Performance and Contributions of the Green Industry to Utah's Economy

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PERFORMANCE AND CONTRIBUTIONS OF THE GREEN INDUSTRY TO UTAH’S ECONOMY

by

Lara Gale

A research paper submitted in the partial fulfillment
of the requirements for the degree
of
MASTER OF SCIENCE
in
Applied Economics

Approved:

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UTAH STATE UNIVERSITY
Logan, Utah
2021
ABSTRACT

PERFORMANCE AND CONTRIBUTIONS OF THE GREEN INDUSTRY TO UTAH’S ECONOMY

by

Lara Gale, MS in Applied Economics
Utah State University, 2021

Major Professor: Dr. Man Keun Kim
Department: Applied Economics

Landscaping and nursery enterprises, commonly known as green industry enterprises, can be found everywhere in Utah, and are necessary to create both aesthetic appeal and human well-being in the built environment. In order to understand the impact that events such as economic shocks or policy changes may have on the green industry, the baseline performance and contribution of the industry must be specified for comparison following these shocks. This study provides a summary and evaluation of the current performance of the green industry in Utah, and estimates the industry’s contributions to Utah’s economy in terms of transactions between industries, employee compensation, and government tax revenue using economic multipliers from the IMPLAN (IMpact analysis for PLANning) model for Utah. While the green industry contributed less than 1% of overall employment and taxable sales in Utah in 2018, the follow-on economic impacts contributed by green industry activity are important to consider. More than 12 thousand green industry jobs distributed throughout the state stimulated an additional 6,679 jobs in the wider economy through business-to-business purchasing and employee spending.
Many thanks to my major professor, Dr. Man Keun Kim, for inviting me to undertake this project and for his patience and encouragement throughout this research. From his insight into effective economic impact analysis, to instruction in technical skills for data analysis, to guidance on professional data presentation, his mentorship provided me with the tools I needed to be successful. I would also like to thank my committee members, Dr. Ruby Ward and Dr. Larry Rupp, for their additional guidance and feedback throughout this process. Dr. Rupp was a driving force behind this research from its earliest inception and I am grateful to have been able to support his vision and persistent advocacy for the green industry. Dr. Ward provided invaluable instruction in the application of IMPLAN. I’m grateful to my professors in the Department of Applied Economics for excellent instruction and support, and to my fellow students for countless hours of study sessions.

I’d also like to thank Meeja Fortie and the Utah Nursery and Landscape Association (UNLA) for financial support for this research and for helping facilitate a supplemental survey. Thank you also to the Utah Department of Agriculture and Food (UDAF) for providing financial support.

I’d like to thank my colleagues at the Utah Community Development Office and Bear River Association of Governments for your generous mentorship and the opportunity to learn while doing over the last three years. And finally, thanks so much to my family and friends for your support and encouragement, especially my mom and dad, Maureen and Blaine Gale. It will be an honor to pay it forward.
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CHAPTER 1

INTRODUCTION\(^1\)

1.1. Introduction

The green industry is a necessary part of the U.S. economy (Hall et al. 2020) as well as the economy of Utah that enables end users to maximize the value of landscapes in the built environment. Portions of the green industry are clearly agricultural production (nursery and greenhouse production), while others are professional (landscape architecture), retail (garden centers and home stores), service (florists and landscape maintenance), manufacturing (small equipment and sprinkler irrigation supplies), construction (landscape construction and irrigation installation), recreation (golf and botanical gardens), or government (campuses and parks). The diversity of the industry makes it difficult to assess its value to Utah, which, in turn, makes it difficult for the state to make decisions regarding it.

The findings in this research paper establish a baseline for continued monitoring of the contribution of the industry as a whole to the economy of Utah, and provide useful information for green industry participants concerned with the industry's current economic performance and future outlook. It also offers policymakers information to consider when making decisions that affect the allocation of resources such as water and labor among competing interests.

This research paper begins with a review of referenced literature an explanation for the inclusion of specific industries in consideration of the green industry in Utah. Chapter 2 summarizes and evaluates current performance of the green industry in the U.S. and Utah. Chapter 3 introduces

\(^1\) Note that a report based on this research paper has been submitted to the funding agencies, Utah Nursery and Landscape Association (UNLA) and Utah Department of Agriculture and Food (UDAF) as Gale, L. and Kim, M-K. (2021) *Economic Contribution of the Green Industry in Utah*, Applied Economics, Utah State University, February.
the method of input-output modeling, followed by an analysis of the contributions of the green industry to Utah’s economy in terms of transactions between industries, employee compensation and government tax revenue using economic multipliers from the IMPLAN (IMpact analysis for PLANning)² model for Utah. Finally, the report concludes with recommendations for future research and ongoing data collection and reporting.

1.2. Literature

In 1992, Snyder and Wilde conducted the first, and until now most recent, study of the size and contribution of Utah’s green industry. Data were gathered in four major surveys which sought to capture complete information about green industry demand and production practices in Utah. Since then, methods used by economists to estimate the contribution of an industry to a region’s economy have evolved, as software has made it possible to construct detailed models of regional economies using available data. Information about the software and computations used for modeling Utah’s economy for this study is included in later sections.

New methods in estimating the economic contribution of industry have been used in several reports of the performance and contribution of the green industry in various states and for the entire nation over the last two decades. Methods used for this study have been selected from those of several other studies, including: 1) choosing industries and sectors for the model, 2) modifying model output to reflect region-specific data, 3) determining contributions versus impacts of the industry.

