Abstract of the Madison Region's Health Care Industry Cluster

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Prepared for
Madison Region Economic Partnership

Matt Kures
University of Wisconsin-Madison
Division of Extension
Center for Community and Economic Development

Craig Kettleson and Michael Gay

Madison Region Economic Partnership

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Introduction

Contemporary economic development strategies recognize that regional assets are the true drivers of employment and income growth. The Madison Region is endowed with many potential assets, including competitive industry concentrations; high levels of human and social capital; robust physical infrastructure; unique natural resources; and exceptional quality of life characteristics. While these assets influence many aspects of the regional economy, several are directly connected to the Health Care Industry Cluster.[1] Specifically, the Region has a diversity of firms engaged in a variety of health care related niches; a robust innovation and entrepreneurial (I&E) ecosystem; world-class educational institutions; and extraordinary levels of human capital that contribute to a highly skilled labor force. The mere presence of these regional strengths, however, does not guarantee future prosperity and development of the health care cluster or the broader Region. Instead, the Madison Region must find ways to leverage these assets in innovative manners that build economic opportunities, but also maintain the Region's quality of life.

Over the past two decades, industry cluster initiatives have become a popular means for leveraging competitive assets in communities and regions. While a more in-depth discussion is provided below, industry clusters are geographically-concentrated businesses that are connected through: 1) the products they produce; 2) the supplies, services, infrastructure and technologies they require; and 3) a common labor force. In other words, industry clusters are "groups of industries closely related by skill, technology, supply, demand, and/or other linkages" (Delgado, Porter and Stern, 2014, p. 2). Importantly, industries in a cluster also share some level of common opportunities and threats. Developing an industry cluster strategy around the Region's health care industries provides one opportunity for addressing any potential opportunities and threats by ultimately making these industries more competitive.

The Madison Region certainly possesses the necessary components to further develop its health care industry cluster. However, Southern Wisconsin is by no means the only region attempting to build a cluster around similar assets. Cities, regions and states across the nation are aggressively pursuing cluster opportunities in health care related industries, such as health care providers; health IT; drugs and pharmaceuticals; medical devices and equipment; and research, development and testing. Regions are also considering how their health care related industries are being influenced by modern technologies associated with Industry 4.0. *The challenge for the Madison Region is to build its health care cluster around its comparative advantages in a manner that differentiates itself from other health care related initiatives.* Accordingly, a primary goal of this abstract is to begin understanding the Region's health care cluster in a way that identifies its potential comparative advantages.

[1] The *Advance Now* economic development strategy formally identifies health care as a cluster initiative that holds promise for the Madison Region.

Understanding Industry Clusters

While industry clusters are popular as economic development strategies, cluster initiatives are often misunderstood and misused. Many economic development practitioners fail to understand how clusters operate from a theoretical perspective, leading to poor participation of cluster stakeholders and improper implementation. Consequently, identifying potential sources of comparative advantage for the Region's health care cluster requires a basic understanding of industry cluster theory. While potential cluster stakeholders do not need an in-depth knowledge of this theory, they should appreciate how cluster components interact with each other.

As previously suggested, industry clusters are groups of industries connected by skills, technologies, supply chains, demand sources and other linkages. More commonly, industry clusters are "geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions (e.g. universities, standards agencies, trade associations) in a particular field that compete but also cooperate" (Porter 1998, p. 197). Several key terms in this definition provide guidance for this study of the Region's health care cluster:

- *Industry clusters involve interconnected companies, specialized suppliers, service providers, and firms in related industries* - The concept of clusters goes beyond the recognition of a single industry sector or classification. Clusters acknowledges important connections and relationships among industries and other business types that support each other through supply chains and service provision. In theory, the presence of these quality local suppliers and services creates efficiencies and increases firm competitiveness. For instance, nearby firms in the health care cluster might have shared infrastructure needs or require similar inputs in their supply chains that could be provided by local firms;

- *Industry clusters include associated institutions* – Industry clusters are not solely comprised of for-profit, private-sector firms. Industry clusters recognize the potential assistance and knowledge spillovers (transfers) that universities, trade associations, and government agencies can provide.[2] The participation of these institutions in cluster-based initiatives can provide research, workforce development, advocacy, and other support for cluster establishments. While the Madison Region Economic Partnership (MadREP) will be a key partner in developing the health care cluster, the initiative will also depend on support and participation from state agencies; other economic development organizations; local municipalities; educational institutions; workforce development entities; and non-profit enterprises that work with health care-related businesses and talent;

- *Industry clusters have a geographic concentration* – Clusters and their associated components are concentrated in a distinct geographic area. Geographic concentration allows for increased interaction and efficiencies to be developed among companies in a cluster. While the exact geographic extent of a cluster will depend on a variety of factors, the geographic scope of a cluster relates to the distance in which informational, transactional, incentive, and other efficiencies occur (Porter, 2000). Accordingly, the geographic boundaries of clusters are defined by inter-company relationships and *not* political boundaries

[2] Knowledge transfers can also occur among individual firms in an industry cluster.

(Rosenfeld, 2001). While the geographic area for this cluster analysis is based on a pre-determined geography (see below), there may be instances where health care cluster opportunities extend into nearby areas (such as Milwaukee, Chicago or Minneapolis-St. Paul);

- *Industry cluster firms compete, but also cooperate* - Individual firms within an industry cluster are in competition with each other, but also exhibit a level of cooperation. Cooperation in an area allows firms to engage in activities such as joint-contract bidding; developing custom labor force training programs; coordinating research efforts; providing a unified voice on industry-wide issues; and improving their industry's visibility. The precondition of cooperation requires that private industry stakeholders, or industry champions, have a lead role in the potential success of industry clusters. *Without cooperation, a region does not have an industry cluster, but rather a simple industry concentration.* Broad participation of cluster firms in the Madison Region will be vital to the success of a health care cluster initiative. The true challenge is providing authentic incentives to firms and stakeholders to engage in cluster efforts.

Report Outline

Based on the preceding discussion, a successful health care cluster initiative will require: 1) considering the breadth and depth of industries in the health care cluster; 2) understanding characteristics of the Region's labor force or human capital; 3) identifying potential niches or opportunities for differentiating the Region's health care cluster; 4) enhancing the cluster's support and development ecosystem; and 5) developing key strategic initiatives to support the cluster in the Madison Region. To explore these cluster requirements, the remainder of this health care cluster abstract is organized as follows:

Section 1 – Health Care Industries in the Madison Region. Understanding the cluster in terms of its industry classifications is an important step to identifying initiatives to support and grow the Region's health care cluster. Measures of health care industry scale and scope include employment, location quotients, establishments, and concentration. Definitions of health care industries are further detailed below and in Section 1.

Section 2 – Health Care Human Capital - Section 2 focuses on health care-related talent, or human capital, by considering measures of the labor force's scale and scope. Talent is largely defined by using occupations. Specific measures of health care human capital include occupational concentrations, talent diversity, mobility and wage rates.

Section 3 – Health care Industry Cluster Support and Development Ecosystem. Section 3 examines other factors that contribute to the support and development of the Region's health care industry including: broadband availability and distribution; regional assets that influence talent attraction and retention; research parks, certified and gold shovel sites, and specialized commercial spaces; educational institutions; and support organizations that foster innovation and connect firms to resources.

As noted earlier, identifying potential niches or opportunities for differentiating the Region's health care industry cluster; and developing key strategic initiatives to support the cluster in the Madison Region are two

important components of a cluster analysis. These components will be completed at a later date once this portion of the cluster analysis has generated conversation and feedback from key stakeholders in the Region's health care cluster.

Defining Health Care

This analysis relies on several distinct categories of health care related industries including health care providers, direct life and health insurance carriers, health IT, drugs and pharmaceuticals, medical devices and equipment, and research, testing and medical laboratories. More specifically, these industries include:

- **Health Care Providers** – Firms that provide direct health care services including ambulatory health care services, hospitals and nursing and residential care facilities.
- **Direct Life, Health, and Medical Insurance Carriers** - This industry comprises establishments primarily engaged in initially underwriting (i.e., assuming the risk and assigning premiums) annuities and life insurance policies, disability income insurance policies, accidental death and dismemberment insurance policies, and health and medical insurance policies.
- **Health IT** – Health IT includes a variety to digital technologies in the form of electronic health records, wearable devices, preventative health systems, and telemedicine. Some of these firms are found in the medical devices and equipment and research, testing and medical laboratory categories. Others are concentrated in software publishers and computer systems design and related services. For purposes of this analysis, the Health IT category largely considers in software publishers and computer systems design and related services industries.
- **Drugs and pharmaceuticals** — Firms that develop and produce biological and medicinal products and manufacture pharmaceuticals and diagnostic substances.
- **Medical devices and equipment** — Establishments that develop and manufacture surgical and medical instruments and supplies, laboratory equipment, electromedical apparatus including MRI and ultrasound equipment, dental equipment and supplies.
- **Research, testing and medical laboratories** — Firms engaged in research and development in biotechnology and other life sciences, life science testing laboratories and medical laboratories. Includes contract and clinical R&D organizations.

Note that many industries included in this analysis are also analyzed in additional detail in MadREP's ICT, Advanced Manufacturing, and Bioscience Industry Cluster Abstracts. Accordingly, many health care related industries also complement other industry clusters and vice versa.

Health Care Core and Related Industries (NAICS)

Health Care Providers

- Ambulatory Health Care Services (621)
- Hospitals (622)
- Nursing and Residential Care Facilities (623)

Health, and Medical Insurance

- Direct Life, Health, and Medical Insurance Carriers (52411)

Drugs and Pharmaceuticals

- Medicinal and Botanical Manufacturing (325411)
- Pharmaceutical Preparation Manufacturing (325412)
- In-Vitro Diagnostic Substance Manufacturing (325413)
- Biological Product (Except Diagnostic) Mfg. (325414)

Medical Devices and Equipment

- Electromedical Apparatus Manufacturing (334510)
- Analytical Laboratory Instrument Mfg. (334516)
- Irradiation Apparatus Manufacturing (334517)
- Medical Equipment and Supplies Mfg. (3391)

Research, Testing, and Medical Laboratories

- Research and Development in the Physical, Engineering and Life Sciences (54171)
- Testing Laboratories (54138)
- Medical and Diagnostic Laboratories (6215)

Life Science Talent

Health Care Provider and Health Care Support Occupations

- Physicians and Surgeons
- Family and General Practitioners
- Registered Nurses
- Nurse Practitioners
- Licensed Practical and Vocational Nurses
- Pharmacists
- Medical Assistants
- Home Health Aides
- Medical Secretaries
- Personal Care Aides
- Dental Assistants/Hygienists
- Physical Therapists
- Paramedics
- Physician Assistants
- Dentists
- Phlebotomists

Life Science Occupations

- Medical Scientists
- Epidemiologists
- Chemists
- Biochemists and Biophysicists
- Biological Scientists, All Other
- Microbiologists
- Clinical Laboratory Technologists and Technicians
- Chemical Technicians
- Biological Technicians
- Dental Laboratory Technicians

Engineers and Computer Occupations

- Industrial Engineers
- Mechanical Engineers
- Electrical Engineers
- Electronics Engineers, Except Computer
- Engineers, All Other
- Chemical Engineers
- Biomedical Engineers
- Electrical and Electronics Engineering Technicians
- Software Developers, Systems Software
- Software Developers, Applications
- Computer and Information Research Scientists
- Computer Systems Analysts
- Computer Network Architects

Production, Transportation and Repair Occupations

- Inspectors, Testers, Sorters, Samplers, and Weighers
- Assemblers and Fabricators
- Chemical Equipment Operators and Tenders
- Packaging and Filling Machine Operators and Tenders
- Mixing and Blending Machine Setters, Operators, and Tenders
- Industrial Machinery Mechanics
- Machinists
- Maintenance and Repair Workers, General
- Shipping, Receiving, and Traffic Clerks
- Laborers and Freight, Stock, and Material Movers, Hand
- Production, Planning, and Expediting Clerks

Business, Management and Financial Occupations

- General and Operations Managers
- Architectural and Engineering Managers
- Natural Sciences Managers
- Industrial Production Managers
- Compliance Officers
- Accountants and Auditors
- Bookkeeping, Accounting, and Auditing Clerks
- Market Research Analysts and Marketing Specialists
- Business Operations Specialists, All Other

Health Care Support and Development Components

- Specialized Financial, Legal and Advertising Services
- Air, Truck and Rail Transportation
- Educational Institutions/R&D Funding
- Entrepreneurial Support Organizations
- Specialized Commercial Space
- Government
- Regional Quality of Life

Health Care Related Industry Supply Chains

Health Care Providers

- Insurance
- Pharmaceuticals
- Sanitary paper products
- In-vitro diagnostic substances
- Surgical and medical instruments
- Surgical appliance and supplies
- Medical and diagnostic laboratories
- Commercial and industrial machinery and equipment repairs, maintenance, rental and leasing
- Electronic and precision equipment repairs and maintenance
- Pressed and blown glass and glassware
- Plastics bottles and glass containers
- Employment services
- Management consulting services
- Wholesale trade distribution services
- Accounting, tax preparation, bookkeeping, and payroll services
- Advertising, public relations, and related services
- Legal services
- Telecommunications

Drugs and Pharmaceuticals

- Basic organic and inorganic chemicals
- Pharmaceutical preparations and botanicals
- Biological products
- In-vitro diagnostic substances
- Refined petroleum products
- Petrochemical and other chemical products and preparations
- Scientific research and development services
- Management, scientific, and technical consulting services
- Plastics bottles and glass containers
- Other pressed and blown glass and glassware
- Processed animal and rendered byproducts
- Laminated/unlaminated paper and plastic materials, films and sheets
- Light gauge metal containers
- Glass containers
- Oilseeds
- Industrial gases
- Adhesives

Medical Devices and Equipment

- Computer terminals, storage devices and peripheral equipment
- Software
- Scientific research and development services
- Semiconductor and related devices
- Printed circuit assemblies (electronic assemblies)
- Bare printed circuit boards
- Communication and energy wires and cables
- Electron tubes
- Relay and industrial controls
- Electronic capacitors, resistors, coils, transformers, and other inductors
- Measuring and controlling devices
- Crowned, forged, stamped, and sintered metals
- Plates and fabricated structural products, metal and plastic
- Coated, engraved, heat treated products
- Rolled, drawn, extruded and alloyed metals
- Paperboard containers
- Custom roll formed metals
- Electronic connectors and other electronic components
- Plastics materials and resins

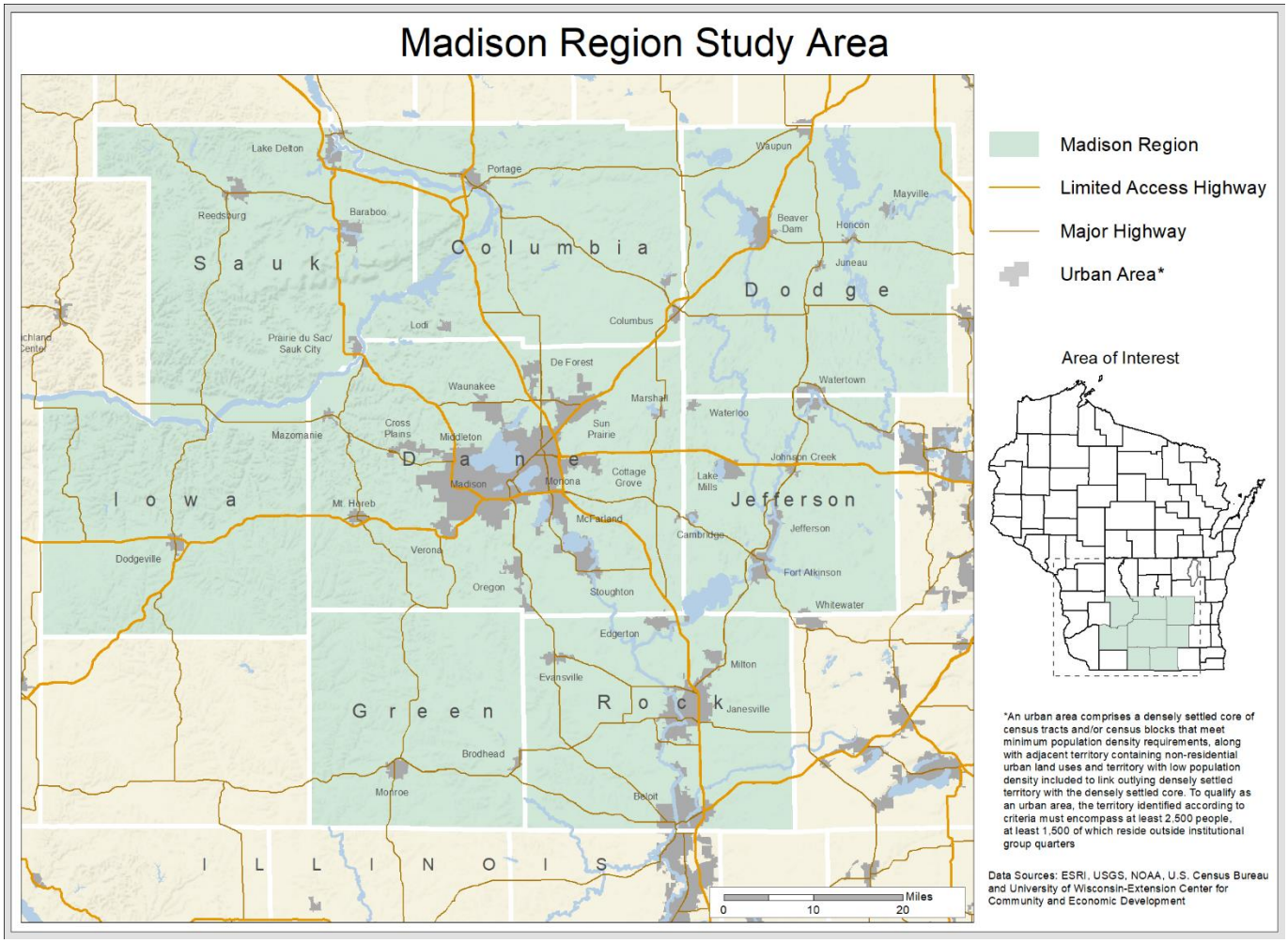
Research, Testing, and Medical Laboratories

- Management, scientific, and technical consulting services
- Architectural, engineering, and related services
- Computer systems design services
- Other computer related services, including facilities management
- Scientific R&D services
- Accounting, tax preparation, bookkeeping, and payroll services
- Environmental and other technical consulting services
- Other plastics and rubber products
- Soaps and cleaning compounds
- Waste management and remediation services
- Other basic organic chemicals
- Commercial and industrial machinery and equipment repair, maintenance, sales and leasing
- Electronic and precision equipment repairs and maintenance
- Pharmaceutical preparations
- Other pressed and blown glass and glassware
- Printed materials
- Computer terminals and other computer peripheral equipment

Study Area

The health care study area used in this analysis is the eight-county Madison Region served by MadREP (Figure I.2). Specifically, the Madison Region consists of Columbia, Dane, Dodge, Green, Iowa, Jefferson, Rock, and Sauk counties. Columbia, Dane, Green and Iowa counties are part of the Madison metropolitan statistical area (MSA) while Rock County is part of the Janesville-Beloit MSA. These MSA definitions will become important units of analysis in portions of this analysis of the health care cluster. Importantly, the Madison Region's geographic location also allows access to the significant metro areas of Milwaukee, Chicago and the Twin Cities.

Figure I.2 – Madison Region Study Area



Readers of this abstract should note that the broad appeal of cluster initiatives often leads to high expectations for results. Despite all of the proposed benefits to regions and firms, it is important to recognize that the success of clusters as an economic development strategy is uncertain, even when fully understood and properly implemented. While examples of successful cluster initiatives exist, empirical evidence on the ability of clusters to increase competitiveness, generate job growth, and produce new economic activity is being actively debated among researchers (for examples see: Palazuelos, 2005; McDonald et al, 2007; Motoyama, 2008; Woodward, 2012; and Delgado et al, 2014). Nonetheless, the lack of conclusive evidence does not mean that regions should

abandon cluster initiatives. Clusters can succeed with proper guidance and participation. Furthermore, industry clusters remain beneficial as a framework for analyzing health care industries as they can identify the potential connections and synergies among firms in the Region.

Finally, this analysis recognizes that it cannot capture every element and aspect of the health care cluster. The cluster is constantly evolving and will continue to change at a rapid pace. Accordingly, this analysis is intended to be consistently revisited and updated and this report is intended to be a living document. Readers are welcome to suggest opportunities for improvement and amendments.

Section 1 – Health Care Industries in the Madison Region

As noted in the Introduction to this analysis, the Madison Region's Health Care Industry Cluster includes a diversity of industries that have individual strengths and characteristics, but also complement one another in terms of their needs for human, social, physical and financial capital. In other words, each category of health care is somewhat unique, but together are important contributors to the Region's labor market, quality of life, innovation environment, entrepreneurial ecosystem and overall regional prosperity. To better understand the scale and scope of the Madison Region's health care industries, the following section considers the cluster from the perspectives of health care industry employment, concentration and diversity.

This analysis relies on several distinct categories of health care related industries including health care providers, direct life and health insurance carriers, health IT, drugs and pharmaceuticals, medical devices and equipment, and research, testing and medical laboratories. While this analysis touches on all categories, more detailed analyses of other health care related industries are available in the Madison Region ICT and Bioscience Industry Cluster Abstracts. As noted in the introduction, health care related industries include:

- **Health Care Providers** – Firms that provide direct health care services including ambulatory health care services, hospitals and nursing and residential care facilities.
- **Direct Life, Health, and Medical Insurance Carriers** - This industry comprises establishments primarily engaged in initially underwriting (i.e., assuming the risk and assigning premiums) annuities and life insurance policies, disability income insurance policies, accidental death and dismemberment insurance policies, and health and medical insurance policies.
- **Health IT** – Health IT includes a variety to digital technologies in the form of electronic health records, wearable devices, preventative health systems, and telemedicine. Some of these firms are found in the medical devices and equipment and research, testing and medical laboratory categories. Others are concentrated in software publishers and computer systems design and related services. For purposes of this analysis, the Health IT category largely considers in software publishers and computer systems design and related services industries.
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- **Research, testing and medical laboratories** — Firms engaged in research and development in biotechnology and other life sciences, life science testing laboratories and medical laboratories. Includes contract and clinical R&D organizations.

Health Care Providers and Direct Life, Health, and Medical Insurance Carriers

Health providers include ambulatory health care services, hospitals, and nursing and residential care facilities. Specific definitions of these health care providers from the Census Bureau include:

- *Ambulatory Health Care Services (NAICS 621)* - Industries in the Ambulatory Health Care Services subsector provide health care services directly or indirectly to ambulatory patients and do not usually provide inpatient services. Health practitioners in this subsector provide outpatient services, with the facilities and equipment not usually being the most significant part of the production process.

- *Hospitals (NAICS 622)* - Industries in the Hospitals subsector provide medical, diagnostic, and treatment services that include physician, nursing, and other health services to inpatients and the specialized accommodation services required by inpatients. Hospitals may also provide outpatient services as a secondary activity. Establishments in the Hospitals subsector provide inpatient health services, many of which can only be provided using the specialized facilities and equipment that form a significant and integral part of the production process.

- *Nursing and Residential Care Facilities (NAICS 623)* - Industries in the Nursing and Residential Care Facilities subsector provide residential care combined with either nursing, supervisory, or other types of care as required by the residents. In this subsector, the facilities are a significant part of the production process, and the care provided is a mix of health and social services with the health services being largely some level of nursing services.

Direct Life, Health, and Medical Insurance Carriers (NAICS 52411) includes establishments primarily engaged in initially underwriting (i.e., assuming the risk and assigning premiums) annuities and life insurance policies, disability income insurance policies, accidental death and dismemberment insurance policies, and health and medical insurance policies.

In 2016 there were almost 1,800 health care provider industries in the Madison Region (Figure 1.1). The greatest number of establishments are found in ambulatory health care services, followed by nursing and residential care facilities and hospitals. Ambulatory health care services include a variety of health care categories such as the offices of physicians, dentists and other health care providers including chiropractors. The category also includes outpatient care centers and home health care services. Most of these establishments have either 1 to 9 employees or 10 to 99 employees, but 33 establishments have 100 or more employees.

The 24 hospitals in the Madison Region do not include those operated by local, state of federal governments. If these are added, there are three additional facilities in the Region. Not surprisingly, most hospitals have a large number of employees. Indeed, these establishments are often among the largest employers in many communities and are anchor institutions in local economies.

Nursing and residential care facilities include Nursing Care Facilities (Skilled Nursing Facilities); Residential Intellectual and Developmental Disability, Mental Health, and Substance Abuse Facilities; and Continuing Care Retirement Communities and Assisted Living Facilities for the Elderly. As with ambulatory health care

services, most establishments in this category have fewer than 100 employees. There are also three establishments run by state and local government not included in Figure 1.1.

Figure 1.1 – Madison Region Establishments by Employment size in Health Care Provider Industries (2016)

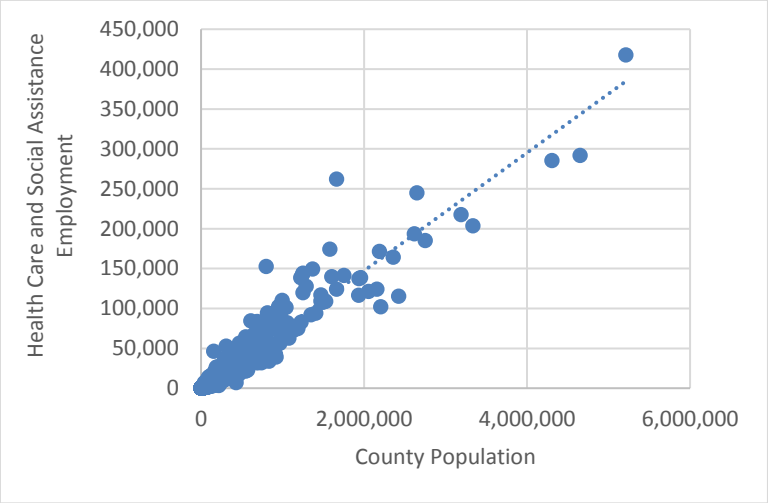
NAICS	Description	Total Establishments	Establishments by Number of Employees			
			1 to 9 Emp.	10 to 99 Emp.	100 to 499 Emp.	500 or More Emp.
621	**Ambulatory Health Care Services**	**1,265**	**843**	**389**	**31**	**2**
6211	Offices of Physicians	273	136	123	13	1
6212	Offices of Dentists	305	199	106	0	0
6213	Offices of Other Health Practitioners	474	418	54	2	0
6214	Outpatient Care Centers	98	46	44	8	0
6215	Medical and Diagnostic Laboratories	18	12	4	2	0
6216	Home Health Care Services	62	21	36	4	1
6219	Other Ambulatory Health Care Services	35	11	22	2	0
622	**Hospitals**	**24**	**1**	**1**	**10**	**12**
6221	General Medical and Surgical Hospitals	21	1	0	9	11
6222	Psychiatric and Substance Abuse Hospitals	1	0	0	0	1
6223	Specialty (except Psychiatric and Substance Abuse) Hospitals	2	0	1	1	0
623	**Nursing and Residential Care Facilities**	**480**	**231**	**216**	**33**	**0**
6231	Nursing Care Facilities (Skilled Nursing Facilities)	65	11	34	20	0
6232	Residential Intellectual and Developmental Disability, Mental Health, and Substance Abuse Facilities	236	173	60	3	0
6233	Continuing Care Retirement Communities and Assisted Living Facilities for the Elderly	168	45	114	9	0
6239	Other Residential Care Facilities	11	2	8	1	0
	Total	*1,769*	*1,075*	*606*	*74*	*14*

Source: U.S. Census Bureau County Business Patterns

Overall, health care providers account for 68,545 employees in the Madison Region, with ambulatory health care services having just over 27,000 employees, 26,900 in hospitals and approximately 14,600 in nursing and residential care facilities (Figure 1.3). *While not depicted in Figure 1.3, direct life, health, and medical insurance carriers have 5,335 employees in the Madison Region (**73,880 total employees**).*

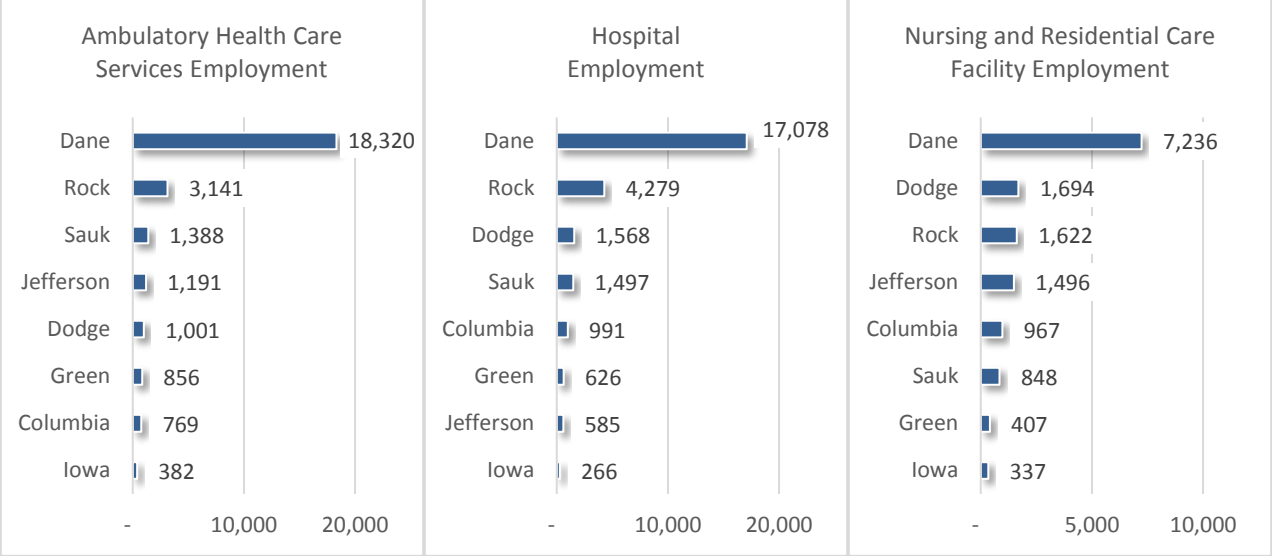
While the health care provider industry has a sizeable number of total employees, health care provider employment is highly correlated with an area's population. In fact there is almost a perfect correlation (0.96) between a county's health care and social assistance employment and its population (Figure 1.2). While these trends vary somewhat among individual categories of health care, these correlations are mostly found in the Madison Region as well. The correlation between population and health care employment is important from an economic development strategy standpoint as additional health care provider employment will be primarily driven by population growth. However, this connection to population growth should not suggest that there are not ample opportunities to grow and develop the Madison Region's health care industry cluster.

Figure 1.2 – Correlation between County Population and Health Care and Social Assistance Employment



Source: Bureau of Economic Analysis Authors' Calculations

Figure 1.3 – Madison Region Employment in Health Care Provider Industries (2017)

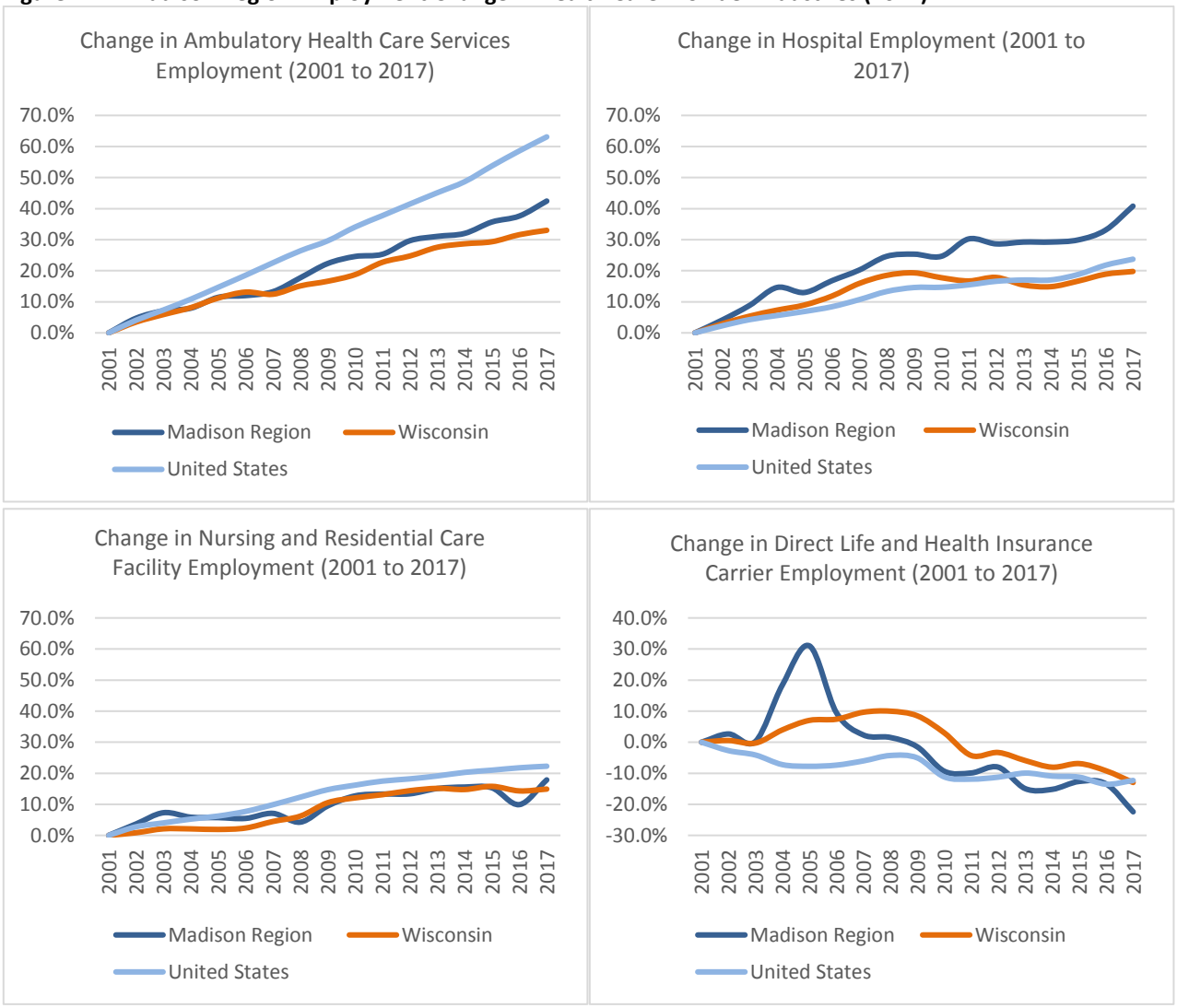


Source: IMPLAN, Quarterly Census of Employment and Wages and Authors' Calculations

All categories of health care providers have grown in employment over the past 15 years. Both ambulatory care service and hospital employment grew by over 40% between 2001 and 2017 (Figure 1.4). While ambulatory health care services did not grow as fast as the national average, the slower growth rate may be partially tied to the Region's lower population growth rate. The slower employment growth rate for ambulatory care services may also be reflected in the Region's higher growth rate among hospitals.

Change in nursing and residential care employment was somewhat slower between 2001 and 2017, with a Regional growth rate of 17.9%. This rate was slightly larger than that of the State of Wisconsin (14.9%) and less than the national average (22.3%). However, as the Region's population grows older, it is likely this category will see continued growth (See Section 2). Despite a large spike between 2003 and 2006, employment in the direct life and health insurance carrier industry has been on the decline in the Madison Region. This Regional trend in employment largely mirrors state and national trends. Note that the employment spike may have resulted from a temporary industry re-classification of insurance providers.

Figure 1.4 – Madison Region Employment Change in Health Care Provider Industries (2017)



Source: Quarterly Census of Employment and Wages and Authors' Calculations

Location quotients provide another means for comparing employment. A location quotient (LQ) is calculated by comparing an industry's share of local employment to the industry's share of overall national employment.

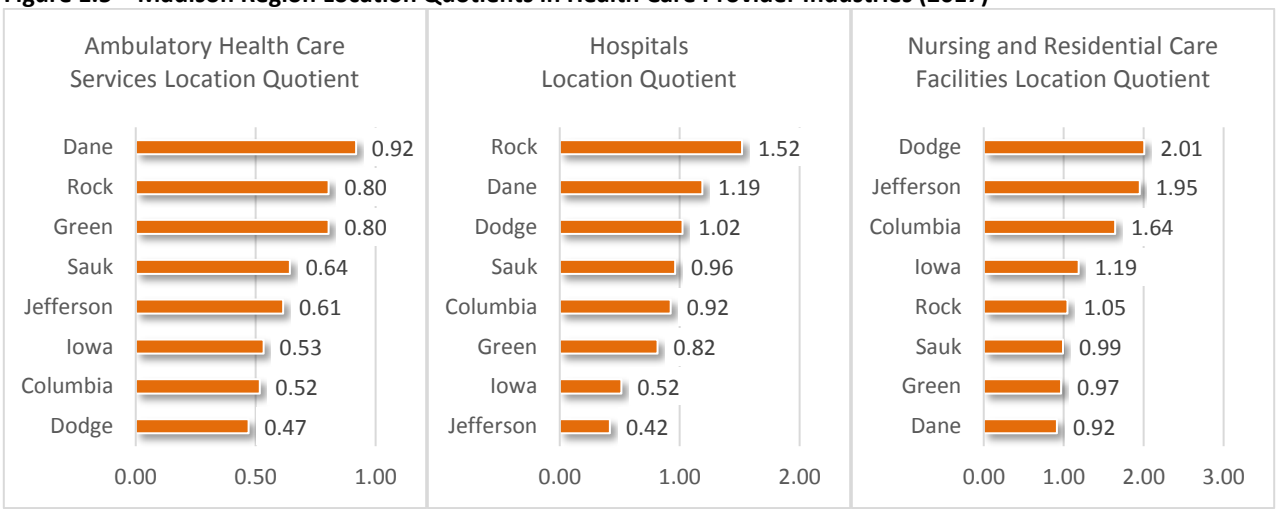
$$\textit{Location Quotient (LQ) for a health care industry} = \frac{\frac{\text{Health care industry employment in the Region}}{\text{Total employment in the Region (all industries)}}}{\frac{\text{Health care industry national employment}}{\text{Total national employment (all industries)}}}$$

The critical value for a location quotient is 1.0. An LQ of 1.0 means an area has the same proportion of local employment in an industry as the nation. An LQ greater than 1.0 denotes that an area's share of employment in a given industry is more than its national share. Conversely, an LQ less than 1.0 indicates an area's employment in an industry is below the national percentage. Due to accuracy issues with employment data, location quotients between 0.75 and 1.25 are generally considered not to be significantly different from 1.0.

Location quotients greater than 1.25 are important as they imply that an area has a specialization in a given industry. More specifically, an LQ greater than 1.25 suggests that an industry is producing more goods or services than can be consumed locally. These goods and services are in turn exported out of the Region, connecting the area to external economies and bringing outside dollars into local communities (i.e. they have an export-orientation). In contrast, an LQ less than 0.75 suggests that local industries are not meeting demand (demand is greater than supply) and the good or service must be imported into the Region.

With several exceptions, location quotients are at or below 1.0 for many health care provider categories throughout the Madison Region (Figure 1.5). These values are not surprising given the aforementioned correlation between population and health care employment. Several location quotients below 0.75 are also expected in counties where patients may cross county lines to receive health care services. Nursing and residential care facilities have location quotients well above 1.0 in several counties, which partially reflect the older populations in these counties. It is likely that these LQs could continue to grow.

Figure 1.5 – Madison Region Location Quotients in Health Care Provider Industries (2017)



Source: IMPLAN, Quarterly Census of Employment and Wages and Authors' Calculations

Health IT

As previously noted, Health IT includes software publishers (NAICS 5112) and computer systems design and related services (NAICS 5415) for purposes of this analysis. *Note that not all firms in these industry categories are involved in Health IT, and several other industry categories included in this analysis could also include Health IT firms.* The following descriptions from the U.S. Census Bureau provide more detail on these industries:

- *Software Publishers (NAICS 5112)* - This industry comprises establishments primarily engaged in computer software publishing or publishing and reproduction. Establishments in this industry carry out operations necessary for producing and distributing computer software, such as designing, providing documentation, assisting in installation, and providing support services to software purchasers. These establishments may design, develop, and publish, or publish only. These establishments may publish and distribute software remotely through subscriptions and downloads.

- *Computer Systems Design and Related Services (NAICS 5415)* - This industry comprises establishments primarily engaged in providing expertise in the field of information technologies through one or more of the following activities: (1) writing, modifying, testing, and supporting software to meet the needs of a particular customer; (2) planning and designing computer systems that integrate computer hardware, software, and communication technologies; (3) on-site management and operation of clients' computer systems and/or data processing facilities; and (4) other professional and technical computer related advice and services.

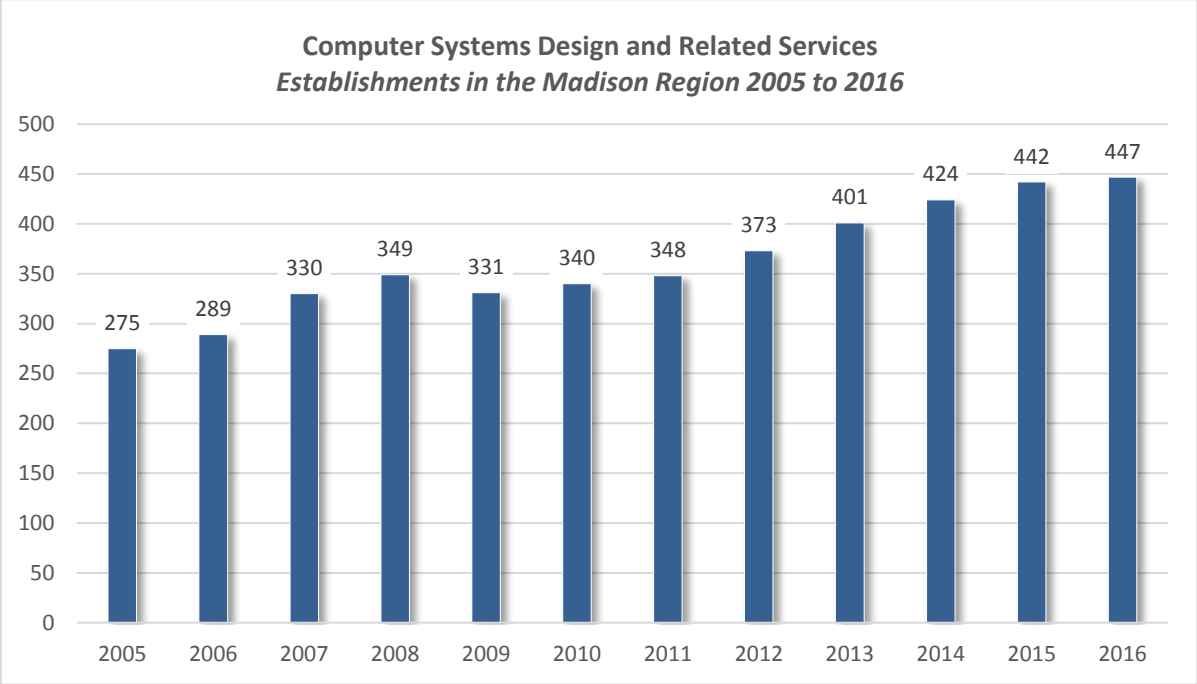
As of 2016, 485 establishments in these two industries were located in the eight-county Madison Region. The majority of these establishments are found in computer systems design and related services (Figure 1.6). The computer systems design industry has also been a notable source of establishment growth over the past decade. Specifically, the Region's computer systems design industry grew from 275 establishments in 2005 to 447 establishments in 2016; or an increase of 63 percent (Figure 1.7)

Figure 1.6 – Madison Region Establishments by Employment size in Health IT Related Industries (2016)

NAICS	Description	Total Establishments	Establishments by Number of Employees				
			1 to 9 Emp.	10 to 99 Emp.	100 to 249 Emp.	250 to 500 Emp.	500 or More Emp.
5112	Software publishers	38	21	12	4	0	1
5415	Computer systems design and related services	447	368	70	7	1	1
	Total Establishments	485	389	82	11	1	2

Source: U.S. Census Bureau County Business Patterns

Figure 1.7 - Change in Computer Systems Design and Related Service Establishments – 2005 to 2016



Source: U.S. Census Bureau County Business Patterns

While the software publishing industry has a fewer number of establishments among the Region's potential Health IT industries, it includes Epic Systems, which is by far the largest establishment in the Health IT industry cluster. As Epic Systems is a privately held corporation, its exact number of employees is unknown. However, several estimates place Epic Systems' employment level near 10,000 employees. With this level of employment, Epic Systems is one of the largest private sector employers in the entire state of Wisconsin. The magnitude of Epic Systems provides a growth pole for the entire Health IT industry in the Madison Region.

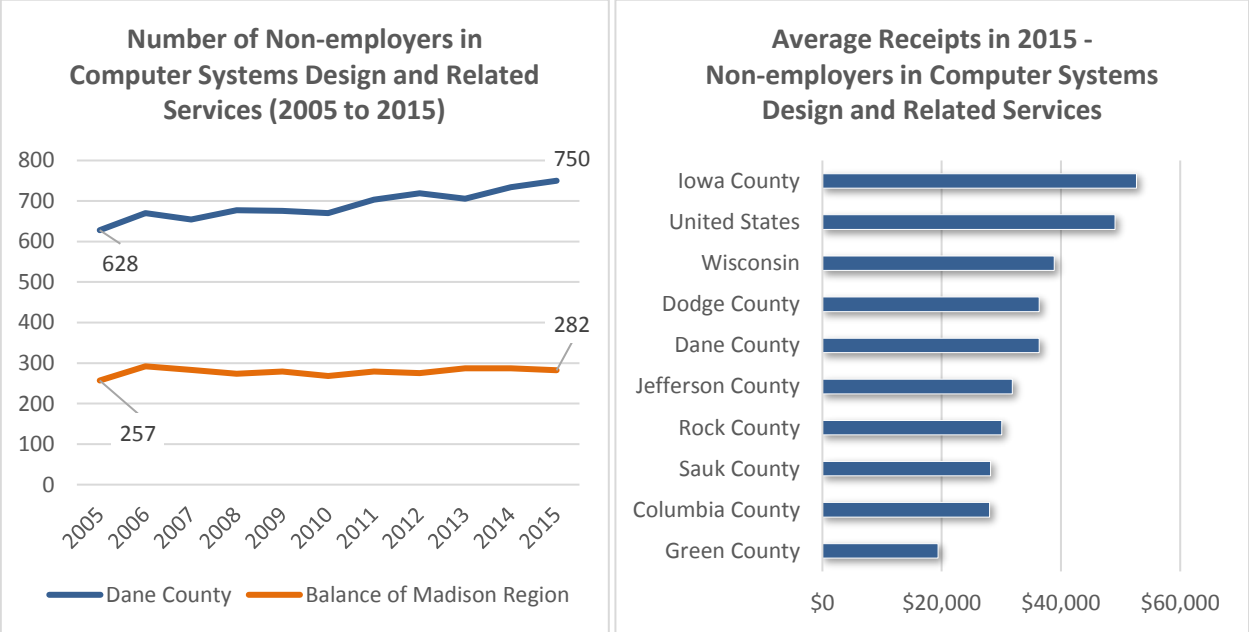
It is important not to overlook Epic as a key component of the Health IT industry, but it is also critical not to ignore other establishments in the Region. Indeed, most Health IT related establishments have fewer than 250 employees, with many firms having under 100 employees. These smaller firms are often neglected by economic development policies and incentives that target larger establishments for business recruitment and workforce development activities. In contrast, the needs of smaller firms may vary and often require greater support in the form of access to capital and technical assistance.

