



Mass Benchmarks

A JOURNAL OF THE MASSACHUSETTS ECONOMY

State Growth Continues in Moderation

**Foreign-born Diversity Energizes
Worcester's Economy**

**Massachusetts' Medical Device
Industry: Anatomy of
a Business Ecosystem**

**UMass Center Energizes
Development of Medical
Device Prototypes**



MassBenchmarks

2016 | volume 18 issue 1

MassBenchmarks, published by the University of Massachusetts in cooperation with the Federal Reserve Bank of Boston, provides timely information about the Massachusetts economy, including reports, commentary, and key data about the state's regions and industry sectors that comprise them.

The editors invite queries and articles on current topics involving the Massachusetts economy, regional economic development, and key growth industries from researchers, academic or professional economists, and others. A topical outline and brief biography of the author should be sent to info@donahue.umassp.edu.

A complete list of past issues, latest news, updates, and additional research on the Massachusetts economy can be found at www.massbenchmarks.org.



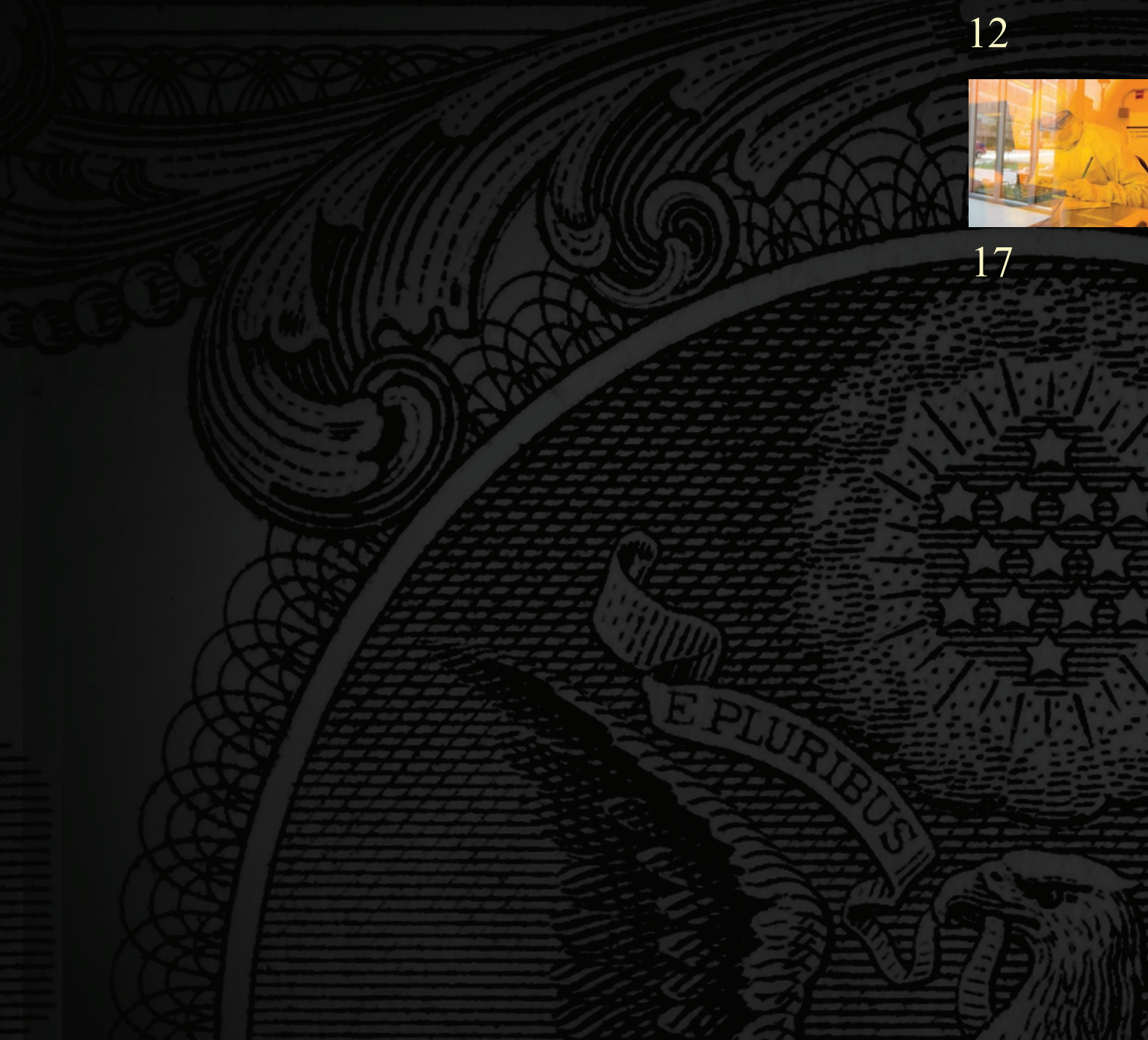
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FROM THE PRESIDENT



This issue of *MassBenchmarks* reminds us that the strengths of our state remain embedded in the talents of its people and the innovative capacity of its leading institutions. And it offers the Commonwealth's leaders several important lessons that they should take to heart as they work together to ensure that Massachusetts remains a competitive place to live, do business, and raise a family.

As always, the issue opens with an assessment of the current conditions in the state economy, this time co-authored by UMass Lowell Professor Robert Farrant and UMass Amherst Professor Robert Nakosteen. While every indication is that the outlook for the Massachusetts economy remains positive, Professors Farrant and Nakosteen warn that the state economy is entering "a period of increased economic risk and uncertainty." By highlighting the drag that regionally imbalanced growth, weak global trade, and inadequate levels of housing production are placing on state growth prospects, they underscore the need for active policy efforts to position every region of the Commonwealth for the kind of economic success that has been experienced in the dynamic Greater Boston area.

The remainder of the issue is focused on exploring two examples of how regions outside of the core Boston area are doing just that, first in Worcester and then again in the Merrimack Valley region.

In the issue's first feature article, a team of scholars and students (now alumni) from UMass Dartmouth led by Professor Michael Goodman summarize the main findings of their recent analysis of the economic contributions of immigrants in the City of Worcester. They systematically document the significant contributions that foreign-born workers and entrepreneurs are making in the "Heart of the Commonwealth." As has been the case from our very founding, they remind us that Massachusetts continues to rely heavily on the talent and hard work of our neighbors who have come to the U.S. and to our Commonwealth in search of a better life.

This issue's second feature article focuses on one of the Bay State's leading industrial sectors, the Medical Device industry. Authored by UMass Lowell Professor Robert Farrant, this article highlights the critical role that our public university system plays in the dynamic industrial ecosystem that has helped make Massachusetts home to one of the largest concentrations of medical device firms in the nation (and arguably the most innovative).

The important role that the public university plays in state and regional economic development is discussed further in this issue's Endnotes, where UMass Lowell's Associate Vice Chancellor for Entrepreneurship and Economic Development Steven Tello describes the critical role the Medical Device Development Center (M2D2) — a collaboration between the UMass Lowell and Worcester campuses — plays in helping Medical Device startups to transcend the so-called "Valley of Death" by providing research, technical assistance, and important connections to public and private sources of funding and investment. The result is an estimated \$75 million in new regional economic activity, a clear sign that when universities and businesses work together, both they and the people of the Commonwealth directly benefit in important ways.

Once again the lessons in this issue of *MassBenchmarks* provide our state's political, business and labor leaders with the kind of timely information and insight that has characterized this journal since its founding nearly two decades ago. It also reminds us that the public service and economic development activities of the University of Massachusetts remain a major part of the reason why Massachusetts is home to the best educated residents and most innovative enterprises in the world.

