<tr>
<td>1993</td>
<td>12,128,503</td>
<td>9,508,176</td>
</tr>
<tr>
<td>1994</td>
<td>13,926,923</td>
<td>10,771,015</td>
</tr>
</tbody>
</table>

Source: Annual Sales Tax Reports. Nevada Tax Commission, Various Issues

*Real taxable sales were derived by employing the implicit price deflator for personal consumption expenditure where 1987 = 100.
Table 7. Selected Population and Housing Characteristics - 1990, Lincoln County, Nevada

<table>
<thead>
<tr>
<th>Total Population</th>
<th>3,775</th>
<th>Total Housing Units</th>
<th>1,800</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SEX</strong></td>
<td></td>
<td><strong>OCCUPANCY &amp; TENURE</strong></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>1,964</td>
<td>Occupied Housing Units</td>
<td>1,325</td>
</tr>
<tr>
<td>Female</td>
<td>1,811</td>
<td>Owner occupied</td>
<td>974</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Percent owner occupied</td>
<td></td>
</tr>
<tr>
<td><strong>AGE</strong></td>
<td></td>
<td>Renter occupied</td>
<td>351</td>
</tr>
<tr>
<td>Under 5 years</td>
<td>304</td>
<td>Vacant housing units</td>
<td>475</td>
</tr>
<tr>
<td>5 to 17 years</td>
<td>978</td>
<td>For seasonal, recreational or occasional use</td>
<td>175</td>
</tr>
<tr>
<td>18 to 20 years</td>
<td>96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21 to 24 years</td>
<td>114</td>
<td>Homeowner vacancy rate</td>
<td>2.6%</td>
</tr>
<tr>
<td>25 to 44 years</td>
<td>916</td>
<td>Rental vacancy rate (%)</td>
<td>11.6%</td>
</tr>
<tr>
<td>45 to 54 years</td>
<td>399</td>
<td></td>
<td></td>
</tr>
<tr>
<td>55 to 59 years</td>
<td>199</td>
<td>Persons per owner-occupied unit</td>
<td>2.68</td>
</tr>
<tr>
<td>60 to 64 years</td>
<td>170</td>
<td>Persons per renter-occupied unit</td>
<td>2.49</td>
</tr>
<tr>
<td>65 to 74 years</td>
<td>354</td>
<td>Units with over 1 person per room</td>
<td>74</td>
</tr>
<tr>
<td>75 to 84 years</td>
<td>208</td>
<td></td>
<td></td>
</tr>
<tr>
<td>85 years and over</td>
<td>37</td>
<td>UNITS IN STRUCTURE</td>
<td></td>
</tr>
<tr>
<td>Median age</td>
<td>33.4</td>
<td>1-unit, detached</td>
<td>1,028</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1-unit, attached</td>
<td>10</td>
</tr>
<tr>
<td>Under 18 years</td>
<td>1,282</td>
<td>2 to 4 units</td>
<td>109</td>
</tr>
<tr>
<td>Percent of Total Population</td>
<td>34.0</td>
<td>5 to 9 units</td>
<td>2</td>
</tr>
<tr>
<td>65 years and over</td>
<td>599</td>
<td>10 or more units</td>
<td>29</td>
</tr>
<tr>
<td>Percent of total population</td>
<td>15.9</td>
<td>Mobile home, trailer or other</td>
<td>622</td>
</tr>
<tr>
<td><strong>HOUSEHOLDS BY TYPE</strong></td>
<td></td>
<td><strong>VALUE</strong></td>
<td></td>
</tr>
<tr>
<td>Total households</td>
<td>1,325</td>
<td>Specified owner-occupied units</td>
<td>534</td>
</tr>
<tr>
<td>Family households (families)</td>
<td>907</td>
<td>Less than $50,000</td>
<td>259</td>
</tr>
<tr>
<td>Married-couple families</td>
<td>776</td>
<td>$50,000 to $99,999</td>
<td>234</td>
</tr>
<tr>
<td>Percent of total households</td>
<td>58.6</td>
<td>$100,00 to $149,999</td>
<td>33</td>
</tr>
<tr>
<td>----------------------------</td>
<td>------</td>
<td>--------------------</td>
<td>----</td>
</tr>
<tr>
<td>Other family, male household</td>
<td>24</td>
<td>$150,000 or more</td>
<td>8</td>
</tr>
<tr>
<td>Other family, female household</td>
<td>107</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonfamily households</td>
<td>418</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of total households</td>
<td>31.5</td>
<td>Median (dollars)</td>
<td>50,900</td>
</tr>
<tr>
<td>Householder living alone</td>
<td>388</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Householder 65 years and over</td>
<td>211</td>
<td>CONTRACT RENT</td>
<td></td>
</tr>
<tr>
<td>Persons living in households</td>
<td>3,488</td>
<td>Renter-occupied units paying cash rent</td>
<td>264</td>
</tr>
<tr>
<td>Persons per household</td>
<td>2.63</td>
<td>Less than $250</td>
<td>213</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$250 or more</td>
<td>51</td>
</tr>
<tr>
<td>GROUP QUARTERS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Persons living in group quarters</td>
<td>287</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Institutionalized persons</td>
<td>287</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other persons in group quarters</td>
<td>0</td>
<td>Median (dollars)</td>
<td>180</td>
</tr>
<tr>
<td>RACE &amp; HISPANIC ORIGIN</td>
<td></td>
<td>RACE &amp; HISPANIC ORIGIN OF HOUSEHOLDER</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>3,555</td>
<td>Occupied housing units</td>
<td>1,325</td>
</tr>
<tr>
<td>Black</td>
<td>81</td>
<td>White</td>
<td>1,288</td>
</tr>
<tr>
<td>Percent of total population</td>
<td>2.1</td>
<td>Black</td>
<td>1</td>
</tr>
<tr>
<td>American Indian, Eskimo or Aleut</td>
<td>58</td>
<td>Percent of occupied units</td>
<td>0.1</td>
</tr>
<tr>
<td>Percent of total population</td>
<td>1.5</td>
<td>American Indian, Eskimo or Aleut</td>
<td>22</td>
</tr>
<tr>
<td>Asian or Pacific Islander</td>
<td>16</td>
<td>Percent of occupied units</td>
<td>1.7</td>
</tr>
<tr>
<td>Percent of total population</td>
<td>0.4</td>
<td>Asian or Pacific Islander</td>
<td>2</td>
</tr>
<tr>
<td>Other race</td>
<td>65</td>
<td>Percent of occupied units</td>
<td>0.2</td>
</tr>
<tr>
<td>Hispanic origin (of any race)</td>
<td>156</td>
<td>Other race</td>
<td>12</td>
</tr>
<tr>
<td>Percent of total population</td>
<td>4.1</td>
<td>Hispanic origin (of any race)</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Percent of occupied units</td>
<td>2.6</td>
</tr>
</tbody>
</table>

Source: 1990 Census
Table 7 shows 1990 Census data pertaining to population and housing for Lincoln County. Lincoln County has 1,964 males and 1,811 females. The median age in Lincoln County is 33.4 years. Lincoln County has 34.0 percent of their total population under 18 and 15.9 percent is 65 years and over. There are a total of 1,325 households with 907 being family households and 776 households that are married couples. Twenty-four households are males only and 107 are females only. Lincoln County has 418 households that are non-family and 388 households that are living alone. The average persons per household is 2.63.