Furthermore, the establishment figures in Figure 1.6 do not include firms classified as *non-employers*. Non-employers are sole-proprietors who may have small enterprises located at home or elsewhere. Non-employer figures originate from tax return information collected by the Internal Revenue Service and provide some perspective on the so-called "gig" economy. In 2015, there were more 1,000 sole proprietors

classified in the computer systems design and related service industry within the Madison Region; a number that has grown over the last decade (Figure 1.8).[3]

While many of these sole proprietors are located in Dane County, a notable number are found in the balance of the Region, with every county in the Madison Region having more than 15 sole proprietors in computer systems design and related services. As these sole proprietors have average receipts under $40,000 in most counties, many of these businesses may not be the sole source of income for their operators (Figure 1.8). However, these non-employers may be an overlooked source of nascent entrepreneurs looking to grow their businesses. The numbers of these sole proprietors have also gradually increased over time.

Figure 1.8 – Madison Region Non-employers in Computer Systems Design and Related Services



Source: U.S. Census Bureau County Business Patterns

Stage 2 firms, or so-called second-stage companies, are also often overlooked by economic and business development activities (Figure 1.9). Stage 2 companies are distinct from other firms as they have survived the start-up process, but also reached a position where the complexity of running the company has exceeded the capacity of one owner or CEO. Consequently, more formal operational structures and strategy may be needed to continue growth and evolve into the next stage of business. However, the time, expertise and revenue are often unavailable within the firm to support these changes (Edward Lowe Foundation, 2012). Due to their unique position, these firms often fall between economic development efforts that look to generate start-ups and those that work with the retention and attraction of larger firms.

[3] While sole proprietors are also found in the other categories of health care related industries, they are much more limited than in computer systems design and related services. Consequently, the data for these other categories are often suppressed and unavailable.

Figure 1.9 – Business Stages

- Self-Employed/Non-Employer (1 employee) - Includes small-scale business activity that can be conducted in homes as well as sole proprietorships;
- Stage 1 (2-9 employees) – Includes partnerships, lifestyle businesses and startups. This stage is focused on defining a market, developing a product or service, obtaining capital and finding customers;
- Stage 2 (10-99 employees) - At this phase, a company typically has a proven product, and survival is no longer a daily concern. Companies begin to develop infrastructure and standardize operational systems. Leaders delegate more and wear fewer hats;
- Stage 3 (100-499 employees) - Expansion is a hallmark at this stage as a company broadens its geographic reach, adds new products and pursues new markets. Stage 3 companies introduce formal processes and procedures, and the founder is less involved in daily operations and more concerned with managing culture and change;
- Stage 4 (500 or more employees) – By Stage 4, an organization dominates its industry and is focused on maintaining and defending its market position. Key objectives are controlling expenses, productivity, global penetration and managing market niches.

Source: Edward Lowe Foundation/YourEconomy.org

Importantly, research from the Edward Lowe Foundation suggests that second-stage companies provide an important source of employment growth. For instance, second-stage companies represented only 11.6% of U.S. establishments between 1995 and 2012, but generated nearly 34% of jobs and about 34.5% of sales over this period. Second-stage establishments typically have 10-99 employees and $1 million to $50 million in revenue. Accordingly, over 80 of the Region's establishments in this industry category could potentially fit into this definition. *While not all of these firms may want to grow, dedicated programs to support enterprises in this growth stage could provide a unique opportunity for the Region and fill a common gap in service provision.*

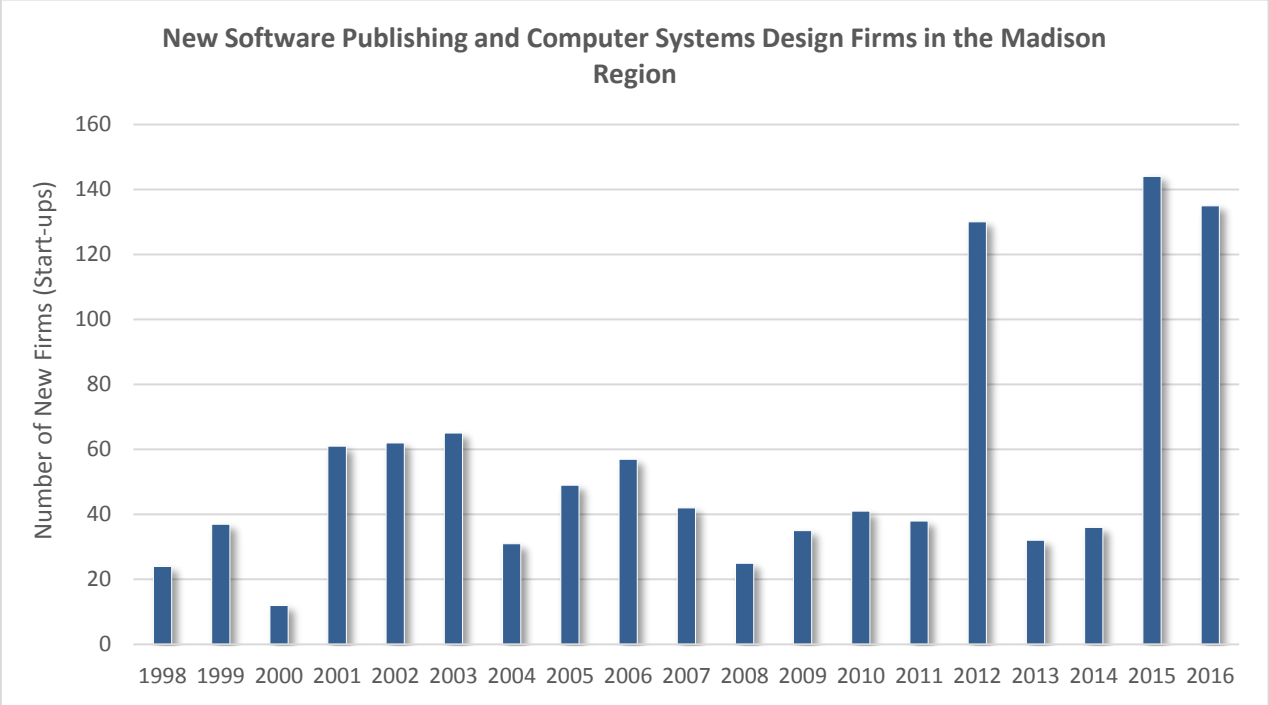
Start-Up Trends in Software Publishing and Computer Systems

The importance of new business start-ups to economic growth has been well established (see Conroy, Chen, Chriestenson, Kures and Deller, 2018 for one summary of this research). High levels of business start-up activity signal a dynamic economy supportive of entrepreneurs. Start-ups of all sizes provide employment opportunities, but also have the opportunity to grow and scale to significant employment and revenue levels. Furthermore, even if a start-up does not succeed, an entrepreneur may have learned lessons from this experience that will help her or him in future ventures.

While start-up activity for detailed industry categories is difficult to determine, we consider the number of business start-ups for two categories of software publishing and computer systems design and related services. The figures on start-ups are compiled from the YourEconomy Time Series (YTS) data set developed by UW-Extension/UW-System. Between 2000 and 2011, the Madison Region averaged 43 start-up firms per year in these two industry categories. More recently, the Region has experienced significant growth in the number of new firms, with over 100 per year in 2012, 2015, and 2016. Note that revisions to

the data set may change the figures from 2013 to 2016 as it may take several years for a new firm to enter the database. That is, some of the firms reported as start-ups in 2015 and 2016 may actually have started in prior years. However, the data set is continually refined to make these types adjustments and the data can be re-visited to examine any potential corrections.

Figure 1.10 – Start-up Trends in Software Publishing and Computer Systems Design & Related Services (1998 to 2016)

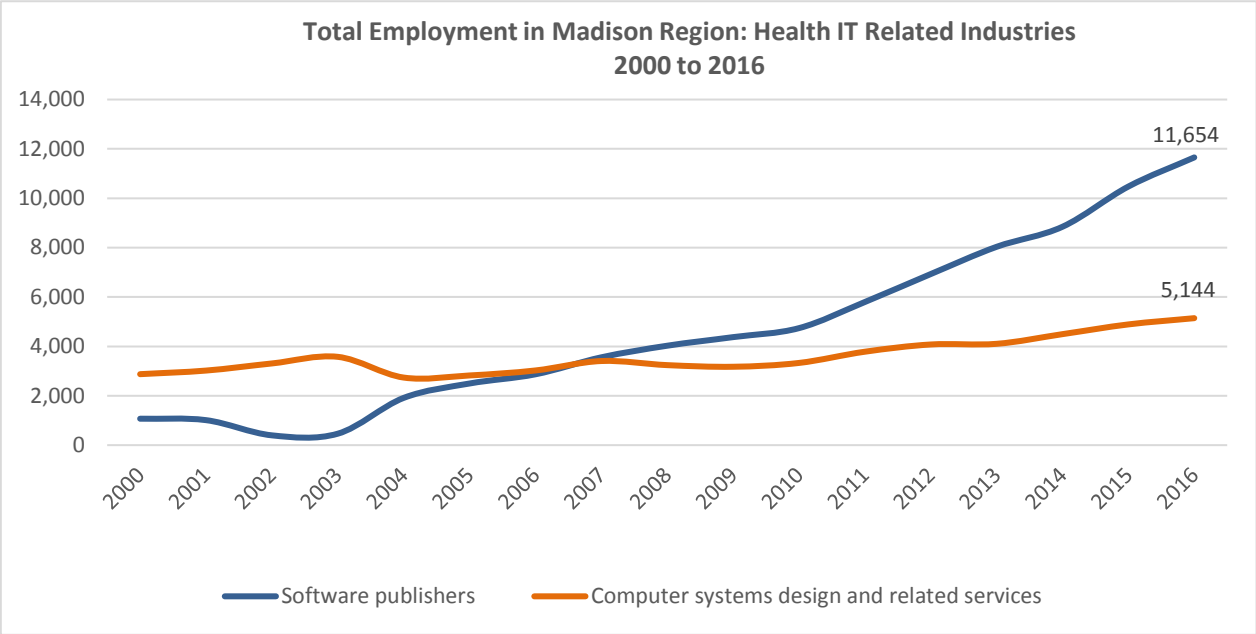


Source: YourEconomy Time Series and Authors' calculations

Health IT Industry Employment Trends

Employment growth in potential Health IT related industries has been dramatic since the turn of the century, increasing from 5,500 employees in 2000 to over 19,000 employees in 2016 (an increase of 250%). *Notably, a large share of this growth has occurred since 2007 in the post-recessionary period when Wisconsin's economy struggled to regain employment lost during the Great Recession.* Not surprisingly, software publishers account for the greatest amount of Health IT employees at 11,654. Computer systems design accounts for an additional 5,144 employees (Figure 1.11).

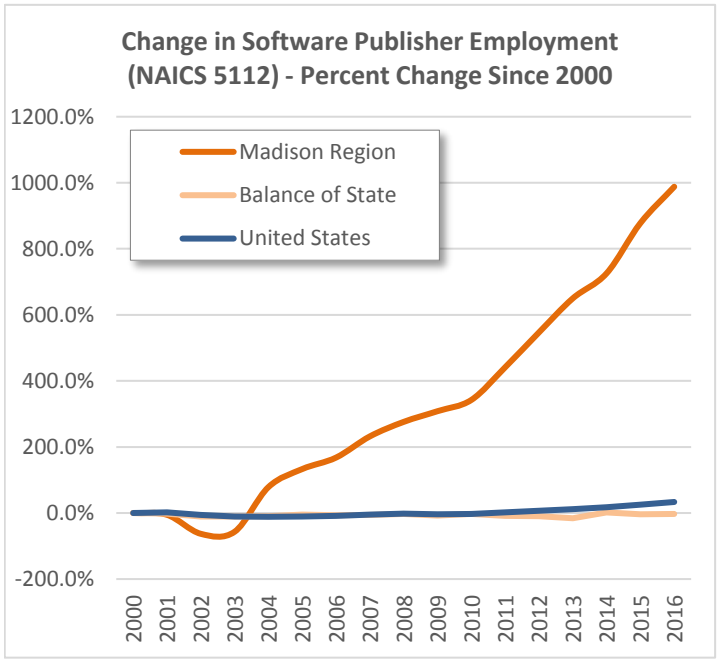
Figure 1.11 – Total Employment in Health IT Related Industries – 2000 to 2016 Annual Averages



Source: U.S. Census Bureau LEHD and Authors' Calculations

When compared to employment growth rates in the United States and the remainder of Wisconsin, employment in the software publishing industry has climbed sharply in the Madison Region (Figure 1.12).[4] Part of this growth is due to the Region's small base of employment in 2000, but the growth has nonetheless been substantial. Indeed, much of this growth is attributed to the employment contributions of Epic Systems. However, growth has also occurred among other software publishers in the Region such as Human Head Studios, Raven Software and PerBlue.

Figure 1.12 – Employment Change in Software Publishers

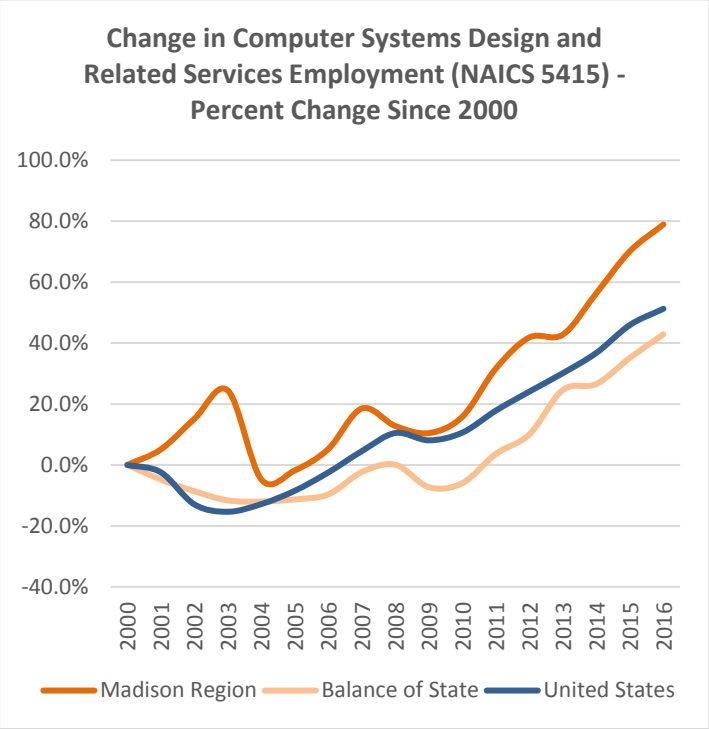


Source: U.S. Census Bureau LEHD and Authors' Calculations

[4] The Madison Region accounts for a significant and disproportionate share of Wisconsin's overall computer and mathematical occupations. Accordingly, the influence of the Madison Region is removed from overall state employment when comparing growth rates in this industry to that of the State of Wisconsin.

Madison Region employment in computer systems design and related services increased by almost 80% since 2000, outpacing the national rate of 51% (Figure 1.13). The State of Wisconsin's employment growth in computer systems design is positive, but remains slower than that of the United States. *However, the overall employment growth in this industry throughout Wisconsin has outpaced the growth other many other industries since the Great Recession and likely deserves greater attention as an important source of nascent economic growth.*

Figure 1.13 – Employment Change in Computer Systems Design and Related Services



Source: U.S. Census Bureau LEHD and Authors' Calculations

Drugs and Pharmaceuticals

The drugs and pharmaceuticals category is covered by the *Pharmaceutical and Medicine Manufacturing (NAICS 3254)* industry. As reported by the Census Bureau, this industry "comprises establishments primarily engaged in one or more of the following: (1) manufacturing biological and medicinal products; (2) processing (i.e., grading, grinding, and milling) botanical drugs and herbs; (3) isolating active medicinal principals from botanical drugs and herbs; and (4) manufacturing pharmaceutical products intended for internal and external consumption in such forms as ampoules, tablets, capsules, vials, ointments, powders, solutions, and suspensions." Subcategories of pharmaceuticals include:

- Medicinal and Botanical Manufacturing (NAICS 325411);
- Pharmaceutical Preparation Manufacturing (NAICS 325412);
- In-Vitro Diagnostic Substance Manufacturing (NAICS 325413); and
- Biological Product (Except Diagnostic) Manufacturing (NAICS 325414).

In 2017, the Madison Region's drug and pharmaceutical manufacturing industry accounted for over 2,200 employees, $1.66 billion in industrial output and $221.5 million in employee compensation ($100,000 per employee). The Region also accounts for more than 50% of Wisconsin's total output and employment in this industry category (Figure 1.14).[5] While firms may actually produce products found in multiple categories, most firms are found in pharmaceutical preparation manufacturing and biological product manufacturing (Figure 1.15). Six firms in the Region have at least 100 employees, with one firm having more than 500 employees. These larger firms include Promega, Invitrogen (Thermo Fisher), and Scientific Protein Laboratories (SPL). However, most firms are again classified as Stage 2 enterprises.

Figure 1.14 - Drugs and Pharmaceuticals Industry Employment, Output and Employee Compensation in the Madison Region

Industry Measure	Madison Region
Total Employment	2,210
Total Industrial Output	$1,663,300,000
Total Employee Compensation	$221,500,000

Source: IMPLAN and Authors Calculations

Figure 1.15 – Madison Region Establishments by Employment size in Drugs and Pharmaceuticals (2016)

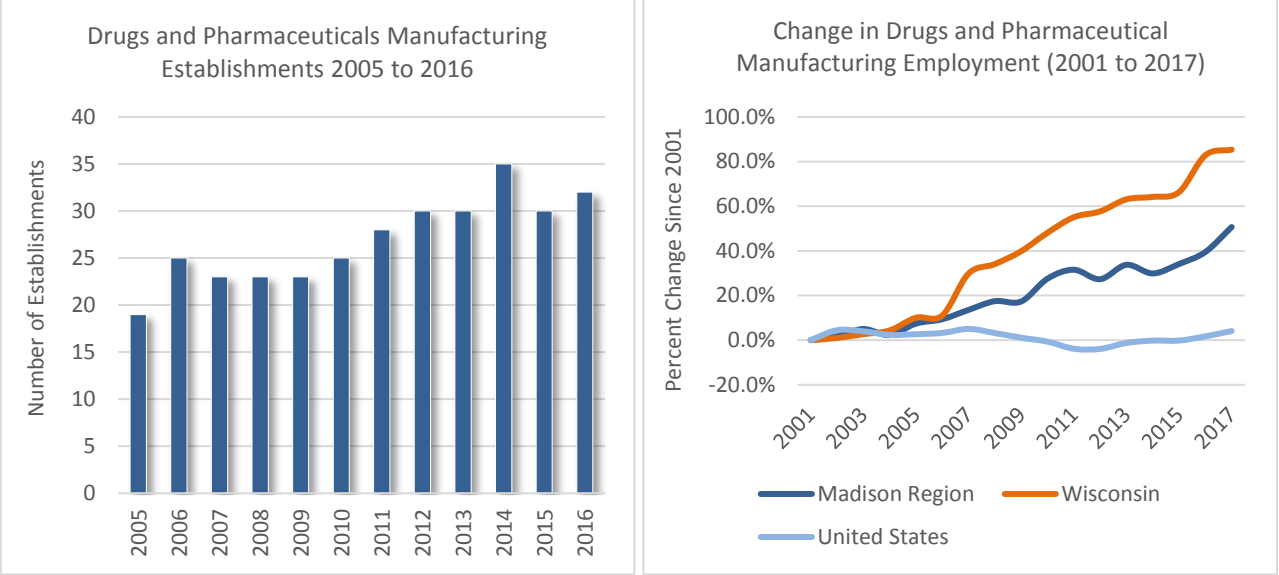
NAICS	Description	Total Establishments	Establishments by Number of Employees			
			1 to 9 Emp.	10 to 99 Emp.	100 to 499 Emp.	500 or More Emp.
325411	Medicinal and botanical manufacturing	4	0	2	2	0
325412	Pharmaceutical preparation manufacturing	12	4	6	2	0
325413	In-vitro diagnostic substance manufacturing	6	1	4	0	1
325414	Biological product (except diagnostic) mfg.	10	2	7	1	0
	Drugs and Pharmaceuticals Total	*32*	*7*	*19*	*5*	*1*

Source: U.S. Census Bureau County Business Patterns

[5] The Madison Region accounts for 18% of Wisconsin's total population

While data suppression issues preclude a detailed analysis of change within individual categories of the drugs and pharmaceuticals industry, broader trends in establishments and employment can be measured. While the number of individual establishments in the Region changes from year-to-year, the total number of firms has largely increased over the last decade. Indeed, the number of establishments grew from 19 in 2005 to the current level of 32 (Figure 1.16). Drug and pharmaceutical manufacturing employment in the Madison Region also increased notably with a 50% increase since 2001 (Figure 1.16). While the rate of employment growth in the Madison Region was somewhat slower than that of the State of Wisconsin, the Region's employment grew significantly faster than the national rate. Furthermore, the Region's drug and pharmaceutical manufacturing industry did not experience the downturn in employment the national industry faced during the Great Recession.

Figure 1.16 – Madison Region Employment and Establishment Change in Drugs and Pharmaceuticals (2016)



Source: U.S. Census Bureau County Business Patterns, Bureau of Labor Statistics QCEW and Authors' Calculations

In terms of total pharmaceutical and medicine manufacturing establishments, the Madison MSA ranks 25th among all metro areas (Figure 1.17). Note that the number of establishments and total employment in Figure 1.17 differs slightly from those previously reported due to differences in year, geography and data sources. Large metropolitan areas that are long established centers of pharmaceutical manufacturing are found near the top of these rankings such as New York, Los Angeles, Philadelphia, San Diego, San Francisco, Boston and Chicago. In fact, the Madison MSA is among the smaller metro areas included in Figure 1.17. However, many of the smaller to mid-sized metro areas that are ranked among the top 50 are home to an R1 research university, which reinforces the role of UW-Madison and other educational institutions in driving the health care industry cluster.

The establishment rankings also provide location quotients for the pharmaceutical and medicine manufacturing industry in these metro areas. The Madison Region's location quotient for pharmaceutical and medicine manufacturing is 2.62. This LQ value reflects that the Region has a notable specialization in this industry. While many LQs in Figure 1.17 are suppressed, the Madison Region is among the highest of those reported. The Region's LQ and employment levels are also larger than those of many metro areas with populations of one million or more.

Figure 1.17 – Top 50 MSAs for Pharmaceutical and Medicine Manufacturing (NAICS 3254) Establishments (2017)

Rank	Metropolitan Statistical Area	Number of Establishments	Total Employment	Employment Location Quotient
1	New York-Newark-Jersey City, NY-NJ-PA MSA	345	31,776	1.70
2	Los Angeles-Long Beach-Anaheim, CA MSA	185	11,990	0.99
3	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD MSA	115	14,637	2.61
4	Miami-Fort Lauderdale-West Palm Beach, FL MSA	114	2,590	0.51
5	San Diego-Carlsbad, CA MSA	111	7,088	2.43
6	San Francisco-Oakland-Hayward, CA MSA	95	S	S
7	Boston-Cambridge-Newton, MA-NH MSA	85	9,465	1.77
8	Chicago-Naperville-Elgin, IL-IN-WI MSA	82	17,181	1.89
9	Washington-Arlington-Alexandria, DC-VA-MD-WV MSA	72	5,562	0.88
10	Denver-Aurora-Lakewood, CO MSA	69	1,404	0.48
11	Seattle-Tacoma-Bellevue, WA MSA	66	S	S
12	Atlanta-Sandy Springs-Roswell, GA MSA	53	1,542	0.30
13	Dallas-Fort Worth-Arlington, TX MSA	53	4,168	0.59
14	Phoenix-Mesa-Scottsdale, AZ MSA	52	S	S
15	Houston-The Woodlands-Sugar Land, TX MSA	49	2,468	0.42
16	Tampa-St. Petersburg-Clearwater, FL MSA	49	1,745	0.68
17	St. Louis, MO-IL MSA	42	4,095	1.53
18	Minneapolis-St. Paul-Bloomington, MN-WI MSA	41	3,253	0.85
19	Salt Lake City, UT MSA	41	S	S
20	San Juan-Carolina-Caguas, PR MSA	41	12,080	9.50
21	Kansas City, MO-KS MSA	39	1,626	0.78
22	Portland-Vancouver-Hillsboro, OR-WA MSA	35	S	S
23	Detroit-Warren-Dearborn, MI MSA	34	S	S
24	Baltimore-Columbia-Towson, MD MSA	33	2,554	0.95
25	**Madison, WI MSA**	**33**	**2,025**	**2.62**
26	San Jose-Sunnyvale-Santa Clara, CA MSA	30	2,754	1.25
27	Austin-Round Rock, TX MSA	28	2,023	1.01
28	Durham-Chapel Hill, NC MSA	26	6,264	10.47
29	Riverside-San Bernardino-Ontario, CA MSA	26	1,081	0.37
30	Provo-Orem, UT MSA	24	S	S
31	Trenton, NJ MSA	24	2,024	4.03
32	Boulder, CO MSA	23	1,142	3.13
33	Cincinnati, OH-KY-IN MSA	23	2,098	1.00
34	Orlando-Kissimmee-Sanford, FL MSA	23	909	0.37
35	Charlotte-Concord-Gastonia, NC-SC MSA	22	2,123	0.90
36	Ogden-Clearfield, UT MSA	22	1,455	2.84
37	Milwaukee-Waukesha-West Allis, WI MSA	21	S	S
38	Indianapolis-Carmel-Anderson, IN MSA	20	S	S
39	Boise City, ID MSA	19	S	S
40	Raleigh, NC MSA	19	S	S
41	San Antonio-New Braunfels, TX MSA	19	1,166	0.58
42	Portland-South Portland, ME MSA	18	1,814	3.31
43	Buffalo-Cheektowaga-Niagara Falls, NY MSA	17	S	S
44	Las Vegas-Henderson-Paradise, NV MSA	16	524	0.27
45	Richmond, VA MSA	16	719	0.56
46	Sacramento--Roseville--Arden-Arcade, CA MSA	16	743	0.38
47	Albuquerque, NM MSA	15	551	0.73
48	Allentown-Bethlehem-Easton, PA-NJ MSA	15	S	S
49	Charleston-North Charleston, SC MSA	15	136	0.20
50	Oklahoma City, OK MSA	15	562	0.46

Source: U.S. Bureau of Labor Statistics Quarterly Census of Employment and Wages S = Supressed

Medical Devices and Equipment

The medical devices and equipment component of the health care industry includes several specific categories of manufacturing. As described by the U.S. Census Bureau, these categories include:

- *Electromedical and Electrotherapeutic Apparatus Manufacturing (NAICS 334510)* - This U.S. industry comprises establishments primarily engaged in manufacturing electromedical and electrotherapeutic apparatus, such as magnetic resonance imaging equipment, medical ultrasound equipment, pacemakers, hearing aids, electrocardiographs, and electromedical endoscopic equipment.

- *Analytical Laboratory Instrument Manufacturing (NAICS 334516)* - This U.S. industry comprises establishments primarily engaged in manufacturing instruments and instrumentation systems for laboratory analysis of the chemical or physical composition or concentration of samples of solid, fluid, gaseous, or composite material.

- *Irradiation Apparatus Manufacturing (NAICS 334517)* - This U.S. industry comprises establishments primarily engaged in manufacturing irradiation apparatus and tubes for applications, such as medical diagnostic, medical therapeutic, industrial, research and scientific evaluation. Irradiation can take the form of beta-rays, gamma-rays, X-rays, or other ionizing radiation.

- *Medical Equipment and Supplies Manufacturing (NAICS 3391)* - This industry comprises establishments primarily engaged in manufacturing medical equipment and supplies. Examples of products made by these establishments are surgical and medical instruments, surgical appliances and supplies, dental equipment and supplies, orthodontic goods, ophthalmic goods, dentures, and orthodontic appliances.

In 2017, the Region's medical devices and equipment manufacturing industry accounted for almost 1,900 employees, $821.3 million in industrial output and $190.8 million in employee compensation (Figure 1.18). The Region is home to approximately 17% Wisconsin's total medical devices and equipment industry in terms of employment, output and compensation, with a large share of the state's employment also located in the nearby Milwaukee metro area. In terms of total establishments, the medical equipment and supplies manufacturing category is the largest with 47 establishments located in the Madison Region (Figure 1.19)

Eight firms in the region have at least 100 employees, with one firm having more than 500 employees. These larger firms include some of the Region's prominent bioscience firms including Thermo Fisher, Bruker AXS, GE Healthcare and Accuray. Again, many firms in this industry category are classified as Stage 2 firms, or so-called second-stage companies. However, the industry also has 42 establishments with less than 10 employees.

Figure 1.18 – Medical Devices and Equipment Industry Employment, Output and Compensation in the Madison Region

Industry Measure	Madison Region
Total Employment	1,897
Total Industrial Output	$821,300,000
Total Employee Compensation	$190,800,000

Source: BLS QCEW (employment), IMPLAN and Authors Calculations

Figure 1.19 – Madison Region Establishments by Employment size in Medical Devices and Equipment (2016)

NAICS	Description	Total Establishments	Establishments by Number of Employees			
			1 to 9 Emp.	10 to 99 Emp.	100 to 499 Emp.	500 or More Emp.
334510	Electromedical and electrotherapeutic apparatus manufacturing	8	3	3	2	0
334516	Analytical laboratory instrument manufacturing	8	3	2	3	0
334517	Irradiation apparatus manufacturing	4	1	1	2	0
3391	Medical equipment and supplies manufacturing	47	35	11	0	1
	Medical Devices and Equipment Total	*67*	*42*	*17*	*7*	*1*

U.S. Census Bureau County Business Patterns, Bureau of Labor Statistics QCEW and Authors' Calculations

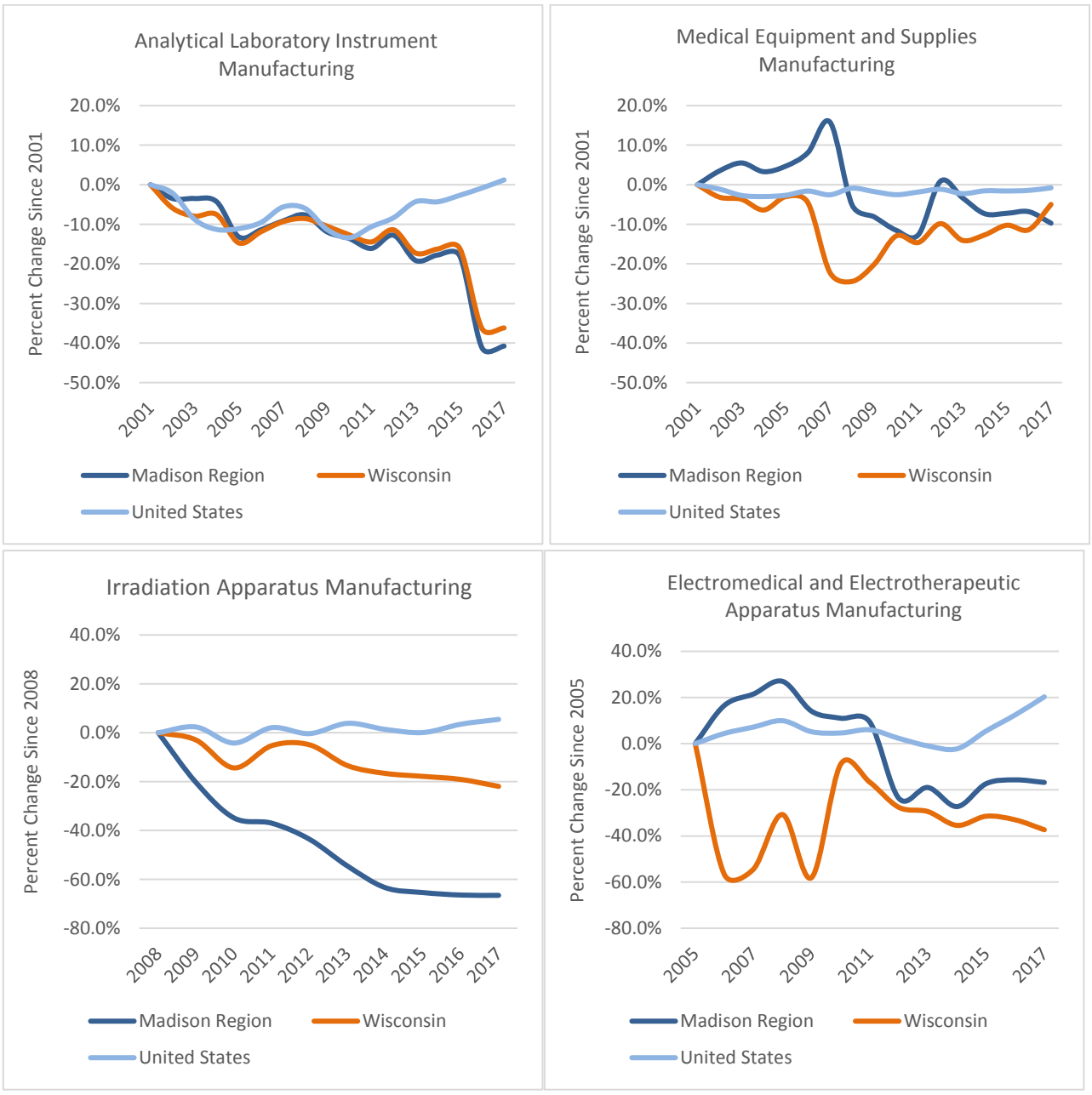
Employment within the medical device and equipment manufacturing industry category has largely declined over the past decade (Figure 1.20). In 2017, employment in analytical laboratory instrument manufacturing in the Madison Region was 41% below 2001 employment levels. Similarly, 2017 employment in medical equipment and supplies manufacturing was 10% below 2001 employment levels in the industry. Employment data suppression precludes an analysis of employment change over the same period since 2001, but 2017 employment in electromedical and electrotherapeutic apparatus manufacturing was 17% below 2005 levels. Furthermore, 2017 employment in irradiation apparatus manufacturing was 66% below 2008 employment values.

The employment changes in medical device and equipment manufacturing may surprise some readers, but are not necessarily unexpected for several reasons. First, total employment within each of these categories is relatively small, making the industries much more sensitive to percentage changes relative to state and national changes in employment. Second, while national employment changes have not been as intense as those found in the Madison Region, employment in these industries has indeed dropped nationwide over the last several decades. These industries in the State of Wisconsin also have not been immune to employment declines. Finally, the Madison Region has experienced a number of well-documented closures or employment reductions in these industries, including: GE Healthcare, Accuray and Hologic (formerly Third Wave Technologies).

Despite these employment changes, the Madison Region remains an important location for the manufacturing of medical devices and equipment. Specifically the Madison MSA ranks 29th among all MSAs for electromedical and electrotherapeutic apparatus establishments, 20th in analytical laboratory instrument manufacturing establishments and 12th for irradiation apparatus manufacturing establishments. The Madison MSA also has location quotients either above 1.25 or well above 1.25 in these three manufacturing categories (Figures 1.21 to 1.23). Accordingly, the 20 or so firms in this category comprise an important niche in the Madison Region.

The Madison MSA is not ranked in the top 50 metro areas for medical equipment and supplies manufacturing. Instead the Madison, WI MSA is ranked 78th in total establishments and has a location quotient of 1.09. The top 10 metro areas for medical equipment manufacturing establishments include the large MSAs of New York, Los Angeles, Chicago, Miami, Minneapolis-St. Paul, Philadelphia, Dallas, Atlanta, San Francisco and Boston (Figure 1.24). Again, many of these areas are also highly ranked for pharmaceutical and drug manufacturing.

Figure 1.20 - Medical Device and Equipment Manufacturing Employment Trends



Source: BLS QCEW and Authors' Calculations

Note: Employment data suppression precludes an analysis of employment change over the same period since 2001 for irradiation apparatus manufacturing and electromedical and electrotherapeutic apparatus manufacturing.

Figure 1.21 – Top 50 MSAs for Electromedical & Electrotherapeutic Apparatus Manufacturing Establishments (2017)

Rank	Metropolitan Statistical Area	Number of Establishments	Total Employment	Employment Location Quotient
1	Los Angeles-Long Beach-Anaheim, CA MSA	79	8,652	3.06
2	Minneapolis-St. Paul-Bloomington, MN-WI MSA	65	13,909	15.56
3	San Francisco-Oakland-Hayward, CA MSA	54	S	S
4	Seattle-Tacoma-Bellevue, WA MSA	50	S	S
5	New York-Newark-Jersey City, NY-NJ-PA MSA	48	2,186	0.50
6	San Jose-Sunnyvale-Santa Clara, CA MSA	48	2,869	5.59
7	Chicago-Naperville-Elgin, IL-IN-WI MSA	42	1,028	0.49
8	San Diego-Carlsbad, CA MSA	35	3,320	4.91
9	Boston-Cambridge-Newton, MA-NH MSA	32	3,784	3.04
10	Salt Lake City, UT MSA	28	S	S
11	Miami-Fort Lauderdale-West Palm Beach, FL MSA	25	1,508	1.27
12	Houston-The Woodlands-Sugar Land, TX MSA	19	624	0.46
13	Atlanta-Sandy Springs-Roswell, GA MSA	15	270	0.22
14	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD MSA	15	S	S
15	Portland-Vancouver-Hillsboro, OR-WA MSA	15	566	1.04
16	Cleveland-Elyria, OH MSA	13	1,363	2.87
17	Dallas-Fort Worth-Arlington, TX MSA	13	1,015	0.62
18	Denver-Aurora-Lakewood, CO MSA	13	104	0.15
19	Pittsburgh, PA MSA	13	2,168	4.15
20	Baltimore-Columbia-Towson, MD MSA	12	S	S
21	Boulder, CO MSA	12	2,244	26.47
22	Washington-Arlington-Alexandria, DC-VA-MD-WV MSA	12	S	S
23	Detroit-Warren-Dearborn, MI MSA	11	81	0.09
24	San Juan-Carolina-Caguas, PR MSA	11	3,354	11.36
25	Milwaukee-Waukesha-West Allis, WI MSA	10	S	S
26	Phoenix-Mesa-Scottsdale, AZ MSA	10	500	0.53
27	Providence-Warwick, RI-MA MSA	10	S	S
28	Gainesville, FL MSA	9	335	5.35
29	**Madison, WI MSA**	**9**	**302**	**1.68**
30	Worcester, MA-CT MSA	9	S	S
31	Orlando-Kissimmee-Sanford, FL MSA	8	292	0.52
32	Oklahoma City, OK MSA	7	S	S
33	Tampa-St. Petersburg-Clearwater, FL MSA	7	446	0.75
34	Akron, OH MSA	6	S	S
35	Durham-Chapel Hill, NC MSA	6	199	1.43
36	Raleigh, NC MSA	6	18	0.06
37	Santa Maria-Santa Barbara, CA MSA	6	189	2.03
38	Tulsa, OK MSA	6	S	S
39	Bridgeport-Stamford-Norwalk, CT MSA	5	69	0.35
40	Iowa City, IA MSA	5	S	S
41	Nashville-Davidson--Murfreesboro--Franklin, TN MSA	5	16	0.04
42	Riverside-San Bernardino-Ontario, CA MSA	5	S	S
43	Jacksonville, FL MSA	4	S	S
44	Knoxville, TN MSA	4	S	S
45	Louisville-Jefferson County, KY-IN MSA	4	15	0.05
46	New Haven-Milford, CT MSA	4	119	0.69
47	Richmond, VA MSA	4	28	0.09
48	State College, PA MSA	4	266	8.13
49	Albuquerque, NM MSA	3	S	S
50	Boise City, ID MSA	3	S	S

Source: U.S. Bureau of Labor Statistics Quarterly Census of Employment and Wages S = Supressed

Figure 1.22 – Top 50 MSAs for Analytical Laboratory Instrument Manufacturing Establishments (2017)

Rank	Metropolitan Statistical Area	Number of Establishments	Total Employment	Employment Location Quotient
1	Boston-Cambridge-Newton, MA-NH MSA	75	S	S
2	San Francisco-Oakland-Hayward, CA MSA	41	3,015	5.13
3	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD MSA	38	1,457	2.13
4	New York-Newark-Jersey City, NY-NJ-PA MSA	36	880	0.39
5	San Diego-Carlsbad, CA MSA	25	779	2.19
6	Houston-The Woodlands-Sugar Land, TX MSA	24	658	0.92
7	San Jose-Sunnyvale-Santa Clara, CA MSA	23	S	S
8	Washington-Arlington-Alexandria, DC-VA-MD-WV MSA	21	685	0.89
9	Los Angeles-Long Beach-Anaheim, CA MSA	19	S	S
10	Chicago-Naperville-Elgin, IL-IN-WI MSA	18	S	S
11	Pittsburgh, PA MSA	14	317	1.16
12	Seattle-Tacoma-Bellevue, WA MSA	14	S	S
13	Boulder, CO MSA	12	386	8.67
14	Cincinnati, OH-KY-IN MSA	11	333	1.30
15	Minneapolis-St. Paul-Bloomington, MN-WI MSA	11	302	0.64
16	Baltimore-Columbia-Towson, MD MSA	10	S	S
17	New Haven-Milford, CT MSA	10	125	1.39
18	Salt Lake City, UT MSA	9	79	0.46
19	Austin-Round Rock, TX MSA	8	47	0.19
20	**Madison, WI MSA**	**8**	**427**	**4.53**
21	Santa Maria-Santa Barbara, CA MSA	8	495	10.11
22	Dallas-Fort Worth-Arlington, TX MSA	7	S	S
23	Miami-Fort Lauderdale-West Palm Beach, FL MSA	7	184	0.30
24	Portland-Vancouver-Hillsboro, OR-WA MSA	7	765	2.67
25	Raleigh, NC MSA	7	S	S
26	Worcester, MA-CT MSA	7	1,658	17.38
27	Albany-Schenectady-Troy, NY MSA	6	S	S
28	Bridgeport-Stamford-Norwalk, CT MSA	6	S	S
29	Hartford-West Hartford-East Hartford, CT MSA	6	S	S
30	Riverside-San Bernardino-Ontario, CA MSA	6	294	0.82
31	State College, PA MSA	6	630	36.65
32	Tucson, AZ MSA	6	61	0.68
33	Atlanta-Sandy Springs-Roswell, GA MSA	5	S	S
34	Denver-Aurora-Lakewood, CO MSA	5	S	S
35	Indianapolis-Carmel-Anderson, IN MSA	5	30	0.12
36	Manchester-Nashua, NH MSA	5	146	2.92
37	Omaha-Council Bluffs, NE-IA MSA	5	S	S
38	Orlando-Kissimmee-Sanford, FL MSA	5	S	S
39	Providence-Warwick, RI-MA MSA	5	S	S
40	Sacramento--Roseville--Arden-Arcade, CA MSA	5	198	0.83
41	St. Louis, MO-IL MSA	5	851	2.61
42	Trenton, NJ MSA	5	S	S
43	Virginia Beach-Norfolk-Newport News, VA-NC MSA	5	S	S
44	Albuquerque, NM MSA	4	32	0.35
45	Baton Rouge, LA MSA	4	S	S
46	Cleveland-Elyria, OH MSA	4	S	S
47	Columbia, SC MSA	4	29	0.31
48	Columbus, OH MSA	4	43	0.17
49	Detroit-Warren-Dearborn, MI MSA	4	S	S
50	Durham-Chapel Hill, NC MSA	4	146	2.00

Source: U.S. Bureau of Labor Statistics Quarterly Census of Employment and Wages S = Supressed

Figure 1.23 – Top 50 MSAs for Irradiation Apparatus Manufacturing Establishments (2017)

Rank	Metropolitan Statistical Area	Number of Establishments	Total Employment	Employment Location Quotient
1	Milwaukee-Waukesha-West Allis, WI MSA	25	S	S
2	Chicago-Naperville-Elgin, IL-IN-WI MSA	17	S	S
3	Los Angeles-Long Beach-Anaheim, CA MSA	13	S	S
4	New York-Newark-Jersey City, NY-NJ-PA MSA	11	S	S
5	Boston-Cambridge-Newton, MA-NH MSA	10	S	S
6	San Francisco-Oakland-Hayward, CA MSA	10	581	2.63
7	Atlanta-Sandy Springs-Roswell, GA MSA	6	32	0.13
8	Houston-The Woodlands-Sugar Land, TX MSA	5	150	0.55
9	Salt Lake City, UT MSA	5	S	S
10	Bridgeport-Stamford-Norwalk, CT MSA	4	S	S
11	Dallas-Fort Worth-Arlington, TX MSA	4	5	0.02
12	**Madison, WI MSA**	**4**	**264**	**7.43**
13	Miami-Fort Lauderdale-West Palm Beach, FL MSA	4	S	S
14	New Orleans-Metairie, LA MSA	4	32	0.63
15	Raleigh, NC MSA	4	S	S
16	Rochester, NY MSA	4	S	S
17	San Diego-Carlsbad, CA MSA	4	S	S
18	San Jose-Sunnyvale-Santa Clara, CA MSA	4	S	S
19	Cleveland-Elyria, OH MSA	3	158	1.68
20	Denver-Aurora-Lakewood, CO MSA	3	15	0.11
21	New Haven-Milford, CT MSA	3	S	S
22	Orlando-Kissimmee-Sanford, FL MSA	3	65	0.58
23	Provo-Orem, UT MSA	3	S	S
24	Richmond, VA MSA	3	S	S
25	Tampa-St. Petersburg-Clearwater, FL MSA	3	S	S
26	Washington-Arlington-Alexandria, DC-VA-MD-WV MSA	3	S	S
27	Albany-Schenectady-Troy, NY MSA	2	S	S
28	Anchorage, AK MSA	2	S	S
29	Baltimore-Columbia-Towson, MD MSA	2	S	S
30	Charleston-North Charleston, SC MSA	2	S	S
31	Cincinnati, OH-KY-IN MSA	2	S	S
32	Jacksonville, FL MSA	2	S	S
33	Knoxville, TN MSA	2	S	S
34	Memphis, TN-MS-AR MSA	2	S	S
35	Nashville-Davidson--Murfreesboro--Franklin, TN MSA	2	S	S
36	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD MSA	2	S	S
37	Pittsburgh, PA MSA	2	S	S
38	Providence-Warwick, RI-MA MSA	2	S	S
39	Santa Cruz-Watsonville, CA MSA	2	S	S
40	Santa Maria-Santa Barbara, CA MSA	2	S	S
41	Akron, OH MSA	1	S	S
42	Albuquerque, NM MSA	1	S	S
43	Ann Arbor, MI MSA	1	S	S
44	Augusta-Richmond County, GA-SC MSA	1	S	S
45	Austin-Round Rock, TX MSA	1	S	S
46	Birmingham-Hoover, AL MSA	1	S	S
47	Boulder, CO MSA	1	S	S
48	Buffalo-Cheektowaga-Niagara Falls, NY MSA	1	S	S
49	Charlotte-Concord-Gastonia, NC-SC MSA	1	S	S
50	Charlottesville, VA MSA	1	S	S

Source: U.S. Bureau of Labor Statistics Quarterly Census of Employment and Wages S = Supressed

Figure 1.24 – Top 50 MSAs for Medical Equipment and Supplies Manufacturing Establishments (2017)

Rank	Metropolitan Statistical Area	Number of Establishments	Total Employment	Employment Location Quotient
1	New York-Newark-Jersey City, NY-NJ-PA MSA	727	S	S
2	Los Angeles-Long Beach-Anaheim, CA MSA	669	25,721	2.00
3	Chicago-Naperville-Elgin, IL-IN-WI MSA	444	11,962	1.24
4	Miami-Fort Lauderdale-West Palm Beach, FL MSA	363	4,749	0.88
5	Minneapolis-St. Paul-Bloomington, MN-WI MSA	269	14,995	3.69
6	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD MSA	231	S	S
7	Dallas-Fort Worth-Arlington, TX MSA	225	S	S
8	Atlanta-Sandy Springs-Roswell, GA MSA	223	4,124	0.75
9	San Francisco-Oakland-Hayward, CA MSA	220	5,570	1.09
10	Boston-Cambridge-Newton, MA-NH MSA	209	S	S
11	Seattle-Tacoma-Bellevue, WA MSA	195	2,538	0.61
12	Tampa-St. Petersburg-Clearwater, FL MSA	185	4,897	1.82
13	Washington-Arlington-Alexandria, DC-VA-MD-WV MSA	171	1,374	0.21
14	Denver-Aurora-Lakewood, CO MSA	166	S	S
15	San Diego-Carlsbad, CA MSA	158	6,196	2.01
16	Salt Lake City, UT MSA	152	8,282	5.51
17	San Jose-Sunnyvale-Santa Clara, CA MSA	151	S	S
18	Detroit-Warren-Dearborn, MI MSA	150	2,378	0.58
19	Phoenix-Mesa-Scottsdale, AZ MSA	149	S	S
20	Houston-The Woodlands-Sugar Land, TX MSA	143	S	S
21	Portland-Vancouver-Hillsboro, OR-WA MSA	142	3,513	1.41
22	St. Louis, MO-IL MSA	129	2,262	0.80
23	Orlando-Kissimmee-Sanford, FL MSA	119	1,080	0.42
24	Riverside-San Bernardino-Ontario, CA MSA	113	2,847	0.92
25	Cleveland-Elyria, OH MSA	99	S	S
26	Kansas City, MO-KS MSA	89	1,861	0.84
27	Providence-Warwick, RI-MA MSA	78	S	S
28	Indianapolis-Carmel-Anderson, IN MSA	77	2,284	1.07
29	Milwaukee-Waukesha-West Allis, WI MSA	77	1,515	0.86
30	Pittsburgh, PA MSA	77	3,209	1.35
31	San Antonio-New Braunfels, TX MSA	74	1,375	0.64
32	Sacramento--Roseville--Arden-Arcade, CA MSA	73	S	S
33	Baltimore-Columbia-Towson, MD MSA	71	S	S
34	Las Vegas-Henderson-Paradise, NV MSA	70	471	0.23
35	Austin-Round Rock, TX MSA	69	S	S
36	Memphis, TN-MS-AR MSA	64	6,471	4.95
37	Charlotte-Concord-Gastonia, NC-SC MSA	63	S	S
38	Virginia Beach-Norfolk-Newport News, VA-NC MSA	63	425	0.27
39	Cincinnati, OH-KY-IN MSA	59	943	0.42
40	Buffalo-Cheektowaga-Niagara Falls, NY MSA	58	1,552	1.34
41	New Orleans-Metairie, LA MSA	57	S	S
42	Jacksonville, FL MSA	56	S	S
43	Richmond, VA MSA	54	S	S
44	Columbus, OH MSA	53	1,395	0.64
45	Nashville-Davidson--Murfreesboro--Franklin, TN MSA	53	950	0.47
46	Albuquerque, NM MSA	50	S	S
47	North Port-Sarasota-Bradenton, FL MSA	49	904	1.46
48	Oxnard-Thousand Oaks-Ventura, CA MSA	49	775	1.12
49	Oklahoma City, OK MSA	48	528	0.41
50	Hartford-West Hartford-East Hartford, CT MSA	47	1,074	0.81

Source: U.S. Bureau of Labor Statistics Quarterly Census of Employment and Wages S = Supressed

The Madison, WI MSA is ranked 78th in total establishments and has 890 employees with a location quotient of 1.09

Research, Testing and Medical Laboratories

The research, testing and medical laboratories component of the industry cluster includes several specific categories of health care and professional, scientific and technical services. As described by the U.S. Census Bureau, these categories include:

- *Research and Development in the Physical, Engineering, and Life Sciences (NAICS 54171)* - This industry comprises establishments primarily engaged in conducting research and experimental development in the physical, engineering, and life sciences, such as agriculture, electronics, environmental, biology, botany, biotechnology, computers, chemistry, food, fisheries, forests, geology, health, mathematics, medicine, nanotechnology, oceanography, pharmacy, physics, veterinary, and other allied subjects.

