Economic Impacts of Utah's Life Sciences Industry

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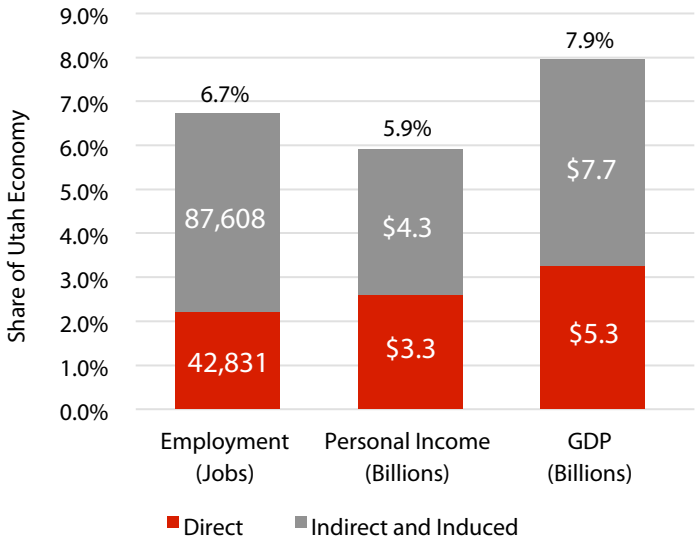
Executive Summary

The Utah Governor's Office of Economic Development (GOED) and BioUtah, the trade association for life sciences companies in the state, commissioned the Kem C. Gardner Policy Institute to analyze the role of the life sciences industry in Utah's economy.

Life sciences companies deliver technologies and services to improve personal health. They develop, manufacture, and distribute medical devices, pharmaceuticals, and related products. The life sciences industry includes biotechnology firms, medical laboratories, diagnostics companies, and support services providers.

Life sciences companies made significant economic impacts in Utah during 2017 (Figure 1). These companies directly and

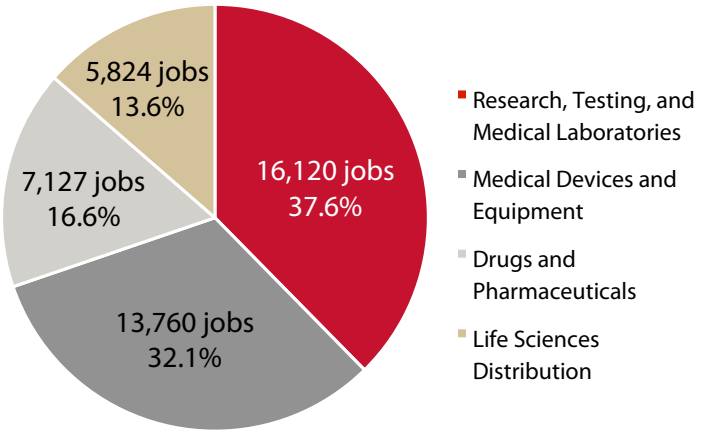
Figure 1: Utah Life Sciences Industry Economic Impact, 2017



Note: Employment includes full-time and part-time jobs. Personal income includes employee wages and benefits and proprietors' income. Direct amounts were from companies in Utah's life sciences industry. Indirect and induced effects apply to companies in any Utah industry supported by the in-state purchases of life sciences companies and by employees of life sciences companies spending their personal income in-state.

Source: Kem C. Gardner Policy Institute analysis of data from the Utah Department of Workforce Services, Utah Governor's Office of Economic Development, and Bureau of Economic Analysis, using the REMI PI+ economic model.

Figure 2: Utah Employment for Life Sciences Industry Components, 2017



Source: Utah Department of Workforce Services and Biotechnology Innovation Organization.

indirectly supported 6.7 percent of the state's employment, 5.9 percent of its personal income, and 7.9 percent of its gross domestic product (GDP).

In 2017, life sciences companies provided 42,831 full-time and part-time jobs in Utah. In-state spending by those companies and their employees supported another 87,608 jobs in many industries. Total economic impacts that year were 130,439 jobs, $7.6 billion in personal income, and $13.0 billion in GDP.

Utah's life sciences industry sold over 40 percent of its 2017 output of $9.6 billion to in-state customers, such that medical providers, pharmacies, and other buyers in Utah did not require out-of-state alternatives for $4.0 billion in goods and services. Nearly 60 percent of life sciences industry sales were to buyers in other states and countries, bringing $5.6 billion to Utah.

From 2002 to 2017, the average job growth rate was 3.3 percent per year in Utah's life sciences industry, compared to 2.1 percent in all other industries in Utah. Employment in the life sciences industry was more stable than employment in other industries.

In terms of direct employment (42,831 jobs), Utah's life sciences industry offered about 10 percent more jobs than the state's private hospital industry and about 5 percent fewer jobs than the state's securities and investments industry.

Table 1: Fiscal Impacts of Life Sciences Industry in Utah, 2017
(Millions of Dollars)

Government	Net Tax Revenue	Share
State	$299.7	63.0%
Local	$176.1	37.0%
Total	**$475.8**	**100.0%**

Note: Net revenue equals government tax revenue generated by the life sciences industry minus government operating expenditures associated with the industry's direct, indirect, and induced economic impacts. Local government includes counties and school districts.

Source: Kem C. Gardner Policy Institute.

Average compensation per employee in the life sciences industry, $86,396 in 2017, was 46 percent higher than average compensation in Utah, including all industries.

Life sciences companies are categorized in four groups, adapted from those used by GOED, BioUtah, and Biotechnology Innovation Organization (Figure 2). The research, testing, and medical laboratories industry group directly contributed 16,120 jobs in 2017, followed by the medical devices and equipment group with 13,760 life sciences jobs. The drugs and pharmaceuticals industry group directly provided over 7,100 jobs, and life sciences distribution provided over 5,800 jobs.

Utah's life sciences industry generated $475.8 million in net tax revenue in 2017 (Table 1). This amount is adjusted by an estimate of additional government expenditures during the year for workers and their households that are part of the life sciences industry's economic impact. Over one-third of tax revenues went to counties and school districts, and the remaining 63 percent, or nearly $300 million, accrued to the state.

This report begins by describing Utah's life sciences industry itself in terms of companies, customers, workers, income, output, and growth. Next, we present our economic impact results showing the impact of direct economic activity in the life sciences industry on the other industries in the state economy. We proceed to state and local fiscal impact results that correspond to the life sciences economic impacts. The report concludes with notes on research methods and acknowledgments.

Section 1. Direct Economic Activity

The life sciences industry applies knowledge of biological systems to health care. The industry includes research, manufacturing, and distribution. Its companies provide medical devices and equipment, drugs and pharmaceuticals, and services to pharmacies, medical providers, and other customers. The life sciences industry is also referred to as the biotech or biosciences industry.

Results in this section on direct economic activity pertain to Utah life sciences companies themselves. Measures of direct economic activity do not include indirect and induced economic activity generated by the life sciences industry. We will discuss indirect and induced effects in the economic impact section.

We begin with an overview of the life sciences industry in Utah, measured by the employment, income, and GDP it provides. We offer some details on where companies are located in the state and where they sell their goods and services. We comment on life sciences work outside of private sector companies. Section 1 concludes with comparisons to other industries in the state.

1.1 Industry Definition

The Utah Governor's Office of Economic Development (GOED) investigated best practices for identifying life sciences companies and provided the Gardner Policy Institute with a detailed list of industries and named companies to include in this analysis. GOED consulted publications and staff at BioUtah, the Economic Development Corporation of Utah, and prominent life sciences organizations in other states. Life sciences industry definitions in use around the country vary somewhat. The Gardner Policy Institute reviewed GOED's definition of Utah's life sciences industry and believes it strikes an appropriate balance between maintaining focus, being comprehensive, incorporating knowledge of individual Utah companies, and permitting comparability to other states. The resulting definition discussed below is roughly comparable to most leading life sciences industry research in other states and nationwide, while accounting for Utah-specific industry attributes.

As of 2017, Utah's life sciences industry included all 898 establishments in 15 NAICS industries, as well as 140 individually selected establishments spread across 26 other NAICS industries (Table 1.1). We placed these industries in four groups, adapted from those used by GOED, BioUtah, and Biotechnology Innovation Organization.[1] NAICS refers to the North American Industry Classification System, a standard for categorizing companies based on their primary function. An establishment is a business location. Since many companies have more than one Utah establishment, the number of life sciences companies is less than 1,038. The life sciences industry also includes 6,781 self-employed workers in these NAICS industries, not shown in Table 1.1 but fully incorporated in the economic impact analysis.

Of the 1,038 life sciences establishments, 38 percent were in life sciences distribution, 34 percent were in the research, testing, and medical laboratories category, 17 percent were in medical devices and equipment, and 10 percent were in drugs and pharmaceuticals.

The Utah Department of Workforce Services (DWS) responded to an information request for granular data on Utah life sciences aggregate wages and average monthly employment. DWS manages Utah data from the Quarterly Census of Employment and Wages (QCEW), which benefits from reporting requirements that apply to almost every employer. In all but a few situations where additional grouping was required by disclosure limitations, DWS provided data by six-digit NAICS industry.

Private sector workers not represented in QCEW data are all self-employed workers, most workers on small farms and railroads, some domestic workers and nonprofit employees, and students working at schools. Since self-employed workers (proprietors) were the largest QCEW omission affecting our understanding of the life sciences sector, we estimated their employment and income based on data from DWS and the Bureau of Economic Analysis, as shown below. However, the number of proprietorships for Table 1.1 was not available.