The data show there are 3,555 whites; 81 African American; 58 American Indian, Eskimo or Aleut; 16 Asian and 156 Hispanic. Whites make up 91.9 percent of total population; African Americans make up 2.1 percent; American Indian, Eskimo or Aleut 1.5 percent; Asian 0.4 percent and Hispanic make up 4.1 percent of total Lincoln County population.

Lincoln County has 1,800 total housing units with 974 units owner occupied, 351 rent occupied, 475 vacant units and 175 units for seasonal, recreational or occasional use. Homeowner vacancy rate is 2.6 percent and rental vacancy rate is 11.6 percent. Of the owner occupied units, 259 are valued at less than $50,000; 234 are $50,000 to $99,000; 33 are $100,000 to $149,000; and 8 are $150,000 or more. The median value for owner occupied units is $50,900. Rental data shows that 213 persons are paying less than $250 for rent and 51 are paying $250 or more. The median rent is $180 per month.

Out of the 1,325 occupied housing units, 1,288 are white; 1 is African American; 22 are American Indian, Eskimo or Aleut; 2 are Asian and 34 are Hispanic. White occupy 97 percent of total housing units, African American occupy 0.1 percent; American Indian, Eskimo or Aleut occupy 1.7 percent; Asians occupy 0.2 percent and Hispanics occupy 2.6 percent of the occupied housing units.
INTERINDUSTRY ANALYSIS

Within a regional economy, there are numerous economic sectors performing different tasks. All sectors are dependent on each other to some degree. A change in activities will directly or indirectly affect the response or level of production of the other regional sectors. The amount of economic activity among economic sectors shows the degree of interrelationships between sectors. That is, an increase in production by the regional livestock sector would directly increase purchases of alfalfa hay. With increased alfalfa hay purchases, farm workers will have greater incomes which would increase their purchases from the trade sector. The trade sector would experience increased economic activity because of its indirect relationship with the livestock and alfalfa hay sectors. These interdependencies among regional economic sectors can be estimated through interindustry or input-output analysis. A detailed mathematical description of interindustry analysis is presented in Appendix A.

Transaction Table

An interindustry study is based on the transactions of the sectors in an economy, i.e. purchases of inputs and sales of outputs. A transaction table (Figure 2) shows the monetary flows of goods and services through the regional economy. Transactions can be delineated into four major classifications. One classification (Quadrant I) is the processing section which produces goods and services. Processing sectors in Quadrant I produce and buy products and/or services from other processing sectors to be used in their production process. Goods and services used in the processing section are intermediate goods which are used in the production of goods and services which are ultimately sold to final consumers.

Another classification (Quadrant II) includes sales to final demand of goods and services. The Final Demand Section includes net inventory change, exports, government purchases, capital formation and purchases by households. The third classification (Quadrant III) is the Final Payment Section. The Final Payments Section includes the non-processing supply sectors such
as imports, depreciation, and households. Quadrant IV (fourth classification) represents direct inputs of final demand which are not produced by industries in the processing sector.

Transactions include costs and revenues concerning an economic sector. First, reading down the column of the transactions table, the inputs (cost) required by a specific sector from other specific sectors to produce its output can be seen. Second, reading across the row of the transactions table, the distribution of sales by a specific sector to other sectors can be seen.

<table>
<thead>
<tr>
<th>Output</th>
<th>Sector</th>
<th>Final Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td>Sector</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
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<td>.</td>
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<tr>
<td></td>
<td>.</td>
<td></td>
</tr>
</tbody>
</table>

Quadrant I (Processing Section)

Quadrant II (Final Demand Section)

Quadrant III (Final Payments Section)

Quadrant IV (Final Demand-Final Payments Section)

Figure 2. A Classification of Transactions
From Figure 2, a total of n industries are listed across the top and left hand side of Quadrant I. For a given industry i, reading across the row gives the sales of that sector to all other sectors in the regional economy. For example, the values in cell where row i intersects with column j (x_{ij}) represents the sales of sector i to sector j. The sales of sector i to j are also the purchases of sector j from sector i.

**Direct Requirements**

The logic of interindustry analysis is to establish the structural relationships among the processing sectors of the model. These relationships can be seen throughout the direct requirements table. A direct requirements coefficient is computed from the processing section (Quadrant I) of the transaction table by dividing the value in a column cell by total output of the column. This can be expressed as:

\[ a_{ij} = \frac{x_{ij}}{X_j}, \quad i, j = 1, 2, \ldots, n \]

where \( a_{ij} \) is the purchase by sector j from sector i to produce one dollar of output by sector j, \( x_{ij} \) is the dollar value of transactions between sector i and sector j, and \( X_j \) is the value of total output for sector j.

The \( a_{ij} \) is a direct requirement coefficient which shows how much a given sector purchases from another sector within the same regional economy in order to produce one dollar's worth of output. Direct requirement coefficients are only calculated for the processing sectors.

The column sum of the direct coefficients of a given sector show the direct effects of changes in the volume of output of a given sector upon other sectors of the economy. The direct effect or "first round" effects show how much a given sector has to increase its purchases of output from other processing sectors when there is an increase in demand for the output of the given sector.
Final Demand Interindustry Coefficients

Due to the direct effect of additional output for a given industry, other processing sectors must supply additional inputs. To supply these additional outputs, the directly effected sectors must increase their output levels which means increased purchases from their input supply sectors. This expansion of output by sectors directly and indirectly related to the principal sector which increased its output to meet final demand sales is referred to as final demand interindustry coefficient. The column sum of final demand interindustry coefficients derives the final demand multiplier for a given economic sector. The final demand multiplier estimates the increase in regional economic activity required for a particular economic sector to increase sales to final demand by one dollar.

Final demand multipliers are calculated for both "open" and "closed" input-output models. An "open" model does not contain a non-processing sector in the processing section of the transaction table. The final demand multiplier of an "open" model derives both direct and indirect effects of a one dollar increase in sales to final demand for a given sector. Indirect effects being those increases in levels of output for the regional economy to meet the output levels of the directly related industries.

A "closed" input-output model contains at least one non-processing sector in the processing section of the transactions model. Usually the Household Sector is incorporated into the processing section of the transactions table to produce a closed mode. The final demand multiplier from a "closed" model derives direct, indirect, and induced effects from a one dollar increase in sales to final demand for a given sector. Induced effects are the effects of new incomes to households upon the individual sectors of the economy from increased sales to final demand by a given sector.

