A Guide to Evaluating State Bioscience Investments

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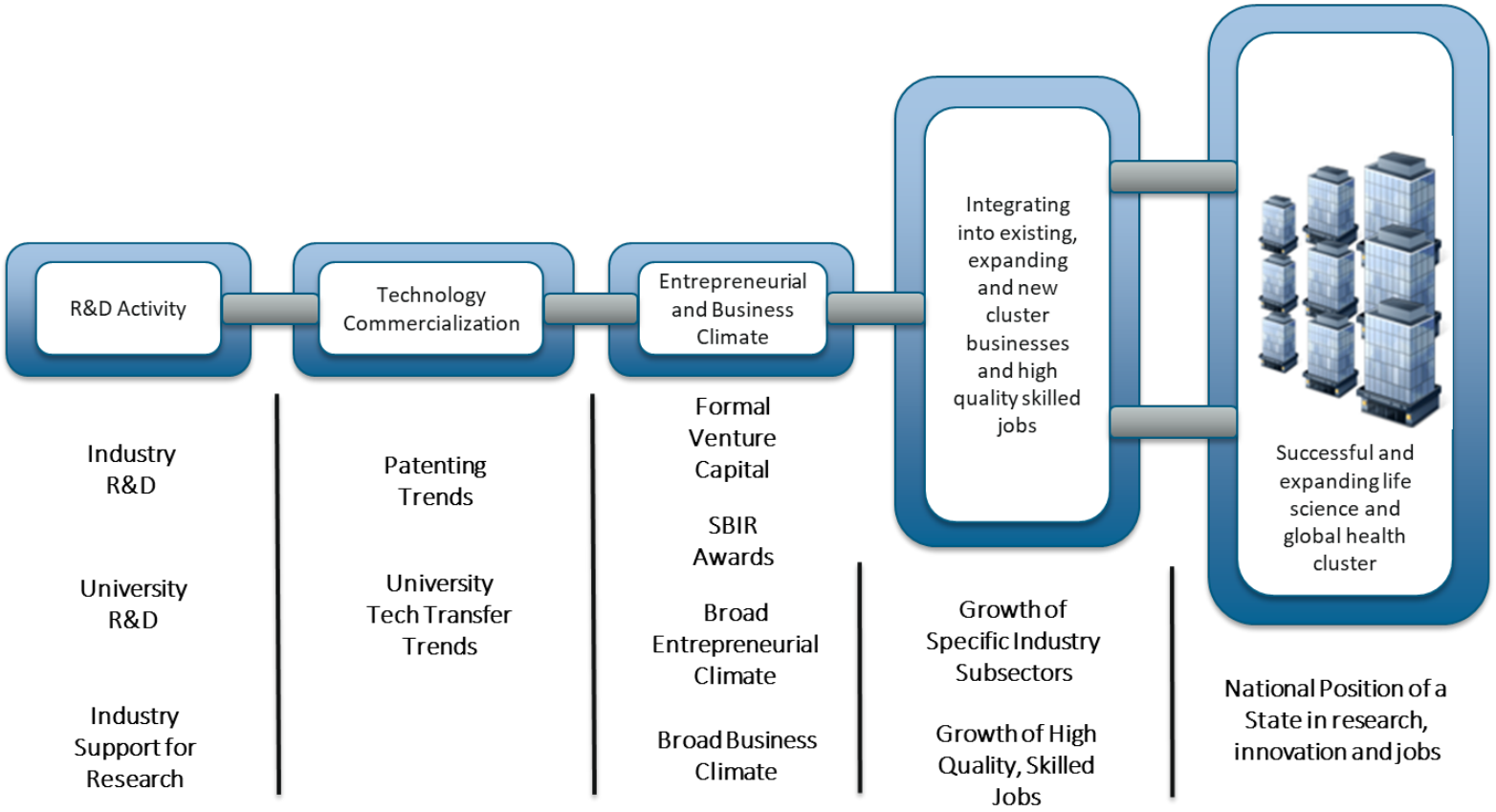
TECONOMY PARTNERS LLC

Background

- The Connecticut State Legislature, as part of Senate Bill 962, mandated the development of “evaluative metrics for bioscience development in the state.”
- To address this requirement, Connecticut Innovations contracted with TEConomy to identify a framework to evaluate the relationship between the state's investments in bioscience initiatives and the economic outcomes resulting from such investments.
- The framework considers:
  - “Macro” level metrics that focus on outcomes associated with industry cluster evaluations or the ultimate outcomes expected from strategic bioscience interventions, programs, or investments at the state or regional level.
  - “Micro” level evaluations that focus on returns on specific program- or company-level investments or state investments into specific individual institutions.

