

University of Colorado Boulder Venture Partners at CU Boulder

Economic Impact of Commercialization on the State and National Economy

Conducted by:

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EXECUTIVE SUMMARY

Research universities provide both foundational basic research and the potential for translating research into commercialized products. Sometimes new technologies lead to the formation of new companies. Venture Partners at CU Boulder translates the university's research innovations into new commercial ventures, including management of intellectual property created on the Boulder, Colorado Springs, and Denver campuses.

Venture Partners at CU Boulder provided data on 367 licensee records representing 315 unique agreements between fiscal year 2017-18 through fiscal year 2021-22. A total of 281 agreements noted paid license revenue to CU, 46 recorded follow-on sales, and 57 were CU startups that recorded a capital round. Awards spanned 36 states and 26 countries. Domestic agreements totaled 263, or 83.5% of the agreements, 91.4% of the license revenue to CU, 99.2% of the inferred product sales, and 99.9% of the start-up capital raised.

From fiscal year 2018 through fiscal year 2022, Venture Partners at CU Boulder recorded:

- \$20.1 million in licensing revenue to the University of Colorado Boulder
- \$1.1 billion in inferred sales by licensees related to CU technology
- \$3.0 billion in capital funding for startup companies commercializing CU Boulder technology
- \$45.4 million in commercialization-specific grants to CU Boulder.

The economic contribution of commercialization activities identifies upstream and downstream economic activity, spanning research and development at the university to commercialization by private enterprises.¹ Removing overlapping funding from follow-on sales and license revenue, and from commercialization grants and license revenue, results in mutually exclusive Venture Partners-related economic activity. The estimated \$4 billion in domestic Venture Partners-related activity resulted in an economic impact on the national economy totaling \$8 billion from fiscal year 2018 through fiscal year 2022. This level of activity supported an estimated 39,000 job years over the five-year period (or an average of 7,8000 per year), paying an estimated \$3.1 billion in labor income. Value added, which removes the estimate of intermediate inputs, totaled \$4.7 billion.

TABLE 1: ECONOMIC IMPACT OF VENTURE PARTNERS-RELATED ACTIVITY ON THE U.S. ECONOMY, FY2018-22

Impact Type	Employment Job Years	Employment Jobs/Year	Labor Income (Billions)	Value Added (Billions)	Output (Billions)
Direct Effect	17,937	3,587	\$1.7	\$2.4	\$4.0
Indirect Effect	8,099	1,620	\$0.6	\$0.9	\$1.7
Induced Effect	13,101	2,620	\$0.7	\$1.4	\$2.3
Total Effect	39,137	7,827	\$3.1	\$4.7	\$8.0

Much of the activity was recorded in Colorado, with \$2.7 billion in tech transfer-related activity, leading to an economic impact of \$5.0 billion on the state's economy.

¹ Given the analysis of on-campus activity and external private-sector sales, the economic impact of technology transfer activities should not be combined or compared with overall University economic contributions.

PROJECT PURPOSE

Research universities provide both foundational basic research and the potential for translation that becomes enabling technology in commercialized products. Sometimes the new technologies lead to the formation of new companies. The purpose of this project was to quantify the economic impacts of commercialization from Venture Partners at CU Boulder (Venture Partners, formerly known as the technology transfer office) on the state and national economy.

DEFINITIONS

Gross Domestic Product (GDP): A measure of economic activity, GDP is the total value added by resident producers of final goods and services.

Gross Output (Output): The total value of production is gross output. Unlike GDP, gross output includes intermediate goods and services.

Value Added: The contribution of an industry or region to total GDP, value added equals gross output, net of intermediate input costs.

Labor Income: Total compensation of employees (wages and benefits) and sole proprietors (profits).

Employment Job Year: Equates to one job in one year.

Direct Impact: Initial economic activity (e.g., sales, expenditures, employment, production, etc.) by a company or industry.

Indirect Impact: The upstream (backward) economic activity impacted by purchases along a company or industry supply chain.

Induced Impact: Economic activity derived from workers spending their earnings on goods and services in the economy.