Output Interindustry Coefficients

Final demand interindustry coefficients derive the effects to the regional economy from sales to final demand for a given sector. In order to meet these final demand sales, the given
sector must increase production by purchases from itself. This intrasectoral purchasing increases output response greater than one. In order to estimate economic effects from total production rather than from deliveries outside the processing sectors, output interindustry coefficients are required.

Output interindustry coefficients are derived by dividing each column entry in the final demand interindustry coefficient matrix by the given sector's intrasectoral interindustry coefficient. This will derive intrasectoral coefficients equal to one. The other entries in the final demand interindustry coefficients matrix are adjusted similarly to refer to production rather than external end product deliveries by dividing all entries in each row by the entry at the intersection with the corresponding column or the intrasectoral coefficient.

Direct and indirect output multiplier coefficients are derived from an "open" model. Indirect effects being the increased purchases in the regional economy created by the purchases of the directly effect sectors from a given sector's increase in production. Direct, indirect, and induced output interindustry coefficients are derived from a "closed" model. Induced effects being the increase in regional economic activity from increase in household incomes created by production increases for a given sector.

**Employment Effects**

Interindustry analysis is used to determine the effects on the regional economy from changes in a given sector's level of output or sales to final demand. Interindustry analysis also can be used to derive the effects on regional employment from changes in a given sector's sales to final demand or output level. Studies by Elrod and Laferney (1972) and Osborn et al. (1973) have derived procedures to determine regional employment impacts from input-output models.

To determine employment effects, it is first required that the direct labor effects for each of the n processing sectors be derived, or:

\[ L_j = E_j / X_j \quad j = 1, 2, \ldots, n \]
where, \( L_j \) is the number of employees required per dollar of output by sector \( j \), \( E_j \) is the number of workers employed by sector \( j \), and \( X_j \) is the dollar value of production by sector \( j \).

From the direct employment requirements vector for each processing sector in the region, direct and indirect labor requirements from a one dollar sales to final demand by a given sector can be derived by premultiplying the direct labor coefficients matrix by the "open" final demand interindustry coefficient matrix. Indirect labor effects are the number of workers employed elsewhere in the regional economy to produce the direct and indirect inputs used by each sector.

Premultiplying the direct labor requirements matrix by the "closed" interindustry coefficients matrix derives the direct, indirect, and induced employment effects in the region from a given sector's change in sales to final demand interindustry coefficients matrix. Direct and indirect employment effects and direct, indirect, and induced employment effects from changes in a given sector's level of output can be derived from the "open" or "closed" output interindustry coefficients matrix.

**Household Income Effects**

The effects on regional household incomes from changes in sectoral sales to final demand and levels of output can be derived through interindustry analysis. If households are exogenous to the model, that is an "open" model, the derivation of direct and indirect household income effects requires the determination of a direct household income vector. The direct household income vector is the division of the Household Sector row value for each processing sector. Direct and indirect household income effects from changes in sales to final demand by a given sector are derived by multiplying the direct household income requirements by the "open" final demand interindustry coefficient matrix. The indirect income effects are those increases in regional income created by increased production activities from those sectors indirectly related to the direct resources supply sectors.

When the Household Sector is made endogenous to the processing section or what is referred to as a "closed" model, direct, indirect, and induced household income effects are
derived. Induced income effects are the changes in regional incomes created by the additional purchases of regional households created by the change in a given sector's sale to final demand. Direct, indirect, and induced household income effects can be read directly off the "closed" final demand interindustry coefficients matrix. The coefficients are the values from the household row in the interindustry coefficients matrix for each given processing sector. Using the output interindustry coefficients matrix, the effects on household income from changes in a given sector's level of production can be derived.

**Lincoln County Impact Model**

An input-output model for Lincoln County was derived using the microcomputer IMPLAN model and supplemented by primary data at the local level. The Micro IMPLAN model was developed by the U.S. Forest Service to estimate sectoral and regional impacts of alternative forest management scenarios (Alward et al., 1989). The update and further development of the Micro IMPLAN has been conducted by the University of Minnesota (1991).

County input-output or interindustry models can be developed from either primary or secondary data. County interindustry models derived through primary data sources are time consuming and very costly. Secondary data procedures use publicly available data sources to estimate county level interindustry models from the national model. IMPLAN uses regional purchase coefficients to estimate regional or county level input-output models. Numerous studies have examined differences between primary and secondary data input-output models (Round, 1983; Schaffer and Chu, 1969; Stevens et al., 1983). Studies have shown differences between these models when compared to primary models, semi-survey models provide the best model (Miller and Blair, 1985).

The input-output model developed for Lincoln County is a semi-survey model. An IMPLAN model for Lincoln County was first developed. The IMPLAN model was modified and updated to 1992 by employing federal, state and county data. In addition, employment data used by IMPLAN was verified using employment data supplied by the Nevada Employment Security Department. For this analysis, the Local Government Sector and the Household Sector were
closed to the processing section. A listing of the economic sectors used in the analysis are shown in Appendix B.

**Program Overview**

The Lincoln County impact model is a full function windows application. To use the model, the user needs a computer running MS Windows 3.1 with five megabytes of hard disk space. The model allows the user to enter values for final demand, output, employment, or income which are used to derive county-wide economic impacts, changes in income, employment, population, and housing demands. The program has a menu for saving and exporting data, and printing reports.

**Program Installation**

The program must be installed from DOS. For instructions on installation, see procedures on diskette label. For more information on creating program groups and adding icons, please refer to your Windows User Guide.

**Estimation of Final Demand Changes**

To use the Lincoln County impact model, the user double clicks on the model icon in the Windows director. At this point the program is initiated and the user sees a screen similar to Figure 3. Since this is an analysis of a final demand change, the user clicks on the worksheet tabs designated as “FD Input”. This initiates the impact model for final demand analysis.

For the final demand analysis, assume there is $10,000,000 in building activity in Lincoln County. The building activity is reflected as $10,000,000 of final demand sales to the Construction Sector. The $10,000,000 is entered into the shaded or green area on the computer screen. After the value has been entered, the user presses “ctrl-i”. This initiates the impact model
which derives the sectoral and total economic, employment, income, population and housing requirements from the final demand change. To print-out the results of the impact analysis, the user chooses **Reports** from the main menu. By clicking on **Reports**, the user proceeds to select **Final Demand Reports** for this analysis.