Macro-Level: Innovation Ecosystem Perspective

Evaluating a State's Bioscience Position from an Innovation Ecosystem Perspective



Source: TEConomy Partners, LLC

Key Evaluation Metrics for Life Sciences R&D Activity

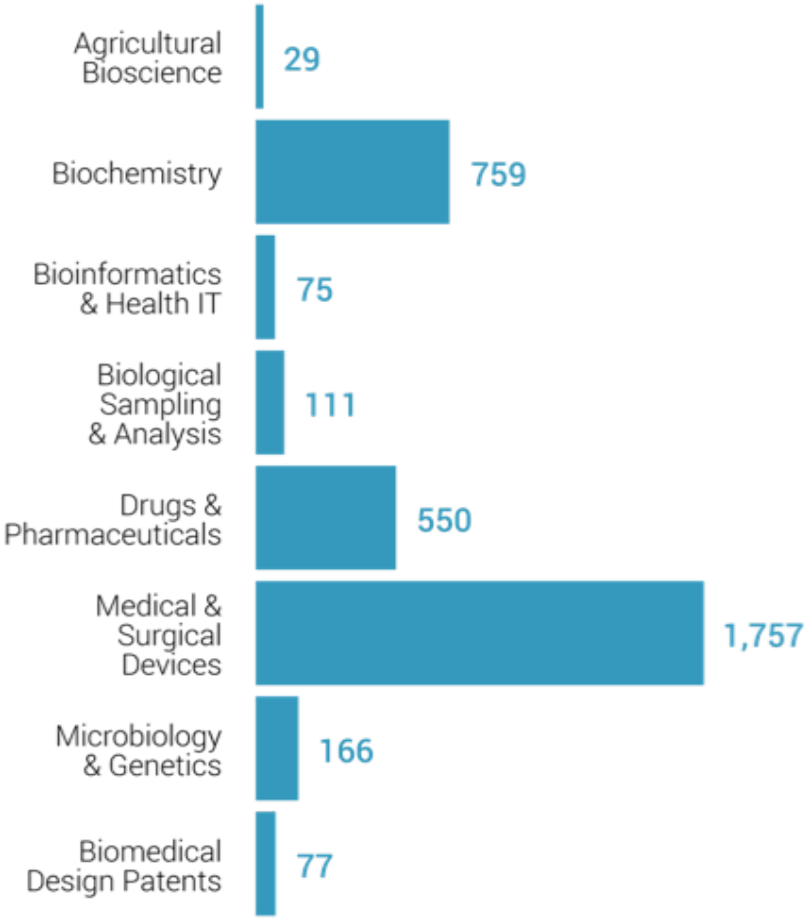
Ecosystem Component	Key Concepts/Definitions	Data Source
Industrial R&D	Mid-level industry detail available for: • Medical equipment & supplies • Drug & Pharmaceutical mfg.	National Science Foundation (NSF) Business R&D and Innovation Survey.
Academic R&D	Life science-related fields/disciplines: • Agricultural sciences • Bioengineering • Biological sciences • Medical sciences • Other life sciences In some cases, also include Psychology, Chemistry.	NSF Higher Education Research and Development (HERD) Survey.
Industry Support for Academic R&D	Sources of funding, including industrial, are published for each life sciences academic field	NSF Higher Education Research and Development Survey.
National Institutes of Health (NIH) Research Funding		NIH RePORTER (Research Online Reporting Tool)

Key Evaluation Metrics for Technology Commercial-ization

Ecosystem Component	Key Concepts/Definitions	Data Source
Intellectual Property: Patent Awards and Applications	TEConomy has developed detailed definition of Bioscience-related patent classes.	Clarivate Analytics' Derwent Innovation patent analysis database *Requires paid subscription
University Technology Transfer	• Not available for bioscience-specific technologies but useful gauge of overall performance/activities. • Key measures include: o Invention disclosures o Start-ups o Patent applications, Awards o Licenses, options executed o License income Important to normalize data relative to total research expenditures	Association of University Technology Managers (AUTM) survey *Requires AUTM membership to access

Illustrative Example for Connecticut

Bioscience-related Patents Awarded to Connecticut Inventors, by Segment, 2012-15



Source: TEConomy/BIO Connecticut State Profile, 2016.