1.2 Industry Components

As shown above, the life sciences industry includes four types of companies. These industry groups are medical devices and equipment; research, testing, and medical laboratories; drugs and pharmaceuticals; and life sciences distribution. Together, in 2017, they attracted 42,831 full-time or part-time workers, of whom 6,781 were self-employed and the remainder were employees of life sciences companies (Table 1.2). Employment data from DWS does not report full- and part-time jobs as separate metrics. These workers earned $3.3 billion in employee compensation and proprietors' income. They produced $5.3 billion in professional services, manufactured goods, and other products, measured as state GDP. The life sciences industry was responsible for 3.2 percent of Utah's $165.6 billion in GDP in 2017.

Research, testing, and medical laboratories were the largest industry group in Utah's life sciences sector in terms of 2017 employment, creating 16,120 jobs and paying $1.1 billion in annual earnings. Companies in this industry group develop and commercialize medicines, delivery systems, cell and gene therapy, and other treatments. Many workers are engaged in biotechnology, nanotechnology, and other health-related science research. Other workers perform diagnostic testing

Table 1.1: Utah Life Sciences Industry Definition, 2017

Industry by Group[1]	Code[1]	Establishments[2]
Research, Testing, and Medical Laboratories:		
Dental Laboratories	339116	141
Medical Laboratories	621511	109
Research and Development in Biotechnology (except Nanotechnology)	541714	62
Research and Development in the Physical, Engineering, and Life Sciences	541715	14
Research and Development in Nanotechnology	541713	5
Testing Laboratories	541380	4
Custom Computer Programming Services	541511	3
Administrative Management and General Management Consulting Services	541611	3
Data Processing, Hosting, and Related Services	518210	2
Research and Development in the Social Sciences and Humanities	541720	2
All Other Professional, Scientific, and Technical Services	541990	2
Other[3]	multiple	10
Subtotal		**357**
Medical Devices and Equipment:		
Surgical and Medical Instrument Manufacturing	339112	59
Surgical Appliance and Supplies Manufacturing	339113	53
Electromedical and Electrotherapeutic Apparatus Manufacturing	334510	32
Analytical Laboratory Instrument Manufacturing	334516	15
Irradiation Apparatus Manufacturing	334517	8
Dental Equipment and Supplies Manufacturing	339114	8
Ophthalmic Goods Manufacturing	339115	4
All Other Plastics Product Manufacturing	326199	1
Subtotal		**180**
Drugs and Pharmaceuticals:		
Pharmaceutical Preparation Manufacturing	325412	66
Medicinal and Botanical Manufacturing	325411	35
In-Vitro Diagnostic Substance Manufacturing	325413	3
Biological Product (except Diagnostic) Manufacturing	325414	3
Subtotal		**107**
Life Sciences Distribution:		
Medical, Dental, and Hospital Equipment and Supplies Merchant Wholesalers	423450	341
Ophthalmic Goods Merchant Wholesalers	423460	21
Wholesale Trade Agents and Brokers	425120	13
Drugs and Druggists' Sundries Merchant Wholesalers	424210	11
Electronic Shopping and Mail-Order Houses	454110	5
Other[4]	multiple	3
Subtotal		**394**
Total		**1,038**

Notes:
1. Industry codes and descriptions are from the North American Industry Classification System (NAICS).
2. Establishments are company sites. Companies may have multiple sites in Utah. Establishment counts include companies with employees.
3. "Other" in the Research, Testing, and Medical Laboratories category includes 10 industries with one company each: NAICS 524292, Third Party Administration of Insurance and Pension Funds; NAICS 524298, All Other Insurance Related Activities; NAICS 541613, Marketing Consulting Services; NAICS 541690, Other Scientific and Technical Consulting Services; NAICS 551114, Corporate, Subsidiary, and Regional Managing Offices; NAICS 561110, Office Administrative Services; NAICS 561312, Executive Search Services; NAICS 561422, Telemarketing Bureaus and Other Contact Centers; NAICS 611430, Professional and Management Development Training; and NAICS 722310, Food Service Contractors.
4. "Other" in the Life Sciences Distribution category includes three industries with one company each: NAICS 425110, Business to Business Electronic Markets; NAICS 454390, Other Direct Selling Establishments; and NAICS 493110, General Warehousing and Storage.

Source: Kem C. Gardner Policy Institute and Utah Governor's Office of Economic Development.

and conduct clinical trials. Contract services also fall under research, testing, and medical laboratories. These services include healthcare information technology, consulting, benefits management, and staffing support for life sciences companies.

In terms of earnings and GDP, the medical devices and equipment industry group was the largest contributor within Utah's life sciences sector. Companies in this industry group added $1.2 billion in earnings for Utah households and generated $2.2 billion in GDP, 34.9 percent and 41.0 percent, respectively, of the state's life sciences sector totals. These companies employed 13,760 Utahns. A national report showing medical devices and equipment employment by metropolitan statistical area (MSA) for the previous year, 2016, ranked Salt Lake City sixth in the nation, Utah's highest MSA ranking for any of the four industry groups.[2] Medical devices and equipment companies manufacture instruments, equipment, and supplies for medical and dental care. Their products have many applications, from routine procedures to advanced surgeries. These companies make, for example, prescription eyewear, digital instruments, and prosthetic and implantable devices.

Companies in the drugs and pharmaceuticals industry group accounted for 7,127 jobs and $1.1 billion in GDP, one-sixth of the life sciences sector's employment and over one-fifth of its GDP. This industry group manufactures pharmaceutical and nutraceutical products for internal and external use. Examples include medication in vials, solutions, tablets, and ointments; biopharmaceutical drugs derived from human, animal, and plant sources; cell and tissue cultures; and vaccines.

The life sciences distribution industry group generated 5,824 jobs, $543.4 million in earnings, and $786.9 million in GDP. Wholesalers distribute drugs, pharmaceuticals, and medical devices and equipment to health care providers and pharmacies. This may involve specialized storage and monitoring, as well as inventory and supply automation.

1.3 In-State and Out-of-State Sales

The life sciences industry in Utah produced $9.6 billion in output in 2017 (Table 1.3). Output represents the sales value of goods and services and is, appropriately, much larger than GDP of $5.3 billion. GDP measures value added by life sciences companies and adjusts sales by the cost of intermediate inputs to avoid double counting. Life sciences goods and services were sold in Utah and outside the state, both of which generated economic impacts in Utah.

We estimated the amount of Utah life sciences output sold in state, out of state, and outside the country from industry averages in 2017. Nearly 60 percent of total output from Utah's life sciences industry was provided to customers outside the state. Almost three-fourths of these out-of-state sales were to buyers in other states, and over one-fourth were to buyers in other countries. Total exports from Utah to other states or countries amounted to an estimated $5.6 billion. This export-financed company revenue, once it entered Utah's economy, benefitted workers and companies in and beyond the state's life sciences industry.

Medical devices and equipment manufactured in Utah accounted for more than half of life sciences sales outside Utah in 2017, $2.9 billion. Over one-fourth of that amount, $0.8 billion, was international exports from Utah (Figure 1.1). Drugs and pharmaceuticals accounted for over one-third of life sciences exports from the state, $2.0 billion. Sales by these two industry groups represent direct sales from manufacturers. Another $0.4 billion came into the state for research, testing, and medical laboratory services provided to out-of-state customers. The remaining $0.3 billion was from Utah wholesalers (life sciences distributors) exporting life sciences products to customers in states or countries outside Utah.

Utah's life sciences industry also provides goods and services needed by Utah healthcare providers, pharmacies, and other in-state buyers. Over 40 percent of output from Utah's life sciences

Table 1.2: Utah Life Sciences Industry Employment, Earnings, and GDP, 2017
(Millions of Dollars)

	Employment		Earnings		GDP	
Industry Group	**Jobs**	**Share**	**Amount**	**Share**	**Amount**	**Share**
Research, Testing, and Medical Laboratories	16,120	37.6%	$1,071.8	32.1%	$1,197.2	22.6%
Medical Devices and Equipment	13,760	32.1%	$1,164.8	34.9%	$2,172.0	41.0%
Drugs and Pharmaceuticals	7,127	16.6%	$558.4	16.7%	$1,146.2	21.6%
Life Sciences Distribution	5,824	13.6%	$543.4	16.3%	$786.9	14.8%
Total	**42,831**	**100.0%**	**$3,338.4**	**100.0%**	**$5,302.2**	**100.0%**

Source: Utah Department of Workforce Services, Bureau of Economic Analysis, REMI PI+ economic model, and Biotechnology Innovation Organization.

Table 1.3: Utah Life Sciences Industry Direct Output by Location Sold, 2017
(Millions of Dollars)

Industry Group	Utah	Other States	Other Countries	Total
Research, Testing, and Medical Laboratories	$1,641.4	$306.6	$70.0	$2,017.9
Medical Devices and Equipment	$958.2	$2,154.3	$786.8	$3,899.3
Drugs and Pharmaceuticals	$574.1	$1,476.0	$485.2	$2,535.3
Life Sciences Distribution	$804.2	$206.2	$132.0	$1,142.3
Total	**$3,977.9**	**$4,143.0**	**$1,474.0**	**$9,594.9**

Source: Utah Department of Workforce Services, Bureau of Economic Analysis, REMI PI+ economic model, and Biotechnology Innovation Organization.

industry was sold in-state. Were it not for these sales, an estimated $4.0 billion would leave the state as other states and countries satisfied Utah demand for life sciences products. Research, testing, and medical laboratories accounted for 41 percent of total in-state life sciences sales. Utah buyers purchased over 80 percent of these services, worth $1.6 billion. In contrast, less than 25 percent of goods manufactured by Utah medical device and equipment companies and drug and pharmaceutical companies stayed in-state, accounting for a combined $1.5 billion in sales. Over two-thirds of sales in the life sciences distribution industry group ($0.8 billion) went to meeting the needs of Utah buyers.