Table 10 shows a print-out of the results from the $10,000,000 increase in Construction Sector activity. From the $10,000,000 direct impact, total economic activity in Lincoln County increases by $16,976,564. Of interest are the distributional impacts among interrelated economic sectors. From the increased Construction Sector activity, Lincoln County sectors, such as the Trade Sector ($348,086), the Service Sector ($286,533), the Manufacturing Sector ($678,146) and the Transportation and Communications Sector ($227,621) realized increased levels of economic activity. Also from Table 10, total household for Lincoln County income increased by $4,646,814, employment increased by 228 jobs, population increased by 820 persons and demands for housing units increased by 245 units. If the user wishes to run different versions of the analysis, such as construction activity at $1,000,000 or another value, the user simply inputs a new value in the input section and initiates impact model. The user can save different analysis scenarios by using the “Get Version” and the “Put Version” from the **File Menu**.
Figure 3. Final Demand Impact Screen for Lincoln County Input-Output Model
<table>
<thead>
<tr>
<th>Economic Sectors</th>
<th>Economic Impact</th>
<th>Income (dollars)</th>
<th>Employment</th>
<th>Population</th>
<th>Housing Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Livestock Production</td>
<td>$37.9</td>
<td>$15.6</td>
<td>0.03</td>
<td>0.09</td>
<td>0.03</td>
</tr>
<tr>
<td>2 Alfalfa Hay Production</td>
<td>$233</td>
<td>$95.6</td>
<td>0.00</td>
<td>0.01</td>
<td>0.00</td>
</tr>
<tr>
<td>3 Other Hay Production</td>
<td>$178</td>
<td>$55.7</td>
<td>0.00</td>
<td>0.01</td>
<td>0.00</td>
</tr>
<tr>
<td>4 Ag, Services</td>
<td>$12231</td>
<td>$41174</td>
<td>0.5%</td>
<td>1.82</td>
<td>0.54</td>
</tr>
<tr>
<td>5 Gold Mining</td>
<td>$1163</td>
<td>$344</td>
<td>0.0%</td>
<td>0.04</td>
<td>0.01</td>
</tr>
<tr>
<td>6 Other Mining</td>
<td>$1282</td>
<td>$352</td>
<td>0.0%</td>
<td>0.05</td>
<td>0.01</td>
</tr>
<tr>
<td>Construction</td>
<td>$10,000,000</td>
<td>$3,140,074</td>
<td>101.34</td>
<td>548.37</td>
<td>183.42</td>
</tr>
<tr>
<td>7 Manufacturing</td>
<td>$576,146</td>
<td>$176,821</td>
<td>4.05</td>
<td>14.55</td>
<td>4.35</td>
</tr>
<tr>
<td>9 Transportation and Comm.</td>
<td>$237,021</td>
<td>$91,256</td>
<td>3.01</td>
<td>10.81</td>
<td>3.23</td>
</tr>
<tr>
<td>10 Utilities</td>
<td>$18,370</td>
<td>$14,848</td>
<td>0.69</td>
<td>2.49</td>
<td>0.74</td>
</tr>
<tr>
<td>11 Trade</td>
<td>$2,389,366</td>
<td>$399,483</td>
<td>14.64</td>
<td>52.66</td>
<td>15.75</td>
</tr>
<tr>
<td>12 Hotels, Gaming, and Recre.</td>
<td>$23,854</td>
<td>$7,110</td>
<td>0.70</td>
<td>2.52</td>
<td>0.77</td>
</tr>
<tr>
<td>13 Eating, Drinking, and Lodg.</td>
<td>$94,872</td>
<td>$31,855</td>
<td>4.27</td>
<td>16.39</td>
<td>4.59</td>
</tr>
<tr>
<td>14 Finance, Insurance, &amp; Real.</td>
<td>$175,404</td>
<td>$49,232</td>
<td>4.09</td>
<td>14.70</td>
<td>4.40</td>
</tr>
<tr>
<td>15 Services</td>
<td>$285,533</td>
<td>$113,614</td>
<td>8.23</td>
<td>22.55</td>
<td>6.77</td>
</tr>
<tr>
<td>16 Health</td>
<td>$22,976</td>
<td>$10,549</td>
<td>0.33</td>
<td>1.30</td>
<td>0.39</td>
</tr>
<tr>
<td>17 Local Government</td>
<td>$160,240</td>
<td>$56,751</td>
<td>3.29</td>
<td>13.93</td>
<td>4.18</td>
</tr>
<tr>
<td>18 Households</td>
<td>$3,922,718</td>
<td>$33,729</td>
<td>0.60</td>
<td>0.01</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Table 10. Results of a Change in Final Demand, Lincoln County Impact Model
Table 11. Results of a Change in Sectoral Employment, Income, or Output, Lincoln County Impact Model
Estimation of Output Changes

Under the estimation of output changes, three types of analysis can be performed. Impacts to the Lincoln County economy, under output menu, are from changes in sectoral output, or changes in sectoral employment or changes in sectoral income. To initiate analysis under output changes, the user sees a screen similar to Table 3 and double clicks on the worksheet tabs designated as “IO Input”. This initiates the impact for output change analysis.

For the output change analysis, assume there is a 3,000 job increase in the Service Sector. When the user inputs the 3,000 job increase, the model automatically estimates sectoral output change of $136,925,461. When the user is ready to derive the total Lincoln County economy impacts, the user presses “ctrl-a”. The impact model derives sectoral and total Lincoln County economy, employment, income, population and housing impacts from employment change. To print out the results of the impact analysis, the user chooses Reports from the main menu. After clicking on Reports, the user selects Output Reports for this analysis.

Table 11 shows a printout of the results from a 3,000 employee increase in the Service Sector. From the 3,000 job increase, total economic activity in Lincoln County increases by $223,223,259. Of interest are the distributional impacts among interrelated economic sectors. From the Service Sector employment increase, Lincoln County economic sectors, such as Finance, Insurance and Real Estate Sector ($4,146,242), the Utilities Sector ($2,962,934), the Trade Sector ($2,517,953) and the Transportation and Communication Sector ($4,173,152) realized increased levels in economic activity. Also from Table 11 for Lincoln County, total household income increased by $74,130,559, employment increased by 4,105 jobs, population rose by 14,765 persons, and demands for housing increased by 4,416.
For both the final demand and output analysis, Bureau of Census (1990) data was employed to derive persons per employee and houses per person. Using the 1990 Census data for Lincoln County, there were 3.60 persons per job and 0.299 houses per person. However, these values can be changes by the user as desired.
CONCLUSION

The microcomputer Lincoln County impact model can be used to estimate total economic impacts to Lincoln County from either increases or decreases in the local economy. The analysis can be performed for changes in final demand (export changes), output (reduction in range cattle production), employment (a sector such as the Test Site lays off employees) or income (a sector expands production and realizes increased payrolls). The model is currently being expanded to derive fiscal impacts from changes in the local economy. Also the impact model is being updated with newly released industry output values from the U.S. Department of Commerce. The update impact model will be based on 1992 production levels.
REFERENCES


APPENDIX A:

MATHEMATICAL DESCRIPTION OF

INPUT-OUTPUT ANALYSIS
MATHEMATICAL DESCRIPTION OF INPUT-OUTPUT ANALYSIS

Given the regional economy of n processing sectors, the transitions can be depicted as:

\[ X_1 = X_{11} + X_{12} + \cdots + X_{1j} + \cdots + X_{1n} + Y_1 \]
\[ X_2 = X_{21} + X_{22} + \cdots + X_{2j} + \cdots + X_{2n} + Y_2 \]
\[ \vdots \]
\[ X_j = X_{j1} + X_{j2} + \cdots + X_{jj} + \cdots + X_{jn} + Y_j \]
\[ \vdots \]
\[ X_n = X_{n1} + X_{n2} + \cdots + X_{nj} + \cdots + X_{nn} + Y_n \]

Where:
- \( X_i \) is the total output of industry \( i \),
- \( X_{ij} \) is the purchase of output from industry \( i \) by industry \( j \) and
- \( Y_i \) is the purchase of output from industry \( i \) by final demand sectors.