A handwritten signature in black ink that reads "Martin T. Meehan". The signature is written in a cursive, flowing style.

Martin T. Meehan, President
University of Massachusetts

NOTES FROM THE BOARD

Uncertain global economy, aging workforce, and deferred investments weigh on growth prospects.

Economic indicators for the Commonwealth are generally positive, including employment, unemployment, and output. In spite of this, there is a sense that the state economic outlook rests on precarious footing. This largely reflects the uncertain outlook for the global economy, and a recent slowing of U.S. economic growth.

State employment in the first quarter of 2016 grew at a 2.0 percent annual rate compared with the final quarter of 2015. Total wage and salary income grew at a 5.6 percent annual rate during the same period. In the most recent release of the *MassBenchmarks* Current Economic Index, a proxy measure for the state's gross domestic product, the state continued to outperform the U.S. economy, with an estimated 2.3 percent annualized rate of growth in the first quarter of the year, compared with the national growth rate of 0.5 percent.

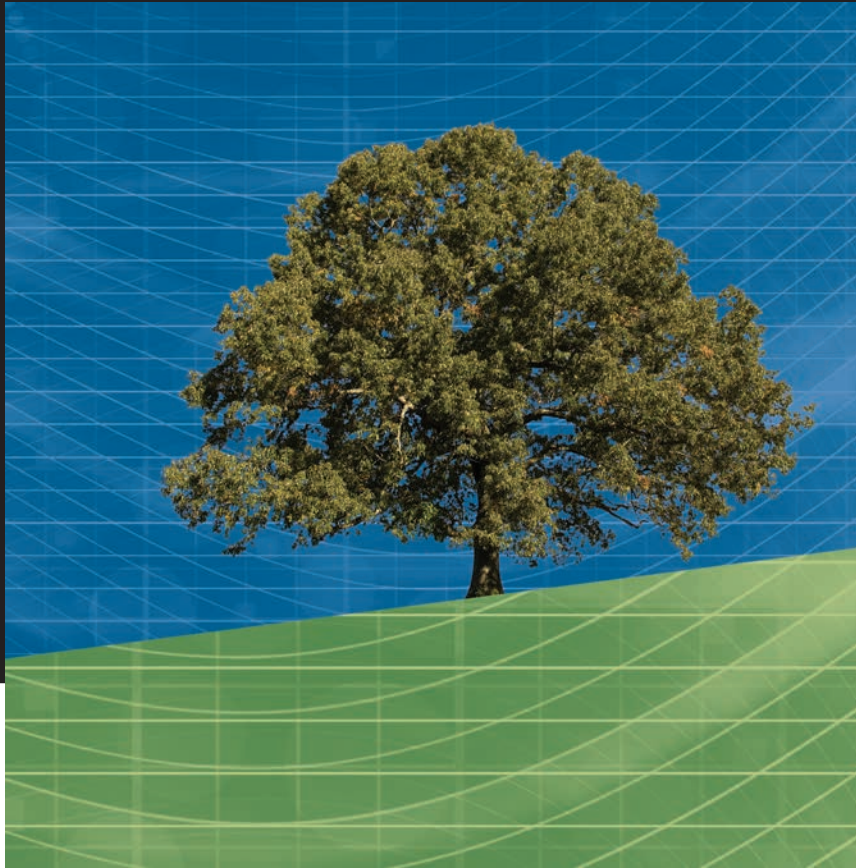
The state is experiencing good economic fortunes in an environment characterized by worrisome global conditions. Among the emerging economies, only India seems to have healthy prospects. China's economic growth has slowed and this deceleration is being felt throughout the global supply chain. The resulting negative impacts have been especially severe in countries that export commodities to China. Global debt issues further cloud prospects for the future. There has been a run-up of dollar-denominated private debt in many emerging markets and, as their economic prospects have declined, increasing concern that we may be on the verge of a new debt crisis.

The state's industry mix — specifically the health, education, advanced manufacturing, and high-tech segments of professional and business services — positions the Commonwealth for future growth. The eastern part of the state in particular benefits significantly from these sectors. Concerns continue, however, over conditions that will likely exert downward pressure on the state's long-term growth trajectory. Foremost among them is the age profile of the state's work force. As its median age increases relentlessly, replacing retiring workers with younger ones assumes paramount importance. In that, the state is limited by an educational system plagued by uneven performance and constrained by inadequate investment and resources. Adding to the challenge, importing workers from outside the state is constrained by the high and rising price of housing, especially in the dynamic eastern part of the state. Like much of the nation, the state's infrastructure is in serious need of repair and updating. These issues cry out for public policy solutions.

It seems likely that the state economy will remain on an even keel in the short run. The economic fundamentals for Massachusetts seem strong and stable. However, the risks of a global slowdown have increased, which could impede the state's continuing economic expansion if conditions worsen. External risk factors aside, sustaining economic momentum over the longer term requires that the Commonwealth address conditions over which it has some control — factors that continue to weigh heavily on its long-term economic outlook. These include education, housing, and infrastructure (including but not limited to transportation).

This summary, prepared by Executive Editor Robert Nakosteen, reflects the discussion of the members of the Editorial Board of MassBenchmarks at its meeting on April 29, 2016.

THE STATE OF THE STATE ECONOMY
ECONOMIC CURRENTS



State Growth Continues in Moderation

ROBERT FARRANT AND ROBERT NAKOSTEEN

DRIVEN BY ITS TECHNOLOGY, EDUCATION, AND HEALTHCARE SECTORS, THE STATE'S ECONOMY WILL REMAIN STRONG, ALTHOUGH THE PACE OF GROWTH WILL CONTINUE TO MODERATE. VULNERABILITIES IN AN OTHERWISE POSITIVE PICTURE INCLUDE THE ECONOMIC CONSEQUENCES OF DECLINING OIL PRICES, A WEAKENED CHINESE ECONOMY, AND A CONTINUED ANEMIC RECOVERY IN EUROPE.

INTRODUCTION

The strong economic expansion in the state continues unabated, though a recent moderation seems likely to continue into the new year. State gross product continues to grow at a rate faster than the national rate, though more slowly than in 2014 and the first part of 2015. The unemployment rate has remained below five percent and total employment is at an all-time high and continues to grow. Employment growth is widespread, but is most prominent among the usual suspects — Business and Professional Services and Education and Health Services.

There are reasons to believe, however, that the pace of growth is now moderating, and that the moderation will continue throughout this year and into next year. The economic expansion both in the state and nationally is entering its sixth year. While there is no inevitable timetable for the end of an expansion, its life expectancy is reduced with every passing year. The economic fundamentals in both Massachusetts and the nation remain solid, but there are issues, both domestic and global that may weigh on the Bay State.¹

Nationally, the energy patch, extending north-south from North Dakota along the Canadian border through Texas, has been hurt by the precipitous fall in the price of oil. Expansion in this sector was important in the national economic expansion; the decline in activity in this part of the country is bound to slow national growth.