GENERAL METHODOLOGY

The Business Research Division conducted a study of the economic impacts of 315 unique tech transfer agreements from the University of Colorado Boulder from fiscal year 2018 through fiscal year 2022.

Per the terms of the agreements, data about licensed technology are remitted to Venture Partners. No companies were contacted for this study. Venture Partners cleaned the data and provided the BRD with summary statistics by agreement. The BRD used an economic input-output model, IMPLAN, to estimate the multiplier effect for Venture Partners agreements, imputed sales, and capital funding. Results are disseminated as direct, indirect (supply chain), and induced (household) impacts.

License revenue, follow-on sales, and capital funding activities were classified using the six-digit North American Industry Classification System (NAICS). Licensing revenue with the University of Colorado

was classified as Professional, Scientific, and Technical Services (541) for the Scientific Research and Development Services. Follow-on sales and capital funding were classified based on the NAICS corresponding to each licensee. Follow-on sales and funding were classified into eight industries based on their operating function:

- 31-33 Manufacturing
- 42 Wholesale Trade
- 51 Information
- 54 Professional, Scientific, and Technical Services
- 56 Administrative and Support and Waste Management and Remediation Services
- 61 Educational Services
- 62 Health Care and Social Assistance
- 81 Other Services (except Public Administration)

IMPLAN multipliers were obtained from MIG by matching the NAICS to IMPLAN's corresponding unaggregated sectors. The BRD converted the NAICS codes to the 546-sector IMPLAN input-output model. Venture Partners license revenue to the University of Colorado was modeled in the Professional, Scientific, and Technical Services sector. While the data span five fiscal years (2018-2022), license revenue, inferred sales, and capital funding were not reported by year. All activity was modeled in 2019 dollars and presented in 2022 dollars, providing a conservative estimate of impacts.

Economic impacts are associated with license agreements, both when the technology is licensed and when the company records follow-on sales. This study quantifies sales activity directly linked to University of Colorado license agreements and estimates the economic multiplier effect of licenses and follow-on sales.

Overview of Economic Impact Analysis

This study estimates the economic impact using the IMPLAN input-output model. Results are disseminated in terms of direct, indirect, and induced impacts on employment, labor income, value added, and output.

Economic benefits refer to dollars generated and distributed throughout the economy. The sources of impacts that sum to economic benefits include capital expenditures and operating expenditures, including the off-site spending by employees and the spending on goods and services within the supply chain.

The multiplier effect of spending within the supply chain, or the indirect impact, estimates the indirect employment and earnings generated in the study area due to the interindustry relationships between the facility and other industries. As an example, consider the University of Colorado Boulder operating the research university in Boulder, Colorado. The university employs research faculty, teaching faculty, support staff, and students for operations. In addition, the university spends on goods and services to support its operations, leading to auxiliary jobs in the community in manufacturing, transportation, wholesale, retail, and so on—the **indirect impact**. Furthermore, employees spend earnings on goods and

services in the community, leading to jobs in retail, accounting, entertainment, and so on—the **induced impact**.

Conceptually, the multiplier effect quantifies the economic ripple effect of economic activity. This ripple effect can be positive or negative depending on if a company or industry is expanding or contracting. Multipliers are static and do not account for disruptive shifts in infrastructure without specifically addressing infrastructure changes. This model uses IMPLAN multipliers for the United States and Colorado using IMPLAN and the most current available multipliers (2020).

VENTURE PARTNERS DATA

Venture Partners recorded 315 unique tech transfer agreements from fiscal year 2018 through fiscal year 2022. Of the 315 unique agreements between fiscal year 2018 and fiscal year 2022, a total of 281 paid license revenue to CU, 46 recorded follow-on sales, and 71 were CU startups that recorded a capital round.

Awards spanned 36 states and 26 countries. Information about the 272 unique agreements was spread across 367 records delineated by revenue type (e.g., royalty earned, royalty minimum, option fee, etc.). Domestic agreements totaled 263, or 83.5% of the agreements, 91.4% of the license revenue to CU, 99.2% of the inferred product sales, and 99.9% of the start-up capital raised.

