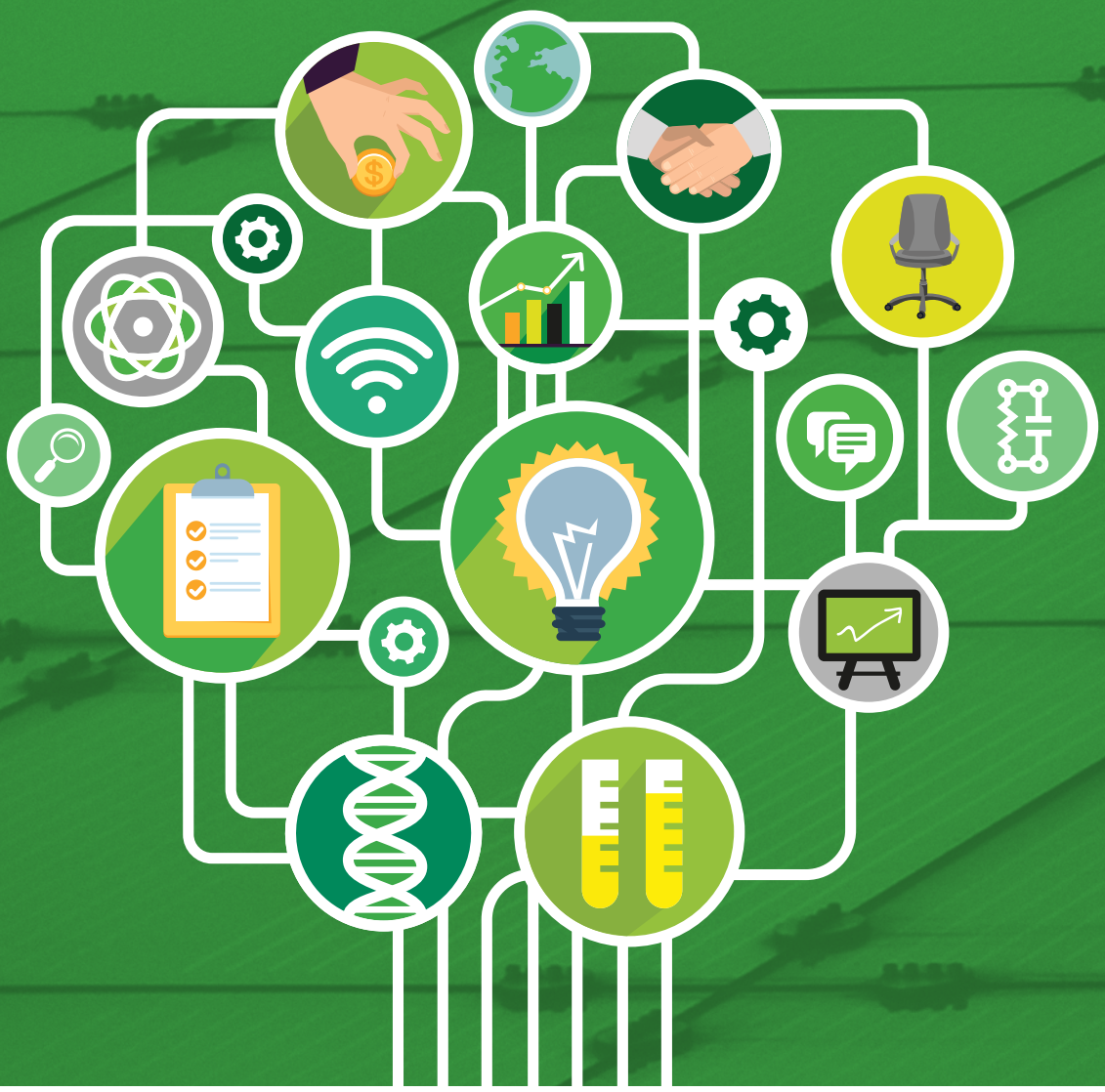
TECHNOLOGY TRANSFER AND COMMERCIALIZATION IN GREATER PHILADELPHIA



CEO COUNCIL FOR GROWTH

PREPARED BY: ECONSULT SOLUTIONS

economics | policy | strategy

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EXECUTIVE SUMMARY

In a knowledge-based economy, regions win when they cultivate **vibrant entrepreneurial ecosystems**, because these are the settings that attract intellectual and financial capital. **Technology transfer**, defined here as **the translation of research discoveries into commercializable products**, is an important component of any region's innovation economy, a marker not only of a region's productivity as a knowledge center but also of its capacity for and receptivity to innovation.

Due to the importance of technology transfer to a region's vitality, the **CEO Council for Growth**, an initiative of the Greater Philadelphia Chamber of Commerce, commissioned a study in 2007 on the Greater Philadelphia region's performance in technology transfer and commercialization. The report described a region rich in potential, but one suffering a gap between its robust science and technology research assets and its lagging private sector development track record.

A lot has happened in the past seven years in the economy as a whole and in the technology transfer space in particular. Notably, the region has seen **significant leadership changes** at key institutions. This has presented an opportunity for these entities to declare and enact fundamental changes in their overall objectives and in the programs, investments, and policies that will help them achieve those objectives. In fact, many research institutions are in the midst of significant reforms in the structure and focus of their technology transfer offices, and entrepreneurship is increasingly emphasized as a way to recruit students, faculty, and researchers. Thus, it is useful to recalibrate the 2007 evaluation of the Greater Philadelphia region's competitive position given these shifts.

Specifically, the region's productivity, relative to that of other regions, was measured in seven categories, commensurate with the **initial inputs**, **innovation activity**, and **desired outcomes** that define technology transfer activity (see Table ES.1). The region scored well in research categories and less well in commercialization categories. Ominously, **the national leaders generated several multiples more in activity than the Greater Philadelphia region**.

TABLE ES.1 – GREATER PHILADELPHIA REGION'S RANK IN TECHNOLOGY TRANSFER METRICS IN 2014 VS. 2007

Category	Metric	Rank (Change)	#1 Region (# Times Larger)
Initial Inputs	STEM Degrees	3 (↑1)	New York 2.2x
	Academic R&D $	7 (-)	Tech Coast 2.6x
Innovation Activity	Invention Disclosures	4 (↑2)	Boston 2.9x
	Patents Granted	6 (↓1)	San Francisco 6.4x
Desired Outcomes	Licenses Executed	5 (↓1)	Boston 3.8x
	Startups Formed	7 (↑1)	Boston 4.9x
	Venture Capital	12 (-)	Silicon Valley 18.6x
Consolidated Index		**6 (↓1)**	**Boston 2.6x**

This research effort yielded the overall finding that innovative regions resemble large, resilient, and diverse ecosystems. Indeed, "The Rainforest: The Secret to Building the Next Silicon Valley," a recent and seminal book about Silicon Valley, asserts that just as rainforests have been

found to yield unexpected and innovative discoveries, so it is that **ecosystems cannot predict what new innovations it will birth, but that rather they emerge as a result of the high number and wide range of random interactions that are contained within them**.

Flourishing, then, comes from a rich, resilient, and multi-faceted setting in which innovation can be birthed and grown. **Evaluating a region's performance and prescribing interventions is less about identifying a singular problem or solution and more about stimulating an environment in which the necessary ingredients are in place for innovation**. These were found to be the common ingredients that characterize strong technology transfer hubs:

1. Venues and entities that facilitate **COLLABORATION**
2. An open and entrepreneurial **CULTURE**
3. Sufficient **FUNDING** and related mechanisms
4. A large and engaged **PRIVATE SECTOR**
5. Strong **RESEARCH INSTITUTIONS**
6. An awareness of the **RESEARCH PRIORITIES** that make sense for a region
7. A deep **TALENT** pool.

The region is strong in research activity but less effective at translating the output of that research activity into commercially viable innovations that attract venture capital. Addressing this mismatch will be crucial to leveraging the region's research strengths and elevating the region as a technology transfer leader. What is needed is **a coordinated regional strategy that yields more capital and more support near the front end of the technology transfer pipeline, to the end of encouraging, seeding, and growing more early stage activity**. Accordingly, this report advances the following overarching goal for the region:

In the next 10 years, the region's research institutions will birth 10 companies that grow to a liquidity event (e.g. acquisition or initial public offering) of $100 million or more.

This report advances four recommended actions that will help the region achieve this goal. These recommendations are intended to provide multiple on-ramps for multiple actors to play their part in coordinating a regional approach to achieving the proposed goal.

Recommendation #1: **FUND.** Public and private sector participation should be recruited to **fund additional pre-venture capital funds and business acceleration services**.

Recommendation #2: **ADVOCATE.** The region should **advocate for policies at all levels of government that demonstrate a commitment to innovation as an economic driver**.

Recommendation #3: **COLLABORATE. Collaboration must be encouraged, particularly through the use of shared space and shared equipment**. A particular focus should be placed on elevating the work of the region's engineering schools, given the promising intersections of engineering and health care (e.g. medical devices), engineering and energy (e.g. energy storage), and engineering and advanced manufacturing (e.g. composite materials).

Recommendation #4: **PROMOTE. The region's leaders must work together to promote the region as an innovation hub**, making particular appeals to venture capital firms seeking deals, young research and entrepreneurship talent seeking a place to learn and grow, and established entrepreneurs with regional ties who can help grow the next generation of startup ventures.

Achieving such a goal will **concentrate the region's institutions, leaders, and resources** in the area of technology transfer and commercialization. It will also create **a virtuous cycle** of more research activity leading to more entrepreneurial ventures, resulting in more potential deals, more investor attention, and more funding. Finally, it will result in **a growing number of extremely successful entrepreneurs** who can serve as mentors, funders, guides, and draws for successive generations of entrepreneurs.

1.0 INTRODUCTION

1.1 THE IMPORTANCE OF TECHNOLOGY TRANSFER AND COMMERCIALIZATION TO A REGION'S VITALITY

In today's increasingly knowledge-based economy, regions win when they are able to cultivate **vibrant entrepreneurial ecosystems**, because these are the settings that attract intellectual and financial capital. Talent and investments are mobile, and they will cluster in regions where collaboration runs high and innovation is encouraged. Conversely, they will opt out of places that lack the structures, leaders, and culture to cooperatively undertake innovative pursuits.

Technology transfer, defined here as **the translation of research discoveries into commercializable products**, is an important component of any region's innovation economy and therefore a priority focus for a region's leaders. It is a marker not only of a region's productivity as a knowledge center but also of its capacity for and receptivity to innovation. This is because it requires a critical mass of world-class research institutions (and, within them, their researchers as well as their technology transfer offices), science and technology companies, supportive organizations, and a complex and multi-layered framework that enables these entities to work together to advance knowledge and commercialize ideas. Regions strong in technology transfer are characterized as open and collaborative environments, that attract talent and investments, which in turn increase the quality and quantity of its entrepreneurial outcomes, further marking an area as promising for students, faculty, and researchers.

Thus, in knowledge industries in general and in technology transfer specifically, success begets more success. This is why all regions work so hard to encourage innovation. Not only does each success bring with it material economic gains – lots of commercial activity and lots of well-paying jobs – but it positions a region to attract even more talent and investments and to increase its chances for even more future successes. And, because of the inherent dynamism in these fields, these efforts must be continually invested in, lest the next wave of talent and investments find their home elsewhere.

1.2 TECHNOLOGY TRANSFER AND COMMERCIALIZATION IN THE GREATER PHILADELPHIA REGION, CIRCA 2007

Due to the importance of technology transfer to a region's vitality, the **CEO Council for Growth (CEO Council)**, an initiative of the Greater Philadelphia Chamber of Commerce, commissioned a study in 2007 on the Greater Philadelphia region's performance in technology transfer and commercialization. This report was written by the Economy League of Greater Philadelphia and was entitled, "Accelerating Technology Transfer: Identifying Opportunities to Connect Universities with Industry for Regional Economic Development." The report described the landscape of technology and commercialization efforts in Greater Philadelphia, assessed the region's performance as compared to that of other regions, and offered a roster of recommendations for the region. Upon publication of this report, regional stakeholders were convened to establish a short and targeted list of recommendations (see Table 1.1).

TABLE 1.1 – HEADLINE RECOMMENDATIONS THAT EMERGED FROM THE 2007 TECHNOLOGY TRANSFER AND COMMERCIALIZATION STUDY COMMISSIONED BY CEO COUNCIL FOR GROWTH AND PRODUCED BY ECONOMY LEAGUE OF GREATER PHILADELPHIA[1]

Financing	Collaboration	Promotion	Advocacy
Establish a regional "Proof of Concept" fund	Improve regional connections through real and virtual "clubhouses"	Market the region's entrepreneurial assets	Advocate for research and commercialization funding at the state and federal level

Source: Economy League of Greater Philadelphia (2007), CEO Council for Growth (2007), Econsult Solutions, Inc. (2014)

1.3 AN UPDATED LOOK AT THE TECHNOLOGY TRANSFER AND COMMERCIALIZATION LANDSCAPE IN THE GREATER PHILADELPHIA REGION

The 2007 report described a region rich in potential, but one suffering a gap between its robust science and technology research assets and its lagging private sector development track record. Given the importance of this issue to the region's future competitive position, it is useful to revisit this assessment seven years later, to see how the Greater Philadelphia region(see Table 1.2) is doing compared to then and to see how it is doing relative to other regions (see Table 1.3).

TABLE 1.2 – COUNTY MAKEUP OF THE GREATER PHILADELPHIA REGION, AS DEFINED BY CEO COUNCIL FOR GROWTH[2]

Pennsylvania	New Jersey	Delaware
Bucks	Burlington	New Castle
Chester	Camden	
Delaware	Gloucester	
Montgomery	Mercer	
Philadelphia	Salem	

Source: CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

[1] See Appendix A for a summary of recommendations from the 2007 CEO Council for Growth study on technology transfer and commercialization.

[2] Throughout the report, this is the makeup of the Greater Philadelphia region except in cases where data unavailability necessitated another but not materially different set of counties.

TABLE 1.3 – COMPARISON REGIONS FOR THIS REPORT, AS DUPLICATED FROM THE 2007 CEO COUNCIL FOR GROWTH STUDY[3]

Atlanta	Houston	Pittsburgh	St. Louis
Austin	Nashville	Raleigh-Durham	Tech Coast (LA/SD)
Baltimore	New York	San Francisco	Tech Valley (Albany)
Boston	Philadelphia	Seattle	Washington, DC

Source: Econsult Solutions, Inc. (2014)

A lot has happened in seven years in the economy as a whole and in the technology transfer space in particular. Thus, it is useful to recalibrate the 2007 evaluation of the Greater Philadelphia region's competitive position given these momentous shifts. To begin with, the Greater Philadelphia region has seen **significant changes in leadership** at key institutions (see Table 1.4). This has presented an opportunity for these entities to declare and enact fundamental changes in their overall objectives and in the programs, investments, and policies that will help them achieve those objectives. Not coincidentally, many research institutions are in the midst of significant reforms in the structure and focus of their technology transfer offices, and entrepreneurship is increasingly emphasized as a way to recruit students, faculty, and researchers.

On a related note, a number of **new initiatives** that are intended to spark commercialization activity and catalyze collaboration across entities did not exist in 2007, but have been birthed since then (see Table 1.5). Indeed, some were conceived in response to the recommendations in the 2007 report. For example, the QED Proof-of-Concept Program was established by the University City Science Center (Science Center) in 2009 to address the region's need for early stage life science capital, as articulated in the 2007 CEO Council study. The Science Center also birthed Quorum, in 2011, to provide a gathering place and related resources to innovators. In addition, Ben Franklin Technology Partners of Southeastern Pennsylvania, Drexel University, University of Pennsylvania, and Penn State University collaborated in 2009 to create the Energy Commercialization Institute (ECI). The ECI is an initiative that collects intellectual property from Greater Philadelphia's universities and uses that property to make licensing offers to corporations, independent of the universities.

[3] The same peer regions are used from the 2007 report to facilitate comparison across reports. One exception is that Los Angeles and San Diego have been consolidated into a singular region known as Tech Coast, commensurate with the rise of this term within technology transfer circles to describe the Southern California market as a distinct and singular region.

TABLE 1.4 – NEW LEADERSHIP (I.E. ARRIVED SINCE 2007) AT SELECTED INSTITUTIONS IN GREATER PHILADELPHIA[4]

Institution	Leader	Year Arrived	Selected Highlights from Resume
Drexel University	John A. Fry	2010	President of Franklin & Marshall College Executive Vice President of University of Pennsylvania
Monell Chemical Senses Center	Robert F. Margolskee	2014	Adjunct Professor, Department of Pharmacology and Systems Therapeutics & Department of Structural and Chemical Biology in Mount Sinai School of Medicine
Princeton University	Christopher L. Eisgruber	2013	Provost of Princeton University
Rowan University	Ali. A. Houshmand	2011	Dean and Interim Provost in Drexel University
Rutgers University	Robert L. Barchi	2012	President of Thomas Jefferson University Provost of the University of Pennsylvania
Rutgers University-Camden	Phoebe A. Haddon, J.D., LL.M.	2014	Dean of the University of Maryland Francis King Carey School of Law
Temple University	Neil D. Theobald	2013	Senior Vice President of Indiana University
Thomas Jefferson University	Stephen K. Klasko	2013	CEO of USF Health Dean of the Morsani College of Medicine at University of South Florida
University City Science Center	Stephen S. Tang	2008	Vice President & General Manager of Life Science at Olympus America Inc. President and CEO of Millennium Cell Inc. Founder and Owner of Tangent Technologies
University of the Sciences in Philadelphia	Helen Giles-Gee	2012	President of Keene State College Provost of Rutgers University

Source: Econsult Solutions, Inc. (2014)

[4] See Appendix C for a more detailed version of this table.

TABLE 1.5 – SELECTED NEW (I.E. ESTABLISHED AFTER 2007) TECHNOLOGY TRANSFER AND COMMERCIALIZATION INITIATIVES IN GREATER PHILADELPHIA[5]

Name (Year Established)	Summary Description
Communication on Increasing Research Efforts (CORE) (2011)	Quarterly networking opportunities for University of the Sciences' students and faculty to identify overlapping research interests
QED Proof-of-Concept Program (2009)	Proof-of-concept assistance for early stage ventures
Quorum (2011)	Gathering space and related resources for entrepreneurs and innovators
Technology Commercialization Network (2008)	Connection to technical assistance and laboratory space from region's research institutions
Upstart (2010)	Virtual incubator to encourage technology commercialization among Penn faculty and staff
Energy Commercialization Institute (2009)	Gathers intellectual property from local universities and offers licensing for the intellectual property to independent corporations
TransCelerate Biopharma Inc. (2012)	A non-profit collaboration of 16 of the world's largest pharma and biotech companies that works to create global standards for clinical trials data interchange, as well as for patient data privacy.

Source: Econsult Solutions, Inc. (2014)

1.4 OVERVIEW OF REPORT AND OF METHODOLOGICAL APPROACH

This report commences with **a definition of technology transfer and commercialization** and of the technology transfer and commercialization landscape in the Greater Philadelphia region (Section 2). This context is important to introduce the concepts that make up this research inquiry and to circumscribe the activities of interest for this report effort.

The report then looks at a series of **metrics** by which one can determine how the Greater Philadelphia region ranks relative to 2007 and relative to peer regions. These metrics are divided into three sub-categories: **initial inputs** (Section 3), **innovation activity** (Section 4), and **desired outputs** (Section 5). Data for these three sub-categories were provided by the CEO Council, and metrics in these sub-categories were selected to mirror those discussed in the CEO Council's 2007 report, to enable easy comparison across time and region.

For each of these metrics, results were indexed such that the Greater Philadelphia region's levels were set at 100 and other regions' levels were calibrated based on that scale (e.g. >100 = higher than Greater Philadelphia, <100 = lower than Greater Philadelphia), yielding a **consolidated index** (Section 6). This enables an easy understanding of how the Greater Philadelphia region's

[5] See Appendix E for a more detailed version of this table.

performance levels compare to those of other regions. To supplement this analysis and confirm its findings, a separate **analysis of industry clusters** was performed, using data from the US Commerce Department's Economic Development Administration (Section 7).

In parallel to these data analyses, this report effort also included interviewing over 30 leaders representing almost all of the major institutions in the region (see Table 1.6), researching interesting technology transfer and commercialization models in other regions,[6] and surveying over a hundred organizations throughout the Greater Philadelphia region.[7] Between these primary and secondary research efforts and the results of the data analyses, a very rich sense of the region's condition as a major technology transfer and commercialization center could be determined, which yielded a set of **implications** and resulting **recommendations** for the region (Sections 8 and 9).

TABLE 1.6 – INSTITUTIONS REPRESENTED IN INFORMATIONAL INTERVIEWS[8]

Ben Franklin Technology Partners of Southeastern PA	Center of Effort, LLC	Children's Hospital of Philadelphia	CommonBond
Computer Aid, Inc. / First State Innovation	Drexel University	First Round Capital	Gabriel Investments
Greenberg Traurig	Independence Blue Cross	Innovation America	Iroko Pharmaceuticals
Johnson & Johnson	Mobiquity, Inc.	New Jersey Technology Council	PACT
Penn Center for Innovation	Philadelphia Industrial Development Corporation	Phoenix IP Ventures	Princeton Office of Technology Licensing
RightCare Solutions, Inc./Domain Associates	Robin Hood Ventures	Safeguard Scientifics	SeventySix Capital
Temple University	The South Jersey Technology Park	The Wistar Institute	Thomas Jefferson University
University City Science Center	University of Pennsylvania	University of the Sciences in Philadelphia	

Source: Econsult Solutions, Inc. (2014)

1.5 ABOUT ECONSULT SOLUTIONS

Econsult Solutions, Inc. is a Philadelphia-based economic consulting firm. It provides businesses and public policy makers with economic consulting services in urban economics, real estate economics, transportation, public infrastructure, development, public policy and finance,

[6] See Appendix F for a full bibliography.

[7] See Appendix G for a copy of the survey and Appendix H for a list of organizations that completed the survey.

[8] See Appendix I for a full list of interviews.

community and neighborhood development, and planning, as well as expert witness services in support of litigation.

Its principals are nationally recognized experts in urban development, real estate, government and public policy, planning, transportation, non-profit management, and business strategy and administration, as well as litigation and commercial damages. Staff members have outstanding professional and academic credentials, including active positions at the university level, wide experience at the highest levels of the public policy process, and extensive consulting experience.

1.6 ABOUT THE CEO COUNCIL FOR GROWTH

The **CEO Council**, an initiative of the Greater Philadelphia Chamber of Commerce, is a devoted group of more than 55 business, higher education, and civic leaders who commit their time and efforts to enhancing economic growth and prosperity in the 11-county region across northern Delaware, southern New Jersey and southeastern Pennsylvania. The tri-state regional group leverages direct engagement of private sector and higher education research institution leadership to:

- Conduct privately funded, actionable analysis to advance large scale regional projects;
- Advocate for a multifaceted agenda focused on the federal role in innovation, regional mobility and talent;
- Develop sector-specific initiatives to leverage the region's competitive advantages, engage CEO's to advocate, market, retain and grow companies and jobs, and accelerate economic growth (energy and health care innovation);
- Provide strategic counsel and actively engage in the marketing and attraction work of Select Greater Philadelphia; and
- Support key initiatives of CEO Council members.

For almost a decade, the CEO Council has influenced regional and national policy through advocacy for the improvement of the region's transportation infrastructure, availability of a top notch workforce, and expansion of investment capital to support business growth and culture of entrepreneurship.

CEO Council members provide the leadership necessary to achieve these results. Through a focused, consistent and sustained effort over time, the CEO Council works to improve the Greater Philadelphia region.

2.0 TECHNOLOGY TRANSFER AND COMMERCIALIZATION

2.1 OVERVIEW

Before quantitatively and qualitatively evaluating the Greater Philadelphia region's performance in technology transfer and commercialization, it is useful to define terms, identify key actors and resources, and describe the process by which actors and resources interact. This context also provides a structure by which the Greater Philadelphia region can be assessed and recommendations offered.

2.2 DEFINING TECHNOLOGY TRANSFER

Economic growth and human advancement requires innovation. Incremental enhancements in the existing processes of translating labor, capital, and raw materials into various goods and services can only generate a limited amount of improvement in quality of life and in economic output. Innovation is needed to transform those processes into something far greater and better.

Technology transfer is an important conduit in the process of sparking innovation and actualizing its potential. Technology transfer represents the translation of research discoveries into commercializable products and processes. As such, the technology transfer process can be subdivided into three phases (although, as will be discussed later, in reality the process is often not this linear):

1. Initial Inputs – The resources needed to gain new knowledge and generate new innovations.
2. Innovation Activity – Tangible evidence that there is some new discovery that has the potential for commercialization.
3. Desired Outcomes – Various indicators that the translation process has yielded some commercialization success.

2.3 THE REASON FOR AND PURPOSE BEHIND UNIVERSITY TECHNOLOGY TRANSFER OFFICES

Usually, although not always, research discoveries occur in a university setting. Universities house researchers, who use a variety of research methods to build from existing knowledge and try to gain new knowledge. These efforts are the genesis of innovation.

On the other end of this process is the marketplace, which gains from the fruits of innovative ideas in the form of new products and processes that benefit people. Most major research institutions have established centralized **technology transfer offices** because the translation of the inventions of researchers into commercializable products and processes is not necessarily

intuitive. To begin with, there may be a philosophical disconnect between the knowledge-seeking priorities of university researchers and the product-seeking priorities of the marketplace. Also and practically, the process of preparing research discoveries for commercialization involves many steps and skills that may not be best left for the sources of those discoveries.

University technology transfer offices thus represent a centralization of the activities involved in translating research discoveries into commercializable products. These efforts received a significant boost with the passage in 1980 of the Patent and Trademark Law Amendments Act, commonly known as the Bayh-Dole Act, which granted institutions permission to own innovations generated with federal funding. Prior to the Bayh-Dole Act, such inventions were owned by the US government; now, institutions can license these innovations or house them in a spinoff startup venture, both of which confer financial gain and reputation enhancement.

2.4 INITIAL INPUTS

Research institutions represent an important place in which the initial inputs of technology transfer activity are assembled. These inputs include three forms of capital that are deployed in the service of identifying new innovations that advance human knowledge:

- **Human capital** – As research is a knowledge-seeking activity, it requires that people (researchers, faculty, staff, and students) and research institutions are where this talent can be effectively assembled.
- **Financial capital** – Research institutions are among the largest recipients of various federally-funded research and development grants, such as those distributed by the National Institutes of Health and the National Science Foundation.
- **Physical capital** – The research process often requires state-of-the-art buildings and expensive equipment. Research institutions represent sufficient scale of research activity to justify these specialized capital investments.

2.5 INNOVATION ACTIVITY

The translation of research activity into commercializable products and processes requires that that research activity yields commercializable discoveries. One way to gauge the output of research efforts and thus the level of innovation activity they may yield through patent activity and through its precursor, invention disclosures.

The intellectual property represented by knowledge-based inventions is protected through the patent process. A **patent** is a government-granted license awarded to an inventor, whether an individual, corporate laboratory, or research institution to be the sole maker, user, and/or seller of his or her invention for a set period of time. Prior to the filing of a patent by research institutions, an **invention disclosure** report is produced to determine whether patent protection should be

pursued. Both of these items thus represent the extent to which regions have produced innovations that may become commercializable.

2.6 DESIRED OUTCOMES

If a research discovery has commercial potential, the research institution can pursue one of two tracks to actually bring that innovation to the marketplace: it can **license** the innovation to an established firm or it can house the innovation within a spinoff **startup venture**.[9] Thus, the licenses executed and startup ventures formed are both good proxies for the productivity of a research institution in achieving its desired outcomes of translating research discoveries into commercializable products and processes.

Venture capital invested is another good proxy for technology transfer productivity. As noted above, capital is mobile, and will seek out the best opportunities for return. Venture capital represents a vote of confidence by the marketplace in a particular innovation and entity, and is therefore a useful indicator of a region's success levels in commercializing research discoveries, as are earlier rounds of investments such as from angel investors or seed capital funds.

2.7 PARTICIPANTS

Participating in this technology transfer process are a number of different kinds of actors. There are the research institutions themselves, of course; they represent the entities within which research activity takes place as well as the hubs to which talent, assets, and funding are drawn.

Within the private sector are **entrepreneurs** who initiate and build the startup ventures that often serve as the vessel for commercializing an innovation, as well as **larger corporations** who do their own research and/or partner with research institutions, and who may represent both a demand for the end products and processes and a supply for the talent and capital needed to bring those end products and processes to the marketplace.