Methods in this paper were drawn from studies of the contribution of the green industry to other state studies including: Hinson, Pinel and Hughes 2003 study in Louisiana; Thilmany, Watson

² IMPLAN is an economic impact assessment software system that combines a set of extensive databases, economic factors and demographic statistics. It is developed and maintained by the IMPLAN Group, LLC. (French, 2018)
and Davies 2003 study in Colorado; Hodges and Haydu 2009 study in Florida; Kane and Wolfe 2010 study in Georgia, and Hall, Hodges and Haydu 2006 study of the entire US, as well as more recent updates to some of these studies as cited throughout this paper.

1.2.1 Industry Sector Classification

Sectors classified as “green industry” are those which enable end users to maximize the value of outdoor elements of the built environment. Many individual green industry enterprises engage in production that includes some combination of several industry sectors. This study identified sectors that comprise the green industry based on their primary product or service as defined by the North American Industry Classification System (NAICS)\(^3\). The sectors analyzed in this report and their corresponding NAICS codes are found in Table 1.

To identify green industry sectors, this study considers several sources, each of which vary somewhat. This report considers sectors listed in the literature (Hodges et. al., 2015; Hall et. al., 2020) sectors identified by the Utah Nursery and Landscape Association (UNLA) as eligible for membership, and sectors included in a previous study of Utah's green industry (Snyder and Wilde, 1992). Hall et al. (2020), a U.S. study conducted by the Green Industry Research Consortium, a multi-state project under the US Department of Agriculture (USDA), included landscaping services, lawn and garden equipment and supplies stores, nursery and horticulture production, farm and garden equipment merchant wholesalers, nursery and florist merchant wholesalers, landscape architectural services, and lawn and garden equipment manufacturing industry. A Texas study (Palma and Hall, 2018) included prefabricated metal buildings, or green-houses, which is included

---

\(^{3}\) A NAICS code is a classification within the North American Industry Classification System. The NAICS System was developed for use by Federal Statistical Agencies for the collection, analysis and publication of statistical data related to the US Economy. The NAICS code list is available at https://www.naics.com/search/
in this report because by number of establishments and employees it has a relatively significant presence in the state.

Some state studies include in the green industry recreational sectors that are major end-users of landscaping products and services, including botanical gardens and golf courses (Bauman and McFadden, 2017) and private and public entities managing facilities that include large landscaped areas. This study follows the sector identification used by Hodges et al. (2015) and Hall et al. (2020) to report on the green industry nationwide, reporting only on the economic activity of sectors whose primary products and services are to do with landscaping and horticulture. As such, data for large users of landscaping products and services have not been included in this study.

Sectors included in green industry reports nationwide were compared to those specified by sources concerned particularly with the green industry in Utah. The Utah Nursery and Landscape Association (UNLA) defines its membership as “Licensed firms or organizations engaged in the nursery business, landscape construction, landscape architecture, greenhouse production, interior or exterior landscape maintenance, irrigation contracting, professional pesticide use, or any other related green industry in Utah” (UNLA, 2020). The most recent report on the economic impact of Utah's green industry, published in 1992, further specifies the scope of the green industry to include hardware stores, sales of seeds and fertilizer and lawn/garden equipment in lawn/garden sections of retail food/drug stores (Snyder and Wild, 1992). These economic activities are considered to be encompassed by the following NAICS sectors active in Utah's economy:
Table 1. Establishments, Employment, and Wages of UT Green Industry in 2018

<table>
<thead>
<tr>
<th>Industry Sector (NAICS Code)</th>
<th>Employment(^y) (persons)</th>
<th>Number of Firms(^y) (no.)</th>
<th>Total Wages(^y) ($ million)</th>
<th>Taxable Sales(^y) ($ million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nursery and tree production (111421)</td>
<td>516</td>
<td>34</td>
<td>13.98</td>
<td>5.73</td>
</tr>
<tr>
<td>Floriculture production (111422)</td>
<td>547</td>
<td>15</td>
<td>17.19</td>
<td>1.98</td>
</tr>
<tr>
<td>Prefabricated metal building &amp; component manuf (332311)</td>
<td>672</td>
<td>21</td>
<td>43.90</td>
<td>19.37</td>
</tr>
<tr>
<td>Farm &amp; garden equipment merchant wholesalers (423820)</td>
<td>478</td>
<td>56</td>
<td>23.67</td>
<td>38.07</td>
</tr>
<tr>
<td>Flower, nursery stock &amp; florists supplies wholesalers (424930)</td>
<td>285</td>
<td>24</td>
<td>8.81</td>
<td>14.92</td>
</tr>
<tr>
<td>Outdoor power equipment stores (444210)</td>
<td>185</td>
<td>27</td>
<td>6.63</td>
<td>25.49</td>
</tr>
<tr>
<td>Nursery, garden center &amp; farm supply stores (444220)</td>
<td>1,506</td>
<td>101</td>
<td>33.76</td>
<td>111.91</td>
</tr>
<tr>
<td>Landscape architectural services (541320)</td>
<td>241</td>
<td>80</td>
<td>10.69</td>
<td>11.94</td>
</tr>
<tr>
<td>Landscaping services (561730)</td>
<td>7,972</td>
<td>1,189</td>
<td>263.91</td>
<td>13.86</td>
</tr>
<tr>
<td>Home and garden equipment repair &amp; maintenance (811411)</td>
<td>52</td>
<td>23</td>
<td>1.22</td>
<td>11.84</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>12,453</td>
<td>1,569</td>
<td>423.76</td>
<td>255.10</td>
</tr>
</tbody>
</table>