- *Testing Laboratories (NAICS 541380)* - This industry comprises establishments primarily engaged in performing physical, chemical, and other analytical testing services, such as acoustics or vibration testing, assaying, biological testing (except medical and veterinary), calibration testing, electrical and electronic testing, geotechnical testing, mechanical testing, nondestructive testing, or thermal testing. The testing may occur in a laboratory or on-site.

- *Medical and Diagnostic Laboratories (NAICS 6215)* - This industry comprises establishments known as medical and diagnostic laboratories primarily engaged in providing analytic or diagnostic services, including body fluid analysis and diagnostic imaging, generally to the medical profession or to the patient on referral from a health practitioner.

In 2017, the research, testing and medical laboratories industry accounted for over 5,600 employees in the Madison Region (Figure 1.25). *Importantly, the Region is home to approximately 71.2% of Wisconsin's total employment in the research and development in the physical, engineering, and life sciences industry.* The Madison Region also accounts for 30% of the state's employment in medical and diagnostic laboratories. Of the 140 total establishments in the research, testing and medical laboratories category, five have between 100 and 499 employees while four have 500 employees or more (Figure 1.26).

The research, testing and medical laboratories industry includes several highly visible and growing companies in the Madison Region such as Exact Sciences, PPD and Covance. While these firms have achieved significant growth, many more firms have less than 100 employees, with the greatest number of firms having 1 to 9 employees. Helping these firms, and others in the cluster, achieve scale requires a robust, supportive entrepreneurial ecosystem. Important components of this ecosystem are examined later in this Section as well as in Section 3 of this analysis.

Figure 1.25 – Employment in Research, Testing and Medical Laboratories

Industry	Madison Region
Research and Development in the Physical, Engineering, and Life Sciences	4,360
Testing Laboratories	276
Medical and Diagnostic Laboratories	1,021

Source: BLS QCEW and Authors' Calculations

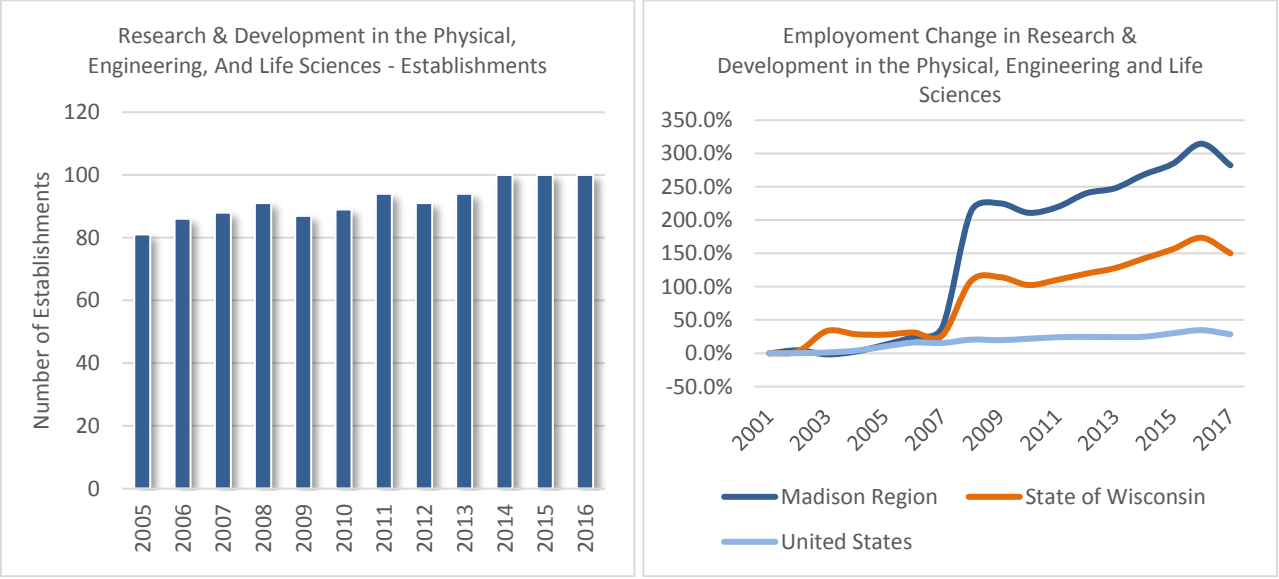
Figure 1.26 – Madison Region Establishments by Employment Size: Research, Testing & Medical Laboratories (2016)

NAICS	Description	Total Establishments	Establishments by Number of Employees			
			1 to 9 Emp.	10 to 99 Emp.	100 to 499 Emp.	500 or More Emp.
54171	Research and development in the physical, engineering, and life sciences	100	63	30	3	4
54138	Testing laboratories	22	16	6	0	0
6215	Medical and diagnostic laboratories	18	12	4	2	0
	Research, Testing & Medical Laboratories Total	*140*	*91*	*40*	*5*	*4*

Source: U.S. Census Bureau County Business Patterns

The research and development in the physical, engineering, and life sciences industry is by far the largest component within this category cluster. The scale and scope of this industry reflects the large amount of capital, human and otherwise, devoted to bioscience and health care related research in the Madison Region. The research and development in the physical, engineering, and life sciences is also one of the categories that has recently grown in terms of establishments and employment. Between 2005 and 2016, this category added almost 20 establishments. Furthermore employment in the industry grew significantly. Note that the large spike in employment growth between 2007 and 2008 is partially attributed to a re-classification of Covance from the testing laboratories industry to research and development in the physical, engineering, and life sciences. A corresponding decline in testing laboratories employment is depicted in Figure 1.27. Nonetheless employment in the industry still increased by 22% since 2008, despite the impacts of the Great Recession.

Figure 1.27 – Madison Region Trends in Research and Development in the Physical, Engineering, and Life Sciences

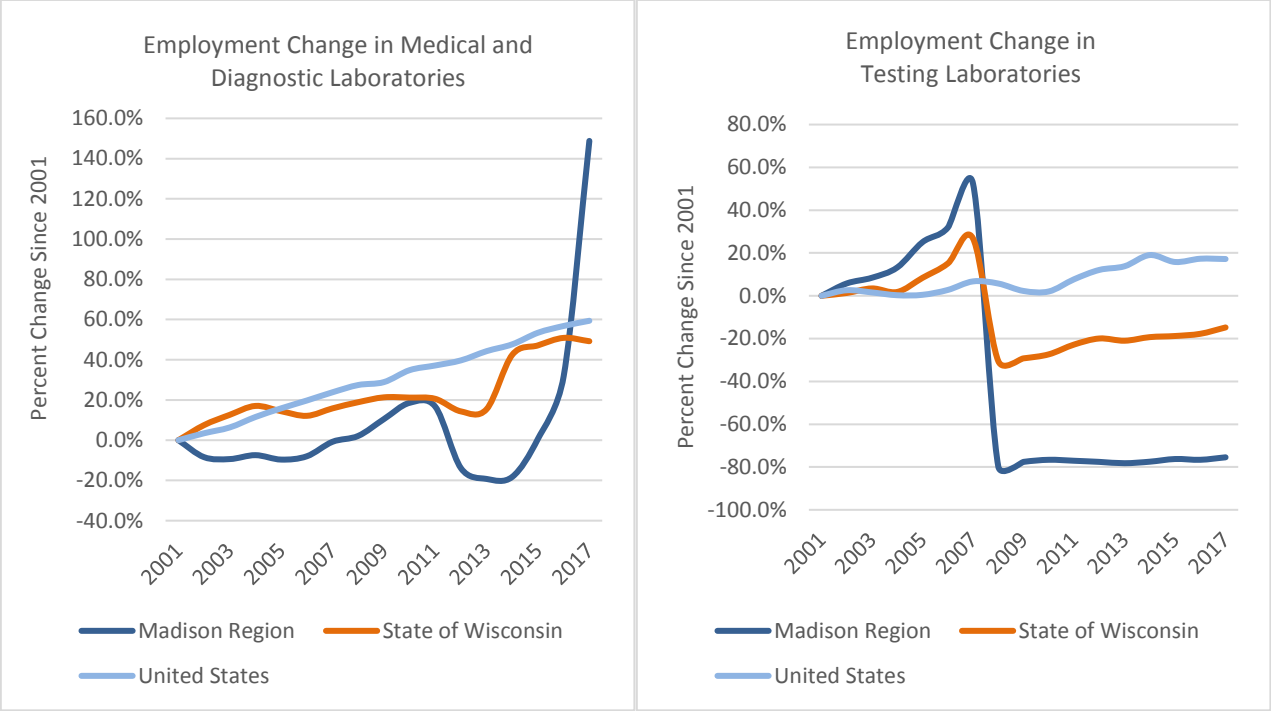


Source: U.S. Census Bureau County Business Patterns, Bureau of Labor Statistics QCEW and Authors' Calculations

Employment growth in medical and diagnostic laboratories and testing laboratories has been somewhat muted (Figure 1.28). Again, these are somewhat smaller industries in the cluster and are sensitive to minor employment changes. As previously mentioned, employment changes in the testing laboratories category

are partially attributed to the industrial re-classification of Covance. Despite these overall trends, employment in the medical and diagnostic laboratories category experienced notable growth between 2016 and 2017 when employment almost doubled.

Figure 1.28 – Madison Region Employment Trends in Medical and Diagnostic Laboratories and Testing Laboratories



Source: BLS QCEW and Authors' Calculations

When compared to other metro areas, the Madison MSA ranks 42nd in terms of establishments in research and development in the physical, engineering, and life sciences. While the Madison MSA employment location quotient is suppressed, Dane County's LQ in the industry is 3.11. As most firms in this category are located in Dane County, this LQ is notable. As mentioned with other categories in this analysis, many metro areas with significant establishments and employment in the life sciences R&D industry are well established bioscience and health care industry centers. Again, health care related industries in many of these metro areas are anchored by R1 research universities. As in other categories of health care (and bioscience), the presence of UW-Madison helps the Madison Region's high ranking in establishments relative to much larger metro areas.

Medical and diagnostic laboratories and testing laboratories are not ranked in the top 50 MSAs for establishments, ranking 159th and 81st respectively. Nonetheless, they are important components in the Madison Region's health care and bioscience industry clusters (often referred to as biohealth).

Figure 1.29 – Top 50 MSAs for Research and Development in the Physical, Engineering, and Life Sciences Establishments (2017)

Rank	Metropolitan Statistical Area	Number of Establishments	Total Employment	Employment Location Quotient
1	Boston-Cambridge-Newton, MA-NH MSA	1,489	S	S
2	Washington-Arlington-Alexandria, DC-VA-MD-WV MSA	964	28,442	2.22
3	New York-Newark-Jersey City, NY-NJ-PA MSA	826	40,761	1.07
4	San Francisco-Oakland-Hayward, CA MSA	809	S	S
5	San Diego-Carlsbad, CA MSA	731	30,533	5.17
6	Los Angeles-Long Beach-Anaheim, CA MSA	603	21,718	0.88
7	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD MSA	519	S	S
8	San Jose-Sunnyvale-Santa Clara, CA MSA	426	S	S
9	Seattle-Tacoma-Bellevue, WA MSA	415	11,418	1.43
10	Houston-The Woodlands-Sugar Land, TX MSA	358	6,918	0.58
11	Miami-Fort Lauderdale-West Palm Beach, FL MSA	351	3,404	0.33
12	Baltimore-Columbia-Towson, MD MSA	307	S	S
13	Chicago-Naperville-Elgin, IL-IN-WI MSA	281	14,522	0.79
14	Durham-Chapel Hill, NC MSA	253	S	S
15	Dallas-Fort Worth-Arlington, TX MSA	251	3,802	0.27
16	Portland-Vancouver-Hillsboro, OR-WA MSA	230	2,672	0.56
17	Raleigh, NC MSA	223	3,854	1.55
18	Atlanta-Sandy Springs-Roswell, GA MSA	211	3,504	0.33
19	Denver-Aurora-Lakewood, CO MSA	199	4,125	0.69
20	Phoenix-Mesa-Scottsdale, AZ MSA	191	S	S
21	Salt Lake City, UT MSA	186	S	S
22	Austin-Round Rock, TX MSA	181	2,338	0.58
23	Minneapolis-St. Paul-Bloomington, MN-WI MSA	177	5,885	0.75
24	St. Louis, MO-IL MSA	167	4,607	0.85
25	Boulder, CO MSA	157	5,231	7.06
26	Tampa-St. Petersburg-Clearwater, FL MSA	148	S	S
27	Providence-Warwick, RI-MA MSA	143	1,742	0.61
28	Kansas City, MO-KS MSA	134	S	S
29	San Antonio-New Braunfels, TX MSA	134	4,506	1.1
30	Cleveland-Elyria, OH MSA	124	1,537	0.37
31	Detroit-Warren-Dearborn, MI MSA	120	14,092	1.8
32	Pittsburgh, PA MSA	120	7,590	1.66
33	Albuquerque, NM MSA	113	12,365	8.03
34	Orlando-Kissimmee-Sanford, FL MSA	113	S	S
35	Huntsville, AL MSA	108	S	S
36	Cincinnati, OH-KY-IN MSA	106	2,649	0.62
37	Worcester, MA-CT MSA	104	S	S
38	New Haven-Milford, CT MSA	100	1,740	1.16
39	Columbus, OH MSA	96	6,534	1.56
40	Ann Arbor, MI MSA	93	2,620	3.03
41	Charlotte-Concord-Gastonia, NC-SC MSA	90	815	0.17
42	**Madison, WI MSA**	**90**	**S**	**S**
43	Indianapolis-Carmel-Anderson, IN MSA	88	2,446	0.59
44	Las Vegas-Henderson-Paradise, NV MSA	79	1,468	0.37
45	Sacramento--Roseville--Arden-Arcade, CA MSA	78	5,259	1.32
46	Nashville-Davidson--Murfreesboro--Franklin, TN MSA	77	559	0.15
47	Buffalo-Cheektowaga-Niagara Falls, NY MSA	75	S	S
48	Tucson, AZ MSA	73	2,375	1.58
49	Urban Honolulu, HI MSA	73	597	0.31
50	Bridgeport-Stamford-Norwalk, CT MSA	69	2,513	1.45

Source: U.S. Bureau of Labor Statistics Quarterly Census of Employment and Wages S = Supressed

Figure 1.30 – Top 50 MSAs for Testing Laboratory Establishments (2017)

Rank	Metropolitan Statistical Area	Number of Establishments	Total Employment	Employment Location Quotient
1	New York-Newark-Jersey City, NY-NJ-PA MSA	373	10,568	1.00
2	Los Angeles-Long Beach-Anaheim, CA MSA	331	6,218	0.90
3	Houston-The Woodlands-Sugar Land, TX MSA	321	8,301	2.49
4	Chicago-Naperville-Elgin, IL-IN-WI MSA	232	5,104	0.99
5	Dallas-Fort Worth-Arlington, TX MSA	175	2,372	0.60
6	Boston-Cambridge-Newton, MA-NH MSA	163	S	S
7	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD MSA	149	S	S
8	Detroit-Warren-Dearborn, MI MSA	142	S	S
9	Miami-Fort Lauderdale-West Palm Beach, FL MSA	141	1,402	0.48
10	Phoenix-Mesa-Scottsdale, AZ MSA	131	S	S
11	San Francisco-Oakland-Hayward, CA MSA	126	2,945	1.08
12	Seattle-Tacoma-Bellevue, WA MSA	126	1,213	0.54
13	Denver-Aurora-Lakewood, CO MSA	119	1,247	0.75
14	Atlanta-Sandy Springs-Roswell, GA MSA	116	1,533	0.52
15	San Diego-Carlsbad, CA MSA	105	2,205	1.33
16	Washington-Arlington-Alexandria, DC-VA-MD-WV MSA	100	1,551	0.43
17	Pittsburgh, PA MSA	91	S	S
18	Portland-Vancouver-Hillsboro, OR-WA MSA	90	1,197	0.90
19	Minneapolis-St. Paul-Bloomington, MN-WI MSA	89	2,521	1.15
20	Tampa-St. Petersburg-Clearwater, FL MSA	89	S	S
21	San Jose-Sunnyvale-Santa Clara, CA MSA	81	S	S
22	Salt Lake City, UT MSA	79	S	S
23	Baltimore-Columbia-Towson, MD MSA	76	S	S
24	Las Vegas-Henderson-Paradise, NV MSA	76	811	0.73
25	Charlotte-Concord-Gastonia, NC-SC MSA	74	558	0.42
26	Cincinnati, OH-KY-IN MSA	67	1,558	1.30
27	Cleveland-Elyria, OH MSA	67	1,365	1.18
28	St. Louis, MO-IL MSA	67	1,221	0.80
29	Columbus, OH MSA	66	1,056	0.90
30	Raleigh, NC MSA	63	S	S
31	Indianapolis-Carmel-Anderson, IN MSA	60	994	0.87
32	Kansas City, MO-KS MSA	59	676	0.57
33	New Orleans-Metairie, LA MSA	59	1,186	1.90
34	Austin-Round Rock, TX MSA	58	711	0.63
35	Riverside-San Bernardino-Ontario, CA MSA	58	700	0.42
36	Hartford-West Hartford-East Hartford, CT MSA	55	683	0.96
37	Sacramento--Roseville--Arden-Arcade, CA MSA	53	734	0.66
38	Milwaukee-Waukesha-West Allis, WI MSA	49	486	0.51
39	Providence-Warwick, RI-MA MSA	49	478	0.60
40	Orlando-Kissimmee-Sanford, FL MSA	48	798	0.58
41	Baton Rouge, LA MSA	46	1,182	2.67
42	Lafayette, LA MSA	46	737	3.29
43	Louisville-Jefferson County, KY-IN MSA	42	386	0.53
44	Tulsa, OK MSA	42	489	1.00
45	Nashville-Davidson--Murfreesboro--Franklin, TN MSA	41	715	0.67
46	Oxnard-Thousand Oaks-Ventura, CA MSA	41	410	1.11
47	San Antonio-New Braunfels, TX MSA	40	847	0.74
48	Richmond, VA MSA	39	498	0.68
49	Birmingham-Hoover, AL MSA	38	415	0.74
50	Buffalo-Cheektowaga-Niagara Falls, NY MSA	37	S	S

Source: U.S. Bureau of Labor Statistics Quarterly Census of Employment and Wages S = Supressed

The Madison, WI MSA is ranked 81st in total establishments with 21 establishments, 276 employees and an LQ of 0.63

Figure 1.31 – Top 50 MSAs for Medical and Diagnostic Laboratory Establishments (2017)

Rank	Metropolitan Statistical Area	Number of Establishments	Total Employment	Employment Location Quotient
1	New York-Newark-Jersey City, NY-NJ-PA MSA	1,282	22,590	1.31
2	Los Angeles-Long Beach-Anaheim, CA MSA	843	14,987	1.34
3	Miami-Fort Lauderdale-West Palm Beach, FL MSA	625	8,324	1.77
4	Washington-Arlington-Alexandria, DC-VA-MD-WV MSA	530	6,610	1.13
5	Dallas-Fort Worth-Arlington, TX MSA	506	8,461	1.31
6	Atlanta-Sandy Springs-Roswell, GA MSA	486	4,807	1.00
7	San Juan-Carolina-Caguas, PR MSA	473	4,122	3.52
8	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD MSA	430	5,815	1.13
9	Houston-The Woodlands-Sugar Land, TX MSA	383	6,088	1.12
10	Chicago-Naperville-Elgin, IL-IN-WI MSA	368	7,775	0.93
11	Charlotte-Concord-Gastonia, NC-SC MSA	310	1,209	0.56
12	San Francisco-Oakland-Hayward, CA MSA	275	S	S
13	Denver-Aurora-Lakewood, CO MSA	251	3,440	1.27
14	Tampa-St. Petersburg-Clearwater, FL MSA	248	4,798	2.04
15	Boston-Cambridge-Newton, MA-NH MSA	236	4,629	0.94
16	Las Vegas-Henderson-Paradise, NV MSA	212	3,273	1.81
17	Raleigh, NC MSA	204	S	S
18	Riverside-San Bernardino-Ontario, CA MSA	201	1,841	0.68
19	Orlando-Kissimmee-Sanford, FL MSA	200	2,462	1.10
20	Phoenix-Mesa-Scottsdale, AZ MSA	183	S	S
21	San Diego-Carlsbad, CA MSA	182	5,074	1.89
22	Baltimore-Columbia-Towson, MD MSA	179	S	S
23	Kansas City, MO-KS MSA	176	3,977	2.06
24	Richmond, VA MSA	165	2,144	1.81
25	Virginia Beach-Norfolk-Newport News, VA-NC MSA	162	1,080	0.78
26	Columbus, OH MSA	159	1,176	0.62
27	Cincinnati, OH-KY-IN MSA	158	1,932	1.00
28	Oklahoma City, OK MSA	156	S	S
29	San Antonio-New Braunfels, TX MSA	152	S	S
30	New Orleans-Metairie, LA MSA	145	1,115	1.10
31	Pittsburgh, PA MSA	144	S	S
32	Seattle-Tacoma-Bellevue, WA MSA	143	2,647	0.73
33	Birmingham-Hoover, AL MSA	132	S	S
34	Detroit-Warren-Dearborn, MI MSA	127	1,960	0.55
35	St. Louis, MO-IL MSA	124	1,710	0.69
36	Portland-Vancouver-Hillsboro, OR-WA MSA	120	2,148	0.99
37	Nashville-Davidson--Murfreesboro--Franklin, TN MSA	118	3,991	2.29
38	Salt Lake City, UT MSA	111	S	S
39	San Jose-Sunnyvale-Santa Clara, CA MSA	111	S	S
40	Austin-Round Rock, TX MSA	107	2,486	1.35
41	Providence-Warwick, RI-MA MSA	104	S	S
42	Indianapolis-Carmel-Anderson, IN MSA	97	2,997	1.60
43	Sacramento--Roseville--Arden-Arcade, CA MSA	97	1,060	0.59
44	Greensboro-High Point, NC MSA	94	2,446	3.74
45	Jacksonville, FL MSA	93	841	0.69
46	Hartford-West Hartford-East Hartford, CT MSA	91	831	0.72
47	Cleveland-Elyria, OH MSA	87	S	S
48	Aguadilla-Isabela, PR MSA	86	S	S
49	Greenville-Anderson-Mauldin, SC MSA	84	446	0.61
50	Albuquerque, NM MSA	82	S	S

Source: U.S. Bureau of Labor Statistics Quarterly Census of Employment and Wages S = Supressed

The Madison, WI MSA is ranked 159th in total establishments

Health Care Industries and the Madison Region's Entrepreneurial Ecosystem

As noted throughout Section 1, the Region's health care related industries have a number of prominent, large employers that are key components of the cluster. While these large firms provide an important foundation for the cluster, it is also critical to consider that most firms have fewer than 100 employees, with many establishments having under 10 employees. These smaller firms are often neglected by economic development policies and incentives that target larger establishments for business recruitment and workforce development activities. In contrast, the needs of smaller firms may vary and often require greater support in the form of access to capital and technical assistance.

As previously suggested, many of these small firms are recent start-ups. The importance of new business start-ups to economic growth has been well established (see Conroy, Chen, Chriestenson, Kures and Deller, 2018 for one summary of this research). High levels of business start-up activity signal a dynamic economy supportive of entrepreneurs. Start-ups of all sizes provide employment opportunities, but also have the opportunity to grow and scale to significant employment and revenue levels. Furthermore, even if a start-up does not succeed, an entrepreneur may have learned lessons from this experience that will help her or him in future ventures.

Compared to many other areas in the United States, the Madison Region has made significant gains in supporting entrepreneurs. Nonetheless, there are many opportunities to develop and grow the Region's entrepreneurial ecosystem. These opportunities partially arise from further recognizing that supporting entrepreneurs should have its foundation in human capital development. Entrepreneurs are "*people* (emphasis added) who design, produce and generate value through the creation or expansion of economic activity" (Ahmad and Hoffman, 2008). That is, the focus of an entrepreneurial ecosystem should be on developing people as they are the drivers of new ventures and are a source of human capital to be leveraged. Importantly, this definition of entrepreneurs includes those involved in many types of economic activities and are not restricted to the creation or expansion of businesses. As noted by Drucker (1985), entrepreneurial ventures are not limited to businesses, but can include non-profits, universities and government institutions.[6]

Furthermore, an entrepreneurial ecosystem should recognize that each entrepreneur may face unique needs related to technical assistance, access to capital or workforce development. Consequently, broad assumptions should not be made about how to best serve entrepreneurs. Instead, community leaders and economic developers should continue listening to the needs of existing and nascent firms in the health care cluster through one-on-one conversations or other learning opportunities.

Economic development professionals and elected officials should be particularly mindful of start-ups and second-stage firms that are going to scale. As firms grow to significant sizes, it may be that other regions or states will offer incentives for their relocations. However, a firm that is valued by its current community is less likely to move. Creating and maintaining relationships with fast-growing firms should be a clear

[6] This discussion of entrepreneurship and entrepreneurial culture is partially drawn from prior work by the author. See Kures, 2013 and Kures, 2014.

economic development strategy, but elected officials and other community leaders are often unaware of the importance of these firms as they may still be small enough to be missed (Zipper, 2016). Importantly, many of these conversations are already occurring in the Madison Region.

While the exact needs of individual entrepreneurs will vary, communities and EDOs can also broadly support entrepreneurship by creating an ecosystem where latent, new and existing entrepreneurs can succeed. In other words, the Region needs to continually enhance its entrepreneurial culture. While a detailed discussion of the Region's entrepreneurial culture is beyond the scope of this study, an entrepreneurial culture can be broadly described as one in which a community is aware of the importance of entrepreneurs to the local economy. It is open to new and different ideas and it accepts failure. It is willing to experiment. Ultimately, it encourages and supports a breadth of entrepreneurs.

More specifically, Hustedde (2007) and Macke et al (2014) maintain that an entrepreneurial culture and support system are fostered by:

- *Welcoming fresh voices and embracing diversity* – Communities often have preconceptions about entrepreneurs. In reality, not all entrepreneurs have the same vision or goals for starting a firm. Some entrepreneurs are interested in generating high-growth companies. Other individuals may desire a limited enterprise that supports a specific lifestyle. A nascent entrepreneur may have never started a company before, while another may be a serial entrepreneur who has started many companies. As previously noted, creating an entrepreneurial culture and support system for the health care cluster requires understanding the needs and motivations of many entrepreneurial types;

- *Creating opportunities to learn, question and think differently about entrepreneurship* - Too often in communities, entrepreneurship outreach and learning are delivered in a reactionary manner. For instance, individuals may be introduced to entrepreneurship in response to an economic shock such as a plant closing. Learning opportunities should occur proactively throughout the community and can start with young residents rather than waiting until they become adults. Importantly, learning opportunities are not just about developing existing and prospective entrepreneurs. Not everyone should be an entrepreneur and outreach also should stress how entrepreneurship is not a good fit for many people;

- *Mobilizing resources for entrepreneurs* – Resources can include technical assistance, access to capital, workforce development, broadband, business spaces, business support services, places to network and other forms of support;

- *Cultivating networks for entrepreneurs to thrive* – Entrepreneurs learn from each other, whether or not they are engaged in the same industry or produce a similar product. Connections can be fostered through entrepreneur networks, peer groups, mentors and advisory boards. These networks can occur in physical and virtual spaces;

- *Focusing on assets instead of deficits* – Too often communities focus on what is missing rather than what is present. Health care entrepreneurs in the Madison Region have access to many competitive assets such as a deepening talent pool, robust university resources, a growing number of entrepreneur networks, and other comparative advantages;

- *Building a shared vision about entrepreneurship* – Placing an emphasis on entrepreneurs does not mean that industry attraction or other economic development strategies should be abandoned. Instead, communities in the Region need a shared understanding about the importance of creating new firms and helping existing firms grow;

- *Fostering entrepreneurial leaders and advocates* – Communities need individuals and organizations who understand entrepreneurs and who can advocate for their needs. These leaders also tolerate failure and celebrate success.

While some areas of the Madison Region are actively and successfully pursuing these elements of developing an entrepreneurial culture, other areas have yet to fully embrace them. To fully grow the health care cluster (and other industry sectors), the Region will need to continue and expand these efforts.

Conclusions – Health Care Industries in the Madison Region

- Health care providers are a sizeable component of the Madison Region's economy, with 68,545 employees and almost 1,800 establishments. Ambulatory health care services is the largest category of health care providers with just over 27,000 employees and 1,265 establishments. Approximately, 26,900 employees are found in 27 hospitals, which reiterates that most hospitals are large employers and anchor intuitions within many communities, while nursing and residential care facilities contribute almost 14,600 employees. Finally, direct life, health, and medical insurance carrier industry has 5,335 employees in the Madison Region, bringing the grand total employment across all subsectors to **73,880**.

- While the health care provider industry has a sizeable number of total employees, health care provider employment is highly correlated with an area's population. In fact, there is almost a perfect correlation between a county's health care and social assistance employment and its population. These trends are important from an economic development strategy standpoint as health care providers as potential sources of new employment are primarily driven by population growth. However, this connection to population growth does not mean that there is a lack of opportunities to grow and develop the Region's health care cluster.

- Location quotients are near or below 1.0 for many health care provider categories in all counties. These values are not surprising given the aforementioned correlation between population and health care employment. Several location quotients below 0.75 are also expected in counties where patients may cross county lines to receive health care services. However, nursing and residential care facilities have location quotients well above 1.0 in several counties, which partially reflect the older populations in these counties. It is likely that these LQs could continue to grow as the Region's population becomes older.

- The presence of Epic Systems provides a growth pole for the Region's Health IT industry and is responsible for a large share of employment growth in the software publishers industry. While it is important not to overlook the importance of Epic Systems, the computer systems design and related services industry grew from 275 establishments in 2005 to 447 establishments in 2016; or an increase of 63 percent. Employment in computer systems design also grew by approximately 80 percent over this period;

- Between 2000 and 2011, the Madison Region averaged 43 start-up firms per year in the combined categories of computer systems design and software publishers. More recently, the Region has experienced significant growth in the number of new firms, with over 100 start-ups per year in 2012, 2015, and 2016. While these numbers may change due to revisions of the dataset, economic development professionals and elected officials should be particularly mindful of these start-ups (and second stage firms) as they scale their operations. As firms grow to significant sizes, it may be that other regions or states will offer incentives for their relocations. However, a firm that is valued by its current community is less likely to move. Creating and maintaining relationships with fast-growing

firms should be a clear economic development strategy, but community leaders are often unaware of the importance of these firms as they may still be small enough to be missed.

- The Madison Region's industry categories of drugs and pharmaceuticals and research and development in the physical, engineer and life sciences are among those that have consistently grown in employment, have notable scales, show significant location quotients and rank highly among other metro areas for total establishments. These two industries also account for 50% and 71% respectively of Wisconsin's total employment in these industry categories. Accordingly, these two health care and bioscience-related categories are additional sources of growth in Region's health care cluster. They also show the importance and prominence of the Madison Region in the state's overall health care related (and bioscience) industries.

- The employment changes in medical device and equipment manufacturing may surprise some readers, but are not necessarily unexpected. Despite these employment changes, the Madison Region remains an important location for the manufacturing of medical devices and equipment. Specifically the Madison MSA ranks 29th among all MSAs for electromedical and electrotherapeutic apparatus establishments; 20th in analytical laboratory instrument manufacturing establishments; and 12th for irradiation apparatus manufacturing establishments. The Madison MSA also has location quotients either above 1.25 or well above 1.25 in these three manufacturing categories. Accordingly, the 20 or so firms in this category comprise a notable niche in the Madison Region.

- Despite the presence of almost 50 establishments, the Madison MSA is not ranked in the top 50 metro areas for medical equipment and supplies manufacturing. Instead the Madison, WI MSA is ranked 78th in total establishments and has a location quotient of 1.09. Instead, the top metro areas for medical equipment manufacturing establishments include the large MSAs of New York, Los Angeles, Chicago, Miami, Minneapolis-St. Paul, Philadelphia, Dallas, Atlanta, San Francisco and Boston. Again, many of these areas are also highly ranked for pharmaceutical and drug manufacturing.

- As noted throughout this analysis, many establishments could potentially fit the definition of a second stage firm. Second-stage companies are distinct from other firms as they have survived the start-up process, but also reached a position where the complexity of running the company has exceeded the capacity of one owner or CEO. Nationally, second stage firms are the largest source of employment growth. However, these firms often fall between economic development efforts that look to generate start-ups and those that work with the retention and attraction of larger firms. While not all of these firms may want to grow, dedicated programs to support enterprises in this growth stage could provide a unique opportunity for the Region and fill a common gap in service provision.

- In addition to second stage firms, many additional health care related firms in the Madison Region have under 10 employees. While these numbers will change over time, economic development professionals and elected officials should be particularly mindful of these small firms (and second stage firms) as they scale their operations. As firms grow to significant sizes, it may be that other regions or states will offer incentives for their relocations. However, a firm that is valued by its current community is less likely to

move. Creating and maintaining relationships with fast-growing firms should be a clear economic development strategy, but community leaders are often unaware of the importance of these firms as they may still be small enough to be missed.

- While the exact needs of individual entrepreneurs will vary, communities and EDOs can also broadly support entrepreneurship by creating an ecosystem where latent, new and existing entrepreneurs can succeed. In other words, the Region needs to continually enhance its entrepreneurial culture. An entrepreneurial culture can be broadly described as one in which a community is aware of the importance of entrepreneurs to the local economy. It is open to new and different ideas and it accepts failure. It is willing to experiment. Ultimately, it encourages and supports a breadth of entrepreneurs. The Madison Region has made strides in fostering its entrepreneurial culture, but there are additional opportunities to grow this culture in many parts of the Region.

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Section 2 – Health Care Human Capital

As mentioned in the Introduction, all industry clusters depend on access to pools of human capital or skilled labor. While human capital is often measured in terms of the educational attainment acquired by the Region's labor force, education provides an incomplete perspective on a worker's knowledge and abilities as it only captures differences in vertical skills, or the amount of skill possessed by people. That is, a person's level of education does not specify the types of individual skills and talents that people possess (Marigee, Blum, and Strange, 2009). Instead, this analysis partially uses occupations to measure human capital. Occupations group employees by the common set of activities, technologies and tasks that they perform. Accordingly, occupations provide a better measure of the skills an employee offers, regardless of an individual's educational attainment or industry of employment.

In assessing human capital for the health care industry cluster, this section largely focuses on the health care provider labor force. Specific measures of health care provider labor force include occupational concentrations, talent diversity, age distribution, and employment churn. Several occupational measures related to bioscience and Health IT are also included for evaluation purposes. **However, readers desiring a more complete analysis of the bioscience and Health IT labor forces should consult the Madison Region's industry abstracts of the bioscience industry cluster and ICT industry cluster.**

Health Care Provider Occupational Structure

Health care provider industries broadly depend on diverse occupations related to health care practitioners, health care support; community and social services; management; personal services and professional and technical occupations. However, a more detailed examination of occupations can be considered using the Standard Occupational Classification (SOC) which classifies occupations based on job duties, skills, education, and/or training requirements. To examine specific occupations concentrated in each health care provider category, the 30 largest occupations by total employment are listed for each subsector in Figures 2.1 to 2.3. *Note that these figures are based on the manufacturing occupational distributions for health care providers as reported by the Bureau of Labor Statistics (BLS). Local occupational structures likely will vary in sub-categories of health care providers and within individual firms.* Nonetheless, the overall national distributions provide a starting point for determining the occupations that are commonly important to these industries.

Information on regional specialization for each occupation is provided by an occupational location quotient calculated for both the Madison and Janesville-Beloit metropolitan statistical areas (MSAs).[7] Each occupation's annual average wages in the metro areas are also provided alongside the industry's national average wage to provide some perspective on pay rates. While these MSAs only cover five counties in the study area, detailed occupational figures are not available for other counties in the Madison Region. Nonetheless, the wage rates found in the five counties covered in this analysis are partly indicative of wages in the Region's overall labor market.

[7] Section 1 provides an overview of location quotients.