1.4 Labor Force

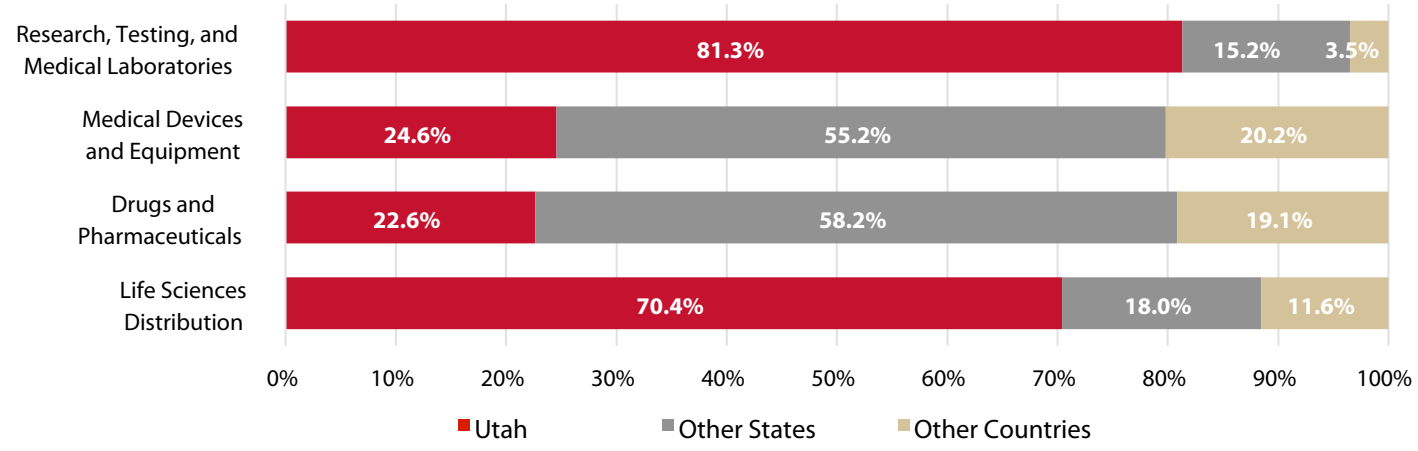
Utah's life sciences industry creates employment opportunities for both company employees and self-employed workers. In 2017, 36,050 employees held 84.2 percent of the state's life sciences jobs and earned 93.3 percent of earnings, including wages and benefits (Table 1.4). An estimated 6,781 self-employed workers held the remaining 15.8 percent of jobs and received 6.7 percent of earnings in the Utah life sciences industry. The proportion of self-employed workers varied by industry group, from a low of 3.4 percent in drugs and pharmaceuticals to a high of 25.1 percent in research, testing, and medical laboratories. The share of earnings for self-employed workers ranged from 2.2 percent in medical devices and equipment to 16.0 percent in life sciences distribution.

Life sciences companies reported paying $2.5 billion in employee wages and salaries (excluding benefits) in Utah during 2017, an average of $68,178 per job (Figure 1.2). Employee wages in the life sciences industry were 49.2 percent above the statewide average of $45,696 that year.[3]

Including benefits, total life sciences industry compensation was $3.1 billion, 3.5 percent of all employee compensation in Utah during 2017. Benefits were estimated from the ratio of compensation to wages in each industry in which life sciences companies operate. Average life sciences compensation per job was $86,396, which was 46.3 percent above the Utah average of $59,070.[4]

Turning to self-employed workers in the life sciences industry, total proprietors' income was an estimated $223.8 million. Proprietors' income is not separated into wages and benefits. Average proprietors' income in the life sciences industry was $33,001, 44.7 percent above the statewide average. Many part-time, self-employed workers were also employees in companies, such that self-employment was not their only source of income.

Figure 1.1: Utah Life Sciences Industry Components, Share of Output Sold by Destination, 2017



Source: Utah Department of Workforce Services, Bureau of Economic Analysis, REMI PI+ economic model, and Biotechnology Innovation Organization.

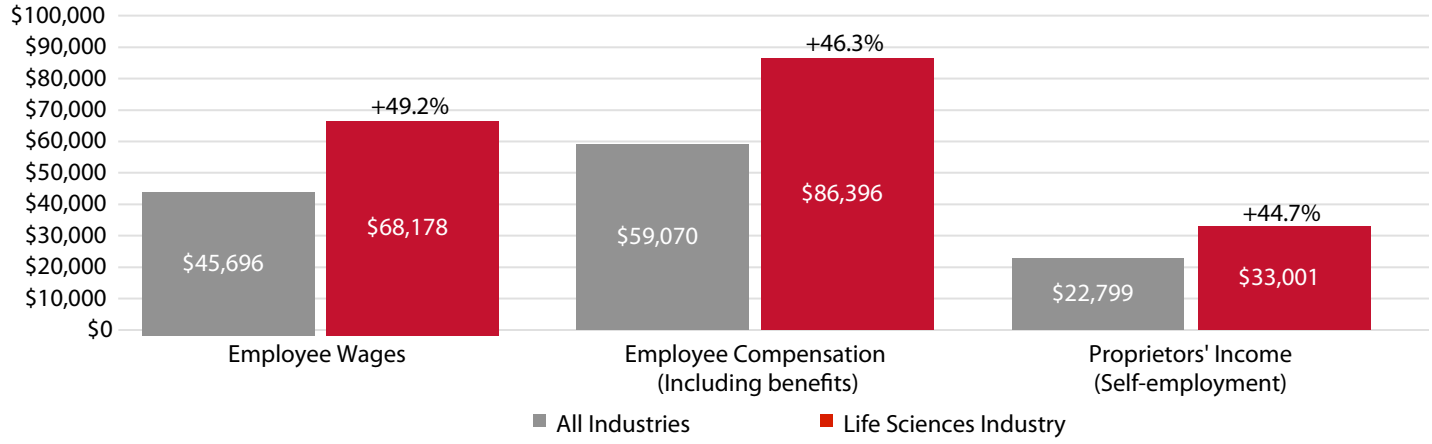
Table 1.4: Utah Life Sciences Industry Employees and Proprietors, 2017
(Millions of Dollars)

	Employment[1]		Earnings	
Industry Group	**Employees**	**Self-Employed**	**Employees[2]**	**Self-Employed**
Research, Testing, and Medical Laboratories	12,066	4,054	$980.8	$90.9
Medical Devices and Equipment	12,371	1,389	$1,139.7	$25.1
Drugs and Pharmaceuticals	6,883	244	$537.6	$20.8
Life Sciences Distribution	4,730	1,094	$456.4	$87.0
Total	**36,050**	**6,781**	**$3,114.6**	**$223.8**
Share[3]	**84.2%**	**15.8%**	**93.3%**	**6.7%**

Notes:
See Table 1.2 for employment and earnings totals for employees and self-employed workers combined.
1. Employees work for a company they do not own. Self-employed workers are labelled "proprietors" in economic data.
2. Earnings for employees reported here includes payroll (wages and salaries) reported by companies and an estimate of employee benefits based on 2017 compensation averages by industry.
3. Share of total employment of 42,831 workers and total earnings of $3,338.4 million in Utah's life sciences industry.

Source: Utah Department of Workforce Services, Bureau of Economic Analysis, Biotechnology Innovation Organization, and REMI PI+.

Figure 1.2: Average Annual Earnings per Worker in Utah's Life Sciences Industry, 2017



Note: Percentage labels for the life sciences industry indicate the percent difference compared to all industries. Life sciences industry wages and compensation are for its 36,050 employees. Life sciences industry proprietors' income is for 6,781 self-employed workers.

Source: Utah Department of Workforce Services and Bureau of Economic Analysis.

1.5 Company Location and Size

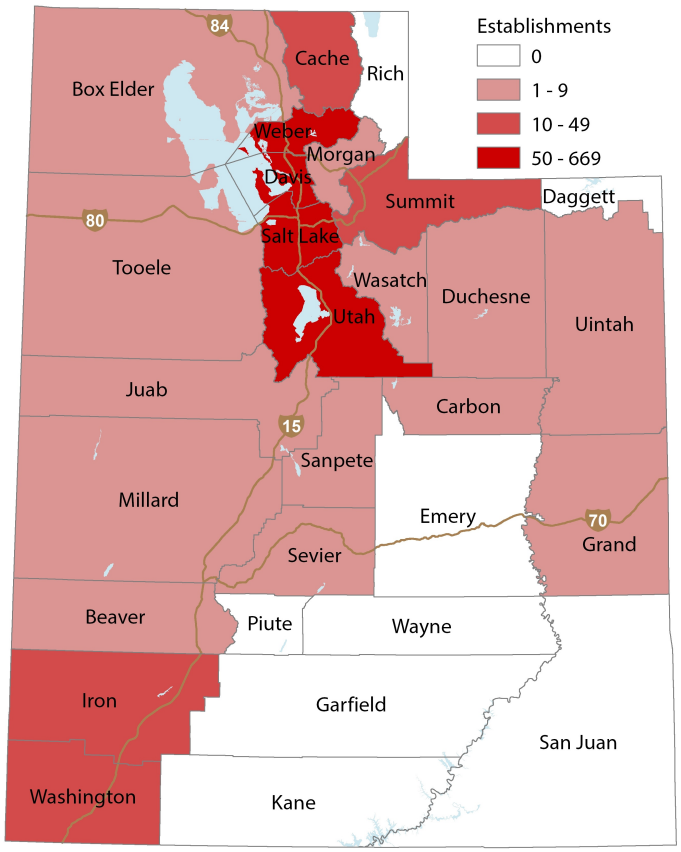
In 2017, life sciences companies with employees were located in 21 of Utah's 29 counties and in at least 84 cities and towns (Figure 1.3).[5] That year, 669 establishments operated in Salt Lake County, the most of any county, followed by Utah County with 115 establishments, Davis County with 68 establishments, and Weber County with 56 establishments. Four counties had 10 to 49 life sciences establishments: Washington, Cache, Summit, and Iron. The remaining counties had fewer than five life sciences establishments.