License Revenue

Venture Partners collects data on licensing agreements per the agreement terms (see Appendix 2 for provided fields). From fiscal year 2018 to fiscal year 2022, a total of 315 agreements yielded \$20.1 million in licensing revenue to the University of Colorado Boulder. The largest 5 agreements represented 63% of license revenue, and the top 20 represented 77% of the revenue (295 agreements represented 23% of licensing revenue). Colorado licensees represented 12.7% of the license revenue and 30.2% of agreements.

TABLE 2: LICENSE REVENUE TO CU

License Revenue	Number of Companies	Percent of Companies
0	34	11%
\$1-\$25,000	204	65%
\$25,000-\$50,000	34	11%
\$50,000-\$100,000	23	7%
>\$100,000	20	6%
Average	\$63,847	-
Median	\$10,000	-

Inferred Sales

Inferred sales volumes based on the royalty agreements indicate company sales of \$1.1 billion, with average sales of \$23 million and median sales of \$264,000 from 46 companies spanning fiscal year 2018 and fiscal year 2022.

TABLE 3: INFERRED LICENSEE SALES

Inferred Sales	Number of Companies
\$1-\$10,000	2
\$10,000-\$50,000	4
\$50,000-\$100,000	5
\$100,000-\$1M	24
\$1M-\$10M	8
>\$10M	3

Capital Funding

University of Colorado Boulder research leads to the spawning of new businesses. The formation of businesses typically includes a license agreement for the legal use of the intellectual property by the startup company. There were 71 agreements associated with CU startups, of which 57 agreements were associated with raised outside capital totaling \$2.96 billion between fiscal year 2018 and fiscal year 2022. Nearly 30% raised up to \$1 million, one-third raised between \$1 million and \$5 million, and 37% raised over \$5 million (including 8 that raised over \$25 million). Additionally, exits via public market or acquisition for three companies totaled \$3.7 billion between FY2018 and FY2022. The economic contribution of these exists is not quantified in this report.

TABLE 4: CU STARTUP CAPITAL RAISED

Capital Raised	Number of Companies
0	14
\$1<\$1M	17
\$1M<\$5M	19
\$5M<\$25M	13
\$25M+	8
Average	\$41,728,648
Median	\$1,860,000

Commercialization-Specific Grants to CU Boulder

Venture Partners supports commercialization grants on the University of Colorado Boulder campus. From fiscal year 2018 through fiscal year 2022, commercialization grants totaled \$45.4 million. These grants take the form of:

- Advanced Industries Accelerator POC Grants
- ARPA-E Grants
- Startup-Funded Research

Advanced Industries Accelerator Proof of Concept Grants include funding from the Colorado Office of Economic Development and International Trade with 25% matching funds from the University of Colorado Boulder. This funding exceeded \$5.6 million from FY2018-FY2022, an average of over \$1.1 million per year.

Advanced Research Projects Agency-Energy (ARPA-E) is a program of the U.S. Department of Energy. ARPA-E “advances high-potential, high-impact energy technologies that are too early for private-sector investment. ARPA-E awardees are unique because they are developing entirely new ways to generate, store, and use energy.”²

Venture Partners reported \$18.3 million in ARPA-E awards over the five fiscal years ending in 2022, averaging \$3.7 million per year, with a maximum of \$6.5 million in FY2018 and a minimum of \$2 million in FY2020. This funding is used for early-stage research and development at the University of Colorado.

Startup-Funded Research is research in a CU Boulder lab, where the research is funded by a startup company founded on intellectual property obtained from Venture Partners.

² <https://arpa-e.energy.gov/?q=arpa-e-site-page/about>, retrieved October 8, 2022.