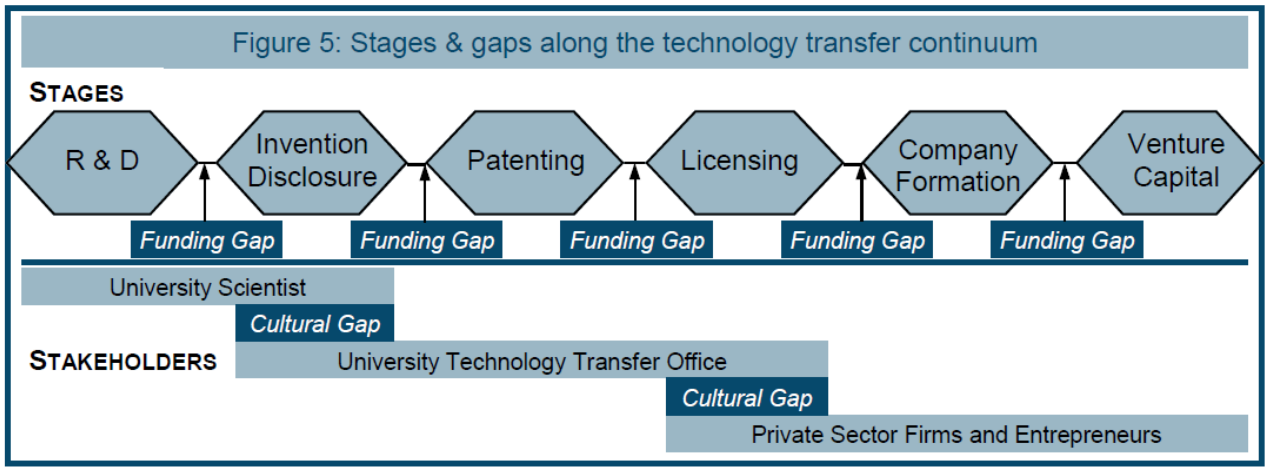
Financial capital can come from these large corporations, and/or from venture capital firms, the federal government (e.g. funding for academic research and development efforts), and state and local governments (many of which have early-stage funds to fill a hole in the funding ladder and to incubate homegrown entities). Technical capital can come from a wide range of **support organizations**, whether public, for-profit, or not-for-profit, and indeed successful regions have a healthy network of entities – mentors, chambers of commerce, scientific research support organizations – that provide technical assistance, fulfill a convening role, and serve as advocates for innovation activity.

[9] Or it can do both: for example, the Massachusetts Institute of Technology regularly licenses inventions to its own startup ventures in exchange for an equity position in the new company.

2.8 DESCRIBING THE PROCESS

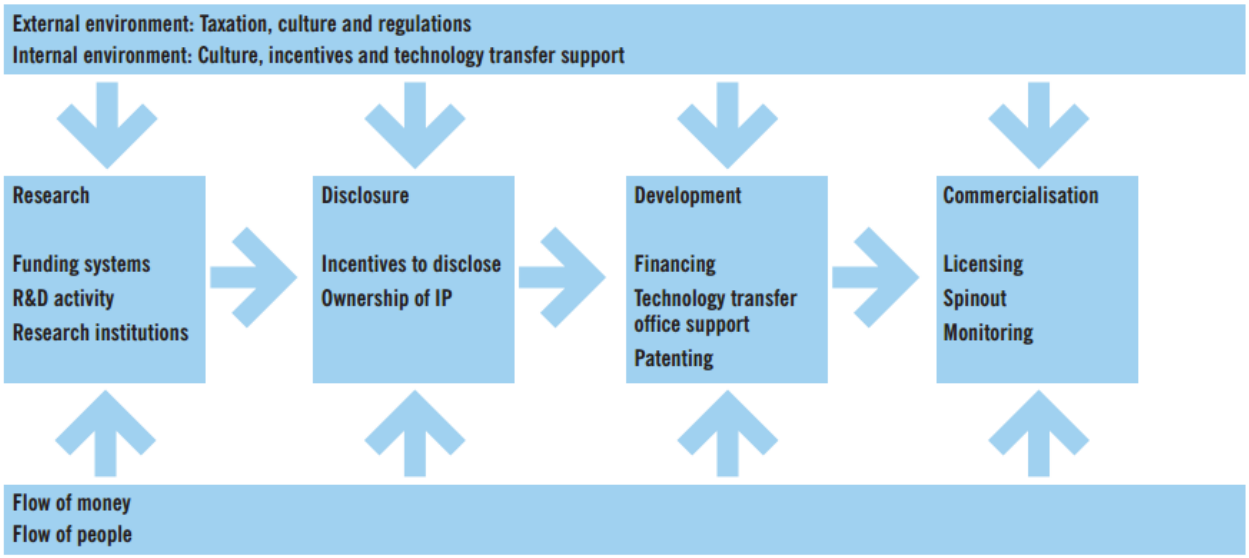
What has been articulated thus far is a simplified and straightforward process involving set actors and a set process. Indeed, traditional textbook explanations of technology transfer and commercialization tend to describe the process as linear, one-directional, and clean (see Figure 2.1 and Figure 2.2).

FIGURE 2.1 – THE TECHNOLOGY TRANSFER PROCESS FLOWCHART, AS OUTLINED IN THE 2007 TECHNOLOGY TRANSFER REPORT PRODUCED BY THE ECONOMY LEAGUE OF GREATER PHILADELPHIA FOR CEO COUNCIL FOR GROWTH



Source: Economy League of Greater Philadelphia (2007)

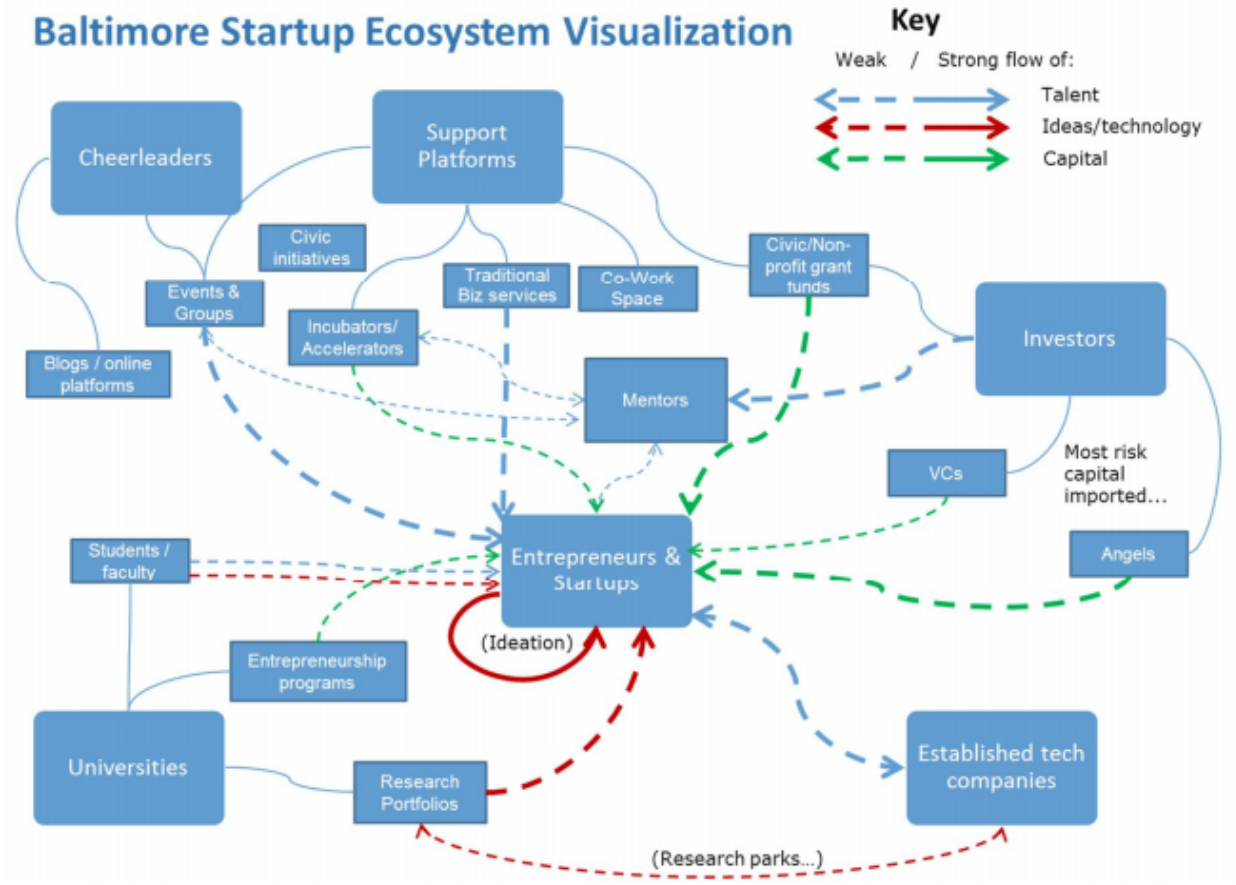
FIGURE 2.2 – THE TECHNOLOGY TRANSFER PROCESS FLOWCHART, AS OUTLINED IN A 2005 TECHNOLOGY TRANSFER REPORT BY APAX PARTNERS FOR THE ECONOMIST INTELLIGENCE UNIT



Source: Apax Partners (2005)

In reality, the technology transfer process is messier and more multi-dimensional, and this is true for both more mature and more developing regional systems, as is evidenced by flowcharts of the startup environment in Baltimore produced by the Abell Foundation in a 2013 report on entrepreneurial ecosystems (see Figure 2.3).[10] This is to be expected: progress does not always advance in a straight line, and many actors and steps do not often neatly cooperate in a straightforward sequential manner.

FIGURE 2.3 – ABELL FOUNDATION VISUALIZATION OF THE STARTUP ECOSYSTEM IN BALTIMORE



Source: Abell Foundation (2013)

Indeed, a recent and seminal book about Silicon Valley describes innovation ecosystems as resembling rainforests. In "The Rainforest: The Secret to Building the Next Silicon Valley," Victor Hwang and Greg Horowitt describe the wide variety of factors and intricate environment that are

[10] "Learning from Boston: Implications for Baltimore from Comparing the Entrepreneurial Ecosystems of Baltimore and Boston," Abell Foundation (August 2013).

needed to birth innovative companies. In fact, they further assert that just as rainforests have been found to yield unexpected and innovative discoveries, so it is that **ecosystems cannot predict what new innovations it will birth, but that rather they emerge as a result of the high number and wide range of random interactions that are contained within them**.

2.9 ORGANIZING AN EVALUATION OF A REGION'S TECHNOLOGY TRANSFER PERFORMANCE

Given the complexities intrinsic to birthing, shepherding, translating, and commercializing knowledge-enhancing innovations, one must allow room for such noise. But it does make describing a region's technology transfer process more challenging, and it also increases the difficulty level associated with diagnosing areas in need of improvement and advancing recommendations that will be effective.

The sections that follow attempt to offer some useful metrics (from the same data sources as the 2007 report) and insightful observations (from interviews with regional leaders) for evaluating the performance of the Greater Philadelphia region now, relative to 2007 and relative to other regions. This assessment will culminate in a series of recommendations which emerge from an interpretation of these metrics and observations, and which attempt to be mindful of the inherent intricacies of the technology transfer process.

3.0 INITIAL INPUTS

3.1 OVERVIEW

One way of assessing a region's ability to compete as a world-class center for technology transfer and commercialization is to identify how dense it is with talent and money. In this section, Greater Philadelphia[11] is evaluated over time and against other regions in its ability to produce science and engineering graduates (Section 3.2) and in its ability to secure academic research and development funding (Section 3.3).

3.2 INITIAL INPUTS METRIC: DEGREES CONFERRED

"Science and engineering degrees conferred" is an output of sorts, for universities and for regions, as it represents how many qualified graduates universities and regions can produce. But it is also an important input for a region, for it represents the depth and breadth of its talent pool to support innovation activity and to initiate technology transfer and commercialization events. So it is useful to consider how Greater Philadelphia is doing in conferring science and engineering degrees, relative to its recent past and relative to other regions.

Greater Philadelphia conferred about 37,000 science and engineering degrees in 2012, up by over 10,000 since 2005 (see Table 3.1). Between 2005 and 2012, Greater Philadelphia overtook the Boston region as the 3rd most prolific region in terms of producing science and engineering graduates, and it now trails only the Tech Coast and New York. However, its overall high ranking masks some variation in where it is dominant; for example, it is 3rd in life science degrees conferred but only 5th in engineering degrees conferred and 6th in math/computer degrees conferred (see Table 3.2).

[11] Throughout this section and the ensuing three sections, regions are referred to by their dominant city.

TABLE 3.1 – SCIENCE AND ENGINEERING DEGREES CONFERRED BY REGION IN 2005 AND 2012[12]

	2005 #	2005 Rank	2012 #	2012 Rank	2005-2012 % Chg
Atlanta	12,521	9	15,493	12	+23.7%
Austin	8,672	14	10,997	14	+26.8%
Baltimore	12,379	10	16,549	9	+33.7%
Boston	27,390	3	36,177	4	+32.1%
Houston	12,794	8	17,552	8	+37.2%
Nashville	4,878	16	7,309	16	+49.8%
New York	60,654	1	80,079	2	+32.0%
Greater Philadelphia	**26,506**	**4**	**36,886**	**3**	**+39.2%**
Pittsburgh	11,319	12	15,908	10	+40.5%
Raleigh Durham	11,062	13	14,682	13	+32.7%
San Francisco	24,572	5	32,321	5	+31.5%
Seattle	12,798	7	18,199	7	+42.2%
St. Louis	12,368	11	15,562	11	+25.8%
Tech Coast	59,285	2	80,177	1	+35.2%
Tech Valley	6,107	15	9,649	15	+58.0%
Washington, D.C.	23,306	6	30,855	6	+32.4%

Source: National Science Foundation (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

[12] See Appendix J for additional detail on science and engineering degrees conferred by region.

TABLE 3.2 – RANK IN SELECTED SCIENCE AND ENGINEERING DEGREES CONFERRED IN 2012

Rank	Engineering	Math / Computer Science	Life Sciences	All Science & Engineering	Arts & Humanities
Atlanta	6	9	13	12	10
Austin	10	14	15	14	13
Baltimore	11	10	7	9	12
Boston	4	4	4	4	4
Houston	13	11	8	8	8
Nashville	16	16	16	16	16
New York	2	1	1	2	1
Greater Philadelphia	**5**	**6**	**3**	**3**	**3**
Pittsburgh	9	8	10	10	11
Raleigh Durham	8	12	11	13	15
San Francisco	3	5	5	5	6
Seattle	12	7	12	7	7
St. Louis	15	13	9	11	9
Tech Coast	1	2	2	1	2
Tech Valley	14	15	14	15	14
Washington, D.C.	7	3	6	6	5

Source: National Science Foundation (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

3.3 INITIAL INPUTS METRIC: FINANCING OF ACADEMIC R & D

"Academic research and development funding" is also an output of sorts, for universities and for regions, as it represents universities' and regions' ability to attract financial support for research and development activities. But it is also an important input for a region, for it represents the initial resources available to explore research inquiries and advance development possibilities. So it is useful to consider how Greater Philadelphia is doing in obtaining academic research and development funding, relative to its recent past and relative to other regions.

Greater Philadelphia obtained about $1.61 billion in academic research and development funding in 2012, up by almost $300 million since 2005 (see Table 3.3). In 2005 and 2012, there was no change in the ranking of the top nine regions, with the Greater Philadelphia region obtaining the 7th most funding, trailing the Tech Coast, New York, San Francisco, Baltimore, Boston, and Raleigh/Durham. However, only Houston saw a smaller increase than the 26.0 percent increase in funding to Greater Philadelphia between 2005 and 2012. Furthermore, as with science and

engineering degrees conferred, Greater Philadelphia lags further behind in key research funding categories such as math and computer sciences, where it is only 11th (see Table 3.4).

TABLE 3.3 – ACADEMIC RESEARCH AND DEVELOPMENT FUNDING OBTAINED BY REGION IN 2005 AND 2012[13]

	2005 $M	2005 Rank	2012 $M	2012 Rank	2005-2012 % Chg
Atlanta	$861	8	$1,282	8	+48.8%
Austin	$802	9	$1,262	9	+57.3%
Baltimore	$1,834	4	$2,606	4	+42.1%
Boston	$1,712	5	$2,460	5	+43.7%
Houston	$794	10	$905	13	+13.9%
Nashville	$402	15	$583	15	+44.9%
New York	$2,287	2	$3,412	2	+49.2%
Greater Philadelphia	**$1,278**	**7**	**$1,610**	**7**	**+26.0%**
Pittsburgh	$731	12	$1,108	11	+51.6%
Raleigh Durham	$1,382	6	$2,282	6	+65.1%
San Francisco	$2,088	3	$2,651	3	+26.9%
Seattle	$709	13	$1,069	12	+50.8%
St. Louis	$612	14	$776	14	+26.8%
Tech Coast	$3,155	1	$4,128	1	+30.9%
Tech Valley	$347	16	$519	16	+49.5%
Washington, D.C.	$765	11	$1,187	10	+55.1%

Source: National Science Foundation (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

[13] See Appendix K for additional detail on academic research and development funding obtained by region.

TABLE 3.4 – RANK IN SELECTED CATEGORIES OF ACADEMIC RESEARCH AND DEVELOPMENT FUNDING OBTAINED IN 2012

	Engineering	Life Sciences	Math & Computer Sciences	All Funding
Atlanta	5	13	8	8
Austin	7	12	5	9
Baltimore	1	5	3	4
Boston	4	6	7	5
Houston	14	8	12	10
Nashville	15	15	16	15
New York	9	2	6	2
Greater Philadelphia	**6**	**7**	**11**	**7**
Pittsburgh	12	11	2	12
Raleigh Durham	10	4	9	6
San Francisco	3	3	10	3
Seattle	13	10	15	13
St. Louis	16	9	13	14
Tech Coast	2	1	1	1
Tech Valley	8	16	14	16
Washington, D.C.	11	14	4	11

Source: National Science Foundation (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

3.4 IMPLICATIONS OF REGIONAL EVALUATION OF INITIAL INPUTS METRICS

Greater Philadelphia's strong showing in degrees conferred and its middle-of-the-pack performance in academic research and development funding received is consistent with many regional leaders' perception of the region's strengths and shortcomings. Greater Philadelphia is dense in institutions of all sizes and disciplines, which produces an impressive number and diversity of graduates. Importantly, more and more are staying in the Greater Philadelphia region, thanks to the kinds of quality of life enhancements that are important to young knowledge workers.

However, while other regions have two or even three institutions that receive more than $500 million per year in research and development funding, the University of Pennsylvania (Penn) stands alone in Greater Philadelphia (see Table 3.5). As more and more research funding concentrates at the very large institutions, regions that have more than one such entity find themselves at a distinct advantage, in terms of scale and diversity, over regions that have one or none.

TABLE 3.5 – ACADEMIC RESEARCH AND DEVELOPMENT FUNDING BY REGION IN 2012

City	# Institutions w/$500M+ in R&D Funding	R&D Funding ($M)
Tech Coast	3 (UCSD, UCLA, USC)	$4,128
San Francisco	3 (UCSF, Stanford, Cal)	$2,651
Boston	2 (MIT, Harvard)	$2,460
Raleigh Durham	2 (Duke, UNC)	$2,282
Austin	2 (Anderson, UT Austin)	$1,262
New York	1 (Columbia)	$3,412
Baltimore	1 (Hopkins)	$2,606
Greater Philadelphia	**1 (Penn)**	**$1,610**
Atlanta	1 (Georgia Tech)	$1,282
Pittsburgh	1 (Pitt)	$1,108
Seattle	1 (UW)	$1,069
St. Louis	1 (Wash. U)	$776
Nashville	1 (Vanderbilt)	$583
Washington, D.C.	0	$1,187
Houston	0	$905
Tech Valley	0	$519

Source: National Science Foundation (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

Furthermore, Penn's research efforts are heavily concentrated in the life sciences, as National Institutes of Health funding represents over half of Penn's research funding. Meanwhile, by prestige or by funding, the region's engineering schools are not yet among the upper echelon in the US: only Princeton University (17th) and Penn (tied for 19th) were listed among the US News and World Report's 2015 ranking of top 50 engineering schools (University of Delaware ranked 55th and Drexel University ranked 63rd).

4.0 INNOVATION ACTIVITY

4.1 OVERVIEW

En route to commercialization events and business success, invention disclosures (Section 4.2) and patents (Section 4.3) represent two barometers of innovation activity. Both indicate a region's ability to convert technology transfer inputs into technology transfer outputs, and are thus worth monitoring to discern how productive and prepared a region is, relative to the past and relative to other regions.

4.2 INNOVATION ACTIVITY METRIC: INVENTION DISCLOSURES REPORTED

As a pre-cursor to patents, **invention disclosures** are a useful barometer of a region's ability to translate research activity into commercializable products and processes. The more that are filed by research institutions, the more prolific research entities are being in advancing innovations that might become valuable intellectual property that generates commercial success.

Invention disclosure data is available annually from the Association of University Technology Managers. Based on an average of 2007 to 2012 invention disclosures, Greater Philadelphia now ranks an impressive fourth among regions, behind Boston, New York, and the Tech Coast (see Table 4.1).

TABLE 4.1 – CHANGE OVER TIME IN INVENTION DISCLOSURES REPORTED BY REGION[14]

	2000-2006	Rank	2007-2012	Rank	% Chg	Rank Chg
Atlanta	372	8	599	5	61.0%	+3
Austin	91	15	N/A	N/A	N/A	N/A
Baltimore	467	3	409	8	-12.6%	-5
Boston	1,539	1	1,975	1	28.3%	-
Houston	423	5	298	12	-29.6%	-7
Nashville	108	14	153	13	42.2%	+1
New York	410	7	902	2	120.1%	+5
Greater Philadelphia	**419**	**6**	**684**	**4**	**63.4%**	**+2**
Pittsburgh	229	11	393	10	71.4%	+1
Raleigh Durham	442	4	512	6	15.9%	-2
San Francisco	316	9	475	7	50.2%	+2
Seattle	251	10	409	8	62.7%	+2
St. Louis	109	13	118	14	8.4%	-1
Tech Coast	704	2	852	3	21.0%	-1
Tech Valley	N/A	N/A	71	15	N/A	N/A
Washington, D.C.	171	12	308	11	80.2%	+1

Source: Association of University Technology Managers (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

4.3 INNOVATION ACTIVITY METRIC: PATENTS GRANTED

Patents are a form of intellectual property and a mechanism for protecting intellectual property. Thus, a region's ability to produce this valuable asset can be assessed in part by determining how many patents have been granted within that region. They represent the ability of research institutions to convert academic explorations into commercializable opportunities, as well as the depth of a region's pool of entrepreneurial individuals and corporate laboratory from which patentable innovations may also emerge.

Patent data is available every year from the US Patent Office. About 13,000 patents are granted to entities within Greater Philadelphia each year. This ranks Greater Philadelphia sixth among regions, behind San Francisco, the Tech Coast, New York, Boston, and Seattle (see Table 4.2).

[14] See Appendix M for additional detail on invention disclosures reported by region.

TABLE 4.2 – CHANGE OVER TIME IN TOTAL PATENTS GRANTED BY REGION[15]

Region	2000-2005	Rank	2006-2011	Rank	% Change	Rank Chg
Atlanta	6,316	10	8,065	11	27.7%	-1
Austin	10,213	6	12,703	7	24.4%	-1
Baltimore	3,774	13	3,618	13	-4.1%	-
Boston	18,636	4	21,559	4	15.7%	-
Houston	10,045	7	10,990	8	9.4%	-1
Nashville	893	16	929	16	4.0%	-
New York	30,715	3	30,875	3	0.5%	-
Greater Philadelphia	**13,509**	**5**	**12,799**	**6**	**-5.3%**	**-1**
Pittsburgh	3,819	12	3,636	12	-4.8%	-
Raleigh Durham	6,116	11	8,471	10	38.5%	+1
San Francisco	62,138	1	81,617	1	31.3%	-
Seattle	8,078	8	18,285	5	126.4%	+3
St. Louis	3,732	14	3,344	15	-10.4%	-1
Tech Coast	36,012	2	41,516	2	15.3%	-
Tech Valley	3,584	15	3,555	14	-0.8%	+1
Washington, D.C.	7,394	9	8,666	9	17.2%	-

Source: US Patent Office (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

4.4 IMPLICATIONS OF REGIONAL EVALUATION OF INNOVATION ACTIVITY METRICS

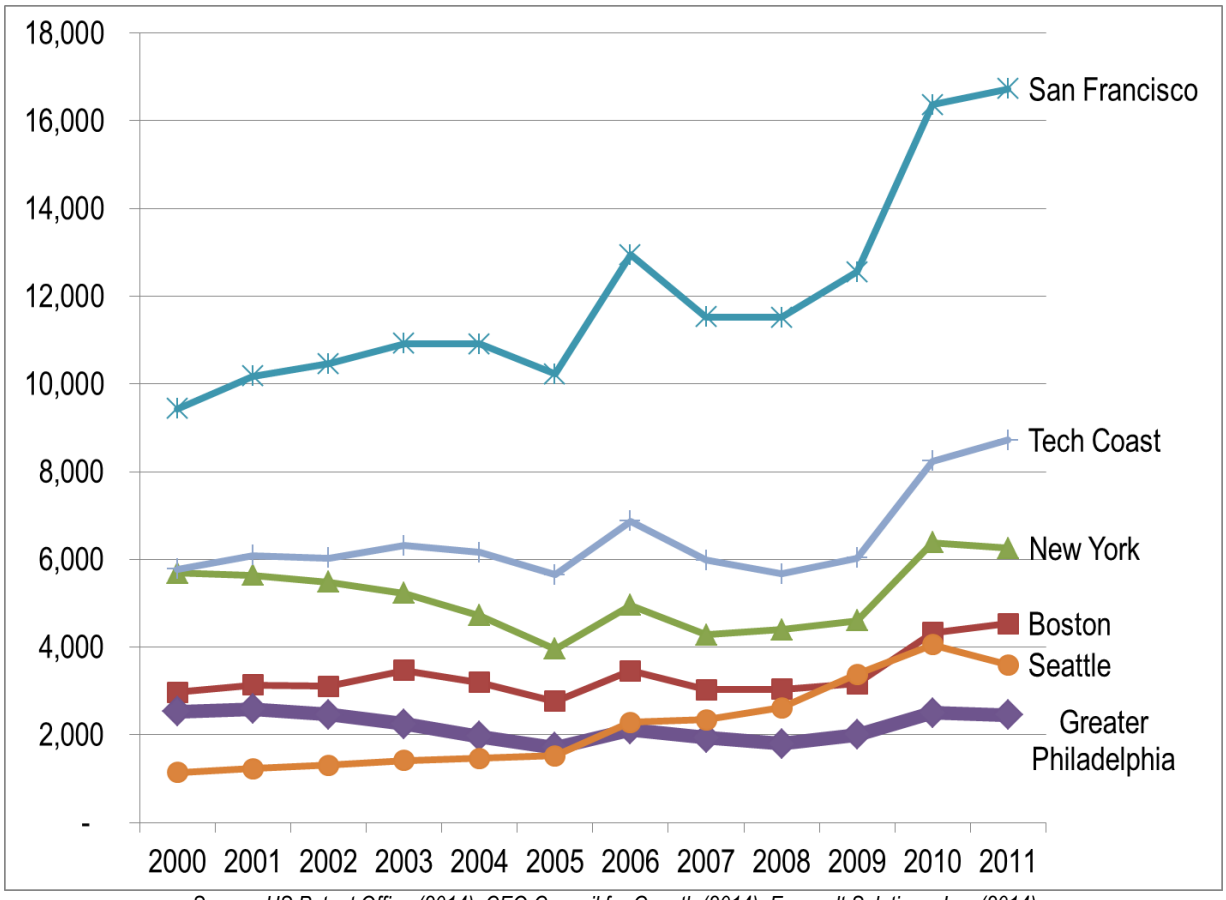
Greater Philadelphia's lower ranking in patents versus invention disclosures bespeaks a commonly held perception about the region, which is that its impressive cluster of research institutions and research activity does not translate into a commensurate amount of commercializable activity relative to its peer regions. And, its slide in the patent rankings from 5th in 2000-2005 to 6th in 2006-2011 describes not only a reduction in innovation production, relative to other regions, but also a potential future decline if it results in the loss of knowledge workers and knowledge activity to other, more productive regions.