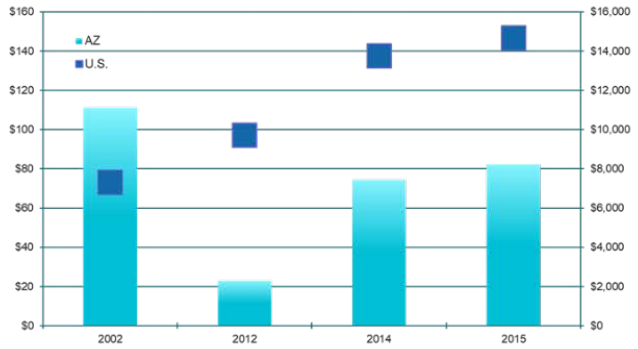
Key Evaluation Metrics for Bioscience Innovation Capital and the Overall Entrepreneurial and Business Climate

Ecosystem Component	Key Concepts/Definitions	Data Source
Venture Capital (VC) Investments	• TEConomy has developed detailed definition of Bioscience-related VC segments (see Figure 7) • Important to track both deal flow volume (companies and deals); dollars invested	Thomson Reuters Thomson ONE database; PitchBook. *Both require paid subscriptions
Federal SBIR/STTR Awards	• To isolate bioscience-related fields focus on awards from Dept. of Health and Human Services o Other Departments for searching for bioscience-related awards include Dept. of Agriculture; National Science Foundation; Dept. of Defense Important to track both award numbers and funding levels by award Phase.	SBIR database at sbir.gov
Ancillary related assessments: **Entrepreneurial Ecosystem** **Business Climate**	Sampling of broad measures for consideration: • Presence of high-growth companies (Inc. 5000) • Entrepreneurial activity (Kauffman Foundation's Startup Activity Index) • New Firm Start-up rate (Census) • Tax Climate (State Business Tax Climate Index) • R&D Facility Tax Burden (Tax Foundation) Business Climate Ratings (Forbes, CNBC, others)	Inc. 5000 The Kauffman Index of Startup Activity Tax Foundation R&D Facility Tax Burden: "Location Matters: The State Tax Costs of Doing Business." Tax Foundation, 2015. Forbes: Forbes Best States for Business CNBC: America's Top States for Business

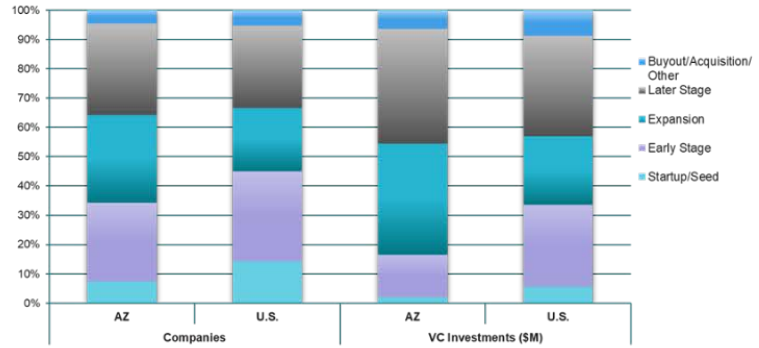
Illustrative Example: Arizona

Examples of How Arizona Tracks Bioscience VC Investments

AZ & U.S. Bio Venture Capital: 2002-15



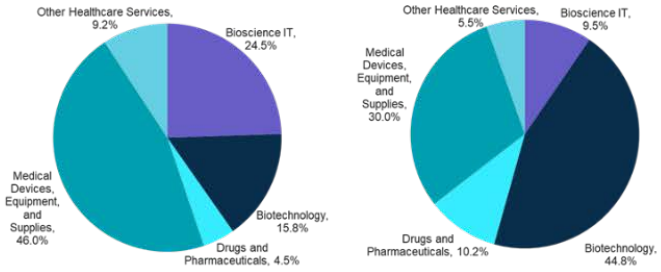
AZ & U.S. Venture Capital by Stage



AZ & U.S. Bio Share of Venture Capital, 2002-15*

Metric	ARIZONA				U.S.		
	Bio VC	Total VC	Bio Share of Total AZ VC	AZ Bio Share of U.S. Bio VC	Bio VC	Total VC	Bio Share of Total U.S. VC
Number of Deals	126	479	26%	0.71%	17,833	67,147	27%
Number of Individual Companies Invested in	40	168	24%	0.78%	5,104	23,613	22%
Investment (in $ Millions)	$716	$3,687	19%	0.50%	$142,964	$567,345	25%