FIGURE 1: ADVANCED INDUSTRIES ACCELERATOR PROOF OF CONCEPT GRANTS, FY2018-FY2022

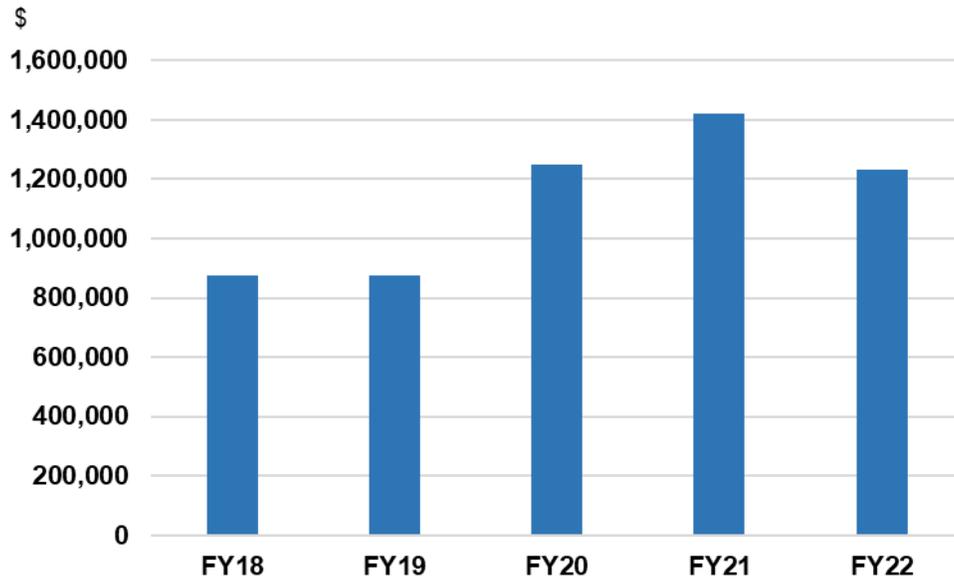


FIGURE 2: ARPA-E SUPPLEMENT, FY2018-FY2022

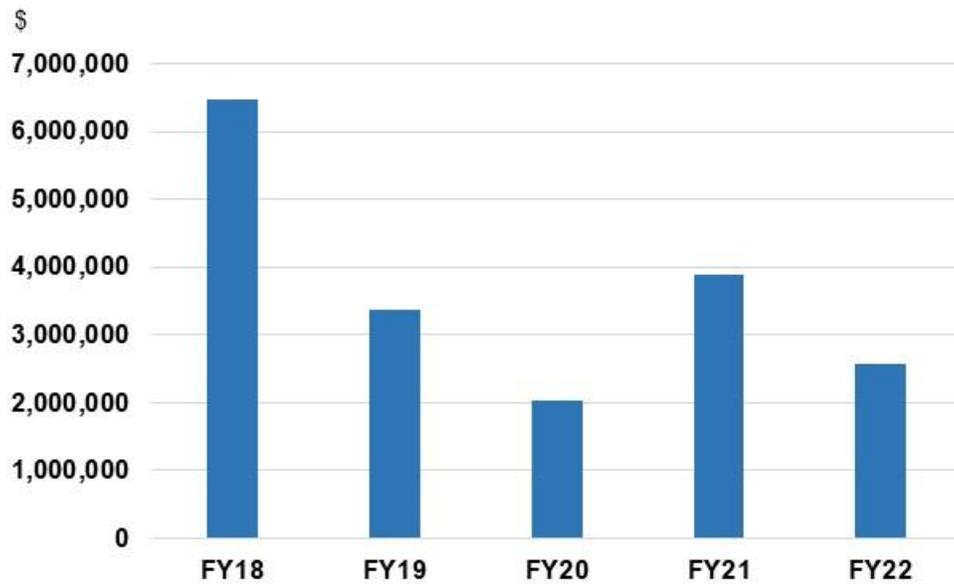
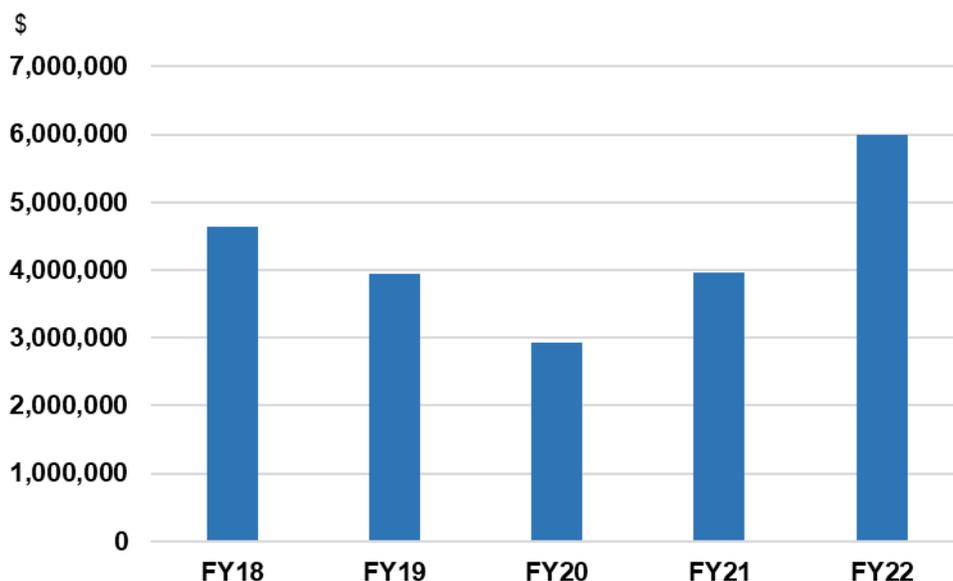