Much of this disconnect can be explained through the importance of engineering and computer science to innovation activity in general and to patent activity in particular. Greater Philadelphia generates intellectual capital in the life sciences and biotechnology spaces, befitting the strength and focuses of its research institutions, but its corporations are not nearly as dominant in producing technology-related innovations. In contrast, San Francisco, the Tech Coast, New York,

[15] See Appendix N for additional detail on patents granted by region.

and Boston, with their concentrations of technology ventures, are prolific in patent activity, and Seattle, also rich in information technology and software companies, saw a significant jump in patent activity between the 2000-2006 and 2007-2012 periods (see Figure 4.3 and Figure 4.4).[16]

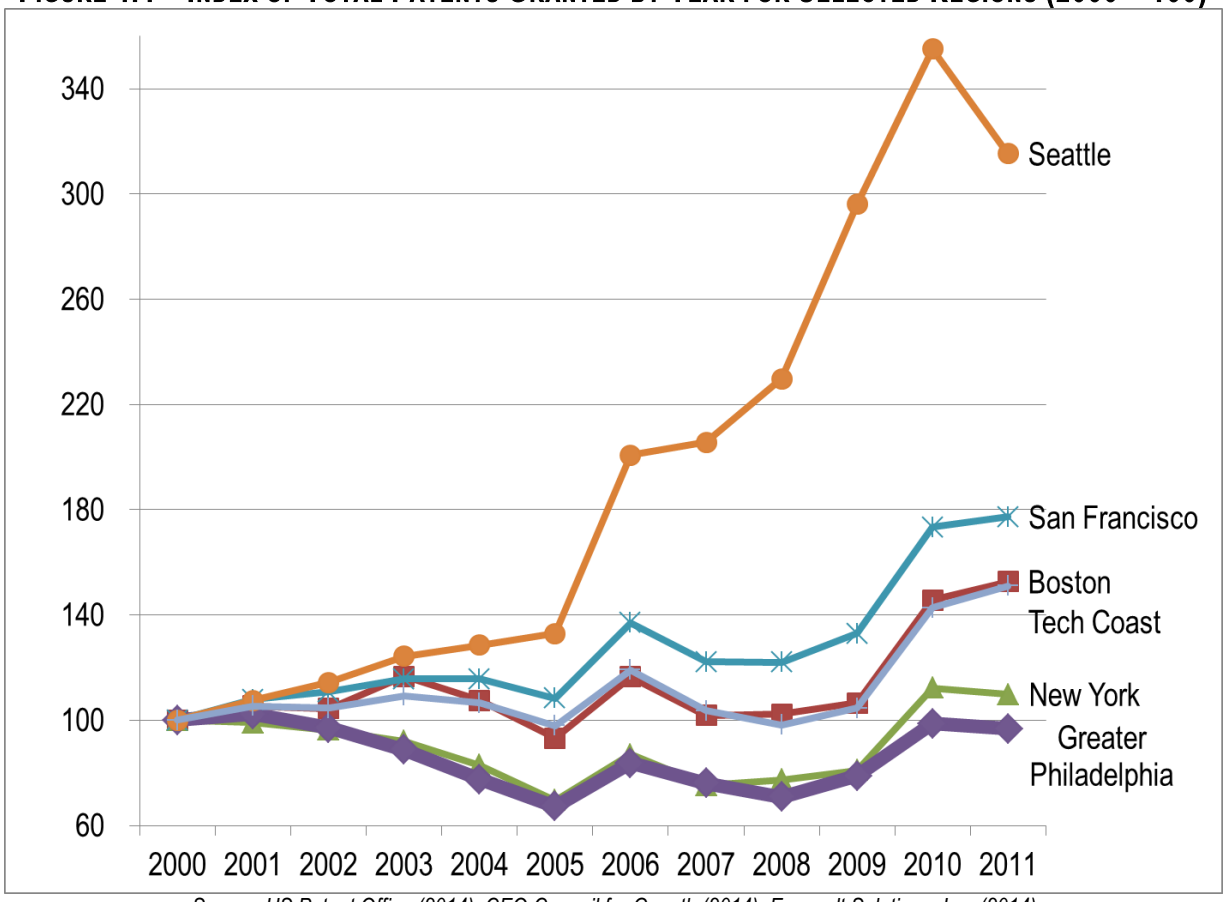
FIGURE 4.3 – TOTAL PATENTS GRANTED BY YEAR FOR SELECTED REGIONS



Source: US Patent Office (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

[16] Microsoft Corporation alone went from 444 patents per year during the 2000-2005 time period to more than four times that, 1,881 patents per year, during the 2006-2013 time period.

FIGURE 4.4 – INDEX OF TOTAL PATENTS GRANTED BY YEAR FOR SELECTED REGIONS (2000 = 100)



Source: US Patent Office (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

It is for these reasons that much attention has been given to strengthening and refocusing university technology transfer offices to facilitate the commercialization process of institution-initiated discoveries and to better connect those innovations to the marketplace via corporate partnerships. For example, Penn and Novartis have developed physical and legal linkages to accelerate the translation of basic cancer research innovations into commercializable therapies.[17]

[17] "University of Pennsylvania and Novartis Form Alliance to Expand Use of Personalized T Cell Therapy for Cancer Patients: Industry-Academic Partnership Will Establish New Research Center to Expedite Study and Development of Gene Transfer Approach," Penn Medicine (August 6, 2012).

5.0 DESIRED OUTPUTS

5.1 OVERVIEW

Technology transfer success can truly be measured by the outputs of research activity that result in commercialization events. These include startup licenses/options executed (Section 5.2), university startup ventures formed (Section 5.3), and venture capital investment received (Section 5.4).

5.2 DESIRED OUTPUTS METRIC: LICENSES EXECUTED

As noted above, one way intellectual property can be brought into the marketplace is through **licenses**, whereby some innovation is licensed to an established firm to use and monetize. Licenses therefore representative one successful outcome in the technology transfer process.

License execution data is available every year from the Association of University Technology Managers. Based on an average of 2007 to 2012 licenses executed, Greater Philadelphia ranks 5th among regions, behind Boston, New York, Raleigh Durham, and Seattle (see Table 5.1).

TABLE 5.1 – LICENSES EXECUTED BY REGION[18]

Region	2000-2006	Rank	2007-2012	Rank	% Chg	Rank Chg
Atlanta	54	13	111	9	103.6%	+4
Austin	33	14	N/A	N/A	N/A	N/A
Baltimore	121	6	128	6	5.8%	-
Boston	444	1	549	1	23.7%	-
Houston	116	7	97	11	-15.9%	-4
Nashville	30	15	49	14	60.7%	+1
New York	122	5	253	2	108.2%	+3
Greater Philadelphia	**123**	**4**	**143**	**5**	**16.3%**	**-1**
Pittsburgh	66	11	123	7	84.9%	+4
Raleigh Durham	160	2	242	3	50.9%	-1
San Francisco	109	9	109	10	-0.7%	-1
Seattle	115	8	225	4	96.4%	+4
St. Louis	67	10	50	12	-24.7%	-2
Tech Coast	155	3	114	8	-26.5%	-5
Tech Valley	N/A	N/A	9	15	N/A	N/A
Washington, D.C.	65	12	49	13	-23.9%	-1

Source: Association of University Technology Managers (AUTM) (2014), Econsult Solutions, Inc. (2014)

5.3 DESIRED OUTPUTS METRIC: UNIVERSITY START-UP VENTURES FORMED

Another way intellectual property can be brought into the marketplace by research institutions is for it to be imbued within a **startup venture** that is spun out of a research institution. This too represents a successful translation of a research innovation into a commercial setting.

Startup venture formation data is available every year from the Association of University Technology Managers. Based on an average of 2007 to 2012 startup venture formations, the Greater Philadelphia region ranks 7th among regions, behind Boston, New York, the Tech Coast, Pittsburgh, Raleigh Durham, and Atlanta (see Table 5.2).

[18] See Appendix O for additional detail on licenses executed by region.

TABLE 5.2 – UNIVERSITY STARTUP VENTURES FORMED BY REGION[19]

Region	2000-2006	Rank	2007-2012	Rank	% Chg	Rank Chg
Atlanta	12	5	13	6	12.4%	-1
Austin	6	13	N/A	N/A	N/A	N/A
Baltimore	7	10	10	9	35.3%	+1
Boston	49	1	60	1	20.7%	-
Houston	11	7	8	10	-27.9%	-3
Nashville	2	15	2	14	25.6%	+1
New York	16	3	32	2	105.8%	+1
Greater Philadelphia	**10**	**8**	**12**	**7**	**20.0%**	**+1**
Pittsburgh	12	5	15	4	27.9%	+1
Raleigh Durham	14	4	14	5	-1.2%	-1
San Francisco	8	9	4	12	-51.7%	-3
Seattle	6	11	10	8	70.7%	+3
St. Louis	2	14	3	13	24.0%	+1
Tech Coast	21	2	22	3	2.6%	-1
Tech Valley	N/A	N/A	2	15	N/A	N/A
Washington, D.C.	6	11	7	11	11.0%	-

Source: Association of University Technology Managers (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

5.4 DESIRED OUTPUTS METRIC: VENTURE CAPITAL INVESTMENT RECEIVED

Finally, since financial capital seeks returns, where it goes gives a good indication of where promising and viable innovations are being commercialized. **Venture capital** comes in many forms and is needed at many levels of business formation, and together it represents a measure of success for a region's technology transfer performance.

Venture capital investment data is available every year from the PricewaterhouseCoopers Moneytree Report. Based on an average of 2007 to 2012 venture capital investment received, the Greater Philadelphia region ranks 12th among regions (see Table 5.3).

[19] See Appendix P for additional detail on startup venture formation by region.

TABLE 5.3 – VENTURE CAPITAL INVESTMENT RECEIVED BY REGION[20]

Region[21]	2000-2006 ($M)	Rank	2007-2012 ($M)	Rank	% Chg	Rank Chg
AK/HI/PR	64	18	11	18	-83.0%	-
Colorado	1,175	11	620	11	-47.3%	-
DC/Metroplex	1,923	7	998	9	-48.1%	-2
LA/Orange County	2,247	5	1,805	4	-19.7%	+1
Midwest	1,784	8	1,304	5	-26.9%	+3
New England	4,739	2	3,329	2	-29.8%	-
North Central	569	13	442	14	-50.2%	-1
Northwest	1,392	9	957	10	-31.3%	-1
NY Metro	3,219	3	2,159	3	-32.9%	-
Greater Philadelphia	**1,004**	**12**	**573**	**12**	**-42.9%**	**-**
Sacramento/N.Cal	111	17	45	17	-59.9%	-
San Diego	1,337	10	1,172	8	-12.4%	+2
Silicon Valley	12,276	1	10,679	1	-13.0%	-
South Central	140	16	90	15	-36.2%	+1
Southeast	2,467	4	1,224	6	-50.4%	-2
Southwest	566	14	493	13	-12.8%	+1
Texas	2,246	6	1,211	7	-46.1%	-1
Upstate NY	143	15	77	16	-46.2%	-1

Source: PricewaterhouseCoopers Moneytree Report (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

5.5 IMPLICATIONS OF REGIONAL EVALUATION OF DESIRED OUTPUTS METRICS

Commercialization through licensing is, all else equal, less risky than commercialization through spinoff startup ventures. Relative to other regions, the Greater Philadelphia region is more high-performing in licensing agreements (5th out of 15) than in spinoff startup ventures (7th out of 15), which is consistent with the assessment among regional leaders that the Greater Philadelphia region is more risk-averse than other regions. This fact is not unrelated to its relative underperformance in venture capital investment received (12th out of 18), since venture capital flows to high-risk and high-return startups rather than to established entities.

[20] See Appendix Q for additional detail on venture capital investment received by region.

[21] Slightly different comparison regions were used in this table due to data availability constraints.

According to many interviewees, Greater Philadelphia continues to need to promote itself to national venture capital firms seeking attractive innovations to invest in. Greater Philadelphia's strengths in life sciences also create a challenge for attracting early stage capital, since the lead times and funding requirements in that space are often long and prohibitive, in contrast to the diminishing turnaround times and funding needs of fundable ventures in other sectors such as information technology and social media.

Fundamentally, capital flows to the best ideas, and is in this sense the purest form of market signal. **Whereas licensing agreements and startup ventures represent institution-originating metrics, venture capital represents a market-defined metric**. This notion of how to translate the impressive density and productivity of the region's research institutions into capital-attracting innovations is further explored in the final two sections of this report.

6.0 INDEXING THE GREATER PHILADELPHIA REGION'S PERFORMANCE

6.1 OVERVIEW

Indexing Greater Philadelphia's performance in key technology transfer metrics against that of other regions provides a sense of where it fits in this competitive landscape. Values were calculated for which data was available for Greater Philadelphia and all comparison regions. For each index, Greater Philadelphia was assigned a score of 100, and all other regions' values were calculated relative to that benchmark. Hence, a score of 200 represents a performance level twice that of Greater Philadelphia, and a score of 50 represents a performance level half that of Greater Philadelphia.

6.2 INITIAL INPUTS INDEX RESULTS[22]

The **initial inputs index** consists of two components: (1) degrees conferred and (2) financing of academic research and development. In the initial inputs index, Greater Philadelphia ranked 6th, down one place from 5th in 2007, and trailing the Tech Coast, New York, San Francisco, Boston, and Baltimore (see Table 6.1).

[22] See Appendix R for additional detail on initial inputs index results.

TABLE 6.1 – INITIAL INPUT INDEX RESULTS FROM THIS REPORT (INDEXED: GREATER PHILADELPHIA = 100)

Region	Index	2014 Rank	2007-2014 Rank Chg
Atlanta	60.8	9	-
Austin	54.1	12	↓1
Baltimore	103.4	5	↓1
Boston	125.5	4	-
Houston	51.9	13	↓3
Nashville	28.0	16	-
New York	214.5	2	↓1
Greater Philadelphia	**100.0**	**6**	**↓1**
Pittsburgh	56.0	11	↓1
Raleigh Durham	90.8	7	-
San Francisco	126.1	3	-
Seattle	57.9	10	↓1
St. Louis	45.2	14	-
Tech Coast	236.9	1	-
Tech Valley	29.2	15	-
Washington, D.C.	78.7	8	-

Source: Econsult Solutions, Inc. (2014)

6.3 INNOVATION ACTIVITY INDEX RESULTS[23]

The **innovation activity index** consists of two components: (1) invention disclosures reported and (2) patents granted. In the innovation activity index, Greater Philadelphia ranked 6th, down one place from 5th in 2007, and trailing San Francisco, Boston, the Tech Coast, and New York (see Table 6.2).

[23] See Appendix S for additional detail on innovation activity index results.

TABLE 6.2 – INNOVATION ACTIVITY INDEX RESULTS FROM THIS REPORT (INDEXED: GREATER PHILADELPHIA = 100)

Region	Index	2014 Rank	2007-2014 Rank Chg
Atlanta	75.3	7	↑2
Austin	N/A	N/A	N/A
Baltimore	44.0	11	↑2
Boston	228.6	2	-
Houston	64.7	9	↓3
Nashville	14.8	15	-
New York	186.5	4	-
Greater Philadelphia	**100.0**	**6**	**↓1**
Pittsburgh	42.9	12	-
Raleigh Durham	70.5	8	↑1
San Francisco	353.6	1	-
Seattle	101.3	5	↑5
St. Louis	21.7	13	-
Tech Coast	224.4	3	-
Tech Valley	19.1	14	N/A
Washington, D.C.	56.3	10	↑1

Source: Econsult Solutions, Inc. (2014)

6.4 DESIRED OUTPUTS INDEX RESULTS[24]

The **desired outputs index** consists of two components: (1) licenses executed and (2) startup ventures formed.[25] In the desired outputs inputs index, Greater Philadelphia ranked 7th, down one place from 6th in 2007, and trailing Boston, New York, Raleigh Durham, the Tech Coast, Seattle, and Pittsburgh (see Table 6.3). Given its relatively poor performance in venture capital investment received, Greater Philadelphia's true ranking in this category is even lower than this.

[24] See Appendix T for additional detail on desired outputs index results.

[25] Data inavailability meant that venture capital investment received could not be included in the desired outputs index results.

TABLE 6.3 – DESIRED OUTPUTS INDEX RESULTS FROM THIS REPORT (INDEXED: GREATER PHILADELPHIA = 100)

Region	Index	2014 Rank	2007-2014 Rank Chg
Atlanta	93.5	8	↓2
Austin	N/A	N/A	N/A
Baltimore	84.7	9	-
Boston	437.5	1	-
Houston	66.3	10	↓5
Nashville	26.6	14	↓1
New York	221.5	2	↓2
Greater Philadelphia	**100.0**	**7**	**↓1**
Pittsburgh	105.3	6	↓1
Raleigh Durham	141.6	3	-
San Francisco	54.5	11	↓3
Seattle	119.9	5	↓6
St. Louis	29.3	13	↓1
Tech Coast	129.6	4	↓2
Tech Valley	9.9	15	N/A
Washington, D.C.	43.9	12	-

Source: Econsult Solutions, Inc. (2014)

6.5 CONSOLIDATED INDEX RESULTS

The **consolidated index** averages all indexes together, and thus accounts for the two initial inputs metrics, the two innovation activity metrics, and the two desired outputs metrics. In this consolidated index, Greater Philadelphia ranked 6th, down one place from 5th in 2007, and trailing Boston, New York, the Tech Coast, San Francisco, and Raleigh Durham (see Table 6.4). It slipped one place in all three indexes (see Table 6.5).

TABLE 6.4 – CONSOLIDATED INDEX RESULTS FROM THE 2007 REPORT AND THIS REPORT (INDEXED: GREATER PHILADELPHIA = 100)

Region	2007 Average	2007 Rank	2014 Average	2014 Rank	Rank Change
Atlanta	68.5	9	76.5	9	-
Austin	46.0	13	N/A	N/A	N/A
Baltimore	83.2	7	77.3	8	↓1
Boston	265.3	1	263.9	1	-
Houston	81.2	8	61.0	11	↓3
Nashville	20.9	15	23.2	14	↑1
New York	164.5	3	207.5	2	↑1
Greater Philadelphia	**100.0**	**5**	**100.0**	**6**	**↓1**
Pittsburgh	59.0	11	68.1	10	↑1
Raleigh Durham	94.9	6	101.0	5	↑1
San Francisco	160.4	4	178.1	4	-
Seattle	62.4	10	93.0	7	↑3
St. Louis	37.5	14	32.0	13	↑1
Tech Coast	206.9	2	197.0	3	↓1
Tech Valley	N/A	N/A	19.4	15	N/A
Washington, D.C.	58.9	12	59.6	12	-

Source: Econsult Solutions, Inc. (2014)

TABLE 6.5 – CONSOLIDATED INDEX RESULTS FOR THE GREATER PHILADELPHIA REGION FROM THE 2007 REPORT AND THIS REPORT

Index	2007 Rank	2012 Rank	Rank Change
Initial Inputs	5	6	↓1
Innovation Activity	5	6	↓1
Desired Outputs	6	7	↓1
Consolidated	5	6	↓1

Source: Econsult Solutions, Inc. (2014)

6.6 THE GREATER PHILADELPHIA REGION'S STANDING RELATIVE TO OTHER REGIONS

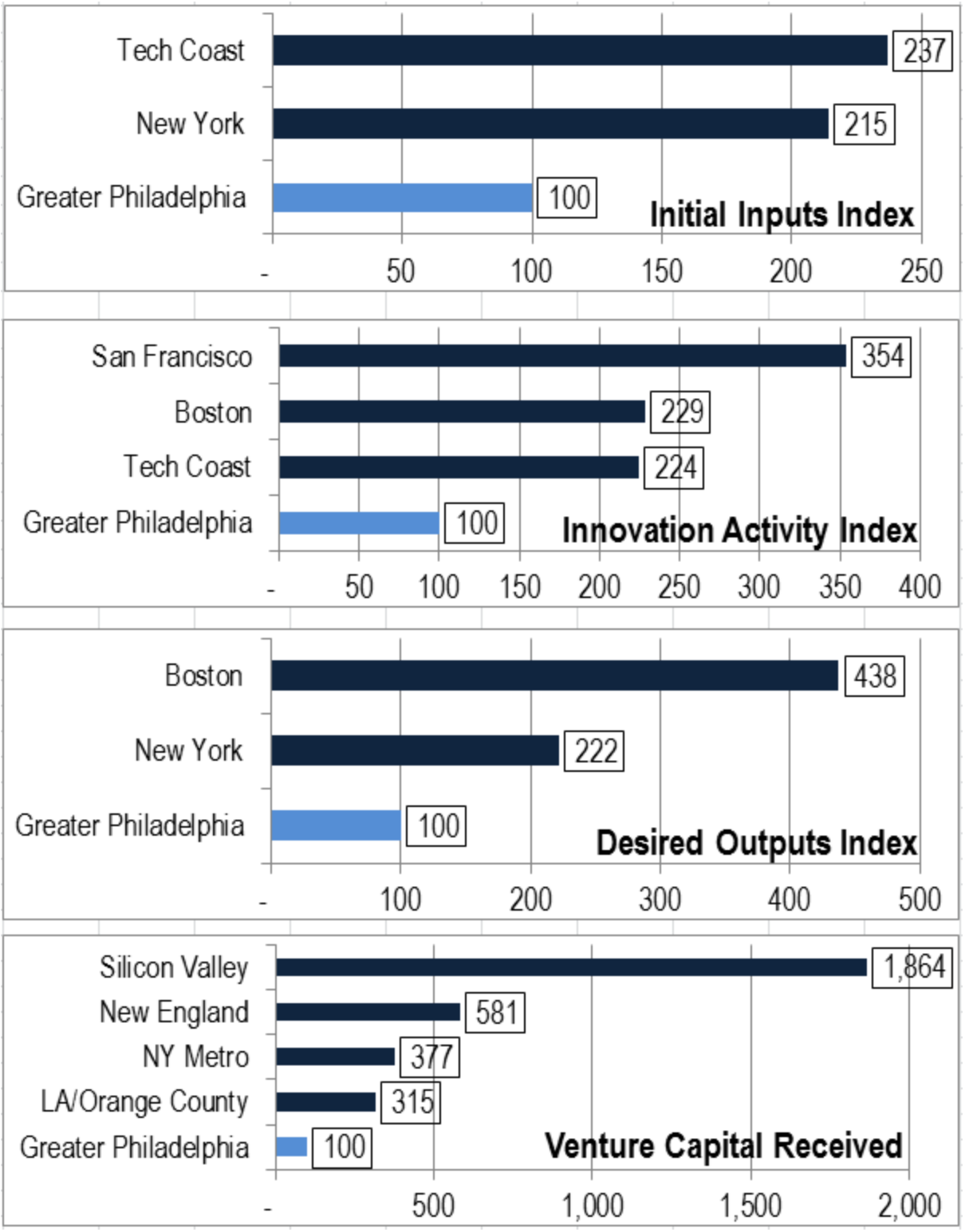
While the regions placing ahead of Greater Philadelphia are bona fide technology transfer giants, it is troubling that Greater Philadelphia's ranking is declining across the board. It is also troubling that the highest ranked regions boast two or more times more activity than Greater Philadelphia (see Figure 6.1):

- Initial inputs – Tech Coast (2.4x), New York (2.1x)

- Innovation activity – San Francisco (3.5x), Boston (2.3x), Tech Coast (2.2x)
- Desired outputs – Boston (4.4x), New York (2.2x)
- Venture capital investment – Silicon Valley (18.6x), New England (5.8x), New York Metro (3.8x), Los Angeles and Orange County (3.1x), Midwest (2.3x), Southeast (2.1x), Texas (2.1x), San Diego (2.0x)[26]

[26] This gap has widened more recently; according to the National Venture Capital Association, the Greater Philadelphia region raised $125 million through 32 venture capital deals during the first three quarters of 2014. This amount is dwarfed by that of the Silicon Valley ($9.3 billion from 506 deals, or 74 times more capital raised), New York ($3.1 billion from 272 deals, or 24 times more capital raised), Boston ($1.1 billion from 158 deals, or 8 times more capital raised), and Washington ($456 million from 77 deals, or 3 times more capital raised).

FIGURE 6.1 – TECH TRANSFER INDEX RESULTS FOR GREATER PHILADELPHIA AND SELECTED REGIONS (INDEXED: GREATER PHILADELPHIA=100)



Source: Econsult Solutions, Inc. (2014)

7.0 INDUSTRY CLUSTER ANALYSIS[27]

7.1 OVERVIEW

There is a growing awareness of the power of industry clusters to produce virtuous cycles of increasing production and positive perception. Industry cluster analysis is a useful way to understand the relative levels and concentrations of certain economic activities within a region, as compared over time or space, from which to identify and build from areas of strength. This is a relevant component of any evaluation of a region's technology transfer potential, because it informs where that region has a competitive edge over others.

7.2 LOCATION QUOTIENT ANALYSIS

A **Location Quotient** (LQ) is an indicator of industry concentration within a region, expressed as the ratio of the proportion of the industry locally within the total local economy to the proportion of the industry nationally within the total national economy. An LQ greater than 1 indicates that the industry is a bigger piece of its local economy than it is of the national economy, with the implication being that the industry is producing more goods and services than are being consumed locally, and must therefore be exporting them to other regions. Through this analysis, it can be determined that the Greater Philadelphia region holds a competitive advantage in at least two clusters: (1) **Education and Knowledge Creation** and (2) **Biopharmaceuticals** (see Table 7.1). In both of these clusters, employment growth was positive between 2000 and 2012, and LQs were well above 1. This suggests that these two clusters are among the Greater Philadelphia region's strongest and most dynamic.

TABLE 7.1 – GREATER PHILADELPHIA REGION INDUSTRY LOCATION QUOTIENTS OVER TIME IN SELECTED INDUSTRY CLUSTERS

Cluster	2000-2012 %Chg Employment	2000 LQ	2012 LQ
Education and Knowledge Creation	**+44%**	**1.77**	**1.79**
Communications Equipment and Services	-40%	0.70	0.79
IT and Analytical Instruments	-11%	0.84	1.10
Aerospace Vehicles and Defense	-16%	0.99	1.00
Medical Devices	-8%	0.97	0.88
Biopharmaceuticals	**+13%**	**2.08**	**2.28**

Source: US Cluster Mapping Project (2014), Econsult Solutions, Inc. (2014)

[27] See Appendix U for a more detailed industry cluster analysis of the Greater Philadelphia region.

7.3 SHIFT SHARE ANALYSIS

Shift Share Analysis is a standard regional analysis method that attempts to determine how much of regional job growth can be attributed to national trends versus industry trends versus unique regional factors. Through this analysis, it can be determined that over 70 percent of the job growth in **Biopharmaceuticals** between 2000 and 2012 (1,002 out of 1,383 jobs added) can be explained by the region's increased competitiveness, and that although the region lost 3,266 jobs in **Information Technology and Analytical Instruments**, the region's increased competitiveness actually resulted in 5,916 jobs added (see Table 7.2).

TABLE 7.2 – GREATER PHILADELPHIA REGION KEY INDUSTRY CLUSTER SHIFT SHARE ANALYSIS FROM 2000 TO 2012

Industry	National	Industry	Region	Total Shift
Education and Knowledge Creation	730	35,075	914	36,719
Communications Equipment and Services	75	-4,082	544	-3,463
Information Technology and Analytical Instruments	253	-9,435	5,916	-3,266
Aerospace Vehicles and Defense	122	-2,327	33	-2,172
Medical Devices	50	79	-576	-447
Biopharmaceuticals	94	288	1,002	1,383

Source: Statsamerica.org (2014), Econsult Solutions, Inc. (2014)

7.4 OCCUPATIONAL CLUSTER ANALYSIS

Occupation Cluster Analysis (OCA) is a relatively new tool in regional economic analysis. It can offer insights into the talent base of the workforce that go beyond the relatively simple measure of educational attainment. In contrast to industry clusters that focus on what businesses produce, occupation clusters focus on the knowledge, skills, and abilities of the individuals who work for those businesses. OCA can therefore help identify which clusters of occupations provide the best opportunities for investment to build different types of skills, supporting existing and emerging industry clusters, and which occupation clusters represent a competitive advantage for the region.

By calculating LQs for occupational clusters relevant to technology transfer, it can be determined that the Greater Philadelphia region holds its strongest competitive advantage in **Health Care and Medical Science**, with LQs well above 1 (see Table 7.3). Through Shift Share Analysis, it can be determined that the Greater Philadelphia region holds its strongest competitive advantage in **Mathematics, Statistics, Data and Accounting**, with 2,500 jobs gained as a result of increased competitiveness at the regional level (see Table 7.4).