It is assumed that a linear relationship exists between purchase of a sector from other sectors and the level of output by that sector. Since total output equals total purchases, this may be expressed as:

(2) \[ X_{ij} = a_{ij} X_j, \quad \text{or} \]

(3) \[ a_{ij} = X_{ij} / X_j \]

Where:
- \( X_j \) is total purchases by sector \( j \),
- \( X_{ij} \) is the value of output from sector \( i \) used by sector \( j \), and
- \( a_{ij} \) is the direct requirement which shows the value of output from the \( i \)-th sector required to produce a dollar’s worth of product in the \( j \)-th using sector.
The matrix equations of equation 1 can be rewritten using direct requirements as:

\[
\begin{align*}
X_1 &= a_{11}X_1 + a_{12}X_2 + \cdots + a_{1i}X_i + \cdots + a_{1n}X_n + Y_1 \\
X_2 &= a_{21}X_1 + a_{22}X_2 + \cdots + a_{2i}X_i + \cdots + a_{2n}X_n + Y_2 \\
&\vdots \\
X_i &= a_{i1}X_1 + a_{i2}X_2 + \cdots + a_{ii}X_i + \cdots + a_{in}X_n + Y_i \\
&\vdots \\
X_n &= a_{n1}X_1 + a_{n2}X_2 + \cdots + a_{ni}X_i + \cdots + a_{nn}X_n + Y_n \\
\end{align*}
\]

(4)

Rearranging (4), the system of equations can be written as:

\[
\begin{align*}
Y_1 &= X_1 - a_{11}X_1 - a_{12}X_2 - \cdots - a_{1i}X_i - \cdots - a_{1n}X_n \\
Y_2 &= -a_{21}X_1 + X_2 - a_{22}X_2 - \cdots - a_{2i}X_i - \cdots - a_{2n}X_n \\
&\vdots \\
Y_i &= -a_{i1}X_1 - a_{i2}X_2 - \cdots + X_i - a_{ii}X_i - \cdots - a_{in}X_n \\
&\vdots \\
Y_n &= -a_{n1}X_1 - a_{n2}X_2 - \cdots - a_{ni}X_i - \cdots + X_n - a_{nn}X_n \\
\end{align*}
\]

(5)

Equation 5 can be written in matrix notation as:

\[
\begin{bmatrix}
(1-a_{11}) & -a_{12} & \cdots & -a_{1i} & \cdots & -a_{1n} \\
-a_{21} & (1-a_{22}) & \cdots & -a_{2i} & \cdots & -a_{2n} \\
\vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\
-a_{i1} & \cdots & -a_{ii} & (1-a_{ii}) & \cdots & -a_{in} \\
\vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\
-a_{n1} & \cdots & -a_{ni} & \cdots & (1-a_{nn})
\end{bmatrix}
\begin{bmatrix}
X_1 \\
X_2 \\
\vdots \\
X_i \\
\vdots \\
X_n
\end{bmatrix}
= 
\begin{bmatrix}
Y_1 \\
Y_2 \\
\vdots \\
Y_i \\
\vdots \\
Y_n
\end{bmatrix}
\]

(6)

Equation 1 can be depicted in matrix notation where A is the $n \times n$ matrix of direct requirements, $X$ is an $n \times 1$ matrix of sectoral output and $Y$ is an $n \times 1$ matrix of sectoral final demands, so the matrix is written as:
(7) \[ X = AX + Y \]

when \( I \) is an \( n \times n \) identity matrix, equation 6 can be written as:

(8) \[ (I - A) X = Y \]

To express output of the processing sectors as a function of final demand, the Leontief matrix, \( (I - A) \) is inverted,

(9) \[ X = (I - A)^{-1} Y \]

where \( (I - A)^{-1} \) is the matrix of interindustry coefficients. Letting \( C_{ij} \) represent an element of the inverted Leontief matrix or 5 show in equation 10 as:

\[
(I - A)^{-1} = \begin{bmatrix}
C_{11} & C_{12} & \ldots & C_{1i} & \ldots & C_{1n} \\
C_{21} & C_{22} & \ldots & C_{2i} & \ldots & C_{2n} \\
\vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\
C_{i1} & C_{i2} & \ldots & C_{ii} & \ldots & C_{in} \\
\vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\
C_{n1} & C_{n2} & \ldots & C_{ni} & \ldots & C_{nn}
\end{bmatrix}
\]

Where \( C_{ij} \) is the interindustry coefficient showing the output from sector \( i \) required by sector \( j \) to produce $1.00 of sales to final demand. With the computed inverted Leontief matrix, equation 9 can be written out as:
Multiplying a row of the \((I - A)^{-1}\) by the column of \(Y\), the following scalar equations are derived as:

\[
\begin{align*}
X_1 &= C_{11}Y_1 + C_{12}Y_2 + \cdots + C_{1i}Y_i + \cdots + C_{1n}Y_n \\
X_2 &= C_{21}Y_1 + C_{22}Y_2 + \cdots + C_{2i}Y_i + \cdots + C_{2n}Y_n \\
\vdots &= \vdots \\
X_i &= C_{i1}Y_1 + C_{i2}Y_2 + \cdots + C_{ii}Y_i + \cdots + C_{in}Y_n \\
\vdots &= \vdots \\
X_n &= C_{n1}Y_1 + C_{n2}Y_2 + \cdots + C_{ni}Y_i + \cdots + C_{nn}Y_n
\end{align*}
\]

The element \(C_{11}\) indicates the amount by which output of sector 1 will change as final demand for output of sector 1 changes by one dollar. The element \(C_{12}\) indicates the amount by which output of sector 1 will change as final demand for sector 2 is changed by one unit. The interdependence coefficient, \(C_{ij}\) indicates the amount by which output of the i-th producing sector will increase for each dollar increase in final demand for the product of the j-th sector.

If the column interindustry coefficients of equation 11 or 12 are summed together, the total effects from a change in a particular sector’s sales to final demand is derived such that:

\[
C_j = \sum_{i=1}^{n} C_{ij} \quad j = 1, 2, \ldots, n
\]
Where $C_{j}$ indicates the change in regional economic activity from a change in sales to final demand by the sector j.