There are global vulnerabilities as well. China's economic growth has slowed significantly, with its stock market volatility signaling continuing difficulty. While the slowdown will likely have little direct effect on Massachusetts, the direct and especially the indirect effects on our national economy bear watching. The effects of a slowdown in China would be most strongly felt in Canada, Brazil, Australia, and many other countries where

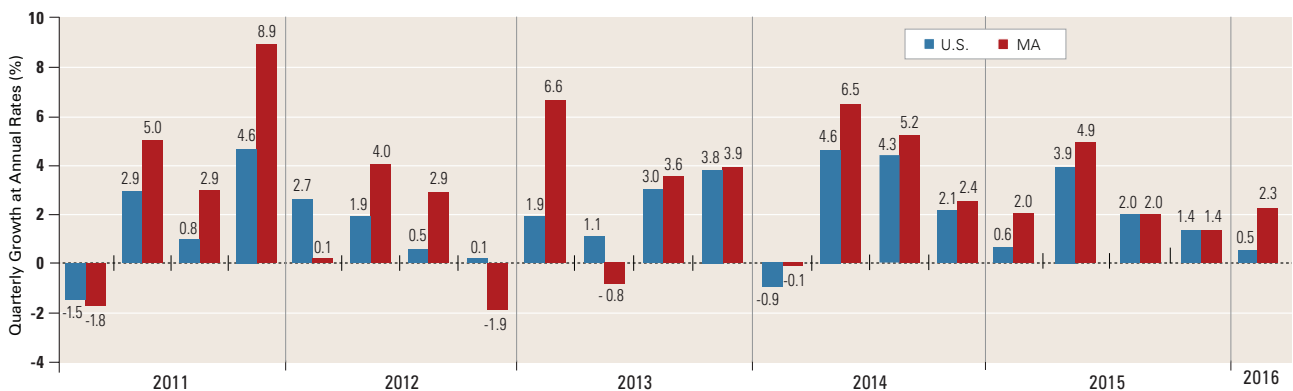
commodity exports fuel their economies. Economic difficulties in these countries can pass through to the U.S., and ultimately, via a slowdown in the domestic economy, to Massachusetts. The European Union countries, especially those within the Eurozone currency union, are experiencing anemic growth at best. Global weakness coupled with the strength of the U.S. economy has led to a strengthening of the dollar on international currency markets. While this is beneficial to households or businesses that import from abroad, it is hurting sectors of the economy that depend on exports. None of these developments will likely prove fatal to the state's economic expansion, but their combined effect explains why we see a moderation of growth in the coming year.

A recurring theme in this space has been the disparity in economic prosperity across the state. In this analysis, the focus has been on a set of Gateway Cities. While we once again describe the condition of these cities collectively, we dedicate a section of the article to a constellation of cities along Route 2 and west of I-495. Little attention has been paid to these cities, though their economic conditions are perilous.

STATE OF THE STATE ECONOMY Output, Employment, and Unemployment

The *MassBenchmarks* Current Economic Index tracks state gross product, the most comprehensive measure of the economy. During most of the economic expansion starting in 2008, the state has outperformed the nation in the growth of gross product. This has been especially true over the past two years, as illustrated in Figure 1. In the most recent quarter for which data are available, the first quarter of 2016, annualized national growth in gross domestic product was 0.5 percent, while state gross product in Massachusetts grew by 2.3 percent.

**Figure 1. Growth in Real Product, Massachusetts and United States
2011 Q1 – 2016 Q1**



Source: U.S. data from the U.S. Bureau of Economic Analysis (BEA); Massachusetts data from *MassBenchmarks*. Calculations by Alan Clayton-Matthews.

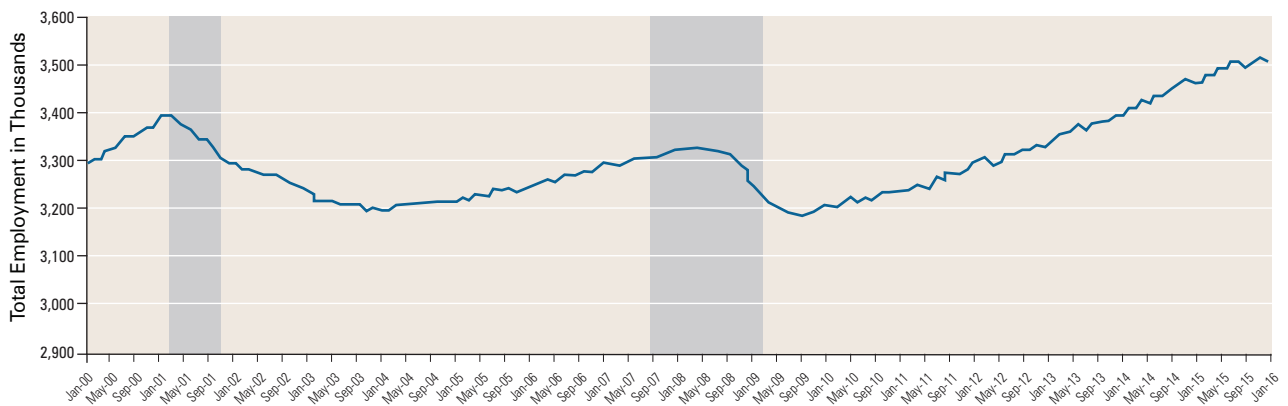
Employment in the state bottomed out in October of 2009, and has grown consistently and at times rapidly since. By December of 2015, total employment in the state exceeded 3.5 million, an all-time high. During the 12-month period ending in January of 2016, total employment increased by over 50,000. By way of comparison, in the 12 months prior to the start of the recession in 2008, from May 2007 through April 2008, employment grew by nearly 40,000.

The state unemployment rate has had a trajectory that reflects the growth in employment, though with a time lag, trending consistently downward since early in 2010. The state unemployment rate has consistently been below the national rate, and at the end of 2015, stood at 4.9 percent, compared with the national rate of 5.0 percent. The U-6 unemployment rate includes workers who

have dropped out of the labor force but would re-enter if there were jobs available, as well as part-time workers who would prefer to work full-time, and would if the hours were available. While the U-6 unemployment rate is about double the headline unemployment rate (also called the U-3 rate of unemployment), it is also on a downward trajectory. Even so, it is clear that the U-3 rate of unemployment significantly understates whatever distress there is in the labor market. The double-digit level of the U-6 rate suggests that there is much work left to do to reach truly full employment.

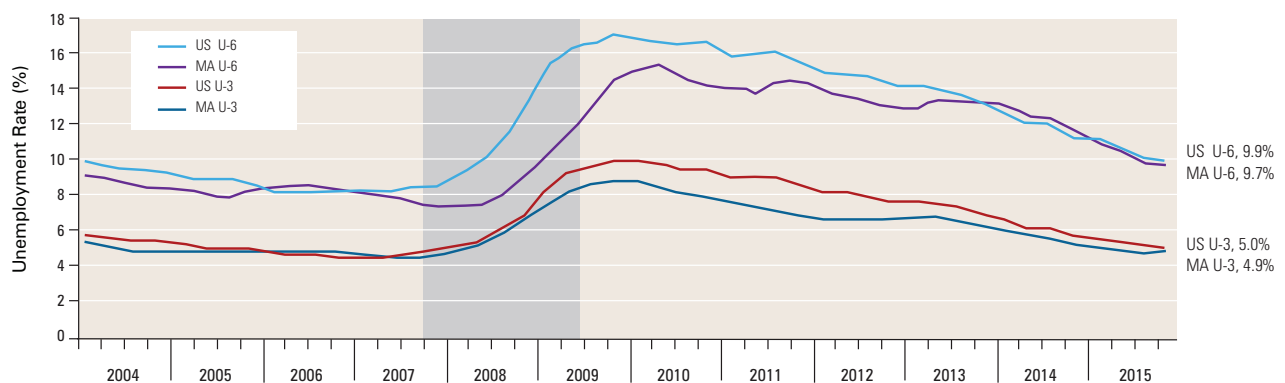
The condition of the labor market is determined by the confluence of many factors: the decision to participate in the labor force by workers; the intensity of job search by those out of work; the volume of new hiring by companies; the intensity of searching for new workers to fill