TABLE 7.3 – GREATER PHILADELPHIA REGION OCCUPATIONAL LOCATION QUOTIENTS OVER TIME IN SELECTED OCCUPATIONAL CLUSTERS

Name	2000-2010 %Chg Employment	2001 LQ	2010 LQ
Health Care and Medical Science (Medical Practitioners and Scientists)	-3%	1.36	1.35
Mathematics, Statistics, Data and Accounting	7%	1.25	1.28
Information Technology (IT)	0%	1.14	1.13
Natural Sciences and Environmental Management	-39%	1.00	0.96
Engineering and Related Sciences	-25%	1.20	1.07
Postsecondary Education and Knowledge Creation	-11%	1.35	1.19

Source: Statsamerica.org (2014), Econsult Solutions, Inc. (2014)

TABLE 7.4 – GREATER PHILADELPHIA REGION KEY OCCUPATIONAL CLUSTER SHIFT SHARE ANALYSIS FROM 2000 TO 2009

Industry	National	Industry	Region	Total Shift
Health Care and Medical Science (Aggregate)	11,330	25,970	-15,000	22,300
Mathematics, Statistics, Data and Accounting	5,119	884	2,511	8,513
Information Technology (IT)	3,921	-1,596	-810	1,514
Engineering and Related Sciences	2,231	-3,990	-1,926	-3,685
Postsecondary Education and Knowledge Creation	2,618	1,675	-6,362	-2,069
Technology-Based Knowledge Clusters	17,314	2,124	-8,953	10,486
Skilled Production Workers	11,364	-16,105	-5,861	-10,602

Source: Statsamerica.org (2014), Econsult Solutions, Inc. (2014)

8.0 EVALUATING THE REGION'S ASSETS

8.1 OVERVIEW

The purpose of this section is to synthesize the analytics from the previous sections as well as lessons learned from interviews, surveys, and best practices research into an assessment of the Greater Philadelphia region's performance in technology transfer and commercialization. This assessment includes affirmations of the region's strengths, identifications of areas of decline, and clarifications of commonly held perceptions that may not be completely true, and is intended to inform the recommendations that follow in the next section.

8.2 INGREDIENTS FOR A VIBRANT TECHNOLOGY TRANSFER ECOSYSTEM

As noted above, the technology transfer process is far too messy to be materially improved through a one-dimensional response. Instead, the "rainforest" analogy presented earlier in this report is a relevant and useful one; flourishing, then, comes from a rich, resilient, and multi-faceted setting in which innovation can be birthed and grown. Given that, **evaluating a region's performance and identifying meaningful interventions is less about identifying a singular problem or solution and more about stimulating an environment in which the necessary ingredients are in place for innovation to take place**.

The research effort behind this report by Econsult Solutions on technology transfer and commercialization yielded a consistent set of these common ingredients that can be found in strong technology transfer hubs (in alphabetical order):

1. Venues and entities that facilitate **COLLABORATION**. Practically, the technology transfer process requires multiple actors working together. Moreover, innovation, by definition, requires thinking that goes well beyond incremental improvements within a field and seeks out new processes and new products. This is often benefitted by the mixing of multiple disciplines and players.
2. An open and entrepreneurial **CULTURE**. Beyond the physical assets and connections that make up a healthy regional economy, culture can play a vital role in birthing innovation. While hard to codify, a healthy culture is one that is open to and predisposed towards new thinking, and it can be reflected in the ways people and organizations interact and in the policies that govern those interactions.
3. Sufficient **FUNDING** and related mechanisms. Commercializing new discoveries requires financial resources throughout the entire process. Regions must therefore be organized and coordinated in identifying, attracting, and securing these funds.
4. A large and engaged **PRIVATE SECTOR**. Research institutions are in the business of knowledge-seeking, whereas the commercialization potential of that effort is actualized in the private sector. Regions that are successful in technology transfer are characterized by large, robust, and engaged clusters of private firms in key industries that benefit and are benefitted by their nearby research entities.

5. Strong **RESEARCH INSTITUTIONS**. While some innovations are birthed within private firms, many originate from the research efforts of academic and medical institutions. These entities serve as repositories for talent, research activity, and related funding, and are increasingly seen as essential to regional economic success in today's modern knowledge economy.
6. An awareness of the **RESEARCH PRIORITIES** that make sense for a region. Perception goes a long way in determining where talent, research activity, and funding will go. So if a region has established itself as the preeminent location in particular research field, it will be successful in building on that status. Conversely, a muddier picture of what a region's strengths are results in an impaired ability to attract the necessary human and financial capital.
7. A deep **TALENT** pool. While it also requires physical and financial capital, innovation ultimately requires human capital. As a result, regions that are successful in birthing, attracting, and growing human talent have a significant competitive advantage.

8.3 ORGANIZATION OF ASSESSMENTS AND THEMES

What follows is a set of assessments and themes that have emerged from the research effort behind this report on technology transfer and commercialization. They bring together the takeaways from a variety of sources – interviews, surveys, best practices research, and analytics – and lay the groundwork for the series of recommendations that follow in the next section.

8.4 THE CENTRALITY OF RESEARCH INSTITUTIONS

The state of the region's **research institutions** is strong. They are a reason the region should feel bullish about its future technology transfer and commercialization prospects, and they are a reason the region has scored well in technology transfer metrics related to research activity. Given the depth and breadth of institutions in the region, this is a commonly understood assessment, and it is largely correct. However, as noted above, the region boasts one research institution that receives over $500 million in research funding, which is Penn, whereas some other regions have two or even three such entities, giving them a significant advantage in both depth and breadth of research activity. Furthermore, it is useful to delve deeper into the state of the region's research institutions, to see where there are points of vulnerability that need to be identified and addressed in order for the region to flourish as an innovation hub.

To do so, first consider the inherent tension between a research institution's core purpose and the role it plays in the technology transfer process. Research institutions exist to pursue knowledge. Without this function, there is no innovation. But there is a difference between pursuing knowledge and pursuing markets for the discoveries that result from that pursuit of knowledge. And depending on the ethos of the institution and the subject matter of its focus, that gap can be large and difficult to bridge.

However, change is happening. An uncertain federal funding climate and a new generation of young talent seeking entrepreneurial venues is pushing our region's institutions to reconsider their technology transfer processes and establish innovation space to remain competitive and woo researchers. Interviews and surveys confirmed that most all institutions in the region anticipate more attention and more resources devoted to commercialization efforts in the coming years.

As a transition to the next sub-section, it must be noted that collaboration across institutions was universally recognized by interviewees as both essential and difficult to accomplish. It is essential because pooled resources and pooled agendas yield the kinds of research breakthroughs that lead to commercialization success. It is difficult to accomplish because institutions are just as much competitors as they are collaborators, whether for talent, patients, research activity, or research funding.

It is noteworthy that Duke University and University of North Carolina (UNC), two intense rival schools, have been able to team up on major research-oriented initiatives. The urology center at Duke Health Center is staffed by Duke employees and draws half it funding from UNC. The two entities share both revenues and expenditures equally. Importantly, they split the cost of a $1.4 million lithotripter, which is a device that bombards kidney stones with shock waves until they disintegrate. In a very real sense, this partnership is centered on this expensive piece of equipment, which the two schools share the cost of and the benefit of. This is instructive for regional explorations to join multiple schools together on shared efforts.

8.5 COLLABORATION IS KEY

Understanding the importance of collaboration in the technology transfer and commercialization process, the region has made great strides in establishing venues, both physical and programmatic, to encourage working across entities. The Greater Philadelphia Alliance for Capital and Technologies (PACT), Pennsylvania Bio, First State Innovation, New Jersey Technology Council, Ben Franklin Technology Partners, and the University City Science Center are examples of convening organizations that encourage greater mixing across research institutions and to the region's entrepreneurial and corporate communities.

Nevertheless, additional collaboration is needed. An instructive collaboration model can be found in Boston, where the Eli and Edythe L. Broad Institute of Harvard and MIT has successfully knit together Massachusetts Institute of Technology (MIT), Harvard University, Beth Israel Deaconess Medical Center, Brigham and Women's Hospital, Children's Hospital, Dana Farber Cancer Institute, and Massachusetts General Hospital. The Broad Institute describes itself as "an experiment in a new way of doing science," and its research work on biology and medicine is organized around the following four principles: (1) act nimbly, (2) work boldly, (3) share openly, and (4) reach globally.

Similarly, the region must consider venues for pursuing additional collaboration for the sake of increasing innovation capacity. University City Science Center is a natural convener, given its ties to all of the region's major research institutions. Indeed, its success in aggregating research

activity and entrepreneurial resources along the "Avenue of Technology" corridor west of downtown Philadelphia is held up as an example of the power of what are now being called "innovation districts" in encouraging collaboration.[28]

The Wistar Institute may be another useful place to originate such efforts. It has a long history of research innovations, is strategically located near Penn, and, importantly, it does not directly compete against its peer academic and medical institutions since it does not have students or patients. Wistar represents neutral territory on which entities can collaborate and not feel they are assisting a competitor.

Other venues should be explored to encourage collaboration. Some may be organized around shared equipment; for example, the region's growing capacity in nanoscale research may benefit from a coordinated approach to the procurement, usage, and leverage of expensive measurement equipment. Other collaborative efforts may be galvanized by shared research priorities; for example, the region's institutions, which are strong in neurosciences, may be motivated by a shared desire to be the first set of institutions to find a cure for Alzheimer's disease.

The Energy Commercialization Institute (ECI) is a good example of a commercialization-focused collaborative initiative. Established in 2009 by Ben Franklin Technology Partnership, Drexel University, University of Pennsylvania, and Penn State University, ECI represents the confluence of the pooling of intellectual property from participating institutions and the provision of technology transfer services to the end of promoting energy commercialization. Importantly, ECI helps corporations by providing a single point of negotiation for the licensing of intellectual property that may otherwise intersect with multiple research institutions.

8.6 THE CORPORATE LANDSCAPE

Regions that are strong in technology transfer and commercialization have **robust corporate sectors** that are well-linked with research institutions. Silicon Valley is perhaps the nation's best such example. Stanford University's Office of Technology Licensing is characterized by strong partnerships with such corporate entities as Lockheed Martin and Samsung Electronics. These alliances are highly cooperative, with these companies providing not only a commercialization venue for the innovations birthed out of Stanford but also in many cases direct partnership in the research work itself. These kinds of alliances help foster a bent towards commercialization within a research institution's culture and policies.

The Greater Philadelphia region's density of pharmaceutical giants is a plus for its research institutions and for technology transfer efforts. The close proximity of such entities as Pfizer, GlaxoSmithKline, and AstraZeneca creates bountiful opportunities for collaboration and commercialization. The collaboration between Novartis and Penn around cancer therapies is an excellent example of this. Nevertheless, more can be done to ensure that proximity and history translate into actual collaboration and commercialization into the future.

[28] "The Rise of Innovation Districts: A New Geography of Innovation in America," Brookings Institution (May 2014).

Outside of pharmaceuticals, there are other possibilities for corporate engagement. Comcast, one of the largest corporations in the region and a fast-growing corporate giant, is a natural partnership possibility. Indeed, Comcast is positioning itself to be more participatory in regional innovation; its new office tower in Center City Philadelphia will be called the Comcast Innovation and Technology Center. This represents an ambitious transition and it behooves the region and its research institutions to assist in that transformation.

There is also something to be said about the tax and regulatory burden imposed by City of Philadelphia on firms located within the City. In today's knowledge economy, strong regions require strong central cities, because it is in those core urban areas that a bulk of the knowledge activity is often located, in the form of universities, hospitals, and research centers. Hence, how successful a region is in innovation activity depends greatly on how friendly a region's central city is to knowledge firms and high-skilled workers. Unfortunately, the reputation and reality about the City's tax and regulatory burden is that it drives away such activity. This creates a real drag on the region's technology transfer and commercialization prospects.

8.7 THE STATE OF VENTURE CAPITAL

As noted above, the distribution of **venture capital** represents the will of the marketplace in finding the most attractive deals. Capital is extremely mobile in this regard, and will go to the regions, industries, and companies that offer the highest returns. It is therefore incomplete to suggest that there is an insufficient amount of available venture capital in the region, because capital-seeking ventures in the region are not constrained to just that pool of money.

It is true, though, that the region does not do as well in attracting venture capital investment as other regions, especially when one considers how prolific the region's many research institutions are. This raises the legitimate question of why the region struggles to attract venture capital.

To begin with, there is something to be said about a local public policy role in incentivizing technology transfer and commercialization activity. Early-stage money is extremely difficult to come by, even in a fluid global capital market. Many states, most notably Massachusetts and Ohio, have decided to motivate entrepreneurship activity through early-stage funds and/or an investment tax credit. It may be useful to advocate for the states in this region to consider offering similar inducements, which not only symbolize direct investments in homegrown innovation but also send a signal to the marketplace that a location is serious about creating a positive climate for innovation.

There is also something to be said about the importance of trailblazing innovators being a positive influence on subsequent generations of entrepreneurs. An important part of the healthy entrepreneurship ecosystem in Silicon Valley is the ubiquitous presence and active participation of numerous long-standing pioneers who first made their mark years and decades prior. These individuals are often described as "trunks" from which manifold "branches" grow, through mentorship, investment, partnership, or other mechanisms for influence.

The Greater Philadelphia region is far shallower than Silicon Valley in this regard. But it does not need to take long for the emergence of "trunks" to make their mark. Josh Kopelman, one of the

region's preeminent entrepreneurs and now an investor and mentor to this present generation of entrepreneurs through his fund, First Round Capital, considers that it could take as few as one or two $100 million plus deals to create a virtuous cycle of success producing the seeds for even more success.

8.8 TALENT ATTRACTION

While the technology transfer process requires physical and financial capital, fundamentally it is **intellectual capital** that determines success. Here the region has much reason to be optimistic. The Greater Philadelphia region is home to many institutions that draw students, faculty, researchers, and administrators from across the country and around the world. The density of world-class institutions represents a major selling point for the region because it is a powerful draw for talent.

Increasingly, that talent is choosing to stay in the region. Quality of life matters for knowledge workers, and the region has made great strides in investing in quality of life enhancements. These investments are making a difference in retaining young talent.

Whether young talent stays depends on a number of factors, some of which are within the region's control and some which are not. Decisions to stay or go are often motivated by a small handful of factors: climate, family, public school quality, amenities, and jobs. The region should take note of how it can make itself more attractive for young talent at the moment they are making life decisions about moving or staying.

Within the technology transfer and commercialization space, oftentimes talent seeks out the financial, entrepreneurial, and relational resources needed to thrive. Given that innovation depends on the richness of the environment within which it is birthed, it is not surprising that in interviews, the most common reason young entrepreneurs gave for choosing their eventual location for growing their new venture was because it offered the highest concentration of other young entrepreneurs.

Here the ascent of New York City as a technology hub has been a mixed blessing for the Greater Philadelphia region. On the one hand, easy access to one of the world's largest financial centers is a great plus for Greater Philadelphia. On the other hand, that proximity means Greater Philadelphia loses a lot of talent to New York City. One young entrepreneur described it like this:

> *"If you have a connection to Greater Philadelphia because it's your hometown or where you went to school or where you birthed your business, it's easier to go to New York City to grow, and still be able to get back to family and friends in Greater Philadelphia. Before, when your other choices were Boston or Silicon Valley, that was a harder move to make."*

Other regions are providing financial support to help research institutions woo elite researchers. For example, in recent years the State of Texas has used voter-approved bond money to fund more research facilities and provide matching funds for research initiatives, particularly in the area of cancer research. These resources create a powerful draw for top-flight researchers

seeking sufficiency and certainty in funding when contemplating where to locate their research work. Hence, funding can attract talent just as much as talent attracts funding.

8.9 COMPETITIVE ADVANTAGES IN RESEARCH PRIORITIES

Many of the interviews conducted for this report were with research institutions. These interviews yielded a rich sense of where the region sees its **competitive advantages** in terms of research priorities. Those strengths can be summarized as follows:

- Cancer – Whether from a genetic, immunological, or biological standpoint, the understanding of and treatment of cancer is a region-wide area of focus.
- Drugs and vaccines – The focuses of the region's research institutions and its pharmaceutical giants intersect on the chemistry and the clinical research around drugs and vaccines.
- Neurosciences – Depth of neurological research is another manifestation of the present configuration of the region's research assets.
- Nanoscale research – The region's growing work in nanoscale research is enabling potential deployments in a number of fields.
- Health care – The region's focus on life sciences, its geographic proximity to Washington DC, and its concentration of medical centers and insurers is yielding an impressive cluster of activity around the delivery of health care, including health care information technology, wearables, the health care process, and health care policy.

9.0 RECOMMENDATIONS

9.1 OVERVIEW

The purpose of this section is to articulate a roster of recommendations that will move the Greater Philadelphia region to a stronger competitive position in technology transfer and commercialization. These recommendations represent the confluence of assessments, implications, strengths, and opportunities, as identified through the research process undertaken in the production of this report. They reflect the insights gleaned from interviews, surveys, and best practices research, and are advanced in light of the region's performance in the key technology transfer metrics described above. As with the previous section, each recommendation is characterized in part by its intersection with the necessary ingredients for technology transfer and commercialization success, as identified in the previous section.

9.2 THE PREMISE BEHIND THE GOAL AND RECOMMENDATIONS

These recommendations are borne of an assessment of the region as relatively strong in its depth and breadth of research activity on the front end of the technology transfer pipeline, but relatively less effective in translating the output of that research activity into commercially viable innovations that attract venture capital on the back end of the pipeline. That many promising innovations languish here is no surprise and is not unique to the region – as noted in the previous section, this gap is often referred to "the valley of death" and is often where innovations cease to advance – but addressing this mismatch will be crucial to leveraging the region's research strengths and elevating the region as a technology transfer leader.

What is needed, then, is **a coordinated regional strategy that yields more capital and more support near the front end of the technology transfer pipeline, to the end of encouraging, seeding, and growing more early stage activity while increasing opportunities for company scaling.** This will have the effect of attracting more venture capital interest and will ultimately lead to more venture capital deals, providing further stimulus for successive generations of research and commercialization activity.

9.3 ONE OVERARCHING GOAL

Innovation in general and technology transfer in particular do not lend themselves to pre-ordained and centrally determined objectives. The ecosystem analogy advanced in this report reflects a fast-moving field in which nimbleness, resiliency, and initiative trump top-down mandates.

However, singular ambitious goals can have the effect of clarifying and coordinating a region's efforts. They can represent in simple terms a preferred outcome that multiple actors at multiple levels in multiple entities can understand and contribute to. They can also serve as powerful motivators for new actors, drawn into an effort from inside and outside a region to play their role in making an extraordinary aim into a reality.

Returning to the premise articulated earlier in this section, such a goal should activate the manifold strengths of the region in research activity while focusing attention and resources to overcome the region's present shortfall in large-scale commercialization success. Accordingly, this report advances the following overarching goal for the region:

> **In the next 10 years, the region's research institutions will birth 10 companies that grow to a liquidity event (e.g. acquisition or initial public offering) of $100 million or more.**

This goal does not specify what kind of innovations will be represented by these fast-growing startup ventures, as there is too much diversity in the research priorities of institutions across the region and in the investment focuses of venture funds throughout the country to need to know or to want to limit at this juncture. What it does specify is the kind of outcome that will be considered a success for the region, which is that research discoveries birthed in the region's institutions will be grown to a point that they achieve a significant valuation level. This kind of goal is intended to be clear, aspirational, and galvanizing.

9.4 INTENDED IMPACTS FROM PURSUING THIS GOAL

Achieving, or even just pursuing, such a goal is designed to have three impactful outcomes for the region in its quest to be an innovation leader. First, it **concentrates the region's institutions, leaders, and resources in the area of technology transfer and commercialization**. That focus will help stimulate as much research activity as possible in as many fields as possible. It will also highlight the need for additional early stage funding and accompanying incubation resources to support innovations from the time of initial discovery to the first rungs on the venture capital ladder. Finally, it elevates the importance of finding, growing, and funding commercially viable innovations that can scale significantly in the marketplace.

Second, it creates **a virtuous cycle of more research activity leading to more entrepreneurial ventures, resulting in more potential deals, more investor attention, and more funding**. This in turn creates a level of excitement throughout the region and serves as a draw for additional talent, activity, and funding. As regions grow in activity levels they become better positioned to attract and produce even more activity.

Third, it creates **a growing number of extremely successful entrepreneurs who can serve as mentors, funders, guides, and draws for successive generations of entrepreneurs**. This too is a characteristic of innovation hubs throughout the country. Success begets success because talent and funding seek out places of high concentration of talent and funding, but also because it yields successful entrepreneurs who directly and indirectly invest in the growth of additional entrepreneurship activity.

9.5 RECOMMENDATIONS

This report advances four recommended actions that will help the region achieve this goal of birthing 10 $100 million+ companies in the next 10 years. These recommendations are intended

to provide multiple on-ramps for multiple actors to play their part in coordinating a regional approach to achieving the proposed goal.

Recommendation #1: **FUND**

Public and private sector participation should be recruited to **fund additional pre-venture capital funds and business acceleration services**. The need to overcome the aforementioned "valley of death" is such that region-wide attention must be devoted to deploying more resources to encourage, seed, and grow more research innovations to the point at which they attract venture capital attention.

Action here is likely to take on numerous forms. University City Science Center, Ben Franklin Technology Partners, First State Innovation, and New Jersey Technology Partners are four examples of entities whose direct funding, assistance in accessing capital, and provision of supportive services already pay dividends in the region, in the form of more and more accelerated startup ventures in the technology transfer space. Private sector efforts such as funds managed by Comcast and Independence Blue Cross represent another useful approach; additional private sector participation may also be in the form of in-kind contributions of intellectual property, staff, work space or equipment. Finally, while it may seem state and local governments in the region are fiscally constrained in investing in technology transfer at this juncture, there is still a case to be made.

Recommendation #2: **ADVOCATE**

The region's private and institutional leadership should **advocate for policies at all levels of government that demonstrate a commitment to innovation as an economic driver**. State and local governments may seem challenged to make such outlays now, but the alternative is that the region continues to slide as an innovation hub and misses out on successive waves of talent, activity, and funding.

How governments participate in stimulating innovation may be manifold. Governments may opt to emulate the State of Texas, which floated a $3 billion bond to accelerate its support of cancer research and thus facilitate the expansion of research activity in that space. Governments may also opt to ally with the growing number of technology transfer focused venture funds whose funding sources include public pension funds. In encouraging Washington, Harrisburg, Trenton, and Dover to consider some or all of these avenues, the advocacy message must be that the region's strength in research institutions must be leveraged through the support of entrepreneurial ventures in order for that strength to translate into commercialization success, innovation clusters, and job creation.

Recommendation #3: **COLLABORATE**

Collaboration must be encouraged, particularly through the use of shared space and shared equipment. A particular focus should be placed on elevating the work of the region's engineering schools, given the promising intersections of engineering and health care (e.g. medical devices), engineering and energy (e.g.

energy storage), and engineering and advanced manufacturing (e.g. composite materials).

As noted above, the field of innovation moves too fast to dictate in a centralized and pre-conceived way what discoveries will yield the most commercial success far into the future. Rather, what makes more sense is to foster a vibrant ecosystem of research activity in which collaboration is high, action is rewarded, and resources exist to advance promising breakthroughs to higher and higher levels of commercial viability.

This collaboration should be encouraged in areas of particular regional strength, in which many innovations can be birthed and allowed to grow. In health care, energy, and advanced manufacturing, the region possesses promising drivers of innovation that can yield commercially attractive discoveries. Engineering proficiency is the common denominator to multiply innovation in these fields, and shared space and shared equipment are two ways to facilitate the collaboration needed to translate this potential into actual commercialization.

Recommendation #4: **PROMOTE**

Alongside funding, advocating, and collaborating, **the region's leaders must work together to promote the region as an innovation hub**, making particular appeals to venture capital firms seeking deals, young research and entrepreneurship talent seeking a place to learn and grow, and established entrepreneurs with regional ties who can help grow the next generation of startup ventures. Select Greater Philadelphia is an example of the power of private sector initiative in promoting the region, and any such efforts should be coordinated with Select's work.

Each of the aforementioned targeted groups would benefit from a better perception of the region as an innovation hub. While capital is mobile, investors do tend to invest in what they know, so perception matters. Regions seen as innovative are going to attract more attention. Investors choose the best deals from the ones they are aware of, so if they look at ten times more possible companies in the Boston region than in the Greater Philadelphia region, more money will flow to Boston even if the commercialization potential of Greater Philadelphia's companies are higher. Hence, there must be a coordinated approach to conveying to the venture community the depth, breadth, and trajectory of the technology transfer activity taking place here.

Just as capital is mobile, so are many talented researcher entrepreneurs. Since there are a finite number of places with the scale of physical, financial, and human resources to accommodate this kind of research activity, many among this universe of intellectual talent are constantly aware of the opportunities available in new places to build a base of research activity and pursue potential commercialization opportunities. Research institutions in this region are fundamentally reshaping their technology transfer offices to encourage more risk-taking and higher upside potential. This message needs to be amplified so that

talented young research entrepreneurs will recalibrate their perception of the region and consider it anew as a place to grow and thrive.

Finally, the region must retain and activate its base of successful entrepreneurs. They represent an invaluable source of guidance, connections, and resources to show the way for a new generation. An enthusiastic promotional campaign to encourage these success stories to reinvest in the region in which they first found success will afford them the positive affirmation they deserve for catalyzing even more innovation activity.

10.0 CONCLUSION

In the global economy as a whole and in technology transfer in particular, everything is in motion. Today's advantages are not guaranteed tomorrow, past windows of opportunity can close, and present barriers can be overcome. As in 2007, the region has been evaluated in full and has been found to be robust, dynamic, and successful, but not without its areas of concern.

After the publication of and subsequent discussions around the CEO Council's technology transfer report in 2007, the region implemented numerous successful initiatives and saw significant infusions of dynamic leadership. However, other regions have also continued to build on their strengths and shore up their weaknesses.

Nevertheless, while there is cause for concern, there is not cause for pessimism. The Greater Philadelphia region has numerous strengths and assets from which to build a strong case for the talent, funding, and activity that is currently in play. Macro-economic forces are creating an environment which may play to Greater Philadelphia's strengths and characteristics. Those existing assets must be actively built upon, though, and these current opportunities seized upon.

A way forward is advanced through the recommendations contained in this report. It is anticipated that their successful implementation will move the region towards a more competitive position relative to its peer regions, creating a virtuous cycle of more innovation activity attracting more of the innovation inputs needed to continue to thrive. It is also projected that stasis, alternatively, will result in the region continuing to slide in performance and in perception.

It is therefore incumbent on the region's leaders to choose action over inaction, to position the region for future success in technology transfer and commercialization, and to ensure that the region continues to be a draw for innovation inputs and innovation activity. To that end, each institution must consider what it can do to help the region realize this vision and achieve this goal.