Utah's life sciences industry includes companies of all sizes. DWS provides employment counts by establishment. The average establishment size in 2017 was 35 employees, based on a total of 36,050 employees and 1,038 establishments. Of all life sciences establishments, 63.0 percent had fewer than five employees, 26.2 percent had 5–49 employees, and 10.8 percent had more than 50 employees (Figure 1.4). Available data on company size does not include Utah's 6,781 life sciences sole proprietors and general partners.

1.6 University Research

Academic research is a key component of the ecosystem that supports life sciences companies. Life sciences research at public and private higher education institutions in Utah attracts out-of-state funding, such as federal grants, to the state. Faculty, staff, and students on Utah college and university campuses do applied work to improve health care and develop medical technologies for commercialization. This study follows GOED's definition of the life sciences industry and focuses on companies in Utah's private sector. While we capture the 2017 spend-

Figure 1.3: Utah Life Sciences Industry Establishments, 2017



Note: Establishments are company sites. Companies may have multiple sites in Utah. Includes companies with employees, not proprietorships staffed only by self-employed workers.

Source: Utah Department of Workforce Services.

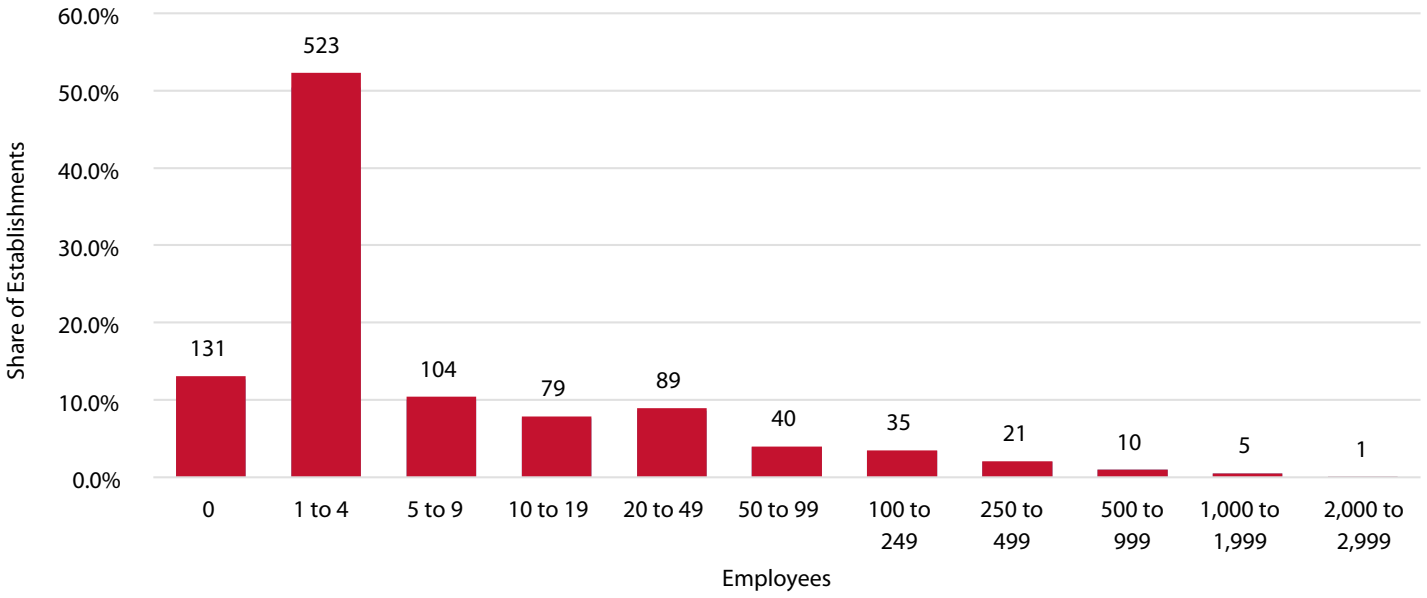
ing of active life sciences companies spawned by academic research in 2017 and prior, we did not include life sciences-related spending at academic institutions themselves in our economic impact analysis.[6] However, we describe it here.

Federal grants from the National Institutes of Health (NIH) are a significant funding source for life sciences research. Inflation-adjusted NIH funding grew an average of 1.9 percent per year from fiscal year 2007 to 2017 (Figure 1.5). In federal fiscal year 2017, Utah recipients were awarded $187.5 million in NIH grants. As much as 94.3 percent of NIH grants to Utah recipients were for life sciences research directly, while 5.7 percent of the grants were devoted to education, training, and awards for researchers. Of the $187.5 million total, 91.0 percent went to the University of Utah, Utah State University, and Brigham Young University. Private companies received the remaining 9.0 percent.

1.7 Relative Size and Performance

With its 42,831 jobs, the life sciences industry's direct employment was 12.2 percent larger than 2017 employment at private hospitals in Utah (Figure 1.6). Life sciences employment was 5.4 percent smaller than employment in securities and investments. Private hospitals and securities and investments are the two Utah industries most similar to the life sciences industry in terms of employment, from a list of 69 public and private industries in our REMI economic model based on data from the Bureau of Economic Analysis.[7] Three others are within 10,000 jobs of life sciences employment in the state: federal civilian (21.4 percent

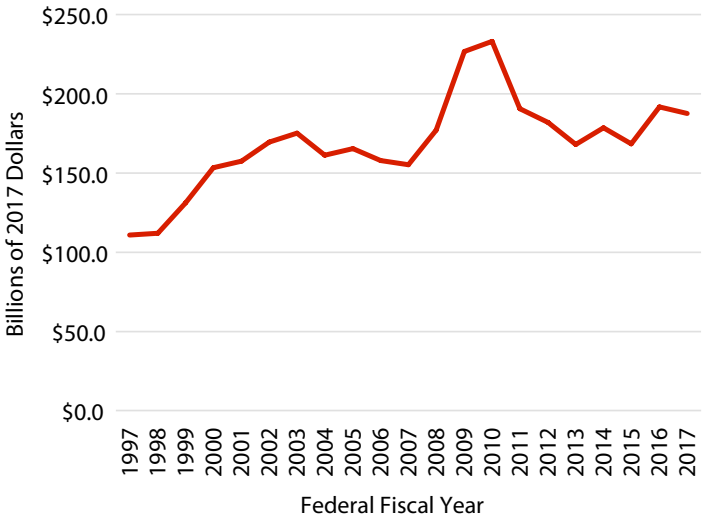
Figure 1.4: Utah Life Sciences Industry Establishments by Company Size, 2017



Note: Labels indicate the number of establishments in each size range. Includes companies with employees, not companies staffed only by self-employed workers (proprietors). Establishments are company sites. Companies may have multiple sites in Utah. Number of employees is a four-quarter average. Some establishments reported no employees for one or more quarters for an annual average rounding to zero.

Source: Utah Department of Workforce Services.

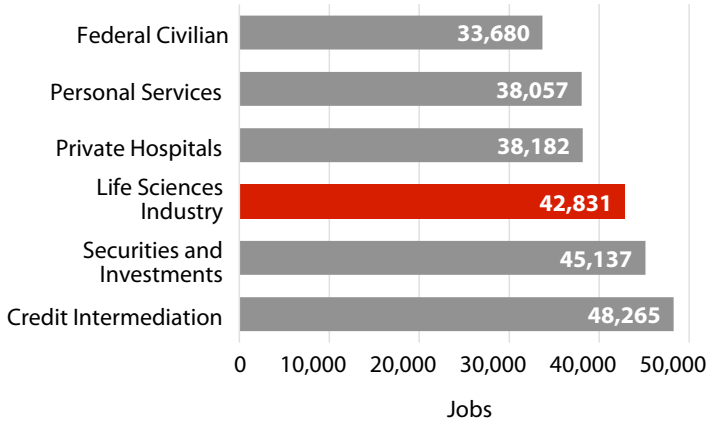
Figure 1.5: Value of Grants Awarded to Utah Recipients by the National Institutes of Health, FY 1997–2017



Note: Federal fiscal year 2017 began October 1, 2016 and ended September 30, 2017. Amounts do not include subprojects conducted in Utah under parent grants in other states, less than 10 percent of the funding shown for all years. Dollars are adjusted for inflation by the Bureau of Labor Statistics Consumer Price Index (CPI) for urban areas in the West size class B/C from their fiscal year CPI to the 2017 calendar year CPI.

Source: USAspending.org by the U.S. Department of the Treasury.

Figure 1.6: Utah Employment in Life Sciences and Selected Industries, 2017



Note: Employment includes full-time and part-time jobs, both private and public. Selected industries are those with Utah employment within 10,000 jobs of life sciences' direct employment.

Source: Bureau of Economic Analysis and Utah Department of Workforce Services.

below), personal services (11.1 percent below), and credit intermediation (12.7 percent above).