\(^y\) Source: US Bureau of Labor Statistics, Quarterly Census of Employment and Wages (QCEW), which includes part-time and seasonal employees

\(^z\) Utah Tax Commission

Production and manufacturing:

- Nursery and tree production (NAICS 111421)
- Floriculture production (NAICS 111422)
- Prefabricated metal building & component manufacturing (NAICS 332311)

Landscape design, construction and maintenance services:

- Landscape architectural services (NAICS 541320)
- Landscape services (NAICS 561730)

Retail and wholesale trade:

- Farm and garden equipment merchant wholesalers (NAICS 423820)
- Flower, nursery stock and florists' supply merchant wholesalers (NAICS 424930)
- Outdoor power equipment stores (NAICS 444210)
- Nursery, garden center and farm supply stores (NAICS 444220)
- Home and garden equipment repair and maintenance (NAICS 811411)
CHAPTER 2
INDUSTRY PERFORMANCE

Determining the performance of the green industry at the regional level is useful for observing changes over time and comparing regional performance to national trends. The recession of 2009-2010 revealed that green industry performance is vulnerable to shocks affecting the housing market (Hall, 2010). This analysis can serve as a baseline for ongoing monitoring and assessment of green industry performance.

2.1. Data and Methods

Data for this section is compiled from peer reviewed literature, the US Census Bureau Quarterly Census of Employment and Wages (QCEW) 2005-2019 (Bureau of Labor Statistics, 2021) which is available at https://www.bls.gov/cew, taxable sales reports from the Utah Tax Commission 2005 – 2019, which is available at https://tax.utah.gov, and construction data reported by the Kem C. Gardner Institute from https://gardner.utah.edu. The time period was chosen because 2005 marks the beginning of consistent reporting for all sectors in all sources of data.

All dollars are adjusted to match the 2018 Consumer Price Index (CPI) as reported by the US Bureau of Labor Statistics because this is the most current year for which IMPLAN modeling data is available (see Industry Economic Contribution section below). Numbers of employees, business establishments and monthly wages reported for each year in the analysis are an average of totals reported by quarter in the QCEW.

2.2. Green Industry Performance

The green industry as a whole has historically been a fast-growing segment of the U.S. economy, but recently has grown slowly and even declined in some sectors (Hall et al., 2020). Since
publication of the last report of the economic contribution of Utah's green industry in 1992 (Snyder and Wild, 1992), the recession of 2008-2010 in the U.S. had a strong effect on employment, and the green industry was heavily impacted. Since the industry as a whole recovered to pre-recession levels of employment in 2013, several individual sectors of the green industry in Utah have shown consistently fast growth, while others have grown more slowly.

The performance of the green industry is tied closely to the performance of the housing industry, which was hit severely by the 2008 recession (Figure 1). The “silver lining” to the recovery from that recession was a market correction that helped stabilize housing (Hall, 2010). This has helped provide a foundation for a strong recovery of both the housing industry and the green industry in Utah. Since regaining pre-recession levels in 2012, the number of homes under construction (housing starts) in Utah has increased by 16% annually. At the same time, taxable sales in the green industry have increased by 7% (Figure 1).

Nationwide, employment in the principal sectors of the U.S. green industry reached a peak of 1.285 million jobs in 2007 before dropping sharply during the 2008 - 2010 recession. Over the 2001-2013 period, the green industry in the U.S. experienced a decline in total employment of -0.4%, although employment levels varied greatly by individual sector. The landscaping services sector saw the highest increase in employment in this period, increasing by more than 20%. At the same time, other sectors experienced a severe decline in employment, including landscape architectural services (-28%), lawn and garden equipment manufacturing (-21%) and nursery and horticulture production (-9%) (Hodges et al., 2015).
Utah's green industry directly employed 12,454 people in full and part-time positions in 2018, according to the 2018 QCEW as reported in Table 1. Since 2011, the industry has shown slow but steady growth in employment at an average rate of 5% per year. During the 2008 recession period, employment levels in Utah as a whole decreased less than the rest of the nation, however the green industry in Utah experienced a steeper drop in employment than the state average (Figure 2).

While some green industry sectors have shown strong growth in recent years, others experienced more severe employment decreases, similar to the industry nationwide during this period, and have not recovered to pre-recession levels (Figure 3). Sectors that experienced the smallest decline in employment and have recovered to at least pre-recession levels include landscaping services, farm and garden equipment merchant wholesalers, and nursery, garden center and farm supply stores. Sectors that have not recovered to pre-recession employment levels include outdoor power equipment stores, floriculture production, landscape architectural services, nursery wholesalers and home and garden equipment repair and maintenance providers.
The average real monthly wage for the green industry as a whole in Utah dipped slightly during the 2008 recession period, dropping by an average of -2% every year between 2008 and 2011. Starting in 2012, real wages began to increase again by an average of 3% per year. By 2014, the average real monthly wage for the industry was $2,820, exceeding the pre-recession peak in 2007. Since then, wages have continued increasing steadily, reaching an industry average monthly wage of $3,109 in 2019. Wages reported by the Bureau of Labor Statistics are not differentiated by employment type, so average wages here include wages to part-time and seasonal workers.

Considered separately, primary green industry sectors' actual average monthly wage rates vary widely. Much of the whole industry's average wage growth can be attributed to growth in the prefabricated metal building and component manufacturing sector, which has seen 5% growth in real average monthly wages annually between 2012 and 2019, to reach $5,436 in 2019. Without including prefabricated buildings, the average real monthly wage for the whole industry in 2019 was $2,925. Primary sectors averaging 3% growth in wages since 2012 include landscaping.
architectural services and landscaping services. Most other sectors experienced an average rise of between 1% and 2% in average wages between 2012 and 2019 (Figure 4).