Figure 2.1 - Ambulatory Health Care Service Occupations by Share of Industry Employment – Top 30 Occupations (2017)

SOC	Occupation Title	Job Zone	Percent of Industry Employment	Madison MSA LQ	Janesville-Beloit MSA LQ	U.S. Annual Average Wage	Madison MSA Annual Avg. Wage	Janesville-Beloit MSA Annual Avg. Wage
29-1141	Registered Nurses	3	7.46%	0.96	1.00	$70,280	$78,910	$66,950
31-9092	Medical Assistants	3	6.94%	0.93	1.09	$33,480	$36,700	$35,800
31-1011	Home Health Aides	2	6.14%	0.32	N/A	$23,850	$27,010	N/A
43-4171	Receptionists and Information Clerks	2	5.32%	1.07	1.54	$31,280	$29,200	$28,590
43-6013	Medical Secretaries	3	5.09%	0.48	0.51	$35,610	$38,380	$35,530
39-9021	Personal Care Aides	2	4.59%	1.03	1.09	$21,720	$24,200	$20,570
31-9091	Dental Assistants	3	4.43%	0.68	1.06	$38,610	$40,710	$36,460
29-2061	Licensed Practical and Licensed Vocational Nurses	3	2.98%	0.40	0.50	$44,790	$46,290	$45,750
29-2021	Dental Hygienists	3	2.85%	1.18	1.04	$74,900	$65,860	$66,010
43-9061	Office Clerks, General	2	2.72%	1.25	1.15	$34,360	$36,430	$34,060
29-1069	Physicians and Surgeons, All Other	5	2.63%	1.76	2.57	$237,890	$255,030	$260,310
43-3021	Billing and Posting Clerks	2	2.13%	0.40	0.44	$37,720	$39,700	$37,670
43-1011	First-Line Supervisors of Office and Admin Support Workers	3	2.03%	0.89	1.01	$55,220	$59,190	$52,260
29-1123	Physical Therapists	5	1.75%	0.97	1.03	$88,120	$80,220	$84,340
29-2041	Emergency Medical Technicians and Paramedics	3	1.74%	1.18	1.15	$34,000	$32,230	$41,640
31-1014	Nursing Assistants	2	1.67%	0.91	1.26	$28,400	$31,860	$27,570
29-2010	Clinical Laboratory Technologists and Technicians	2	1.59%	1.30	0.82	$50,650	$54,150	$45,990
43-6014	Secretaries and Administrative Assistants	3	1.58%	0.50	0.43	$35,340	$38,880	$34,970
11-9111	Medical and Health Services Managers	5	1.50%	0.99	1.24	$103,490	$110,440	$101,690
29-1021	Dentists, General	5	1.47%	0.97	1.04	$175,290	$212,680	$206,210
29-1171	Nurse Practitioners	5	1.44%	0.73	0.65	$107,090	$98,650	$105,480
29-1062	Family and General Practitioners	5	1.31%	0.56	N/A	$213,590	$234,410	$208,050
21-1018	Substance Abuse, Behavioral Disorder & Mental Health Counselors	4	1.17%	0.89	0.61	$47,070	$55,490	$46,130
43-4051	Customer Service Representatives	2	1.16%	1.40	1.55	$35,670	$37,680	$36,640
29-1071	Physician Assistants	5	1.02%	1.41	1.23	$104,420	$97,390	$102,910
31-9097	Phlebotomists	3	0.99%	1.40	N/A	$35,240	$34,530	N/A
29-2034	Radiologic Technologists	3	0.97%	1.09	0.94	$57,180	$58,440	$54,420
29-2099	Health Technologists and Technicians, All Other	3	0.85%	1.98	1.13	$43,190	$47,950	$46,050
29-2071	Medical Records and Health Information Technicians	3	0.80%	1.24	N/A	$37,590	$45,360	$35,940
31-2021	Physical Therapist Assistants	3	0.77%	0.53	1.06	$56,960	$47,020	$52,640

Source: Bureau of Labor Statistics, O*NET and Authors' Calculations

Figure 2.2 - Hospital Occupations by Share of Industry Employment – Top 30 Occupations (2017)

SOC	Occupation Title	Job Zone	Percent of Industry Employment	Madison MSA LQ	Janesville-Beloit MSA LQ	U.S. Annual Average Wage	Madison MSA Annual Avg. Wage	Janesville-Beloit MSA Annual Avg. Wage
29-1141	Registered Nurses	3	29.78%	0.96	1.00	$75,770	$78,910	$66,950
31-1014	Nursing Assistants	2	6.66%	0.91	1.26	$30,630	$31,860	$27,570
29-2010	Clinical Laboratory Technologists and Technicians	3	2.75%	1.30	0.82	$55,430	$54,150	$45,990
43-6013	Medical Secretaries	3	2.64%	0.48	0.51	$36,410	$38,380	$35,530
11-9111	Medical and Health Services Managers	5	2.10%	0.99	1.24	$120,420	$110,440	$101,690
29-2034	Radiologic Technologists	3	2.02%	1.09	0.94	$61,850	$58,440	$54,420
29-1069	Physicians and Surgeons, All Other	5	1.83%	1.76	2.57	$177,690	$255,030	$260,310
29-2061	Licensed Practical and Licensed Vocational Nurses	3	1.82%	0.40	0.50	$44,690	$46,290	$45,750
37-2012	Maids and Housekeeping Cleaners	2	1.82%	0.71	0.69	$27,400	$23,100	$20,180
29-1126	Respiratory Therapists	3	1.75%	0.70	0.71	$61,970	$62,540	$57,240
31-9092	Medical Assistants	3	1.57%	0.93	1.09	$34,840	$36,700	$35,800
29-1051	Pharmacists	5	1.31%	1.05	0.95	$122,840	$144,440	$124,440
43-4111	Interviewers, Except Eligibility and Loan	2	1.30%	N/A	N/A	$34,960	$34,730	N/A
29-2055	Surgical Technologists	3	1.29%	0.71	1.14	$47,620	$56,920	$52,170
29-2071	Medical Records and Health Information Technicians	3	1.22%	1.24	N/A	$45,430	$45,360	$35,940
43-9061	Office Clerks, General	2	1.22%	1.25	1.15	$35,820	$36,430	$34,060
37-2011	Janitors and Cleaners, Except Maids and Housekeeping Cleaners	2	1.17%	1.15	0.95	$29,190	$27,850	$27,100
29-2052	Pharmacy Technicians	3	1.11%	0.93	1.11	$38,100	$33,240	$31,520
29-1123	Physical Therapists	5	1.05%	0.97	1.03	$88,410	$80,220	$84,340
43-6014	Secretaries and Administrative Assistants	3	1.04%	0.50	0.43	$39,700	$38,880	$34,970
43-4051	Customer Service Representatives	2	0.95%	1.40	1.55	$35,800	$37,680	$36,640
29-2099	Health Technologists and Technicians, All Other	3	0.89%	1.98	1.13	$49,100	$47,950	$46,050
21-1022	Healthcare Social Workers	5	0.88%	1.14	0.86	$62,120	$50,010	$48,220
29-2041	Emergency Medical Technicians and Paramedics	3	0.79%	1.18	1.15	$37,940	$32,230	$41,640
43-1011	First-Line Supervisors of Office and Admin Support Workers	3	0.79%	0.89	1.01	$62,880	$59,190	$52,260
31-9097	Phlebotomists	3	0.76%	1.40	N/A	$33,770	$34,530	N/A
29-1171	Nurse Practitioners	5	0.75%	0.73	0.65	$111,650	$98,650	$105,480
29-2031	Cardiovascular Technologists and Technicians	3	0.74%	1.04	N/A	$56,510	$69,780	N/A
43-4171	Receptionists and Information Clerks	2	0.73%	1.07	1.54	$31,700	$29,200	$28,590
33-9032	Security Guards	2	0.72%	0.58	0.22	$35,980	$29,550	$34,100

Source: Bureau of Labor Statistics, O*NET and Authors' Calculations

Figure 2.3 - Nursing and Residential Care Facility Occupations by Share of Industry Employment – Top 30 Occupations (2017)

SOC	Occupation Title	Job Zone	Percent of Industry Employment	Madison MSA LQ	Janesville-Beloit MSA LQ	U.S. Annual Average Wage	Madison MSA Annual Avg. Wage	Janesville-Beloit MSA Annual Avg. Wage
31-1014	Nursing Assistants	2	23.71%	0.91	1.26	$27,290	$31,860	$27,570
39-9021	Personal Care Aides	2	12.40%	1.03	1.09	$24,220	$24,200	$20,570
29-2061	Licensed Practical and Licensed Vocational Nurses	3	8.21%	0.40	0.50	$46,850	$46,290	$45,750
29-1141	Registered Nurses	3	6.26%	0.96	1.00	$64,860	$78,910	$66,950
31-1011	Home Health Aides	2	5.02%	0.32	N/A	$24,590	$27,010	N/A
37-2012	Maids and Housekeeping Cleaners	2	3.56%	0.71	0.69	$23,510	$23,100	$20,180
35-3041	Food Servers, Non-restaurant	1	3.09%	0.56	N/A	$22,530	$21,600	$21,310
35-2012	Cooks, Institution and Cafeteria	2	2.78%	0.99	1.38	$26,950	$30,950	$29,680
39-9032	Recreation Workers	4	1.91%	0.63	1.52	$28,400	$26,540	$23,710
21-1093	Social and Human Service Assistants	4	1.63%	1.67	1.56	$30,800	$35,860	$45,220
39-9041	Residential Advisors	3	1.62%	0.67	0.62	$27,940	$27,140	$23,780
49-9071	Maintenance and Repair Workers, General	3	1.45%	1.16	1.12	$36,190	$41,330	$35,500
21-1018	Substance Abuse, Behavioral Disorder & Mental Health Counselors	4	1.28%	0.89	0.61	$39,980	$55,490	$46,130
39-1021	First-Line Supervisors of Personal Service Workers	3	1.14%	1.19	0.90	$39,110	$40,050	$43,330
11-9111	Medical and Health Services Managers	5	1.13%	0.99	1.24	$89,530	$110,440	$101,690
43-4171	Receptionists and Information Clerks	2	1.08%	1.07	1.54	$26,510	$29,200	$28,590
35-2021	Food Preparation Workers	1	1.01%	0.63	0.66	$23,240	$23,870	$23,830
35-3021	Combined Food Preparation and Serving Workers	1	0.94%	0.94	1.25	$22,710	$20,600	$21,140
43-9061	Office Clerks, General	2	0.83%	1.25	1.15	$32,040	$36,430	$34,060
39-9011	Childcare Workers	2	0.81%	0.63	N/A	$25,980	$25,590	$22,090
51-6011	Laundry and Dry-Cleaning Workers	1	0.81%	0.82	N/A	$23,430	$28,330	N/A
11-1021	General and Operations Managers	4	0.73%	0.82	0.66	$95,360	$125,630	$110,390
37-2011	Janitors and Cleaners, Except Maids and Housekeeping Cleaners	2	0.72%	1.15	0.95	$26,630	$27,850	$27,100
43-6014	Secretaries and Administrative Assistants	3	0.67%	0.50	0.43	$34,720	$38,880	$34,970
21-1022	Healthcare Social Workers	5	0.59%	1.14	0.86	$50,010	$50,010	$48,220
31-9092	Medical Assistants	3	0.58%	0.93	1.09	$28,320	$36,700	$35,800
35-1012	First-Line Supervisors of Food Preparation and Serving Workers	2	0.55%	0.86	1.50	$40,900	$34,580	$25,890
29-1123	Physical Therapists	5	0.52%	0.97	1.03	$92,000	$80,220	$84,340
11-9151	Social and Community Service Managers	4	0.51%	1.31	1.15	$66,320	$68,420	$61,710
21-1021	Child, Family, and School Social Workers	4	0.50%	0.83	0.60	$39,110	$51,720	$42,030

Source: Bureau of Labor Statistics, O*NET and Authors' Calculations

While each category of health care providers relies on a diversity of occupations, the overall industry has several occupations that are common across all three categories. These include: licensed practical and licensed vocational nurses; medical and health services managers; medical assistants; nursing assistants; office clerks; physical therapists; receptionists and information clerks; registered nurses and secretaries and administrative assistants. As expected, other specialized and important occupations in terms of their numbers and frequency include physicians and surgeons; nurse practitioners; radiologic technologists; emergency medical technicians and paramedics; health technologists and technicians; health care social workers; home health aides; medical records and health information technicians; medical secretaries; and phlebotomists. Some readers may be surprised that other key occupations, such as family and general practitioners, comprise a relatively small share of total employment in the sector. Nonetheless, these occupations are a foundation of the industry.

As noted in the Introduction, the magnitude of the health care provider industry tends to be very highly correlated with a region's population size. Given this correlation, it is not surprising that very few occupations have large location quotients. In fact, most occupation LQs in the Madison MSA and the Janesville-Beloit MSA are clustered between 0.75 and 1.25. Key exceptions include physicians and surgeons (1.76 and 2.57 in the Madison MSA and Janesville-Beloit MSA respectively); social and human service assistants (1.67 and 1.56); and health technologists and technicians (1.98 and 1.13). The high location quotients among surgeons likely reflects the Region's specialization in a variety surgery specializations.

Wages within the Madison MSA and Janesville-Beloit MSA are at or above the national average for most occupations. These differences may be partly attributed to the overall size of the health care sector in the Region. Key exceptions appear to include physical therapists, nurse practitioners, and physician's assistants. Importantly, the top 10 occupations in each category of health care providers are a mix of high and lower wage jobs. While many occupations in the industry have annual average wages above $100,000, other common health care occupations have annual average earnings of $40,000 or less. These varied wage rates reflect the diversity of skills and educational attainments needed in the health care industry. The diversity of wage rates are also important when considering how the industry depends on affordable housing and other measures of cost of living in the Region.

Common Occupations in Bioscience and Health IT

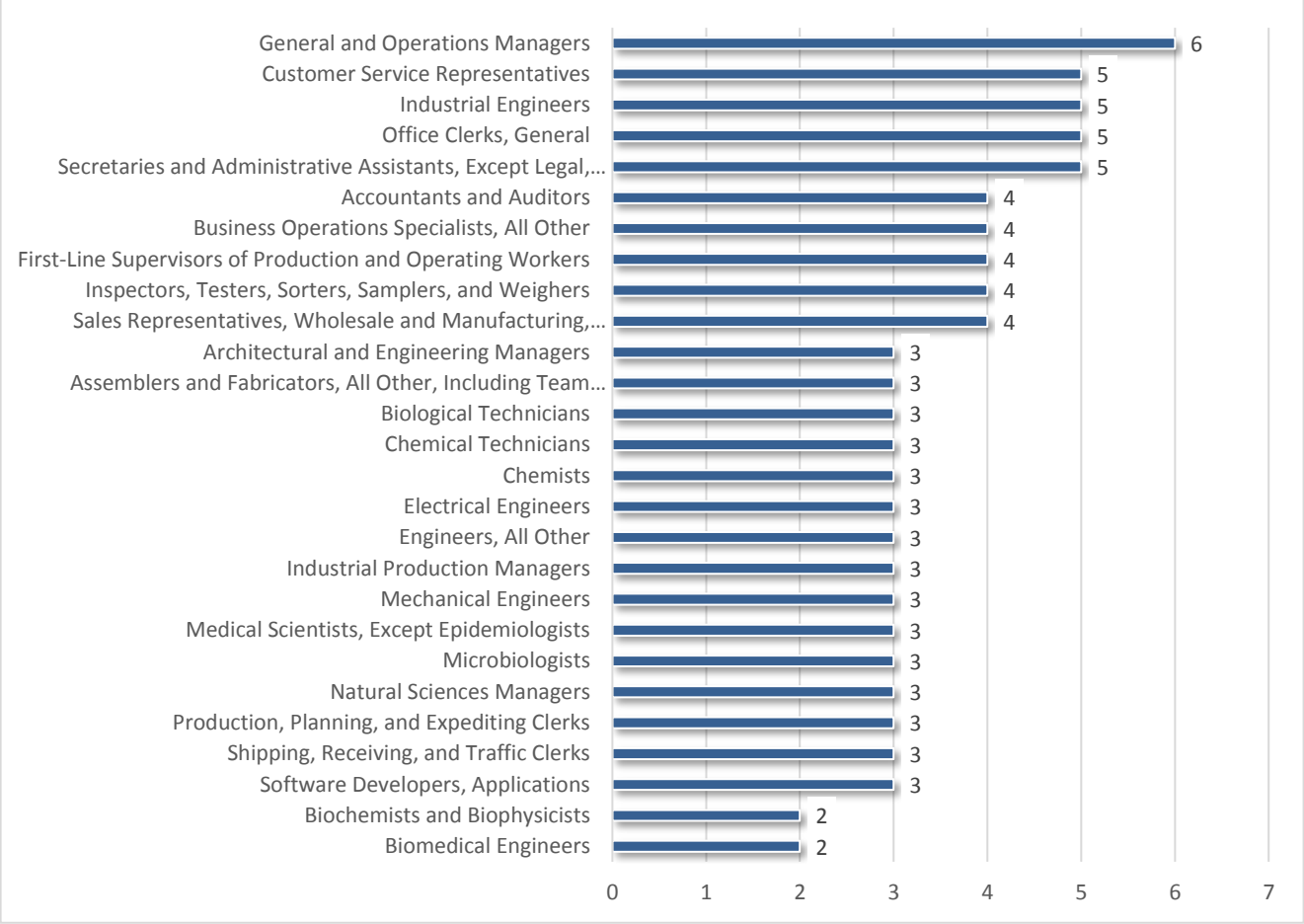
In addition to the distribution occupations among health care providers, the bioscience and health IT industries also have important concentrations of occupations that are foundations of the cluster. *Again, readers desiring a more complete analysis of the bioscience and health IT labor forces should consult the Madison Region's industry abstracts of the bioscience industry cluster and ICT industry cluster.*

While each bioscience industry relies on a diversity of occupations, the overall bioscience cluster has several occupations that are common across multiple subsectors. Occupations that span multiple categories could provide opportunities for joint talent development initiatives such as recruitment, DACUM efforts, and internships. The frequency of an individual occupation appearing in the top 30 occupations for each subsector of bioscience shows that several occupational categories are found in the top 30 for several subsectors (Figure

2.4). These occupations include management, customer service, industrial engineers, and office support. Other common occupations across the bioscience industry cluster include chemists and chemical technicians, mechanical engineers, and several production related occupations that are found in the manufacturing portions of the bioscience cluster (i.e. pharmaceutical manufacturing, electromedical devices, medical supplies, etc.).

Common occupations in bioscience industries also include medical scientists, microbiologists, biological technicians, biochemists and biophysicists, and biomedical engineers. While these occupations do not have large numbers like several other occupation categories, they drive the research and technical knowledge that are fundamental to the bioscience cluster.

Figure 2.4 – Bioscience Occupational Frequency – Number of Times an Occupation Appears in the Top 30 Occupations for Each Bioscience Industry Category



Source: Bureau of Labor Statistics and Author's Calculations

Sales and customer service occupations are also common across the bioscience industry cluster. Customer sales are driven by both in-house sales representatives or traveling sales reps. Due to the highly technical nature of many products produced by firms in the bioscience industry, particularly in pharmaceuticals and medical devices, salespeople often require extensive levels of training and product knowledge. They may often have an educational background in engineering or life science disciplines.

While management occupations are common in most industry sectors, bioscience and otherwise, the importance of management occupations in the bioscience cluster is often overlooked. Skilled managers and executives with expertise in a specific bioscience discipline are often a prerequisite for success. These individuals can help manage the unique regulatory aspects of the industry. They can efficiently operate diverse supply chains. They are also vital to raising capital that is often needed by small and mid-sized bioscience firms to achieve scale. Consequently, the recruitment and retention of these individuals in the Madison Region are important activities of the bioscience industry cluster.

For purposes of this analysis, health IT occupations are largely associated with computer and mathematical occupations that create the core of the information and communication technology (ICT) cluster. While not all of these occupations work directly in health IT related industries, the number and concentration of computer and mathematical occupations reflect the thickness of the labor market that is available to health IT firms. With more than 7,500 employees, software developers for applications are the largest category of computer occupations in the Madison MSA (Figure 2.5). Computer systems analysts, computer programmers and computer user support specialists also account for sizeable employment within the classification.

With a few exceptions, almost every detailed category of computer and mathematical occupation also has a location quotient above 1.0 in the Madison MSA. As a share of total Wisconsin computer and mathematical occupations, the Madison MSA has notably large percentages in computer and information research scientists, computer programmers, software developers for applications and statisticians. These categories show the prominence of the Madison MSA in application development and research in addition to providing services related to administration, security or support.

Figure 2.5 - Distribution of Computer and Mathematical Occupations in the Madison MSA (2016)

SOC	Occupation Title	Total Employment	Share of All Wisconsin Computer/Mathematical Occupations	Location Quotient
15-0000	Computer and Mathematical Occupations	23,750	31.7%	2.10
15-1111	Computer and Information Research Scientists	120	63.2%	1.66
15-1121	Computer Systems Analysts	3,630	28.4%	2.35
15-1122	Information Security Analysts	350	25.2%	1.34
15-1131	Computer Programmers	2,610	46.1%	3.54
15-1132	Software Developers, Applications	7,540	47.6%	3.49
15-1133	Software Developers, Systems Software	1,070	29.3%	0.96
15-1134	Web Developers	880	32.6%	2.49
15-1141	Database Administrators	570	32.2%	1.83
15-1142	Network and Computer Systems Administrators	1,370	19.5%	1.34
15-1143	Computer Network Architects	320	14.7%	0.75
15-1151	Computer User Support Specialists	2,440	21.1%	1.49
15-1152	Computer Network Support Specialists	1,290	31.4%	2.50
15-1199	Computer Occupations, All Other	890	25.3%	1.26
15-2011	Actuaries	210	31.8%	3.93
15-2031	Operations Research Analysts	250	17.4%	0.84
15-2041	Statisticians	210	44.7%	2.34

Source: Bureau of Labor Statistics Occupational Employment Statistics (OES) and Authors' Calculations

Within the Janesville-Beloit MSA, large relative concentrations of computer and mathematical occupations are found in computer user support specialists, computer systems analysts, and network and computer systems administration (Figure 2.6). These occupations are more likely to provide support within the health IT industry rather than provide development or research functions. However, the Janesville-Beloit MSA does have 200 software developers for applications.

Figure 2.6 - Distribution of Computer and Mathematical Occupations in the Janesville-Beloit MSA (2016)

SOC	Occupation Title	Total Employment	Share of All Wisconsin Computer/Mathematical Occupations	Location Quotient
15-0000	Computer and Mathematical Occupations	1,090	1.5%	0.57
15-1121	Computer Systems Analysts	170	1.3%	0.63
15-1131	Computer Programmers	40	0.7%	0.34
15-1132	Software Developers, Applications	200	1.3%	0.54
15-1133	Software Developers, Systems Software	40	1.1%	0.19
15-1134	Web Developers	30	1.1%	0.51
15-1142	Network and Computer Systems Administrators	140	2.0%	0.82
15-1143	Computer Network Architects	30	1.4%	0.45
15-1151	Computer User Support Specialists	240	2.1%	0.87
15-1152	Computer Network Support Specialists	80	1.9%	0.90
15-1199	Computer Occupations, All Other	80	2.3%	0.62

Source: Bureau of Labor Statistics Occupational Employment Statistics (OES) and Authors' Calculations

Occupations by Job Zone

Each occupation is associated with a *Job Zone* from the Occupational Information Network (O*NET). Job Zones provide information on the usual types of preparation needed for given occupations within an industry. Job Zones also suggest the typical length of time workers need to acquire information, learn techniques, and develop the capacity needed for average performance in these occupations. Note that training may be acquired in a variety of environments (vocational education, apprenticeship training, on-the-job, etc.) and does not include the orientation time required to become a fully-qualified worker or accustomed to special conditions of a job.

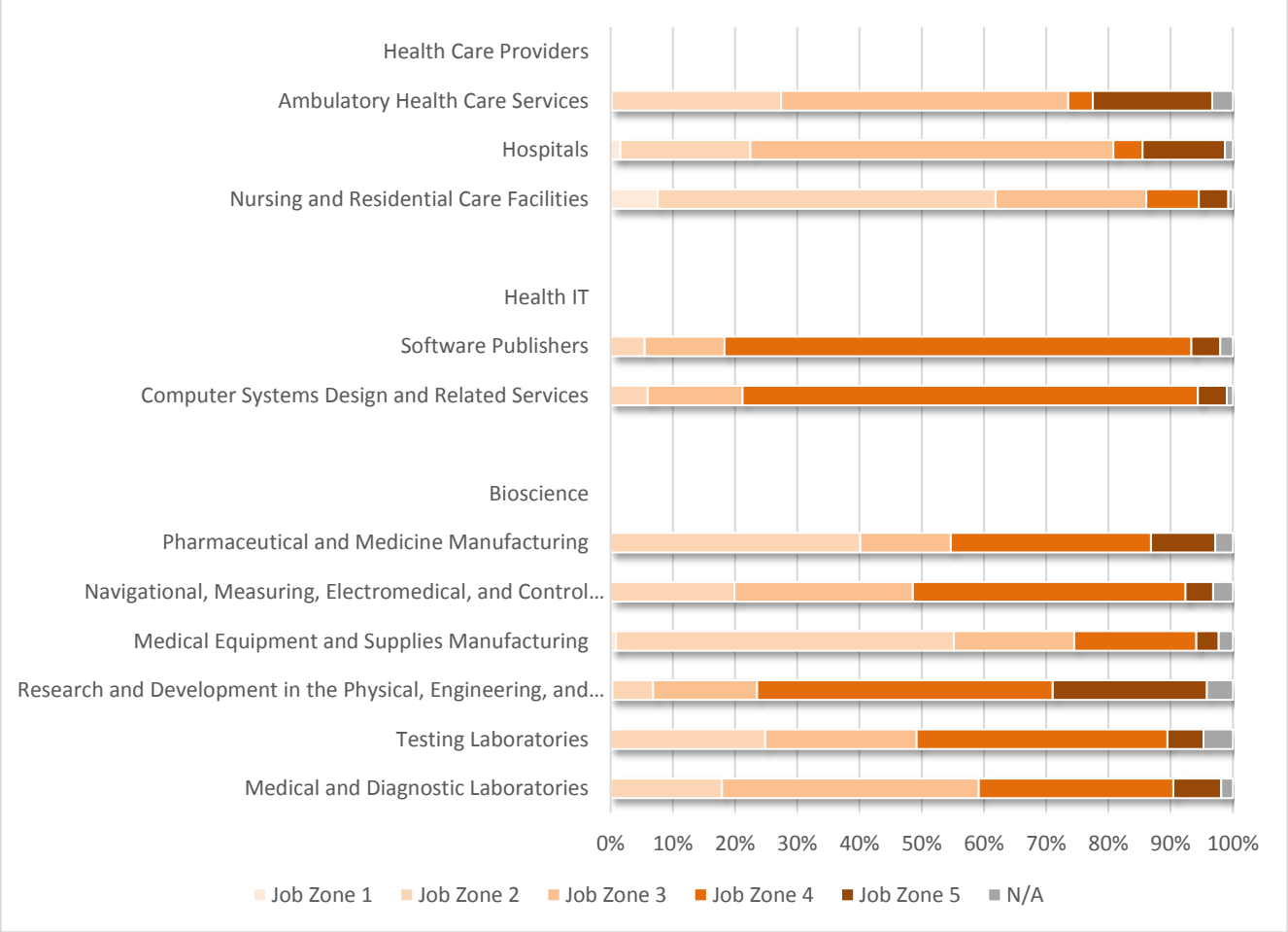
Occupations in Job Zone 1 have lower preparation requirements and occupations in Job Zone 5 require the largest amount of preparation (see Appendix 2A for more on Job Zones). Again, the levels of educational attainment and training for each job zone are "typical" and there are exceptions to these requirements. Nonetheless, the typical levels of educational attainment are important when considering factors concerning: 1) the capacities of the Region's educational system, 2) developing the Region's talent pipeline, and 3) retention and recruitment efforts.

Ambulatory health care services and hospitals are dominated by occupations found in Job Zone 3 (Figure 2.7). Accordingly, many of these jobs require some sort of post-secondary training, such as a certification or an

Associate's degree, but do not necessarily require a Bachelor's degree or higher. These Job Zone distributions may surprise some readers unfamiliar with the health care industry. That is, we often associate health care with physicians and other occupations that require advanced levels of education and training. However, the industry depends heavily upon individuals with a breadth of post-secondary educational attainments.

Nursing and residential care facilities also have a notable share of occupations found in Job Zone 3, but its largest shares are found in Job Zone 2. While many of these occupations require specific types of skills and training, many of these skills can be acquired without formal post-secondary credentials. The high share of occupations in Job Zone 2 is also reflected in the lower relative wages found in the nursing and residential care facility industry. Importantly, these wages may present a challenge in attracting workers with lesser levels of education who may have many other employment options, especially in a tight labor market such as that of the Madison Region.

Figure 2.7 – Health Care Industry Cluster Occupations by Job Zone



Source: BLS, (O*NET) and Authors' Calculations

The bioscience industry is highly reliant upon employment in occupations classified in Job Zone 3, Job Zone 4 and Job Zone 5. Indeed, the four categories of navigational, measuring, electromedical, and control instruments manufacturing; research and development in the physical, engineering, and life sciences; testing laboratories; and medical and diagnostic laboratories all have 70% or more of their employment in Job Zone 3

or higher. As these industries tend to have the highest education and training requirements, it should not be surprising that these bioscience subsectors often have the highest average wages as well.

While the bioscience industry cluster is dependent on occupations that require higher levels of skill and education, a number of categories also provide opportunities for individuals working in occupations in Job Zone 2. Pharmaceutical and medicine manufacturing; medical equipment and supplies manufacturing; and chemical manufacturing all have 40% to 55% of their employment concentrated in occupations with Job Zone 2. These concentrations of workers in Job Zone 2 should not necessarily suggest that these categories of the bioscience industry are reliant on unskilled workers. Instead, many of these occupations require specific skills and involve detailed training. As a result, these occupations also tend to pay greater wages than occupations with Job Zone 2 found in many other industries. Accordingly, the bioscience cluster also provides a diversity of employment opportunities for people across the skill and education continuums.

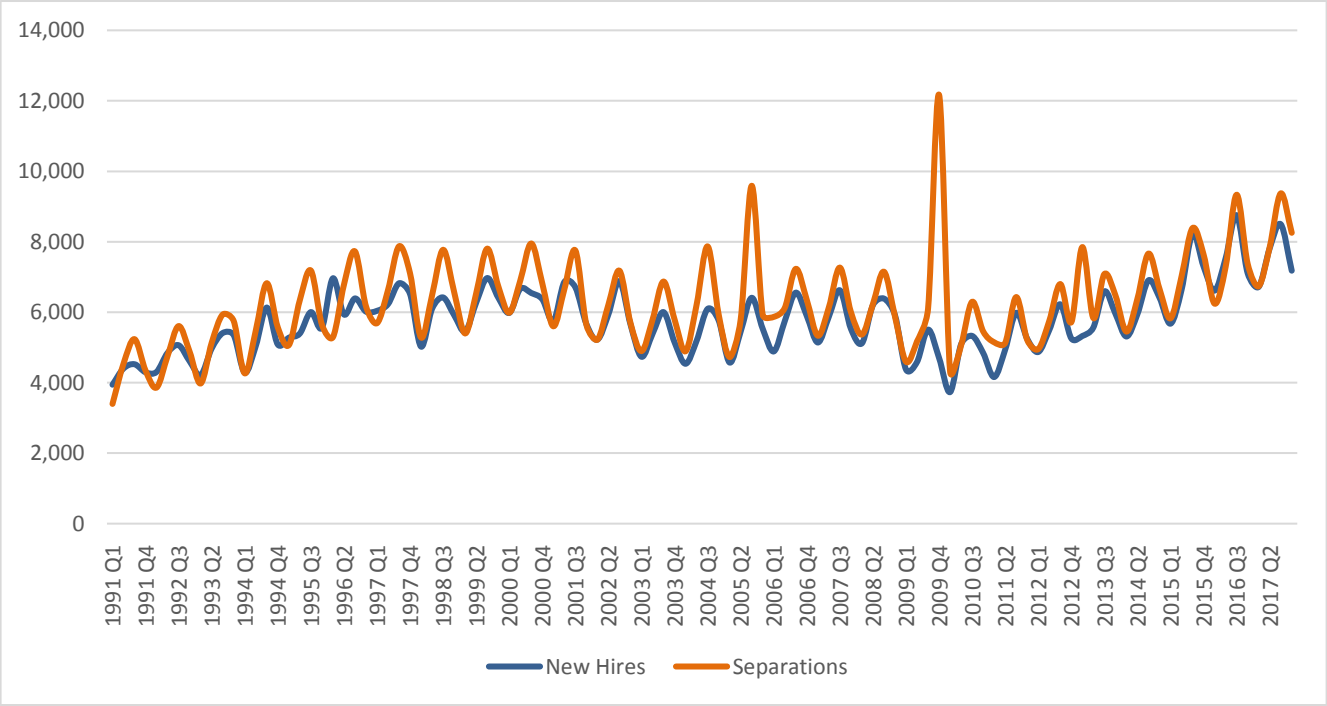
Compared to other industries, health IT related industries have a significant amount of their employment found in Job Zone 4 and Job Zone 5 (Figure 2.10). These concentrations suggest that 50% to 70% of employees in these industries require significant training and educational attainments of at least a Bachelor's degree. Those occupations that do not require a Bachelor's degree or higher still require some formal type of post-secondary education in the form of an Associate's degree or a post-secondary certificate. These Job Zone distributions reinforce the importance of human capital as a primary driver of success in health IT.

Employment Churn and Age Structure in Health Care Provider Industries

The health care provider employment trends in Section 1 show the largely positive nature of job growth in the industry. However, total employment trends should not be viewed as the only means of measuring demand for labor among health care providers. Job separations occur regularly as workers leave firms for other employment opportunities. Workers also may retire or exit the labor force for various reasons. Consequently, hires can occur in establishments that are expanding, contracting, or staying the same size simply for purposes of worker replacement. In fact, most hiring and separations reflect *churn* within an industry, rather than the overall expansion or contraction of the industry. More specifically, churn is defined as the simultaneous hiring and separation within an industry (Hyatt and Spletzer 2013).

Data on employment churn specific to each health care provider category is unavailable for every county in the Madison Region. However, data on new hires and separations for the entire health care and social assistance sector are available and serve as a proxy for industry subsectors. As the industry grew between 1991 and 2000, both new hires and separations also increased (Figure 2.8).[8] With the turn of the century, new hires and separations first declined somewhat in 2001 and then remained largely consistent between 2002 and 2007. The exception to this trend is a large spike in separations in 2005. It is unknown whether this spike is due to an establishment closure, the re-classification of a firm or an anomaly in the dataset. New hires and separations again declined with the beginning of the Great Recession, but have resumed their growth since 2010. Again, there is a notable spike in separations in Q4 2009. The exact reason for this outlier is unidentified.

Figure 2.8 – Health Care and Social Assistance New Hires and Separations by Quarter – 1991 to 2017



Source: U.S. Census Bureau LEHD and Authors' Calculations

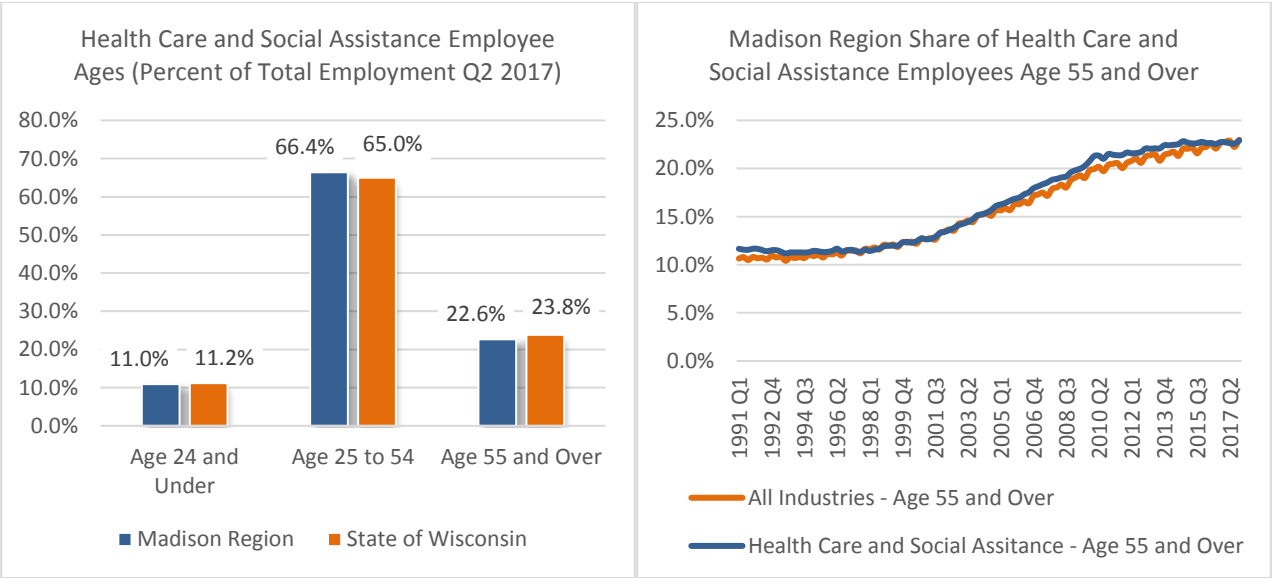
[8] New hires are workers who started a new job with an employer and were not employed by that employer in any of the previous four quarters. These figures do not include workers who returned to the same employer where they had worked within the previous year (such as those who may have been recalled from a layoff or work stoppage).

The movements in new hires and separations reflect the Region's overall trend in health care and social assistance employment. However, most quarters saw health care providers accounting for 6,000 or more new hires. Even at the lowest point over this time period (Q1 2010), the Region still had 3,700 new hires. More recently, the Madison Region reported between 7,000 and 9,000 new hires and separations per quarter. These current levels of new hires are the highest in more than two decades.

The growth in new hires and separations shows the current strength of the industry in the Region, but also suggests that employees may have more confidence in their employment prospects. That is, employees are often more willing to change jobs when the economy offers greater opportunities to advance careers or increase wages. While job hopping is not ideal to employers, many companies understand that talent coming from other employers also bring new knowledge and ideas from their prior employer that may benefit a company. Higher levels of employment churn also offer opportunities for firms to examine their internal working environment and wages. If employers are in fact experiencing higher levels of employee turnover, they may want to consider whether their wages, benefits and work environment are competitive relative to other firms in the Region. Furthermore, employers may want to also consider the costs of employee turnover relative to wage increases.

Employees leave their workplace for many reasons such as layoffs, new employment opportunities, schooling, and child care needs. One looming issue facing employers in the Madison Region is the share of workers that may leave the labor force as they reach retirement age. Almost 23 percent of health care and social assistance employees in the Madison Region and the State of Wisconsin were age 55 older in 2017 (Figure 2.9). Furthermore, the share of the overall health care workforce age 55 and over has almost doubled over the past two decades.

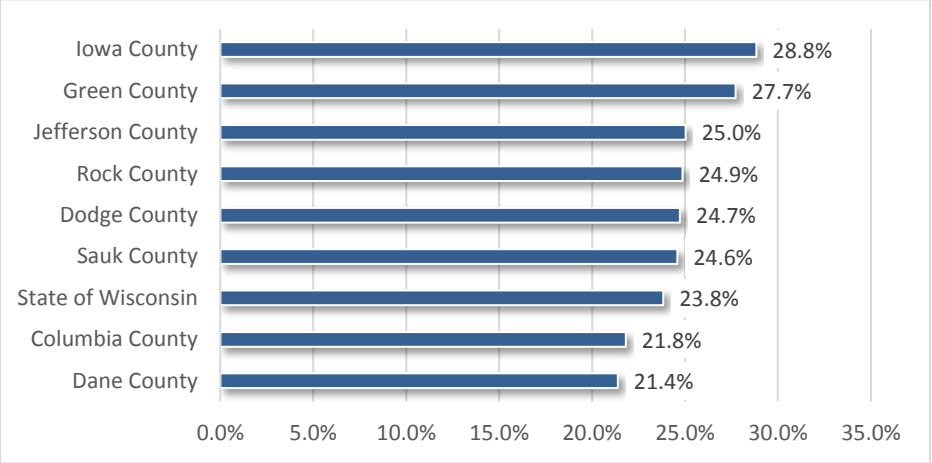
Figure 2.9 – Health Care and Social Assistance Employee Age Structure and Share of All Health Care and Social Assistance Employees Age 55 and Over



Source: U.S. Census Bureau LEHD and Authors' Calculations

When compared to the State of Wisconsin, the Madison Region has a somewhat smaller share of employees age 55 and over. However, these differences are largely driven by the smaller share of workers age 55 and older in Dane County. Instead, most counties have a higher share of their health care workers age 55 and older than the state average. Iowa County and Green County have the highest shares at 28.8% and 27.7% respectively. Nonetheless, every county has at least 20% of its labor force comprised by workers age 55 and over (Figure 2.10). Accordingly, the Region's health care provider industry will need to consider how to replace these workers over the next decade or more.

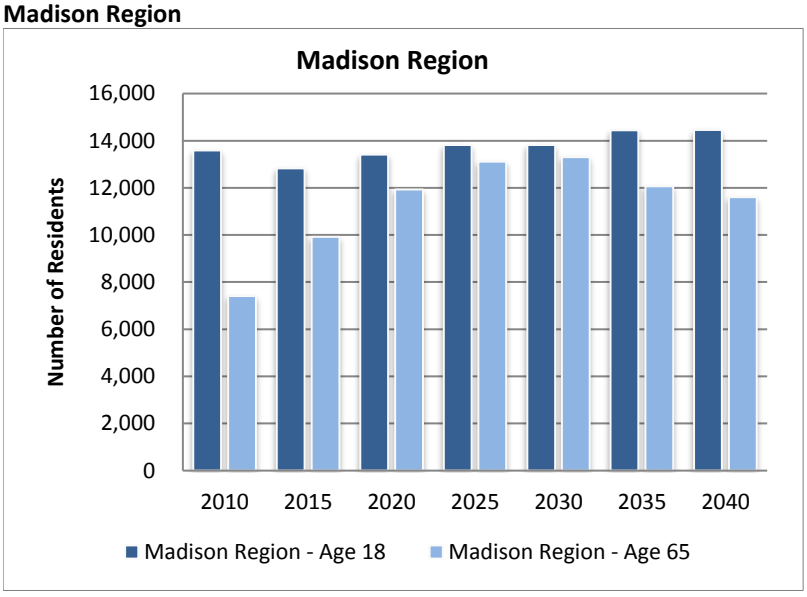
Figure 2.10 – Share of Employees Age 55 or Over in Health Care and Social Assistance by County (Q2 2017)



Source: U.S. Census Bureau LEHD and Authors' Calculations

The growing share of health care workers age 55 and over reflects an overall aging of the labor force in the Region. To illustrate potential changes in labor force age structure, Figure 2.11 provides estimates on the number of residents turning age 18 and age 65 in the Madison Region over a 30-year period. Age 18 and age 65 provide proxies for when individuals may respectively enter and exit the labor force. Certainly workers may start a job before age 18 and continue to work past age 65, but these ages provide a beginning point for comparing worker availability. In 2010, there were almost twice as many residents turning age 18 as those turning age 65 in the Madison Region. By 2025, there are approximately as many people turning age 65 as those turning age 18. Specific trends will vary by individual county, but even Dane County faces an aging workforce despite the large number of young residents contributed annually to the area by UW-Madison. *Importantly, the aging population will also place further stresses on the health care provider industry in terms of additional demand for services.*

Figure 2.11 – Convergence of the Population Age 18 and Age 65 in the Madison Region



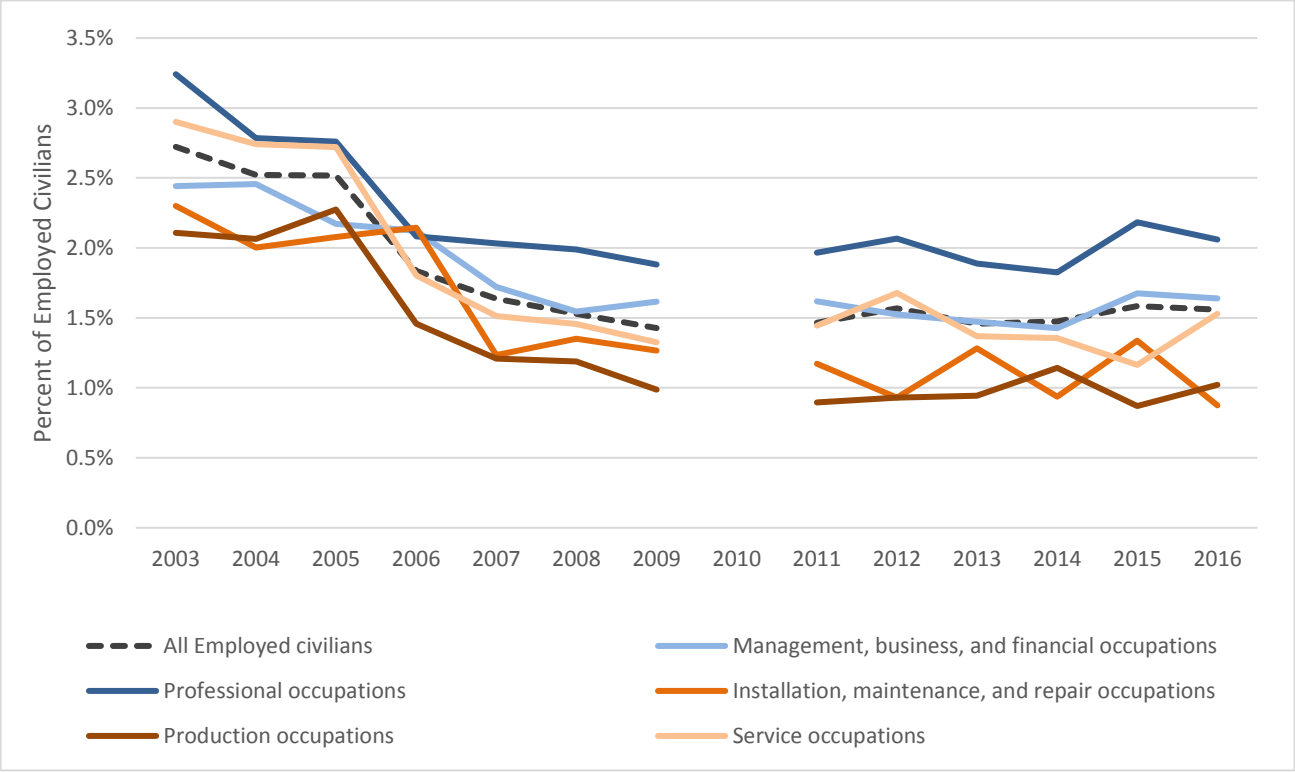
Source: Wisconsin Deparment of Administration Demographic Services Center and Authors' Calculations

Labor Mobility

As the Madison Region's health care industry considers how to meet its future labor force demands, it will likely need to consider how to attract talent from outside the Region while also growing its internal pipeline within the Region. More specifically, there is a distinct difference in the mobility of individuals working in different occupations. In terms of moves across state lines, professional occupations (such as engineers and computer occupations) tend to be the most mobile of any occupational category, while service occupations that include many health care related categories tend to be less mobile (Figure 2.12). Production and installation, maintenance and repair occupations, which are common in several health care provider and bioscience industry categories, are among the least mobile.

The mobility trends in Figure 2.12 also show how mobility rates have declined across all occupational categories. These declining mobility rates are part of larger societal trend in the United States where moves of all types have dropped over the last several decades. These mobility trends of people working in different occupations have two important characteristics: First, talent attraction efforts may help to fill professional or technical occupations, but it is less likely that many categories of service workers will be attracted to the Madison Region from outside the state. Physicians, surgeons and other highly educated service occupations are a likely exception. Green County and Rock County may be also be outliers to this observation given their location on the Illinois state line. Consequently, talent development initiatives for many service and production occupations will likely need to emphasize a "grow your own" approach. Second, broad declines in mobility suggest that fewer people are moving overall and efforts to attract people from outside of Wisconsin will need to recognize the factors that motivate those people that do move.

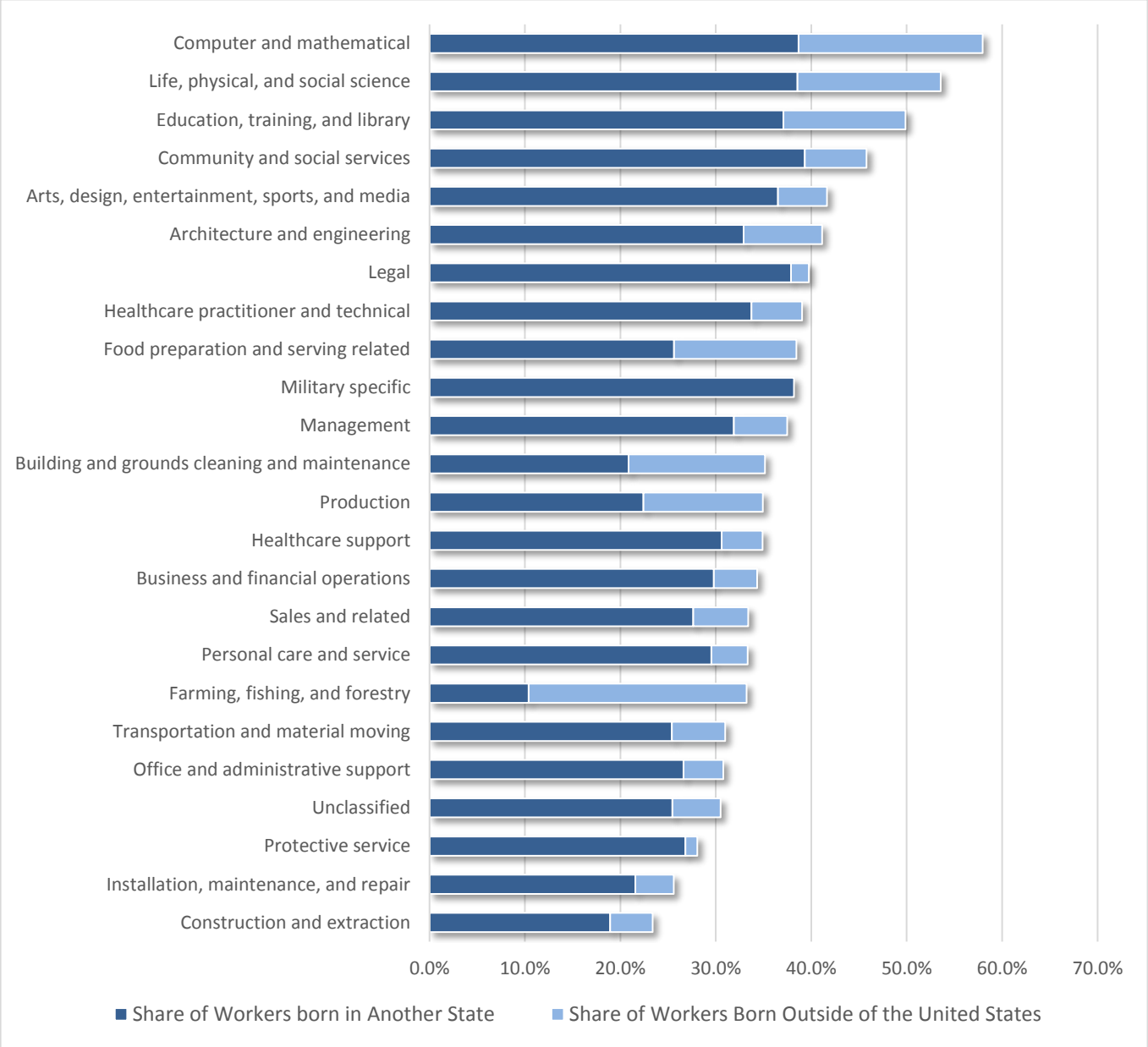
Figure 2.12 - Share of Employed Civilians Moving Across State Lines by Occupation (2003 to 2015)



Source: BLS/Census Bureau Current Population Survey and Authors' Calculations

While the figures depicted in Figure 2.12 are national trends, the origins of individuals working in different occupations can also be considered for the Madison Region. Specifically, individuals in various occupations can be identified by their place of birth. *When compared to other occupations in the Madison Region, computer and mathematical; life physical and social science; engineering; and health care practitioner occupations have among the highest share of individuals who were either born in another state or born outside of the United States (Figure 2.13).* In contrast, health care support; production occupations; and installation, maintenance and repair occupations have a much lower share of residents born in another state or another country. If only those people born in another state are considered, production occupations and installation, maintenance and repair occupations have among the lowest shares.