Share of VC Investments by Bio-Related Industry



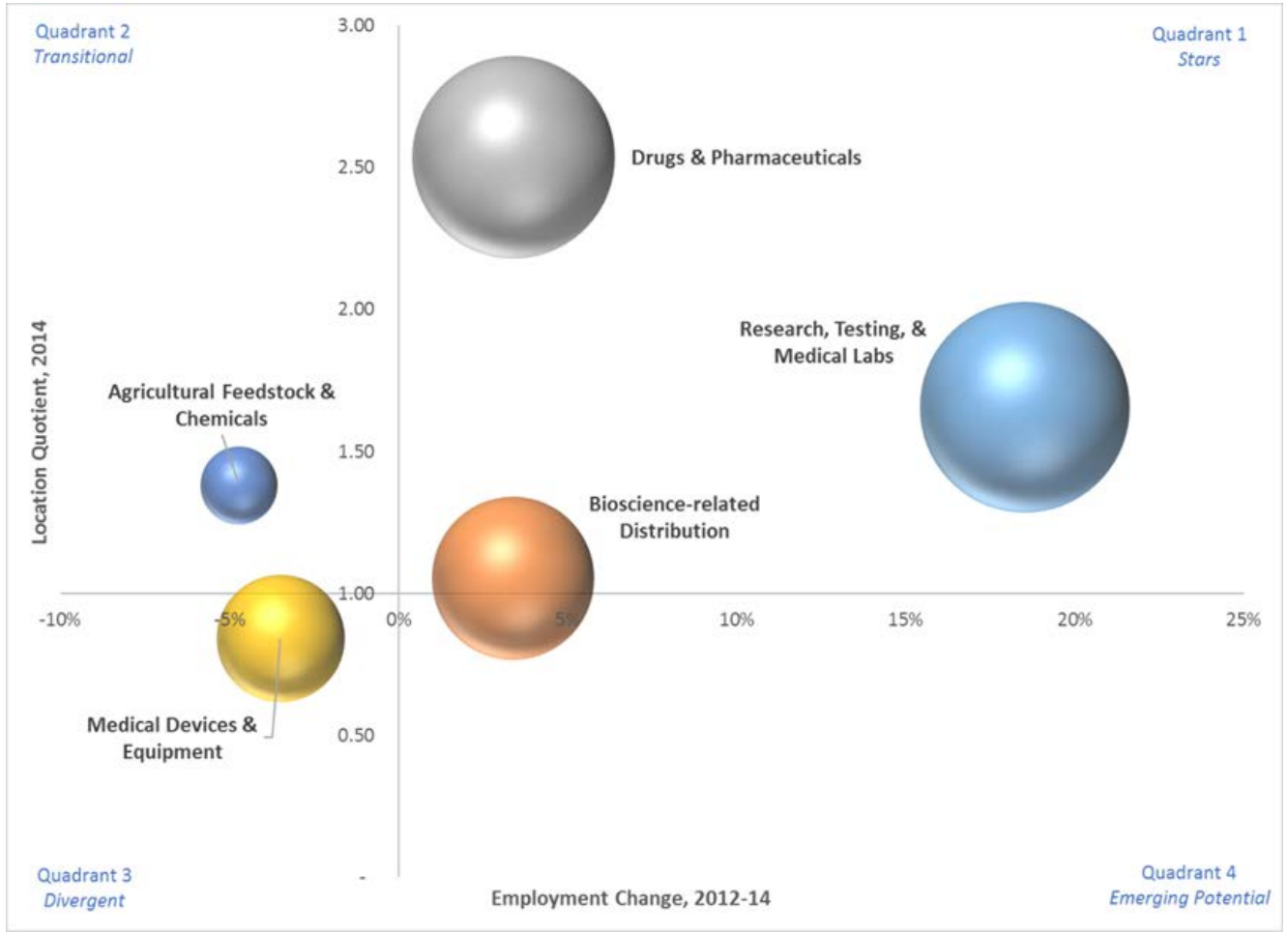
Source: Thomson Reuters Thomson One Database with TEConomy Partners, LLC Calculations.