Figure 3: Utah Green Industry Employment by Sector, 2005 – 2019

Figure 4: Utah Green Industry Average Real Monthly Wage by Sector, 2005 – 2019
CHAPTER 3
INDUSTRY ECONOMIC CONTRIBUTION

The economic contribution analysis illustrates the way the green industry relates to the entire Utah economy. This section begins with an introduction to Input-Output modeling generally. It then explains not only the green industry’s direct contribution of benefits like employment and production output, but also the way its direct contributions further stimulate benefits from other industries and actors in the regional economy.

3.1. Methods

3.1.1. Input-Output Modeling

The contribution of an industry sector or group of sectors to an entire economy can be estimated using Input-Output (IO) analysis, an analytic framework developed in the 1930s by Nobel laureate Wassily Leontief (Leontief, 1936). The framework tabulates the flow of goods and services between industries for a particular economic area, showing the way output from one industry is used by other industries, and the requirements one industry has for output from other industries. Ultimately, an IO table offers a detailed breakdown of inter-industry relationships that can be used to estimate the relative importance of an existing business or industry, like the green industry, to a given regional economy (Henderson and Evans, 2017).

For example, the IO table in Figure 5 is constructed using the 2018 IMPLAN database for Utah. Industries are highly aggregated to four for illustrative purposes: Agriculture, Green industry, Manufacturing and Services. As mentioned above, the central concept of the IO modeling is tabulating the interrelationship between the producing sectors of a region. Additionally, IO tables specify the interrelationship between industry sectors and consuming sectors, or households, and the rest of the world, or regional imports and exports.
As illustrated in Deller (Deller, 2019), the IO table in Figure 5 is best understood in rows, columns and sections. Reading across each industry row, it is possible to determine total commodity demand from industry and from final consumers. Each row accounts for the sales by the industry named at its left to the industries identified across the top of the table and to the final consumers listed in the right-hand section of the table. As you can see, Section A in Figure 5 is composed of commodities consumed by activities in production; this section shows intermediate, inter-industry demand relationships. For example, the Green industry may purchase plastic containers produced by the Manufacturing industry to produce Green industry end products. Reading from the left, you can see that in 2018 the Manufacturing industry sold $119 million in intermediate goods to the Green industry for Green industry production. To the right of Section A
in Figure 5 are shown sales to final demanders, which are those to household consumers, government expenditures and changes in inventory, investment, and exports. Altogether, including both industry and exogenous demands for goods, total demand for output from industry can be seen in the total at the far right, a row sum. For example, total demand for Green industry in Utah in 2018 was $1.42 billion.

Reading down each industry column, it is possible to determine total payments by an industry sector to other entities. Each column accounts for payments by the industry named at the top of the column to entities named on the left. Below Section A (inter-industry transaction), payments made by industry to employees (employment compensation, EC), holders of capital (proprietor income, PI), and indirect business taxes (IBT) are found in the box labeled “V” for “value-added.” Exogenous purchases are purchases made from industries outside the region and are identified as imports and categorized as other payments. Altogether, the sum of entries in each column represents the total purchases by the industry in 2018. For example, purchases and payments of the Green industry can be seen in column 2 of Figure 5: $17 million from Agriculture, $119 million from Manufacturing, and $280 from Service. There is also payment to labor (EC), $505 million, PI, $66 million, and other property income, $104 million. Imports from out of state, $277 million.

Notice that the total inputs, $1.42 billion, is the same as total outputs or total demand identified on the far right of row 2. Since profits, losses, capital depreciation, taxes, etc. are recorded in the table as “other” payments and demands, the total purchases and payments must equal total sales – or, in other words, inputs must equal outputs. This is the meaning of “Input-Output” table.
3.1.2. Computing Direct Requirements Table

Input-Output models predict how changes in final demand affect the economy. Industries produce goods and services to meet changes in final demand, which requires them to purchase inputs from other industries. Inter-industry transactions stimulate additional transactions as each sector of the economy responds to the initial change in final demand, and the results are tabulated as, round-by-round, each sector responds to the initial change in final demand.

To see how this framework can be used as a predictive model, consider Section A (inter-industry transactions) in Figure 5. Let \( z_{ij} \) be the sales from row sector \( i \) to column sector \( j \), that is, inter-industry flow. Let \( x_j \) be the total output of the industry (\( j = \text{Agriculture, Green, Manufacturing, and Service} \)). Let \( y_j \) be the final demand in industry \( j \). The following identities for each row are:

\[
\begin{align*}
x_1 &= z_{11} + z_{12} + z_{13} + z_{14} + y_1 \quad (1) \\
x_2 &= z_{21} + z_{22} + z_{23} + z_{24} + y_2 \quad (2) \\
x_3 &= z_{31} + z_{32} + z_{33} + z_{34} + y_3 \quad (3) \\
x_4 &= z_{41} + z_{42} + z_{43} + z_{44} + y_4 \quad (4)
\end{align*}
\]

Given \( z_{ij} \) and \( x_j \) we can form the ratio of input to output or the input requirement for each industry to produce exactly one additional unit of output, that is, \( a_{ij} = z_{ij} / x_j \). For example, the Green industry requires $0.012 of Agriculture products, $0.022 of Green industry products, $0.084 of Manufacturing goods and $0.197 of Service outputs to produce one dollar of Green industry output. This ratio is called a technical coefficient (Miller and Blair, 2009). Calculating \( a_{ij} \) for each \((i, j)\) results in a table also known as a direct requirements table, represented by matrix \( A \).