Figure 2. Employment, Total Nonfarm Massachusetts
January 2000 – January 2016
Seasonally adjusted



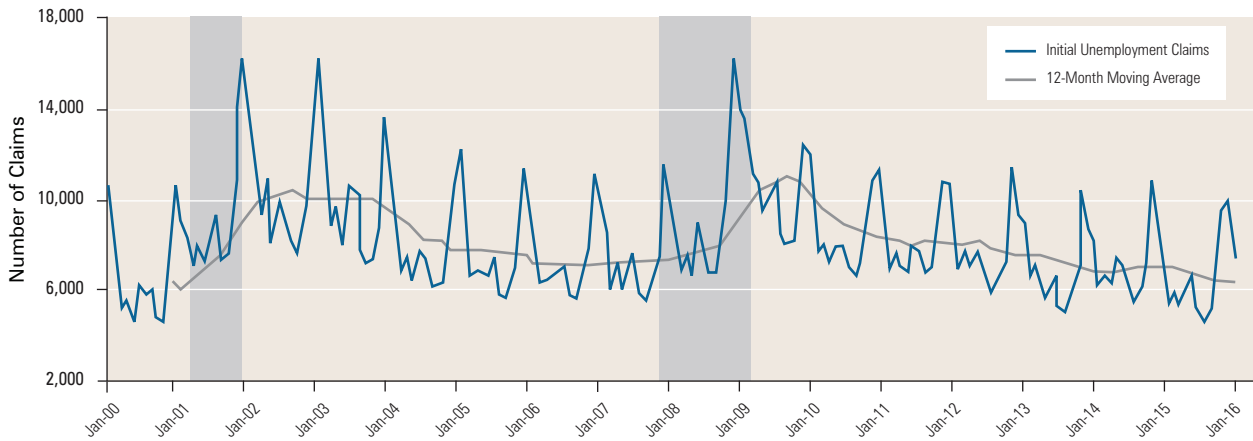
Source: Massachusetts Executive Office of Labor and Workforce Development (EOLWD), Current Employment Statistics (CES-790). Shaded areas indicate periods of recession; recession dates were obtained from the National Bureau of Economic Research (NBER).

Figure 3. U-3 and U-6 Unemployment Rates Massachusetts and the United States
2004 Q1 – 2015 Q4



Source: Massachusetts and United States U-3 from the Massachusetts Executive Office of Labor and Workforce Development (EOLWD), Local Area Unemployment (LAU) Statistics, Massachusetts and United States U-6 rates from the U.S. Bureau of Labor Statistics. The Massachusetts U-6 rate is not seasonally adjusted but all other rates are seasonally adjusted. Shaded areas indicate periods of recession; recession dates were obtained from the National Bureau of Economic Research (NBER).

Figure 4. Initial Unemployment Insurance Claims, Massachusetts
January 2000 – February 2016
Not seasonally adjusted



Source: U.S. Employment and Training Administration, *Initial Claims in Massachusetts* [MAICLAIMS], retrieved from FRED, Federal Reserve Bank of St. Louis, <https://research.stlouisfed.org/fred2/series/MAICLAIMS#>, March 17, 2016. Shaded areas indicate periods of recession; recession dates were obtained from the National Bureau of Economic Research (NBER). Calculations by the authors.

openings by companies; the volume of workers who lose their jobs. This last factor is captured by the magnitude of those who file claims for unemployment insurance. This figure, though quite volatile on a week-to-week

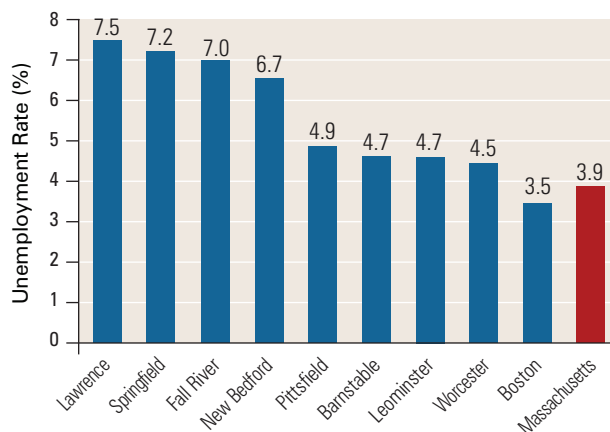
basis, has fallen steadily over the past few years, and is not at historically low levels. In other words, at the same time that hiring has increased during the expansion, firms have increasingly held on to their workers.

Tales of Disparity from Route 2

It appears that while several Gateway Cities have begun to turn around their economies, there is still much work to be done. Unemployment rates in all Gateway Cities have come down, some dramatically, since the recession. Still, some cities — for example, Lawrence, Springfield, Fall River, and New Bedford — remain mired in economic malaise.

We focus here on a strip of the state adjacent to Route 2, north of I-495. We have chosen city pairs, where each city shares a border or is located in very close proximity, suggesting that the paired cities have a common economic environment and prospects. And yet, there are sharp contrasts between each pair of cities, reflecting economic disparities seen across the Commonwealth. In this article, we note some of the contrasts between these pairs — Fitchburg and Princeton; Leominster and Harvard; Gardner and Westminster. A future article in this magazine will attempt to account for these disparities, which we hope will shed explanatory light on widespread patterns of growth and income inequality in the Commonwealth.

Unemployment Rates in Gateway Cities
April 2016
Not seasonally adjusted



Source: Massachusetts Executive Office of Workforce and Labor Development (EOWLD), Labor and Unemployment (LAU) Statistics.

Such disparities can be seen in a consideration of unemployment figures for several Route 2 cities.

The rates have come down somewhat in Fitchburg, Leominster and Gardner since high marks in 2010, but they still far exceed those of the neighboring towns of Harvard, Westminster and Princeton. In 2010, numbers reached just over 11 percent in Fitchburg and Gardner and 10 percent in Leominster, while the comparable figures for Harvard, Westminster and Princeton were 6 percent, 8.0 percent, and 6.6 percent respectively. At the start of 2015, Fitchburg's