Key Evaluation Metrics for Bioscience Industry Positioning and Performance

Ecosystem Component	Key Concepts/Definitions	Data Source
Bioscience Industry Employment, Establishments, and Wages	Key employment measures, by subsector, include: • Size – numbers of industry jobs. • Relative Concentration – industry location quotients represent the bioscience industry share of total state employment relative to that same share nationally, e.g. a LQ of 1.0 means state has same concentration seen nationally; an LQ≥1.2 said to be "Specialized" concentration of 20% or more. • Trends – both long- and near-term trends important to assess performance and evaluate key state investments. • State rankings or quintiles – used to assess relative performance, positioning.	U.S. Bureau of Labor Statistics (BLS), Quarterly Census of Employment and Wages (QCEW) "Enhanced" version of BLS, QCEW data from IMPLAN to fill in estimates for data cells that are suppressed due to confidentiality. *IMPLAN data set requires purchase.
Bioscience Workforce	• In addition to broad industry assessment, expertise in innovation-driving, life science-specific occupations can be measured in a similar manner based on employment size, concentration (LQ), and trends.	U.S. Bureau of Labor Statistics, Occupational Employment Statistics (OES) program and State Labor Market Information offices
Bioscience Talent Generation	• Can measure talent pipeline and degree production in bioscience-related fields from state colleges and universities to gauge "supply" of talent and identify key academic programs or gaps.	U.S. Department of Education, National Center for Education Statistics (NCES), Integrated Postsecondary Education Data System (IPEDS) database

Illustrative Example: North Carolina

NC Life Science Industry: Employment Size, Concentration, and Change, 2012-14



Source: TEConomy Partners, LLC analysis of BLS, QCEW data; enhanced file from IMPLAN.