APPENDIX A – SUMMARY OF RECOMMENDTIONS FROM THE 2007 CEO COUNCIL FOR GROWTH STUDY ON TECHNOLOGY TRANSFER AND COMMERCIALIZATION

Regional Needs	Overarching Strategies	Recommendations for Private Sector	Recommendations for Public and Not-for-Profit Sector
Reduce cultural gap and funding gap (1) between industry and academia and (2) between research grants and seed money Encourage more collaborations and regional celebrations of technology transfer and commercialization success	Create a culture of entrepreneurship Researchers and entrepreneurs should connect more Increase the talent and capital in the Greater Philadelphia area	Increase funding to support research and start-up companies Attract entrepreneurs and venture capital by the innovation in Greater Philadelphia Region Collaborate with other sectors	Build ventures to attract more researchers, entrepreneurs and investors Create incubator for early-stage companies Collaborate with other sectors

Source: Economy League of Greater Philadelphia (2007), Econsult Solutions, Inc. (2014)

APPENDIX B – COUNTY MAKE-UP OF COMPARISON REGIONS

Region	ST	Counties						
Atlanta	GA	Barrow	Bartow	Cherokee	Butts	Carroll	Clayton	Cobb
	GA	Coweta	Dawson	DeKalb	Douglas	Fayette	Forsyth	Fulton
	GA	Gwinnett	Haralson	Heard	Henry	Jasper	Lamar	Meriwether
	GA	Newton	Paulding	Pickens	Pike	Rockdale	Spalding	Walton
Austin	TX	Bastrop	Caldwell	Williamson	Travis	Hays		
Baltimore	MD	Anne Arundel	Baltimore	Carroll	Harford	Howard	Queen Anne's	Baltimore City
Boston	MA	Norfolk	Plymouth	Middlesex	Suffolk	Essex		
	NH	Strafford	Rockingham					
Houston	TX	Austin	Brazoria	Chambers	Fort Bend	Harris	Galveston	Liberty
	TX	Waller	San Jacinto		Montgomery			
Nashville	TN	Cannon	Cheatham	Davidson	Dickson	Hickman	Robertson	Rutherford
	TN	Trousdale	Smith	Sumner	Macon	Wilson	Williamson	
New York	NJ	Middlesex	Monmouth	Ocean	Somerset	Bergen	Hudson	Passaic
	NJ	Essex	Hunterdon	Morris	Sussex	Union		
	NY	Nassau	Suffolk	Bronx	Kings	Putnam	New York	Queens
	NY	Richmond	Rockland	Westchester				
	PA	Pike						
Greater Philadelphia	PA	Bucks	Chester	Delaware	Montgomery		Philadelphia	
	NJ	Burlington	Camden	Gloucester	Mercer	Salem		
	DE	New Castle						
Pittsburgh	PA	Allegheny	Armstrong	Beaver	Butler	Fayette	Westmoreland	Washington
Raleigh-Durham	NC	Franklin	Johnston	Wake	Chatham	Durham	Orange	Person
San Francisco	CA	Alameda	Contra Costa	Marin	San Francisco	San Mateo	San Benito	Santa Clara
Seattle	WA	King	Snohomish	Pierce				
St. Louis	IL	Bond	Calhoun	Clinton	Jersey	Madison	Macoupin	Monroe
	IL	St. Clair						
	MO	Crawford	Franklin	Jefferson	Lincoln	Warren	St. Charles	St. Louis

Region	ST	Counties						
	MO	St. Louis city		Washington				
Tech Coast	CA	Orange	San Diego	Los Angeles				
Tech Valley	NY	Albany	Rensselaer	Schoharie	Saratoga	Schenectady		
Washington, DC	MD	Frederick	Calvert	Charles	Prince George's		Montgomery	
	DC	District of Columbia						
	VA	Arlington	Clarke	Fairfax	Fauquier	Loudoun	Prince William	Stafford
	VA	Warren	Fairfax city	Falls Church city		Spotsylvania	Alexandria city	
	VA	Manassas Park city		Manassas city		Fredericksburg city		
	WV	Jefferson						

APPENDIX C – BACKGROUND INFORMATION ON THE LEADERS OF SELECTED INSTITUTIONS IN THE GREATER PHILADELPHIA REGION

Institution	Leader	Year	Background Information
Children's Hospital of Philadelphia	Steven M. Altschuler	2000 (14Y)	1. 1982 – 2000: Physician-in-Chief and first holder of the Leonard and Madlyn Abramson Endowed Chair in Pediatrics at The CHOP. 2. 1985 – 2000: Faulty member of Department of Pediatrics at the University of Pennsylvania 3. B.A. in mathematics and M.D. from Case Western Reserve University 4. Former editor-in-chief of E-Medicine-Pediatrics and co-editor of two medical textbooks 5. Guest lecturer, study section reviewer for the NIH, a scientific journal reviewer
Drexel University	John Anderson Fry	2010 (4Y)	1. 2002 - 2010: President of Franklin & Marshall College 2. 1995 – 2002: Executive vice president of the University of Pennsylvania 2.1. 1996 – 2001: "Agenda for Excellence", a plan guided strategic initiatives 3. Before 1995: Management consultant for the higher education & nonprofit sectors 4. Previously served as chair of the NCAA Division III Presidents Council and on the Executive Committee of the NCAA 5. A native of Brooklyn, N.Y.; Graduated from Lafayette College; Master Degree in business administration from the New York University Stern School of Business.
Penn Center for Innovation	John S. Swartley	2014 (-Y)	1. 2013 – 2014: Associate Vice provost for Research and Executive Director, CTT in the University of Pennsylvania 2. 2009 – 2013: Deputy Executive Director in University of Pennsylvania, Center for Technology 3. 2007 – 2009: Senior Director and Head of New Ventures in the University of Pennsylvania, Center for Technology 4. 2003 – 2007: Senior Vice President and Partner of BCM Technologies 5. 1998 – 2003: Associate Director, Office of Cooperative Research in Yale University 6. 1997 – 1998: Licensing Associate, Office of Cooperative Research in Yale University
Princeton University	Christopher L. Eisgruber	2013 (1Y)	1. 2004-2013: Princeton's provost 2. 2002-2013: Princeton's faculty 3. 2001-2004: Director of Princeton's Program in Law and Public Affairs & Ethics and Public Affairs 4. 1990 – 2001: Faculty member of New York University Law School 5. 1988-1990: Law clerk to Judge Patrick Higginbotham of the United States Court of Appeals for the Fifth Circuit and then Justice John Paul Stevens of the Supreme Court of the United States 6. 1988: JD cum laude from the University of Chicago Law School 7. 1983 AB magna cum laude in physics from Princeton University

Institution	Leader	Year	Background Information
Rutgers University	Robert L. Barchi	2012 (2Y)	1. 2004 – 2012: President of Thomas Jefferson University 2. 1999 – 2004: Provost of the University of Pennsylvania 3. 1972 – 1999: Faculty member of the University of Pennsylvania 4. 1973: M.D. in University of Pennsylvania, Medicine 5. 1972: Ph.D. in University of Pennsylvania, Biochemistry 6. 1968: M.S.(Cell Biology) & B.S. in Georgetown University (Biology)
Temple University	Neil D. Theobald	2013 (1Y)	1. 2007 – 2013: Senior vice president of Indiana University 2. 2002 – 2007: Director of Indiana Education Policy Center 3. 1988 – 2007: Professor of Indiana University 4. 1988: Ph.D. in the University of Washington, Educational Policy, Governance, and Administration 5. 1986 – 1988: At-Risk Program Administrator, Northshore Public Schools 6. 1986: M.Ed. in the University of Washington, Mathematics Education 7. 1983 – 1986: Public School Teacher of Northshore Junior High School, Bothell, DC 8. 1978: B.A. in Trinity College, Economics
University of Pennsylvania	Amy Gutmann	2004 (10Y)	1. Princeton University: 1.1 Provost (2001-2004); 1.2 Director in the University Center for Human Values (1998 – 2001); 1.3 Director in the Program in Ethics and Public Affairs (1997 – 2000); 1.4 Academic Advisor to the President (1997-1998); 1.5 Dean of the Faculty (1995 – 1997) 1.6 Director in the University Center for Human Values & the Program in Ethics and Public Affairs (1990-1995) 2. Laurance S. Rockefeller University Professor (1990 – 2004) 3. Professor of Politics of Princeton University (l987-) 4. Associate Professor (1981-86); 5. Assistant Professor (1976-81)
University of the Sciences in Philadelphia	Helen Giles-Gee	2012 (1Y)	1. 2005 – 2012: President of Keene State College in New Hampshire 2. -2005: Provost of Rutgers University 3. University of Pennsylvania: 2.1 Bachelor of arts in psychobiology; 2.2 Master of science in science education with Pennsylvania teaching certificates in biology and general science; 2.3 PhD in measurement, evaluation, and techniques of experimental research 4. Rutgers University: MS in zoology
The Wistar Institute	Russel E. Kaufman	2002 (12Y)	1. 2002 – 2010: Director of the Wistar Institute Cancer Center 2. 1973 – 2002: Vice Dean for Education and Academic Affairs in Duke University Medical Center 3. Chief, Division of Hematology/Oncology of Duke University School of Medicine 4. 1973 – 1980: Master Degree Duke University School of Medicine (MD) 5. 1969-1973: The Ohio State University College of Medicine (MD)
Ben Franklin Technology Partners (Southeastern PA)	RoseAnn B. Rosenthal	1996 (18Y)	1. 1978 – 1996: Senior Vice President in Philadelphia Industrial Development Corporation 2. 2007: Ph.D. Philadelphia University

Institution	Leader	Year	Background Information
			3. B.A. Temple University
The South Jersey Technology Park	Shreekanth Mandayam	2011 (3Y)	1. 2011 – 2012: Publications Vice-President of IEEE Instrumentation & Measurement Society 2. 2009 – 2012: Finance Vice-President of IEEE Instrumentation & Measurement Society 3. 2009 – Now: Professor of Electrical & Computer Engineering in Rowan University 4. 2006 – 2011: Department chair of Electrical & Computer Engineering in Rowan University 5. 2001 – 2009: Associate Professor of Electrical & Computer Engineering in Rowan University 6. 2005 – 2005: Senior Research Associate in NASA 7. 1997 – 2001: Assistant Professor of Electrical & Computer Engineering in Rowan University
University City Science Center	Steven S. Tang	2008 (6Y)	1. 2011 – 2012: Member of Innovation Advisory Board of United States Department of Commerce 2. 2009 – 2011: Member of Board of Directors in iPraxis – Innovation for All 3. 2005 – 2008: Vice President & General Manager of Life Science in Olympus America Inc. 4. 2000 – 2004: President and CEO of Millennium Cell Inc. 5. 1997 – 2000: Vice President & National Director, Healthcare Industry Practice of A.T. Kearney 6. 1992 – 1996: Vice President of Gemini Consulting 7. 1988 – 1992: Assistant Director & SR. Research Engineer of Center for Molecular Bioscience and Biotechnology, Lehigh University 8. 1985 – 1992: Founder and Owner of Tangent Technologies
Rowan University	Ali. A. Houshmand	2011 (3Y)	1. 2000 – 2006: Dean and Interim Provost in Drexel University 2. 1990 – 2000: Faculty and Director of Graduate Studies in University of Cincinnati 3. 19xx – 1990: Staff Analyst in United Airlines (Developing large-scale optimization and forecasting models) 4. Second master's degree and a doctoral degree in industrial and operations engineering from the University of Michigan, Ann Arbor 5. Bachelor's and master's degree in mathematics and mathematics statistics from the University of Essex, UK
Monell Chemical Senses Center	Robert F. Margolskee	2014 (-Y)	1. 2009 – 2014: faculty member at the Monell Center 2. 1996 – 2009: Adjunct Professor, Department of Pharmacology and Systems Therapeutics & Department of Structural and Chemical Biology in Mount Sinai School of Medicine 3. M.D., Ph.D., Molecular Genetics; Johns Hopkins University 4. A. B. in Biochemistry and Molecular Biology from Harvard University
Thomas Jefferson University	Stephen K. Klasko	2013 (1Y)	1. 2004 – 2013: CEO, USF Health Dean College of Medicine in the University of South Florida 2. 2000 – 2004: Dean in Drexel University College of Medicine 3. 1999 – 2003: Consultant in Ortho McNeil Pharmaceutical 4. 1998 – Present: Board of Directors in Teleflex
First State Innovation	Ernest J. Dianastasis	2006 (8Y)	1. 1984 – Present: Managing Director of CAI (Computer Aid, Inc.) 2. 1979 – 1980: MBA, Management in Lehigh University

Institution	Leader	Year	Background Information
			3. 1974 – 1978: BS, Finance in Lehigh University
Philadelphia Industrial Development Corporation	John Grady	1998 (16Y)	1. 1989 - 1998: Executive VP&COO (Previously Project Manager, VP) in Cooper's Ferry Development Association 2. 1989 – 1991: MGA, Government Administration in University of Pennsylvania 3. 1985 – 1989: BA, Economics in La Salle University
Bio NJ	Debbie Hart	1994 (20Y)	1. Member of the Rutgers University Blanche and Irwin LERNER Center 2. Science Advisory Board at Rider University 3. Advisory Board of the College of Science and Mathematics at Montclair University 4. Advisory Board for the New Jersey Healthcare Businesswomen's Association
Pennsylvania Bio	Christopher P. Molineaux	2009 (5Y)	1. 2002 – 2009: Worldwide Vice President and Pharmaceutical Communication & Public Affairs in Johnson & Johnson 2. 1999 – 2002: Vice President and Public Affairs in PhRMA 3. 1993 – 1999: Vice President and Communications & Public Affairs in Blue Cross & Blue Shield Association 4. 1983 – 1987: B.A., History in College of Holy Cross

APPENDIX D – BACKGROUND INFORMATION ON THE LEADERS OF SELECTED PRIVATE SECTORS IN THE GREATER PHILADELPHIA REGION

Private Sector	Leader	Year	Background Information
Iroko Pharmaceuticals	John F. Vavricka	2007 (7Y)	1. Vice President of Chiron Vaccines 2. Vice President and Marketing chair of GlaxoSmithKline 3. Vice President of Global Product Strategy 4. Vice President and Sales of SmithKline Beecham 5. BA degree in neurobiology/physiology form Northwestern University
Lannett Company, Inc.	William Farber R.	2011 (3Y)	1. 1991 – 2011: Chairman of the Board of Directors in Lannett Company, Inc. 2. 1993 – 1993: President and director of Auburn Pharmaceutical Company 3. 1990 – 1993: Director of Purchasing for Major Pharmaceutical Corporation 4. 1965 – 1990: Chief Executive Officer of Michigan Pharmaceutical Corporation
AstraZeneca	Pascal Soriot	2012 (1Y)	1. 2010 – 2012: Chief Operating Officer of the Roche Pharma AG 2. 2009 – 2010: Chief Executive of the Roche subsidiary Genentech 3. 2006 – 2009: member of Roche 4. 2002 – 2006: Chief Operating Officer of Aventis USA 5. 1996 – 1997: General Manager of Hoechst Marion Roussel in Australia
GlaxoSmithKline	Andrew Witty	2008 (6Y)	1. 1985 – 2003: Various senior roles of GlaxoSmithKline in UK, South Africa, the USA and Singapore 2. 2003 – 2008: President of GlaxoSmithKline Europe 3. Joint Honors BA in Economics from the University of Nottingham 4. Director of Singapore Economic Development Board 5. Imperial College Commercialization Advisory Board
The Dow Chemical Company	Andrew N. Liveris	2004 (10Y)	1. 2013 – 2014: Chairman of The Business Council 2. 2011 – 2012: Vice Chairman of The Business Council 3. Bachelor's degree in Chemical Engineering from the University of Queensland 4. 1974: Darwin High School
RightCare Solutions, Inc.	Eric Heil	2011 (3Y)	1. 2008 – Present: Entrepreneur-in-Residence of Domain Associates 2. 2010 – 2012: Senior Director of Business Development in Celator Pharmaceuticals 3. 2008 – 2009: Director of Business Development in Corthera, Inc. 4. 2007 – 2008: Equity Research Associate – Managed Care in Bear Stearns & Co. 5. 2005 – 2006: Research Associate in Easton Associates
Center of Effort, LLC	Michael Pahides	2012 (2Y)	1. 2010 – 2011: Project Manager in Keating Building Company 2. 2008 – 2008: Project Manager in Vinci Concessions 3. 2003 – 2007: Partner of Law and Financial Consulting 4. 1999 – 2003: Company representative in Kurum Holding
Independence Blue	Daniel J.	2010	1. 2011 – 2014: Director of Greater Philadelphia Chamber of Commerce

Private Sector	Leader	Year	Background Information
Cross	Hilferty	(4Y)	2. 1997 – 2010: President and chief executive officer of AmeriHealth Mercy 3. Senior Vice President of corporate and government affairs for Mercy Health System 4. Executive director of PennPORTS 5. Master's degree in public administration from American University 6. Bachelor of science in accounting from Saint Joseph's University
SeventySix Capital	Wayne Kimmel	1999 (15Y)	1. 2004 – Present: Board of Trustees in Einstein Healthcare Network 2. 2006 – Present: Treasurer and Board of Directors Member in Jewish Federation of Greater Philadelphia 3. 2008 - Present: Board Member of StartUp Health 4. 2011 – Present: Advisory Board in Robert H. Smith School of Business
Game Changing Partnerships, LLC	Gregory Byrnes	2011 (3Y)	1. 2009 – Present: Senior Advisor of Econsult Solutions 2. 2010 – 2011: Vice President of Pennsylvania Bio 3. 2006 – 2010: President of Byrnes Communications 4. 1991 – 2005: Director of Economic & Business Development in PECO Energy 5. 1986 – 1991: President of Philadelphia Developers Alliance 6. 1979 – 1986: Reporter and Assignment Editor in Philadelphia inquirer

APPENDIX E – BACKGROUND INFORMATION ON SELECTED TECHNOLOGY TRANSFER AND COMMERCIALIZATION INITIATIVES IN THE GREATER PHILADELPHIA REGION

Initiatives	Involved Institutions	Description
QED Program	Children's Hospital of Philadelphia	The QED Program is a multi-institutional proof-of-concept program that provides business development support for academic researchers developing early-stage life science and healthcare IT technologies with high commercial potential. The key goal is to retire the business risk in these early-stage projects, increasing their attractiveness to follow-on investment by established life science companies and private investors. The QED Program integrates four elements that are critical to successfully and efficiently performing early-stage proof-of-concept technology development: business advice, bridge funding, market drivers and guidance to exit.
	Delaware State University	
	Drexel University	
	Fox Chase Cancer Center	
	Harrisburg University of Science and Technology	
	Lankenau Institute for Medical Research	
	Lehigh University	
	Monell Chemical Senses Center	
	New Jersey Institute of Technology	
	Pennsylvania State University	
	Philadelphia College of Osteopathic Medicine	
	Philadelphia University	
	Rowan University	
	Rutgers University	
	Temple University	
	Thomas Jefferson University	
	University of Delaware	
	University of Pennsylvania	
	University of the Sciences in Philadelphia	
	Widener University	
	Wistar Institute	
Quorum Program	Alliance for Women Entrepreneurs (AWE)	Quorum unites the region's entrepreneurship and innovation communities through a central gathering space on the Science Center campus and related programs that enable idea generators to meet, share and learn. **Quorum Programming**: We have developed a suite of programs designed to connect entrepreneurs to investors and the other resources they need to launch a successful business. Quorum programming includes: **Coffee & Capital** matches a small group of entrepreneurs with an investor for an informal Q&A session. **How To Talk To Money** gives insight into what angels and VCs are looking for, what to say first, second and third, and how to break through the
	American Israel Chamber of Commerce (AICC)	
	Baiada Institute	
	Ben Franklin Technology Partners of Southeastern Pennsylvania	
	BioAdvance	
	BioStrategyPartners	
	Campus Philly	
	Center for Entrepreneurial Studies	
	Center for Innovation, Creativity, & Entrepreneurship (ICE)	
	Consortium for Building Energy Innovation (CBEI)	
	Delaware Bio	
	Delaware Valley Industrial Resource Center (DVIRC)	
	Economy League of Greater Philadelphia	

Initiatives	Involved Institutions	Description
	Entrepreneurial Law Clinic at the Earle Mack School of Law	wall of skepticism. **Office Hours** brings an advisor to Quorum to meet one-on-one with entrepreneurs, answer their questions and offer targeted advice. **Smart Talk** gives startups and growing companies a look at best practices and business strategies from industry leaders in the region. **Lunch For Hungry Minds** highlights excellence in regional academic research. Topics range from life science and energy to materials sciences and IT.
	Greater Philadelphia Alliance for Capital and Technologies (PACT)	
	Greater Philadelphia Chamber of Commerce	
	Greater Philadelphia Senior Executive Group (GPSEG)	
	Health Innovation Partnership	
	Innovation America	
	Life Sciences Collaborative	
	Mid-Atlantic – Russia Business Council	
	Network for Teaching Entrepreneurship	
	New Jersey Technology Council	
	Penn Biotech Group	
	Pennsylvania Bio	
	Philadelphia Institute for Neurodegenerative Disorders (PhIND)	
	Philadelphia-Israel Chamber of Commerce	
	Philly BioBreak	
	Philly Startup Leaders	
	Select Greater Philadelphia	
	Society of Physician Entrepreneurs	
	Technology Forum of Delaware	
	Temple University Innovation & Entrepreneurship Institute	
	Wharton Entrepreneurial Programs	
	Wharton Entrepreneurship	
	World Trade Center of Greater Philadelphia	
International Programs - Global Soft Landing	Canadian Consulate General	International companies can take advantage of the Global Soft Landing Program, which leverages the assets and resources of the Science Center and Greater Philadelphia entrepreneurial community to helps global companies establish a foothold in the region's life sciences and technology markets. Philadelphia offers a strategic location within easy reach of the nation's regulatory/legislative hub in Washington and its financial center in New York.
	Economic Development Administration	
	Mid-Atlantic-Russia America Business Council	
	Pennsylvania Department of Community and Economic Development	
	Select Greater Philadelphia	
	U.S. Department of Commerce	
	Wallonia Foreign Trade and Investment Agency	
Upstart	BDO	UPstart, a virtual incubator at the University of Pennsylvania, is dedicated to supporting technology commercialization within the Penn community. Since 2010, UPstart has worked with over 100 faculty and staff members to form and launch new companies based on selected inventions and innovative technologies. While there are many paths to commercialization of a new technology, the UPstart team works with Penn inventors to develop a commercial strategy which utilizes company creation as a means to
	Bio Advance	
	Bookminders	
	IP Group PLC	
	JTR & Associates	
	Kanda Software	
	Michael Best & Friedrich LLP	
	Morgan Lewis	
	NovoBio Pharma	

Initiatives	Involved Institutions		Description
	Pepper Hamilton LLP		increase the value of the technology while giving it exposure in the marketplace. By connecting local entrepreneurs, investors and partners with Penn inventors, UPstart adds a powerful platform for a larger entrepreneurial ecosystem in Greater Philadelphia and beyond.
	Provonix		
	Richard Liu		
	Science Center		
	Stephano Slac LLC		
	Stradley Ronon		
	The BDH Group		
	Usa Payroll		
	Valex Consulting		
	Woodmansee & Company		
The Navy Yard (Keystone Innovation Zone)	Ben Franklin Technology Partners of Southeastern Pennsylvania		The Navy Yard Keystone Innovation Zone (KIZ) promotes technology innovation and commercialization through the collaboration of world-class academic institutions, federal, state, and local government agencies, and private industry to support growth of research and business activity focused on the following technology sectors: Power and Energy, Nanotechnology, Advanced Materials & Manufacturing, Communications and IT, Homeland Security, Life Sciences
	City of Philadelphia and several private industry partners		
	Delaware Valley Industrial Resource Center		
	Penn State University		
	Philadelphia Industrial Development Corporation (PIDC)		
	U.S. Surface Warfare Center (Carderock Division)		
Technology Commercialization Network	**Providers**	**Clients & Partners**	The Technology Commercialization Network (TCN) is designed to assist companies in addressing near-term technical needs by utilizing Greater Philadelphia area research institutions. The TCN provides consulting and use of laboratory facilities. Over the past 5 years, Ben Franklin's Technology Commercialization Fund has helped more than 250 companies to solve product development and commercialization challenges by working with members in our Technology Commercialization Network.
	Bucknell University	BioNano Genomics	
	CITECH (Medical Device Testing)	Clear Align	
	Delaware Valley College	Dell Boomi	
	Drexel University	DVIRC	
	Fox Chase Cancer Center	InfraScan	
	Lankenau Institute for Medical Research	InstaMed	
	LaSalle University	MODA	
	Lehigh University	Monetate	
	Lincoln University	Morphotek	
	NextFab Studio	Neat Company	
	Northampton Community College	NFTE (Network For Teaching Entrepreneurship)	
	Pennsylvania State University	Nupathe (merged with Teva Pharmaceutical Industries Ltd.)	
	Pennsylvania College of Technology	Pennsylvania BIO	
	Philadelphia University	Philly Startup Leaders	
	Temple University	Science Center	
	Thomas Jefferson University	SELECT Greater Philadelphia	

Initiatives	Involved Institutions		Description
	University of the Sciences in Philadelphia		
	University of Pennsylvania		
	Villanova University		
	West Chester University of Pennsylvania		
	Widener University		
	Wistar Institute		
CORE - Communication On increasing Research Efforts	University of the Sciences in Philadelphia		A quarterly event/workshop series of interest to USciences faculty and graduate students. - Provide a mechanism for communication and collaboration between faculty and students with similar or overlapping interests - Identify research strengths and interests among faculty - Promote and expand ongoing research efforts and programs at USciences - Identify suitable funding sources for faculty based upon specific research areas, interests, and expertise - Foster faculty development and mentorship, particularly for junior faculty - Support faculty in development of pilot or preliminary data for future grant submissions
Drexel Smart House	Baiada Center Incubator Company		The Drexel Smart House's ultimate goal is to improve life through smart design and technology. The broad scope of our goals is up to the interpretation of the applicant, however we are most interested in innovations in the built environment - that is, innovations that improve life in some way within buildings, homes, workplaces, schools, etc. To date, Drexel Smart House projects have had a strong sustainability component, encompassing energy, health, the environment, human computer interaction, and automation.
	Summalux LLC		
	U.S. Environmental Protection Agency		
PERC - Philadelphia Education Research Consortium	Drexel University		Research for Action (RFA) received a three-year grant from the William Penn Foundation to establish this partnership–designated the Philadelphia Education Research Consortium, or PERC. "With the launch of PERC, Philadelphia is joining a cadre of other major cities, including Chicago, New York City, Baltimore, and Los Angeles, that have the benefit of an organization devoted exclusively to improving the capacity of its public schools to make evidence-based decisions," said Kate Shaw, RFA's executive director and the founding director of PERC.
	Temple University		
	University of Pennsylvania		
Energy Commerciali	Drexel University		ECI pools intellectual property from participating institutions, providing dedicated technology transfer
	University of Pennsylvania		

Initiatives	Involved Institutions	Description
zation Institute (ECI)	Penn State University	services with expertise to promote energy commercialization. It offers corporations a single point of negotiation for IP licensing, independent of the number of institutions with ownership of that IP.
	Ben Franklin Technology Partners	
	Philadelphia University	
	Temple University	
	Villanova University	
	Widener University	

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APPENDIX G – SURVEY QUESTIONS

Questions:

Screening Question:

1). Where is your organization's headquarters located?
- In the Greater Philadelphia Region.
- Outside of the Region.
- Outside of the United States.

2). In what county or counties in the Greater Philadelphia region does your organization have facilities/offices? Please select all that apply.
New Castle, DE
Burlington, NJ
Camden, NJ
Gloucester, NJ
Mercer, NJ
Salem, NJ
Bucks, PA
Chester, PA
Delaware, PA
Montgomery, PA
Philadelphia, PA

3). Which of the following best describes your organization?
- Private Industry
- Academic Institution
- Non-profit
- Public Sector
- Other, please specify

Questions for Private Industry Only

1). What is your firm's industry segment:
- Aerospace products/parts
- Chemicals
- Communications equipment
- Computer systems design/related services
- Computers/peripherals
- Digital health/Healthcare IT
- Machinery
- Motor vehicles/trailers/parts
- Navigation/measuring/electromedical/control instruments
- Pharmaceuticals/medicines

- Semiconductor products/parts
- Scientific R&D services
- Software publishers
- Telecommunications/Internet service providers/Web search portals/Data processing services
- Other, please specify

2). What is your firm's annual revenue for the most recently completed fiscal year?

- Less than $100 million
- $100 million - $500 million
- $501 million–$1 billion
- $1.1 billion–$5 billion
- $5.1 billion–$10 billion
- Over $10 billion

3). Please estimate how much your company spent on R&D over the past three (3) years.

Basic Research: experimental or theoretical work undertaken to acquire new knowledge of the underlying foundation of the phenomena or observable facts without any particular application or use in view. Typical activities include: mapping the human genome, exploring outer space, determining how culture has affected the rate of economic growth in different countries, particle physics, etc.

Applied Research: original investigations performed to acquire new knowledge directed towards a specific objective. Compared to basic research, applied research is usually designed to solve a particular problem, and has a shorter time frame before it can be practically applied. Typical activities include: developing new medicines based on a better understanding of how a particular virus works, improving an existing production process, investigating the feasibility of using nanotechnology to make chemical coatings with superior properties, etc.

Experimental Development: using knowledge from basic or applied research and experience to evaluate and produce new goods or services, or to substantially improve existing goods and services. Typical activities include: clinical trials of pharmaceutical products, use of prototypes to determine the feasibility of using new processes, market feasibility studies, etc.

Year	Basic Research	Applied Research	Experimental Development	Total R&D Spending
2011				
2012				
2013				

4). Does your firm conduct R&D activities within the Greater Philadelphia region?

- Yes, my firm conducts R&D within the Region
- My firm conducts R&D, but only outside of the Region
- No, my firm does not conduct R&D

4a). What fields of R&D does your organization undertake in the Region. Please select all that apply.***<<this question will only be shown to those respondents that answer yes to Q4>>***

- Aerospace
- Alternative/Renewable Energy
- Biotechnology/Pharmaceutical
- Business
- Chemistry
- Economics
- Energy Efficiency
- Engineering
- Environmental
- Health
- IT
- Market Research
- Materials
- Medicine
- Optics/Imaging/Photonics
- Physics
- Product Development
- Other, please specify

4b). Please estimate how much your company spent on R&D in the Greater Philadelphia region over the past there (3) years. ***<<this question will only be shown to those respondents that answer yes to Q4>>***

Year	Basic	Applied	Development	Total
2011				
2012				
2013				

4c). How many R&D employees does your firm employ within the Region? ***<<this question will only be shown to those respondents that answer yes to Q4>>***

- 2011
- 2012
- 2013

4d). Please estimate how many patents have been generated by the research and development activities undertaken by your organization within the Region over the last three (3) years. ***<<this question will only be shown to those respondents that answer yes to Q4>>***

5). Does your firm provide R&D funding to institutions located within the Greater Philadelphia Region?