Figure 2.13 – Place of Birth by Occupation for the Madison Region – Share of Workers born in Another State or Outside of the United States



Source: American Community Survey data extracted from IPUMS-USA, University of Minnesota, www.ipums.org and Authors' Calculations

Why are statistics on places of birth important? First, they suggest that many individuals are less likely to have been born in Wisconsin and moved to the Region at some point in their lives. While some of these individuals may have moved to the Region when they were very young or resided in the Region for some time, the measure suggests that that the national occupational mobility characteristics in Figure 2.12 are somewhat present in the Madison Region. Consequently, external talent attraction and retention efforts are more likely to be effective for professional and health care practitioner occupations and internal efforts have a greater priority for health care support and production occupations.

Second, the State of Wisconsin has one of the highest share of residents who were born in their state of residence. *Specifically, over 70% of the people who live in Wisconsin were also born here*. This high share of native residents also extends to many portions of the Madison Region. This raises the question of how the Region considers newcomers. That is, do we embrace residents who may not be native Wisconsinites or do we have an in-group preference for people who may be long term residents? As part of the survey process for this report, several of individuals interviewed who had relocated to the Region indicated they experienced problems breaking into established friend groups. Therefore, the inclusivity of the Region should be considered with regards to talent retention.

Despite the overall downward mobility rates across all occupational categories, the young, educated demographic remains one of the most mobile among all age groups and levels of educational attainment. The Madison Region has been successful in attracting this demographic more so than any other place in Wisconsin. However, this demographic is also increasingly targeted by talent attraction and retention initiatives by states and regions across the United States. While many of these efforts are misguided, the competition for talent will continue. For the Madison Region to continue its success in attracting and retaining talent, it needs to continue to build on those assets and qualities.

In terms of talent attraction and retention efforts that focus on individuals living outside of Wisconsin, efforts that focus on health care practitioners, engineers, life science and computer occupations may be the most relevant to the health care sector. Many of these occupations are highly sought after. In the Region, many 4-year and 2-year institutions have world class programs to develop individuals in these occupational categories. However, it is likely that local firms in a variety of health care industries will also need to look beyond the Region to meeting their needs in occupations requiring highly educated individuals.

While individuals have many considerations when choosing a place to work, wages and labor market thickness are two important factors. In considering labor market thickness (i.e. the number of jobs present in a region) and wages for several health care practitioner occupations, Figures 2.14 to 2.17 list annual average wages in the metropolitan areas with the 50 largest numbers of surgeons, nurse practitioners, physician's assistants and registered nurses. Note that similar comparisons for other occupations of interest in available health care practitioner categories compare favorably as well. As these values are averages rather than median annual wages, it could be that these earnings are skewed by several high values. Nonetheless, it may be that the Region is well positioned from a wage perspective to recruit these occupations, especially when considering differences in costs of living. However, there may be other factors that make the Region somewhat less competitive that are not reflected in these numbers.

Figure 2.14 – Annual Avg. Wages for Surgeons and Physicians (Not Family or General Practitioners) - Metro Areas with the 50 Most Surgeons in 2017 (Ranked by Annual Average Wage)

Rank	Metropolitan Statistical Area	Total in 2017	Location Quotient in 2017	Annual Average Wage in 2017
1	Austin-Round Rock, TX	1,590	0.64	$275,480
2	Birmingham-Hoover, AL	2,350	1.87	$269,770
3	Virginia Beach-Norfolk-Newport News, VA-NC	1,540	0.83	$267,400
4	Nashville-Davidson--Murfreesboro--Franklin, TN	2,460	1.05	$266,420
5	Richmond, VA	1,550	0.97	$264,790
6	Denver-Aurora-Lakewood, CO	1,520	0.42	$260,780
7	San Jose-Sunnyvale-Santa Clara, CA	1,740	0.64	$255,830
8	Minneapolis-St. Paul-Bloomington, MN-WI	2,870	0.60	$255,260
9	**Madison, WI**	**1,700**	**1.76**	**$255,030**
10	Tampa-St. Petersburg-Clearwater, FL	3,000	0.94	$254,520
11	Atlanta-Sandy Springs-Roswell, GA	5,600	0.86	$244,600
12	Las Vegas-Henderson-Paradise, NV	1,610	0.67	$241,830
13	Milwaukee-Waukesha-West Allis, WI	2,080	0.99	$241,590
14	Seattle-Tacoma-Bellevue, WA	4,760	0.98	$239,020
15	Sacramento--Roseville--Arden-Arcade, CA	1,530	0.64	$238,010
16	Phoenix-Mesa-Scottsdale, AZ	4,290	0.87	$237,180
17	Kansas City, MO-KS	2,340	0.89	$234,110
18	San Antonio-New Braunfels, TX	2,150	0.86	$233,700
19	Riverside-San Bernardino-Ontario, CA	2,330	0.65	$232,620
20	Indianapolis-Carmel-Anderson, IN	5,380	2.10	$231,760
21	Los Angeles-Long Beach-Anaheim, CA	9,600	0.64	$230,640
22	San Diego-Carlsbad, CA	3,830	1.07	$228,800
23	Charlotte-Concord-Gastonia, NC-SC	2,760	0.93	$226,890
24	Providence-Warwick, RI-MA	2,440	1.72	$226,780
25	Akron, OH	1,580	1.94	$225,130
26	Cleveland-Elyria, OH	2,950	1.15	$221,650
27	Buffalo-Cheektowaga-Niagara Falls, NY	1,960	1.44	$221,400
28	St. Louis, MO-IL	2,590	0.76	$218,360
29	Hartford-West Hartford-East Hartford, CT	2,350	1.62	$217,750
30	Allentown-Bethlehem-Easton, PA-NJ	1,500	1.68	$214,430
31	Orlando-Kissimmee-Sanford, FL	2,790	0.93	$211,010
32	Columbus, OH	2,940	1.13	$209,950
33	New Orleans-Metairie, LA	1,810	1.32	$204,330
34	Miami-Fort Lauderdale-West Palm Beach, FL	5,020	0.79	$203,110
35	Baltimore-Columbia-Towson, MD	3,930	1.16	$201,870
36	Boston-Cambridge-Nashua, MA-NH	12,090	1.78	$193,690
37	Washington-Arlington-Alexandria, DC-VA-MD-WV	9,630	1.24	$192,030
38	Dallas-Fort Worth-Arlington, TX	5,600	0.64	$190,730
39	Albany-Schenectady-Troy, NY	1,480	1.33	$190,260
40	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	10,620	1.51	$188,330
41	Houston-The Woodlands-Sugar Land, TX	4,640	0.64	$184,670
42	Chicago-Naperville-Elgin, IL-IN-WI	8,090	0.71	$183,270
43	Portland-Vancouver-Hillsboro, OR-WA	3,270	1.13	$180,290
44	New York-Newark-Jersey City, NY-NJ-PA	48,040	2.07	$179,130
45	Cincinnati, OH-KY-IN	2,440	0.93	$172,730
46	Oklahoma City, OK	1,770	1.17	$169,280
47	San Francisco-Oakland-Hayward, CA	5,680	0.96	$159,620
48	Pittsburgh, PA	4,410	1.56	$158,840
49	Detroit-Warren-Dearborn, MI	9,170	1.87	$148,120
50	Rochester, NY	1,480	1.16	$148,050

Source: Bureau of Labor Statistics Occupational Employment Statistics (OES) and Authors' Calculations

Figure 2.15 – Annual Avg. Wages for Nurse Practitioners - Metro Areas with the 50 Most Nurse Practitioners in 2017 (Ranked by Annual Average Wage)

Rank	Metropolitan Statistical Area	Total in 2017	Location Quotient in 2017	Annual Average Wage in 2017
1	San Francisco-Oakland-Hayward, CA	2,450	0.89	$138,380
2	Los Angeles-Long Beach-Anaheim, CA	4,260	0.60	$128,220
3	Houston-The Woodlands-Sugar Land, TX	2,540	0.74	$126,380
4	Sacramento--Roseville--Arden-Arcade, CA	730	0.66	$124,820
5	Rochester, MN	1,140	8.49	$124,690
6	Durham-Chapel Hill, NC	760	2.18	$124,420
7	Boston-Cambridge-Nashua, MA-NH	4,560	1.43	$123,580
8	New York-Newark-Jersey City, NY-NJ-PA	12,600	1.16	$122,850
9	Riverside-San Bernardino-Ontario, CA	1,350	0.81	$119,360
10	San Diego-Carlsbad, CA	1,350	0.81	$118,560
11	Baltimore-Columbia-Towson, MD	2,340	1.47	$116,070
12	Portland-Vancouver-Hillsboro, OR-WA	910	0.67	$115,030
13	Minneapolis-St. Paul-Bloomington, MN-WI	1,950	0.86	$112,700
14	Hartford-West Hartford-East Hartford, CT	940	1.39	$112,390
15	Seattle-Tacoma-Bellevue, WA	1,890	0.83	$112,130
16	Providence-Warwick, RI-MA	810	1.22	$109,420
17	Indianapolis-Carmel-Anderson, IN	1,530	1.28	$108,650
18	Dallas-Fort Worth-Arlington, TX	3,190	0.78	$108,290
19	Washington-Arlington-Alexandria, DC-VA-MD-WV	2,600	0.72	$108,270
20	Denver-Aurora-Lakewood, CO	1,570	0.93	$108,120
21	Memphis, TN-MS-AR	1,110	1.54	$107,080
22	Atlanta-Sandy Springs-Roswell, GA	2,900	0.95	$106,430
23	Virginia Beach-Norfolk-Newport News, VA-NC	900	1.03	$106,110
24	Jackson, MS	740	2.41	$104,880
25	Detroit-Warren-Dearborn, MI	1,770	0.77	$104,080
26	Austin-Round Rock, TX	800	0.69	$103,710
27	Chicago-Naperville-Elgin, IL-IN-WI	3,320	0.62	$103,170
28	Phoenix-Mesa-Scottsdale, AZ	2,290	0.99	$102,840
29	Cincinnati, OH-KY-IN	1,260	1.02	$102,540
30	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	3,580	1.09	$101,610
31	Columbus, OH	1,230	1.02	$101,520
32	Louisville/Jefferson County, KY-IN	1,110	1.47	$101,340
33	Milwaukee-Waukesha-West Allis, WI	960	0.98	$101,030
34	Kansas City, MO-KS	1,550	1.26	$100,870
35	Cleveland-Elyria, OH	2,020	1.68	$100,710
36	Salt Lake City, UT	870	1.08	$100,020
37	Miami-Fort Lauderdale-West Palm Beach, FL	2,940	0.98	$99,590
38	Buffalo-Cheektowaga-Niagara Falls, NY	820	1.28	$98,660
39	Birmingham-Hoover, AL	1,050	1.79	$98,290
40	Richmond, VA	1,140	1.51	$98,180
41	Charlotte-Concord-Gastonia, NC-SC	820	0.60	$97,620
42	Rochester, NY	1,000	1.68	$97,420
43	San Antonio-New Braunfels, TX	1,120	0.96	$96,660
44	Orlando-Kissimmee-Sanford, FL	1,280	0.91	$96,490
45	St. Louis, MO-IL	2,070	1.31	$95,100
46	Pittsburgh, PA	1,260	0.95	$93,930
47	Knoxville, TN	1,210	2.72	$93,920
48	Tampa-St. Petersburg-Clearwater, FL	1,680	1.13	$93,590
49	Jacksonville, FL	1,080	1.39	$90,900
50	Nashville-Davidson--Murfreesboro--Franklin, TN	1,640	1.50	$87,550

Source: Bureau of Labor Statistics Occupational Employment Statistics (OES) and Authors' Calculations Note: **The Madison MSA ranks 90th in total nurse practitioners and has an average salary of $98,650. The Janesville-Beloit MSA has an average salary of $105,480**

Figure 2.16 – Annual Avg. Wages for Physician's Assistants - Metro Areas with the 50 Most Physician's Assistants in 2017 (Ranked by Annual Average Wage)*

Rank	Metropolitan Statistical Area	Total in 2017	Location Quotient in 2017	Annual Average Wage in 2017
1	San Francisco-Oakland-Hayward, CA	2,420	1.33	$120,800
2	Portland-Vancouver-Hillsboro, OR-WA	560	0.64	$120,230
3	San Jose-Sunnyvale-Santa Clara, CA	650	0.77	$119,890
4	Seattle-Tacoma-Bellevue, WA	1,510	1.01	$119,550
5	Sacramento--Roseville--Arden-Arcade, CA	640	0.87	$117,920
6	Hartford-West Hartford-East Hartford, CT	800	1.80	$116,110
7	New York-Newark-Jersey City, NY-NJ-PA	10,490	1.47	$115,800
8	Riverside-San Bernardino-Ontario, CA	810	0.74	$112,250
9	San Diego-Carlsbad, CA	1,030	0.94	$111,870
10	Cleveland-Elyria, OH	660	0.84	$109,250
11	Grand Rapids-Wyoming, MI	780	1.85	$109,210
12	Minneapolis-St. Paul-Bloomington, MN-WI	1,170	0.79	$108,680
13	Boston-Cambridge-Nashua, MA-NH	2,180	1.04	$107,750
14	Syracuse, NY	540	2.33	$107,560
15	Washington-Arlington-Alexandria, DC-VA-MD-WV	2,290	0.96	$106,340
16	Columbus, OH	590	0.74	$106,340
17	Miami-Fort Lauderdale-West Palm Beach, FL	1,640	0.84	$106,090
18	Albany-Schenectady-Troy, NY	650	1.90	$105,770
19	Asheville, NC	480	3.30	$105,550
20	Los Angeles-Long Beach-Anaheim, CA	2,920	0.63	$105,030
21	Atlanta-Sandy Springs-Roswell, GA	2,440	1.21	$104,990
22	Milwaukee-Waukesha-West Allis, WI	680	1.05	$104,930
23	Denver-Aurora-Lakewood, CO	1,690	1.53	$104,220
24	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	2,310	1.07	$103,560
25	Cincinnati, OH-KY-IN	520	0.64	$102,690
26	Richmond, VA	460	0.94	$101,990
27	Rochester, NY	730	1.87	$101,940
28	Raleigh, NC	540	1.17	$101,940
29	Virginia Beach-Norfolk-Newport News, VA-NC	680	1.20	$101,800
30	Tampa-St. Petersburg-Clearwater, FL	1,010	1.03	$101,760
31	Chicago-Naperville-Elgin, IL-IN-WI	1,770	0.50	$101,210
32	Oklahoma City, OK	610	1.32	$100,750
33	Omaha-Council Bluffs, NE-IA	540	1.45	$100,170
34	Kansas City, MO-KS	460	0.57	$99,830
35	Charleston-North Charleston, SC	440	1.71	$99,380
36	Buffalo-Cheektowaga-Niagara Falls, NY	560	1.33	$99,170
37	Baltimore-Columbia-Towson, MD	1,760	1.69	$98,420
38	Jacksonville, FL	530	1.03	$98,420
39	Orlando-Kissimmee-Sanford, FL	530	0.57	$98,270
40	Salt Lake City, UT	600	1.13	$97,380
41	Houston-The Woodlands-Sugar Land, TX	1,880	0.84	$97,320
42	Detroit-Warren-Dearborn, MI	1,940	1.28	$96,950
43	Phoenix-Mesa-Scottsdale, AZ	1,630	1.08	$96,520
44	Charlotte-Concord-Gastonia, NC-SC	750	0.83	$96,310
45	Dallas-Fort Worth-Arlington, TX	2,210	0.83	$95,580
46	Pittsburgh, PA	1,450	1.67	$94,700
47	Indianapolis-Carmel-Anderson, IN	640	0.81	$92,180
48	Allentown-Bethlehem-Easton, PA-NJ	540	1.95	$91,640
49	San Antonio-New Braunfels, TX	780	1.01	$85,080
50	Nashville-Davidson--Murfreesboro--Franklin, TN	580	0.81	$78,910

Source: Bureau of Labor Statistics Occupational Employment Statistics (OES) and Authors' Calculations Note: **The Madison MSA ranks 54th in total Physician's Assistants and has an average salary of $97,390. The Janesville-Beloit MSA has an average salary of $102,910**

Figure 2.17 – Annual Avg. Wages for Registered Nurses - Metro Areas with the 50 Most Registered Nurses in 2017 (Ranked by Annual Average Wage)

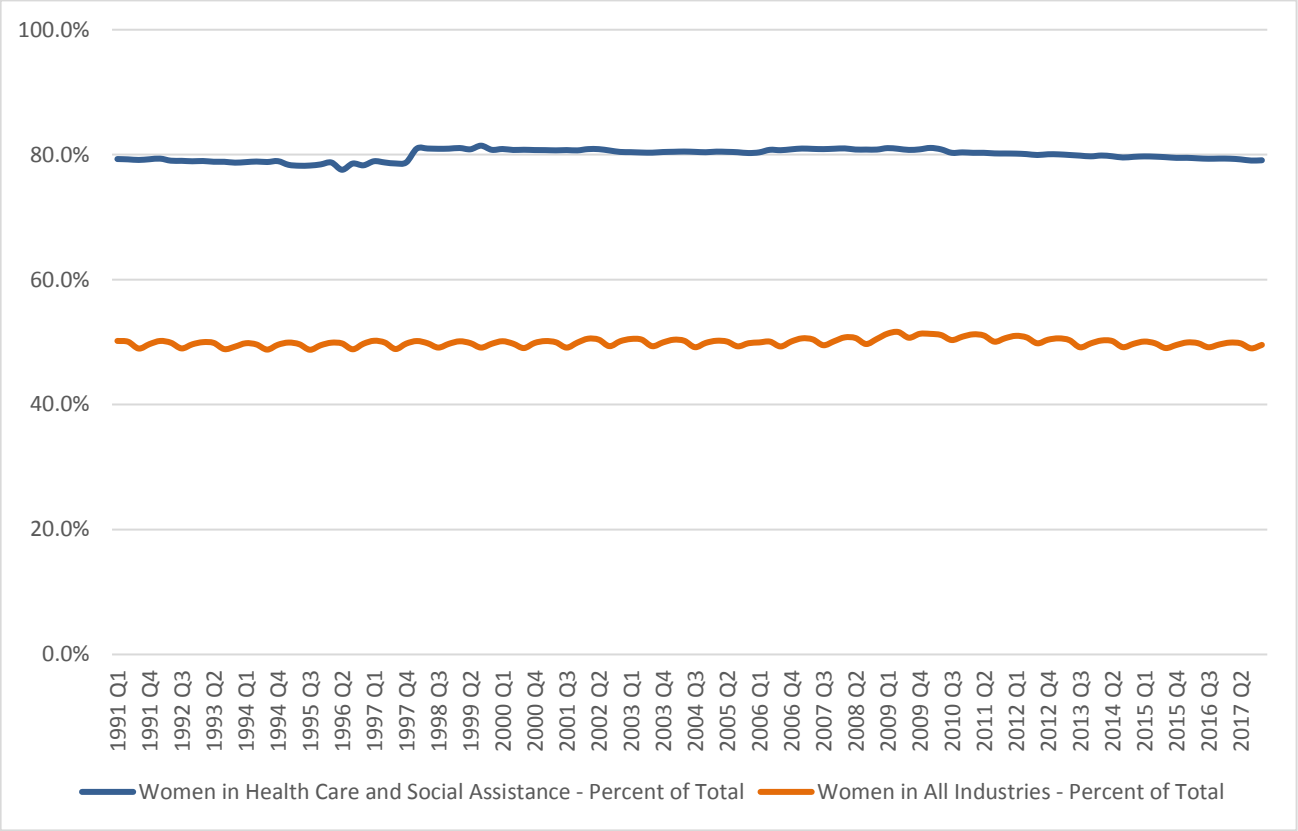
Rank	Metropolitan Statistical Area	Total in 2017	Location Quotient in 2017	Annual Average Wage in 2017
1	San Jose-Sunnyvale-Santa Clara, CA	15,990	0.72	$129,140
2	San Francisco-Oakland-Hayward, CA	35,480	0.73	$124,970
3	Sacramento--Roseville--Arden-Arcade, CA	18,240	0.93	$116,170
4	Riverside-San Bernardino-Ontario, CA	27,720	0.95	$97,520
5	San Diego-Carlsbad, CA	23,100	0.79	$94,740
6	Los Angeles-Long Beach-Anaheim, CA	102,330	0.83	$93,800
7	Boston-Cambridge-Nashua, MA-NH	60,260	1.08	$92,180
8	Portland-Vancouver-Hillsboro, OR-WA	22,500	0.95	$91,070
9	New York-Newark-Jersey City, NY-NJ-PA	176,770	0.93	$89,400
10	Las Vegas-Henderson-Paradise, NV	15,620	0.80	$87,200
11	Seattle-Tacoma-Bellevue, WA	32,660	0.82	$82,710
12	Minneapolis-St. Paul-Bloomington, MN-WI	39,290	1.00	$81,510
13	Washington-Arlington-Alexandria, DC-VA-MD-WV	42,210	0.67	$80,760
14	Hartford-West Hartford-East Hartford, CT	12,310	1.04	$79,470
15	Houston-The Woodlands-Sugar Land, TX	51,610	0.86	$79,060
16	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	72,530	1.26	$77,670
17	Providence-Warwick, RI-MA	14,460	1.25	$76,420
18	Baltimore-Columbia-Towson, MD	32,880	1.19	$76,160
19	Phoenix-Mesa-Scottsdale, AZ	38,670	0.96	$76,140
20	Chicago-Naperville-Elgin, IL-IN-WI	93,710	1.00	$75,570
21	Dallas-Fort Worth-Arlington, TX	59,570	0.84	$74,670
22	Denver-Aurora-Lakewood, CO	27,130	0.92	$74,010
23	Detroit-Warren-Dearborn, MI	41,470	1.03	$71,630
24	Atlanta-Sandy Springs-Roswell, GA	40,400	0.76	$70,540
25	Milwaukee-Waukesha-West Allis, WI	18,910	1.10	$69,880
26	New Orleans-Metairie, LA	16,730	1.48	$68,800
27	Austin-Round Rock, TX	12,990	0.64	$68,780
28	Richmond, VA	13,620	1.04	$68,670
29	Cleveland-Elyria, OH	27,540	1.31	$68,320
30	San Antonio-New Braunfels, TX	18,950	0.93	$68,020
31	Durham-Chapel Hill, NC	11,700	1.92	$67,360
32	Miami-Fort Lauderdale-West Palm Beach, FL	54,350	1.04	$67,340
33	Columbus, OH	22,070	1.04	$67,080
34	Tampa-St. Petersburg-Clearwater, FL	30,390	1.16	$67,000
35	Cincinnati, OH-KY-IN	23,580	1.09	$66,850
36	Indianapolis-Carmel-Anderson, IN	26,100	1.24	$66,690
37	St. Louis, MO-IL	36,670	1.33	$65,910
38	Memphis, TN-MS-AR	11,690	0.93	$65,560
39	Kansas City, MO-KS	25,310	1.18	$65,490
40	Pittsburgh, PA	31,260	1.35	$65,380
41	Rochester, NY	11,840	1.14	$64,280
42	Oklahoma City, OK	12,030	0.98	$63,740
43	Virginia Beach-Norfolk-Newport News, VA-NC	13,490	0.89	$63,730
44	Louisville/Jefferson County, KY-IN	14,880	1.13	$63,580
45	Omaha-Council Bluffs, NE-IA	12,280	1.24	$63,480
46	Orlando-Kissimmee-Sanford, FL	22,070	0.89	$63,270
47	Charlotte-Concord-Gastonia, NC-SC	20,980	0.87	$62,390
48	Nashville-Davidson--Murfreesboro--Franklin, TN	20,720	1.08	$62,310
49	Jacksonville, FL	13,750	1.01	$61,680
50	Nashville-Davidson--Murfreesboro--Franklin, TN	580	0.81	$78,910

Source: Bureau of Labor Statistics Occupational Employment Statistics (OES) and Authors' Calculations Note: **The Madison MSA ranks 73rd in total registered nurses and has an average salary of $78,910. The Janesville-Beloit MSA has an average salary of $66,950**

Talent Diversity

Health care and social assistance is one of the few industry categories where employment is dominated by women. At the end of 2017, women comprised 79% of all health care and social assistance employees in the Madison Region (Figure 2.18). Indeed the four occupational categories that have the highest share of women in the Madison MSA include those that are highly concentrated in health care provider industries. These include health care support; community and social service; personal care and service and health care practitioner and technical occupations (Figure 2.19). As the share of employment in the industry attributed to women has stayed largely consistent since the early 1990s, the health care industry may want to consider opportunities to further engage men in many health care occupations that have traditionally been held by women.

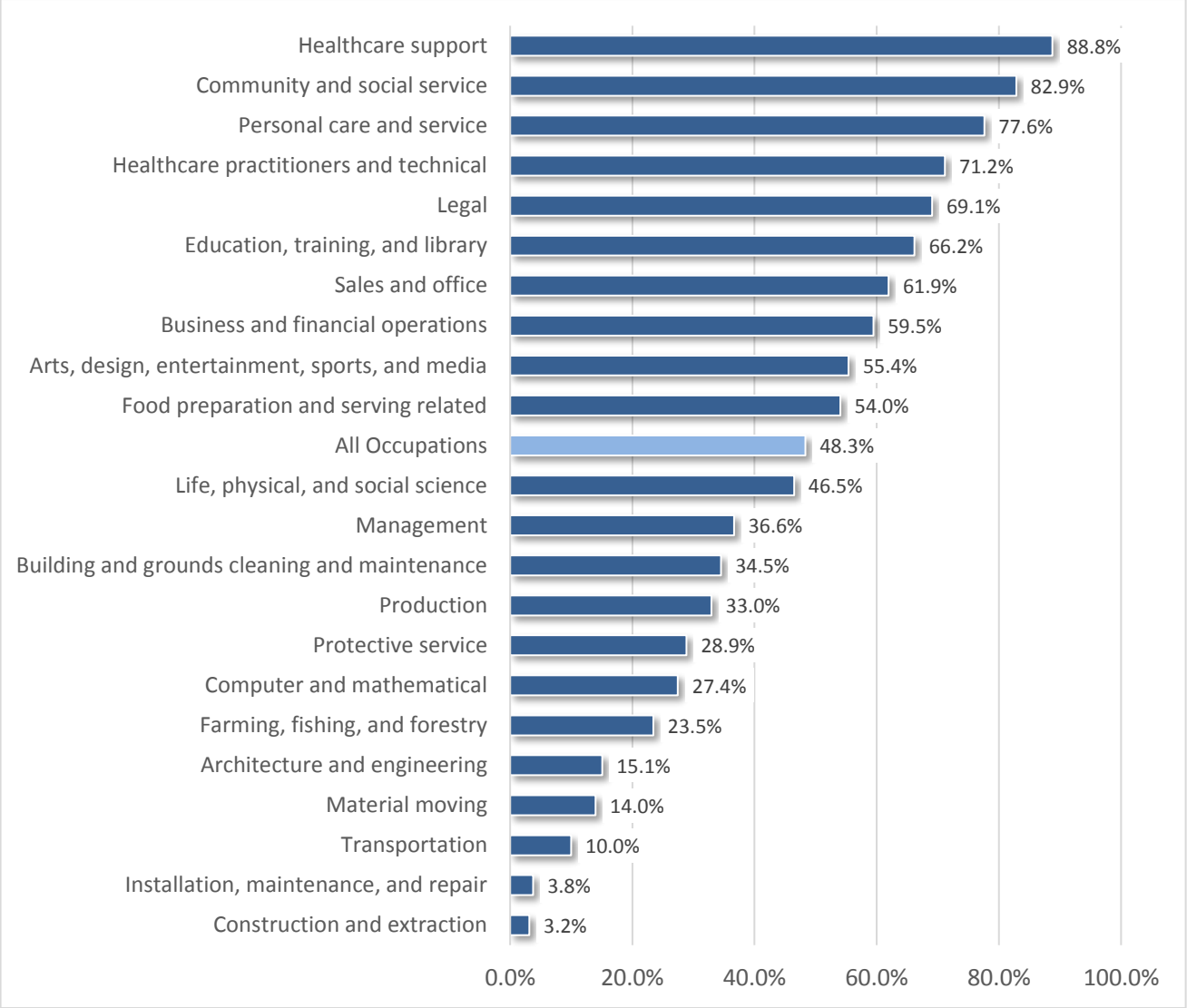
Figure 2.18 - Women as a Share of Health Care and Social Assistance Employees



Source: U.S. Census Bureau LEHD and Authors' Calculations

While women comprise a large share of employment in health care provider occupations, there are likely discrepancies among women employed in individual categories of health care practitioners and health care support occupations. Furthermore, women occupy a smaller share of several science, technology, engineering and mathematics (STEM) related occupations important to bioscience and health IT industries. For instance, women comprise just 15.1% of engineering and architecture occupations and 27.4% of computer and mathematical occupations (Figure 2.19). Given these occupational distributions, certainly there are opportunities to increase the share of women in many health care related occupations.

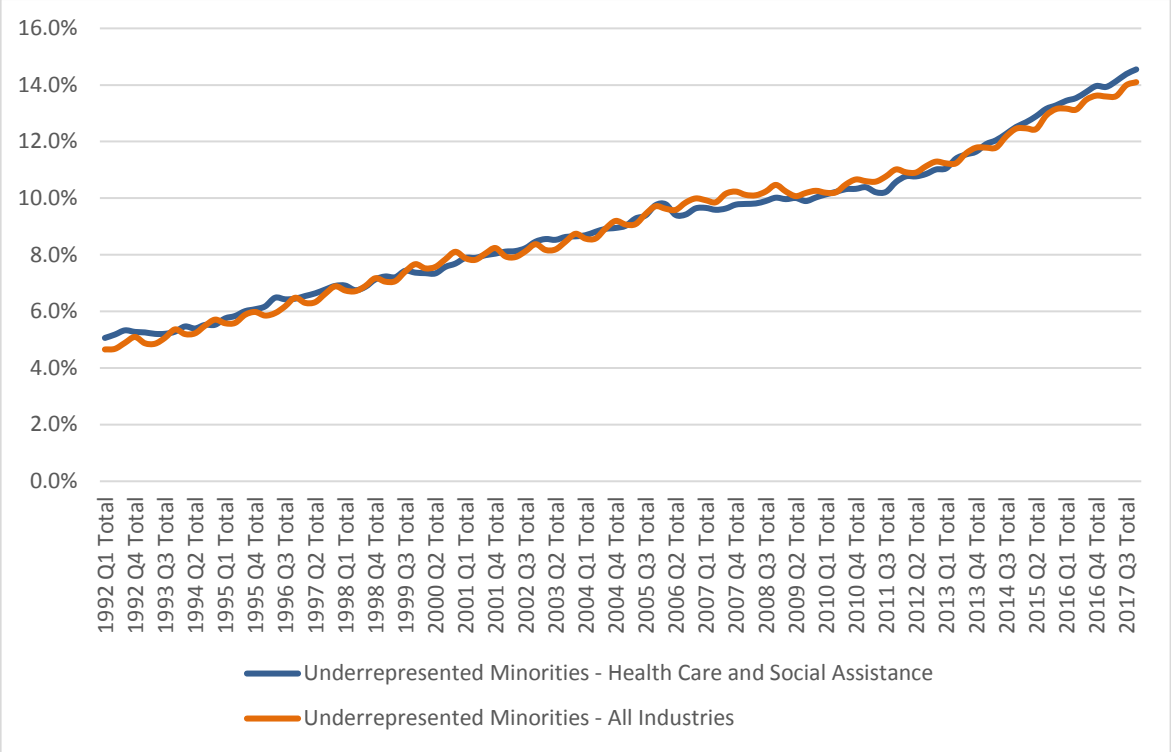
Figure 2.19 – Women as a Share of Total Employment by Occupation - Madison MSA in 2016



Source: U.S. Census Bureau American Community Survey and Authors' Calculations

Underrepresented minorities (URMs) also provide greater opportunities for talent development in the health care industry cluster. While official definitions of underrepresented minorities may vary, for purposes of this analysis we consider URMs to include those who identify as African Americans, American Indians/Alaska Natives, Latinos, and Asian or Pacific Islanders. Health care and social assistance employment attributed to underrepresented minorities comprises a growing and proportionate share of employment. More specifically, underrepresented minorities comprised just 5.1% of health care employment and 4.9% of all employment in 1992. By the end of 2017, the share of health care employment attributed to underrepresented minorities increased to 14.5% (Figure 2.20). The share of all employment comprised by underrepresented minorities also increased, but to a smaller level (14.1%) than health care and social assistance.

Figure 2.20 – Underrepresented Minorities as a Share of Health Care and Social Assistance Employment



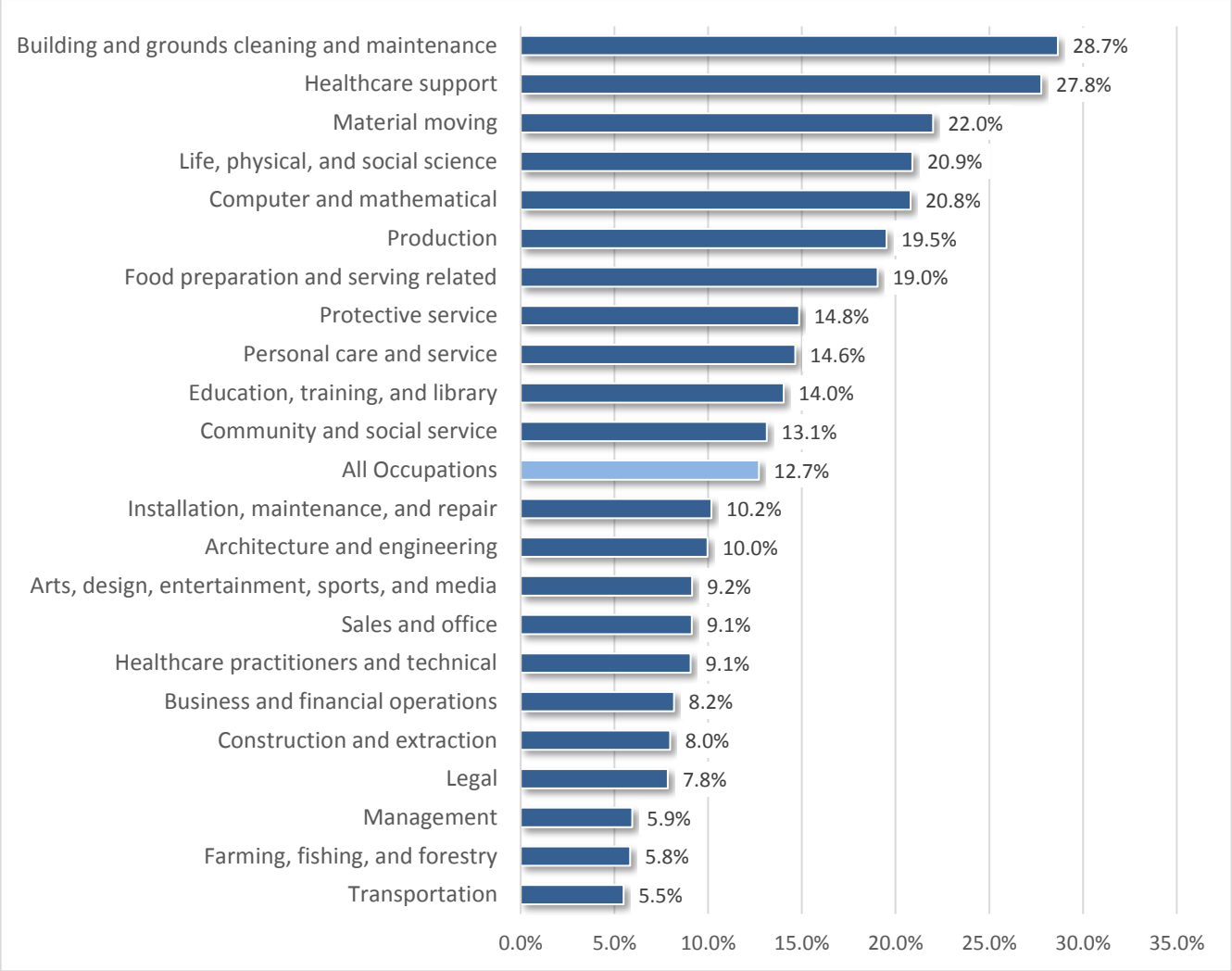
Source: U.S. Census Bureau LEHD and Authors' Calculations

In terms of occupational categories concentrated in health care provider industries, underrepresented minorities account for 27.8% of all health care support occupations and 14.6% of personal care and service occupations (Figure 2.21). Underrepresented minorities also hold 20.9% of life, physical and social science occupations and 20.8% of computer and mathematical science occupations that are important to the bioscience and health IT industries. These occupational categories all have employment shares above the 12.7% of all employment attributed to underrepresented minorities in the Madison MSA.[9] In contrast, URMs hold only 10.0% of engineering and architecture occupations and 9.1% of health care practitioner and technical occupations (Figure 2.21).

The share of health care employment found among URMs does not necessarily mean that the Madison MSA is diverse. In comparison to many other metropolitan areas with large concentrations of health care related industries, the Madison MSA has a low share of employment attributed to underrepresented minorities. This share is partly driven by the relatively low levels of overall diversity in the Madison MSA. That is, more diverse metro areas are more likely to have a higher share of health care-related occupations found among underrepresented minorities. Accordingly, efforts to increase diversity in the Region's health care related industries should continue to grow.

[9] Note that differences in underrepresented minority employment in Figure 2.20 and 2.21 are attributed to time period (2016 vs 2017), geography (Madison MSA vs Madison Region) and data source (LEHD vs American Community Survey).

Figure 2.21 – Underrepresented Minorities as a Share Total Employment by Occupation - Madison MSA 2016



Source: U.S. Census Bureau 2016 American Community Survey and Authors' Calculations

Conclusions and Summary

- As noted earlier in this abstract, employment in the health care provider industry tends to be very highly correlated with a region's population. Given this correlation, it is not surprising that very few health care provider occupations have significant location quotients in either the Madison MSA or the Janesville-Beloit MSA. Exceptions include physicians and surgeons (1.76 and 2.57 in the Madison NSA and Janesville-Beloit MSA respectively); social and human service assistants (1.67 and 1.56); and health technologists and technicians (1.98 and 1.13). The high location quotients among surgeons likely reflects the Region's specialization in a variety of types of surgery.

- Wages within the Madison MSA and Janesville-Beloit MSA are at or above the national average for most health care provider occupations. These differences may be partly attributed to the overall size of the health care sector in the Region. Notable exceptions appear to include physical therapists, nurse practitioners and physician's assistants. However, wages among physical therapists, nurse practitioners and physician's assistants are competitive among the 50 largest metro areas for these occupations.

- The top 10 occupations among categories of health care providers are a mix of high and lower wage jobs. While many occupations in the industry have annual average wages above $100,000 a number of other common occupations have annual average wages below $40,000. These varied wage rates reflect the diversity of skills and educational attainments needed in the health care industry. The wage rates are also important when considering housing and other measures of cost of living in the Region. That is, costs of living may disproportionately affect lower wage occupations in the industry.

- Ambulatory health care services and hospitals are dominated by occupations found in Job Zone 3. Accordingly, many of these jobs require some sort of post-secondary training, such as a certification or an Associate's degree, but do not necessarily require a college degree. These distributions may surprise some readers unfamiliar with the health care industry. That is, people often associate health care with physicians and other occupations that require advanced levels of education and training. However, the industry depends heavily upon individuals with a breadth of post-secondary education levels.

- Nursing and residential care facilities also have a notable share of occupations found in Job Zone 3, but the largest shares are found in Job Zone 2. While many of these occupations require specific types of skills and training, many of these skills can be acquired without formal post-secondary credentials. The high share of occupations in Job Zone 2 is also reflected in the lower relative wages found in the nursing and residential care facility industry. These wage rates may present a challenge to the industry in attracting workers with lesser levels of education who may have many other employment options, especially in a tight labor market such as that of the Madison Region.

- The movements in new hires and separations reflect the region's overall trend in health care and social assistance employment. However, most quarters saw health care establishments accounting for 6,000 or more new hires. Even at the lowest point over this time period (Q1 2010), the Region still had 3,700 new

hires. More recently, the Madison Region reported between 7,000 and 9,000 new hires and separations per quarter. In particular, the current levels of new hires are the highest level in more than two decades.

- The growth in new hires and separations shows the current strength of the industry in the Region, but also suggests that employees may have more confidence in their employment prospects. As employees are often more willing to change jobs when the economy offers greater opportunities to advance careers or increase wages, higher levels of employment churn also offer opportunities for firms to examine their internal working environment and wages. If employers are in fact experiencing higher levels of employee turnover, they may want to consider whether their wages, benefits and work environment are competitive relative to other firms in the Region. Furthermore, employers may want to also consider the costs of employee turnover relative to wage increases.

- Almost 23% of health care and social assistance employees in the Madison Region and the State of Wisconsin were age 55 older in 2017. Furthermore, the share of the overall health care workforce age 55 and over has almost doubled over the past two decades. The growing share of health care workers age 55 and over reflects an overall aging of the labor force in the Region and creates greater needs for new employees in the industry. Importantly, this aging population will also place further stresses on the health care provider industry in terms of additional demand for services.

- When compared to other occupations in the Madison Region, computer and mathematical; life physical and social science; engineering; and health care practitioner occupations have among the highest shares of individuals who were either born in another state or born outside of the United States. In contrast, health care support; production occupations; and installation, maintenance and repair occupations have a much lower share of residents born in another state or another country. These mobility trends are important as external talent attraction efforts may help to fill professional or technical occupations, but it are less likely to influence many categories of service or production workers. Consequently, talent development initiatives for many service and production occupations will likely need to emphasize a "grow your own" approach.

- Health care and social assistance is one of the few industry categories where employment is dominated by women. At the end of 2017, women comprised 79% of all health care and social assistance employment in the Madison Region. Indeed the four occupational categories that have the highest shares of women in the Madison MSA include those that are highly concentrated in health care provider industries: health care support; community and social service; personal care and service and health care practitioner and technical occupations. As the share of employment in the industry by women has stayed largely consistent since the early 1990s, the health care firms may want to consider opportunities to further engage men in many health care occupations that have traditionally been held by women.

- While women comprise a large share of employment in health care provider occupations, there are likely discrepancies among individual categories of health care practitioners and health care support occupations. Furthermore, women occupy a smaller share of several science, technology, engineering and mathematics (STEM) related fields important to bioscience and health IT industries. For instance, women comprise just 15.1% of engineering and architecture occupations and 27.4% of computer and

mathematical occupations. Given these occupational distributions, certainly there are opportunities to increase the share of women in many health care related occupations.

- Underrepresented minorities (URMs) also provide greater opportunities for talent development in the health care industry cluster. As a share of all occupations concentrated in the health care provider industries, underrepresented minorities account for 27.8% of all health care support occupations and 14.6% of personal care and service occupations. Underrepresented minorities also hold 20.9% of life, physical and social science occupations and 20.8% of computer and mathematical science occupations that are important to the bioscience and health IT industries. These occupational categories all have employment shares above the 12.7% of total employment attributed to underrepresented minorities in the Madison MSA. In contrast, URMs hold only 10.0% of engineering and architecture occupations and 9.1% of health care practitioner and technical occupations.

Appendix 2A – Understanding Job Zones

Job Zone One: Little or No Preparation Needed

- *Education* - Some of these occupations may require a high school diploma or GED certificate.
- *Related Experience* - Little or no previous work-related skill, knowledge, or experience is needed for these occupations. For example, a person can become a waiter or waitress even if he/she has never worked before.
- *Job Training* - Employees in these occupations need anywhere from a few days to a few months of training. Usually, an experienced worker could show you how to do the job.
- *Specific Vocational Preparation Time* – Short demonstration, up to one month or one to 3 months.

Job Zone Two: Some Preparation Needed

- *Education* - These occupations usually require a high school diploma.
- *Related Experience* - Some previous work-related skill, knowledge, or experience is usually needed. For example, a teller would benefit from experience working directly with the public.
- *Job Training* - Employees in these occupations need anywhere from a few months to one year of working with experienced employees. A recognized apprenticeship program may be associated with these occupations.
- *Specific Vocational Preparation Time* – 3 to 6 months, 6 months to 1 year

Job Zone Three: Medium Preparation Needed

- *Education* - Most occupations in this zone require training in vocational schools, related on-the-job experience, or an associate's degree.
- *Related Experience* - Previous work-related skill, knowledge, or experience is required for these occupations. For example, an electrician must have completed three or four years of apprenticeship or several years of vocational training, and often must have passed a licensing exam, in order to perform the job.
- *Job Training* - Employees in these occupations usually need one or two years of training involving both on-the-job experience and informal training with experienced workers. A recognized apprenticeship program may be associated with these occupations.
- *Specific Vocational Preparation Time* – 1 to 2 years

Job Zone Four: Considerable Preparation Needed

- *Education* - Most of these occupations require a four-year bachelor's degree, but some do not.
- *Related Experience* - A considerable amount of work-related skill, knowledge, or experience is needed for these occupations. For example, an accountant must complete four years of college and work for several years in accounting to be considered qualified.
- *Job Training* - Employees in these occupations usually need several years of work-related experience, on-the-job training, and/or vocational training.
- *Specific Vocational Preparation Time* – 2 to 4 years

Job Zone Five: Extensive Preparation Needed

- *Education* - Most of these occupations require graduate school. For example, they may require a master's degree, and some require a Ph.D., M.D., or J.D. (law degree).
- *Related Experience* - Extensive skill, knowledge, and experience are needed for these occupations. Many require more than five years of experience. For example, surgeons must complete four years of college and an additional five to seven years of specialized medical training to be able to do their job.
- *Job Training* - Employees may need some on-the-job training, but most of these occupations assume that the person will already have the required skills, knowledge, work-related experience, and/or training.
- *Specific Vocational Preparation Time* – 4 to 10 years, or over 10 years

Source: O*NET

Section 3 – Health Care Cluster Support and Development Ecosystem

As noted in the introduction, industry clusters are not comprised solely of for-profit, private-sector firms. Instead, industry clusters involve companies that are interconnected through supply chains, common infrastructure, a shared labor pool, connective and networking assets, and quality of place/quality of life considerations. Industry clusters also recognize the potential assistance and knowledge transfers that universities, trade associations, government agencies and similar organizations can provide. Accounting for all of these cluster elements together provides a clearer understanding of the health care support and development ecosystem. Accordingly, the following analysis builds upon the prior analyses of health care industries and talent by considering:

- Broadband availability and distribution;
- Regional assets that influence talent attraction and retention;
- Research Parks, certified and gold shovel sites, and specialized commercial spaces;
- Educational institutions;
- Support organizations that foster innovation and connect firms and resources. These organizations may provide technical assistance, mentoring, access to capital or other forms of assistance.