A State's National Position/Ranking

Summary of Connecticut's Performance in Bioscience-related Metrics

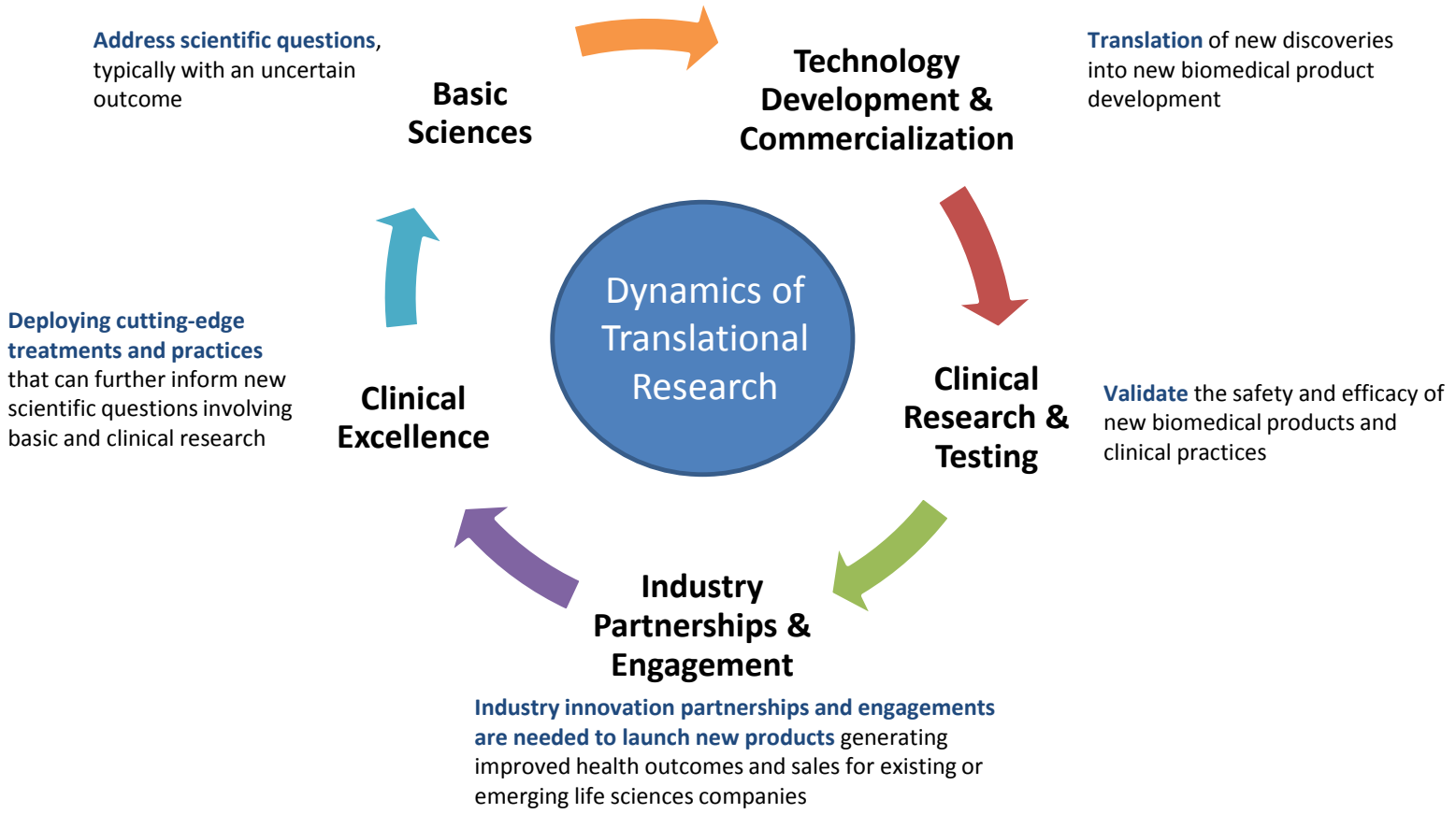
Metric	Connecticut	United States	Quintile
Bioscience Industry, 2014			
Bioscience Industry Employment	23,338	1,655,680	III
Bioscience Industry Location Quotient	1.15	n/a	II
Bioscience Industry Establishments	853	77,283	III
Academic Bioscience R&D Expenditures, FY 2014			
Bioscience R&D ($ thousands)	$802,460	$38,873,926	II
Bioscience Share of Total R&D	78%	61%	I
Bioscience R&D Per Capita	$223	$122	I
NIH Funding, FY 2015			
Funding ($ thousands)	$461,254	$22,869,746	II
Funding Per Capita	$128	$71	I
Bioscience Venture Capital Investments, 2012–15 ($ millions)	$980.0	$48,742.10	II
Bioscience and Related Patents, 2012–15	3,524	101,026	II

State ranking figures for bioscience performance metrics are calculated as quintiles, where:
top quintile — I II III IV V — bottom quintile

Source: TEConomy/BIO Connecticut State Profile, 2016.

Macro-Level: Translational Research Perspective

Evaluating a State's Bioscience Position from a Translational Research Perspective



Source: TEConomy Partners, LLC

Key Evaluation Metrics for Bioscience Translational Research Activity and Performance via Industry-Academic Collaboration

Ecosystem Component	Key Concepts/Definitions	Data Source
Industry-Sponsored University Biosciences Research	• Using the life sciences disciplines detailed previously, can track the dollars and share of University R&D expenditures that are funded by industry to assess levels/trends in partnerships, collaborations.	NSF Higher Education Research and Development Survey.
Industry-Academic Research Publications	• Identifying industry and university co-authors of scientific papers in the life sciences from state universities to assess levels/trends in partnerships/ collaborations.	Web of Science publications database; includes published research articles, proceedings papers, and reviews. *Requires paid subscription
Industry-Assigned Biomedical Patents with Citations to Academic Journals	• Examining industry patents in biomedical technology classes to identify which cite academic research as foundational to the innovation.	Clarivate Analytics' Derwent Innovation patent analysis database *Requires paid subscription
Industry-Funded Clinical Trials with a University Sponsor/Collaborator	• Federal clinical trials database identifies industry-funded trials where a university is also sponsoring or collaborating. • At a state level can identify state-based universities or academic medical centers acting as sponsors or collaborators.	NIH's National Library of Medicine maintains a database at ClinicalTrials.gov. Includes privately and publicly funded clinical studies conducted around the world.