- Yes, my firm provides R&D funding to institutions located within the Region.
- My firm provides R&D funding to institutions, but they are located outside of the Region.
- No, my firm does not provide R&D funding to institutions.

5a). Please estimate how much your company spent on R&D funding to colleges and universities within the Greater Philadelphia region over the past three (3) years. ***<<this question will only be shown to those respondents that answer yes to Q5>>***

- 2011
- 2012
- 2013

5b). Which local institutions has your firm worked with in the past on R&D projects? Please select all that apply. ***<<this question will only be shown to those respondents that answer yes to Q5>>***

- University of Delaware
- University of Pennsylvania
- University of the Sciences in Philadelphia
- Temple University
- Thomas Jefferson University
- Princeton University
- Drexel University
- Rowan University
- Rutgers University, Camden
- Villanova University
- Wistar Institute
- Widener University
- Other, please specify

Questions for all Respondents

1). What do you see as your organization's role in the Region's technology innovation ecosystem? Please select all that apply. I/We…

- Provide research funding.
- Help shape the policy debate.
- Conduct Research and Development.
- Connect members of the technology innovation ecosystem.
- Educate the technology workforce.
- Am/Are an entrepreneur.
- Other, please specify.

2). What have been the biggest trends in the technology innovation ecosystem over the last decade? Please select all that apply.

- Universities have become more active in commercialization.
- Large companies have decreased their internal R&D activities.
- Large companies have entered into strategic partnerships with smaller firms.
- Decreased Federal funding (e.g. NSF, NIH, etc.).
- Increased use of non-traditional funding sources (e.g. Kickstarter).
- Foundations as a source of R&D funding.
- Increased collaboration.

- Cohabitation working environments.
- Other, please specify.

3). What will be the biggest trends in technology innovation ecosystem over the next decade? Please select all that apply.

- Universities will become more active in commercialization.
- Large companies will decrease their internal R&D activities.
- Large companies will enter into strategic partnerships with smaller firms.
- Federal funding (e.g. NSF, NIH, etc.) will decrease.
- The use of non-traditional funding sources (e.g. Kickstarter) will increase.
- Foundations will become a source of R&D funding.
- Increased collaboration.
- Cohabitation working environments.
- Other, please specify

4). How would you describe/rate the Region's overall entrepreneurial culture?

- Positive
- Neutral
- Negative

5). How would you describe/rate the Region's overall risk tolerance?

- Positive
- Neutral
- Negative

6). How are each of the following impacting the Greater Philadelphia region's technology and innovation ecosystem.

Choices: Negative, Neutral, Positive

- Culture
- Politics
- Policies
- Regulations
- Access to Capital
- Labor Supply
- Insufficient scale of entrepreneurs/entrepreneurial activity
- Technology Infrastructure
- Other, please specify.

7). What are the greatest barriers to innovation in the Greater Philadelphia Region? Please select all that apply.

- Lack of capital.
- Firms want to be close to their investors.
- High regulatory burden.
- High taxes/perception of high taxes.
- Lack of a highly trained workforce.
- Lack of a peer community.
- High legal costs that impose a significant impediment to patenting efforts.

- Lack of adequate incubator and laboratory space.
- Weak entrepreneurial culture and a lack of serial entrepreneurialism.
- Other, please specify.

8). How can commercialization be accelerated in the Greater Philadelphia Region. Please select all that apply.

- Increased access to capital.
- Involving more large corporations in the commercialization process.
- Streamline the permitting/business formation process.
- Stopping the brain drain.
- Other, please specify.

9). How does the Greater Philadelphia region compare to the following regions?

Choices – Behind, On par with, Ahead of

- Atlanta
- Austin, TX
- Baltimore
- Houston
- Nashville
- New York
- Pittsburgh
- Raleigh/Durham, NC
- San Francisco
- Seattle
- St. Louis
- Tech Coast (Los Angeles/San Diego, CA)
- Tech Valley (Albany, NY)
- Washington, DC

10). What are some of the innovative approaches used by other regions to cultivate their technology and innovation ecosystems?

<<open ended question>>

11). How does the Greater Philadelphia Region's technology infrastructure stack up against that of other regions?

Choices – Behind, On par with, Ahead of

- Telecommunications infrastructure
- Information systems
- Data centers
- Research

12). Which regions are ahead of the Greater Philadelphia region in terms of technology infrastructure? Please select all that apply.

- Atlanta
- Austin, TX
- Baltimore

- Houston
- Nashville
- New York
- Pittsburgh
- Raleigh/Durham, NC
- San Francisco
- Seattle
- St. Louis
- Tech Coast (Los Angeles/San Diego, CA)
- Tech Valley (Albany, NY)
- Washington, DC

13). How does the Greater Philadelphia Region's healthcare infrastructure stack up against other regions?

Choices – Behind, On par with, Ahead of

- Healthcare delivery
- Life Sciences/Pharmaceuticals
- Healthcare and Medical Research Institutions
- Financing for healthcare related ventures
- Digital Health/Healthcare IT

14). Which regions are ahead of the Greater Philadelphia region in terms of healthcare infrastructure? Please select all that apply.

- Atlanta
- Austin, TX
- Baltimore
- Houston
- Nashville
- New York
- Pittsburgh
- Raleigh/Durham, NC
- San Francisco
- Seattle
- St. Louis
- Tech Coast (Los Angeles/San Diego, CA)
- Tech Valley (Albany, NY)
- Washington, DC

15). What should the Region focus on to cultivate its innovation ecosystem?

<<open ended question>>

Thank you for taking time to participate in the CEO Council/Econsult Solutions, Inc. R&D survey.

If you have any additional comments, please provide them below.

<<open ended response>>

APPENDIX H – LIST OF COMPANIES COMPLETED THE SURVEY

Aria Health System	Ben Franklin Technology Partners of SEPA	Bentley Systems
BioAdvance	BioEntrep	BiologicsMD, Inc
Braskem	Braskem America	BSG Advisors
Campus Philly	Campus Philly	Capgemini
Centaur Animal Health	Chester County Economic Development Council	Children's Hospital of Philadelphia
Clinical Difference LLC	Cognizance Biomarkers, LLC	Comcast
Consulate General of Canada	Curbside Care	Cynyne Advisors
Day & Zimmermann	DreamIt Ventures	Drexel University
Entrepreneur with multiple start-ups	Exelon	Fox Chase Cancer Center
Gabriel	Galt Medical & NeedleTech Products	GlaxoSmithKline
Graphene Frontiers	GSK	GSK
Gwynedd Mercy University	Harrisburg University	Hill International, Inc.
Holt logistics	Independence Blue Cross	InfraScan, Inc.
Job Opportunity Investment Network (JOIN)	Jumpstart NJ Angel Network	La Salle University
La Salle University	Main Line Health	McCormick Taylor
Metagenics	Monell	Monroe Energy
Monroe Energy	NeuroDx Development	NewSpring Capital
NovaPharm Therapeutics	OCI	Office Economic Innovation and Partnerships - U of Del.
PCCI	PECO	PECO Energy
Peirce College	Pennoni Associates Inc.	Pennoni Associates Inc.
PhaseBio Pharmaceuticals	Philadelphia College of Osteopathic Medicine	Philadelphia Energy Solutions
PHS	R3 ENTERPRISES, LLC	Robin Hood Ventures
Rosemont College	Rutgers Camden	Safeguard Scientifics
Safeguard Scientifics	Salus University	Sanofi
Shire Pharmaceuticals	Teva Pharmaceuticals	The Business/Technology Interface, LLC
The Children's Hospital of Philadelphia	The Children's Hospital of Philadelphia	The University of Pennsylvania
The Wistar Institute	The Wistar Institute	The Wistar Institute
University City Science Center	University of Delaware	University of Delaware, Office of Economic Innovation and Partnerships
University of PA - Wharton School - Wharton Entrepreneurship	University of Pennsylvania	University of Pennsylvania
University of Pennsylvania	University of Pennsylvania	University of Pennsylvania
University of Pennsylvania	University of Pennsylvania Fels Institute of Gov't	Urban Engineers
Valley Forge Military Academy and College	VALUEDsolutions and the tTAp	Verizon
Verizon Communications	WCU	WuXi AppTec Inc
Zentek Automation US Inc.		

APPENDIX I – INTERVIEWS CONDUCTED FOR THIS REPORT

Institution	Individual	Title
Ben Franklin Technology Partners	RoseAnn B. Rosenthal	President/CEO
Center of Effort, LLC	Michael Pahides	Managing Director
Children's Hospital of Philadelphia	Philip R. Johnson, M.D.	Chief Scientific Officer, Executive VP, and Director of the Research Institute
CommonBond	David Klein	Co-Founder & CEO
Computer Aid, Inc/ First State Innovation	Ernie Dianastasis	Managing Director and Principal of CAI/ Chairman of First State Innovation
Drexel University	Robert McGrath, Ph.D	Senior Associate Vice Provost and Executive Director of Technology Commercialization
Drexel University College of Medicine	Kenny Simansky	Vice Dean for Research
First Round Capital	Josh Kopelman	President
Gabriel Investments	Richard Vague	Managing partner of Gabriel Investments; Chairman of the Governor's Woods Foundation
Greenberg Traurig	Beth Cohen	Director of Global Emerging Growth Services
Independence Blue Cross	Tom Olenzak	Director of Corporate Development and Innovation
Innovation America	Richard Miller	VP for Marketing and Editor
Iroko Pharmaceuticals; Phoenix IP Ventures	Osagie Imasogie	Founder, Executive Chairman of the Board, Iroko Pharmaceuticals; Co-founder, Senior Managing Partner, Phoenix IP Ventures
Johnson & Johnson	Christine Knoblauch	VP of Business Development Vision Care
Mobiquity, Inc.	Scott Snyder	President, Chief Strategy Officer
New Jersey Technology Council	Maxine Ballen	Founder, President & CEO
PACT	Dean Miller	President and CEO, PACT; Private Equity Partner, Evergreen
Penn Center for Innovation	John S. Swartley, PhD	Associate Vice Provost for Research and Executive Director
Philadelphia Industrial Development Corporation	John Grady	Senior VP
Princeton Office of Technology Licensing	John F. Ritter	Director of Technology Licensing and Intellectual Property
RightCare Solutions, Inc./Domain Associates	Eric Heil	Co-founder, President & CEO/Entrepreneur-in-residence
Safeguard Scientifics	Stephen Zarrilli	President and CEO
Temple University	Stephen G. Nappi	Assoc. VP for Technology Development and Commercialization

Institution	Individual	Title
The South Jersey Technology Park	Shreekanth Mandayam, Ph.D.	VP for Research of Rowan University and Executive Director of SJTP
The Wistar Institute	Russel E. Kaufman, M.D.	President and CEO
Thomas Jefferson University	Theodore Taraschi	Vice Provost for Research
Thomas Jefferson University	Robin Sheldon	VP of Innovation Management
University City Science Center	Christopher Laing, MRCVS, PhD	Vice President
University City Science Center	Steven S. Tang Ph.D.	President/CEO
University City Science Center	Saul Behar	Vice President and General Counsel
University City Science Center	Peter Melley	QED Program Manager
University of Pennsylvania	Marc L. Rigas, Ph.D.	Director of Research Initiatives Office of the Vice Provost for Research
University of Pennsylvania Graduate School of Education	Barbara “Bobbi” Kurshan	Executive Director of Academic Innovation & Senior Fellow in Education
University of Pennsylvania School of Medicine	Glen N. Gaulton, Ph.D.	Executive Vice Dean and Chief Scientific Officer
University of the Sciences in Philadelphia	Helen Giles-Gee, PhD	President

APPENDIX J – ADDITIONAL DETAIL ON SCIENCE AND ENGINEERING DEGREES CONFERRED BY REGION

TABLE J.1 – DEGREES CONFERRED BY REGION IN 2005

Subject	Engineering	Physical Sciences	Geo Sciences	Life Sciences	Math & Computer Sciences	Other Science & Engr[29]	All Science & Engr	Arts and Humanities[30]	All Degrees
Atlanta	2,429	329	47	2,514	2,479	4,723	12,521	18,219	30,740
Austin	1,527	239	81	1,921	1,021	3,883	8,672	13,263	21,935
Baltimore	1,378	294	66	4,476	2,133	4,032	12,379	13,704	26,083
Boston	3,081	810	143	8,235	2,934	12,187	27,390	43,150	70,540
Houston	949	242	43	4,247	1,482	5,831	12,794	18,688	31,482
Nashville	522	106	29	1,610	404	2,207	4,878	9,004	13,882
New York	4,493	1,107	190	18,590	9,487	26,787	60,654	125,012	185,666
Greater Philadelphia	**2,600**	**674**	**83**	**9,696**	**2,570**	**10,883**	**26,506**	**45,504**	**72,010**
Pittsburgh	1,258	350	70	3,038	2,017	4,586	11,319	17,525	28,844
Raleigh Durham	1,897	470	56	3,702	1,163	3,774	11,062	11,238	22,300
San Francisco	4,107	650	180	5,399	3,156	11,080	24,572	38,995	63,567
Seattle	1,032	566	130	3,176	1,803	6,091	12,798	22,363	35,161
St. Louis	700	198	25	3,629	1,341	6,475	12,368	22,020	34,388
Tech Coast	6,382	1,495	263	13,419	7,319	30,407	59,285	114,996	174,281
Tech Valley	973	287	48	1,334	919	2,546	6,107	10,515	16,622
Washington	2,403	361	37	4,964	3,970	11,571	23,306	32,155	55,461

Source: National Science Foundation (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

[29] Includes: Psychology, Social Sciences, Science and Engineering Technologies, and Interdisciplinary or Other Sciences.

[30] Includes: Humanities, Religion and Theology, Arts and Music, Architecture and Environmental Design, Education, Business and Management, Communication and Librarianship, Law, Social Service Professions, Vocational Studies and Home Economics, and other non-science or unknown disciplines.

TABLE J.2 – RANK OF DEGREES CONFERRED BY REGION IN 2005

Rank (2005)	Engineering	Physical Sciences	Geo Sciences	Life Sciences	Math & Computer Sciences	Other Science & Engr	All Science & Engr	Arts and Humanities	All Degrees
Atlanta	6	10	12	13	7	10	9	10	10
Austin	9	14	7	14	14	13	14	13	14
Baltimore	10	11	9	7	8	12	10	12	12
Boston	4	3	4	4	5	3	3	4	4
Houston	14	13	13	8	11	9	8	9	9
Nashville	16	16	15	15	16	16	16	16	16
New York	2	2	2	1	1	2	1	1	1
Greater Philadelphia	**5**	**4**	**6**	**3**	**6**	**6**	**4**	**3**	**3**
Pittsburgh	11	9	8	12	9	11	12	11	11
Raleigh Durham	8	7	10	9	13	14	13	14	13
San Francisco	3	5	3	5	4	5	5	5	5
Seattle	12	6	5	11	10	8	7	7	7
St. Louis	15	15	16	10	12	7	11	8	8
Tech Coast	1	1	1	2	2	1	2	2	2
Tech Valley	13	12	11	16	15	15	15	15	15
Washington	7	8	14	6	3	4	6	6	6

Source: National Science Foundation (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

TABLE J.3 – DEGREES CONFERRED BY REGION IN 2012

	Engineering	Physical Sciences	Geo Sciences	Life Sciences	Math & Computer Sciences	Other Science & Engr	All Science & Engr	Arts and Humanities	All Degrees
Atlanta	3,081	419	71	4,499	2,169	5,254	15,493	21,519	37,012
Austin	1,905	307	142	3,229	941	4,473	10,997	15,438	26,435
Baltimore	1,824	464	111	6,678	1,995	5,477	16,549	17,197	33,746
Boston	4,047	1,021	179	12,826	3,010	15,094	36,177	48,914	85,091
Houston	1,204	347	140	6,278	1,760	7,823	17,552	25,353	42,905
Nashville	566	170	31	3,188	491	2,863	7,309	11,466	18,775
New York	6,831	2,161	251	28,230	7,830	34,776	80,079	142,914	222,993
Greater Philadelphia	**3,353**	**1,018**	**135**	**15,061**	**2,451**	**14,868**	**36,886**	**53,405**	**90,291**
Pittsburgh	2,040	416	83	5,178	2,339	5,852	15,908	18,398	34,306
Raleigh Durham	2,644	497	91	5,038	1,368	5,044	14,682	13,301	27,983
San Francisco	4,802	718	208	8,432	2,634	15,527	32,321	40,133	72,454
Seattle	1,288	713	137	5,018	2,350	8,693	18,199	27,652	45,851
St. Louis	795	250	42	5,459	1,109	7,907	15,562	24,427	39,989
Tech Coast	8,581	2,012	363	20,838	6,898	41,485	80,177	124,011	204,188
Tech Valley	973	404	53	3,851	814	3,554	9,649	13,973	23,622
Washington	2,954	468	83	7,525	5,183	14,642	30,855	43,218	74,073

Source: National Science Foundation (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

TABLE J.4 – RANK OF DEGREES CONFERRED BY REGION IN 2012

Rank (2005)	Engineering	Physical Sciences	Geo Sciences	Life Sciences	Math & Computer Sciences	Other Science & Engr	All Science & Engr	Arts and Humanities	All Degrees
Atlanta	6	10	13	13	9	12	12	10	10
Austin	10	14	5	15	14	14	14	13	14
Baltimore	11	9	9	7	10	11	9	12	12
Boston	4	3	4	4	4	4	4	4	4
Houston	13	13	6	8	11	9	8	8	8
Nashville	16	16	16	16	16	16	16	16	16
New York	2	1	2	1	1	2	2	1	1
Greater Philadelphia	**5**	**4**	**8**	**3**	**6**	**5**	**3**	**3**	**3**
Pittsburgh	9	11	11	10	8	10	10	11	11
Raleigh Durham	8	7	10	11	12	13	13	15	13
San Francisco	3	5	3	5	5	3	5	6	6
Seattle	12	6	7	12	7	7	7	7	7
St. Louis	15	15	15	9	13	8	11	9	9
Tech Coast	1	2	1	2	2	1	1	2	2
Tech Valley	14	12	14	14	15	15	15	14	15
Washington	7	8	11	6	3	6	6	5	5

Source: National Science Foundation (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

TABLE J.5 – CHANGE IN DEGREES CONFERRED BY REGION FROM 2005 TO 2012

	2005-2012 % Change		2005-2012 Change in Rank (+: Rose in Rank, -:Fell in Rank)	
Region	**Science & Engr**	**All**	**Science & Engr**	**All**
Atlanta	23.7%	20.4%	-3	-
Austin	26.8%	20.5%	-	-
Baltimore	33.7%	29.4%	+1	-
Boston	32.1%	20.6%	-1	-
Houston	37.2%	36.3%	-	+1
Nashville	49.8%	35.2%	-	-
New York	32.0%	20.1%	-1	-
Greater Philadelphia	**39.2%**	**25.4%**	+1	-
Pittsburgh	40.5%	18.9%	+2	-
Raleigh Durham	32.7%	25.5%	-	-
San Francisco	31.5%	14.0%	-	-1
Seattle	42.2%	30.4%	-	-
St. Louis	25.8%	16.3%	-	-1
Tech Coast	35.2%	17.2%	+1	-
Tech Valley	58.0%	42.1%	-	-
Washington, D.C.	32.4%	33.6%	-	+1

Source: National Science Foundation (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

APPENDIX K – ADDITIONAL DETAIL ON ACADEMIC RESEARCH AND DEVELOPMENT FUNDING OBTAINED BY REGION

TABLE K.1 – ACADEMIC RESEARCH AND DEVELOPMENT FUNDING OBTAINED BY REGION AND SOURCE IN 2005 (IN $M)

Subject	Federal	State/Local	Industry	Institution	Other	Total
Atlanta	$580	$25	$44	$177	$35	$861
Austin	$418	$122	$63	$132	$67	$802
Baltimore	$1,468	$46	$84	$118	$118	$1,834
Boston	$1,381	$10	$119	$73	$129	$1,712
Houston	$523	$26	$31	$109	$104	$794
Nashville	$327	$0	$6	$56	$13	$402
New York	$1,560	$76	$74	$359	$218	$2,287
Greater Philadelphia	**$883**	**$32**	**$63**	**$180**	**$119**	**$1,278**
Pittsburgh	$598	$23	$20	$63	$27	$731
Raleigh Durham	$813	$133	$180	$213	$42	$1,382
San Francisco	$1,345	$77	$94	$306	$267	$2,088
Seattle	$607	$10	$45	$30	$17	$709
St. Louis	$451	$14	$15	$95	$37	$612
Tech Coast	$2,165	$65	$135	$503	$286	$3,155
Tech Valley	$160	$94	$17	$57	$19	$347
Washington, D.C.	$526	$21	$24	$149	$44	$765

Source: National Science Foundation (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

TABLE K.2 – ACADEMIC RESEARCH AND DEVELOPMENT FUNDING OBTAINED BY REGION AND DISCIPLINE IN 2005 (IN $M)

Subject	Engineering	Physical Sciences	Geo Sciences	Life Sciences	Math & Computer Sciences	Psychology	Social Sciences	Other	Total
Atlanta	$288	$53	$15	$393	$65	$19	$24	$5	$861
Austin	$142	$95	$41	$394	$76	$17	$32	$5	$802
Baltimore	$449	$155	$59	$992	$103	$7	$22	$48	$1,834
Boston	$311	$222	$117	$846	$70	$30	$77	$39	$1,712
Houston	$48	$30	$6	$669	$21	$14	$6	$0	$794
Nashville	$38	$23	$0	$313	$2	$10	$5	$12	$402
New York	$130	$141	$104	$1,691	$73	$51	$63	$32	$2,287
Greater Philadelphia	**$175**	**$95**	**$32**	**$809**	**$34**	**$35**	**$78**	**$20**	**$1,278**
Pittsburgh	$75	$36	$2	$461	$116	$13	$15	$14	$731
Raleigh Durham	$116	$70	$52	$1,019	$43	$9	$69	$5	$1,382
San Francisco	$312	$248	$55	$1,315	$37	$28	$70	$23	$2,088
Seattle	$72	$34	$85	$485	$6	$10	$16	$0	$709
St. Louis	$19	$20	$9	$531	$9	$7	$12	$5	$612
Tech Coast	$353	$324	$215	$1,865	$229	$46	$90	$32	$3,155
Tech Valley	$134	$53	$11	$123	$9	$2	$15	$0	$347
Washington	$112	$88	$22	$335	$84	$15	$108	$1	$765

Source: National Science Foundation (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

TABLE K.3 – RANK OF ACADEMIC RESEARCH AND DEVELOPMENT FUNDING OBTAINED BY REGION AND SOURCE IN 2005

Subject	Federal	State/Local	Industry	Institution	Other	Total
Atlanta	10	10	10	6	12	8
Austin	14	2	8	8	8	9
Baltimore	3	7	5	9	6	4
Boston	4	14	3	12	4	5
Houston	12	9	11	10	7	10
Nashville	15	16	16	15	16	15
New York	2	5	6	2	3	2
Greater Philadelphia	**6**	**8**	**7**	**5**	**5**	**7**
Pittsburgh	9	11	13	13	13	12
Raleigh Durham	7	1	1	4	10	6
San Francisco	5	4	4	3	2	3
Seattle	8	15	9	16	15	13
St. Louis	13	13	15	11	11	14
Tech Coast	1	6	2	1	1	1
Tech Valley	16	3	14	14	14	16
Washington, D.C.	11	12	12	7	9	11

Source: National Science Foundation (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

TABLE K.4 – RANK OF ACADEMIC RESEARCH AND DEVELOPMENT FUNDING OBTAINED BY REGION AND DISCIPLINE IN 2005

Subject	Engineering	Physical Sciences	Geo Sciences	Life Sciences	Math & Computer Sciences	Psychology	Social Sciences	Other	Total
Atlanta	5	11	11	13	8	6	9	11	8
Austin	7	7	8	12	5	7	8	12	9
Baltimore	1	4	5	5	3	14	10	1	4
Boston	4	3	2	6	7	4	4	2	5
Houston	14	14	14	8	12	9	15	14	10
Nashville	15	15	16	15	16	12	16	8	15
New York	9	5	3	2	6	1	7	3	2
Greater Philadelphia	**6**	**6**	**9**	**7**	**11**	**3**	**3**	**6**	**7**
Pittsburgh	12	12	15	11	2	10	13	7	12
Raleigh Durham	10	9	7	4	9	13	6	10	6
San Francisco	3	2	6	3	10	5	5	5	3
Seattle	13	13	4	10	15	11	11	15	13
St. Louis	16	16	13	9	13	15	14	9	14
Tech Coast	2	1	1	1	1	2	2	4	1
Tech Valley	8	10	12	16	14	16	12	16	16
Washington	11	8	10	14	4	8	1	13	11

Source: National Science Foundation (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

TABLE K.5 – ACADEMIC RESEARCH AND DEVELOPMENT FUNDING OBTAINED BY REGION AND SOURCE IN 2012 (IN $M)

Subject	Federal	State/Local	Industry	Institution	Other	Total
Atlanta	$923	$22	$75	$198	$64	$1,282
Austin	$535	$276	$132	$186	$133	$1,262
Baltimore	$2,149	$27	$68	$196	$167	$2,606
Boston	$1,751	$8	$186	$270	$246	$2,460
Houston	$530	$55	$31	$213	$75	$905
Nashville	$472	$1	$12	$75	$24	$583
New York	$2,213	$97	$137	$659	$306	$3,412
Greater Philadelphia	**$1,188**	**$37**	**$79**	**$213**	**$94**	**$1,610**
Pittsburgh	$834	$10	$33	$196	$35	$1,108
Raleigh Durham	$1,367	$97	$296	$380	$142	$2,282
San Francisco	$1,543	$128	$214	$370	$395	$2,651
Seattle	$880	$15	$20	$69	$85	$1,069
St. Louis	$479	$21	$55	$133	$88	$776
Tech Coast	$2,720	$167	$231	$528	$483	$4,128
Tech Valley	$208	$126	$91	$76	$18	$519

Washington, D.C.	$800	$20	$17	$278	$70	$1,187

Source: National Science Foundation (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

TABLE K.6 – ACADEMIC RESEARCH AND DEVELOPMENT FUNDING OBTAINED BY REGION AND DISCIPLINE IN 2012 (IN $M)

Subject	Engineering	Physical Sciences	Geo Sciences	Life Sciences	Math & Computer Sciences	Psychology	Social Sciences	Other	Total
Atlanta	$501	$80	$16	$485	$100	$58	$24	$18	$1,282
Austin	$202	$112	$71	$694	$107	$32	$33	$10	$1,262
Baltimore	$888	$178	$64	$1,270	$149	$8	$23	$27	$2,606
Boston	$572	$276	$152	$1,056	$108	$40	$111	$146	$2,460
Houston	$114	$44	$17	$682	$25	$12	$7	$5	$905
Nashville	$59	$32	$2	$465	$2	$14	$6	$2	$583
New York	$242	$171	$135	$2,557	$99	$74	$106	$28	$3,412
Greater Philadelphia	**$249**	**$115**	**$49**	**$1,026**	**$64**	**$41**	**$59**	**$8**	**$1,610**
Pittsburgh	$121	$43	$11	$761	$126	$21	$10	$16	$1,108
Raleigh Durham	$185	$70	$69	$1,706	$68	$65	$117	$3	$2,282
San Francisco	$308	$207	$58	$1,782	$40	$38	$65	$154	$2,651
Seattle	$104	$50	$161	$691	$45	$8	$7	$3	$1,069
St. Louis	$25	$23	$12	$695	$7	$9	$3	$3	$776
Tech Coast	$465	$483	$251	$2,462	$239	$90	$111	$28	$4,128
Tech Valley	$322	$19	$10	$130	$16	$6	$15	$0	$519
Washington	$153	$146	$44	$558	$74	$34	$172	$5	$1,187

Source: National Science Foundation (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

TABLE K.7 – RANK OF ACADEMIC RESEARCH AND DEVELOPMENT FUNDING OBTAINED BY REGION AND SOURCE IN 2012

Subject	Federal	State/Local	Industry	Institution	Other	Total
Atlanta	8	10	9	9	13	8
Austin	12	1	6	12	7	9
Baltimore	3	9	10	10	5	4
Boston	4	15	4	6	4	5
Houston	13	7	13	7	11	13
Nashville	15	16	16	15	15	15
New York	2	5	5	1	3	2
Greater Philadelphia	**7**	**8**	**8**	**8**	**8**	**7**
Pittsburgh	10	14	12	11	14	11
Raleigh Durham	6	6	1	3	6	6
San Francisco	5	3	3	4	2	3
Seattle	9	13	14	16	10	12
St. Louis	14	11	11	13	9	14