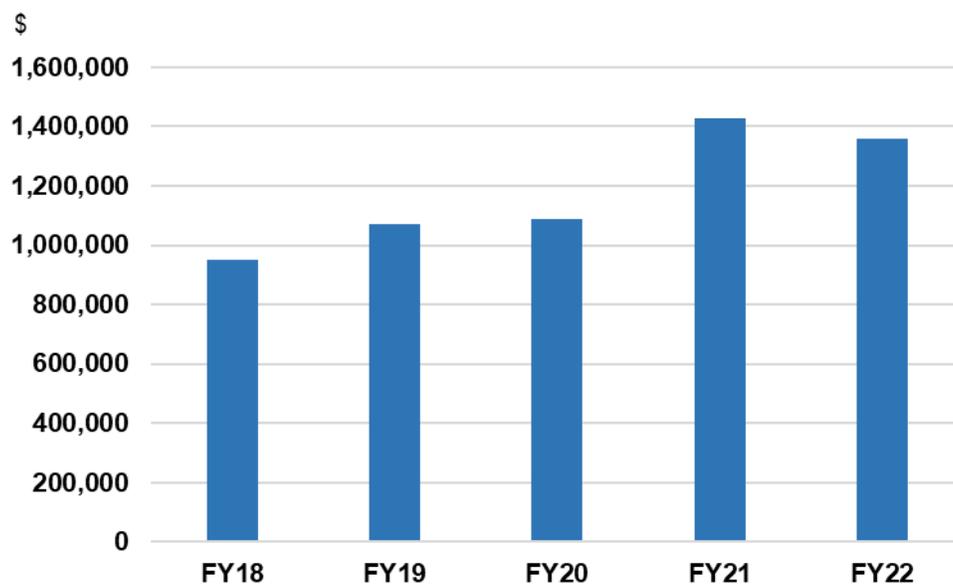
FIGURE 3: STARTUP-FUNDED RESEARCH, FY2018-FY2022



Patents

Patents protect the intellectual property of innovations developed by researchers at the University of Colorado. Venture Partners reported spending \$5.9 million on patents over the five years ending in FY2022, averaging \$1.2 million per year. Patents are a cost to Venture Partners, with a caveat that patent expenditures are reimbursable if technology (intellectual property) is licensed. Two-fifths (39.1%) were reimbursed (\$2.3 million).

FIGURE 4: PATENT EXPENDITURES, FY2018-FY2022



ECONOMIC IMPACT

Economic impacts are associated with license revenue, follow-on company sales, capital funding, and commercialization grants. Removing overlapping funding from follow-on sales and license revenue, and from commercialization grants and license revenue results in mutually exclusive Venture Partners-related economic activity. The estimated \$4 billion in domestic commercialization-related activity resulted in an economic impact on the national economy totaling \$8 billion from fiscal year 2018 through fiscal year 2022. This level of activity supported an estimated 39,000 job years over the five-year period (average of 7,800 per year), paying an estimated \$3.1 billion in labor income. Value added, which removes the estimate of intermediate inputs, totaled \$4.7 billion.