The interindustry model described has been an open interindustry model, that is, no non-processing sectors are incorporated into the processing section of the model. If a non-processing sector is incorporated into the processing section of the transactions table, the model is classified as a “closed” model. If the transactions table is “closed” with the Households Sector included in the processing section, an $n + 1$ matrix of interindustry coefficients are derived. It can be shown as:

\[
\begin{bmatrix}
C_{11} & C_{12} & \cdots & C_{1i} & \cdots & C_{1n} & C_{1n+1} \\
C_{21} & C_{22} & \cdots & C_{2i} & \cdots & C_{2n} & C_{2n+1} \\
\vdots & \vdots & \ddots & \vdots & \ddots & \vdots & \vdots \\
C_{n1} & C_{n2} & \cdots & C_{ni} & \cdots & C_{nn} & C_{nn+1} \\
\vdots & \vdots & \ddots & \vdots & \ddots & \vdots & \vdots \\
C_{n+1,1} & C_{n+1,2} & \cdots & C_{n+1,i} & \cdots & C_{n+1,n} & C_{n+1,n+1}
\end{bmatrix}
\]

(14)

The $C_{ij}$’s are interpreted like the coefficients in equation 11 and 12 except these include the effects of household spending. The column sum of the interindustry coefficient derive the “closed” final demand multipliers or:

\[
C_{j}^H = \sum_{i=1}^{n+1} C_{ij} \quad j = 1, 2, \ldots, n
\]

(15)
The $C_j^H$ indicates the increase in regional economic activity from an increase in sales to final demand by sector j. The “closed” final demand interindustry coefficient is similar to the coefficient in equation 13 ($C_j$) but the “closed” coefficient $C_j^H$ includes the effects of household spending in the regional economy and this effect is called the induced effects (induced effects = $C_j^H - C_j$). The $C_j^H$ indicates the direct, indirect and induced effects in the regional economy from a change in sales to final demand by sector j.

**Output Interindustry Coefficients**

The matrix of final demand interindustry coefficients shown in equations 11 and 12 relate to deliveries of sectoral output outside the processing sectors or to final demand rather than to total production. In order to adjust to production changes rather than external end-product deliveries, column entries in the final demand coefficients matrix are divided by the intra-sectoral coefficient or:

\[ b_{ij} = \frac{C_{ij}}{C_{jj}} \quad i = 1, 2, \ldots, n \quad \text{and} \quad j = 1, 2, \ldots, n \]
The “open” model output interindustry coefficient matrix is described below as:

\[
\begin{bmatrix}
 b_{11} & b_{12} & \cdots & b_{1i} & \cdots & b_{1n} \\
 b_{21} & b_{22} & \cdots & b_{2i} & \cdots & b_{2n} \\
 \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\
 b_{i1} & b_{i2} & \cdots & b_{ii} & \cdots & b_{in} \\
 \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\
 b_{n1} & b_{n2} & \cdots & b_{ni} & \cdots & b_{nn}
\end{bmatrix}
\]

(17)

The element \( b_{11} \) indicates the amount by which output of sector 1 will change as output for sector 1 changes by one dollar. From equation 16, the coefficient \( b_{11} \) is equal to 1 as well as all intrasectoral coefficients of the output interindustry coefficients matrix or \( b_{jj} = 1 \). The element \( b_{12} \) indicates the amount by which output of sector 1 will change as output for sector 2 changes by one dollar.

The column sum of the output interindustry coefficients indicate the change in regional economy activity from increased output by sector \( j \), or:

\[
B_j = \sum_{i=1}^{n} b_{ij} \\
\text{where } B_j \text{ indicates the total change in regional economic activity from a $1.00 change in output by sector } j.
\]

(18) \( B_j = \sum_{i=1}^{n} b_{ij} \quad j = 1, 2, \ldots, n \)

where \( B_j \) indicates the total change in regional economic activity from a $1.00 change in output by sector \( j \). Since this is an “open” model and contains no non-processing sectors in the processing section, the output interindustry coefficient, \( B_j \), shows only direct and indirect changes to the regional economy from changes in sector \( j \)’s level of output.

Including the Household Sector in the processing section of the transaction table, a “closed” interindustry model is derived. As shown in equation the “closed” final demand
interindustry coefficients are divided by the intra-sectoral coefficient to derive output interindustry coefficients or:

\[
(19) \quad b_{i,j}^{H} = \frac{C_{i,j}^{H}}{C_{j,j}^{H}} \quad i = 1, 2, \ldots, n + 1 \quad j = 1, 2, \ldots, n + 1
\]

The “closed” output interindustry matrix of coefficients are shown below as:

\[
\begin{bmatrix}
    b_{11}^{H} & b_{12}^{H} & \cdots & b_{1i}^{H} & \cdots & b_{1n}^{H} & b_{1,n+1}^{H} \\
    b_{21}^{H} & b_{22}^{H} & \cdots & b_{2i}^{H} & \cdots & b_{2n}^{H} & b_{2,n+1}^{H} \\
    \vdots & \vdots & \ddots & \vdots & \ddots & \vdots & \vdots \\
    b_{i1}^{H} & b_{i2}^{H} & \cdots & b_{ii}^{H} & \cdots & b_{in}^{H} & b_{i,n+1}^{H} \\
    \vdots & \vdots & \ddots & \vdots & \ddots & \vdots & \vdots \\
    b_{n1}^{H} & b_{n2}^{H} & \cdots & b_{ni}^{H} & \cdots & b_{nn}^{H} & b_{n,n+1}^{H} \\
    b_{n+1,1}^{H} & b_{n+1,2}^{H} & \cdots & b_{n+1,i}^{H} & \cdots & b_{n+1,n}^{H} & b_{n+1,n+1}^{H}
\end{bmatrix}
\]

The \( b_{ij}^{H} \)'s are interpreted similar to the coefficients in equation 17 except these coefficients include the effects of regional spending by households. The column sum of the output interindustry coefficients derive the “closed” output multipliers as:

\[
(21) \quad B_{j}^{H} = \sum_{i=1}^{n+1} b_{ij}^{H} \quad j = 1, 2, \ldots, n
\]

When \( B_{j}^{H} \) indicates the increase in regional economic activity from increase in output by sector \( j \) of one dollar. The “closed” output interindustry coefficients include the effects of household spending patterns in the regional economy which is denoted as induced effects (induced effects = \( B_{j}^{H} - B_{j} \)). The \( B_{j}^{H} \) indicates the direct, indirect and induced effects in the regional economy from a change in sectoral output by sector \( j \).
**Income Multipliers**

The interindustry model can be used to derive the effects on regional household incomes from changes in a given sector’s sales to final demand or output. If households are exogenous to the model or there exists an “open” input-output model, the first step for income effects is to derive from the direct requirements table, the direct requirements coefficient for the household row as:

\[
W = \begin{bmatrix}
    a_{n+1,1} & a_{n+1,2} & \cdots & a_{n+1,i} & \cdots & a_{n+1,n}
\end{bmatrix}
\]