Tech Coast	1	2	2	2	1	1
Tech Valley	16	4	7	14	16	16
Washington, D.C.	11	12	15	5	12	10

Source: National Science Foundation (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

TABLE K.8 – RANK OF ACADEMIC RESEARCH AND DEVELOPMENT FUNDING OBTAINED BY REGION AND DISCIPLINE IN 2012

Subject	Engineering	Physical Sciences	Geo Sciences	Life Sciences	Math & Computer Sciences	Psychology	Social Sciences	Other	Total
Atlanta	3	9	12	14	6	4	9	6	8
Austin	9	8	5	10	5	9	8	8	9
Baltimore	1	4	7	5	2	15	10	5	4
Boston	2	2	3	6	4	6	3	2	5
Houston	13	12	11	12	13	12	14	11	13
Nashville	15	14	16	15	16	11	15	15	15
New York	8	5	4	1	7	2	5	4	2
Greater Philadelphia	**7**	**7**	**9**	**7**	**10**	**5**	**7**	**9**	**7**
Pittsburgh	12	13	14	8	3	10	12	7	11
Raleigh Durham	10	10	6	4	9	3	2	14	6
San Francisco	6	3	8	3	12	7	6	1	3
Seattle	14	11	2	11	11	14	13	12	12
St. Louis	16	15	13	9	15	13	16	13	14
Tech Coast	4	1	1	2	1	1	4	3	1
Tech Valley	5	16	15	16	14	16	11	16	16
Washington	11	6	10	13	8	8	1	10	10

Source: National Science Foundation (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

TABLE K.9 – CHANGE IN ACADEMIC RESEARCH AND DEVELOPMENT FUNDING OBTAINED BY REGION FROM 2005 TO 2012

Region	2005-2012 % Change	2005-2012 Change in Rank (+: Rose in Rank, -:Fell in Rank) All
Atlanta	48.8%	-
Austin	57.3%	-
Baltimore	42.1%	-
Boston	43.7%	-
Houston	13.9%	-3
Nashville	44.9%	-
New York	49.2%	-
Greater Philadelphia	**26.0%**	**-**
Pittsburgh	51.6%	+1

Raleigh Durham	65.1%	-
San Francisco	26.9%	-
Seattle	50.8%	+1
St. Louis	26.8%	-
Tech Coast	30.9%	-
Tech Valley	49.5%	-
Washington, D.C.	55.1%	+1

Source: National Science Foundation (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

APPENDIX L – ADDITIONAL DETAIL ON DISTRIBUTION OF ACADEMIC RESEARCH AND DEVELOPMENT FUNDING OBTAINED BY REGION

City/Institution	2013 R&D $M	% City
Atlanta	**$1,282**	**100%**
Georgia Institute of Technology	$684	53%
Emory University	$475	37%
Georgia State University	$62	5%
Morehouse School of Medicine	$38	3%
Clark Atlanta University	$10	1%
Other	$13	1%
Austin	**$1,262**	**100%**
University of Texas M. D. Anderson Cancer Center, The	$686	54%
University of Texas at Austin, The	$549	44%
Texas State University-San Marcos	$24	2%
St. Edward's University	$2	0%
Other	$0	0%
Baltimore	**$2,606**	**100%**
Johns Hopkins University	$2,093	80%
University of Maryland Baltimore	$415	16%
University of Maryland, Baltimore County	$66	3%
Morgan State University	$17	1%
United States Naval Academy	$9	0%
Other	$6	0%
Boston	**$2,460**	**100%**

City/Institution	2013 R&D $M	% City
Massachusetts Institute of Technology	$770	31%
Harvard University	$754	31%
Boston University	$329	13%
Tufts University	$159	6%
University of New Hampshire	$152	6%
Other	$295	12%
Houston	**$905**	**100%**
Baylor College of Medicine	$475	52%
University of Texas Medical Branch, The	$181	20%
Rice University	$115	13%
University of Houston	$106	12%
Prairie View A&M University	$15	2%
Other	$14	0%
Nashville	**$583**	**100%**
Vanderbilt U.	$534	92%
Meharry Medical C.	$26	4%
TN State U.	$14	2%
Middle Tennessee State University	$5	1%
Fisk U.	$4	0%
Other	$0	0%
New York	**$3,412**	**100%**
Columbia University in the City of New York	$848	25%
New York University	$425	12%
Rutgers, The State University of New Jersey, New Brunswick	$421	12%
Icahn School of Medicine at Mount Sinai	$401	12%
Rockefeller University	$293	9%
Other	$1,025	30%
Greater Philadelphia	**$1,610**	**100%**
University of Pennsylvania	$813	51%
Princeton University	$265	16%
University of Delaware	$161	10%
Temple University	$119	7%
Drexel University	$112	7%
Other	$139	9%

City/Institution	2013 R&D $M	% City
Pittsburgh	**$1,108**	**100%**
U. Pittsburgh all campuses	$840	76%
Carnegie Mellon U.	$255	23%
Duquesne U.	$13	1%
Other	$0	0%
Raleigh Durham	**$2,282**	**100%**
Duke University	$1,005	44%
University of North Carolina at Chapel Hill, The	$865	38%
North Carolina State University	$400	18%
North Carolina Central University	$11	0%
Shaw University	$2	0%
Other	$0	0%
San Francisco	**$2,651**	**100%**
University of California, San Francisco	$1,033	39%
Stanford University	$855	32%
University of California, Berkeley	$697	26%
San Jose State University	$30	1%
San Francisco State University	$29	1%
Other	$8	0%
Seattle	**$1,069**	**100%**
University of Washington, Seattle	$1,065	100%
Bastyr University	$3	0%
Seattle University	$1	0%
Seattle Pacific University	$0	0%
Other	$0	0%
St. Louis	**$776**	**100%**
Washington University in St. Louis	$689	89%
St. Louis University	$48	6%
Southern Illinois University, Edwardsville	$26	3%
University of Missouri, St. Louis	$13	2%
Barnes-Jewish College Goldfarb School of Nursing	$0	0%
Other	$0	0%
Tech Coast	**$4,128**	**100%**

City/Institution	2013 R&D $M	% City
University of California, San Diego	$1,065	26%
University of California, Los Angeles	$970	23%
University of Southern California	$593	14%
Scripps Research Institute, The	$399	10%
California Institute of Technology	$361	9%
Other	$741	18%
Tech Valley	**$519**	**100%**
SUNY, University at Albany, College of Nanoscale Science and Engineering	$265	51%
SUNY University at Albany	$136	26%
Rensselaer Polytechnic Institute	$92	18%
Albany Medical College	$18	3%
Albany College of Pharmacy and Health Sciences	$3	1%
Other	$5	1%
Washington, D.C.	**$1,187**	**100%**
University of Maryland, College Park	$498	42%
George Washington University	$188	16%
Georgetown University	$172	14%
Uniformed Services University of the Health Sciences	$151	13%
George Mason University	$80	7%
Other	$97	8%

Source: National Science Foundation (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

APPENDIX M – ADDITIONAL DETAIL ON INVENTION DISCLOSURES REPORTED BY REGION

TABLE M.1 – INVENTION DISCLOSURES REPORTED BY REGION

Region	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Atlanta	263	281	323	340	396	470	529	527	536	567	621	658	682
Austin	87	85	83	68	87	127	98	139	154	N/A	N/A	N/A	N/A
Baltimore	445	437	451	420	469	542	507	455	453	352	355	409	427
Boston	1141	1386	1497	1510	1681	1646	1914	1765	1996	1836	1927	2069	2259
Houston	329	386	426	461	450	456	453	492	453	161	204	251	226
Nashville	80	93	85	121	131	111	132	144	134	150	133	167	190
New York	400	444	465	348	412	370	428	857	797	910	878	895	1072
Greater Philadelphia	**479**	**210**	**337**	**450**	**483**	**485**	**487**	**541**	**648**	**691**	**624**	**781**	**819**
Pittsburgh	216	201	196	181	243	281	286	387	369	370	333	411	486
Raleigh Durham	439	477	440	430	423	419	465	471	471	459	463	560	649
San Francisco	256	280	329	380	364	60	544	428	459	453	482	518	510
Seattle	235	157	237	212	247	302	367	381	389	381	394	402	504
St. Louis	100	83	98	109	127	124	119	100	98	125	104	136	143
Tech Coast	417	680	636	764	780	894	757	919	804	886	924	803	773
Tech Valley	N/A	N/A	70	86	91	82	75	99	53	67	77	63	69
Washington, D.C.	168	158	135	134	187	202	211	344	382	223	248	348	301

Source: Association of University Technology Managers (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

TABLE M.2 – RANK OF INVENTION DISCLOSURES BY REGION

Region	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Atlanta	8	7	9	9	8	5	4	5	5	5	5	5	5
Austin	14	14	15	16	16	12	15	14	13	N/A	N/A	N/A	N/A
Baltimore	3	5	4	6	4	3	5	8	8	10	9	9	10
Boston	1	1	1	1	1	1	1	1	1	1	1	1	1
Houston	7	6	6	3	5	6	8	6	8	12	12	12	12
Nashville	15	13	14	13	13	14	13	13	14	13	13	13	13
New York	6	4	3	8	7	8	9	3	3	2	3	2	2
Greater Philadelphia	**2**	**9**	**7**	**4**	**3**	**4**	**6**	**4**	**4**	**4**	**4**	**4**	**3**
Pittsburgh	11	10	11	11	11	10	11	10	12	9	10	8	9
Raleigh Durham	4	3	5	5	6	7	7	7	6	6	7	6	6
San Francisco	9	8	8	7	9	16	3	9	7	7	6	7	7
Seattle	10	12	10	10	10	9	10	11	10	8	8	10	8
St. Louis	13	15	13	14	14	13	14	15	15	14	14	14	14
Tech Coast	5	2	2	2	2	2	2	2	2	3	2	3	4
Tech Valley	N/A	N/A	16	15	15	15	16	16	16	15	15	15	15
Washington, D.C.	12	11	12	12	12	11	12	12	11	11	11	11	11

Source: Association of University Technology Managers (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

APPENDIX N – ADDITIONAL DETAIL ON PATENTS GRANTED BY REGION

TABLE N.1 – PATENTS GRANTED BY REGION

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Atlanta	1,023	1,097	1,034	1,083	1,082	997	1,267	1,102	1,136	1,224	1,656	1,680
Austin	1,680	1,732	1,653	1,792	1,733	1,623	1,912	1,794	1,951	2,137	2,449	2,460
Baltimore	645	685	669	650	602	523	601	532	531	576	711	667
Boston	2,972	3,133	3,103	3,465	3,195	2,768	3,461	3,027	3,039	3,165	4,330	4,537
Houston	1,767	1,778	1,734	1,678	1,628	1,460	1,781	1,611	1,616	1,619	2,190	2,173
Nashville	155	164	151	159	151	113	149	116	126	130	196	212
New York	5,689	5,638	5,479	5,233	4,717	3,959	4,951	4,285	4,399	4,605	6,383	6,252
Greater Philadelphia	**2,534**	**2,591**	**2,461**	**2,249**	**1,967**	**1,707**	**2,123**	**1,929**	**1,797**	**1,997**	**2,501**	**2,452**
Pittsburgh	736	664	644	665	618	492	623	491	495	571	740	716
Raleigh Durham	997	1,056	1,008	1,091	1,013	951	1,273	1,099	1,249	1,378	1,753	1,719
San Francisco	9,437	10,177	10,463	10,922	10,911	10,228	12,939	11,528	11,511	12,551	16,364	16,724
Seattle	1,141	1,227	1,306	1,419	1,467	1,518	2,290	2,346	2,622	3,378	4,052	3,597
St. Louis	632	674	688	672	596	470	537	485	452	533	721	616
Tech Coast	5,772	6,087	6,035	6,314	6,154	5,650	6,876	5,977	5,667	6,035	8,240	8,721
Tech Valley	495	613	764	661	583	468	544	492	516	554	736	713
Washington, D.C.	1,218	1,286	1,307	1,252	1,226	1,105	1,371	1,203	1,242	1,302	1,758	1,790

Source: US Patent Office (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

TABLE N.2 – RANK OF PATENTS GRANTED BY REGION

Patents Granted	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Atlanta	10	10	10	11	10	10	11	10	11	11	11	11
Austin	7	7	7	6	6	6	7	7	6	6	7	6
Baltimore	13	12	14	15	13	12	13	12	12	12	15	14
Boston	4	4	4	4	4	4	4	4	4	5	4	4
Houston	6	6	6	7	7	8	8	8	8	8	8	8
Nashville	16	16	16	16	16	16	16	16	16	16	16	16
New York	3	3	3	3	3	3	3	3	3	3	3	3
Greater Philadelphia	**5**	**5**	**5**	**5**	**5**	**5**	**6**	**6**	**7**	**7**	**6**	**7**
Pittsburgh	12	14	15	13	12	13	12	14	14	13	12	12
Raleigh Durham	11	11	11	10	11	11	10	11	9	9	10	10
San Francisco	1	1	1	1	1	1	1	1	1	1	1	1
Seattle	9	9	9	8	8	7	5	5	5	4	5	5
St. Louis	14	13	13	12	14	14	15	15	15	15	14	15
Tech Coast	2	2	2	2	2	2	2	2	2	2	2	2
Tech Valley	15	15	12	14	15	15	14	13	13	14	13	13
Washington, D.C.	8	8	8	9	9	9	9	9	10	10	9	9

Source: US Patent Office (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

APPENDIX O – ADDITIONAL DETAIL ON LICENSES EXECUTED BY REGION

TABLE O.1 – LICENSES EXECUTED BY REGION

Region	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Atlanta	32	35	60	52	66	77	58	90	81	104	78	132	178
Austin	42	34	35	20	23	25	50	20	56	N/A	N/A	N/A	N/A
Baltimore	134	96	109	177	127	124	82	124	127	99	104	159	157
Boston	359	404	398	444	470	511	523	548	487	548	526	553	634
Houston	80	79	114	130	135	139	133	162	160	71	68	66	57
Nashville	24	15	21	28	28	49	47	44	49	46	43	48	62
New York	121	130	118	88	119	132	143	177	236	305	256	241	304
Greater Philadelphia	**219**	**54**	**112**	**122**	**123**	**135**	**95**	**89**	**107**	**139**	**127**	**186**	**209**
Pittsburgh	45	38	52	72	75	97	86	82	84	61	128	175	207
Raleigh Durham	151	149	193	159	161	145	165	282	223	260	212	233	243
San Francisco	164	150	106	130	91	9	116	93	111	83	96	127	142
Seattle	133	110	80	72	81	140	186	223	231	246	213	212	225
St. Louis	159	50	53	44	71	50	41	40	52	53	51	60	46
Tech Coast	144	159	170	158	150	157	146	108	149	97	113	122	94
Tech Valley	N/A	N/A	6	9	11	14	18	11	10	10	8	8	6
Washington, D.C.	51	74	90	29	61	79	68	78	61	36	42	46	32

Source: Association of University Technology Managers (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

TABLE O.2 – RANK OF LICENSES EXECUTED BY REGION (IN $M)

Region	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Atlanta	14	13	11	11	12	11	12	9	11	6	10	8	7
Austin	13	14	14	15	15	14	13	15	13	N/A	N/A	N/A	N/A
Baltimore	7	7	7	2	5	8	10	6	7	7	8	7	8
Boston	1	1	1	1	1	1	1	1	1	1	1	1	1
Houston	10	8	5	5	4	5	6	5	5	10	11	11	12
Nashville	15	15	15	14	14	13	14	13	15	13	13	13	11
New York	9	5	4	8	7	7	5	4	2	2	2	2	2
Greater Philadelphia	**2**	**10**	**6**	**7**	**6**	**6**	**8**	**10**	**9**	**5**	**6**	**5**	**5**
Pittsburgh	12	12	13	9	10	9	9	11	10	11	5	6	6
Raleigh Durham	5	4	2	3	2	3	3	2	4	3	4	3	3
San Francisco	3	3	8	5	8	16	7	8	8	9	9	9	9
Seattle	8	6	10	9	9	4	2	3	3	4	3	4	4
St. Louis	4	11	12	12	11	12	15	14	14	12	12	12	13
Tech Coast	6	2	3	4	3	2	4	7	6	8	7	10	10
Tech Valley	N/A	N/A	16	16	16	15	16	16	16	15	15	15	15
Washington, D.C.	11	9	9	13	13	10	11	12	12	14	14	14	14

Source: Association of University Technology Managers (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

APPENDIX P – ADDITIONAL DETAIL ON STARTUP VENTURES FORMED BY REGION

TABLE P.1 – STARTUP VENTURES FORMED BY REGION

Region	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Atlanta	6	11	12	12	17	13	12	15	12	10	12	12	19
Austin	5	9	4	6	5	4	7	3	10	N/A	N/A	N/A	N/A
Baltimore	11	7	5	6	7	8	6	4	14	10	11	11	8
Boston	52	56	50	32	48	51	57	60	67	51	48	73	59
Houston	12	12	17	8	9	7	11	18	10	4	4	6	5
Nashville	2	0	1	1	2	4	3	4	4	1	0	0	5
New York	18	18	15	9	13	16	21	33	29	30	29	39	34
Greater Philadelphia	**9**	**7**	**13**	**14**	**8**	**11**	**9**	**9**	**6**	**8**	**10**	**17**	**23**
Pittsburgh	9	8	9	10	14	15	18	16	13	13	16	13	20
Raleigh Durham	13	23	11	10	17	9	15	8	17	9	14	16	19
San Francisco	8	6	13	12	9	0	10	6	9	9	0	0	0
Seattle	7	5	2	3	7	6	11	11	10	11	9	9	10
St. Louis	1	2	1	4	3	3	2	5	4	2	2	2	2
Tech Coast	23	24	21	16	23	24	18	15	22	28	20	25	21
Tech Valley	N/A	N/A	1	2	4	2	2	1	1	1	2	2	3
Washington, D.C.	4	6	3	8	6	9	5	13	9	4	4	7	2

Source: Association of University Technology Managers (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

TABLE P.2 – RANK OF STARTUP VENTURES FORMED BY REGION

Region	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Atlanta	11	6	7	4	3	5	6	5	7	6	6	7	6
Austin	12	7	11	11	13	12	11	15	8	N/A	N/A	N/A	N/A
Baltimore	6	9	10	11	10	9	12	13	5	6	7	8	9
Boston	1	1	1	1	1	1	1	1	1	1	1	1	1
Houston	5	5	3	9	7	10	7	3	8	11	10	11	10
Nashville	14	15	14	16	16	12	14	13	14	14	14	14	10
New York	3	4	4	8	6	3	2	2	2	2	2	2	2
Greater Philadelphia	**7**	**9**	**5**	**3**	**9**	**6**	**10**	**9**	**13**	**10**	**8**	**4**	**3**
Pittsburgh	7	8	9	6	5	4	3	4	6	4	4	6	5
Raleigh Durham	4	3	8	6	3	7	5	10	4	8	5	5	6
San Francisco	9	11	5	4	7	16	9	11	11	8	14	14	15
Seattle	10	13	13	14	10	11	7	8	8	5	9	9	8
St. Louis	15	14	14	13	15	14	15	12	14	13	12	12	13
Tech Coast	2	2	2	2	2	2	3	5	3	3	3	3	4
Tech Valley	N/A	N/A	14	15	14	15	15	16	16	14	12	12	12
Washington, D.C.	13	11	12	9	12	7	13	7	11	11	10	10	13

Source: Association of University Technology Managers (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

APPENDIX Q – ADDITIONAL DETAIL ON VENTURE CAPITAL INVESTMENT RECEIVED BY REGION

TABLE Q.1 – VENTURE CAPITAL INVESTMENT RECEIVED BY REGION (IN $M)

Region	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
AK/HI/PR	$249	$70	$5	$18	$15	$43	$47	$21	$21	$7	$14	$1	$1
Colorado	$4,092	$1,245	$588	$610	$363	$623	$703	$686	$873	$462	$454	$654	$589
DC/Metroplex	$5,795	$2,103	$1,096	$792	$1,087	$1,234	$1,353	$1,412	$1,148	$683	$975	$1,014	$758
LA/Orange County	$6,782	$2,265	$1,287	$1,069	$920	$1,506	$1,899	$1,926	$2,022	$1,078	$1,671	$2,051	$2,081
Midwest	$5,777	$2,185	$977	$914	$712	$916	$1,010	$1,159	$1,364	$966	$1,364	$1,554	$1,419
New England	$12,039	$5,397	$2,999	$3,039	$3,410	$2,970	$3,323	$4,065	$3,800	$2,604	$2,612	$3,349	$3,546
North Central	$3,628	$670	$434	$268	$464	$367	$386	$533	$633	$411	$337	$381	$360
Northwest	$3,628	$1,427	$768	$643	$1,001	$1,004	$1,275	$1,604	$1,076	$636	$718	$711	$998
NY Metro	$10,275	$3,498	$1,549	$1,385	$1,636	$1,973	$2,217	$1,936	$2,170	$1,749	$1,874	$2,868	$2,360
Greater Philadelphia	**$2,591**	**$1,087**	**$637**	**$555**	**$735**	**$593**	**$834**	**$909**	**$803**	**$389**	**$452**	**$457**	**$429**
Sacramento/N.Cal	$372	$203	$65	$32	$38	$38	$29	$75	$69	$19	$17	$68	$20
San Diego	$2,298	$1,579	$997	$826	$1,198	$1,204	$1,259	$1,849	$1,209	$950	$887	$928	$1,208
Silicon Valley	$33,404	$12,619	$7,249	$6,729	$7,976	$8,134	$9,819	$11,567	$11,527	$8,303	$9,438	$12,128	$11,111
South Central	$447	$110	$69	$66	$130	$96	$64	$153	$91	$25	$75	$98	$95
Southeast	$7,970	$2,685	$1,782	$1,115	$1,418	$1,094	$1,204	$1,859	$1,356	$1,032	$1,101	$1,193	$802
Southwest	$1,388	$515	$394	$220	$394	$525	$527	$611	$561	$317	$285	$581	$605
Texas	$6,271	$3,137	$1,192	$1,221	$1,212	$1,173	$1,518	$1,501	$1,438	$678	$1,079	$1,617	$954
Upstate NY	$294	$159	$104	$123	$105	$60	$156	$137	$92	$27	$45	$113	$49

Source: PricewaterhouseCoopers Moneytree Report (2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

TABLE Q.2 – RANK OF VENTURE CAPITAL INVESTMENT RECEIVED BY REGION (IN $M)

Region	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
AK/HI/PR	18	18	18	18	18	17	17	18	18	18	18	18	18
Colorado	9	11	12	11	14	11	12	12	11	11	11	11	12
DC/Metroplex	7	8	7	9	7	5	6	9	9	8	8	8	10
LA/Orange County	5	6	5	6	9	4	4	4	4	4	4	4	4
Midwest	8	7	9	7	11	10	10	10	6	6	5	6	5
New England	2	2	2	2	2	2	2	2	2	2	2	2	2
North Central	10	13	13	13	12	14	14	14	13	12	13	14	14
Northwest	10	10	10	10	8	9	7	7	10	10	10	10	7
NY Metro	3	3	4	3	3	3	3	3	3	3	3	3	3
Greater Philadelphia	**12**	**12**	**11**	**12**	**10**	**12**	**11**	**11**	**12**	**13**	**12**	**13**	**13**
Sacramento/N.Cal	16	15	17	17	17	18	18	17	17	17	17	17	17
San Diego	13	9	8	8	6	6	8	6	8	7	9	9	6
Silicon Valley	1	1	1	1	1	1	1	1	1	1	1	1	1
South Central	15	17	16	16	15	15	16	15	16	16	15	16	15
Southeast	4	5	3	5	4	8	9	5	7	5	6	7	9
Southwest	14	14	14	14	13	13	13	13	14	14	14	12	11
Texas	6	4	6	4	5	7	5	8	5	9	7	5	8
Upstate NY	17	16	15	15	16	16	15	16	15	15	16	15	16

Source: PricewaterhouseCoopers Moneytree Report(2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

TABLE Q.3 – REGION CLASSIFICATIONS FOR VENTURE CAPITAL INVESTMENT REGIONS

Region							
AK/HI/PR	Alaska	Hawaii	Puerto Rico				
Colorado	The state of Colorado						
DC/Metroplex	Washington, D.C.	Virginia	West Virginia	Maryland			
LA/Orange County	Southern California (Excluding San Diego)	the Central Coast	San Joaquin Valley				
Midwest	Illinois	Missouri	Indiana	Kentucky	Ohio	Michigan	Western Pennsylvania
New England	Maine	New Hampshire	Vermont	Massachusetts	Rhode Island	Connecticut (Excluding Fairfield county)	
North Central	Minnesota	Iowa	Wisconsin	North Dakota	South Dakota	Nebraska	
Northwest	Washington	Oregon	Idaho	Montana	Wyoming		
NY Metro	Metropolitan NY	Northern New Jersey	Fairfield County	Connecticut			
Greater Philadelphia	Eastern Pennsylvania	Southern New Jersey	Delaware				
Sacramento/N.Cal	Northeastern California						
San Diego	San Diego area						
Silicon Valley	Northern California	Bay area and coastline					
South Central	Kansas	Oklahoma	Arkansas	Louisiana			
Southeast	Alabama	Florida	Georgia	Mississippi	Tennessee	South Carolina	North Carolina
Southwest	Utah	Arizona	New Mexico	Nevada			
Texas	The state of Texas						
Upstate NY	Northern New York state (Excluding Metropolitan New York City area)						

Source: PricewaterhouseCoopers/National Venture Capital Association Moneytree ™ Report, Data: Thomson Reuters(2014), CEO Council for Growth (2014), Econsult Solutions, Inc. (2014)

APPENDIX R – ADDITIONAL DETAIL ON INITIAL INPUT INDEX RESULTS

TABLE R.1 – INITIAL INPUT INDEX RESULTS FROM 2007 REPORT

Region	Total S&E Degrees Conferred, 2005	Financing of Academic R&D, 2005	Average of Both Indexes	2007 Rank
Atlanta	47.2	67.4	57.3	9
Austin	32.7	62.8	47.7	13
Baltimore	46.7	143.6	95.1	6
Boston	103.3	134.0	118.7	4
Houston	48.3	62.2	55.2	10
Nashville	18.4	31.5	24.9	16
New York	228.8	179.0	203.9	2
Greater Philadelphia	**100.0**	**100.0**	**100.0**	**5**
Pittsburgh	42.7	57.2	50.0	12
Raleigh Durham	41.7	108.2	74.9	7
San Francisco	92.7	163.4	128.1	3
Seattle	48.3	55.5	51.9	11
St. Louis	46.7	47.9	47.3	14
Tech Coast	223.7	246.9	235.3	1
Tech Valley	23.0	27.2	25.1	15
Washington, D.C.	87.9	59.9	73.9	8

Source: Econsult Solutions, Inc. (2014)

TABLE R.2 – INITIAL INPUT INDEX RESULTS FROM THIS REPORT

Region	Total S&E Degrees Conferred, 2012	Financing of Academic R&D, 2012	Average of Both Indexes	2014 Rank	2007-2014 Rank Chg
Atlanta	42.0	79.6	60.8	9	-
Austin	29.8	78.4	54.1	12	↓1
Baltimore	44.9	161.9	103.4	5	↓1
Boston	98.1	152.8	125.5	4	-
Houston	47.6	56.2	51.9	13	↓3
Nashville	19.8	36.2	28.0	16	-
New York	217.1	212.0	214.5	2	↓1
Greater Philadelphia	**100.0**	**100.0**	**100.0**	**6**	**↓1**
Pittsburgh	43.1	68.8	56.0	11	↓1
Raleigh Durham	39.8	141.8	90.8	7	-
San Francisco	87.6	164.7	126.1	3	-
Seattle	49.3	66.4	57.9	10	↓1
St. Louis	42.2	48.2	45.2	14	-
Tech Coast	217.4	256.5	236.9	1	-
Tech Valley	26.2	32.2	29.2	15	-
Washington, D.C.	83.6	73.7	78.7	8	-

Source: Econsult Solutions, Inc. (2014)