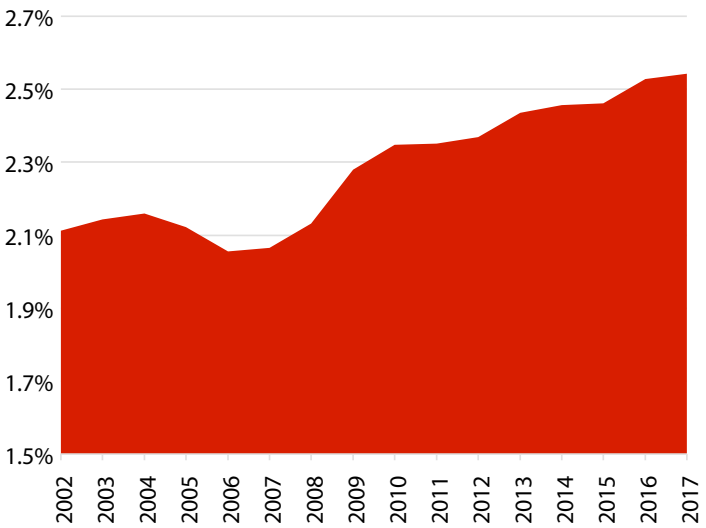
Employment in Utah's life sciences industry grew markedly from 2002 to 2017.[8] For the first five years of the period, 2002 to 2007, the number of life sciences company employees increased 13.9 percent. From 2007 to 2012, a period that began with a severe recession, industry employment rose slightly faster, for a 14.5 percent gain. During the last five years of the period, 2012 to 2017, employee job growth was a notable 25.4 percent as the state's recovery progressed.

A nationwide study of biopharmaceutical and medical device employment observed 26.2 percent job growth in Utah from 2012 to 2016, exceeding the 21.9 percent growth for the state's life sciences industry as a whole during that period. Utah's growth in biopharmaceutical and medical device employment was above that of every other state from 2012 to 2016. By 2016, Utah was the 13th largest employer in the U.S. in these two life sciences categories, biopharmaceuticals and medical devices.[9]

In terms of job creation, Utah's life sciences industry has grown faster than the rest of the state's economy. The industry made up a larger share of Utah's employment in 2017 than it did 10 or 15 years earlier (Figure 1.7). In 2002, life sciences companies provided 2.1 percent of all jobs in the state. Industry employment rose to 2.5 percent in 2017.

From 2002 to 2017, annual growth in the number of Utah employees in the life sciences industry exceeded employee job growth in other industries in 11 of 17 years (Figure 1.8). The average annual growth rate during that period was 3.3 percent in the life sciences industry, compared to 2.1 percent in all other industries in Utah. Job growth during that period was also more consistent in the life sciences industry than in other industries. Growth for life sciences companies stayed between 1.5 and 6.4 percent, while non-life sciences growth ranged from –4.0 to 7.1 percent. Standard deviation is a statistic that summarizes variation within a set of numbers. Higher values indicates more volatility. From 2002 to 2017, standard deviation for employee job growth was 1.4 percent in the life sciences industry, less than half of the 3.0 percent in all other Utah industries. The life sciences industry's relatively rapid and steady growth is favorable for investors, employees, government, and other stakeholders.

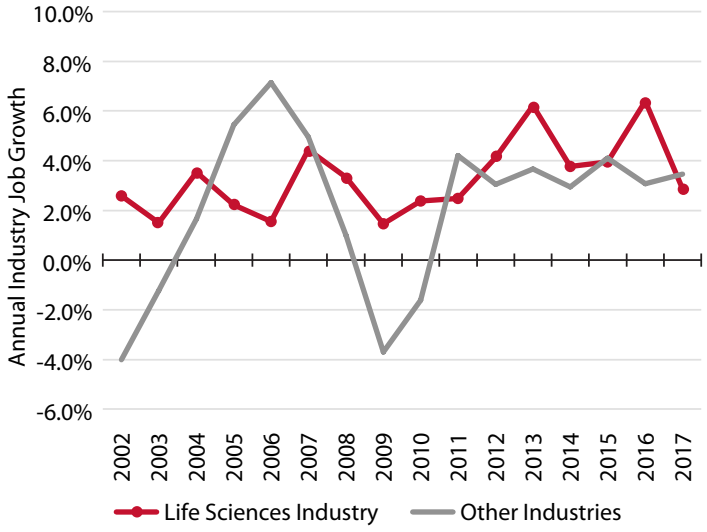
Figure 1.7: Life Sciences Industry Share of Total Utah Employment, 2002–2017



Notes: Percentages are calculated from annual averages of monthly employment data for the life sciences industry and all other industries in Utah, excluding proprietors. Preliminary 2017 employment is based on the first nine months. Historical data follows a legacy life sciences industry definition that differs somewhat from the definition used for 2017 in other sections of this report.

Source: Utah Department of Workforce Services.

Figure 1.8: Utah Life Sciences Industry Annual Employment Growth, 2002–2017



Notes: Percentages for the life sciences industry and the rest of the Utah economy are calculated from annual averages of monthly employment data, excluding proprietors. Preliminary 2017 employment is based on the first nine months. Historical data follows a legacy life sciences industry definition that differs somewhat from the definition used for 2017 in other sections of this report.

Source: Utah Department of Workforce Services.

Section 2. Economic and Fiscal Impacts

Utah's life sciences industry affects the other industries in the state. To this point, we have focused on economic activity within the life sciences industry. Now we will add economic activity it supports in other industries, informed by the counterfactual, "What would Utah's economy look like without its life sciences industry?" We will estimate its total economic impacts in 2017, which includes direct, indirect, and induced effects. We also estimate associated fiscal impacts.

Since we are evaluating the contributions of the industry as a whole, all life sciences activity can be considered an economic impact in one of two ways. First, out-of-state sales bring outside money into Utah's economy. Second, in-state sales are a direct substitute for Utah buyers of life sciences goods and services who would otherwise purchase them from outside the state. Therefore, in-state sales prevent a loss of resources from the state's economy. For these reasons, the life sciences industry's economic impact is approximately equal to its economic contribution in Utah. See Section 3.4 under Research Methods for more information.

2.1 Total Economic Impacts

Economic impact results include direct economic activity described in Section 1, as well as indirect and induced activity generated from purchases by life sciences companies and workers. Spending by life sciences companies on both purchases and employee personal income sustained companies and workers throughout Utah's economy. Indirect economic activity results from spending by the in-state companies from whom life sciences companies purchase goods and services. Induced economic activity results from the personal spending by workers at life sciences companies and at other companies that help provide goods and services to life sciences companies. See Section 3.5 under Research Methods for more information.

In 2017, economic impacts in Utah from life sciences companies were 130,439 jobs, $7.6 billion in employee personal income (including benefits), and $13.0 billion in GDP (Table 2.1). Jobs include employees at companies, as well as self-employed workers. These total direct, indirect, and induced estimates equaled 6.7 percent of Utah employment, 5.9 percent of its personal income, and 7.9 percent of its GDP in 2017. For example, 5.9 percent of all personal income in Utah came either from life sciences companies or from companies in other industries that were supported by purchases by life sciences companies and workers.

2.2 Indirect and Induced Impacts

We have seen that the economic impact of Utah's life sciences industry extends beyond the industry itself. Besides its direct economic activity, the life sciences industry supported indirect and induced activity outside the life sciences industry amounting to 87,608 jobs providing $4.3 billion in personal income, and $7.7 billion in GDP. We will explore indirect and induced activity by industry for two of the three measures: employment and GDP.

The industries with the most indirect and induced employment from the life sciences industry in 2017 were retail trade and construction, which combined for over one-fourth of total indirect and induced jobs (Figure 2.1).[10] The life sciences industry supported 12,124 retail jobs and 11,331 construction jobs in Utah. Four other industries gained more than 7,000 Utah jobs each in 2017 because of the life sciences industry, the largest of which was business services, which includes management and administration. The remaining nine industries collectively received 36.9 percent of the indirect and induced employment effects.

Indirect and induced GDP is another measure of economic impacts outside the life sciences industry (Figure 2.2). The real estate industry, which includes rental and leasing, had the highest concentration of indirect and induced GDP with just over $1.0 billion, followed closely by construction. The life sciences industry supported $0.8 billion in retail trade GDP, which includes companies selling to final consumers (not wholesalers). With another $0.6 billion each from the professional services, business services, and manufacturing industries, these six industries accounted for nearly 60 percent of indirect and induced GDP. The remaining 40.5 percent of indirect and induced GDP from the life sciences industry's economic impact was spread across the other nine industries.

Some industries received larger indirect and induced effects due to life sciences industry activity in terms of GDP than in terms of employment. This is due in part to differences in part-time employment and employee compensation rates across industries. For example, manufacturing had 7.8 percent of indirect and induced GDP, compared to only 4.5 percent of indirect and induced employment. On the other hand, the leisure and hospitality industry received larger indirect and induced effects in terms of employment than in terms of GDP. Leisure and hospitality includes accommodation and food services, as well as arts, entertainment, and recreation. The industry had 8.4 percent of indirect and induced employment, compared to only 3.2 percent of indirect and induced GDP.

Table 2.1: Life Sciences Industry Economic Impacts in Utah, 2017
(Billions of Dollars)

Category	Direct	Indirect & Induced	Total	Share of Utah Economy[1]
Employment[2]	42,831	87,608	130,439	6.7%
Personal Income	$3.3	$4.3	$7.6	5.9%
GDP	$5.3	$7.7	$13.0	7.9%

Note:
1. Shares equal total economic impacts divided by total employment, personal income, and GDP in the state.
2. Employment includes full-time and part-time jobs.

Source: Kem C. Gardner Policy Institute analysis of data from the Utah Department of Workforce Services and Bureau of Economic Analysis using REMI PI+ economic model.