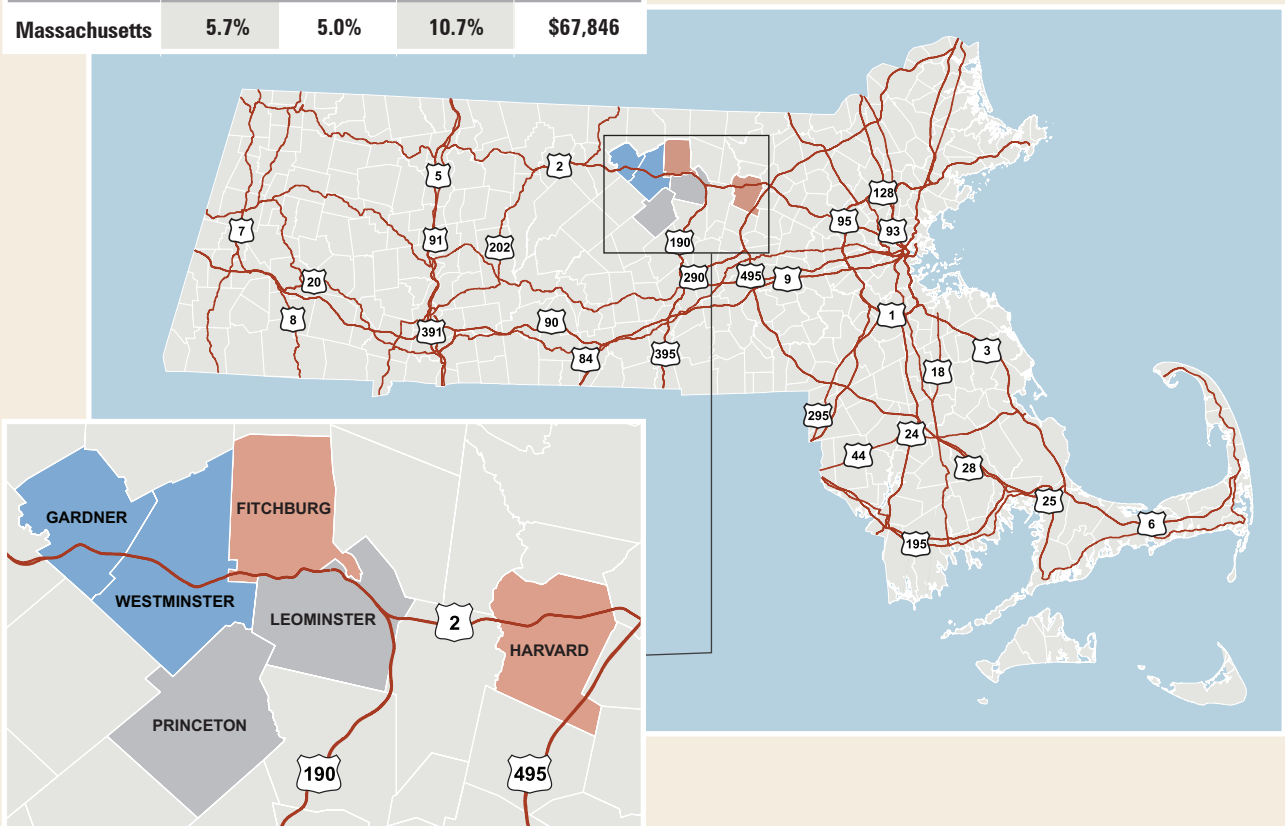
unemployment rate stood at 8.3 percent, Gardner's at 7.6 percent, and Leominster's at 6.8 percent, all well above the Commonwealth's rate of 5.7 percent.

This cluster of communities also demonstrates how income inequality manifests across the Commonwealth, where median household income stands at \$67,846. Gardner (\$46,589), Fitchburg (\$46,628) and Leominster (\$59,263) fall below this mark and trail well behind their neighbors in Westminster (\$87,273), Princeton (\$114,688) and Harvard (\$131,563). Not surprisingly, overall poverty rates in Gardner, Fitchburg and Leominster far exceed the comparable rates among the six communities, with Fitchburg (17.5 percent) and Gardner (14.2 percent) significantly higher than the state average of 10.7 percent.

Annual Unemployment Rates, Poverty Rates and Median Household Income in Six Route 2 Cities

Route 2 Cities	Unemployment Rate		Poverty Rate 2014	Median Household Income 2014
	2014	2015		
Fitchburg	8.3%	6.9%	17.5%	\$46,628
Harvard	4.2%	3.7%	7.8%	\$131,563
Leominster	6.8%	5.9%	11.0%	\$59,263
Princeton	4.7%	3.9%	6.9%	\$114,688
Gardner	7.6%	6.7%	14.2%	\$46,589
Westminster	5.3%	4.4%	2.9%	\$87,273
Massachusetts	5.7%	5.0%	10.7%	\$67,846

By another measure, figures from the U.S. Census Bureau's American Community Survey reveal disparities in economic growth over time. From 2005–2009 to 2010–2014, in Massachusetts median household income decreased by 4.67 percent, a drop adjusted for inflation of \$3,321. In Gardner it dropped 11.37 percent, Fitchburg fell 10.79 percent, and Leominster contracted by 5.8 percent.



Source: Unemployment rates from Massachusetts Executive Office of Workforce and Labor Development (EOWLD), Labor and Unemployment (LAU) Statistics; Poverty Rates and Median Household Income from U.S. Bureau of the Census, American Community Survey.

ECONOMIC PERFORMANCE BY INDUSTRY SECTOR

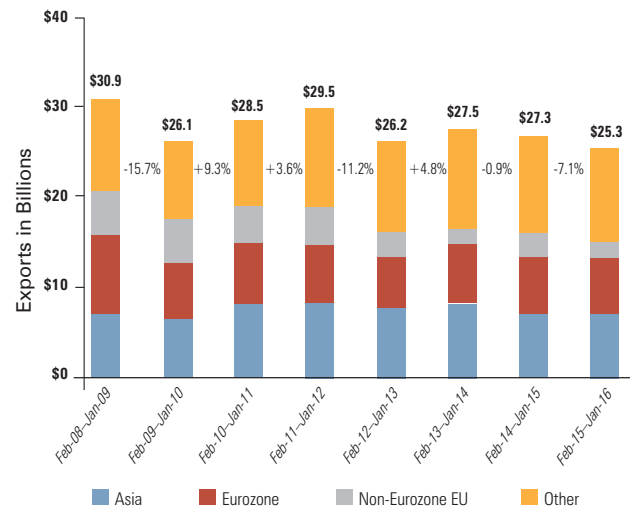
Since the beginning of the employment recovery in October of 2009, which lagged the recovery in state product by nearly a year, the largest sectoral gains in employment were recorded by Professional and Business Services, which has added over 84,000 jobs, and Education and Health Services, which has added nearly 88,000 jobs. The Professional and Business Services sector consists in part of professional, scientific, and technical services, as well as management consulting. The largest percentage gain was in the Construction sector, which grew by nearly 38 percent. The recovery in construction is especially encouraging, given the severity of the previous recession in the sector.

The only relatively large sector to experience a decline in employment during the current expansion was Manufacturing, losing over 2,000, or 0.9 percent of its total. It is clear that manufacturing remains under pressure. The strengthening dollar hurts this sector in two ways: products manufactured here become more expensive in export markets, depressing demand; and, imported manufactured products that compete with products manufactured in the state become less expensive, siphoning away domestic demand. The high costs in the state continue to be an issue, as energy, health care, and housing all raise production costs, either directly or indirectly.

STATE MERCHANDISE EXPORTS

Merchandise exports to international markets declined in the 12 months ending in January to \$25.3 billion. Since 2009-2010 merchandise exports have stagnated, bouncing around in the mid-to-high twenty billions of dollars. The strengthening dollar as well as the weakening economies of the state’s trading partners have depressed the volume of merchandise exports.

Figure 5. Massachusetts Exports by Trading Partner Region February 2008 – January 2016



Source: WISERTrade, calculations by the authors. Dollar values have been adjusted for inflation (\$2015).

Table 1. Employment in Massachusetts by Industry (Seasonally Adjusted), Beginning of Economic Recovery through January 2016

Industry Super-Sectors	Employment at Beginning of Recovery (October 2009)	Employment in Most Recent Month (January 2016)	Employment Change	Employment Percentage Change
Natural Resources & Mining	1,300	1,100	-200	-15.4%
Construction	106,700	147,000	40,300	37.8%
Manufacturing	253,300	251,100	-2,200	-0.9%
Trade, Transportation & Utilities	539,300	568,400	29,100	5.4%
Information	86,100	88,700	2,600	3.0%
Financial Activities	217,200	219,500	2,300	1.1%
Professional & Business Services	452,100	536,100	84,000	18.6%
Education & Health Services	678,900	766,800	87,900	12.9%
Leisure & Hospitality	299,400	347,100	47,700	15.9%
Other Services, Excluding Public Administration	118,500	134,900	16,400	13.8%
Public Administration	437,300	452,200	14,900	3.4%
Total, All Industries	3,190,100	3,512,900	322,800	10.1%

Source: Massachusetts Executive Office of Workforce and Labor Development (EOWLD), Current Employment Statistics (CES-790); Calculations by the authors.