\[
A = \begin{bmatrix} 0.035 & 0.012 & 0.031 & 0.000 \\ 0.001 & 0.022 & 0.002 & 0.002 \\ 0.065 & 0.084 & 0.136 & 0.023 \\ 0.235 & 0.197 & 0.177 & 0.284 \end{bmatrix}
\]
From the fact that $a_{ij} = z_{ij}/x_j$, $z_{ij} = a_{ij}x_j$; substituting each $z_{ij}$ in equations (1) to (4) with $a_{ij}x_j$ results in the following identities:

$$x_1 = a_{11}x_1 + a_{12}x_2 + a_{13}x_3 + a_{14}x_4 + y_1 \quad (6)$$

$$x_2 = a_{21}x_1 + a_{22}x_2 + a_{23}x_3 + a_{24}x_4 + y_2 \quad (7)$$

$$x_3 = a_{31}x_1 + a_{32}x_2 + a_{33}x_3 + a_{34}x_4 + y_3 \quad (8)$$

$$x_4 = a_{41}x_1 + a_{42}x_2 + a_{43}x_3 + a_{44}x_4 + y_4 \quad (9)$$

And after rearranging terms, can be represented in matrix form as:

$$\begin{bmatrix}
1 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & 1
\end{bmatrix} -
\begin{bmatrix}
a_{11} & a_{12} & a_{13} & a_{14} \\
a_{21} & a_{22} & a_{23} & a_{24} \\
a_{31} & a_{32} & a_{33} & a_{34} \\
a_{41} & a_{42} & a_{43} & a_{44}
\end{bmatrix}
\begin{bmatrix}
x_1 \\
x_2 \\
x_3 \\
x_4
\end{bmatrix} =
\begin{bmatrix}
y_1 \\
y_2 \\
y_3 \\
y_4
\end{bmatrix} \quad (10)$$

In matric notation this relationship is denoted $(\mathbf{I} - \mathbf{A})\mathbf{x} = \mathbf{y}$, where $\mathbf{A} = [a_{ij}]$, $\mathbf{x} = [x_j]$ and $\mathbf{y} = [y_j]$ or equivalently, $\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{y}$. $(\mathbf{I} - \mathbf{A})^{-1}$ is known as the Leontief Inverse. The predictive model, $\Delta \mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1}\Delta \mathbf{y}$, relates the change in total industry output as a product of the Leontief Inverse and a change in final demand.

From the example of the Green industry:

$$\begin{bmatrix}
1 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 \\
0 & 0 & 1 & 0 \\
0 & 0 & 0 & 1
\end{bmatrix} -
\begin{bmatrix}
0.035 & 0.012 & 0.031 & 0.000 \\
0.001 & 0.022 & 0.002 & 0.002 \\
0.065 & 0.084 & 0.136 & 0.023 \\
0.235 & 0.197 & 0.177 & 0.284
\end{bmatrix}
= \begin{bmatrix}
0.965 & -0.012 & -0.031 & 0.000 \\
-0.001 & 0.978 & -0.002 & -0.002 \\
-0.065 & -0.084 & 0.864 & -0.023 \\
-0.235 & -0.197 & -0.177 & 0.716
\end{bmatrix} \quad (11)$$

Thus:

$$(\mathbf{I} - \mathbf{A})^{-1} = \begin{bmatrix}
1.039 & 0.016 & 0.037 & 0.002 \\
0.002 & 1.023 & 0.003 & 0.003 \\
0.088 & 0.109 & 1.169 & 0.039 \\
0.363 & 0.314 & 0.301 & 1.407
\end{bmatrix} \quad (12)$$
From this, any change in output, $\mathbf{x}$, as a result of a change in final demand, $\mathbf{y}$, can be calculated. So, for example, a $1,000 increase in final demand, e.g., export, for Green industry output results in an increase in required output from all sectors, specifically, $16 from Agriculture ($0.016 \times 1000$), $1,023 from Green (1.023 \times 1000$), $109 from Manufacturing ($0.109 \times 1000$), and $314 from Service ($0.314 \times 1000$). The total impact will be $1,000 (initial direct effect) plus $462 (indirect effect), for a total effect of $1,462. Mathematically,

$$
\Delta \mathbf{x} = \mathbf{I} \mathbf{A} \mathbf{y} = \begin{bmatrix} 1.039 & 0.016 & 0.037 & 0.002 \\ 0.002 & 1.023 & 0.003 & 0.003 \\ 0.088 & 0.109 & 1.169 & 0.039 \\ 0.363 & 0.314 & 0.301 & 1.407 \end{bmatrix} \times \begin{bmatrix} 0 \\ 1000 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} 16 \\ 1023 \\ 109 \\ 314 \end{bmatrix}
$$

(13)

A Type I multiplier is calculated by dividing the direct effects ($1,000) plus the indirect effects (the additional economic activity from industries buying from other local Industries, $462) by the direct effect. In the case of Green industry above, the Type I multiplier is 1.462, which is the sum of Green industry column of $(\mathbf{I} - \mathbf{A})^{-1}$ in equation (12).