TABLE 5: ECONOMIC IMPACT OF VENTURE PARTNERS-RELATED ACTIVITY ON THE U.S. ECONOMY, FY2018-22

Impact Type	Employment Job Years	Employment Jobs/Year	Labor Income (Billions)	Value Added (Billions)	Output (Billions)
Direct Effect	17,937	3,587	\$1.7	\$2.4	\$4.0
Indirect Effect	8,099	1,620	\$0.6	\$0.9	\$1.7
Induced Effect	13,101	2,620	\$0.7	\$1.4	\$2.3
Total Effect	39,137	7,827	\$3.1	\$4.7	\$8.0

Note: Modeled in 2022 dollars with the 2019 IMPLAN data year. Results presented in 2022 dollars.

Much of the activity was recorded in Colorado, with \$2.7 billion in commercialization-related activity, leading to an economic impact of \$5 billion on the state's economy.

TABLE 6: ECONOMIC IMPACT OF VENTURE PARTNERS-RELATED ACTIVITY ON THE COLORADO ECONOMY, FY2018-22

Impact Type	Employment Job Years	Employment Jobs/Year	Labor Income (Billions)	Value Added (Billions)	Output (Billions)
Direct Effect	13,577	2,715	\$1.2	\$1.7	\$2.7
Indirect Effect	4,523	905	\$0.3	\$0.5	\$0.9
Induced Effect	8,154	1,631	\$0.4	\$0.8	\$1.4
Total Effect	26,254	5,251	\$1.9	\$3.0	\$5.0

Note: Modeled in 2022 dollars with the 2019 IMPLAN data year. Results presented in 2022 dollars.

Economic Impact by Activity

The following section provides the economic impact for individual Venture Partners-related activity. Note that the impact from license revenue, commercialization grants, follow-on sales, or capital funding cannot be summed because the sales are not mutually exclusive from the license revenue or the commercialization grants.

Economic Impact of License Revenue

Revenue from license agreements totaled \$20.1 million from fiscal years 2018 through 2022. Of the total, 50% is used to support early-stage inventions with high commercialization potential, 25% goes to the corresponding inventors' labs, and 25% goes to the corresponding inventors. Assuming this funding was primarily reinvested by the university in Professional, Scientific, and Technical Services, the economic

impact of the license revenue totaled \$44.3 million on the state economy and \$46.2 million on the national economy. Nationally, this level of activity supported an estimated 225 job years over the five-year period (average of 45 per year), paying an estimated \$17.7 million in labor income over the five-year period. Value added, which removes the estimate of intermediate inputs, totaled \$25.6 million.

TABLE 7: ECONOMIC IMPACT OF LICENSE REVENUE ON THE U.S. ECONOMY, FY2018-22

Impact Type	Employment Job Years	Employment Jobs/Year	Labor Income (Millions)	Value Added (Millions)	Output (Millions)
Direct Effect	81	16	\$8.8	\$10.9	\$20.1
Indirect Effect	66	13	\$4.8	\$7.0	\$13.1
Induced Effect	77	15	\$4.1	\$7.6	\$13.1
Total Effect	225	45	\$17.7	\$25.6	\$46.2

Note: Modeled in 2022 dollars with the 2019 IMPLAN data year. Results presented in 2022 dollars.

TABLE 8: ECONOMIC IMPACT OF LICENSE REVENUE ON THE COLORADO ECONOMY, FY2018-22

Impact Type	Employment Job Years	Employment Jobs/Year	Labor Income (Millions)	Value Added (Millions)	Output (Millions)
Direct Effect	81	16	\$8.8	\$10.9	\$20.1
Indirect Effect	63	13	\$4.5	\$6.6	\$12.2
Induced Effect	70	14	\$3.8	\$6.9	\$11.9
Total Effect	214	43	\$17.0	\$24.5	\$44.3

Note: Modeled in 2022 dollars with the 2019 IMPLAN data year. Results presented in 2022 dollars.