The downturn in state merchandise exports is concentrated among a small number of trading partners, most importantly, the leading destination for state exports, Canada. The appreciation of the U.S. dollar has been especially strong relative to the Canadian dollar; declining commodity prices and global demand have hurt the Canadian economy. Exports to Japan, the United Kingdom, and China — all important Massachusetts trading partners — have all declined.

Table 2. Massachusetts Merchandise Exports Change from February 2014 – January 2016

Partner Country	Percentage Change
Canada	-17.0%
Mexico	11.3%
China	-14.5%
Germany	3.5%
Japan	-20.4%
Netherlands	726.0%
United Kingdom	-40.6%
Switzerland	53.9%
Korea, Republic Of	16.7%
Hong Kong	11.2%
Total (Top Five)	-12.1%
Total (Top Ten)	-9.4%
Total (All Exports)	-7.1%

Source: WISERTrade, calculations by the authors. Dollar values have been adjusted for inflation (\$2015).

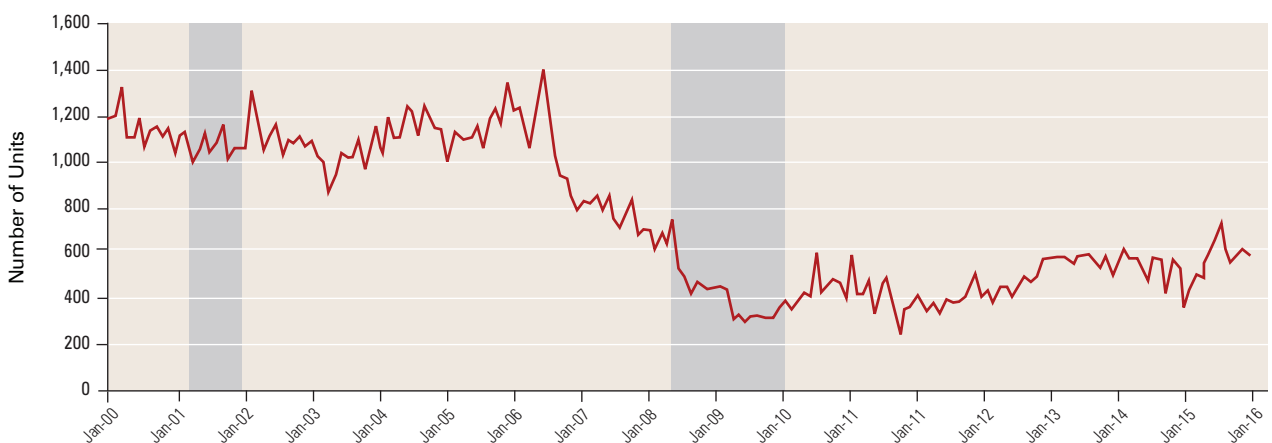
HOUSING CONSTRUCTION

While still considerably below its peak of over 1,400 in February of 2006, housing permits continue to rebound. The cyclical low in permits was reached in February of 2011 at 245 permits, compared with the January number from this year (the most recent available) of 587 permits.

Two patterns within this growth trend have emerged recently and are continuing. The first is a shift away from single-family to multi-family structures. At the beginning of the time period covered by the accompanying figure spanning the end of 2001 into 2002, permits for single-family structures represented 75.7 percent of the total, while multi-family permits accounted for the remaining 24.3 percent. In the most recent period for which data are available, the pattern flipped. For the period ending in January 2016, permits for single-family dwellings fell to 34.1 percent of the total, while 65.9 percent of permits were approved for multi-family units.

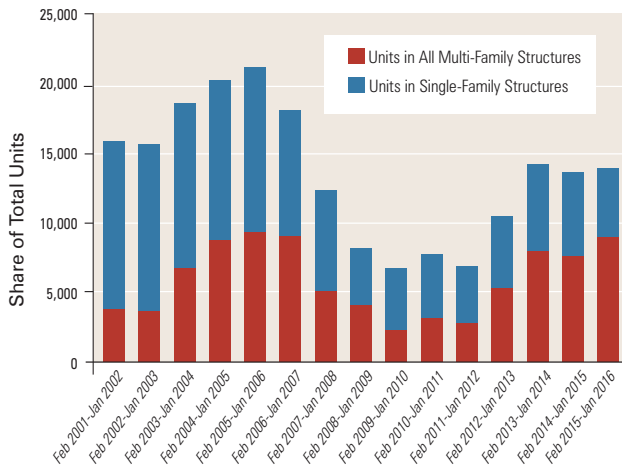
Simultaneously with the shift from single-family to multi-family structures, a geographic shift into the Boston metropolitan area from the rest of the state has been occurring. In 2004, 76.8 percent of housing construction in the state took place outside of Boston. This pattern started to change at the beginning of the recovery from the recession. From 2009 onward, the percentage of housing construction outside of Boston has declined continually, while Boston’s dominance in the state’s housing industry has grown. By 2015, the metropolitan Boston area ac-

Figure 6. New Private Housing Units Authorized by Building Permits for Single-unit Structures Massachusetts, January 2000 – January 2016
Seasonally adjusted



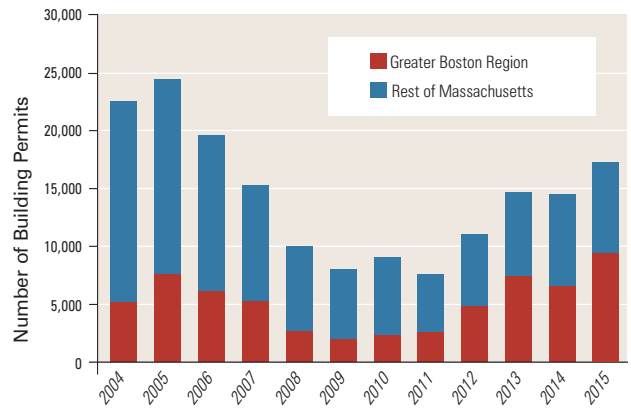
Source: Federal Reserve Bank of St. Louis, *New Private Housing Units Authorized by Building Permits: 1-Unit Structures for Massachusetts* [MABP1FHSA], retrieved from FRED, Federal Reserve Bank of St. Louis <https://research.stlouisfed.org/fred2/series/MABP1FHSA>, March 17, 2016. Shaded areas indicate periods of recession; recession dates were obtained from the National Bureau of Economic Research (NBER).

Figure 7. Housing Permits for Multi-Family and Single-Family Structures Massachusetts, February 2001 – January 2015



Source: U.S. Housing & Urban Development, State of the Cities Data System (SOCDS) Building Permits Database; Calculations by the authors. Preliminary data for 2016 are subject to subsequent monthly revision throughout the remainder of the year.