To derive the direct and indirect income effects, premultiply the \( W \) matrix by the “open” interindustry coefficients matrix or:

\[
Z = \begin{bmatrix}
    c_{11} & c_{12} & \cdots & c_{1i} & \cdots & c_{1n} \\
    c_{21} & c_{22} & \cdots & c_{2i} & \cdots & c_{2n} \\
    \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\
    c_{i1} & c_{i2} & \cdots & c_{ii} & \cdots & c_{in} \\
    \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\
    c_{n1} & c_{n2} & \cdots & c_{ni} & \cdots & c_{nn}
\end{bmatrix} \cdot \begin{bmatrix}
    a_{n+1,1} & a_{n+1,2} & \cdots & a_{n+1,i} & \cdots & a_{n+1,n}
\end{bmatrix}
\]

This derives the \( Z \) matrix which is 1 x n or is expressed as:

\[
Z = \begin{bmatrix}
    z_1, z_2, \ldots, z_i, \ldots, z_n
\end{bmatrix}
\]

where \( z_1 \) denotes the direct and indirect income effects to the regional economy from a $1.00 increase in sales to final demand by sector 1.
When the household sector is endogenous to the processing sector or a “closed” model is used, the vector Z is calculated directly in the inversion process that yields the interdependence coefficients. From equation 14, the direct, indirect and induced employment effects are denoted as:

\[
Z = \begin{bmatrix}
\xi_{n+1,1}^H & \xi_{n+1,2}^H & \cdots & \xi_{n+1,n}^H \\
\eta_1^h & \eta_2^h & \cdots & \eta_n^h
\end{bmatrix}
\]

(25)

Where \( z_{1}^h \) denotes the direct, indirect and induced employment effects from a $1.00 increase in sales to final demand by sector 1. The indirect employment effects from a $1.00 change in sales to final demand by sector i is derived by subtracting the direct income change from the direct and indirect income change derived in equation 24 (indirect employment change in sector \( i = z_i - a_{n+1,i} \)); while induced income effects are derived by subtracting the direct and indirect income effects coefficient from the direct, indirect and induced employment coefficient from equation 25 (induced employment effects = \( z_{1}^h - z_{i} \)).

Output income effects are derived using the same procedures as for the final demand income effects except the output interindustry coefficients matrix is used in place of the final demand interindustry coefficients matrix. Therefore, effects to regional income from changes in a particular sector’s output is derived.

The Type I multiplier derives the direct and indirect change in regional income from a one unit increase direct income for a given sector, or:

\[
(26) \quad YI_j = z_j / a_{n+1,j} \quad j = 1, 2, ..., n
\]
where $YI_j$ is the type I income multiplier for sector $j$, or indicates the direct and indirect increase in regional household income from a one unit increase in income to sector $j$ from increased sales to final demand. The Type II income multiplier is derived as:

\[
YII_j = \frac{Y}_{h,j} / a_{n+1,j} \quad j = 1, 2, ..., n
\]

where $YII_j$ is the Type II income multiplier for sector $j$ which indicates the direct, indirect and induced change in regional incomes from a one dollar increase in income by sector $j$ from increased sales to final demand. Type I and Type II income multipliers can also be derived for output multipliers using the same procedures as shown above in equations 26 and 27.

**Employment Multipliers**

The input-output model also can be used to determine the effects on regional employment from changes in a given sector’s sales to final demand or output. The direct employment coefficient is derived by dividing total employment for a given sector by that sector’s value of total output or:

\[
e_j = \frac{L_j}{X_j} \quad j = 1, 2, ..., n
\]

where $e_j$ is the amount of employment by sector $j$ per unit of output by sector $j$;

$L_j$ is total employment by sector $j$; and

$X_j$ is total output of sector $j$. 
Direct and indirect change in employment from increased sales to final demand by a given sector is derived as:

\[
N = \begin{bmatrix}
  c_{11} & c_{12} & \cdots & c_{1i} & \cdots & c_{1n} \\
  c_{21} & c_{22} & \cdots & c_{2i} & \cdots & c_{2n} \\
  c_{i1} & c_{i2} & \cdots & c_{ii} & \cdots & c_{in} \\
  c_{n1} & c_{n2} & \cdots & c_{ni} & \cdots & c_{nn}
\end{bmatrix}
\]

where \( N \) is a vector of direct and indirect employment coefficient designated as:

\[
N = \begin{bmatrix}
  n_{1} \\
  n_{2} \\
  \vdots \\
  n_{i} \\
  \vdots \\
  n_{n}
\end{bmatrix}
\]

where \( n_{i} \) is the direct and indirect changes in regional employment from a change in sales to final demand by sector \( i \).

Direct, indirect and induced employment changes are derived by multiplying the “closed” interindustry matrix by the direct employment coefficient or:

\[
N^h = \begin{bmatrix}
  c_{11}^h & c_{12}^h & \cdots & c_{1i}^h & \cdots & c_{1n}^h & c_{1n+1}^h \\
  c_{21}^h & c_{22}^h & \cdots & c_{2i}^h & \cdots & c_{2n}^h & c_{2n+1} \\
  c_{i1}^h & c_{i2}^h & \cdots & c_{ii}^h & \cdots & c_{in}^h & c_{in+1} \\
  c_{n1}^h & c_{n2}^h & \cdots & c_{ni}^h & \cdots & c_{nn}^h & c_{n,n+1} \\
  c_{n+1,1}^h & c_{n+1,2}^h & \cdots & c_{n+1,i}^h & \cdots & c_{n+1,n}^h & c_{n+1,n+1}
\end{bmatrix}
\]

When \( N^h \) is vector of direct, indirect and induced employment coefficient designated as:

\[
N^h = \begin{bmatrix}
  n_{1}^h \\
  n_{2}^h \\
  \vdots \\
  n_{i}^h \\
  \vdots \\
  n_{n}^h
\end{bmatrix}
\]
when \( n^h_j \) denotes the direct, indirect and induced changes in regional employment from increased sales to final demand by sector \( j \).

Employment multipliers based on output changes by particular sectors are derived by using the output interindustry matrix.

The Type I employment multiplier derives the direct and indirect changes in regional employment from a given sector’s one unit increase in employment or:

\[ NI_j = \frac{n_j}{e_j} \quad j = 1, 2, ..., n \]

\( NI_j \) is the direct and indirect change in regional employment from a one unit increase in employment by sector \( j \) from increased sales to final demand. The Type II employment multiplier derives direct, indirect and induced employment effects from a one unit change in a given sector employment or:

\[ NII_j = \frac{n^h_j}{e_j} \quad j = 1, 2, ..., n \]

where \( NII_j \) is the direct, indirect and induced change in regional employment from a one unit increase in employment by sector \( j \) from changes in sales to final demand.
APPENDIX B:

LISTING OF ECONOMIC SECTORS
Table A.1. Sectors and Sector Definitions for the Lincoln County Interindustry Model.