Economic Impact of Commercialization Grants

Commercialization grants include the Advanced Industries Accelerator Proof of Concept grants, Advanced Research Projects Agency-Energy (ARPA-E) grants, and startup-funded research. This funding primarily engages research and development activities on campus. Funding totaled an estimated \$45.4 million from fiscal year 2018 through fiscal year 2022. Assuming the funding is used primarily for R&D, the economic contribution totaled \$100 million on the state economy and \$104.4 billion on the national economy. Nationally, this level of activity supported an estimated 508 job years over the five-year period (average of 102 per year), paying an estimated \$39.9 million in labor income. Value added, which removes the estimate of intermediate inputs, totaled \$57.8 million. Note: commercialization grants are partially funded by license revenue, thus, the economic impacts should not be summed.

TABLE 9: ECONOMIC IMPACT OF COMMERCIALIZATION GRANTS ON THE U.S. ECONOMY, FY2018-22

Impact Type	Employment Job Years	Employment Jobs/Year	Labor Income (Millions)	Value Added (Millions)	Output (Millions)
Direct Effect	184	37	\$19.8	\$24.7	\$45.4
Indirect Effect	150	30	\$10.8	\$15.9	\$29.5
Induced Effect	174	35	\$9.3	\$17.2	\$29.5
Total Effect	508	102	\$39.9	\$57.8	\$104.4

Note: Modeled in 2022 dollars with the 2019 IMPLAN data year. Results presented in 2022 dollars.

TABLE 10: ECONOMIC IMPACT OF COMMERCIALIZATION GRANTS ON THE COLORADO ECONOMY, FY2018-22

Impact Type	Employment Job Years	Employment Jobs/Year	Labor Income (Millions)	Value Added (Millions)	Output (Millions)
Direct Effect	184	37	\$19.8	\$24.7	\$45.4
Indirect Effect	141	28	\$10.2	\$14.9	\$27.7
Induced Effect	159	32	\$8.5	\$15.7	\$26.9
Total Effect	485	97	\$38.5	\$55.3	\$100.0

Note: Modeled in 2022 dollars with the 2019 IMPLAN data year. Results presented in 2022 dollars.

Economic Impact of Follow-On Sales

Inferred revenue by licensees totaled \$1.1 billion from fiscal year 2018 through fiscal year 2022, with over 99% domestically sourced. These revenues represent total sales of the products or services related to licensed technology from the University of Colorado Boulder. Inferred sales totaled \$28.7 million for companies domiciled in the state of Colorado. The economic impact of inferred sales totaled \$58.7 million in the state and \$2.3 billion nationally. This level of activity supported an estimated nearly 9,600 job years over the five-year period (average of 1,900 per year), paying an estimated \$987 million in labor income. Value added, which removes the estimate of intermediate inputs, totaled \$1.3 billion.

TABLE 11: ECONOMIC IMPACT OF FOLLOW-ON SALES ON THE U.S. ECONOMY, FY2018-22

Impact Type	Employment Job Years	Employment Jobs/Year	Labor Income (Millions)	Value Added (Millions)	Output (Millions)
Direct Effect	3,714	743	\$457.4	\$620.1	\$1,057.5
Indirect Effect	2,533	507	\$217.9	\$333.8	\$566.3
Induced Effect	3,398	680	\$212.2	\$394.0	\$638.0
Total Effect	9,646	1,929	\$887.5	\$1,347.9	\$2,261.8

TABLE 12: ECONOMIC IMPACT OF FOLLOW-ON SALES ON THE COLORADO ECONOMY, FY2018-22

Impact Type	Employment Job Years	Employment Jobs/Year	Labor Income (Millions)	Value Added (Millions)	Output (Millions)
Direct Effect	139	28	\$10.7	\$16.0	\$28.4
Indirect Effect	80	16	\$5.3	\$8.1	\$15.2
Induced Effect	90	18	\$4.8	\$8.8	\$15.2
Total Effect	308	62	\$20.8	\$32.9	\$58.7

Economic Impact of Capital Funding

Some licensees reported capital funding related to licensed technology. Often, when early-stage companies raise capital, it is used for investment in research and development, or in taking a product to market. Funding may also buy out early investors. Funding totaled nearly \$3 billion (almost all domestic), of which \$2.7 billion was to Colorado companies. Assuming the funding is used to further industry activity (e.g., R&D, marketing, sales, capital improvements, etc.), the economic contribution totaled \$4.9 billion on the state economy and \$5.7 billion on the national economy. Nationally, this level of activity supported an estimated 29,000 job years over the five-year period (average of 5,900 per year), paying an

estimated \$2.2 billion in labor income. Value added, which removes the estimate of intermediate inputs, totaled \$3.4 billion.