Broadband Infrastructure

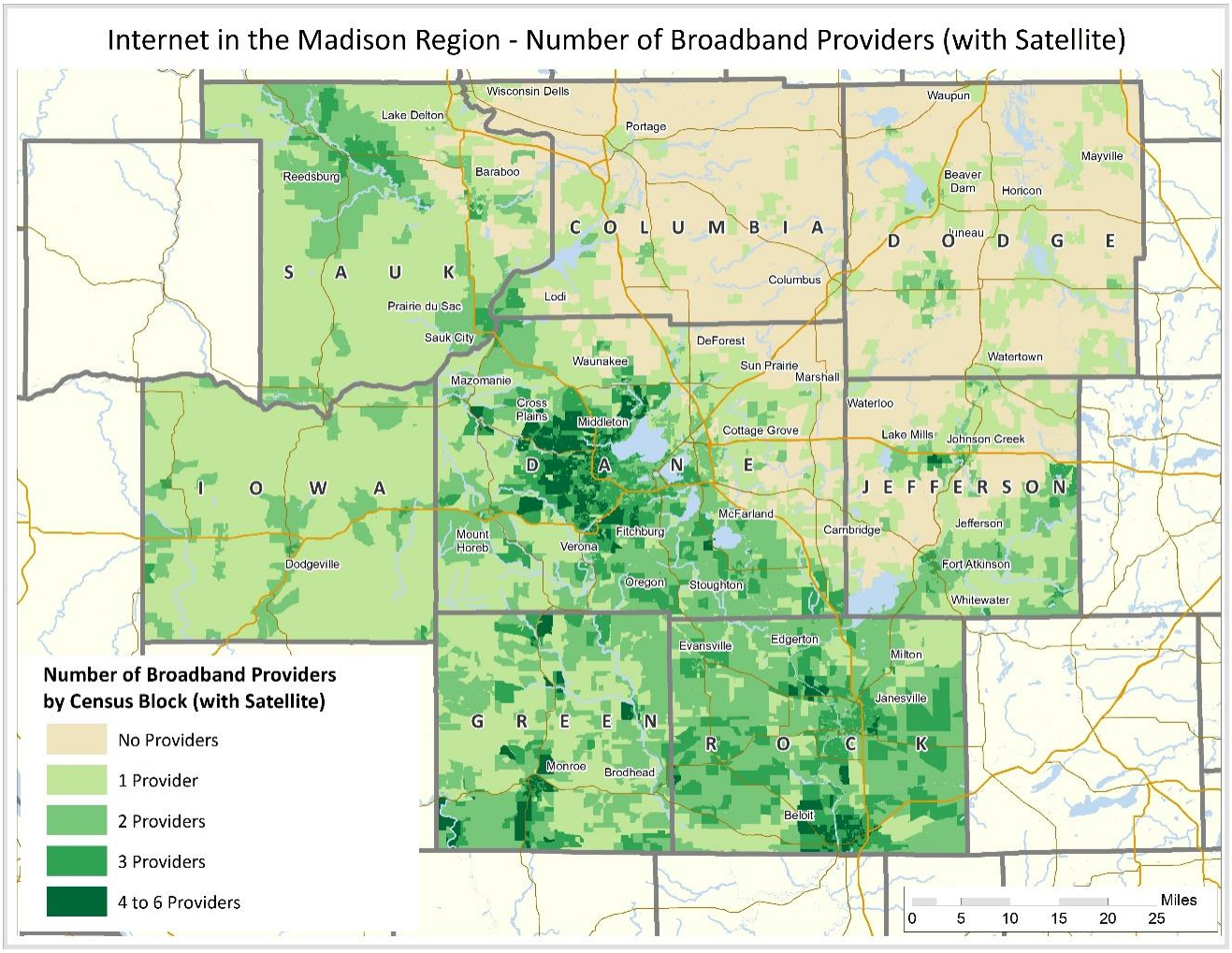
While all industries increasingly rely on broadband availability, inexpensive and reliable high-speed Internet access is becoming very important to the health care industry cluster. Companies will increasingly require connectivity to drive their Internet of Things (IoT) technologies, monitor research, maintain databases, share discoveries, monitor patient interactions, and implement virtual and augmented reality production and worker training systems. To provide some perspectives on broadband infrastructure in the Madison Region, several measures of access and speed are mapped below using Fixed Broadband Deployment Data from the Federal Communications Commission Form 477. As noted by the FCC, all facilities-based broadband providers are required to file data twice a year on the census blocks where Internet access service is offered at speeds exceeding 200 kilobits per second (Kbps) in at least one direction.[10]

While the Form 477 data provide some perspectives on general Internet availability, it has several inherent challenges that prohibit users from effectively mapping or identifying comprehensive broadband access. First, providers file lists of census blocks in which they either can or do offer service to at least one location. However, there may be other addresses or locations within a given census block that do not have access to any broadband providers. Second, the most recent data are from December 2016; therefore, improvements in either speed or access made through provider investments over the last 2 years will not be reflected on these maps. Finally, the data provide no information on cost to the user.

[10] For more information see: https://www.fcc.gov/general/broadband-deployment-data-fcc-form-477

The following maps consider 1) the maximum reported upload speed, 2) the maximum download speed and 3) the number of broadband providers in each census block. This analysis relies on the federal definition of broadband which is 25 megabits per second (Mbps) for download speeds and 3 Mbps for upload speeds. As the 25/3 definition is increasingly inadequate for some users, the maps showing maximum download and upload speeds provide additional detail on transfer rates. Note that these maps include "fixed" broadband connections such as cable, DSL and terrestrial fixed wireless. Accordingly, these maps do not include mobile or cellular data. Furthermore, the maps do no depict the locations of "dark fiber" or fiber optic infrastructure that is in place, but unused. Depending on where this dark fiber is located, it could provide opportunities to both expand and improve access in some parts of the Madison Region. Finally, the maps below also include satellite access, but a separate series of maps excluding satellite access are included in Appendix 3A.

Figure 3.1 – Number of Broadband Providers by Census Block (including Satellite)

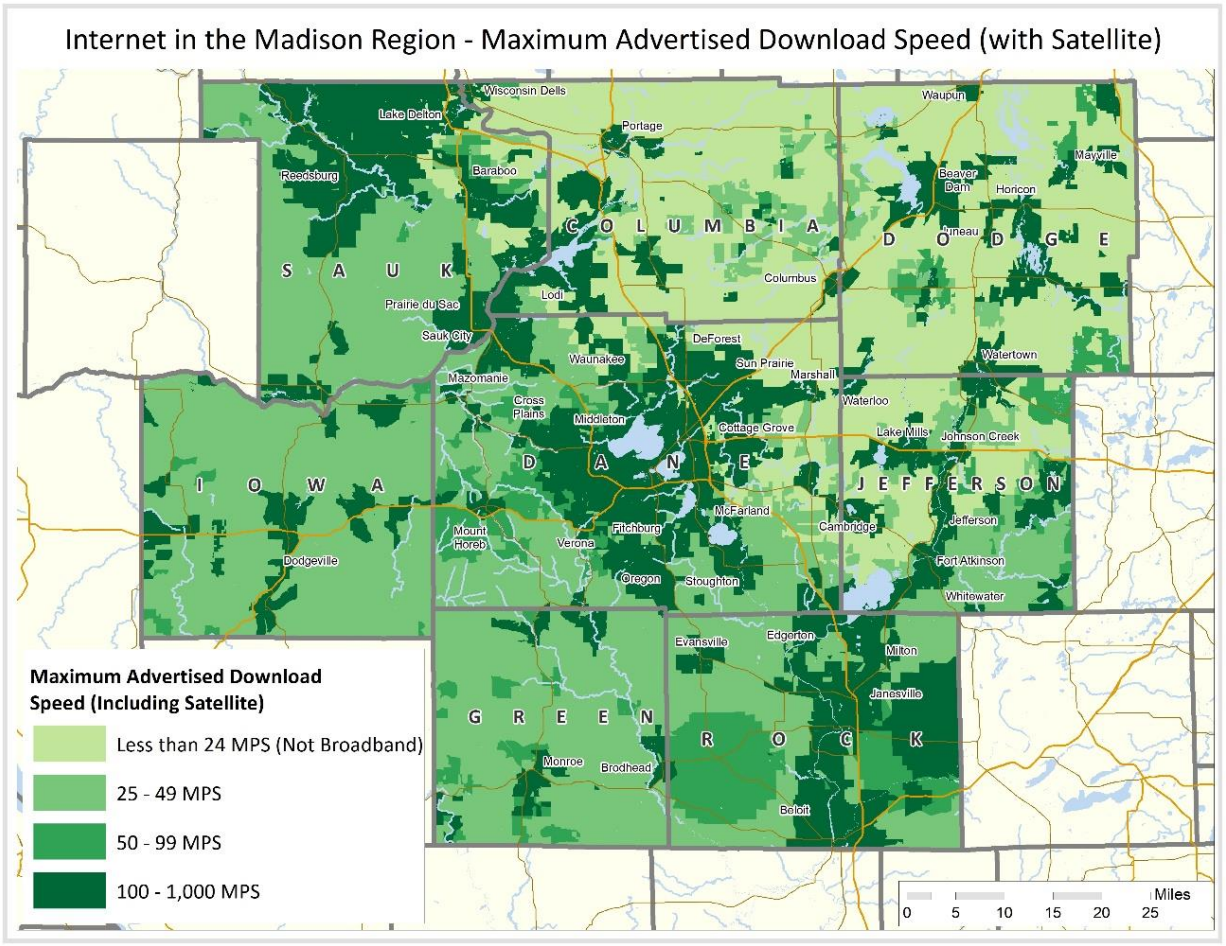


Source: Fixed Broadband Deployment Data - Federal Communications Commission Form 477 and Author's Calculations

The numbers of broadband providers available in each census block vary dramatically across the Region (Figure 3.1). The urban-rural divide in the number of providers is particularly apparent. A relatively large number of providers are found across the western portion of Madison and its surrounding communities. More than one broadband provider is also found in many smaller communities across the Region such as Monroe, Beloit and Reedsburg. In contrast, extensive rural areas throughout Dodge, Columbia, and Jefferson counties are without a reported broadband provider. Some rural areas in Dane and Sauk counties also lack broadband access. Again, these areas have some level of internet availability, but they do not have a provider that meets the 25/3 broadband definition. *If access to satellite providers is removed from consideration, a significant portion of all counties in the Madison Region are without a broadband provider (see Appendix 3A).*

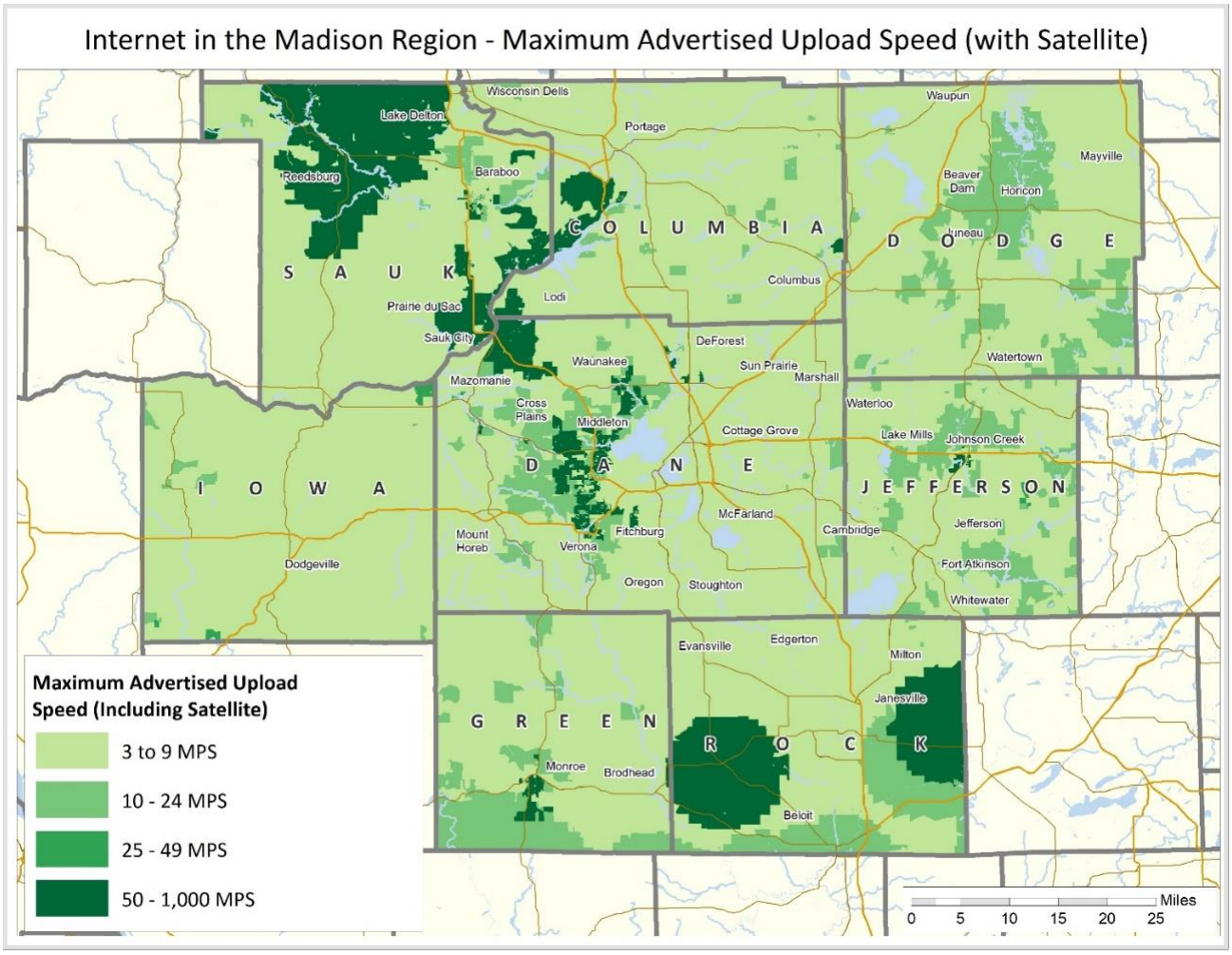
Download speeds also vary considerably across the Madison Region. Most of Madison and its surrounding communities have access to speeds of at least 100 Mbps, with some communities (such as Sun Prairie) having access to 1 gigabits per second (Gbps or 1,000 Mbps) download speeds (Figure 3.2). Most communities outside of Dane County also have at least partial access to download speeds of 100 Mbps or more. However, it is important to reiterate that the Form 477 data used to produce these maps cannot guarantee the availability of any specific download (or upload) speeds. Areas with high upload speeds are more concentrated in the Region. Notable areas with upload speeds between 50 to 1,000 Mbps include Reedsburg, Sauk City/Prairie du Sac, Middleton, Verona, Monroe, Orfordville and eastern Rock County (Figure 3.3).

Figure 3.2 – Maximum Advertised Download and Upload Speeds by Census Block (including Satellite)



Source: Fixed Broadband Deployment Data - Federal Communications Commission Form 477 and Author's Calculations

Figure 3.3 – Maximum Advertised Upload Speeds by Census Block (including Satellite)



Source: Fixed Broadband Deployment Data - Federal Communications Commission Form 477 and Author's Calculations

An important MadREP key strategic initiative (KSI) is to promote the increased availability and reliability of broadband in the ring counties, and particularly in rural communities, wherein many hospitals, clinics and ambulatory care facilities that make up the Region's health care industry are located. Wireless technologies beyond satellite, including the 5G wireless systems discussed in the next section, could be a huge potential mechanism used to assist in meeting this objective in these hard to serve areas.

5G Wireless

While the previous discussion of broadband infrastructure did not consider wireless technologies, fifth-generation (5G) broadband technology can be used to replace or supplement cable and fiber technologies and can potentially be used to deliver wireless broadband to remote areas previously unreachable. Furthermore, the near-term development and installation of 5G is essential to the successful implementation of artificial intelligence and machine learning applications, as well as the edge processing software applications that are anticipated as part of future IoT installations. 5G has the ability to deliver operating speeds of more than 100 Mbps and allows wireless communication to occur in high-frequency bands (particularly important will be the 28, 37-40 and 64-71 GHz ranges).

5G systems will require mini-cell towers (or "small cell" antenna arrays) placed in a dense network to ensure high frequency signal transmission through thick walls and in bad weather. Units will be located on common structures, such as buildings, telephone poles and street lights, throughout a customer service area. Indeed, a proof of concept 20 Gbps 5G network made its debut during the 2018 Winter Olympics in PyeongChang, South Korea. Particularly impressive was the drone synchronization demonstration made possible by the technology, in which anywhere from 300 to a record 1,218 drones were used to create 3-D patterns against the night sky during the opening and closing ceremonies (Barrett, 2018).

Distinguishing Features of 5G

As noted by West (2016), four factors distinguish 5G from 4G Long Term Evolution (LTE) networks:

1. *Connected devices* - By 2020, the 5G network is expected to support 50B connected devices and 212B connected sensors that will essentially be machines talking to each other through IoT protocols and middleware technologies. These connected devices will allow people to enjoy more personalized, more immersive and more enhanced experiences anywhere in the world that deploys the network, as well as allow health care businesses to increase operating efficiencies through deployment of their connected factory and research related technologies;

2. *Fast and intelligent networks* - The end goal is to develop a fully software driven and virtualized network where human decision making is removed from the computational process. The network will rely upon machine-to-machine communication, remote sensors and automated decision making (including data traffic prioritization) to speed execution and make more efficient use of computational power. The network speed will enable applications such as social multiplayer gaming, interactive television, high definition and 3-D video, virtual reality, augmented reality, robotics, driverless cars, advanced manufacturing, telehealth and other forms of precision medicine, and research simulation technologies;

3. *Extremely low latency* - The goal of 5G will be to lower the time between when a command is requested to when it is executed from the current 50 to 80 milliseconds to a few milliseconds;

4. *Back-end services* - The emerging network will enlist back-end data centers, cloud services and remote file servers to provide users a responsive experience using "computing at the edge" technology, meaning computations are performed either at the source or at a nearby cloud based processing center. This combination of edge technology, faster operating speeds and low latency will allow machines to talk and

react in real time, improving their efficiency and increasing system safety (such as the quick braking of an autonomous vehicle to avoid a collision or the shutting down of a machine when a worker is perceived to be in danger). The marketplace is currently developing new chipsets and end point devices to utilize 5G networks. Intel plans to release the first 5G enabled laptops by 2019.

5G System Rollout

AT&T, Verizon and Sprint have targeted late 2018 and 2019 launch dates for U.S. rollouts. Providers located in China and Japan will roll out their networks in 2020. As noted earlier, in South Korea the provider Korean Telecom already began implementation of a nationwide 5G network in advance of the Olympics.

In the Madison region, a representative from AT&T indicated during a Wisconsin Innovation Network luncheon that planning has begun for the rollout of a local 5G network. The exact dates of the implementation effort have yet to be made public. Several important legislative bills and actions are currently pending, which will assist with the rollout of this network across all regions of the state (Still, 2018):

- Assembly Bill 348: Provides for administrative and regulatory changes that will speed up the deployment of a network of "small cell" antennas for 5G use.

- Assembly Joint Resolution 100/Senate JR 96: Encourages the use of television white space technology to increase access to the Internet.

5G Technology Headwinds

The marketplace is still attempting to settle on the final protocols for edge devices and middleware systems that will connect to the 5G network. Other technologies which will be helpful to implementation, such as Web3 design and blockchain, are also in their infancy and need to develop accepted standards before 5G networks can operate at top efficiencies. Unlike 4G, which was developed for a smartphone product that was already available and commercialized in the market, all the use cases for 5G are in development and not currently well commercialized. These include: connected factories, autonomous vehicles, smart city platforms and virtual reality. Until these use cases become commercially viable, it will be hard for providers to justify large scale investments and wide-ranging rollouts of 5G networks, particularly in remote and under-served areas. Thus, it is anticipated that the earliest implementations of the technology will occur in the larger, more technology dense, metropolitan areas of the country. MadREP needs to ensure that its eight-county Region is high on the list of target areas to be served and the network gets built out as quickly as possible.

5G and Business Retention and Attraction Issues

5G will help usher in the IoT era which will result in the commodification of information and data intelligence (West, 2016). Health care businesses that are currently investing in IoT technologies, including UW Hospital and Clinics, SSM Health, Eyecor, DotCom Therapy, and GE Healthcare, as well as the health IT and bioscience businesses that serve the industry, will benefit from this transition to 5G. The Region cannot afford to lag the nation on the network rollout or staff believes we risk compromising our competitiveness in retaining and attracting these types of health care businesses.

Mobility Trends Influencing the Attraction and Retention of Health care Talent

As noted throughout this analysis, the quantity and quality of health care talent is a primary factor in driving the success and growth of the overall cluster. Furthermore, there is evidence that jobs, particularly those in the knowledge economy, increasingly flow to areas with high levels of talent rather than people moving to areas with a large number of jobs. That is, knowledge economy jobs follow talent rather than talent following jobs (see Hicks and Faulk, 2016 for one summary of this research). These trends suggest that economic development strategies should incorporate talent attraction, expansion and retention rather than simply trying to attract, expand and retain companies. Accordingly, talent attraction and retention strategies should be an emphasis of health care cluster development in the Madison Region.

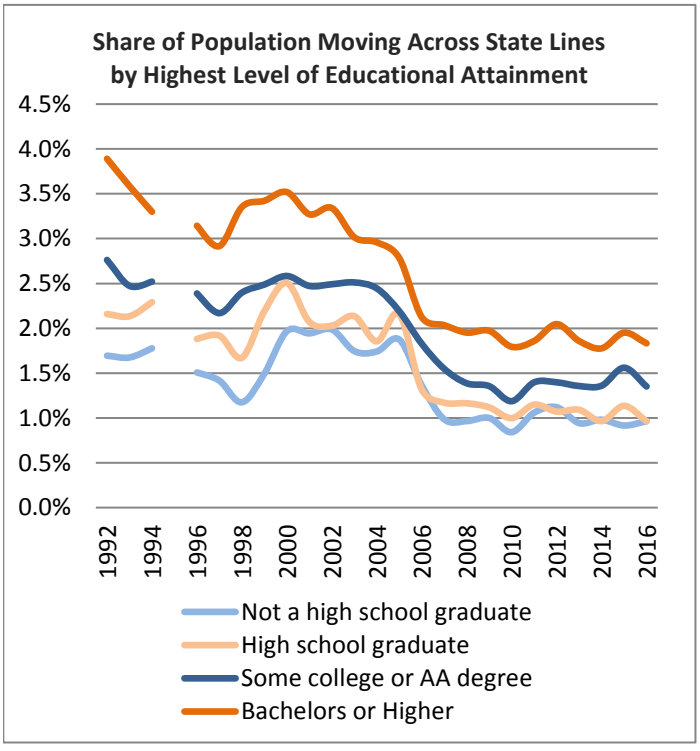
What factors drive the movement and locational decisions of health care talent? While a large body of research specific to the locational factors of talent working in health care related occupations does not yet exist, other research on the movement of college graduates and individuals by age group provides some insights. The movement of college graduates is an important consideration as Section 2 noted that many portions of the health care cluster tends to rely heavily on occupations that often require a college degree. Subsequently, those factors that influence the location and concentration of highly educated individuals also could inform talent attraction and retention strategies related to the health care cluster. Furthermore, several industries in the health care cluster have a higher concentration of young workers. Accordingly, the locational decisions made by younger workers may also inform attraction and retention strategies.

For purposes of this analysis, talent attraction is considered from an interstate rather than an intrastate perspective. While the Madison Region will continue to attract individuals from other parts of Wisconsin, the Madison Region is focused more so on bringing new talent into the area from other states rather than trying to actively poach talent from within the state.

Interstate Mobility Rates by Educational Attainment and Age

The ability of the Madison Region to attract talent is influenced by trends in the interstate mobility of workers. This mobility is influenced by many factors. For instance, mobility across state lines varies by levels of educational attainment. Nationally, individuals with a Bachelor's degree or higher tend to be the most mobile with almost two percent of this demographic group moving across state lines in recent years (Figure 3.4). In contrast, only one percent of individuals with a high school degree or less move across state lines. Accordingly, college graduates, who comprise a

Figure 3.4 – Interstate Mobility by Educational Attainment

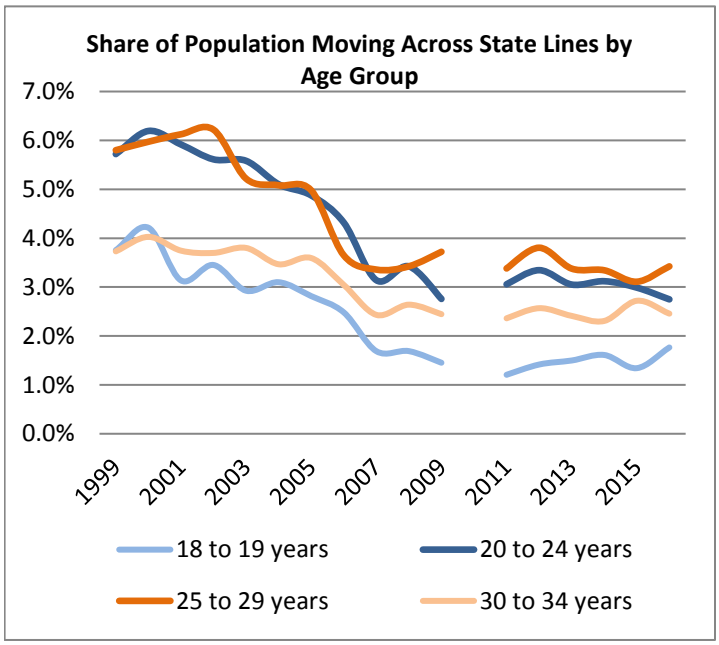


Source: Current Population Survey and Authors' Calculations

large share of potential health care talent, are more likely to make this type of move than individuals with lower levels of educational attainment. These rates should not be surprising as Section 2 noted that many health care related occupations in the Madison Region have among the highest share of individuals who were born in another state among all occupational categories.

Mobility rates also vary by age group with individuals between the ages of 20 and 34 being the most mobile in terms of moves across state lines (Figure 3.5). While other age groups not depicted on Figure 3.5 do also move from state to state, mobility rates decline dramatically for individuals over the age of 40 who are in the labor force. However, mobility does increase somewhat again as individuals approach retirement.

Figure 3.5 – Interstate Mobility by Selected Age Group



Source: Current Population Survey and Author's Calculations

An important trend depicted in Figure 3.4 and Figure 3.5 is the downward share of people moving across state lines. While the young and college educated still remain one the most mobile demographic segments, their interstate mobility rates have declined notably since the late 1990s. Similar trends are also apparent among other demographic categories as overall interstate mobility has been on the decline over the last several decades. Indeed, recent mobility rates are among the lowest recorded. Some of these declines are attributed to economic cycles (such as the Great Recession), but the trend is also secular in nature (Benetsky and Fields, 2015). *Accordingly, regions that are trying to attract talent from other states are faced with a population that is increasingly rooted in place*. These trends also suggest that producing talent locally and retaining existing talent are important strategies for the health care cluster.

Migration Characteristics from a Life Stage Perspective

As young, educated workers are increasingly pursued by regions and states through a variety of direct and indirect incentives, it is worth noting that the factors influencing the migration of these individuals change from a life stage perspective. While an in-depth analysis of these factors is beyond the scope of this report, it is broadly important to recognize that the factors influencing the movement of college graduates vary by recent graduates, young households without children, and somewhat older households with children (Whisler, Waldorf, Mulligan and Plane, 2008). For instance, the availability of recreational opportunities are important to all three categories, while cultural environments are more important to recent graduates and young households without children (Figure 3.6). Job markets are also important to all three broad life stages considered here. The importance of diversity and tolerance has also been cited as a factor in attracting and retaining creative, educated talent (Florida, 2002). However, diversity was not explicitly identified as a factor in a study of recent college graduates who were raised in rural areas (Fiore et al., 2015). Accordingly, preferences may vary according to the locales where talent originates.

These types of differences among college educated individuals are important as a talent attraction strategy cannot be solely based on an all-encompassing message for the Madison Region. Furthermore, recognizing how these factors change could also help in talent retention as individuals move from one life stage to the next. Indeed, the Region should highlight the strength of its job market in health care industries. The Region should also highlight its diverse quality of life assets that are desired by each life stage. While basing economic development strategies on rankings often leads to poor policy, talent attraction and retention in the health care sector is an exception to this statement. That is, the Madison Region should highlight all of its accolades and rankings to showcase its desirability to individuals and households across these different life stages. Finally, individual communities in the Region should be prepared to tailor their messages to their target audiences, be they recent graduates, households without children or households with children.

Figure 3.6 – Selected Factors Influencing Migration among College Graduates

Recent Graduates	Young households without children	Middle aged households with children
• Recreational opportunities	• Recreational opportunities	• Crime rates
• Cultural Environment	• Cultural Environment	• Recreational Opportunities
• Cost of Living	• Climate	• Job Market
• Job Market	• Crime Rates	• Climate
	• Job Market	

Source: Whisler, Waldorf, Mulligan and Plane, 2008

Housing Market

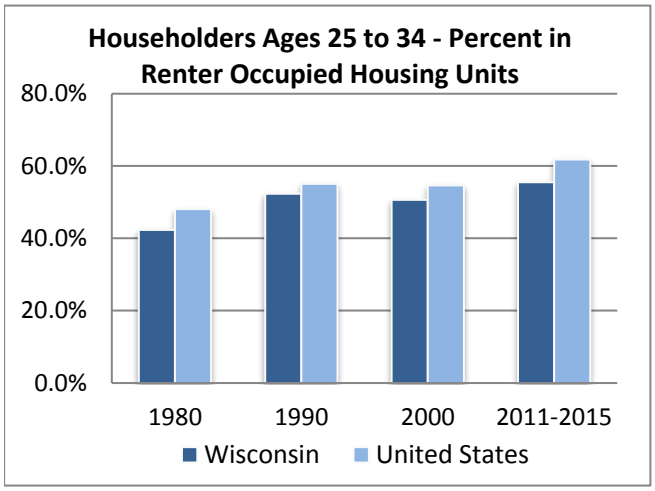
The Region's housing market should also be considered as a factor in talent attraction and retention, not only for the health care cluster, but all industries in the Region. Conversations with the Region's economic development professionals, employers and workforce development organizations suggest that housing cost and availability, particularly for first-time buyers, is emerging as a challenge for many communities. These changes may be particularly relevant to talent attraction as cost of living is particularly important to new college graduates and cost of living is greatly influenced by housing costs (Figure 3.6). While a full housing market study is beyond the scope of this analysis, it worth examining several measures of the regional housing market.

Housing costs are a potential advantage of the Madison metro area compared to the many of the large metro areas with large health care industry and talent concentrations (see Section 1 and Section 2). When comparing housing costs, it is important to recognize that these costs can vary considerably within a metro area. Furthermore, we do not necessarily compare similar homes across metro areas in terms of size, number of bedrooms, year of construction, and other characteristics that may influence housing costs. However, comparisons of gross median monthly rent and median monthly owner costs for owners with a mortgage do provide some perspectives on housing cost variations (and cost of living differences).

Rental unit availability and cost are important considerations to attracting and retaining talent. While younger residents may be driving recent increases in home sales, the rates of young adults living in rental housing have increased over the past several decades. In 1980, when a cohort of Baby Boomers were young, only 48 percent of U.S. residents between the ages of 25 and 34 lived in rental units. Wisconsin's rate that year was even smaller at just 42 percent. By 2015, when this age category consisted of Millennials, the proportion of

renters had grown to 62 percent of U.S. residents between the ages of 25 and 34 (Figure 3.7). The Joint Center for Housing Studies of Harvard University notes that factors such as higher levels of student debt, lower incomes and a limited inventory of new starter homes contribute to these higher renter rates. Delayed marriage and household formation rates are also factors.

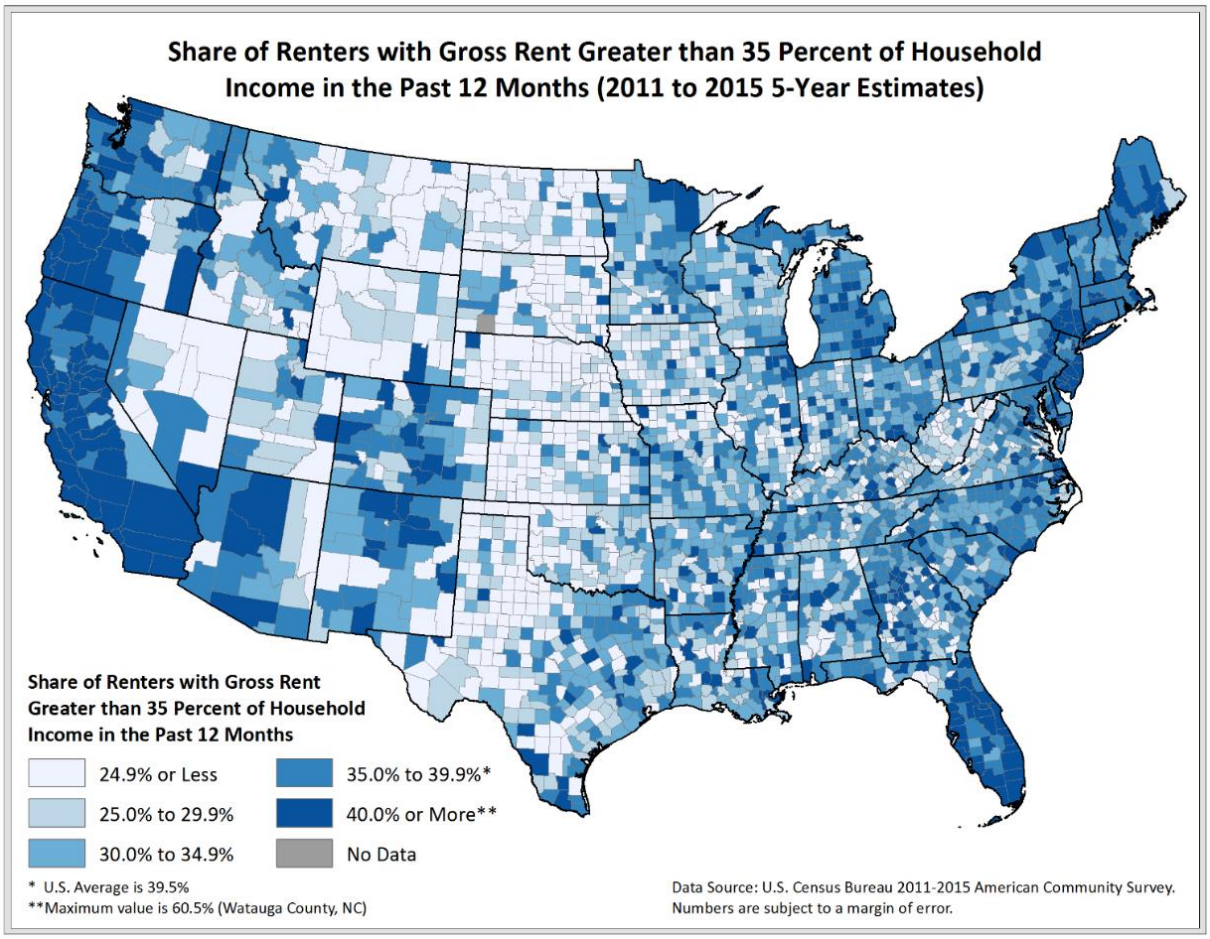
Figure 3.7 – Trends in Renter Occupied Housing



Source: U.S. Census Bureau and Authors' Calculations

Using rental housing costs that exceed 35% of household income as a measure of cost burden, rental costs in the Madison Region can be viewed from several perspectives. Lower shares of renter household in the Madison Region are considered to be cost-burdened relative many areas in the United States. When compared to many other areas along the West Coast, the Mountainous West, the Northeast, the Madison Region has a lower share of households that would be considered as rent burdened, or above the 35% threshold. The Madison Region also has an advantage to neighboring large metro areas such as Minneapolis and Chicago (Figure 3.8).

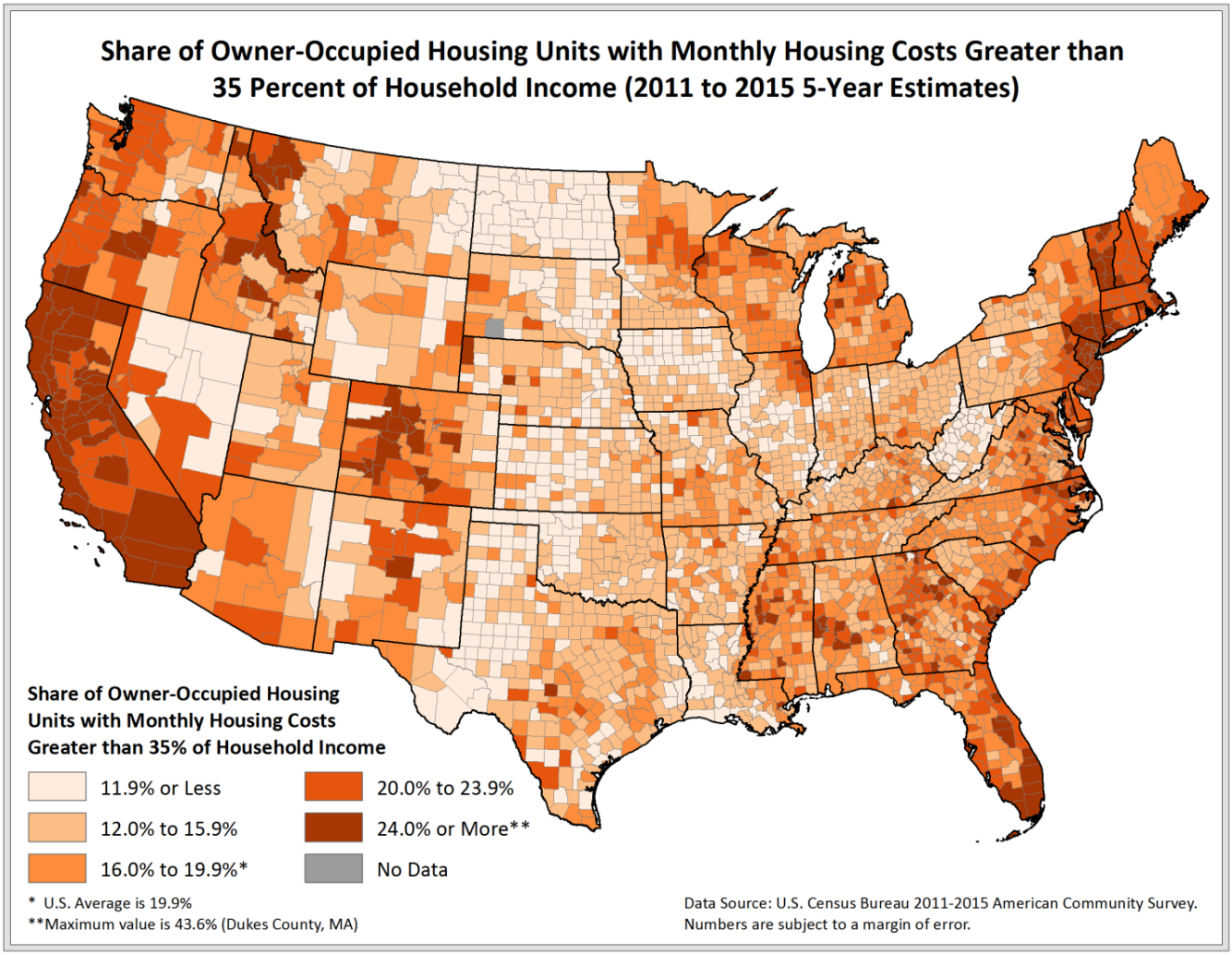
Figure 3.8 – Renter Occupied Housing Units with Monthly Housing Costs Greater than 35% of Income



Second, rates of cost-burdened renter households vary throughout counties and communities within the Madison Region. Dane County and Rock County tend to have a higher share of renter households considered to be cost-burdened while Green and Iowa counties have lower shares. Finally, renter costs do not necessarily describe housing quality. That is, lower costs (and higher costs in some instances) could also be associated with low quality housing stock. Accordingly, the Madison Region will likely need to consider its rental market from both local and regional perspectives. More detailed assessments of housing supply and demand are needed than can be provided in this overview.

Similar to rates of renter burdened household, owner occupied housing costs in the Madison Region have lower levels of stress relative to many other areas in the United States. Again, using 35% of income as a threshold for housing stress shows that all counties in the Madison Region have less than 20 percent of their owner-occupied households that exceed this threshold (Figure 3.9). As with cost burdens for renters, many areas on the coasts and in the high amenity mountainous west have more shares of households that may be under housing cost stress. Again, many of these areas have large concentrations of health care related industries and talent.

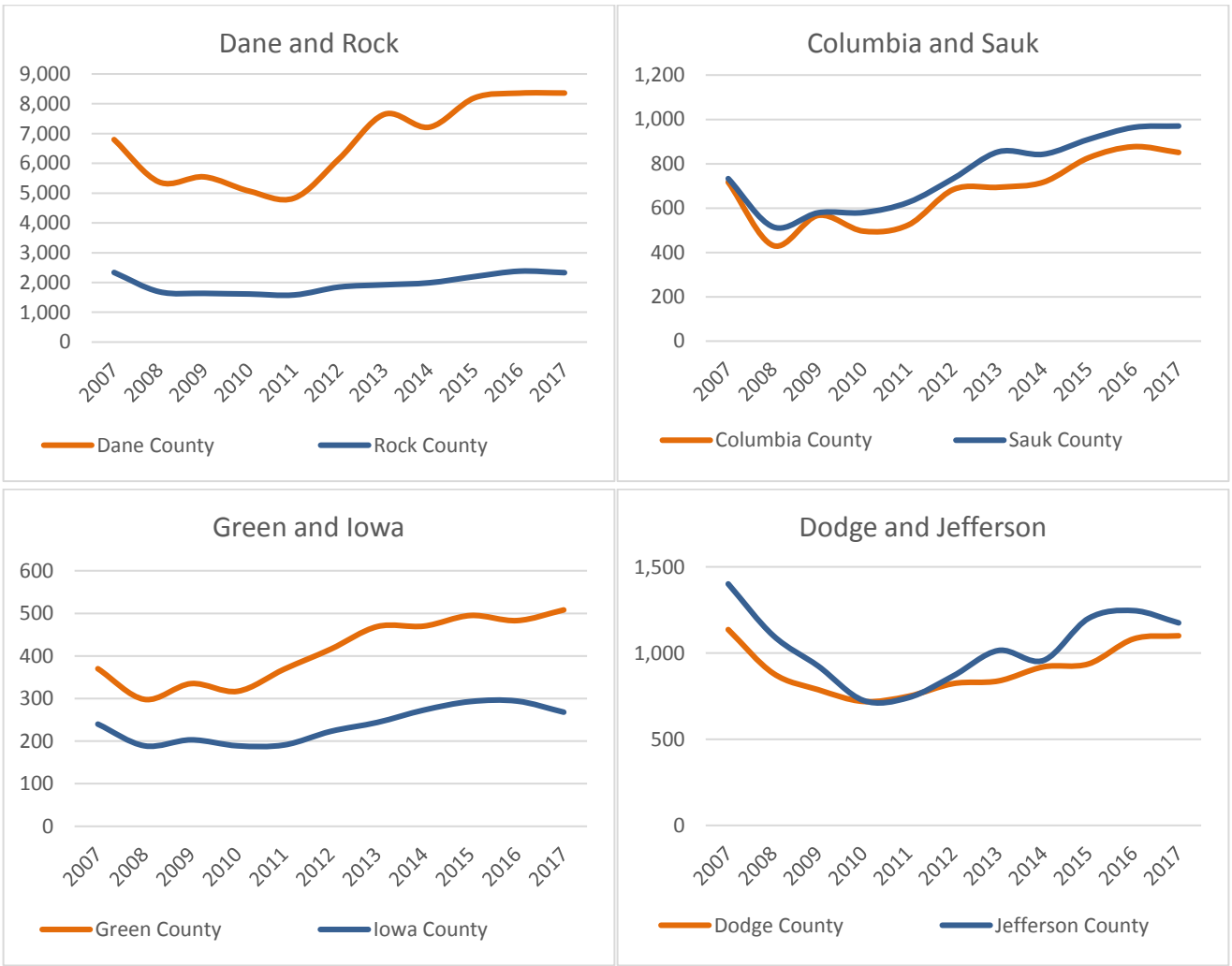
Figure 3.9 – Owner Occupied Housing Units with Monthly Housing Costs Greater than 35% of Income



While the Madison Region fares well in terms of median housing costs relative to many other areas, Section 2 noted annual average salaries for many health care-related occupations are $40,000 or less. As a result, the housing cost advantages may not be as large as they appear for some employees in the health care sector. Consequently, the Region should consider whether its potential advantage in housing costs may extend to all types of health care occupations and talent.

When considering current and future housing costs and availability in the Madison Region, it is important to note that the cost and supply of housing in the Region has experienced a number of changes since the Great Recession. In particular, the number of home sales in most Madison Region counties are above or well above sales volumes at the start of the Great Recession. Dane, Columbia, Sauk and Green counties have seen significant growth in sales over the past six years. Only Jefferson and Rock counties have lagged somewhat in sales activity (Figure 3.10). The recent growth in home sales is partially driven by Millennials who are increasingly entering the housing market.