Figure 8. Housing Construction for the Greater Boston Region and Rest of the State 2004 – 2015




Source: U.S. Bureau of the Census, Building Permits Survey; calculations by the authors. Data represent reported data plus the data imputed for non-reporters and partial reporters. The Greater Boston Region consists of Suffolk and Middlesex counties.

counted for 57.2 percent of all housing construction, while the share in the remainder of the state had fallen to 42.8 percent. The growing dominance of metropolitan Boston in housing construction explains the shift to multi-family housing structures.

CONCLUSION

The Massachusetts economy has experienced more or less sustained growth since the end of the 2008 recession. We expect this growth to continue, though at slower rates and now surrounded by increasing domestic and global risks. The state’s dynamic high-technology sector has been an engine of continuing economic growth, and the education and health care sector have continued to provide a solid base. A weakened China, continuing anemic growth in Europe, southern hemisphere countries experiencing declines in commodities demand, and a slowing Canadian economy represent a global economy beset with difficulties.

For the first time in memory, declining oil prices are creating difficulties for the domestic economy, especially in states that produce energy. Domestic banks also have large exposures to the oil sector. One result of global economic weakness is a strong dollar in international currency exchange markets, damaging U.S. producers of tradable goods and services.

So the state enters a period of increased economic risk and uncertainty. Fortunately, it does so with a strong economy and reasonable prospects for continuing growth. 

ROBERT FORRANT is a professor of history at the University of Massachusetts Lowell and is on the editorial board of this journal.

ROBERT NAKOSTEEN is a professor of economics at the Isenberg School of Management at UMass Amherst and is Executive Editor of this journal.

The authors wish to thank ANDREW HALL of the UMass Donahue Institute for his research assistance and contributions to this article.

Endnote

1.) A few of the data series used in our analysis were updated as we went to press, and are not included in this article. None of the data updates change our assessment of the state of the Massachusetts economy.



Foreign-born Diversity Energizes Worcester's Economy

MICHAEL GOODMAN, DAVID BORGES, MICHAEL MCCARTHY,
JASON WRIGHT, TREVOR MATTOS

THE EXCEPTIONAL INTERNATIONAL DIVERSITY AND SIZE OF WORCESTER'S FOREIGN-BORN POPULATION OFFERS DISTINCT ADVANTAGES. IMMIGRANTS ARE MORE LIKELY TO BECOME ENTREPRENEURS, TO BE OF WORKING AGE, AND TO HAVE RECEIVED STEM OR MEDICAL TRAINING.

INTRODUCTION

Worcester, Massachusetts has long been a center for innovation, industry, and education. Throughout its history, these assets have made it a destination for immigrants from diverse national, cultural, and socioeconomic backgrounds. As with most New England mill towns, Worcester's immigration history began with successive waves of European migrants. In the mid-twentieth century, Worcester began receiving a large number of Latin Americans, peaking in the 1970s. Worcester has seen a surge in African and Asian immigrants since the 1990s, though Asian immigration has outpaced African arrivals since 2010. Most African immigrants have emigrated from Ghana and Kenya, and Asian immigrants from Vietnam, China, and India. Currently, Worcester is home to more foreign-born residents than any other Massachusetts Gateway City.

The continual flow of immigrants into Worcester from different parts of the world lends a level of diversity to the foreign-born population that makes Worcester unique compared with the state or other Gateway Cities. Worcester's estimated 37,970 immigrants from 85 countries make up 21 percent of the city's population. This compares with 15 percent statewide.

- The majority of Worcester's current foreign-born residents entered the country after 1990.
- The largest concentrations of foreign-born residents hail from Ghana (10 percent of all foreign born), the Dominican Republic (10 percent), Vietnam (9 percent), Brazil (6 percent), and Albania (5 percent).
- Over half (51 percent) of Worcester's foreign born are not U.S. citizens, while 49 percent are naturalized U.S. citizens, most who gained citizenship between 2000 and 2010.
- Among noncitizens in Worcester, an estimated 5,500 are unauthorized immigrants.
- The U.S. Department of State reported 2,196 refugee arrivals in Worcester between 2007 and 2012.
- An estimated 70 percent of all Asians and 46 percent of all Africans in Worcester are foreign born. That compares with 24 percent of all Hispanics and 12 percent of all white residents.

DEMOGRAPHIC AND SOCIOECONOMIC CHARACTERISTICS OF THE FOREIGN BORN

Many of the foreign born, especially noncitizens, are of prime working age (25-44 years old) and actively participate in the workforce. Economically, naturalized immigrants as a group fare better than both natives and noncitizens, while noncitizens are more likely to be

economically disadvantaged than natives or naturalized immigrants.

- Worcester's foreign born are almost two times more likely than natives to be ages 25 to 44, with this age cohort accounting for 42 percent of immigrants. This compares with 24 percent of natives.
- Naturalized foreign born have the highest median household income (\$50,865) of all groups — measured against native households (\$46,263) and noncitizen households (\$37,944).
- Overall, the foreign born, particularly naturalized citizens, are slightly less likely than natives to live in poverty.
- Naturalized foreign-born residents have the highest rates of home ownership (53 percent) in Worcester compared with natives (46 percent) and noncitizens (19 percent).
- Approximately half of all foreign born spend 30 percent or more of their income on housing, compared with one-third of all natives.
- Despite having the highest average number of workers per household, noncitizen households earn considerably less than native and other foreign-born households, and are most likely to live in poverty.
- More than half of immigrants in Worcester have low English proficiency. English proficiency correlates with earnings — on average, those with high proficiency earn \$15,000 more per year than those with low proficiency.
- Foreign-born residents access public benefits at rates equal to or below those of their native-born counterparts.

Health insurance enrollment is high for all groups; 96 percent of natives and 91 percent of foreign-born residents have health insurance. Use of publicly supported health insurance (Medicaid/MassHealth) is slightly higher for native residents. Noncitizens have the highest concentration of uninsured individuals.

While labor participation by immigrants is virtually equal to, or for some groups considerably higher than, the native-born population of Worcester, immigrants become entrepreneurs at a high rate. Also, immigrants are more likely than natives to have received STEM (science, technology, engineering, and mathematics) or medical training. The remainder of this article focuses on entrepreneurship and STEM training among Worcester's immigrants. We also discuss how visa programs can be used to retain highly skilled foreign-born workers.

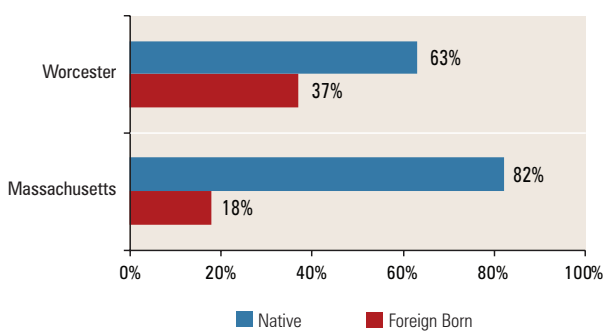
IMMIGRANT ENTREPRENEURSHIP

Immigrant entrepreneurship was and remains vital to economic development and sustainability in the United States. Throughout Worcester's history, its immigrants have played a major role in developing many of the city's early industries and in supporting business development in various industry sectors.¹

ACS PUMS data estimates suggest that between 1,393 and 1,879 Worcester residents work in their own incorporated business.² These individuals are assumed to be directly involved with the daily operations of their business and do not include day laborers or similar types of workers. Natives account for 63 percent of these entrepreneurs, representing between 849 and 1,195 business owners, the midpoint of which is 1,022. Given these data, we estimate that approximately 37 percent or approximately 764 of Worcester's incorporated business owners are foreign born.