TABLE 13: ECONOMIC IMPACT OF CAPITAL FUNDING ON THE U.S. ECONOMY, FY2018-22

Impact Type	Employment Job Years	Employment Jobs/Year	Labor Income (Millions)	Value Added (Millions)	Output (Millions)
Direct Effect	14,190	2,838	\$1,284.8	\$1,800.8	\$2,949.5
Indirect Effect	5,540	1,108	\$401.9	\$606.1	\$1,124.7
Induced Effect	9,673	1,935	\$524.0	\$965.4	\$1,648.6
Total Effect	29,403	5,881	\$2,210.7	\$3,372.3	\$5,722.9

TABLE 14: ECONOMIC IMPACT OF CAPITAL FUNDING ON THE COLORADO ECONOMY, FY2018-22

Impact Type	Employment Job Years	Employment Jobs/Year	Labor Income (Millions)	Value Added (Millions)	Output (Millions)
Direct Effect	13,406	2,681	\$1,177.0	\$1,656.7	\$2,712.5
Indirect Effect	4,419	884	\$314.6	\$467.1	\$869.3
Induced Effect	8,037	1,607	\$429.4	\$790.4	\$1,358.6
Total Effect	25,862	5,172	\$1,921.0	\$2,914.2	\$4,940.4

APPENDIX 1: STUDY NAICS CODES—FOLLOW-ON ACTIVITY

NAICS	Description
325199	All Other Basic Organic Chemical Manufacturing
325412	Pharmaceutical Preparation Manufacturing
325414	Biological Product (except Diagnostic) Manufacturing
325510	Paint and Coating Manufacturing
325998	All Other Miscellaneous Chemical Product and Preparation Manufacturing
334511	Search, Detection, Navigation, Guidance, Aeronautical, and Nautical System and Instrument Manufacturing
334515	Instrument Manufacturing for Measuring and Testing Electricity and Electrical Signals
334516	Analytical Laboratory Instrument Manufacturing
339112	Surgical and Medical Instrument Manufacturing
339999	All Other Miscellaneous Manufacturing
423490	Other Professional Equipment and Supplies Merchant Wholesalers
423830	Industrial Machinery and Equipment Merchant Wholesalers
424690	Other Chemical and Allied Products Merchant Wholesalers
513130	Book Publishers
518210	Computing Infrastructure Providers, Data Processing, Web Hosting, and Related Services
541330	Engineering Services
541380	Testing Laboratories and Services
541511	Custom Computer Programming Services
541512	Computer Systems Design Services
541519	Other Computer Related Services
541611	Administrative Management and General Management Consulting Services
541713	Research and Development in Nanotechnology
541714	Research and Development in Biotechnology (except Nanobiotechnology)
541715	Research and Development in the Physical, Engineering, and Life Sciences (except Nanotechnology and Biotechnology)
541910	Marketing Research and Public Opinion Polling
561110	Office Administrative Services
561622	Locksmiths
561990	All Other Support Services
611310	Colleges, Universities, and Professional Schools
611699	All Other Miscellaneous Schools and Instruction
611710	Educational Support Services
621111	Offices of Physicians (except Mental Health Specialists)
621511	Medical Laboratories
621999	All Other Miscellaneous Ambulatory Health Care Services
813319	Other Social Advocacy Organizations

APPENDIX 2: DATA FIELDS

Data fields provided for this study included:

- Licensee
- Agreement_ID
- City
- State
- CU Startup?
- If CU Startup, capital raised
- If CU Startup, exit value
- License revenue to CU
- Revenue_Type
- Royalty rate (%)
- Inferred Product Sales
- State