### 3.1.3. Economic Contribution Analysis

While economic impact and contribution analysis are two different concepts with meaningful differences in regional economic analysis, both terms are used interchangeably, yielding confusion among practitioners (Henderson and Evans, 2017; Parajuli et al., 2018). The economic contribution analysis, for example, captures gross change in the region's existing economy (relative importance of an existing industry to an economy), whereas the impact analysis reveals the ripple effect of new activity (exogenous demand change) (Henderson and Evans, 2017; Parajuli et al., 2018). In other words, contribution analysis is about looking at how the current state of sector supports other businesses in the local economy. Using the total production values to represent the sector's final
demands in an input-output model will overestimate the value of the sector of interest and its associated economic contribution to other sectors of the economy (Henderson and Evans, 2017).

As discussed in Henderson and Evans (2017); Parajuli et al. (2018), economic contribution analysis (ECA) uses the IO table as in impact analysis. The difference is that ECA estimates the direct and indirect effects of the sector in situ, that is, without assuming any external change in the final demands. Since the final demand remains unchanged, the analysis focuses on calculating a value that represents the direct contribution of a sector of the economy such that the sum of the total output is preserved.

The contribution of an existing sector of the economy can be calculated with an adjustment factor that preserves the output values in the transactions table and the adjustment factor is the reciprocal of the sector's Type I multiplier. In the previous example, a Type I multiplier for the green industry is 1.462. The direct contributions made by the Green industry are total output of the green industry \( \times 1.462^{-1} \), which is $972 million = $1,420 million/1.462. It is a value which fully preserves the transaction table's output value for Green industry.

3.2. Adapting IO Modeling for Contribution Analysis Using IMPLAN

The contribution of the green industry to the economy of Utah was estimated using economic multipliers from a 2018 model of the region’s economy created with the IMPLAN Input-Output model as illustrated using equation (13). The information used to produce the model reflects regional production practices, and is gathered from sources of data with well-established methodology such as the Quarterly Census of Employment and Wages (QCEW) reported by the Bureau of Labor Statistics (BLS), Regional Economic Accounts and National Income and Product Accounts reported by the Bureau of Economic Analysis, and County Business Patterns reported by the US Census Bureau (IMPLAN, 2020).
The IMPLAN modeling system contains economic data for 546 industry sectors in the U.S. The model of Utah's economy includes 497 industry sectors that are active in the state. Data incorporated into the model includes commodity production, employment, household income, commodity trade, capital investment, taxes, transfer payments (e.g. social programs for low-income people and retirement), and gross margins for wholesale and retail trade sectors (the value of services provided, not including the value of items sold within their establishment) (Miller and Blair, 2009).

IMPLAN aggregates some industries that are analyzed separately by the BLS in the data used for Chapter 2. Table 2 notes the NAICS code corresponding to IMPLAN codes and sector descriptions, and reports direct contribution of the industry as reported by IMPLAN without concern for identifying just the contribution of the green industry. Table 3 shows the proportion of aggregated IMPLAN sector employment that can be attributed just to the green industry sector(s) as reported by QCEW. Employment was chosen as the number for comparison because in both the QCEW and IMPLAN, “employment” represents an equivalent estimate of the number of covered workers who worked during the evaluated pay period (the year 2018).

For example, IMPLAN reports that architectural, engineering, and related services (IMPLAN Sector 457) employed 11,842 people in Utah in 2018. The green industry sector of landscape architecture (NAICS sector 561730) makes up only a portion of architectural, engineering and related services. QCEW reports that landscape architecture employed 241 people. So landscape architecture employees make up about 2% of employment in the architectural, engineering and related services sector as it is defined by IMPLAN. Applying 2% as a deflator to all economic contributions of the architectural, engineering and related services sector as reported by IMPLAN allows us to estimate the portion that can be attributed just to landscape architecture. For example, total production of architectural, engineering, and related services (IMPLAN Sector
Table 2: Direct Contributions of Utah Green Industry in 2018 (2018 dollars), without Adjustment

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Greenhouse, nursery, and floriculture production (111421, 111422)</td>
<td>100.9</td>
<td>948</td>
<td>37.7</td>
<td>51.3</td>
<td>5.8</td>
<td>12.8</td>
</tr>
<tr>
<td>235. Prefabricated metal building &amp; component manufacturing (332311)</td>
<td>152.2</td>
<td>466</td>
<td>39.5</td>
<td>55.4</td>
<td>6.9</td>
<td>14.5</td>
</tr>
<tr>
<td>395. Wholesale - Machinery, equipment and suppliers (423820)</td>
<td>1,030.0</td>
<td>3,798</td>
<td>345.6</td>
<td>591.2</td>
<td>98.6</td>
<td>136.7</td>
</tr>
<tr>
<td>400. Wholesale - Other nondurable goods merchant wholesalers (424020)</td>
<td>1,357.2</td>
<td>4,722</td>
<td>328.3</td>
<td>601</td>
<td>228.5</td>
<td>171.4</td>
</tr>
<tr>
<td>405. Retail - Building material &amp; garden equipment, supplies (444210, 444220)</td>
<td>1,024.2</td>
<td>9,270</td>
<td>412.4</td>
<td>691.7</td>
<td>200.8</td>
<td>156.5</td>
</tr>
<tr>
<td>457. Architectural, engineering, &amp; related services (541320)</td>
<td>2,413.4</td>
<td>11,842</td>
<td>990.4</td>
<td>1,364</td>
<td>136.6</td>
<td>342.8</td>
</tr>
<tr>
<td>477. Landscape and horticultural services (561730)</td>
<td>493.7</td>
<td>8,099</td>
<td>277.0</td>
<td>291.6</td>
<td>36.7</td>
<td>79.6</td>
</tr>
<tr>
<td>516. Personal and household goods repair and maintenance (811411)</td>
<td>320.0</td>
<td>4,417</td>
<td>202.7</td>
<td>244.1</td>
<td>43.0</td>
<td>48.0</td>
</tr>
<tr>
<td>Total</td>
<td>6,891.5</td>
<td>43,471</td>
<td>2,633.6</td>
<td>3,980.3</td>
<td>757.0</td>
<td>962.2</td>
</tr>
</tbody>
</table>