APPENDIX S – ADDITIONAL DETAIL ON INNOVATION ACTIVITY INDEX RESULTS

TABLE S.1 – INNOVATION ACTIVITY INDEX RESULTS FROM 2007 REPORT

Region	Invention Disclosure, 2000-2006	Patents Granted, 2000-2005	Average of Both Indexes	2007 Rank
Atlanta	88.8	46.8	67.8	9
Austin	21.7	75.6	48.6	11
Baltimore	111.6	27.9	69.8	8
Boston	367.6	138.0	252.8	2
Houston	101.0	74.4	87.7	6
Nashville	25.7	6.6	16.2	15
New York	97.8	227.4	162.6	4
Greater Philadelphia	**100.0**	**100.0**	**100.0**	**5**
Pittsburgh	54.7	28.3	41.5	13
Raleigh Durham	105.5	45.3	75.4	7
San Francisco	75.5	460.0	267.7	1
Seattle	59.9	59.8	59.9	10
St. Louis	25.9	27.6	26.8	14
Tech Coast	168.1	266.6	217.4	3
Tech Valley	N/A	26.5	N/A	N/A
Washington, D.C.	40.8	54.7	47.8	12

Source: Econsult Solutions, Inc. (2014)

TABLE S.2 – INNOVATION ACTIVITY INDEX RESULTS FROM THIS REPORT

Region	Invention Disclosure, 2007-2012	Patents Granted, 2006-2011	Average of Both Indexes	2014 Rank	2007-2014 Rank Chg
Atlanta	87.5	63.0	75.3	7	↑2
Austin	N/A	99.2	N/A	N/A	N/A
Baltimore	59.7	28.3	44.0	11	↑2
Boston	288.8	168.4	228.6	2	-
Houston	43.5	85.9	64.7	9	**↓3**
Nashville	22.4	7.3	14.8	15	-
New York	131.8	241.2	186.5	4	-
Greater Philadelphia	**100.0**	**100.0**	**100.0**	**6**	**↓1**
Pittsburgh	57.4	28.4	42.9	12	-
Raleigh Durham	74.9	66.2	70.5	8	↑1
San Francisco	69.4	637.7	353.6	1	-
Seattle	59.7	142.9	101.3	5	↑5
St. Louis	17.2	26.1	21.7	13	-
Tech Coast	124.5	324.4	224.4	3	-
Tech Valley	10.4	27.8	19.1	14	N/A
Washington, D.C.	45.0	67.7	56.3	10	↑1

Source: Econsult Solutions, Inc. (2014)

APPENDIX T – ADDITIONAL DETAIL ON DESIRED OUTCOMES INDEX RESULTS

TABLE T.1 – DESIRED OUTCOMES INDEX RESULTS FROM 2007 REPORT

Region	Licenses Executed, 2000-2006	Startups Formed, 2000-2006	Average of Both Indexes	2007 Rank
Atlanta	44.2	116.9	80.5	10
Austin	26.6	56.3	41.5	13
Baltimore	98.7	70.4	84.6	9
Boston	361.5	487.3	424.4	1
Houston	94.2	107.0	100.6	5
Nashville	24.7	18.3	21.5	15
New York	99.0	154.9	126.9	4
Greater Philadelphia	**100.0**	**100.0**	**100.0**	**6**
Pittsburgh	54.1	116.9	85.5	7
Raleigh Durham	130.6	138.0	134.3	3
San Francisco	89.1	81.7	85.4	8
Seattle	93.3	57.7	75.5	11
St. Louis	54.4	22.5	38.5	14
Tech Coast	126.0	209.9	168.0	2
Tech Valley	N/A	N/A	N/A	N/A
Washington, D.C.	52.6	57.7	55.2	12

Source: Econsult Solutions, Inc. (2014)

TABLE T.2 – DESIRED OUTCOMES INDEX RESULTS FROM THIS REPORT

Region	Licenses Executed, 2007-2012	Startups Formed, 2007-2012	Average of Both Indexes	2014 Rank	2007-2014 Rank Chg
Atlanta	77.4	109.6	93.5	8	↑2
Austin	N/A	N/A	N/A	N/A	N/A
Baltimore	89.8	79.5	84.7	9	-
Boston	384.6	490.4	437.5	1	-
Houston	68.1	64.4	66.3	10	↑5
Nashville	34.1	19.2	26.6	14	↑1
New York	177.2	265.8	221.5	2	↑2
Greater Philadelphia	**100.0**	**100.0**	**100.0**	**7**	**↓1**
Pittsburgh	86.0	124.7	105.3	6	↑1
Raleigh Durham	169.5	113.7	141.6	3	-
San Francisco	76.1	32.9	54.5	11	↑3
Seattle	157.5	82.2	119.9	5	↑6
St. Louis	35.2	23.3	29.3	13	↑1
Tech Coast	79.7	179.5	129.6	4	↑2
Tech Valley	6.2	13.7	9.9	15	N/A
Washington, D.C.	34.4	53.4	43.9	12	-

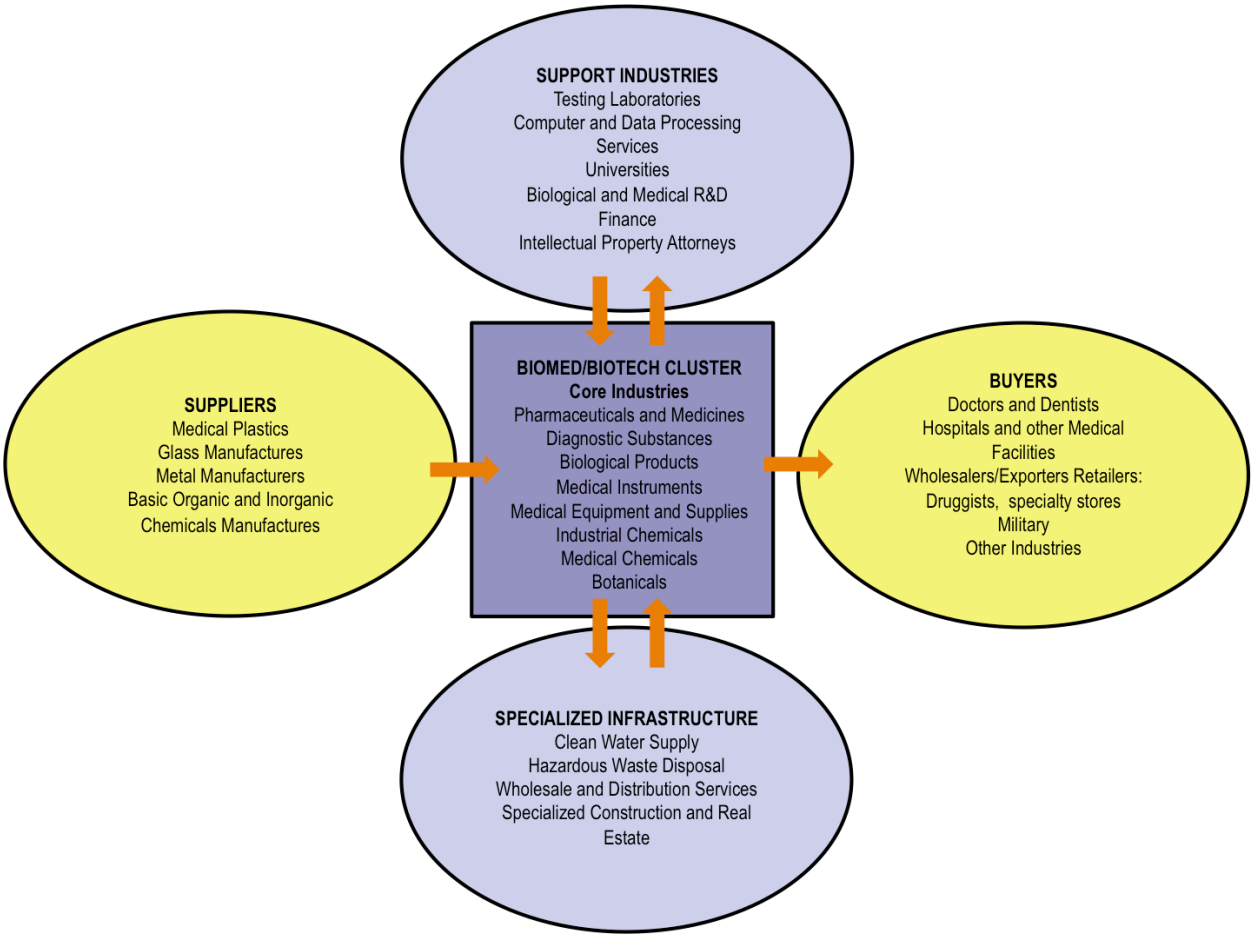
Source: Econsult Solutions, Inc. (2014)

APPENDIX U – INDUSTRY CLUSTER ANALYSIS

U.1 DEFINING INDUSTRY CLUSTER ANALYSIS

In recent years, **industry cluster analysis** has emerged as a new way of looking at economic development. An industry cluster is a group of firms, and related economic actors and institutions, that are located near one another and that draw productive advantage from their proximity and connections. An example of a specialty industry cluster is the Biopharmaceutical cluster (see Figure U.1). The core industries that make up the cluster, pharmaceutical manufacturers, are supported by a number of supporting industries, suppliers, specialized infrastructure, and consumers.

FIGURE U.1 – ILLUSTRATION OF THE BIOPHARMACEUTICAL CLUSTER



Source: Center for Regional Development, Purdue University (2007)

Cluster analysis can help diagnose a region's economic strengths and challenges and identify realistic ways to shape the region's economic future. Clusters benefit the economy in several

ways. The close proximity of suppliers and supporting industries help companies be more efficient and productive. The existence of cluster also helps encourage knowledge spillover and innovation. This is especially important for knowledge intensive industries such as medical devices and biopharmaceuticals. Most importantly from a technology transfer perspective clusters make the formation of new businesses easier by providing a base suppliers and partners that the new business can easily draw upon.

The US Cluster Mapping Project identifies 51 Traded Clusters[31] and 16 Local Clusters.[32] This analysis focuses on the six traded industry clusters that are most relevant for technology transfer and innovation: (1) Education and Knowledge Creation, (2) Communication Equipment and Services, (3) Information Technology and Analytical Instruments, (4) Aerospace and Defense, (5) Medical Devices, and (6) Biopharmaceuticals.

U.2 LOCATION QUOTIENT ANALYSIS

Evaluating the importance of each the key clusters requires examining total employment in each cluster in 2012 and the change in employment over the 2000 to 2012 period. To examine the competitiveness of each of the key clusters, **Location Quotients (LQs)** were calculated for each industry. A location quotient is an indicator of industry concentration within a region, expressed as the ratio of the proportion of the industry locally within the total local economy to the proportion of the industry nationally within the total national economy. It can help reveal what makes a particular region "unique" in comparison to the national average. Therefore, an LQ greater than 1 indicates that the industry is a bigger piece of its local economy than it is of the national economy, with the implication being that the industry is producing more goods and services than are being consumed locally, and must therefore be exporting them to other regions. Conversely, an LQ less than one indicates that the industry is a smaller piece of the local economy than it is of the national economy, and therefore the region must be importing those goods and services from outside.

By calculating LQs for industry clusters relevant to technology transfer, it can be determined that the Greater Philadelphia region holds a competitive advantage in at least two of those clusters: (1) Education and Knowledge Creation and (2) Biopharmaceuticals (see Table U.1 and Figure U.2). In both of these clusters, employment growth was positive between 2000 and 2012, and LQs were well above 1. This suggests that these two clusters are among the Greater Philadelphia region's strongest and most dynamic.

[31] Traded clusters serve markets in other regions and/or nations and tend to be located in regions that afford specific competitive advantages.

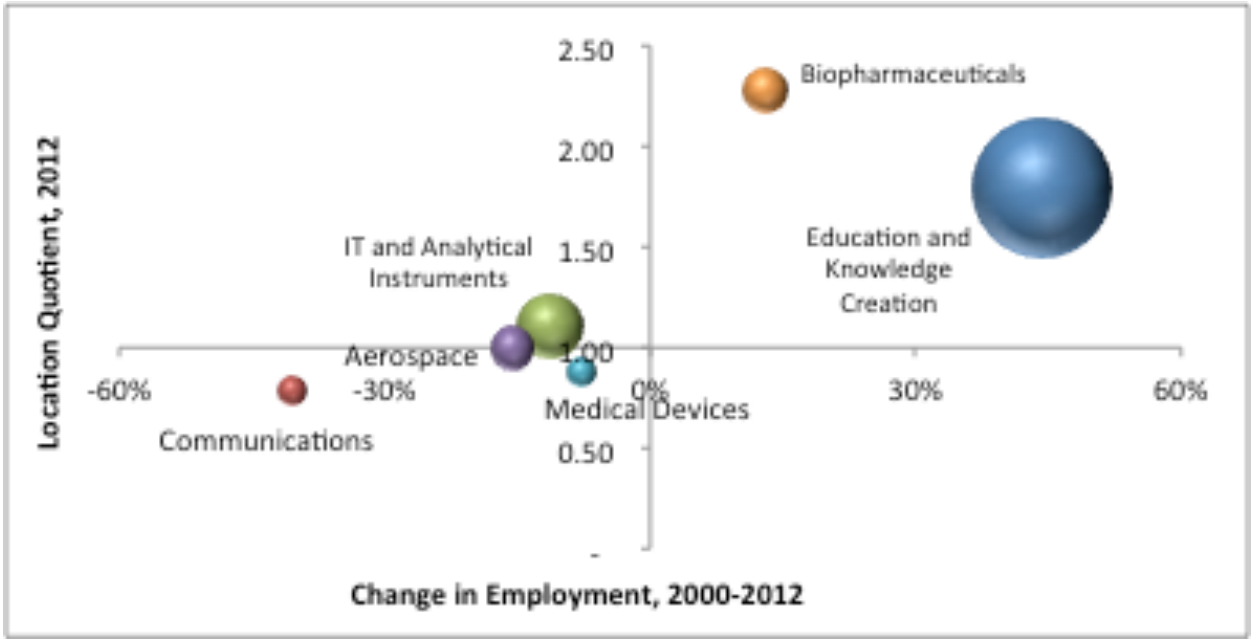
[32] Local industries are industries present in most (if not all) geographic areas, and primarily sell locally

TABLE U.1 – GREATER PHILADELPHIA REGION INDUSTRY LOCATION QUOTIENTS OVER TIME IN SELECTED INDUSTRY CLUSTERS

Cluster	2000 Employ-ment	2012 Employ-ment	%Chg	2000 LQ	2012 LQ	Chg
Education and Knowledge Creation	83,059	119,778	+44%	1.77	1.79	↑
Communications Equipment and Services	8,564	5,101	-40%	0.70	0.79	↑
IT and Analytical Instruments	28,779	25,513	-11%	0.84	1.10	↑
Aerospace Vehicles and Defense	13,905	11,733	-16%	0.99	1.00	↑
Medical Devices	5,719	5,272	-8%	0.97	0.88	↓
Biopharmaceuticals	10,668	12,051	+13%	2.08	2.28	↑

Source: US Cluster Mapping Project (2014), Econsult Solutions, Inc. (2014)

FIGURE U.2 – GREATER PHILADELPHIA REGION INDUSTRY LOCATION QUOTIENTS VS. 2000-2012 CHANGE IN EMPLOYMENT IN SELECTED CLUSTERS (SIZE OF BUBBLE PROPORTION TO NUMBER OF JOBS)



Source: US Cluster Mapping Project (2014), Econsult Solutions, Inc. (2014)

U.3 SHIFT SHARE ANALYSIS

Shift Share Analysis is a standard regional analysis method that attempts to determine how much of regional job growth can be attributed to national trends and how much may be due to unique regional factors. It is similar to LQ in that it highlights the uniqueness of a regional economy, but it does so in terms of job growth, rather than total jobs in an industry. Shift Share shows the industries in which the region is outcompeting or under-competing the nation. It can be useful in identifying investment targets so that planners can help high-performing regional

industries either continue to outperform national trends or catch up with national trends so that the regional economy is not left behind in those industries.

Shift Share segments regional job growth into three components:

1). National Growth Effect: the change in employment associated with the overall health of the national economy.

2). Industrial Mix Effect: the change in employment associated with the health of the industry nationally.

3). Regional Competitive Effect: the change in employment associated with the health of the industry locally.

The three components can move in different directions, but their sum is equal to the total change in jobs observed in the region's economy. The most important indicator for a local economy is the regional shift; a positive value indicates that the local industry is outperforming the national industry, which can be true even if there is a net decrease of jobs. A negative value indicates that the local industry is lagging the national industry, which can be true even when there is a net-increase in employment. Table U.2 summarizes the Shift Share analysis key industries in the Greater Philadelphia region from 2000 to 2012.

TABLE U.2 – GREATER PHILADELPHIA REGION KEY INDUSTRY CLUSTER SHIFT SHARE ANALYSIS

Industry	2000	National	Industry	Region	Total Shift	2012
Education and Knowledge Creation	83,059	730	35,075	914	36,719	119,778
Communications Equipment and Services	8,564	75	-4,082	544	-3,463	5,101
Information Technology and Analytical Instruments	28,779	253	-9,435	5,916	-3,266	25,513
Aerospace Vehicles and Defense	13,905	122	-2,327	33	-2,172	11,733
Medical Devices	5,719	50	79	-576	-447	5,272
Biopharmaceuticals	10,668	94	288	1,002	1,383	12,051

Source: Statsamerica.org (2014), Econsult Solutions, Inc. (2014)

A positive regional competitive effect for an industry indicates that the regional industry is out performing national trends (both overall national trends and national trends specific for that industry). While, a negative regional competitive effect, means that the industry is underperforming compared to national trends. The Region enjoys a positive regional competitive effect across all of the key industry clusters, except for Medical Devices. This suggests that the other key local industries are outperforming the national industry.

It is important to note that in three of the key industries – Communications Equipment and Services; Information Technology and Analytical instruments – the Region had a positive regional competitive effect. The positive value for those sectors do not mean that those sectors added

jobs; in fact they all lost jobs over the 2000-2012 period. The positive value means that those sectors performed better than would have been expected given trends in the national economy and those sectors nationally; in other words, while those sectors did lose jobs in the region over the 2000-2012, they did not lose as many jobs as would have been expected given national and sectorial trends.

U.4 OCCUPATIONAL CLUSTER ANALYSIS

Occupation Cluster Analysis (OCA) is a relatively new tool in regional economic analysis. It can offer insights into the talent base of the workforce that go beyond the relatively simple measure of educational attainment. In contrast to industry clusters that focus on what businesses produce, occupation clusters focus on the knowledge, skills, and abilities of the individuals who work for those businesses. OCA can therefore help identify which clusters of occupations provide the best opportunities for investment to build different types of skills, supporting existing and emerging industry clusters, and which occupation clusters represent a competitive advantage for the region.

The Purdue Center for Regional Development and the Indiana Business Research Center at Indiana University's Kelly School of Business developed a series of 15 knowledge-based occupation clusters based on the education and experience required for each occupation. This analysis focused on the following six occupational clusters: (1) Medical Practitioners and Scientists; (2) Mathematics, Statistics, Data, and Accounting; (3) Information Technology; (4) Natural Sciences and Environmental Management; (5) Engineering and Related Sciences; and (6) Postsecondary Education and Knowledge Creation.

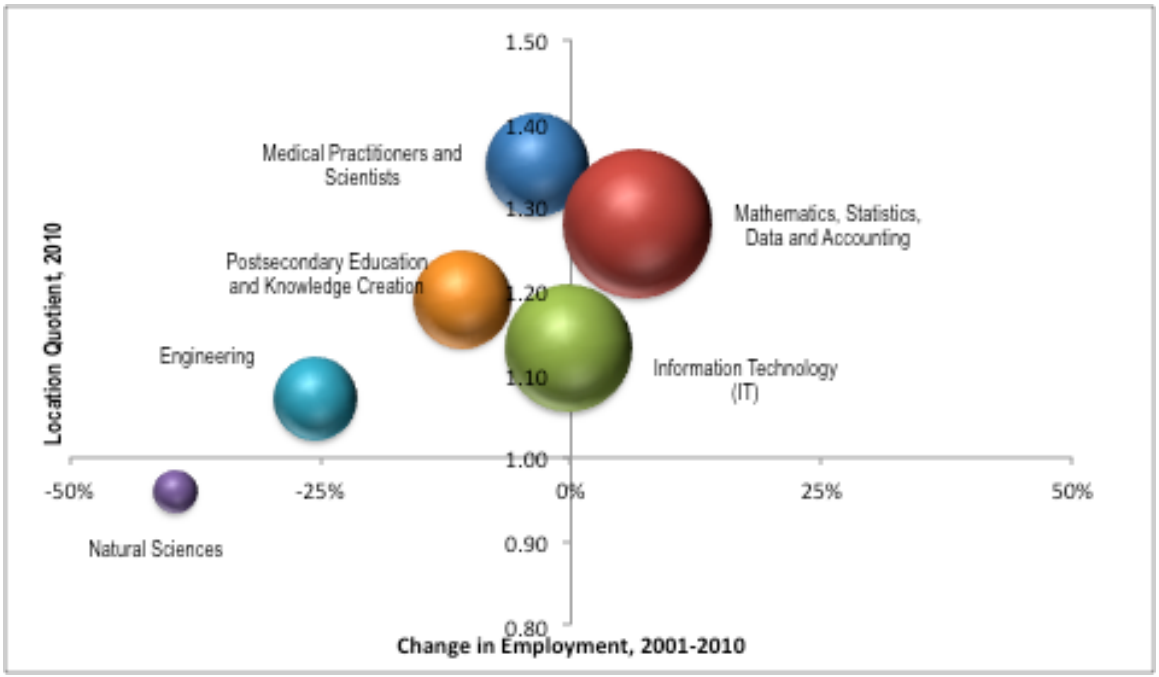
By calculating LQs for occupational clusters relevant to technology transfer, it can be determined that the Greater Philadelphia region holds its strongest competitive advantage in Health Care and Medical Science (see Table U.3 and Figure U.3). In this cluster, LQs were well above 1, although employment growth was negative. Notably, the Greater Philadelphia region saw significant declines in employment and in LQ for Engineering and Related Sciences and for Postsecondary Education and Knowledge Creation. This occupation-based analysis provides a useful assessment of the concentration of certain work skills in the Greater Philadelphia region, and the extent to which that concentration has changed over time relative to the national economy.

TABLE U.3 – GREATER PHILADELPHIA REGION OCCUPATIONAL LOCATION QUOTIENTS OVER TIME IN SELECTED OCCUPATIONAL CLUSTERS

Name	2001 Employ-ment	2010 Employ-ment	%Chg	2001 LQ	2010 LQ	Chg
Health Care and Medical Science (Medical Practitioners and Scientists)	52,121	50,334	-3%	1.36	1.35	↓
Mathematics, Statistics, Data and Accounting	99,362	105,967	7%	1.25	1.28	↑
Information Technology (IT)	76,109	75,890	0%	1.14	1.13	↓
Natural Sciences and Environmental Management	14,380	8,700	-39%	1.00	0.96	↓
Engineering and Related Sciences	43,312	32,272	-25%	1.20	1.07	↓
Postsecondary Education and Knowledge Creation	50,820	45,292	-11%	1.35	1.19	↓

Source: Statsamerica.org (2014), Econsult Solutions, Inc. (2014)

FIGURE U.3 – GREATER PHILADELPHIA REGION OCCUPATIONAL LOCATION QUOTIENTS VS. 2000-2012 CHANGE IN EMPLOYMENT IN SELECTED CLUSTERS (SIZE OF BUBBLE PROPORTION TO NUMBER OF JOBS)

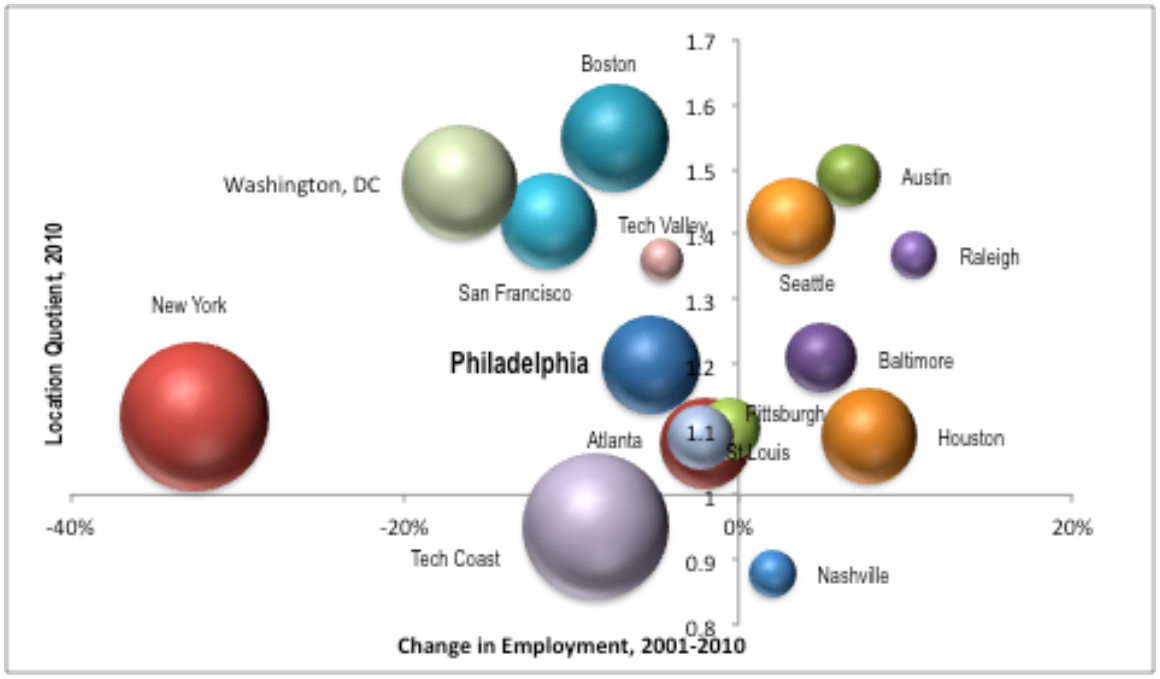


Source: Statsamerica.org (2014), Econsult Solutions, Inc. (2014)

The Technology-based Knowledge occupation clusters aggregates the technology related occupation clusters into one group. Compared to other regions, Greater Philadelphia falls in the middle of the pack in terms of specialization (LQ of 1.20) and employment change (-5%) over the

2001-2010 period (Figure 7.4). The LQ ranged from 0.88 (Nashville) to 1.55 (Boston), with an average value of 1.24. The regions that had a larger LQ than Greater Philadelphia include: Boston (1.55), Austin (1.49), Washington, DC (1.48), San Francisco (1.42), Seattle (1.42), Raleigh (1.37), Tech Valley (1.36), and Baltimore (1.21). Of the comparator regions, only two had a LQ less than 1 – Tech Coast (0.95) and Nashville (0.88). The percent change in employment ranged from a decrease of 32.6% (New York) to an increase of 10.5% (Raleigh), with an average of a 3.4% decrease. The regions that fared better than Greater Philadelphia in terms of population growth include: Raleigh (10.5%), Houston (7.8%), Austin (6.6%), Baltimore (5.0%), Seattle (3.1%), Nashville (2.0%), Pittsburgh (-0.6%), Atlanta (-2.0%), St Louis (-2.3%), and Tech Valley (-4.6%).

FIGURE 7.4 – TECHNOLOGY-BASED KNOWLEDGE OCCUPATION CLUSTERS



Source: Statsamerica.org (2014) and ESI (2014)

However, while the region appears to enjoy a competitive advantage in many of the key occupation clusters, most of these occupation clusters have had a decrease in employment over the 2001 to 2010 period. Similar to the industrial clusters analysis, we can use shift share analysis to determine how much of regional job growth can be attributed to national trends and how much may be due to unique regional factors. Table U.4 summarizes the Shift Share analysis for key occupation clusters between 2001 and 2009. During this time period, the regional experienced a negative regional effect in all clusters save Mathematics, Statistics, Data and Accounting.

TABLE U.4 – GREATER PHILADELPHIA REGION KEY OCCUPATIONAL CLUSTER SHIFT SHARE ANALYSIS

Industry	2001	National	Industry	Region	Total Shift	2009
Health Care and Medical Science (Aggregate)	219,930	11,330	25,970	-15,000	22,300	242,230
Mathematics, Statistics, Data and Accounting	99,362	5,119	884	2,511	8,513	107,875
Information Technology (IT)	76,109	3,921	-1,596	-810	1,514	77,623
Engineering and Related Sciences	43,312	2,231	-3,990	-1,926	-3,685	39,627
Postsecondary Education and Knowledge Creation	50,820	2,618	1,675	-6,362	-2,069	48,751
Technology-Based Knowledge Clusters	336,104	17,314	2,124	-8,953	10,486	346,590
Skilled Production Workers	220,591	11,364	-16,105	-5,861	-10,602	209,989

Source: Statsamerica.org (2014), Econsult Solutions, Inc. (2014)

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