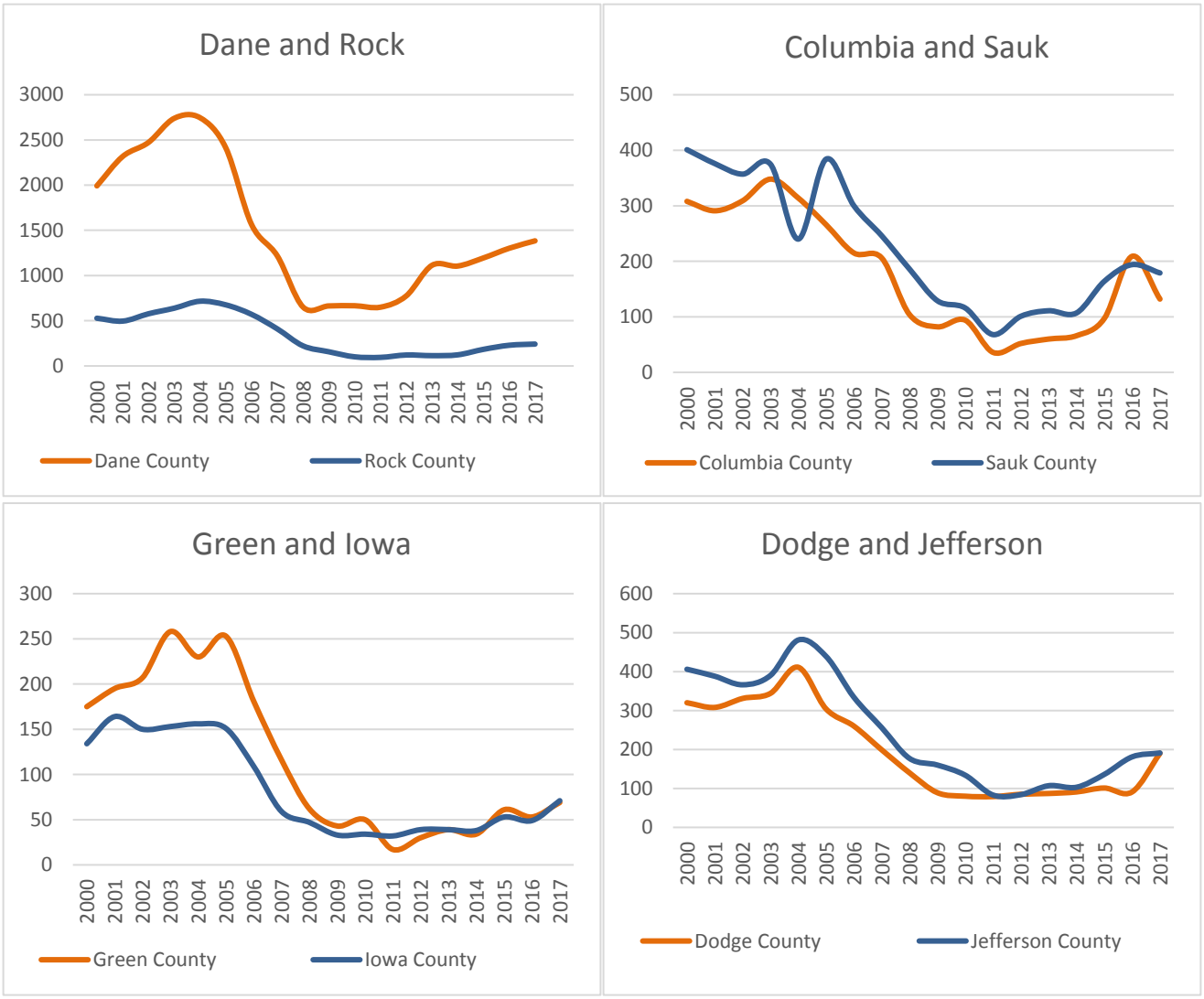
Figure 3.10 – Annual Home Sales by County in the Madison Region



Source: Wisconsin Realtors Association

While sales have rebounded somewhat in the last five years, single family housing permits for new construction continue to remain below their 2007 levels in all counties in the Madison Region with the exception of Dane. From a longer term perspective, single family home permits continue to be well below the levels found in the early 2000s (Figure 3.11). These changes to single family housing market are certainly attributed to lingering effects of the recessionary period, but are due to other factors such as changes to the construction sector. For instance, 82% of builders nationally report labor shortages compared with just 11% in 2011. These shortages drive up builder costs, lengthen building cycle times and hamper construction activity. Labor force conditions in the Region make it unlikely these shortages will change in the near future.

Figure 3.11 – Single Family Home Permits by County in the Madison Region



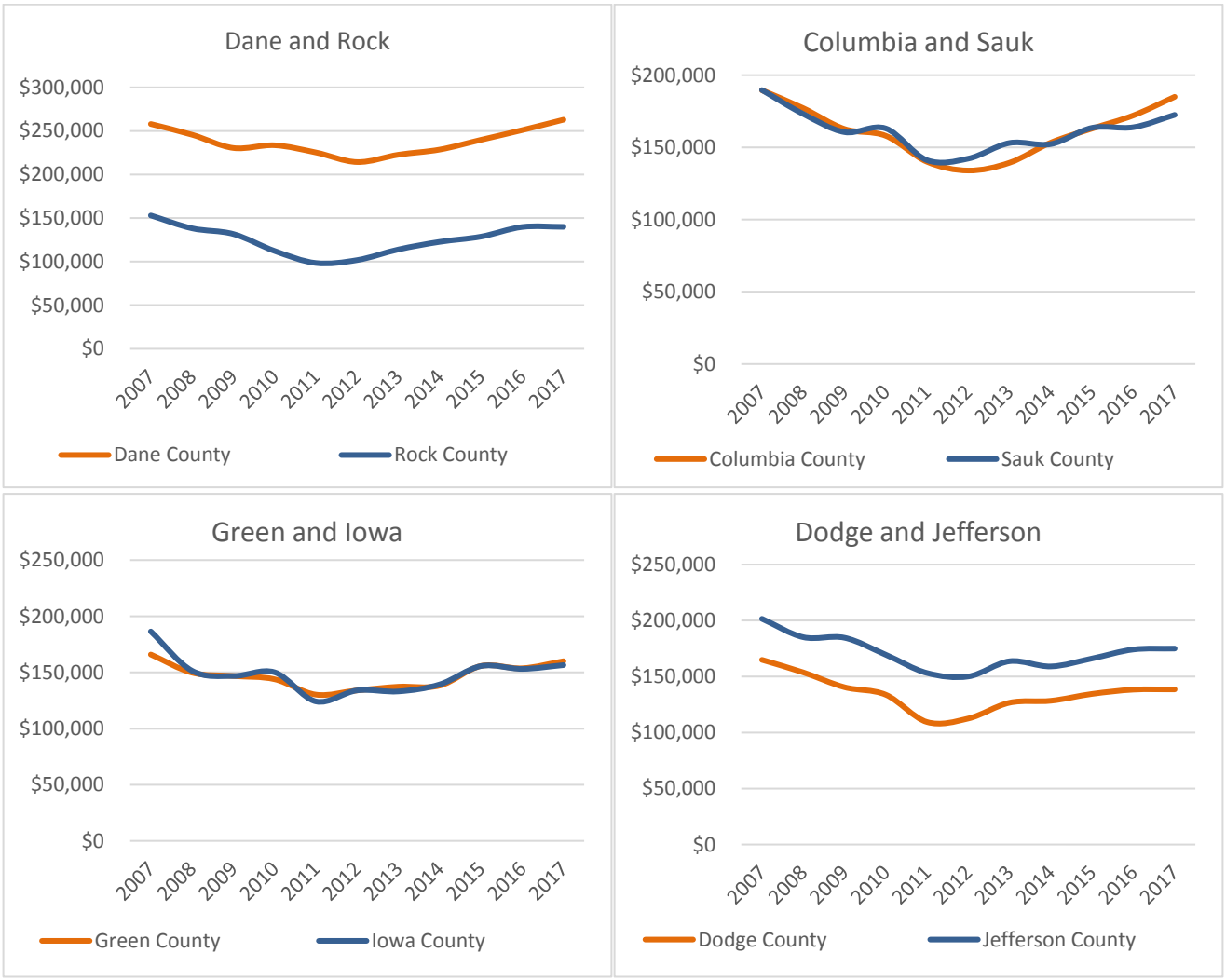
Source: U.S. Census Bureau Business Permits Survey

While not included in this analysis, it is important to note that Dane County has continued to add a significant number of multi-family units, averaging almost 2,500 units per year over the past five years. In 2016 and 2017, Dane County added approximately 3,000 units each year, which were the highest levels in the last two decades. In contrast, other counties have struggled to add multi-family units. Combined, the other seven counties in the Madison Region have only added 250 to 300 total units per year since 2013. If these areas are

to attract younger residents, the development of multi-family rental units should be considered as one strategy. Otherwise, outlying counties may not have the housing stock desired by many younger households. The question with rates of new home construction is whether they will increase in a manner that will keep home prices in the Region affordable and competitive, particularly for first-time buyers. After adjusting for inflation, the median sales prices for single family homes in most Madison Region counties have rebounded over the last five years and are now approaching 2007 values (Figure 3.12). Dane County is one exception to this trend, where the median sales price now exceeds its 2007 value. In contrast, median sales prices in Dodge and Jefferson counties have not experienced the same levels of increases found in other counties.

While median sales prices have rebounded, they have done so during a period of historically low interest rates. However, average 30 year mortgage rates have increased from 3.96% to 4.52% in the past year. As the Federal Reserve is expected to continue increasing interest rates, mortgage rates will continue to rise as well. As interest rates rise, they will continue to impact the number of households that can afford home mortgages as well as the value of homes that can be purchased.

Figure 3.12 – Median Sales Price by County in the Madison Region



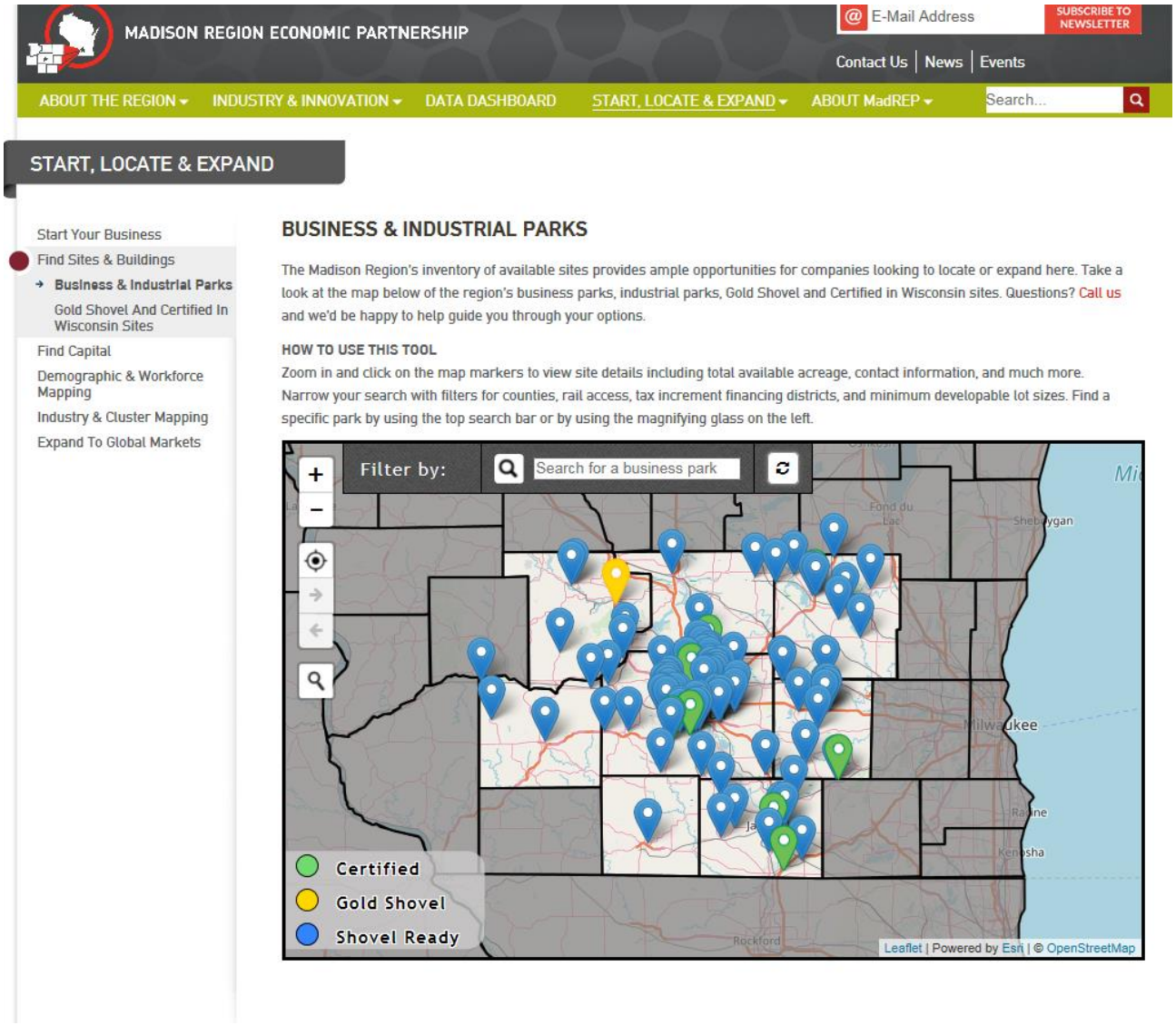
Source: Wisconsin Realtors Association

Research Parks, Certified and Gold Shovel Sites, and Specialized Commercial Spaces

There are many real estate based assets that are available to assist targeted industries, including health care businesses, find suitable locations to start or expand their operations in the Region. A summary of three of these assets are provided below.

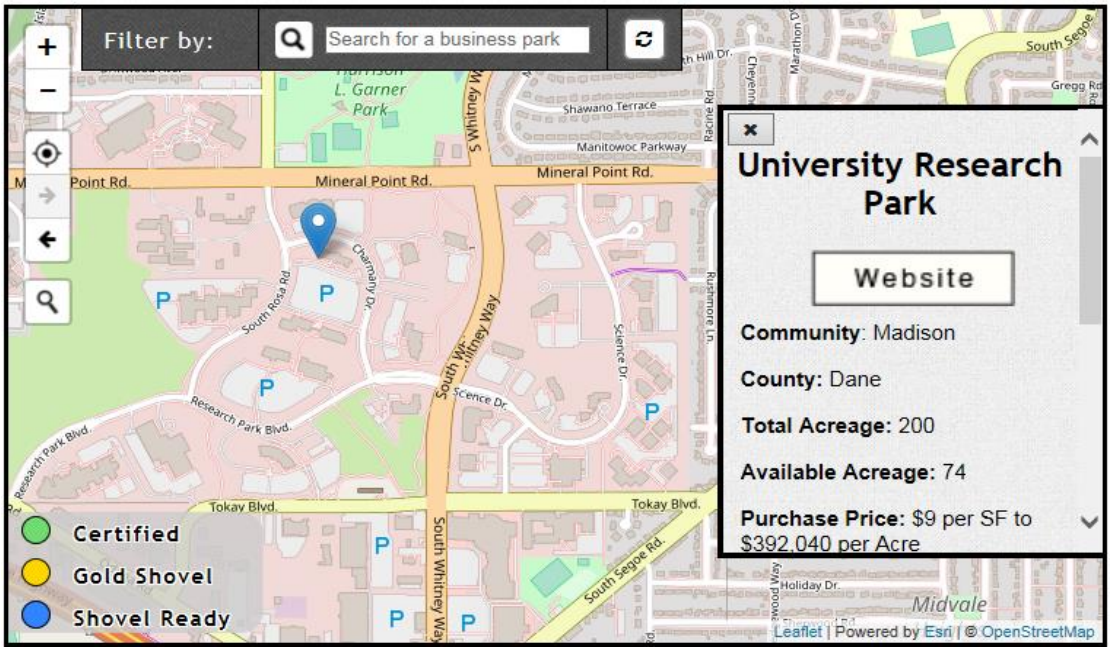
- *Business, Industrial and Research Parks* - MadREP maintains an interactive map of all 103 business, industrial and research parks located in the Region. In 2017, these parks totaled a combined 11,000 acres (115 acres average) of which 4,200 acres were available for development (48 acres average). See http://madisonregion.org/start-locate-expand/find-sites-and-buildings/business-industrial-parks/ for a link to the map. A screen shot of the mapping tool is provided below along with a pop-out dialogue box for the University Research Park showing the information included when a user clicks on the map markers.

Figure 3.13 – Screen Shot of MadREP Interactive Business and Industrial Park Mapping Tool



Source: MadREP

Figure 3.14 – Screen Shot of Dialogue Box for University Research Park



Source: MadREP

These types of parks allow for the co-location of similar firms, which create localization economies and benefits for the firms in those locations (Niu et al, 2015). Similar firms may co-locate in many different types of commercial districts including but not limited to central business districts, industrial parks, suburban office parks and research parks. To help understand office market conditions and space availability in these types of commercial districts, Appendix C includes several key statistics related to office market transactions, vacancy rates and absorption rates.

Another way to consider opportunities for co-locating health care firms is through the lens of *innovation districts*. As defined by Katz and Wagner (2014), innovation districts are "geographic areas where leading-edge anchor institutions and companies cluster and connect with start-ups, business incubators, and accelerators. They are also physically compact, transit accessible, and technically wired and offer mixed-use housing, office, and retail." Katz and Wagner suggest that innovation districts are emerging throughout metropolitan areas and are being driven by innovative firms and talent choosing to concentration and co-locate in compact downtowns or employment centers that are amenity rich and foster networking, knowledge spillovers and access to resources that support innovation. Specifically, innovation districts can be largely described by three different archetypes:

1. *Anchor Plus Model* – The Anchor Plus type of innovation districts are largely located in downtowns and mid-towns of central cities. These districts are characterized by large scale, mixed-used development with proximity to anchor institutions and a concentration of similar firms, entrepreneurs and start-ups involved in the commercialization of innovation.

2. *Re-imagined Urban Area Model* – This type of innovation district is characterized by historic industrial and warehouse districts that are undergoing transformations. Historical building stocks, transit access and

proximity to downtowns in higher rent cities are features of the Re-imagined Urban Area Model. Many of these districts are often found near historic waterfronts.

3. *Urbanized Science Park Model* – Science parks, university or otherwise, were traditionally located in suburban or exurban areas that avoided mixed use development in favor of single uses that focused solely on research and innovation. However, science parks are increasingly recognizing that these isolated facilities are no longer optimal for fostering innovation and attracting young talent to the firms found in these locations. Accordingly, many research parks are undergoing a mixed use transformation that increase the density and amenities offered by these innovation centers. In addition to the North Carolina Research Triangle, the University of Virginia Research Park, the University of Arizona Tech Park and the University Research Park at UW-Madison are all pursuing this type of redevelopment.

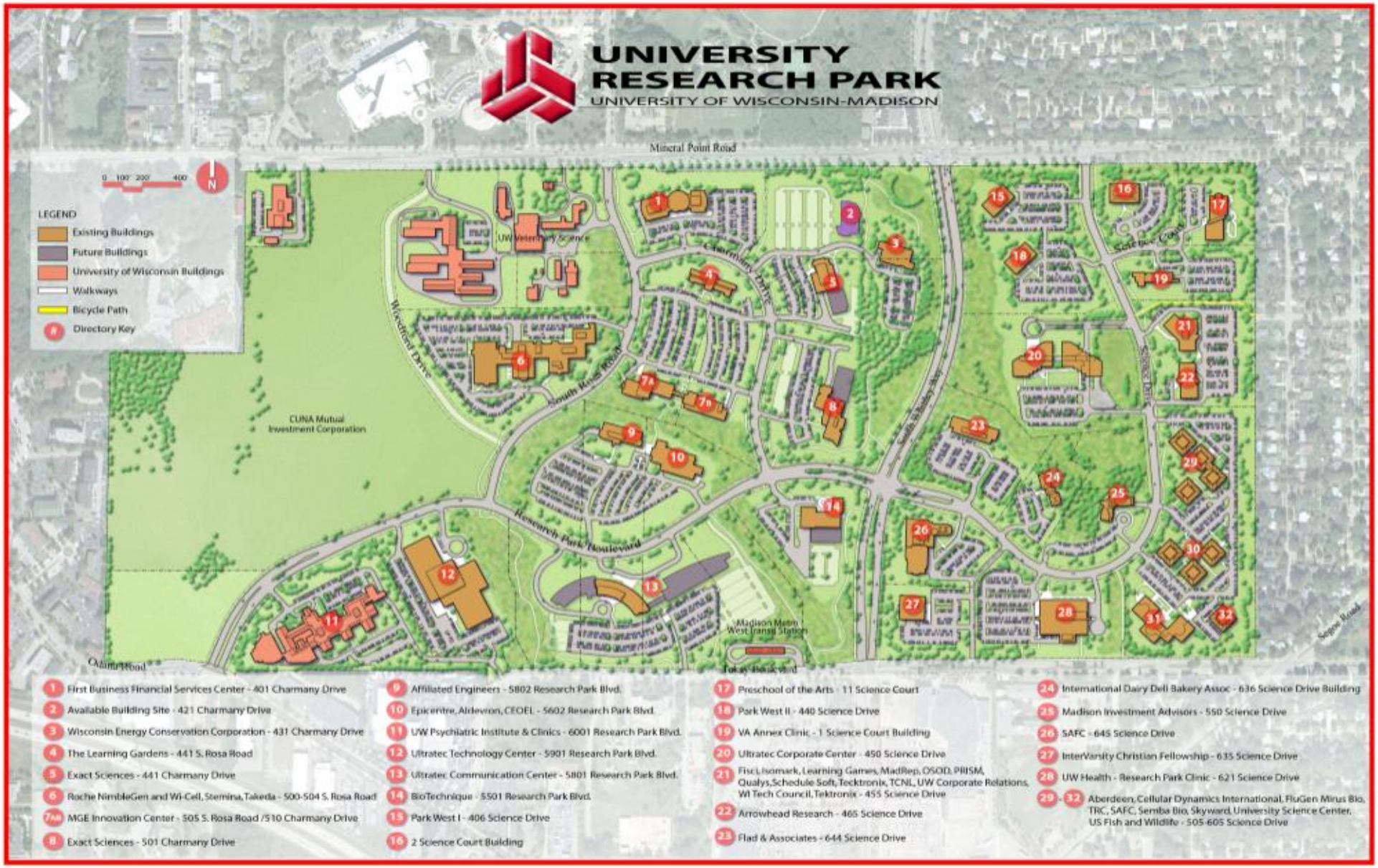
In the Madison Region, health care businesses tend to cluster in or around several research parks. Two of the largest are operated by a non-profit affiliate of UW-Madison and are designated as URP and URP^2. Details regarding URP, which is located on the near west side of Madison, are provided below and a map for the park in provided in Figure 3.15.

- Established in 1984
- Currently 274 acres – 200 acres developed; 74 available
- 37 buildings
- 1.8 million square feet under roof
- $183.3 million in value
- $3.6 million per year paid in property taxes
- 121 tenants
- More than 3,800 employees
- More than $260 million in annual payroll

URP^2 consists of 270 acres located on the far west side of Madison. Early designs call for the property to be developed with a "New Urbanism" feel consisting of 64 sites containing a mixture of office, commercial and residential development. Emphasis will be placed on environmentally friendly design, including walkable neighborhoods where people can live and work. A conceptual plan for the property is provided in Figure 3.16.

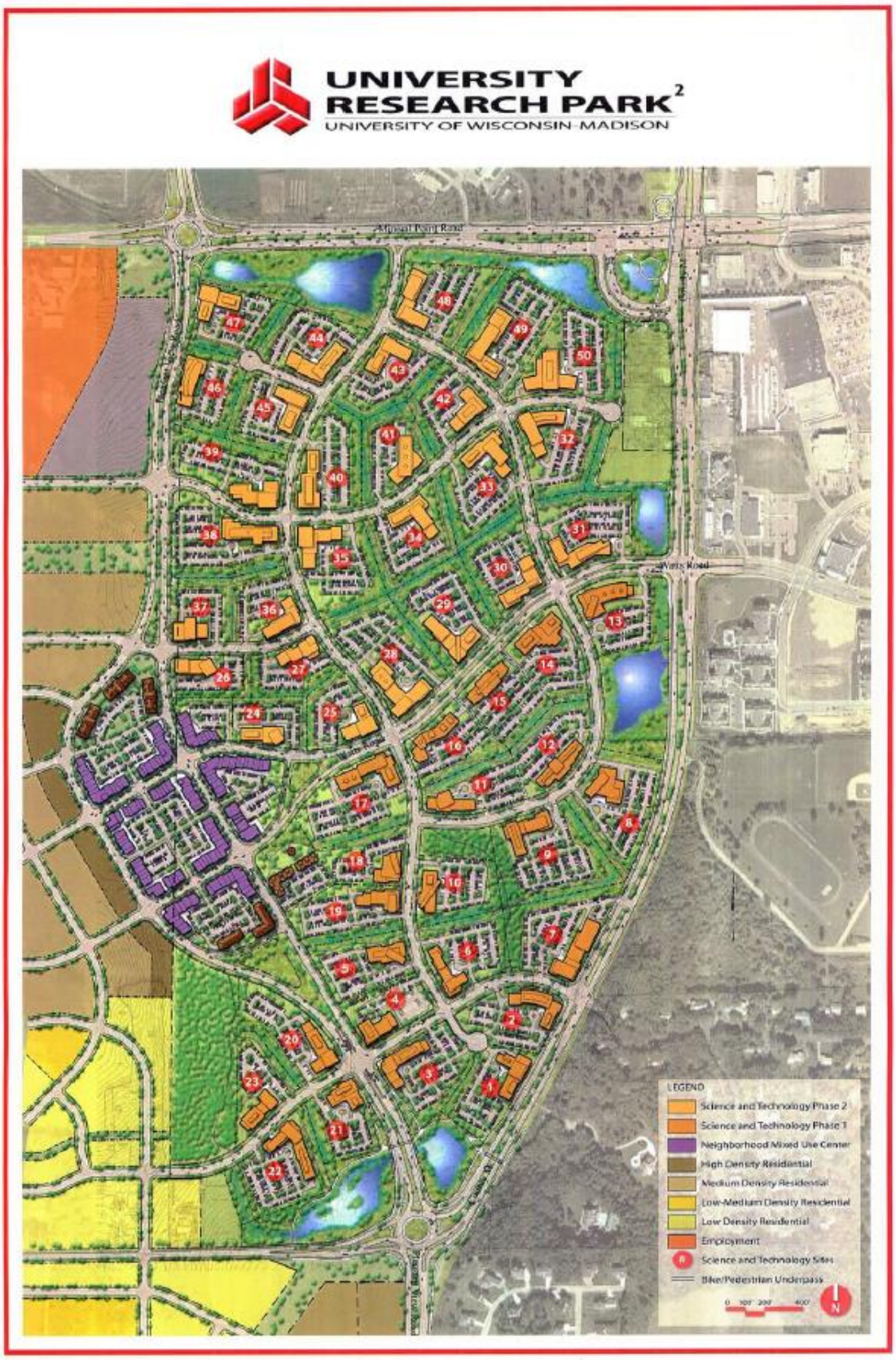
In addition, Promega and Epic Systems have developed campuses in Fitchburg and Verona respectively that provide opportunities to leverage the Urbanized Science Park model (see Appendix 3D). The concept also serves as a model for other current and future office parks/commercial developments in the Region to offer the types of amenities desired by health care and (other knowledge industries).

Figure 3.15 - University Research Park



Source: University Research Park

Figure 3.16 – University Research Park^2



Source: University Research Park

- *Certified and Gold Shovel Sites* – The WEDC developed the Certified In Wisconsin® program to set consistent standards for the certification of commercial and industrial sites, putting in place all the key reviews, documents and assessments most commonly required for office or industrial use. Certified sites mean faster turnaround times, quicker approvals and lower risk for businesses seeking developable land for a start-up or expansion project. There are currently eight certified sites located in the Region (or 38.1% of the 21 total sites located in the state) representing a combined 950 developable acres of land.

  Similar to the Certified program, the Gold Shovel Site Verification Program assists communities, counties, and private land owners in packaging and marketing development ready land to site selectors and business owners looking to locate or expand in the Region. However, in this case, the approval process is available to the site's developer at lower cost, making it a more attractive option particularly for smaller sites. Under the Gold Shovel program, administered by MadREP, a site is not held to the same level of review, documentation, and assessment as the Certified site program, but the designation does provide some assurance to a business that a site is ready for development shortly following a close. The program currently has one approved 26.66 acre site located in Baraboo. Four additional sites are currently going through the approval process in Evansville, Whitewater, Horicon and Madison.

  See http://madisonregion.org/start-locate-expand/find-sites-and-buildings/gold-shovel-sites/ for an up to date listing and map showing the location of all the Certified in Wisconsin and Gold Shovel sites in the Region (a screen shot of the most recent landing page is provided in Figure 3.17).

Figure 3.17 – Screen Shot of Madison Region Gold Shovel and Certified in Wisconsin Sites Landing Page

GATEWAY BUSINESS PARK
Baraboo, Wisconsin
Ideally located off the newly completed Highway 12 (slated to open in 2017) at the entrance to the City of Baraboo. Read more.

BEAVER DAM 151 BUSINESS PARK
Beaver Dam, Wisconsin
A brand new, 200-plus-acre corporate park development bordered on the east by Highway 151. Read more.

DEFOREST BUSINESS PARK
DeForest, Wisconsin
DeForest's Business Park is located on 115 acres on US 51 adjacent to existing industrial uses. Read more.

GATEWAY BUSINESS PARK
Beloit, Wisconsin
The new Gateway Business Park is easily accessible on the east side of the Interstate. Read more.

HIGHWAY 11 BUSINESS PARK
Janesville, Wisconsin
A 224-acre business park located on the southern side of the city, along Hwy 11, east of I-90/39. Read more.

LIBERTY BUSINESS PARK
Verona, Wisconsin
This 130-acre site fronts US Hwy 151, which connects to US Hwys 12/18, then to I-90/39/94. Read more.

NORTH MENDOTA ENERGY AND TECHNOLOGY PARK
Westport, Wisconsin
33 acres of contiguous buildable land 5 miles away from I-94 and I-90/39. Read more.

RDC FITCHBURG TECHNOLOGY CAMPUS PHASE II
Fitchburg, Wisconsin
Easily accessible and located within minutes of commercial activity and area amenities. Read more.

WHITEWATER UNIVERSITY TECHNOLOGY PARK
Whitewater, Wisconsin
A 35-acre park on the east side of the city with convenient access to I-90. Read more.

Source: MadREP

- *Specialized Commercial Spaces* – A robust inventory of specialized commercial spaces that cater to research and technology-based firms is an important economic development asset to the Region, in that it represents property that can be quickly occupied by either expanding or new businesses starting or relocating to the area. This is an important tool used retain and attract businesses to the Region without requiring the extensive lead time necessary to obtain approvals and construct new space. It is particularly important for businesses that would like to try operating in the Region prior to making a sizable capital investment in real estate. The Region has several spaces that are specialized for health care businesses that are profiled below.

- MG&E Innovation Center - 2840 Innovation Way, Madison
  Website: https://universityresearchpark.org/the-property/mge-innovation-center/

Picture credit: University Research Park and Vogel Bros Building Company

Figure 3.18 – MG&E Innovation Center

Size	113,000 sf
Available for Incubation	50,000 sf
Number of Office Suites	27
Number of Lab Suites	34
Total Suites	61
Amenities-Office Suites	Open floor plan; phone and high-speed Internet connections
Amenities-Lab Suites	Sink and water; 12-foot bench with cabinets; increased electrical service capacity; chemical exhaust fume hoods

Source: University Research Park

- University Research Park Accelerator – 5602 Research Park Boulevard, Madison
  Website: https://universityresearchpark.org/the-property/university-research-park-accelerator/

Picture Credit: University Research Park and Vogel Bros Building Company

Figure 3.19 - Building Specifications: URP Accelerator

Size	80,000 sf
Divisibility	3,000 to 6,000 sf
Construction	3 stories
Key Building Features	Mechanical equipment redundancy for reliability
	Unlimited HVAC zoning capacity
	Computerized monitoring for precision climate control
	280 to 400 tons of building cooling
	80,000 to 120,000 cfm of supply air
	4.0M to 7.0M BTU's of heating capacity
	22,000 to 44,000 cfm of exhaust capacity
	2 megawatts of power; variety of voltage options
Key Lab Features	BSL wet labs; clean rooms; fume hoods

Source: University Research Park

- @1403 (including Madworks Accelerator) – 1403 University Avenue, Madison
  Website: https://urpat1403.com/

  @1403 is an approximately 15,000 square foot innovation center that is located on the campus of UW-Madison and managed by the URP. The center is home to gBETA, Madworks Coworking, Madworks Accelerator, UW-Madison Discovery to Product (D2P) and UW-Madison Law & Entrepreneurship Clinic.

- Fitchburg Center (including the Faraday Center) – 2800 S. Fish Hatchery Road, Fitchburg
  Website: http://www.fitchburgcenter.com/

Source: Promega Corporation

The Fitchburg Center is a mixed-use community located on over 400 prairie, woodland, and wetland acres, which was developed by Promega Corporation and caters to a mix of high technology businesses with civic, retail, educational, and residential opportunities (see Appendix 3D). Protection of the environment, quality design, community and sustainability are the Center's guiding principles. The Center has rental space available for new and existing health care and technology-based businesses. It also is home to the Faraday Center, a 2,800 square foot research and development facility, and the BioPharmaceutical Technology Center Institute (BTCI). The key features of the development include:

- Ten minutes to downtown Madison, University of Wisconsin campus, and the arts district. Twenty minutes to the Dane County International Airport (MSN)
- Four-lane access to interstate system and air transportation
- 16-acre Wi-Fi canopy for wireless outdoor access to the Internet
- Access to premium high-speed communication technology. On-site Internet service provider with Sonnet Ring connectivity
- Extensive trail system for walking, biking, and cross-country skiing
- Conference and meeting rooms for 300+ within development
- On-site services including: day care, clinic, restaurants, and printing
- Private school, city government and community center located within Center
- Lodging, financial centers, health club and a variety of housing choices

- Wisconsin Information Security Research Center, University Research Park, Madison
  Website: https://universityresearchpark.org/the-property/wisc/

The Wisconsin Information Security Research Consortium operates and maintains a Sensitive Compartmented Information Facility (SCIF) in the URP on the near west side of Madison. The facility is designed to meet federal standards for conducting classified research. Its mission is to foster collaborative and strategic alliances between government agencies, private industry and academic institutions. It is available for lease to businesses with enhanced cybersecurity needs or that require a secure facility in order to perform contract work with government entities including the Department of Defense and Department of Energy or private businesses requiring extraordinary project secrecy.

An important MadREP KSI is to assist the property owners through site searches and other business start-up and expansion activity in filling these spaces.

Educational Institutions

As noted in Section 2, a large share of health care-related talent requires graduates at the Bachelor's level or higher. Furthermore, connections to universities also creates opportunities for developing new technologies though research. Accordingly, the connections between firms and universities are often an important component of health care sector development initiatives. However, health care support from educational institutions extends beyond 4-year universities to include colleges and technical schools that may provide Associate's degrees, certificates or continuing education. The development of health care talent also starts in the region's K-12 system to provide a pipeline of students to higher educational institutions.

The Madison Region's vast network of higher education institutions serves as a launch pad for professionals ready to fill positions with new and expanding health companies. In 2016-2017, higher education institutions in and adjacent to the Madison Region conferred 11,178 degrees and certificates applicable to health care positions (See Figure 3.20).

Table 3.20 - 2016-17 Degrees Conferred: Health Care

Institution	Certificate	Associate	Bachelor	Master	Doctor	Total
UW-Madison	442		1,955	368	721	**3,486**
UW-Milwaukee	91		866	145	93	**1,195**
UW-Platteville			135			**135**
UW-Whitewater			229	14		**243**
Alverno College	12		143	53		**208**
Beloit College			41			**41**
Blackhawk Technical College	150	84				**234**
Concordia University	8		262	263	113	**646**
Edgewood College			185	47	4	**236**
Herzing University – Madison	166	190	95	129		**580**
Madison College	1,238	405				**1,643**
Medical College of Wisconsin	15			48	251	**314**
Moraine Park Technical College	461	170				**631**
Southwest Wisconsin Technical	390	87				**477**
Total	**2,973**	**936**	**3,911**	**1,067**	**1,182**	**10,069**
Total Degrees Conferred	7,315	2,794	15,741	4,463	1,759	32,072
Percent (Health care)	40.2%	33.5%	22.3%	15.8%	46.5%	27.8%

Source: National Center for Education Statistics. Note: Includes programs and award levels that are offered as a distance education program. Degree programs in health care include biological and biomedical sciences; family and consumer sciences/human sciences; health professions and related programs; and psychology-general.

- *University of Wisconsin-Madison* – UW-Madison is a powerhouse in generating research and talent for the health care industry. The University granted a total of 3,486 total degrees in health care majors during the 2016-17 school year or 25.6% of the 13,604 total degrees conferred across all programs (Figure 3.21). The top health care fields included: health professional and related programs (1,558 degrees) and biological and biomedical sciences (1,343). UW-Madison also provides significant course and degree offerings in family and consumer sciences, and psychology. Almost 49% of all the Doctorate degrees conferred in 2016-17 were in health care programs. The UW School of Medicine and Public Health is one of the nation's leaders in securing funding for National Institute of Health (NIH) research. Departments within the School include:

anesthesiology, dermatology, emergency medicine, family medicine and community health, human oncology, neurological surgery, neurology, obstetrics and gynecology, ophthalmology and visual services, orthopedics and rehabilitation, pathology and laboratory medicine, pediatrics, psychiatry, radiology, surgery, urology, biomolecular chemistry, biostatics and medical informatics, cell and regenerative biology, genetics, medical history and bioethics, medical microbiology and immunology, medical physics, and neuroscience. The University also excels in generating talent from its top ranking Schools of Pharmacy and Veterinary Medicine, as well as geneticists from the College of Agriculture and Life Sciences (CALS).

Table 3.21 - 2016-17 Degrees Conferred by University of Wisconsin-Madison: Health Care

Degree Program	Certificate	Bachelor	Master	Doctor	Total
Biological and Biomedical Sciences	92	1,037	84	130	**1,343**
Family and Consumer Sciences/Human Sciences		197	15	5	**217**
Psychology-General		285	52	31	**368**
Health Professions and Related Programs	350	436	217	555	**1,558**
Total	**442**	**1,955**	**368**	**721**	**3,486**
Total Degrees Conferred (UW Madison)	2,664	7,198	2,262	1,480	13,604
Percent (Health care)	16.6%	27.2%	16.3%	48.7%	25.6%

Source: National Center for Education Statistics

- *University of Wisconsin System* - Wisconsin's four UW System schools, located in or immediately adjacent to the Madison Region (UW-Madison, UW-Milwaukee, UW-Whitewater, and UW-Platteville), support the Region's strong history and exceptional strength in the health care industry. Independently and collectively, all four universities conferred 5,059 degrees in health care related fields including: medicine, nursing, biology, microbiology, biochemistry, molecular biology, and neuroscience. Health care degrees represented 21.7% of all degrees conferred at UW-Milwaukee, 8.8% of all degrees at UW-Whitewater, and 7.5% of all degrees at UW-Platteville from 2016-17.

- *Alverno College* – This four year, primarily women's, college located in Milwaukee offers Bachelor's degrees in biology, molecular biology, nursing (including psychiatric nurses), music therapy, and art therapy.

- *Beloit College* – This private liberal arts college offers Bachelor's degrees in computer sciences, engineering, chemistry, biological and biomedical sciences, and mathematics.

- *Blackhawk Technical College (Janesville)* **–** Blackhawk Technical College offers certificates and Associate's degrees in nursing, emergency medical technician (EMT), biotechnology technician, medical laboratory technician, diagnostic medical sonography, medical assistant, pharmacy assistant, and computer technologies. These programs represented 47% of the degrees conferred in 2016-17.

- *Concordia University* – Concordia is a private liberal arts college based in Milwaukee that offers Bachelor's, Master's and Doctorate's degrees in biology, biomedical sciences, exercise therapy, human development, nursing, medical sonography, health services administration, occupational therapy, pharmacy, physical therapy, and physician assistant. These majors represented over 40% of the 2016-17 graduating class including 100 Registered Nurses, 84 pharmacists and 30 physician's assistants.

- *Edgewood College (Madison)* - This private four-year institution offers Bachelor's degrees in nursing, biology, marriage and family therapy, environmental science, computer information systems and mathematics, and boasts 100% field placement upon graduation.

- *Herzing University (Madison)* **–** Associate's degree programs include nursing, health information records administration, medical insurance coding, computer networking and security technology, and software development. Bachelor's degrees offered include Registered Nurse, information technology, software development, and modeling virtual environments and simulation. Master's degrees are offered in family practice nursing and nursing education. These programs represented 73% of all degrees conferred in 2016-17.

- *Madison College (Madison)* - Degrees and certificates in bioinformatics, biotechnology, physical therapy, animal health, nursing, radiology, optometrics, horticulture and stem cell technologies are among the programs offered at Madison College, while information technology, manufacturing and laboratory technician programs offer supporting and supplementary education for the health care workforce. These programs conferred 1,944 degrees or 51% of all degrees in 2016-17.

- *Medical College of Wisconsin* – The College is a private medical school and graduate school of the sciences based in Milwaukee, which along with UW Madison represents one of two teaching medical schools in the state. Similar to UW-Madison, it also engages in research and to this end maintains a close affiliation with Froedtert Hospital, which operates an adult level 1 trauma center and a specialty clinic proximate to campus. The College offers certificates and Master's and Doctorate's degrees in biochemistry, bioinformatics, biophysics, cell biology and anatomy, microbiology, pharmacology, physiology, medicine, clinical sciences, and bioethics. Health care majors make up 100% of its graduating class which included 219 physicians in 2016-17.

- *Moraine Park Technical College (Beaver Dam)* **-** Several specializations are available within Associate's degree and certificate programs including: nursing, respiratory care, surgical technology, EMT, chiropractic assistant, medical laboratory technician, health information records administration, medical office management, radiologist assistant, web designer/developer, information security, and computer programming.

- *Southwest Wisconsin Technical College (Fennimore)* **-** Southwest Tech provides Associate's degrees in nursing, EMT, medical insurance coding, mental health services, physical therapy, dental assistant, digital multimedia design, computer networking and telecommunications, and computer support specialist.

- *College of Osteopathic Medicine (Jefferson)* – While not reflected in Table 3.20, planning is currently underway for the development of a possible third medical school in the state which would be focused on graduating primary care doctors trained in osteopathic medicine. Planners are hoping to open the college in 2022 with an initial enrollment target of 160 students per year.

Feedback from primary surveys and interviews conducted as part of this analysis indicate that local educational institutions are largely aligning their degree programs to reflect current demand in the job market that help to meet internal placement metrics. While this practice is not necessarily bad, and in most cases is successful in producing graduates that local businesses want to employ, it fails to acknowledge the fundamental shift discussed earlier, wherein jobs follow talent. MadREP believes it is important for educators to be at the

forefront of these trends and be more proactive rather than reactive when defining degree programs that will be attractive to health care employers. Again, a deep pool of talent with diverse skill sets increases the Region's ability to start, grow and attract these employers.

Likewise, educational institutions have an important role to play in increasing the diversity of the STEM talent pool. As discussed in Section 2, the many portions of the Region's health care industry potentially struggles with diversity issues in several STEM categories. This challenge however, is a national versus simply a local trend. In 2015, women filled 47% of all U.S. jobs, but only held 24% of STEM jobs. Similarly, women constitute slightly more than half of college educated workers, but only make-up 25% of college educated STEM workers (U.S. Department of Commerce, 2017). The persistent lack of underrepresented minorities among students completing STEM degrees is also acknowledged by experts as a societal problem that is resistant to quick solutions (Syed and Chemers, 2011). Possible longer-term solutions that can be drawn from research on the issue include:

- Begin promoting science and mathematics to underrepresented groups during the student's middle school and high school years. In the Region, three activities that are being used to begin this STEM career exploration and promotion process at earlier ages are Inspire-Madison Region, high school fabrication laboratories, and the youth apprenticeship program (Shapiro and Sax, 2011).

- Develop curriculum and pedagogies that stress real-world applications of science and seek to create learning environments focused upon collaboration and group dynamics versus competition and individual achievement.

- Introduce faculty and professional role models into classrooms settings who look like the underrepresented students. This has the effect of bolstering the student's confidence and seeing themselves as successful in STEM majors and careers, allows them to overcome some of the negative stereotypes about having a career in STEM, and encourages discussion of the faculty member's own experiences and strategies for working through barriers in STEM fields.

- Use community and technical colleges to introduce underrepresented groups to the STEM fields. Due to open admission, affordable tuition, flexible scheduling, small class sizes, and child care, two-year public institutions have long been the school of choice for underrepresented and non-traditional students. In addition, currently 50% of college students start their postsecondary education at a two-year institution (Jackson, Starobin and Laanan, 2013). As a result, community and technical colleges represent an important pathway to introducing students to STEM fields. In the Madison Region, efforts are already underway to begin this process with the announcement of a partnership between the Madison Metropolitan School District (MMSD) and Madison College to create a STEM academy for high school students at the new south Madison campus.

As suggested, universities and other educational institutions also have a role beyond providing a qualified and diverse workforce for the health care cluster. Educational institutions also provide new research that can hopefully be used by new or existing firms. In the Madison Region, UW-Madison is the primary producer of

new research related to the health care cluster. Indeed, the Wisconsin Alumni Research Foundation (WARF) currently lists numerous inventions and patents related to health care.

While new health care related research is constantly being generated, the bigger challenge may be transferring this technology to the private sector. While the technology transfer process is often criticized as being inefficient, Shane (2010) suggests many factors that can affect university technology transfer. The most important issue may be the willingness of faculty to disclose inventions, or inform the university's technology licensing office (TLO) about their discovery. If a TLO is not aware of an invention, then it cannot be licensed for commercial use. Shane suggests that the number of inventions licensed through a TLO is not tied to inefficiencies in the process, but that license numbers are highly correlated with the number of invention disclosures received by a TLO from faculty.

As suggested by Shane, a faculty member's unwillingness to disclose an invention may be tied to traditional university compensation and culture. Faculty members are often rewarded and promoted by the number and quality of papers published, not by technology licensing. Faculty may work in fields where commercialization is uncommon. They may be in a department where colleagues do not want to participate in technology transfer. A faculty member may have personal reasons for not wanting to pursue commercialization or wanting to disclose an invention. Furthermore, faculty simply may not be familiar or comfortable with the commercialization process.

Importantly, the rate of commercialization also is propelled by the private sector's level of interest in university technology. Shane also notes that a lack of private sector interest can be driven by inventions not yet ready for practical or commercial use (e.g. they are too basic or have insufficient applications). Uncertainly about inventions also creates financial risks that may be deemed as too high to justify private sector investment. Consequently, Shane cites that "industry is uninterested in them for the very reason that the government funds basic research at universities in the first place – the difficulty of appropriating the returns to investment in their development."

Re-thinking university compensation and culture may be worth exploring as one approach to fostering additional technology transfer and commercialization. However, there are many appropriate reasons that current systems exist and it is unlikely that changes will occur in the short term. Another opportunity for transferring university research and ultimately creating technology spin-offs is to better connect university faculty and staff with a network of non-academic contacts such as investors, researchers from private sector firms and entrepreneurial advisors (Hayter, 2015). In fact, university spin-off success may be dependent on the types of sizes of contacts in an academic entrepreneur's social network. Access to these individuals outside of the university allows for a broader base of knowledge and resources than those available in a university setting (Hayter, 2015). As noted below, there are many health care support organizations that could provide a means of establishing these types of connections.

Health care Support Organizations

In addition to MadREP, many local agencies and institutions operate in the Region with the purpose of helping health care companies start, expand and/or relocate in order to grow the local economy. Some provide direct technical assistance, several conduct research and promote product innovation, and others provide financing to commercialize new technologies and help pay for innovation and modernization efforts. These agencies and institutions, along with their primary means of assistance, are identified below.

Physical Spaces

A total of forty physical spaces are located in the Region that provide space and other start-up resources to health care businesses. These spaces include incubators, co-working spaces, hacker/makerspaces, prototyping centers and accelerators. They are identified and geo-coded on a dynamic map available through the MadREP website, with the most up-to-date version found at http://madisonregion.org/start-locate-expand/start-your-business-2/. These spaces are particularly important to supporting the growing number of start-up firms noted in Section 1. Several, including the MG&E Innovation Center and the URP Accelerator, were profiled earlier as part of the discussion on specialized commercial spaces located in the Region.

Fabrication Laboratories

An important subset of the physical spaces are the fabrication laboratories which have been developed at five of the Region's high schools over the last five years. These schools include: Beaver Dam, Edgerton, Stoughton, Waunakee and Waupun High School. All are open to the public and have computer and equipment resources that could potentially cater to health care start-up businesses. The state created a grant program in 2015, implemented by the WEDC, which has funded all of the facilities located in the Region and a majority of the 43 total facilities operating statewide. This represents 24.7% of the labs operating nationally and 3.4% operating globally (174 and 1,267 respectively as reported by the Fab Foundation).