Source: IMPLAN Database (IMPLAN, 2018)

457) in 2018 was $2,413.4 million (Table 2) and it was adjusted to $49.1 million (= $2,431.4 million × 2%). Employment, employee compensation, value added, and taxes were adjusted for architectural, engineering, and related services (IMPLAN Sector 457) sector as well – that is, values from IMPLAN × 2%.

The same exercise was repeated for each sector for which aggregated IMPLAN employment numbers exceeded the numbers reported in the QCEW for specific green industry sectors. Adjustment deflators are reported in Table 3 with IMPLAN employment and QCEW employment for comparison. If QCEW employment equaled or exceeded IMPLAN employment, I did not adjust values in IMPLAN. Table 4 presents the resulting estimates of the direct contributions of the green industry sectors in Utah in 2018.

As IO models, the models created by IMPLAN estimate the impact or ripple effect of a given economic activity within a specific geographic area. The multipliers derived from IMPLAN models describe individual sectors' direct, indirect and induced contributions to a given region’s
Table 3: Comparison of Employment Reported by IMPLAN and QCEW for UT Green Industry

<table>
<thead>
<tr>
<th>IMPLAN Code, IMPLAN Industry Sector (Aggregated NAICS Code)</th>
<th>IMPLAN Employment (persons)</th>
<th>QCEW Employment (persons)</th>
<th>Adjustment Deflator (QCEW/IMPLAN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Greenhouse, nursery, and floriculture production (111411, 111421)</td>
<td>948</td>
<td>1,063</td>
<td>100%</td>
</tr>
<tr>
<td>235. Prefabricated metal building &amp; component manufacturing (332311)</td>
<td>466</td>
<td>672</td>
<td>100%</td>
</tr>
<tr>
<td>395. Wholesale - Machinery, equipment and suppliers (423820)</td>
<td>3,798</td>
<td>478</td>
<td>13%</td>
</tr>
<tr>
<td>400. Wholesale - Other nondurable goods merchant wholesalers (424900)</td>
<td>4,722</td>
<td>285</td>
<td>6%</td>
</tr>
<tr>
<td>405. Retail - Building material &amp; garden equipment, supplies (444210, 444220)</td>
<td>9,270</td>
<td>1,691</td>
<td>18%</td>
</tr>
<tr>
<td>457. Architectural, engineering, &amp; related services (541320)</td>
<td>11,842</td>
<td>241</td>
<td>2%</td>
</tr>
<tr>
<td>477. Landscape and horticultural services (561730)</td>
<td>8,009</td>
<td>7,972</td>
<td>100%</td>
</tr>
<tr>
<td>516. Personal and household goods repair and maintenance (811411)</td>
<td>4,417</td>
<td>52</td>
<td>1%</td>
</tr>
</tbody>
</table>

Source: IMPLAN Database (IMPLAN, 2018) and QCEW

economy. Direct effects of the principal sectors of the green industry and the industry as a whole are presented in Table 4. As discussed previously, in an IO model, these direct effects are created by a given sector's primary economic activities, including sales, purchases, payments, etc. Indirect effects are the economic benefits created by economic activity generated by the sector's purchase of intermediate inputs. Induced effects are created in the economy by household and government spending made possible by wages and taxes paid by the industry sector. Together, the direct, indirect and induced effects comprise the total effect of each industrial sector.

The economic effects determined through IO modeling are reported in terms of contributions to the economy including output, employment, employee compensation and value-added contributions. Employment is the number of total full and part-time jobs. Output is the value of production in a calendar year, or annual revenues plus net inventory change (except for wholesale
Table 4: Direct Contributions of UT Green Industry in 2018 (2018 dollars), Adjusted

<table>
<thead>
<tr>
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<td>6. Greenhouse, nursery, and floriculture production (111421, 111422)</td>
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<td>39.5</td>
<td>55.4</td>
<td>6.9</td>
<td>14.5</td>
</tr>
<tr>
<td>395. Wholesale - Machinery, equipment and suppliers (423829)</td>
<td>129.6</td>
<td>478</td>
<td>43.5</td>
<td>74.4</td>
<td>12.4</td>
<td>17.2</td>
</tr>
<tr>
<td>400. Wholesale - Other nondurable goods merchant wholesalers (424930)</td>
<td>81.9</td>
<td>285</td>
<td>19.8</td>
<td>41.7</td>
<td>13.8</td>
<td>10.3</td>
</tr>
<tr>
<td>405. Retail - Building material &amp; garden equipment, supplies (444210, 444220)</td>
<td>186.8</td>
<td>1,691</td>
<td>75.2</td>
<td>126.1</td>
<td>36.6</td>
<td>28.5</td>
</tr>
<tr>
<td>457. Architectural, engineering, &amp; related services (541320)</td>
<td>49.1</td>
<td>241</td>
<td>20.1</td>
<td>27.8</td>
<td>2.8</td>
<td>7</td>
</tr>
<tr>
<td>477. Landscape and horticultural services (561730)</td>
<td>491.5</td>
<td>7,972</td>
<td>275.7</td>
<td>290.3</td>
<td>36.6</td>
<td>79.2</td>
</tr>
<tr>
<td>516. Personal and household goods repair and maintenance (811411)</td>
<td>3.8</td>
<td>52</td>
<td>2.4</td>
<td>2.9</td>
<td>0.5</td>
<td>0.6</td>
</tr>
<tr>
<td>Total</td>
<td>1,195.7</td>
<td>12,132</td>
<td>514</td>
<td>669.8</td>
<td>115.3</td>
<td>170.2</td>
</tr>
</tbody>
</table>