2.3 Fiscal Impacts

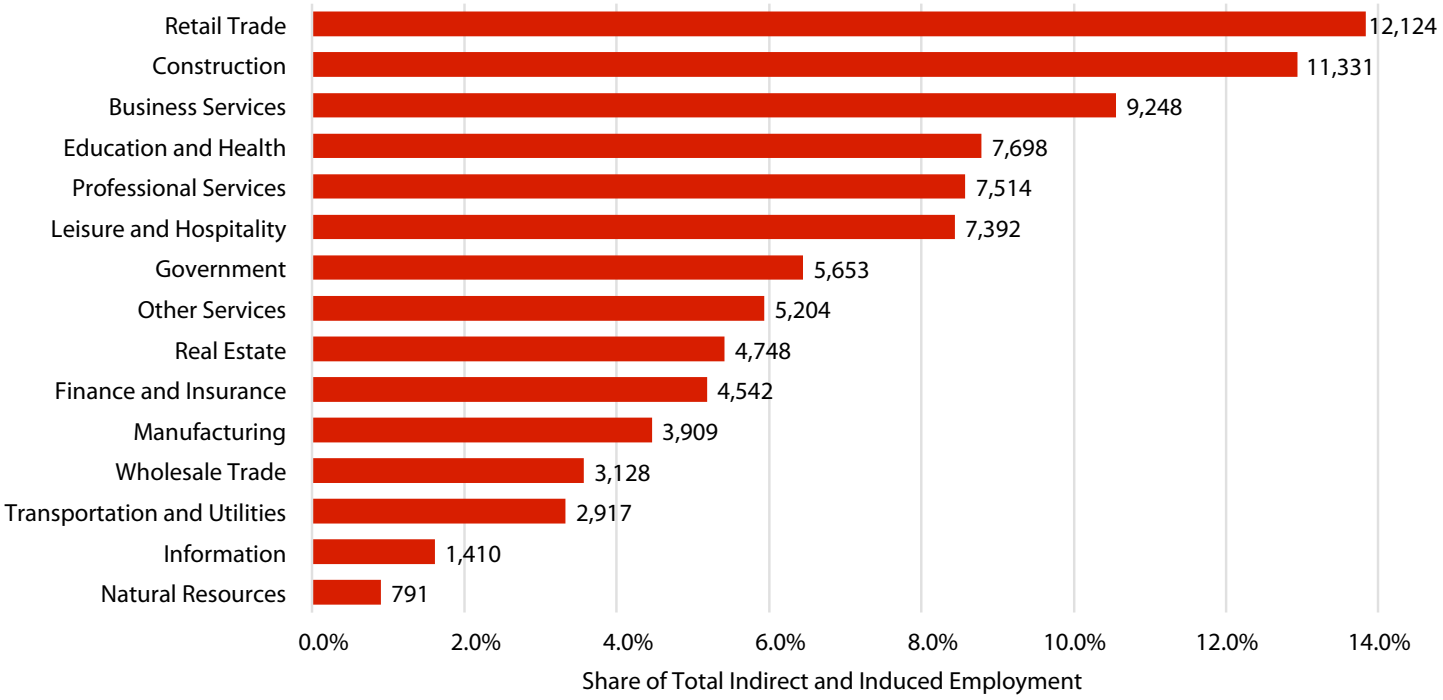
The total economic impacts presented in Section 2.1 resulted in additional tax revenue and government expenditures in Utah. Life sciences companies' operations in 2017 supported a net increase in state and local government revenue of $475.8 million (Table 2.2). This includes $660.3 million in tax revenues paid or indirectly generated, less $184.5 million in additional demand for state, county, and school district expenditures. The analysis does not address revenue and expenses for cities or other entities. See Section 3.6 under Research Methods for more information.

The net fiscal impact resulting from activity in the life sciences industry alone was $224.7 million. That includes taxes paid by workers and companies in the industry. Most fiscal impacts—56.8 percent of revenues and 67.2 percent of government expenditures—came from indirect and induced effects of the life sciences industry. While the life sciences industry's direct fiscal impact is significant, the industry supports larger tax revenue flows and requires more government expenditures through companies and workers that are part of its indirect and induced economic impacts in Utah.

At the state level, most of the $449.9 million in estimated 2017 tax revenue associated with the life sciences industry's economic impact came from sales and personal income taxes (Table 2.3). The state portion of additional sales tax revenue was $219.1 million. Personal income taxes of $200.3 million were paid by employees and proprietors in Utah's life sciences industry and by workers in other industries supported by life sciences company and worker spending. Corporate income taxes paid by life sciences companies and other companies they support were $30.5 million.

Government expenditures help support the population of adults and children living in Utah and working in the life sciences industry or in a job in another industry indirectly supported by the life sciences industry. We estimated the share of state government spending in 2017 that can be attributed to the life sciences industry at $150.2 million. Public and higher education expenditures, nearly half the total, were $72.4 million combined. Non-education expenditures amounted to $77.7 million. Subtracting total state operating expenses from total

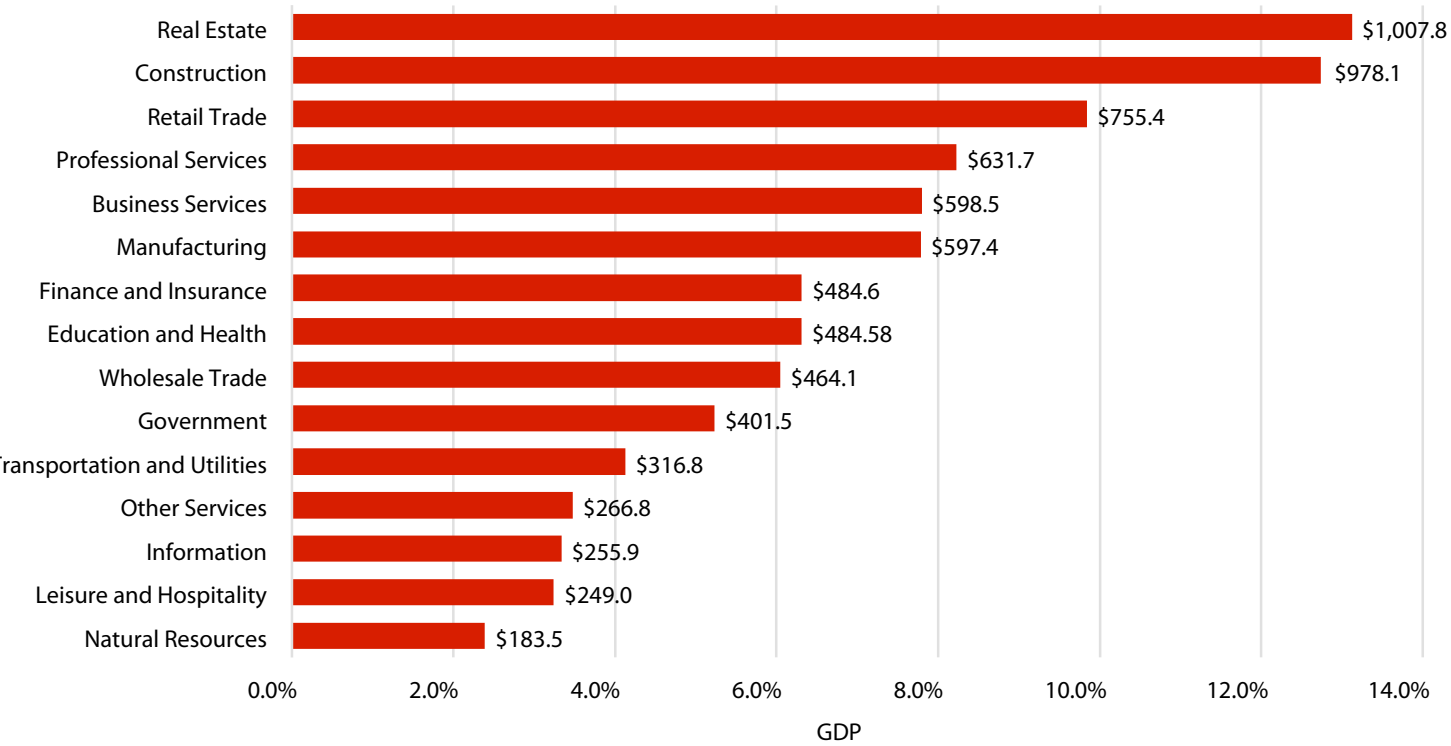
Figure 2.1: Life Sciences Industry Indirect and Induced Employment in Utah by Industry, 2017



Note: Labels indicate the average number of full-time and part-time jobs during the year. This chart includes economic activity outside of Utah's life sciences industry that is part of the industry's economic impact.

Source: Kem C. Gardner Policy Institute analysis of data from the Utah Department of Workforce Services and Bureau of Economic Analysis using REMI PI+ economic model.

Figure 2.2: Life Sciences Industry Indirect and Induced GDP in Utah by Industry, 2017 (Millions of Dollars)



Note: Includes economic activity outside of the life sciences industry that is part of the industry's economic impact.

Source: Kem C. Gardner Policy Institute analysis of data from the Utah Department of Workforce Services and Bureau of Economic Analysis using REMI PI+ economic model.

state revenues yields net state revenue from the life sciences industry of $299.7 million.

We separated total state revenues and expenditures into the portions associated with direct and with indirect and induced economic impacts of the life sciences industry. Direct economic impacts accounted for $148.2 million, which was 49.4 percent of the additional net state government revenue from the life sciences industry in 2017. The industry's indirect and induced effects generated over half of state tax revenues ($252.4 million) and two-thirds of state operating expenditures ($100.8 million).

Turning to local government, the net fiscal impact of Utah's life sciences industry was $176.1 million in 2017 (Table 2.4). That includes an estimated $210.4 million in tax revenues and $34.3 million in operating expenditures for counties and school districts. Most local tax revenues came from the property tax, $179.9 million. The local portion of sales tax collections was $30.5 million. Expenditures for public K–12 programs were $14.7 million. Other county expenditures amounted to $19.6 million.