Micro-Level: Direct, Proximate Measures of Success

- In order to help determine if specific investments should continue to be made in a particular program or initiative, it is necessary to track proximate measures of success in order to improve the quality of decision making by analyzing measures that predict the likelihood of a technology receiving additional financial investment.
- The proximate, or near-term, measures of success will vary depending on where within the life cycle an investment is being made.
  - Too often, “jobs created” is used when the creation of jobs will not occur for many years.
  - This results in either the loss of funds when job numbers are not met quickly (which is not realistic) or mediocre programs receiving funding for years under the promise of future jobs when in reality proximate measures indicate the project will not be successful. Both outcomes are equally undesirable.

Potential Proximate Measures of Success

- Research & Development
  - Cost-share received
  - Follow-on investment received
- Commercialization & Deployment
  - # of patent applications submitted and issued
  - # of technologies licensed and revenue generated
- Entrepreneurial Growth
  - Number of companies and jobs created
  - Income generated from sales
  - Equity investment
  - SBIR/STTR/Federal Research Grant Activity
- Business Development/Scalability
  - Number of Companies involved in project/initiative
    - Increase in product sales/sales revenue from new product development
    - Increase in R&D investment
    - Jobs Created/Total Jobs supported
    - Annual Aggregate Client Payroll/Average Salary per Job
    - Number of companies attracted to state as a result of initiative

Micro-Level: Input/Output Economic Impact Modeling

- A state's investments in significant bioscience projects/centers/ laboratories have direct operational economic impact.
- In addition, many of these expenditures are then recirculated as recipients of the first round of income re-spend a portion of this income with other businesses and individuals - "multiplier effect".
- The standard analytical technique for the quantification of expenditure impacts is input/output (I/O) analysis. The I/O methodology calculates the expenditure impacts of a specific bioscience investment across multiple measures, including:
  - **Economic Output** is the total value of goods and services produced in an economy and represents "economic impact".
  - **Income** is the total amount of income received by labor in the economy because of the presence and operations of the investment.
  - **Employment** includes jobs within the economy as a result of the investment.
- These impacts consist of three types:
  - **Direct effects** (the specific impact of the investment in question),
  - **Indirect effects** (the impact on suppliers), and
  - **Induced effects** (the additional economic impact of the spending of these suppliers and employees in the overall economy).

Illustrative Example: North Carolina

The Economic Contribution to the North Carolina Economy of the 102 Currently Active Companies that Received NCBiotech Business Loans

	Output (Mil. $s)	Labor Income (Mil. $s)	Employment	State/Local Tax Revenue (Mil. $s)
Total Life Science Industry Impact				
Direct Effect	$55,324	$6,654.8	62,937	$700.9
Indirect Impacts	$19,278	$7,295.7	108,590	$891.7
Induced Impacts	$11,761	$3,758.4	88,437	$582.0
Total Impact	$86,364	$17,708.9	259,963	$2,174.6
Impact of the 102 Currently Active Companies that Received Business Development Loans				
Direct Effect	$2,760	$331.6	2,914	$34.2
Indirect Impacts	$957	$366.7	5,307	$51.9
Induced Impacts	$591	$188.9	4,444	$29.8
Total Impact	$4,308	$887.2	12,666	$115.9
Share of Total Industry Impact				
Direct Effect	5.0%	5.0%	4.6%	4.9%
Indirect Impacts	5.0%	5.0%	4.9%	5.8%
Induced Impacts	5.0%	5.0%	5.0%	5.1%
Total Impact	5.0%	5.0%	4.9%	5.3%

Source: TEConomy Partners, LLC analysis of NCBiotech data using IMPLAN Input/Output model for North Carolina.

Conclusion

- The State of Connecticut has made significant investments over time to grow its bioscience industrial base. It is important to understand how these taxpayer-funded initiatives are impacting the state's economy and its citizens.
- It is recommended that an independent, third-party entity with the requisite expertise be engaged to gather the relevant data from the various parties to ensure a thorough analysis as outlined in this bioscience evaluation framework, and communicate its findings in a clear, concise, and meaningful manner to key stakeholders throughout Connecticut.
- **It is important to note,** the macro level data is available from public or publicly-accessible subscription data sources; however, the **micro level data can only be obtained with the cooperation/participation of the programmatic initiatives, and even then, only if the information/metrics have been tracked in a high-quality manner over time.**

Thank You!

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Innovating Tomorrow's Economic Landscape

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