Source: IMPLAN Database (IMPLAN, 2018)

and retail industries, for which output represents margin only and not sales revenues). Employee compensation is the total cost of an employee including wages and salaries, all benefits and payroll taxes. Value added is the difference between total output and the cost of intermediate inputs, and combines employee compensation and proprietor income, other property income, and taxes on production and imports (Miller and Blair, 2009).

For this report, the IMPLAN model was adjusted for multi-industry economic contribution analysis according to a modified version of the method described by Henderson and Evans (Henderson, 2017). IMPLAN software was designed to analyze the impact of major changes in the production function of an industry or enterprise, or its exit from or entry into the market. Economists routinely modify IMPLAN models to instead analyze steady-state contributions of existing industry sectors to a regional economy. For this report, economic contributions for each sector were derived by modeling each green industry sector in Utah using its direct output in 2018. This was derived by deflating the total output reported for each sector in the 2018 model of each
region's economy by the sector's IMPLAN Type I multiplier for the region, which describes only the amount of a sector's total output that is attributable to its own economic activity.

3.2. Economic Contributions of Green Industry

The total direct contribution of the green industry to Utah's economy in 2018 was $1,195.7 million, including products sold, employee wages, returns on capital investment, and taxes. The industry contributed $115.3 million in state and local taxes, and $170.2 million in federal taxes (Table 4).

Every $1,000 of output by the green industry as a whole in Utah in 2018 generated $914 in the wider economy through business activity generated by green industry purchases and employee spending. From Figure 6, Total effect/Direct effect = 2289/1196 = 1.914. Thus, when the direct effect is $1,000, the sum of indirect and induced effect is estimated to be $914. Sectors that contributed the most to overall economic output in Utah include landscape and horticultural services, prefabricated metal buildings (greenhouses), wholesale suppliers of machinery and equipment and retailers offering building material, garden equipment and supplies.

For every 100 jobs created by the green industry as a whole in Utah in 2018, 55 jobs were created in the wider economy. Similarly, from Figure 7, Total effect/Direct effect = 18,810/12,132 = 1.550. Thus every 100 jobs created 55 jobs, which is the sum of indirect and induced effects. Considering each sector separately, wholesalers of flower, nursery stock and florist's supplies had the strongest employment impact on the state, producing 498 jobs in the wider economy in response to its 285 employees (Figure 7).
Figure 6: Economic Contributions of Green Industry by Sector, 2018

Figure 7: Jobs Contributed to Utah Economy by Green Industry by Sector, 2018

Note: Jobs includes full-time, part time, and temporary positions
CHAPTER 4
CONCLUSION

4.1. Summary and Policy Implications

While the green industry contributed less than 1% of overall employment and taxable sales in Utah in 2018, the follow-on economic impacts contributed by green industry activity are important to consider. More than 12 thousand green industry jobs distributed throughout the state stimulated an additional 6,679 jobs in the wider economy through business-to-business purchasing and employee spending. Green industry activity has a ripple effect on the rest of the state economy, as does policy impacting the green industry.

Just as agriculture, mining and other segments of the economy are dependent on water, so too is the green industry. What is different from these other industries is that the green industry is often viewed as largely aesthetic in value and thus not seen as a contributing part of the economy. This misperception becomes critical when considering statewide water conservation efforts. Just as conservation is critical to managing the state's water, water is also critical to the economic success of the green industry. This dependence makes water conservation a critical policy issue to the green industry, and to those in the wider economy that benefit from the green industry.

In a recent report developed for the Utah Division of Water Resources detailing regional municipal and industrial water conservation goals, recommendations for implementation include significant water conservation from landscaping in the built environment (Jones, 2019). The study recommends that in selecting conservation practices for implementation, “Policymakers should consider the full costs and benefits of each approach and the associated tradeoffs.” This report provides a baseline from which to consider the potential impacts proposed conservation practices
may have on the green industry and on the wider economy of Utah, with the hope that green industry input will be considered in the future.

4.2. Study Limitations and Research Recommendations

This study used the robust and comprehensive data about industry performance and regional economic activity available to analyze the green industry in Utah. This data is gathered through reporting mechanisms like surveys and tax reporting. Like other industries that incorporate agriculture, the green industry is vulnerable to under-reporting from these sources because of its seasonal nature, and because some sectors rely heavily on seasonal and part-time labor. Independent business owners may be unaware of reporting requirements or may choose to hire seasonal and part-time employees as contract workers.

Additionally, as has been noted, a wide diversity of industry sectors are required to ensure end users can maximize the value of landscapes in the built environment. Capturing the nuances of the performance of individual sectors, and the performance of certain sectors in particular regions of the state, would require a more detailed investigation of regional environmental and economic conditions and green industry performance. The industry in Utah may benefit from future research using a survey to more accurately estimate the activities of the green industry in particular regions and at particular times of year, including employment levels, wages and revenues.
REFERENCES