<table>
<thead>
<tr>
<th>ECONOMIC SECTOR</th>
<th>DEFINITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Livestock</td>
<td>Ranches engaged in production and sale of cattle, horses, sheep or other livestock.</td>
</tr>
<tr>
<td>2. Alfalfa Hay</td>
<td>Farm enterprises that mainly produce alfalfa hay.</td>
</tr>
<tr>
<td>3. Other Hay</td>
<td>Farm enterprises that mainly produce other types of hay.</td>
</tr>
<tr>
<td>4. Gold Mining</td>
<td>The extraction and processing of gold minerals.</td>
</tr>
<tr>
<td>5. Other Mining</td>
<td>The extraction and processing of metal and non-metal minerals not classified under gold mining.</td>
</tr>
<tr>
<td>6. Construction</td>
<td>Businesses engaged in any type of heavy or general building construction including new construction, additions, alterations, and repairs.</td>
</tr>
<tr>
<td>7. Manufacturing</td>
<td>Businesses engaged in the machining and mechanical assembly or chemical transformation of materials or substances.</td>
</tr>
<tr>
<td>8. Transportation and Communications</td>
<td>Businesses furnishing local or long distance trucking, the associated warehousing services, and air and road transporting firms serving the area. Also businesses furnishing telephone, radio, and television services.</td>
</tr>
<tr>
<td>9. Utilities</td>
<td>Gas and electric power companies.</td>
</tr>
<tr>
<td>10. Trade</td>
<td>All wholesale and retail businesses not elsewhere classified.</td>
</tr>
<tr>
<td>11. Eating, Drinking, and Lodging</td>
<td>Restaurants, bars, motels, and hotels.</td>
</tr>
<tr>
<td>12. Finance, Insurance and Real Estate</td>
<td>Finance, insurance, and real estate firms.</td>
</tr>
<tr>
<td>13. Services</td>
<td>Repair services, social services, professional services, and other services not elsewhere classified.</td>
</tr>
<tr>
<td>14. Hotel, Gaming, and Recreation</td>
<td>Gaming establishments, including restaurants, bars, and lodging accommodations which are part of the establishments. Also includes recreation and amusement enterprises.</td>
</tr>
<tr>
<td>15. Health</td>
<td>Physicians, dentists, clinics, and hospitals.</td>
</tr>
<tr>
<td>16. Local Government</td>
<td>City and county government including special districts.</td>
</tr>
<tr>
<td>17. Household (row)</td>
<td>Labor payments, transfer payments, interests and dividends.</td>
</tr>
<tr>
<td>Household (column)</td>
<td>Expenditures by individuals and families for personal (non-business) uses.</td>
</tr>
<tr>
<td>18. Import (row)</td>
<td>All purchases of goods and services from outside Lincoln County.</td>
</tr>
<tr>
<td>Export (column)</td>
<td>Goods and services provided to places outside the Lincoln County.</td>
</tr>
<tr>
<td>19. Other Final Payments (row)</td>
<td>State and federal taxes, depreciation, retained earnings and savings.</td>
</tr>
<tr>
<td>Other Final Demand (column)</td>
<td>State and federal government consumption, inventory change, and new capital investments.</td>
</tr>
</tbody>
</table>
APPENDIX C:

PRIVATE SECTOR, LOCAL GOVERNMENT, AND

NON-MARKET IMPACTS FROM ECONOMIC CHANGES
Table C.1. Impacts of Economic Change on the Private Sector - Important Considerations

1. How many workers will be hired by the new business activity? What is the dollar value of the anticipated payroll? What will be the value of production or sales from the new business activity?

2. What is the "multiplier" effect and how can it be appraised in a community?

3. When will the new workers be hired? When will the payroll be generated? And when will the new purchases and sales be made in the local economy?

4. Is the new economy activity associated with construction or operation of the business?

5. Will the new economic activity stimulate construction in related businesses, housing, and service and trade sectors of the economy?

6. Do the changes in employment, income, and sales represent net or gross additions to the community's economic base?

7. How does the new economic activity compliment the local economic situation?

8. What will be the incidence of the impacts? More specifically which people and businesses are likely to benefit, and which people and businesses are likely to bear the costs of the economic development.

Table C. 2. Impacts of Economic Change on the Local Government Sector-Important Considerations.

1. Within what governmental jurisdictions will new families live?

2. How many in-migrant families are expected, and what is their anticipated income level?

3. How many school-age children are expected?

4. Do the public services and schools have excess capacity, or would expansions be required to maintain the quality of service at predevelopment levels?

5. Are there migration fees to cover additional public service costs?

6. Will state and federal aid increase as population grows?

7. When will the project be completed?

8. Does the expenditure estimation procedure used include only the additional costs associated with the new growth?

9. Will new revenues be divided among more than one governmental unit, such as city, county, and school district? If so, how much additional revenue will each receive?

10. When will the public expenditures for the project begin and when will the community begin receiving project-generated revenues? How will these change over time?

11. Will projected demands for service require a change in tax rates or a change in the level of service?

12. Who benefits and who loses from the development?

13. Will tax abatements or other publicly supported inducements be used to encourage this growth?

14. Is the project capital-or labor-intensive?

15. What is the probability that the firm will remain in the area and operate successfully over a five, 10, or 20 year period?

16. What are the income and employment multiplier effects of the new industry?

17. How will this development and associated population growth affect state aid to education and local property tax revenues in your state?

Table C.3. Nonmarket Impacts of Economic Change-Important Considerations

I. Distribution: Who Will Be Affected?
   A. Will effects vary among geographic sectors of the community?
   B. What income groups will be affected and in what ways?
   C. Will all or just certain economic sectors of the community have to make adjustments?
   D. Will the impacts vary over time?

II. Employment-Related Impacts.
   A. Will the new jobs be satisfying to workers?
   B. Effects on commuting time and distance. How far must local residents travel to their
      new jobs?
   C. Will the jobs be permanent or will they be highly sensitive to managerial decision and
      economic trends?
   D. Will the workers perceive the new jobs as an improvement over previous conditions?

III. Population-Related Impacts.
   A. Demographic.
      1. How much in-migration will occur?
      2. Will the newcomers and their families match or be different from the prevalent
         age and family structure of the community?
      3. What value changes might occur?
      4. Can the newcomers easily be integrated into the community social structure or
         will adjustments be needed?
   B. Housing.
      1. How will the value of housing change?
      2. How will the quality of housing change?
      3. What changes in housing ownership will occur?
      4. What type of new housing will be needed?

IV. Community Ecology.
   A. How will communication networks be affected?
   B. How will religious organizations be affected?
   C. How will participation in community affairs be affected
   D. What different internal-external linkages will appear?
   E. Will satisfaction with the community change?

V. Political and Local Government.
   A. Political
      1. What leadership changes will occur?
      2. Will voter participation change?
   B. How will public recreation facilities and use be altered?
   C. Will physical safety of workers and residents change?
   D. What short-and long-term health effect could occur?

Source: Shaffer, Ron. "Nonmarket Impacts From Economic Development", in How Extension Can Help
Communities Conduct Impact Analysis, University of Wisconsin-Extension, 1982.99