As with state fiscal impacts, these local revenues and expenditures are associated with direct, indirect, and induced economic impacts of the life sciences industry. Direct economic impacts accounted for $76.5 million, which was 43.4 percent of the additional net local government revenue from the life sciences industry during the year. The industry's indirect and induced effects generated 58.3 percent of local tax revenues and 67.2 percent of local operating expenditures of counties and school districts.

Table 2.2: Utah Life Sciences Industry State and Local Fiscal Impacts, 2017
(Millions of Dollars)

Impact	Direct	Indirect & Induced	Total
Tax Revenues	$285.3	$375.1	$660.3
Government Operating Expenditures	$60.6	$123.9	$184.5
Net State and Local Revenue	**$224.7**	**$251.2**	**$475.8**

Note: Totals may not match exactly due to rounding. These impacts include total revenues and operating expenditures from Tables 2.3 and 2.4.

Source: Kem C. Gardner Policy Institute analysis using the Gardner Policy Institute fiscal model.

Table 2.3: Life Sciences Industry State Fiscal Impacts in Utah, 2017
(Millions of Dollars)

Impact	Direct	Indirect & Induced	Total
State Sales Tax Revenues	$96.3	$122.8	$219.1
Personal Income Tax Revenues	$88.0	$112.3	$200.3
Corporate Income Tax Revenues	$13.2	$17.4	$30.5
Total State Revenues	**$197.5**	**$252.4**	**$449.9**
Non-Education Expenditures	$25.5	$52.2	$77.7
State Public Education Expenditures	$13.2	$27.0	$40.2
Higher Education Expenditures	$10.6	$21.6	$32.2
Total State Operating Expenditures	**$49.3**	**$100.8**	**$150.2**
Net State Revenue	**$148.2**	**$151.6**	**$299.7**

Note: Totals may not match exactly due to rounding.

Source: Kem C. Gardner Policy Institute analysis using the Gardner Policy Institute fiscal model.

Table 2.4: Life Sciences Industry Local Fiscal Impacts in Utah, 2017
(Millions of Dollars)

Impact	Direct	Indirect & Induced	Total
Property Tax Revenues	$74.4	$105.6	$179.9
Local Sales Tax Revenues	$13.4	$17.1	$30.5
Total Local Revenues	**$87.8**	**$122.6**	**$210.4**
Local Non-Education Expenditures	$6.4	$13.2	$19.6
Local Public Education Expenditures	$4.8	$9.9	$14.7
Total Local Operating Expenditures	**$11.3**	**$23.1**	**$34.3**
Net Local Revenue	**$76.5**	**$99.6**	**$176.1**

Note: Totals may not match exactly due to rounding. Local revenues and operating expenditures include counties and school districts. Cities and towns are not included.

Source: Kem C. Gardner Policy Institute analysis using the Gardner Policy Institute fiscal model.

Section 3. Research Methods

This section provides additional insight into how we conducted our analysis. After defining terms used in the report, we offer notes about developing the life sciences industry definition, creating estimates for self-employed workers, determining what portion of economic contributions count as economic impacts, running our economic model, estimating tax revenues and government expenditures, comparing this report to our previous research, and noting economic activity not included in this study.

3.1 Terms

Employment is a measure of the average number of full- and part-time jobs, including those of self-employed workers, held during the year indicated. Jobs are time-bound estimates and cannot be added over time. For example, two jobs held throughout 2017 and two jobs held throughout 2018 would be referred to collectively as two jobs held for 24 months, not four jobs. Employment in this document is by place of work. If a scientist or programmer commutes from Mesquite, Nevada to work in St. George, she will be counted in Utah jobs, even though much of her wages may be spent outside the state. Someone living in Logan who commutes to a life sciences company in Idaho will be counted in Idaho jobs and will not show up in this report.

Compensation is the sum of wage and salary disbursements and supplements to wages and salaries, including, for example, contributions for health insurance policies and retirement accounts. It is recorded by place of work. Compensation does not include income from self-employment, personal investments, or government transfers. Earnings of self-employed life sciences workers are included in earnings and personal income as proprietors' income.

Earnings are the sum of wage and salary disbursements, supplements to wages and salaries, and proprietors' income. Earnings are reported by place of work.

Personal income includes earnings and all other income: wage and salary disbursements, supplements to wages and salaries, proprietors' income, rent, dividends, interest, and net transfer receipts. Transfer receipts include government transfers, such as Social Security payments to individuals, as well as certain payments from businesses to individuals and nonprofit institutions that serve individuals. Personal income is measured by place of residence rather than place of work, and as such includes an adjustment for cross-regional commuting.

Gross domestic product (GDP) is a measure of total economic activity in a region. GDP avoids double counting intermediate sales and captures only the "value added" to final products by capital and labor in a region. Value added is the sum of total income and indirect business taxes; alternatively, it can be thought of as total output or sales, less the value of intermediate inputs purchased to produce that output. Value added is equivalent to the GDP measure. For this study, we estimate GDP for the state of Utah.

Output equals the total sales value of products workers create. Output is not adjusted for the value of inputs coming into a company, so there is double counting. For example, a medical device manufacturer buys parts and supplies, creates a device, and sells it to a wholesale company, which resells the device to a healthcare provider. Output counts all three sales—to the manufacturer, wholesaler, and provider—not just the increments of value created at each stage of production and distribution.

Proprietor refers to a person who works at a company (proprietorship) that they own either alone or as a partner. For example, a mechanical engineer at a medical device company might work part-time as a business partner with a colleague devoted full-time to their proprietorship. They may contract rather than hire to fill needs that arise beyond what they do themselves. Proprietorships that hire employees, workers who are not also owners, are classified as companies with employees in Bureau of Economic Analysis, Bureau of Labor Statistics, and Utah Department of Workforce Services data. Their owners are no longer included under proprietor jobs and income. Rather, their jobs and compensation are reported along with the employees at their companies.

An industry is a category for grouping similar types of companies in the private sector. For uniformity, government agencies and researchers in the U.S. follow the North American Industry Classification System (NAICS), which is periodically updated as new types of companies become common enough to warrant a new category. Industries can be as specific as "research and development in nanotechnology" (NAICS 541713) or as broad as "professional, scientific, and technical services" (NAICS 54). Industries may also be a conglomerate of disparate narrowly defined industries, such as ours for the life sciences industry. The life sciences industry can also be considered an economic "sector," which is a broader term. For example, the service sector includes all industries that primarily provide services, rather than tangible goods, and the defense sector includes private contractors that are included in a NAICS industry along with military installations and their federal military and civilian workers.

3.2 Defining the Industry

To provide the Gardner Policy Institute with a definition of the Utah life sciences industry, GOED consulted publications and staff at BioUtah, Economic Development Corporation of Utah, Biotechnology Innovation Organization, California Life Sciences Association, Indiana Business Research Center, Massachusetts Biotechnology Council, BioOhio, and North Carolina Biotechnology Center. These organizations' industry definitions include similar core NAICS industries for manufacturing medical devices and equipment, developing and commercializing drugs and therapies, and distributing these products. Organizations' definitions vary with regards to whether to include laboratory instruments and dental, ophthalmic, agricultural, chemical, and environmental products. For the definition used in this study, GOED included dental and ophthalmic goods and excluded agricultural, chemical, and environmental products.

Results in this document are conservative because we were unable to include life sciences companies with fewer than 50 employees in three "partial" NAICS industries. These are industries from which GOED selected specific life sciences companies, in accordance with our definition of Utah's life sciences industry, rather than include 100 percent of establishments. Additional input from GOED and the life sciences industry would be needed to individually determine which companies should be included from a list of a few hundred smaller companies in the partial NAICS industries. However, for this study, we determined which companies fit the Utah life sciences definition out of all those with at least 50 employees. Large companies account for most economic activity in their industries. We included companies of all sizes in the 15 "complete" NAICS industries in the life sciences sector. Further collaboration to identify small companies would give us a more complete picture of economic impacts.

This analysis addresses companies in the private sector and did not include public sector activity. For example, we discussed academic research in the life sciences, which is largely publicly funded, in Section 1.6, but we were unable to integrate it into our analysis of the life sciences industry. We also did not include as direct economic activity any government jobs and spending related to the life sciences industry, such as those from federal or state health agencies.

3.3 Self-Employed Workers

The number of self-employed workers in Utah's life sciences industry is not available from the Utah Department of Workforce Services (DWS) because its data comes from surveys answered only by companies with employees. The Bureau of Economic Analysis (BEA) includes self-employed workers, referred to as proprietors. BEA provides Utah proprietor employment for large industry groupings through 2016. DWS provides industry and company granularity for Utah in 2017 that matches GOED's definition of the industry. For this reason, to estimate the number of proprietors, we multiplied DWS employment in each specific NAICS industry by the 2016 ratio of proprietors to total employment in the corresponding larger NAICS industry grouping from BEA. Our analysis suggested 2016 was a better predictor of 2017 employment than an average of multiple prior years.

To estimate proprietors' income, we determined average proprietors' income for corresponding BEA industry groupings in 2016. We multiplied our 2017 proprietor employment estimates by average proprietors' income in 2016, adjusted for inflation to 2017 dollars. This method understates proprietor's income by any 2017 earnings growth above inflation.

We used REMI to estimate non-payroll expenditures by proprietors, just as we did for companies with employees.