In most cases, the laboratories are used as part of the school's technology education and science curriculum, to introduce students to potential Science, Technology, Engineering, Arts and Mathematics (STEAM) careers. Many programs have developed metrics around attracting female and disadvantaged students to use and take classes at the labs in order to expose a diverse mix of students to the "cool" technology. Quite a few schools make their labs available to middle school students and coordinate with counseling and career exploration resources such as Inspire Madison-Region (a career coaching and experiential learning program) to encourage young students to consider majoring in STEAM fields. This is a critically important first step in developing the local health care workforce pipeline.

Mentor Programs and Technical Assistance

- *Biopharmaceutical Technology Center Institute* – The BTCI provides educational opportunities that support scientific understanding and develop talent for the biotechnology industry. Programming is focused on developing skills in the bioscience and health care fields and is designed for a wide range of learners – from upper elementary school students to scientists in academia and industry, as well as the general public.

Engaged participation is emphasized and many activities are laboratory-based.

- *Clinical Trials Education Network* – The Clinical Trials Education Network of Wisconsin is focused on defining clinical research in a way that educates all to the role the bioscience and health care industries play the state's economy. The organization strives to be recognized nationally and internationally as a leader in innovation and collaboration for the benefit of patients. In 2010, Wisconsin was home to 1,496 active clinical trials, or nearly 10% of the 15,134 clinical trials in the United States. This clinical research was concentrated on: cancer (744 trials), rare diseases (419), respiratory disorders (157), cardiovascular diseases (82), diabetes (44), mental behavioral disorders (42) and HIV/AIDS (8) (http://wiclinicaltrials.com/education/ and author's calculations).

- *The Isthmus Project* – A collaboration between UW Health and the UW-Madison School of Medicine and Public Health designed to commercialize more medical innovations originating from university basic research. UW Health will provide financial resources and the ability to pilot test innovation in a clinical setting. The Project will also assist in prioritizing clinical research activity and investments through the creation of a Chief Clinical Research Officer position at the university.

- *Doyenne Group* – A Madison-based organization with the mission of building entrepreneurial ecosystems that invest in the power and potential of women entrepreneurs through mechanisms including networking, collaboration and mentorship. They offer 2.5-day strategic planning retreats, sponsor a local pitch session, and offer one-on-one coaching with the Doyenne Founders and Ambassadors.

- *MERLIN Mentors* -The Madison Entrepreneur Resource, Learning and Innovation Network (MERLIN) is a program which seeks to align the skills and experience of volunteer mentors from the local business community with the needs and preferences of a young company's founder team. The goal is to create a larger pool of viable entrepreneurs and increase the survivability of local start-up businesses. MERLIN was developed with the support of WARF, the University Research Park (URP), the Wisconsin School of Business and the UW-Madison Office of Business Engagement.

- *Catalyst BioConsulting* – A health care consulting group comprised of postdoctoral fellows at the Medical College of Wisconsin. The group's mission is to provide research-based, actionable business recommendations on key projects for biotechnology and pharmaceutical firms. Concurrently, consultants broaden their business acumen and learn how to navigate the evolving biotechnology and pharmaceutical sectors.

- *Health care Member Associations* – Several important member associations exist that provide advocacy and educational services to the Region's health care industry. These include: the Wisconsin Hospital Association, Wisconsin Nurses Association, Wisconsin Assisted Living Association, Wisconsin Health Care Association, and Wisconsin Medical Alumni Association.

- *Service Corp of Retired Executives* - A program of the United States Small Business Administration (SBA) designed to use retired volunteers to offer business counseling and mentoring services to businesses. There are two SCORE chapters that provide service to businesses in the Region.

- *UW-Madison and UW System Centers and Institutes* – Several Centers, Research Consortiums and Institutes have been created within the UW System which serve the bioscience and health care industries in various capacities including the seven that are highlighted and the additional 25 that are listed as part of item eight below (32 total). UW-Madison qualifies for over $1.0B in research dollars annually from sources including the NIH, and much of this research benefits from access to these facilities.

    1. *UW-Madison, Biotechnology Center* - The UWBC, located in the heart of the CALS campus at UW-Madison, offers state-of-the-art research services at competitive user fees to companies and university scientists. The services are designed to increase the quality and quantity of biological science research and enhance the competitiveness of applications for federal grant support. These services include: DNA synthesis and sequencing, peptide synthesis, peptide sequencing and mass spectrometry of phosphopeptides and small metabolites, production of transgenic/knockout mice and rats, and education programs and multimedia technology resources.

    2. *Clinical and Translational Science Institute* – CTSI members work to translate research discoveries more quickly into preventive, diagnostic and therapeutic interventions for patients. Consortium members share resources, technology, knowledge and expertise to work towards those goals. The CTSI's research portfolio includes an archive of more than 185 studies, with more than 47 collaborative research studies currently underway.

    3. *Forward BIO Institute* - The Institute engages with research partners throughout the Midwest and supports innovations in workforce development, transformative research and development, and public-private partnerships in the emerging area of biomanufacturing defined as the advanced manufacturing of therapeutic medical devices, cells, tissues or pharmaceuticals. It was recently designated as a biomanufacturing Center of Excellence by the WEDC.

    4. *Center for Predictive Computational Phenotyping* – CPCP develops, conducts and evaluates training activities that reach a broad set of audiences whose education, research and practice can significantly benefit from having state-of-the-art knowledge about data science, predictive models for biomedicine, and computational phenotyping. These audiences include biomedical scientists, clinicians, data scientists, postdocs, graduate students, undergraduates, and the general public.

    5. *UW-Madison, Advance Materials Industrial Consortium* – The AMIC offers members' opportunities to leverage resources focused around, but not limited to, the College of Engineering. These resources include: taking advantage of senior capstone student projects, which can be guided by industrial goals (through the Materials Science, Mechanical Engineering, and Biomedical Engineering programs). This allows industry to explore important side project ideas while also providing access to potential future hires. Finally, businesses can leverage powerful and unique instrumentation on campus and have an easy point of access to university staff to assist in problem solving based upon relevant research topics or faculty expertise.

6. *Wisconsin Institute for Discovery and Morgridge Institute for Research* – WID-MIR is a 330,000 square foot facility located near the center of the UW-Madison campus which houses two research institutes: the private Morgridge Institute for Research and the public Wisconsin Institute for Discovery. It also houses a public space called the Town Center, managed by WARF. The two research institutes share a common goal of supporting experimentation across campus disciplines and collectively generate a great deal of research relevant to the Region's bioscience and health care clusters.

7. *UW-System, Center for Technology Commercialization* – The Center works with innovators, entrepreneurs and researchers to bring new technologies to market by guiding the commercialization process. Staff help clients develop the business case for a new technology and provide assistance in developing applications to competitive funding sources including the federal government's Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) programs.

8. *UW Madison School of Medicine and Public Health* – Additional Centers and Institutes which benefit the health care industry are located inside this School of 1,200 faculty including: the Carbone Cancer Center, Cardiovascular Research Center, Center for Tobacco Research and Intervention, Center for Training in Pharmacology and Drug Development, Center for Urban Population Health, Center for Woman's Health Research, Collaborative Center for Health Equity, Global Health Institute, Health Emotions Research Institute, Institute for Clinical and Translational Research, McPherson Eye Research Institute, Molecular and Environmental Toxicology Center, Morris Institute for Respiratory Research, Native American Center for Health Professions, Pediatric Pulmonary Center, Population Health Institute, Skin Disease Research Center, Stem Cell and Regenerative Medicine Center, Wisconsin Alzheimer's Disease Research Center, Wisconsin Alzheimer's Institute, and Wisconsin Institute for Sleep and Consciousness.

- *UW-Madison Law & Entrepreneurship Clinic* - A program of the UW-Madison law school, the clinic provides free legal services to help entrepreneurs and small business owners with legal questions regarding starting or expanding a business. Third year law students and faculty provide counsel on issues involving corporate structure, finance, tax, intellectual property and insurance.

- *UW-Madison, Discovery to Product (D2P) Program* - A program designed to help commercialize and license new product innovation at UW-Madison. Staff provide mentorship and idea/market validation to early stage projects conceived by faculty, staff or students. The program is also focused on expanding access to key technology commercialization resources, including investment capital and proven entrepreneurial talent.

- *WARF Accelerator Program* – A program designed to speed up the commercialization of UW-Madison discoveries that have been patented by WARF, by providing founders access to targeted funding and expert advice from seasoned business mentors known as Catalysts.

- *Wisconsin Small Business Development Centers* – The Centers provide business counseling and educational programs designed to support small business creation and growth. Four SBDC's primarily serve the Region, with locations at UW-Madison, UW-Whitewater, UW-Platteville and UW-LaCrosse.

- *Wisconsin Manufacturing Extension Partnership* – WMEP employs a team of industry leading experts that work with manufacturing businesses to find and develop talent, identify and develop new markets for products, innovate new products, and improve a manufacturing plant's operational efficiencies in order to reduce waste and increase profitability. Sample services offered include: ISO 9001 Certification, Lean Sigma Six Green and Black Belt Training, ExporTech™, Profit Risk Assessment (PRA™) evaluations, and various supply chain and cybersecurity evaluation programs.

- *WiSolve Consulting Group* - WiSolve is a non-profit organization composed of graduate students and postdoctoral researchers at UW-Madison that provides research-based business recommendations to solve challenging problems in the Madison business community. Teams consisting of 3 to 6 members are drawn from a pool of over 40 consultants with expertise in the biological sciences, business, pharmacy and engineering to provide services including: market analysis, cost benefit analysis, corporate acquisition analysis, SBIR and STTR grant writing, business plan writing, and marketing strategy development.

Networking Programming

- *BioForward* – A member organization representing over 200 companies including biotech, biopharma, medical device, diagnostics, digital health, as well as research institutions, and service providers. The organization sponsors biohealth related networking events and educational programming.

- *Doyenne Group* – Offers monthly connect events that can be used by entrepreneurs to build and mobilize networks within the regional I&E ecosystem.

- *Forward Fest* – A weeklong festival started in 2010 and modeled after South by Southwest (SXSW), which offers entrepreneurs access to over 40 events designed to bring the technology and start-up communities together to learn, share and network. The festival attracts over 5,000 attendees and is held at a variety of locations in and around Madison.

- *Capital Entrepreneurs* – A grassroots community group founded in 2009 with the goal of offering networking and social events that allow local entrepreneurs to connect and grow the start-up community. The group's marquee networking event is Forward Fest. They also hold monthly meetings, run the Madison Start-up Fair, host the Spring Tech Kickoff, and provide peer support resources.

- *Greater Madison Chamber of Commerce* – A business member organization founded over 140 years ago that provides networking opportunities in the form of over 50 local events each year. Many of these events cater to the Region's growing technology community including: the Annual Dinner, Ice Breaker, neXXpo, Pressure Chamber (a pitch competition that occurs during Forward Fest) and Big Night Out. The Chamber also sponsors a trip each summer for early stage companies to pitch Silicon Valley investors, and markets the Region at technology focused events like SXSW.

- *High Tech Happy Hour* – A networking event started in 2001 to offer a monthly gathering spot for the growing high technology community in Madison to meet and collaborate.

- *1 Million Cups* – A program developed by the Ewing Marion Kauffman Foundation in 2012 which is designed to offer an entrepreneur a safe environment in which to network and pitch a business idea to an audience instructed to listen and offer constructive suggestions for how to evolve the idea into a viable business. The Madison based chapter of the group hosts weekly pitch and peer networking sessions at StartingBlock Madison.

- *WARF Inventor and Entrepreneur Programming* – Several networking related programs are hosted by WARF on the UW-Madison campus which are all designed to bring inventors, entrepreneurs and researchers together and inspire collaboration. These include:

  1. Innovation Roadmap: The Speaker Series - Speakers from across the country who have used an entrepreneurial approach to push boundaries and spur innovation share their stories;

  2. Innovation Roadmap: The Workshop Series - Local leaders and changemakers help UW–Madison faculty, students and staff gain the skills they need to create a company or drive change inside an existing organization;

  3. Noon @ the Niche - Faculty, staff, students and the community are invited to bring their lunch to hear an in-depth talk and discussion about the research currently featured at the Wisconsin Institute of Discovery;

  4. UpStart – A program designed to equip entrepreneurially minded women and people of color in the Madison area with the tools needed to launch or expand any business venture;

  5. WARF Ambassadors - A program which engages students to serve as WARF Ambassadors in order to increase WARF's visibility and presence among researchers on campus, and enhance the vital connection between research and technology transfer.

- *Wisconsin Technology Council/Wisconsin Innovation Network* – The Council was created in 2001 as the science and technology advisor to the Governor and Legislature. It also serves an important in-state networking role through the Innovation Network, a membership arm that is dedicated to fostering innovation and entrepreneurship. It sponsors the Wisconsin Entrepreneurs' Conference, the Governor's Business Plan Contest, the Wisconsin Early Stage Symposium and the Wisconsin Tech Summit. All offer opportunities for existing businesses, entrepreneurs and investors to network and collaborate on technology related projects and issues.

Capital

- *Doyenne Evergreen Fund* – A fund developed by the Doyenne Group that provides grants, equity and/or loans to support businesses led by women and people of color. The Fund is paired with the Doyenne Accelerator, which provides coaching assistance to all entrepreneurs who receive funding.

- *Forward Community Investments (FCI)* - Provides financing, one-on-one advising and group training programs to nonprofit, cooperative and for profit businesses that are reducing racial, social and economic disparities.

- *Madison Development Corporation (MDC)* - Manages a business loan fund created using Community Development Block Grant (CDBG) funding to help start and expand small businesses in the Region.

- *WARF Start-up Portfolio (Internal Seed and Venture Fund)* – WARF currently holds equity in over 30 companies and is seeking to create a $60M start-up fund ($10M seed and $50M venture fund activity) that would increase its investment activity in businesses that commercialize UW-Madison research. Markets that WARF invests in include: bioscience, biotechnology, clean technology, medical devices, medical imaging, stem cells, research tools and therapeutics.

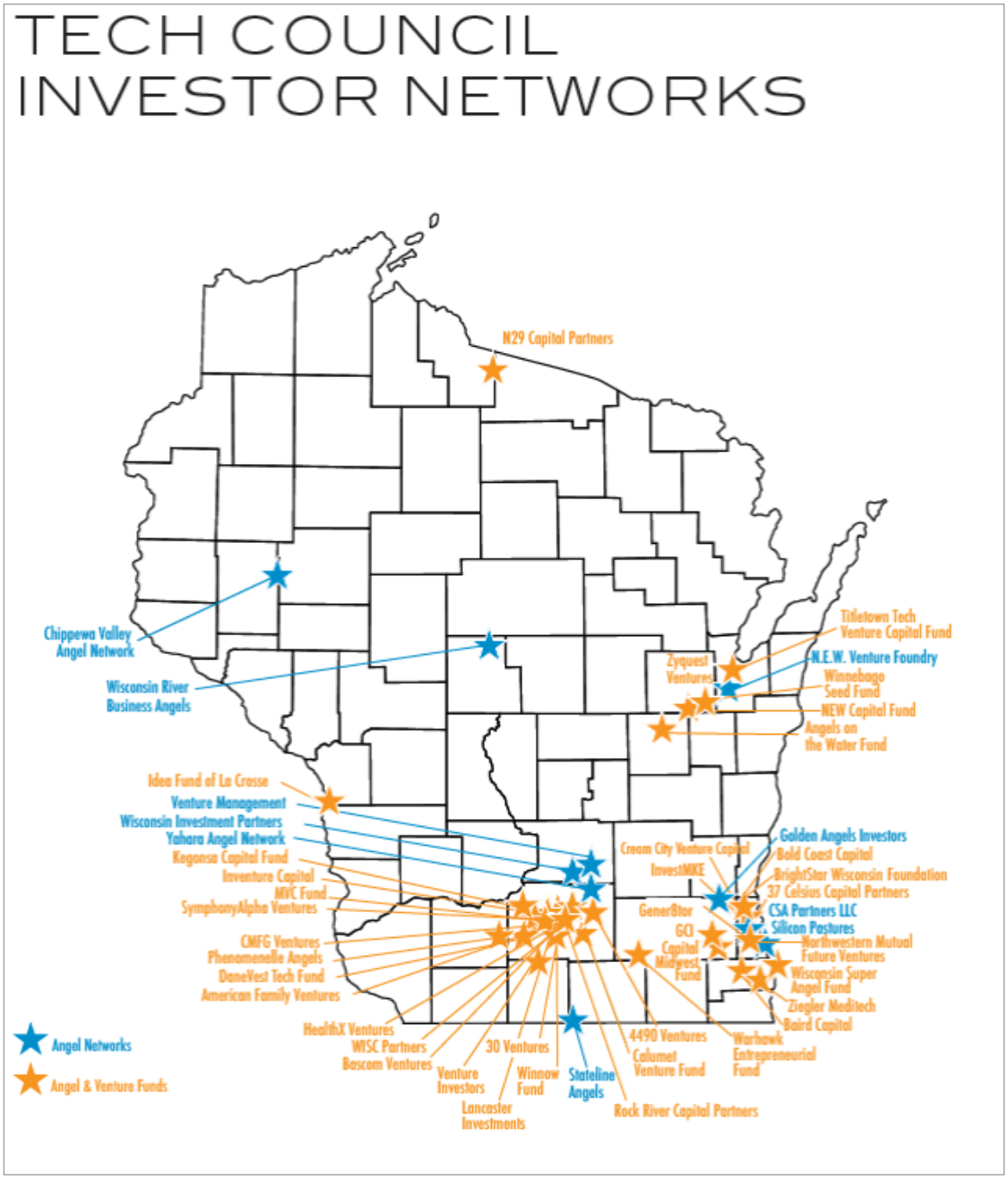
- *Wisconsin Economic Development Corp (WEDC)* - The state's economic development entity that provides business development incentives, including loans, tax credits and training grants to health care businesses looking to start or expand in the Region. The WEDC also administers the important Qualified New Business Venture (QNBV) Program. This program, which began in 2005, provides tax credits to eligible angel and venture fund investors who make cash investments in qualified early-stage technology based businesses. The credit is equal to 25 percent of the value of the investment made in companies certified by the WEDC. The program had 211 certified companies in 2016 (the most recent year for which statistics are publicly available), including 41 or 19% that were classified as health care businesses.[11] Of the 211 total certified companies statewide, 114 or 54% where located in the Region. The total amount of funding received by QNBV companies reached $281.7M in 2016, up 60% from $177M in 2015. Of this funding activity, $44.7M or 16% was invested in health care businesses across the state.

- *Wisconsin Women's Business Initiative Corp (WWBIC)* – Provides access to business and financial education services and financial products through a regional office located in Madison. The organization has provided over $39M in lending to 3,500 businesses statewide since 1987.

- *Angel and Venture Capital Funds* - The Wisconsin Technology Council maintains a listing and generates a map of all the equity based funds operating in the state. The current version of the map, which geo-codes 47 active funds appears in Figure 3.22. Twenty-two of these funds, or 47%, are located in the Region.

[11] "2016 QNBV Report," Wisconsin Economic Development Corporation, September 2017.

Figure 3.22 – Investor Networks



Source: Wisconsin Technology Council, 2018 Wisconsin Portfolio

Some of the most active funds that have or could possibly make investments in the Region's bioscience and health care businesses include[12]:

1. Badger Fund of Funds Program – The Fund of Funds is a limited partnership formed in 2014 to invest up to $25M in capital provided by the state and the State of Wisconsin Investment Board (SWIB) and $10M in private capital ($35M total) into six to eight angel funds around the state. The mission of the

[12] The combination of the bioscience and health care industries is often referred to by economic developers and investors as the biohealth industry.

newly created funds is to make early and middle stage investments in Wisconsin based start-up companies. The Program has made investments in three funds to date; namely, the Idea Fund, LaCrosse, the Winnebago Seed Fund, Neenah, and Rock River Capital Partners, Madison. These funds have raised a combined $40M and invested in Gentueri, a bioscience company based in Madison. Two additional funds, Bold Coast Capital, Milwaukee and the Winnow Fund, Madison, are planned to be created in either late 2018 or early 2019;

2. Wisconsin Investment Partners (WIP) – WIP is currently one of the most active angel funds in the state, having invested over $30M in start-up companies since its formation in 2000. Fund managers invite companies to pitch before up to 50 accredited investors who each make their own individual investment decisions. The fund primarily targets investments in early stage bioscience and health care companies. Key investments to date include: Cellectar Biosciences, ConjuGon, Deltanoid Pharmaceuticals, Invenra, iVMD, Madison Vaccine Corporation, NeoClone, Quintessence Biosciences, Stratatech, Stemina Biomarker Discovery, Swallow Solutions, and Zurex Pharma;

3. HealthX Ventures – HealthX is a $20M digital health care focused seed fund founded in 2015. The Fund has made 14 investments to date in primarily HIT companies including: EnsoData, Redox, Image MoverMD, Medable, Moving Analytics, Health iPass, and Pacifica;

4. Venture Investors (VI) – Since its formation in 1982, VI has raised seven funds totaling $280M, which it has used to make equity investments in 71 total companies. These investments have mainly been placed in biohealth companies originating from research conducted at UW-Madison including: Aerpio, Akebia Therapeutics, Blue Willow Biologics, Cellectar Biosciences, Deltanoid Pharmaceuticals, EBI Life Sciences, Euthymics Bioscience, FluGen, Gala Biotech, GDXI, Invenra, Inviragen, Juentas Therapeutics, MVI Immunotherapies, NeuMoDx, Neurovance, NimbleGen, Preva Cept Infection Control, Promega, and ThirdWave Molecular Diagnotics;

5. Drive Capital – A venture capital fund located in Columbus Ohio, which was formed in 2014 by two former Silicon Valley based investors with the mission of investing in technology based start-ups located in the Midwest. Drive has raised two funds totaling $550M and placed investments in 33 companies to date, including the biohealth start-ups Olive (Columbus) and Triggr Health (Chicago);

6. 4490 Ventures – 4490 is a venture fund created in 2014 with a $30M investment from the SWIB and WARF. Managers raised a second $49M fund in 2018. The Fund has the mission of investing in ICT companies located in the Midwest, including the health IT companies HealthMyne and PhysIQ.

Bioscience and Health Care Investments in Wisconsin

One key resource for tracking equity investment activity in Wisconsin based businesses is the Wisconsin Portfolio, published annually since 2008 by the Wisconsin Technology Council (WTC). Statistics from this report, representing total statewide investment in the bioscience and health care industries (often referred to as biohealth) from 2015 to 2017, are presented in Figure 3.23. Key findings include:

- The combined industries represent on average 56% of all equity investment activity across the state over the last three years.
- Investments in subsectors for the same period have been mixed, rising dramatically in pharmaceuticals from $4.3M (3.9%) to $53.2M (36.7%), remaining stable for health IT at $30.6M (27.3%) and $32.2M (22.2%), and declining steeply for devices and biotechnology from $41.0M (36.5%) to $14.8M (10.2%) and $25.6M (22.8%) to $12.6M (8.7%) respectively.
- Many of the companies that received investment are located in the Region, including Propeller Health ($21.5M), Redox ($10.0M), Cellectar Biosciences ($7.8M), Healthfinch ($7.5M), Elucent Medical ($7.25M), Datica ($6.46M), Zurex Pharma ($6.24M), Moxe Health ($5.5M), Forward Health Group ($4.02M), FluGen ($3.6M), Stemina Biomarker Discovery ($3.1M), Madison Vaccines ($3.3M), Invenra ($2.9M), Healthmyne ($2.37M), Kiio ($1.9M), Imbed Biosciences ($1.6M), and ImageMoverMD ($1.2M).

Figure 3.23 - Wisconsin Angel and Venture Capital Investment - Bioscience and Health care Industries, 2015 to 2017

Category	Year					
	2015	%	2016	%	2017	%
Biotechnology	$25,553,180	22.8%	$4,811,908	3.3%	$12,628,719	8.7%
Devices	$41,001,202	36.5%	$35,639,061	24.6%	$14,814,151	10.2%
Diagnostics	$9,233,900	8.2%	$15,000,750	10.4%	$30,340,255	20.9%
Health IT	$30,649,702	27.3%	$32,727,330	22.6%	$32,166,666	22.2%
Pharmaceuticals	$4,341,640	3.9%	$26,656,348	18.4%	$53,207,244	36.7%
Services	$1,482,050	1.3%	$30,005,000	20.7%	$1,710,000	1.2%
Total	$112,261,674	100.0%	$144,840,397	100.0%	$144,867,035	100.0%
All Industries	$209,479,099 (128 Deals)		$276,191,739 (138 Deals)		$231,040,882 (127 Deals)	
Percent ($)		53.6%		52.4%		62.7%

Source: Wisconsin Technology Council, 2018 Wisconsin Portfolio

In reviewing this support organization activity, it is important to recognize how many resources have been developed within the last 5 to 10 years. It is truly remarkable how far the regional I&E ecosystem has evolved in a relatively short period of time. MadREP's staff has very little reason to believe that it will slow down in the near future, but will most likely continue and may even accelerate.

Staff would recommend continuing to promote efforts to link the evolving I&E ecosystem to UW-Madison, UW-Whitewater and UW-Platteville in order to help accelerate the commercialization of both faculty and student research. It is important to note that UW-Madison and UW-System have been making tremendous strides at assisting these efforts through the enhanced resources represented by MERLIN Mentors, D2P, the Law & Entrepreneurship Clinic, the Center for Technology Commercialization, and the Small Business Development Center. These resources are available on campus centered on @1403 and Grainger Hall. Off campus resources are mainly located at the University Research Park, but also include 100State, Sector67 and StartingBlock Madison. All three of the latter facilities make themselves attractive to students. Finally, it is critically important to acknowledge and continue to support the growing role that WARF is playing in the Region and state's I&E ecosystem through its increasing investment activity in resources and capital programming.

Conclusions - Health Care Cluster Support and Development Ecosystem

- Many areas in the Madison Region have robust broadband access beyond the FCC definition of 25/3. However, other areas in the Region completely lack access to a single broadband provider. The lack of broadband in many of these areas is well-known and discussed. However, for these areas and the entire Region to fully support the growing health care cluster, broadband will need to become more widely available throughout the Madison Region.

- 5G will help usher in the IoT era which will result in the commodification of information and data intelligence. Furthermore, 5G could also provide opportunities for filling broadband availability gaps in rural areas. While it is anticipated that the earliest implementations of the technology will occur in the larger, more technology dense, metropolitan areas of the country, MadREP needs to ensure that its eight-county region is high on the list of target areas to be served and the network gets built out as quickly as possible.

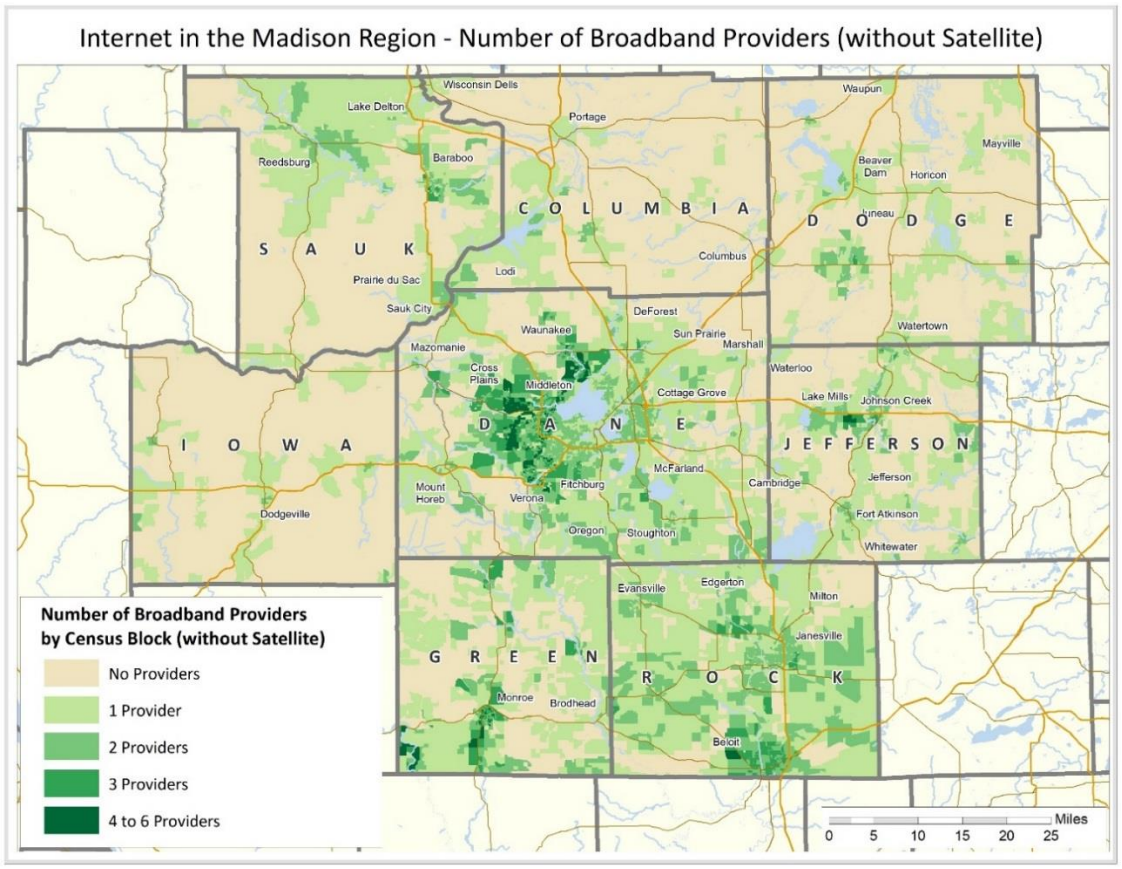
- While college graduates and individuals under the age of 35 remain among the most mobile segments of society, their mobility rates have declined over the last two decades. Accordingly, growing talent from within the Region and talent retention should remain important considerations to building the health care cluster's talent pool. Talent attraction should remain a health care cluster development effort, but the Region should consider attraction from a life stage perspective rather than a one-size-fits all approach. That is, the factors that attract talent from outside the Region vary somewhat by recent college graduates, young college graduates without children, and middle aged college graduates with children. For instance, all of these segments value a robust job market and recreational opportunities, but cost of living is more important to recent grads and cultural opportunities are less of an influence among households with children. Communities attempting to attract talent should be prepared to tailor their message accordingly by building upon their assets that may cater to a specific life stage.

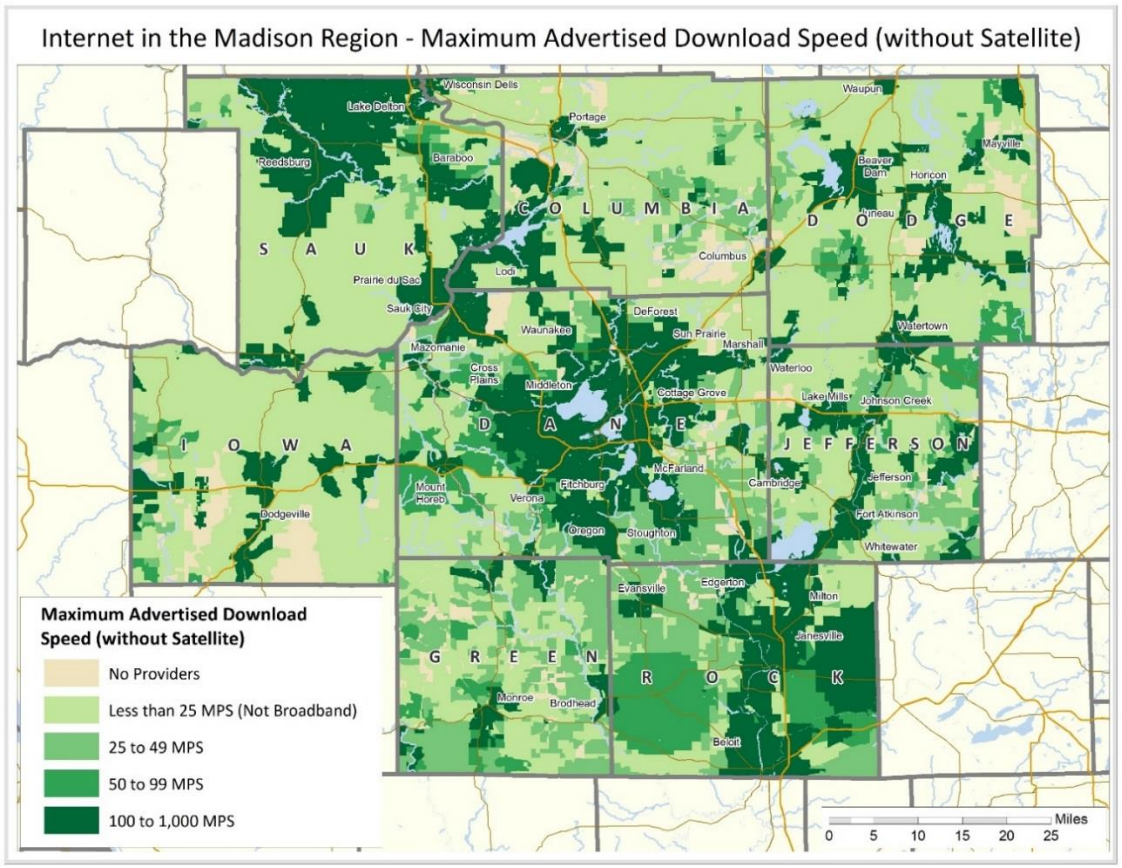
- The Region's housing market provides both opportunities and challenges related to attracting and retaining talent. Compared to other competing health care regions, overall housing costs in the Madison Region are somewhat favorable. However, this potential advantage may be lessened when considering the Madison metro area's somewhat lower wages for many health-care related occupations. As housing costs rise in the Region and new housing construction continues to lag pre-recession levels, the ratio of median wages to median housing costs could continue to erode this source of comparative advantage.

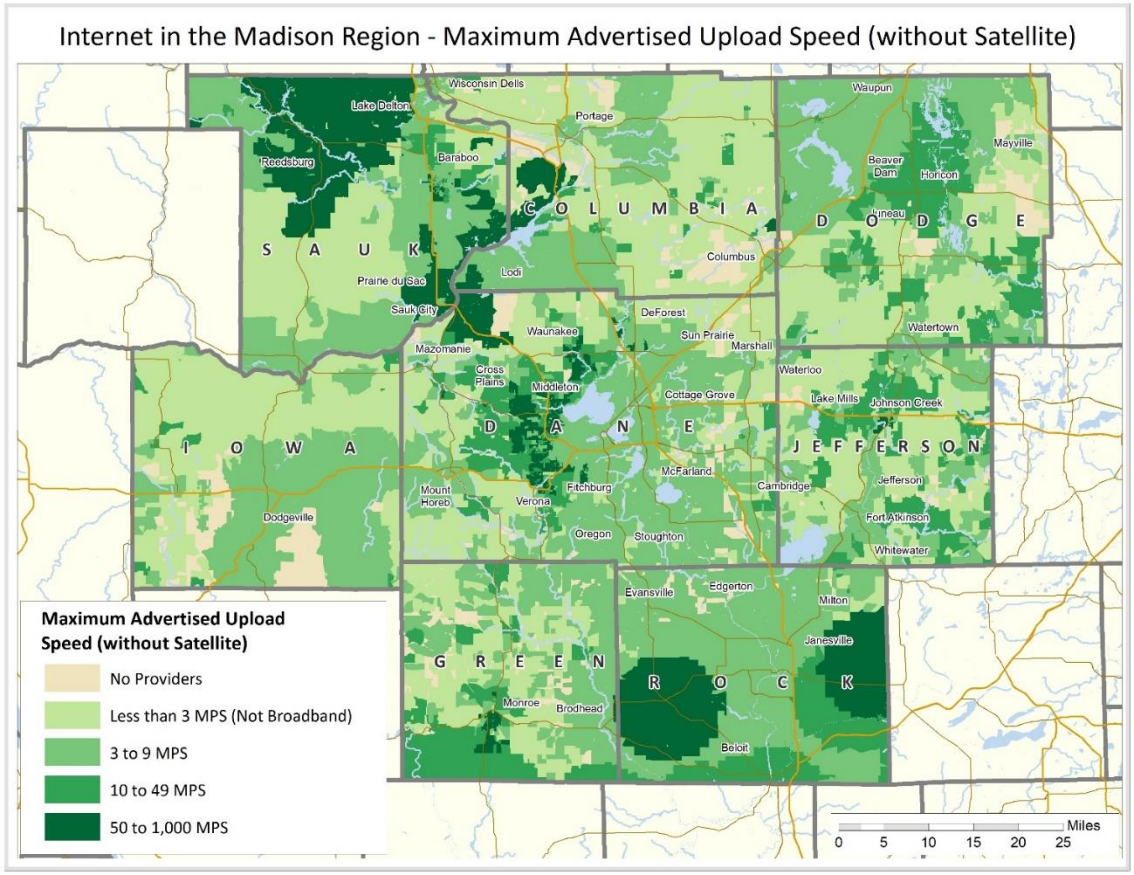
- The connections between firms and universities are often an important component of health care sector development initiatives. However, health care support from educational institutions extends beyond 4-year universities to include colleges and technical schools that may provide Associate's degrees, certificates or continuing education. The development of health care talent also starts in the region's K-12 system to provide a pipeline of students to higher educational institutions. Given the growing prominence of the Region's health care cluster, institutions at all levels should continue to pursue opportunities outlined above that foster a deep, diverse pool of talent.

- In reviewing the Region's support organization activity, it is important to recognize the remarkable number of resources that have been developed within the last 5 to 10 years. It is likely that the support ecosystem will continue to grow and accelerate. However, given the large and growing number of resources to support the health care ecosystem, it is unlikely that many potential stakeholders who could benefit are entirely aware of these organizations and resources in the Madison Region. MadREP should continue to foster and expand the connections among these numerous assets, health care firms and health care talent.

Appendix 3A – Internet Availability Characteristics without Satellite






Internet in the Madison Region - Maximum Advertised Upload Speed (without Satellite)
Wisconsin Dells
Lake Delton
Portage
Waupun
Mayville
Reedsburg
Baraboo
Beaver Dam
Horicon
COLUMBIA
DODGE
SAUK
Columbus
Lodi
Prairie du Sac
Sauk City
DeForest
Watertown
Waunakee
Sun Prairie
Marshall
Mazomanie
Waterloo
Cross Plains
Middleton
Cottage Grove
Lake Mills
Johnson Creek
DANE
IOWA
JEFFERSON
McFarland
Cambridge
Jefferson
Mount Horeb
Fitchburg
Verona
Fort Atkinson
Dodgeville
Oregon
Stoughton
Whitewater
Evansville
Edgerton
Milton
Janesville
GREEN
ROCK
Monroe
Brodhead
Beloit
Maximum Advertised Upload Speed (without Satellite)
No Providers
Less than 3 MPS (Not Broadband)
3 to 9 MPS
10 to 49 MPS
50 to 1,000 MPS
Miles
0 5 10 15 20 25

Appendix 3B – Office Market Snapshot

Office Market Forecast - 2018

- Robust new construction starting to hit the market (we have begun phase III)
- Vacancy has reached its low point; will trend upward
- Absorption will still be higher than average
- High TI costs continue to impact deals
- Sales market cools from 2016 all-time high and strong 2017

Year	2016	2017
Total Inventory (Sq. Ft.)	15.4 million	15.9 million
Average Asking Rate Overall	$20.57	$20.16
Vacancy Rate Overall	8.6%	7.3%
Class A Vacancy	5.3%	4.3%
Absorption (Sq. Ft.)	487,000	304,000
Number of Bldg Sales	56	44
Square Feet Sold	*2,676,100	909,400

*Vanta Portfolio Sale: 35 buildings, 2.29M SF

Statistics as of 4Q 2017

Dane County office submarkets (downtown, east, near and far west side, south/beltline) with information on average lease rates/absorption/vacancy rates per area.

Submarket	Number of Buildings	Inventory (sf)	Vacant (sf)	Vacancy Rate (%)	YTD Total Net Absorption (sf)	Under Construction (sf)
Near West A	7	443,795	744	0.2%	67,127	-
Far West A	27	2,700,785	111,017	4.1%	26,308	235,000
East A	12	771,454	33,117	4.3%	4,362	90,000
Downtown A	15	1,771,149	98,731	5.6%	36,763	200,000
South A	7	512,912	25,716	5.0%	-	110,000
Overall	**68**	**6,200,095**	**269,325**	**4.3%**	**134,560**	**635,000**

Vacancy Rate					
Submarkets	**4Q 2016**	**1Q 2017**	**2Q 2017**	**3Q 2017**	**4Q 2017**
Near West A	15.3%	5.2%	5.2%	1.8%	0.2%
Far West A	4.0%	3.9%	4.8%	4.0%	4.1%
East A	4.9%	5.4%	5.4%	4.3%	4.3%
Downtown A	5.1%	5.7%	8.4%	6.5%	5.6%
South A	5.0%	5.0%	5.0%	5.0%	5.0%

Weighted Average Asking Rent (FSG)					
Submarket	**4Q 2016**	**1Q 2017**	**2Q 2017**	**3Q 2017**	**4Q 2017**
Near West A	$25.25	$25.70	$25.70	$27.00	$27.00
Far West A	$25.58	$29.08	$26.38	$25.58	$25.52
East A	$22.51	$23.14	$22.81	$23.43	$23.43
Downtown A	$26.46	-	$38.00	$38.00	$38.00
South A	$19.74	$23.41	$23.41	$23.41	-

Absorption (sq. ft.)						
Submarket	**2013**	**2014**	**2015**	**2016**	**2017**	**Average**
Near West A	-	20,701	8,456	11,378	67,127	21,532
Far West A	237,876	-13,695	51,663	104,794	26,308	81,389
East A	24,583	21,232	33,016	8,131	4,362	18,265
Downtown A	29,730	16,195	23,176	13,758	36,763	23,924
South A	-13,388	17,099	15,199	31,359	-	10,054
Overall	**278,801**	**61,532**	**131,510**	**169,420**	**134,560**	**155,165**

Recent Key Office Leasing Transactions

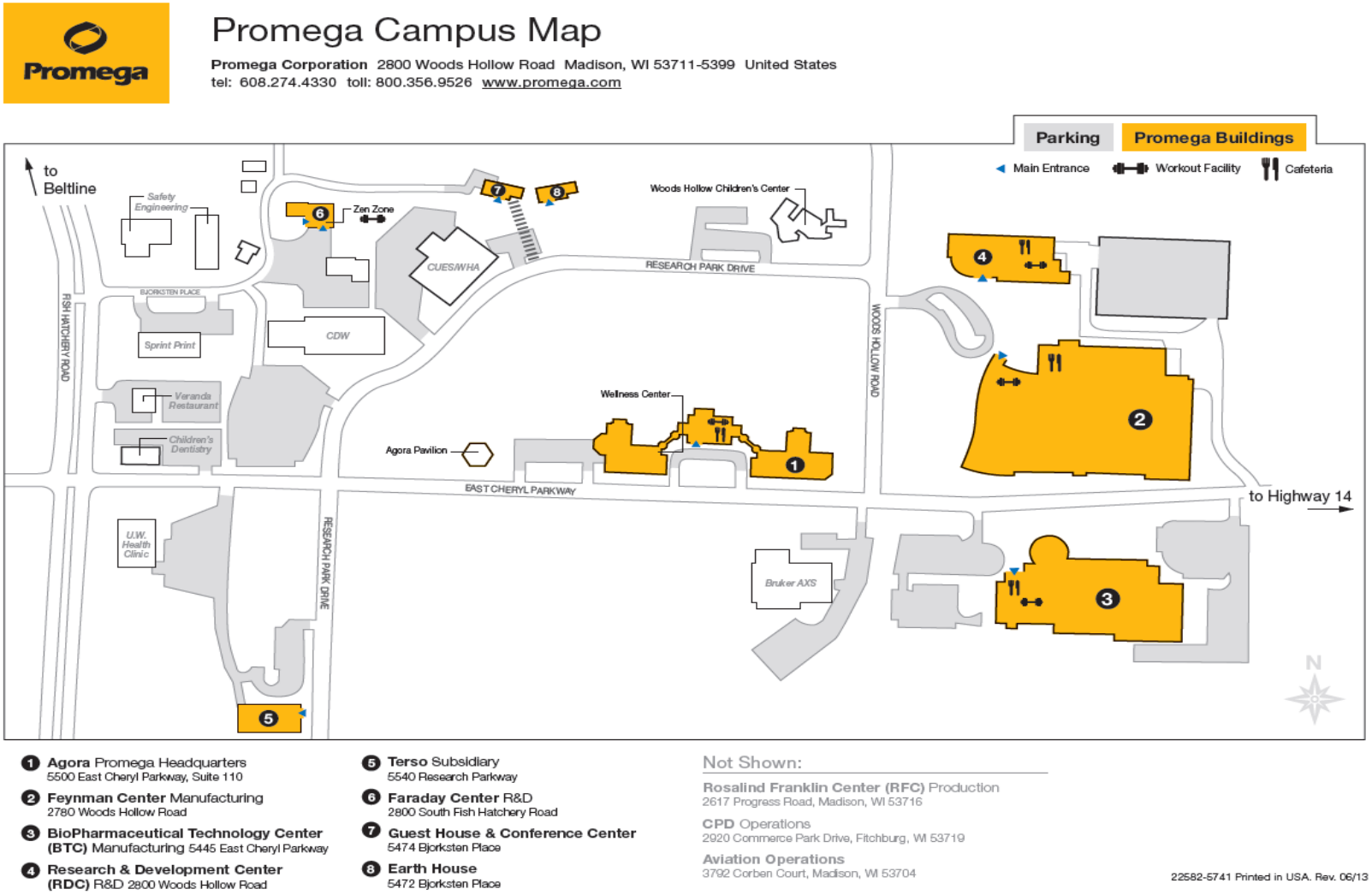
TENANT	SUBMARKET	TYPE	SF
Exact Sciences	Near West	Lease/Purchase	150,000
Illumina	Near West	BTS/Lease	132,000
Navitus	Far West	Exp./Relocate	100,000
NSI/West Bend	Far West	Consolidation	80,000
Zendesk	Downtown	Relo./Expand	78,000
Spectrum Brands	Far West	Bldg. Addition	30,100
BMO Harris	Southeast	Relo. (from Hilldale)	28,000
Performance Gateway	East	Relo./Expand	25,600
Catalent	Far West	Expansion	25,500

Key Deals in the Market this year

TENANT	SUBMARKET	TYPE	Sq. Ft.
Hy-Cite	Far West	Land/New Bldg	90,000
Undisclosed	Suburban	Back-office space	45,000
Boardman & Clark	Downtown	Relocation	40,000
Dean Health Plan	Far West	Expansion	33,000
Tech Company	E. Wash	The Gebhardt	30,000
Cellular Dynamics	Near West	Expansion	27,000
Exact Sciences	Middleton	Short term	26,000
Nordic Consulting	Downtown	Expansion	+20,000

Appendix 3C – Promega Campus Map

Source: Promega Corporation



Source: Promega Corporation