3.4 Contribution versus Impact

Economic impact is a concept that focuses on jobs and spending arising directly and indirectly from new money entering a state. Exports from a state are one way to attract outside dollars. For example, Utah life sciences companies sell drugs and medical devices to pharmacies and healthcare providers in other states and countries. The direct jobs and spending that produce goods and services sold out of state generate economic impacts. In studies such as this encompassing an entire industry, the direct, indirect, and induced economic activity that would be lost to a state in the absence of the industry can also be considered an economic impact. We can refer to this as import substitution, in the sense of imports to a state, whether from abroad or another state. Whereas the life sciences industry's out-of-state sales (exports) bring in additional resources to grow a state's economy, in-state sales prevent an outflow of resources to purchase from companies outside the state (import substitution).

Economic contribution is a broader concept than economic impact. Economic contributions capture the total jobs and spending that are part of an industry's footprint in a state's economy, including direct, indirect, and induced effects. An economic contribution analysis may be appropriate even for direct economic activity that does not constitute an economic impact, for example because it does not have a bearing on the economic resources in a state, but merely circulates in-state money that is not at risk of being spent out of state.

The choice to count import substitution as an economic impact, not just an economic contribution, merits further discussion. It rests on the use of the counterfactual, "What would Utah's economy look like if it had no life sciences industry?" With this framing question, the criterion for determining what economic activity in an industry should be counted as an economic impact is whether economic activity would be lost if the

industry were not present in the state. This criterion qualifies exports as economic impacts and also prompts us to consider what Utah companies and individuals would buy from other states if Utah's life sciences industry were not supplying these goods and services. The life sciences industry's in-state sales keep dollars in Utah that otherwise would leave the state to pay for imports from other states and countries.[11] In this sense, all production by the life sciences industry is an economic impact, either through this "import substitution" logic or the previous "export" rationale, and economic impacts are equal to the full amount of the economic contributions.

3.5 Economic Model

Our direct estimates for sales, GDP, non-payroll spending, compensation, and proprietors' income are based on these five measures' industry-specific relationships with employment and wages.

To estimate the indirect and induced effects resulting from direct economic activity in the life sciences industry, we customized an economic impact model for Utah. REMI PI+ version 2.1, developed by Regional Economic Models, Inc., is a dynamic, multi-regional simulation model that estimates economic, population, and labor market impacts of specific economic or policy changes. The model incorporates input-output relationships, general equilibrium effects, econometric relationships, and economic geography effects.

The 70-sector model generally aggregates to two-digit or three-digit NAICS sectors, rather than fully incorporating the six-digit specificity of our data from DWS. We adjusted for the difference in wages between the aggregated NAICS sectors in REMI and our six-digit NAICS industries to regain precision lost by the model's 70-sector limitation.

We used REMI to estimate the amount of Utah life sciences output sold in state, out of state, and outside the country. REMI reports 2017 sales by location for large industries, based on data from the Bureau of Economic Analysis. The 31 NAICS industries that make up Utah's life sciences sector fall under seven of REMI's large industries. For example, "pharmaceutical preparation manufacturing" falls under "chemical manufacturing." We assumed life sciences companies in Utah sold similar percentages of their 2017 output in state, out of state, and abroad, compared to averages for all companies in the large industries where they belong.

3.6 Fiscal Impact Model

This overview of the Gardner Policy Institute fiscal model supplements the description in Section 2.3. We use the fiscal model to estimate new state and local revenues and expenditures. Inputs to the fiscal model are employment, personal income, output, and population results produced by the REMI PI+ model based on life sciences industry operations in Utah in 2017.

Tax revenue estimates are based on past Utah effective tax rates calculated as ratios of personal income, industry output, and employment to historical tax payments. All government expenditures reported in this memo are estimates based on Utah historical averages for spending per capita, adjusted to 2017 dollars and scaled to match the sector-level spending, compensation rates, and other particulars of Utah's life sciences industry in 2017.

3.7 Previous Research

The Gardner Policy Institute provided GOED and BioUtah with an analysis of the economic contribution of Utah's life sciences industry in 2016.[12] The 2017 results in this report are not comparable to those results for two reasons. First, the 2016 analysis did not include proprietors. This would have increased economic contributions by roughly 23 percent in terms of employment and roughly 8 percent in terms of personal income.

Second, we made a cautious economic modelling assumption for the 2016 economic contributions that after further research proved to be unwarranted. We had calibrated the REMI economic model to treat companies in the life sciences industry as individual firms rather than collectively as an industry. Instead, our framework for 2017 aligns with the concept of what would be lost if the entire industry were removed from the economy, which is more than if each company were removed separately. Corresponding adaptation of the REMI model for 2016, without adding proprietors or making other changes, would have increased economic contributions by 48 percent in terms of employment and by 41 percent in terms of GDP.

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Mark Knold, Senior Economist, Utah Department of Workforce Services

Andrew Laver, Founder and Managing Director, APL Capital Advisors, life sciences industry consultant for BioUtah

Kelly Slone, President and CEO, BioUtah

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Endnotes

1 See, for example, "Life Science," Utah Governor's Office of Economic Development, accessed July 25, 2018, https://business.utah.gov/industries/life-science/; "Utah Life Sciences Industry Report," BioUtah, 2018, accessed July 25, 2018, http://www.bioutah.org/blog/bioutah-life-science-blog-121/post/bioutah-releases-2018-utah-life-sciences-report-10730; and "Bioscience Innovation in the States: Legislation and Job Creation through Public-Private Partnerships," Biotechnology Innovation Organization, 2017, accessed July 25, 2018, https://www.bio.org/press-release/bio-releases-bioscience-economic-development-guide.

2 In 2016, the Salt Lake City MSA's medical devices and equipment employment of 8,948 jobs ranked sixth among 383 MSAs in the U.S., after New York and Chicago and before San Francisco and San Diego. Utah's only other top-20 ranking, Salt Lake City's research, testing, and medical laboratories industry group, was 18th, after the Kansas City and Phoenix-Mesa MSAs and before Atlanta and St. Louis. Utah's other four MSAs were not ranked in 2016. See "Investment, Innovation, and Job Creation in a Growing U.S. Bioscience Industry," TEConomy and Biotechnology Innovation Organization, 2018, accessed July 25, 2018, https://www.bio.org/sites/default/files/TEConomy_BIO_2018_Report.pdf.

3 Statewide average wages and salaries of $45,696 is preliminary from the fourth quarter of 2016 through the third quarter of 2017, the most recent four quarters of employment, wage, and salary data publicly available from DWS. Wages and salaries from 2016 Q4 were adjusted for inflation to 2017 Q4 dollars based on the Bureau of Labor Statistics' West B/C Consumer Price Index. Wage and salary data does not include self-employed workers.

4 The $59,070 average in 2017 statewide compensation is calculated as $89.5 billion in aggregate Utah compensation from the Bureau of Economic Analysis divided by statewide employment from DWS of 1,463,786 jobs. DWS employment is preliminary, calculated as average monthly employment during the first three quarters of 2017, seasonally adjusted by the Gardner Policy Institute.

5 DWS data includes Utah addresses for life sciences companies with employees. We map workplace locations for 36,050 life sciences employees at the county level. We do not have similar workplace locations for the proprietorships of our 6,781 self-employed workers.

6 The omission from our economic impact analysis of NIH grants and other funding sources for applied life sciences research represents a future research opportunity and makes results in this report conservative. A more comprehensive economic study would include other sources of academic and public sector funding for life sciences research too, such as state and donor funding. Higher education institutions in Utah could be asked to respond to information requests about their life sciences-related personnel and spending. Criteria could be developed and applied to parse NIH funding for life sciences research projects and programs from NIH funding for institutions, basic science research, education, and other causes.

7 The 69 REMI industries used for the analysis in Section 1.7 comprise 66 three-digit NAICS industries, plus three government categories—state and local, federal civilian, and federal military.

8 Historical data in Figures 1.7 and 1.8 are based on a life sciences industry definition that includes all Utah companies that have employees in 19 NAICS industries. The industry definition used for 2017 in the rest of this report treats 16 of those NAICS industries the same as the historical data, selects individual life sciences companies for inclusion from the three remaining NAICS industries, adds in several life sciences companies outside the 19 NAICS industries, and estimates the number of self-employed workers who are not included in historical data. Section 1.9 trends in the life

sciences industry and comparisons to other industries are relevant because the definitions mostly overlap. For example, 2017 employment from this historical data was 86.6 percent of 2017 employment under the more precise definition selected for this report.

9 Besides focusing on part of the life sciences industry, the study of biopharmaceutical and medical device employment from 2012 to 2016 did not include self-employed workers. For these reasons, its 19,353 Utah jobs for 2016 are much lower than the 42,831 jobs we report for the following year. See "California Life Sciences Industry Report," California Life Sciences Association, 2018, accessed July 25, 2018, http://info.califesciences.org/2018report.

10 We grouped standard NAICS industries to create the simplified industries in Figures 2.1 and 2.2. The real estate industry includes rental and leasing. The professional and technical services industry includes scientific services. The business services industry includes administrative and waste management services, as well as management of companies and enterprises. The education and health industry does not include public education but does include social services. The transportation and utilities industry includes warehousing. The other services industry does not include public administration. The natural resources industry includes mining, as well as forestry, fishing, and related activities.

11 This import substitution logic would generally not apply to an analysis of the economic impact to a state of a single company with many in-state competitors, since in-state buyers could readily find alternatives without buying from outside the state.

12 "The Economic Contribution of Utah's Life Sciences Industry," Kem C. Gardner Policy Institute, February 2018, accessed July 25, 2018, http://gardner.utah.edu/wp-content/uploads/LifeSciencesFactSheet.pdf and "Utah Life Sciences Industry Report," BioUtah, 2018, accessed July 25, 2018, http://www.bioutah.org/blog/bioutah-life-science-blog-121/post/bioutah-releases-2018-utah-life-sciences-report-10730.

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