The foreign born represent just over two times the proportion of entrepreneurs in Worcester (37 percent) than at the state level, where approximately 18 percent of all Massachusetts entrepreneurs are foreign born (see Figure 1).³ Also, the foreign-born share of entrepreneurs is disproportionate when compared with their share of Worcester's population (37 percent versus 21 percent).

Figure 1. Foreign-born Share of Entrepreneurs 2009 – 2013



Source: ACS five-year 2009–2013 PUMS analysis.

National research on foreign-born business owners notes that these entrepreneurs are more likely to own a Main Street business than any other type of business. Main Street business refers to shops and services that are the backbone of most local/neighborhood economies—including restaurants, gas stations, dry cleaners, grocery stores, beauty salons and barber shops, liquor stores, and clothing stores.⁴ In larger metropolitan areas, foreign-born residents are more likely than natives to own Main Street businesses. While the data for Worcester are

not robust enough to support such a claim, the foreign born account for nearly one-third of all entrepreneurs in Worcester, which suggests that they may be more likely than natives to own Main Street businesses.

H-1B VISAS AND WORCESTER'S INNOVATION ECONOMY

To remain competitive in the global marketplace, regional economies need to create, attract, and retain talented and highly skilled workers. As a center for higher education and a hub of innovation, Worcester is in a strong position to recruit these workers. Attracting highly skilled immigrants stimulates economic growth and is an essential component for cultivating an innovation-intensive economy.⁵ In many cases, foreign workers bring an array of technical skills, creativity, and patentable ideas, all of which promote innovation and improve the competitiveness of the regional economy.

A significant portion of Worcester's foreign-born are skilled and educated workers who arrived in the U.S. on H-1B visas. The H-1B visa program began in the 1990s as a way for employers to sponsor temporary workers in specialty occupations that require highly specialized skills and knowledge⁶ and typically a bachelor's degree or higher.⁷ Metropolitan areas receive the bulk of all H-1B visa applications nationally. This is particularly true for Massachusetts. In 2012, the Commonwealth had 14,758 H-1B visa requests, placing the state sixth nationally. The Boston and Worcester metro areas had the highest concentrations of demand in Massachusetts and the first and fifth highest number of requests in New England, respectively. In 2012, metro Worcester had 1,105 requests, or 7.5 percent of the state total, while the metropolitan Boston region had over 13,000 requests.⁸

Proponents of the H-1B program argue that these visas allow U.S. corporations to recruit high-skilled workers from abroad and to retain foreign students who have completed specialized degree programs in the U.S. Opponents contend that the visas allow companies to train highly skilled workers temporarily in the U.S. in preparation for outsourcing their new skills as part of offshoring. Research by the Federal Reserve Bank of Boston shows that this does in fact occur in some labor markets nationwide, and may limit employment opportunities for qualified citizens.⁹

However, in Massachusetts the type of offshoring preparations cited by visa opponents generally does not occur. For example, in the Worcester metro area, which has larger-than-average demand for H-1B visa requests compared with other New England metro areas, less than five percent of H-1B visa requests come from potential outsourcing firms.¹⁰ On average, the metro areas of New England capture approximately 13 percent of all

visa requests coming from potential outsourcers, compared with 10 percent of requests nationally.¹¹

H-1B visa applicants are critical sources of talent for Worcester’s science, technology, engineering, and mathematics employers.¹² These industries are crucial to the growth of the economy in Worcester and throughout Massachusetts, and the demand for visas reflects the recognized market value of skilled foreign labor. Those who have argued that retaining foreign STEM graduates and recruiting foreign STEM workers through H-1B program crowds out native workers may also be neglecting the alternative. If foreign workers are not employed domestically, they will instead seek opportunities outside of the U.S., which may further incentivize American outsourcing and offshoring. Reporting to Congress and the Bureau of Economic Analysis on the effects of offshoring, the National Academy of Public Administration noted that the H-1B visa program “provides businesses a viable alternative to shifting high-tech services offshore to secure similar critical skills.”¹³ For Worcester, which produces some of the highest numbers of STEM graduates in the state, programs that incentivize the retention of these graduates serve to sustain the local economy and increase the city’s global competitiveness.

The H-1B visa program is thus helping STEM employers in the Worcester area remain competitive in the global economy by broadening their base for recruitment of international talent. It also helps to retain highly skilled foreign STEM students after they graduate from Worcester’s colleges. As evident in Table 1, many of the city’s largest employers rely heavily on employees with STEM-relevant backgrounds and skills.

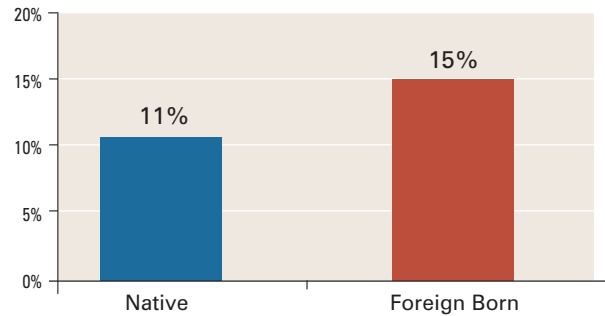
Table 1. Top Companies in Worcester

Company	Number of Employees
UMass Memorial Health Care	13,764
University of Massachusetts Medical School	5,678
City of Worcester	5,128
Saint Vincent Hospital	2,386
Hanover Insurance	1,850
Saint-Gobain	1,807
Reliant Medical Group	1,801
Polar Beverages	1,400
College of the Holy Cross	1,107
Quinsigamond Community College	900

Source: City of Worcester 2010 Comprehensive Annual Report.

Worcester is home to an estimated 14,589 individuals with postsecondary training in STEM or medical professions (STEM+). Of those with STEM+ training, 9,503 are native residents, and 5,086 are foreign-born residents (see Figure 2). These data reveal a higher concentration (15 percent) of STEM+ training within the foreign-born community than the native population (11 percent).

Figure 2. STEM+ Training in Worcester




Source: ACS five-year 2009–2013 PUMS analysis.

Note that, despite the high rate of H-1B visa applicants from the Worcester metro area and the comparatively high percentage of foreign-born workers with STEM training compared with native workers, there is reason to believe that not all professionally trained foreign-born workers are able to use the professional and educational licenses/credentials from their home countries due to licensing and accreditation requirements. The inability of some refugees and immigrants to apply their relevant training and skills in certain, often higher-paying jobs not only has direct implications for workforce capacity, but may also perpetrate the myth that immigrants and refugees lack education and skills. This may reinforce the popular misconception that immigrants lack the skills to make significant economic contributions.

CONCLUSION

The data presented in this article and discussed in much greater detail in our larger report demonstrate that immigrants play an integral role in Worcester’s continued economic and cultural vitality. The city’s foreign-born residents make a disproportionately large contribution to the local economy through their spending and reinvestment, labor participation, and business ownership. Furthermore, interviews with immigration agency leaders reaffirmed the entrepreneurial successes of foreign-born residents, many of whom have started small businesses. Many other foreign-born workers have health and human service occupations that contribute to workforce

development and community building. Notably, the foreign-born population in Worcester is more likely than the native population to be of working age, meaning that in the coming years its role in the local economy is likely to increase as native residents age out of the workforce. This underscores the clear need for thoughtful and evidence based immigration policies that are designed to both meet the needs of growing employers, and maximize the economic benefits that the foreign born offer their communities. 

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Learn more about the Public Policy Center at UMass Dartmouth by visiting its website: www.umassd.edu/ppc

Endnotes

1.) We define immigrant entrepreneurs as individuals identified by the American Community Survey and being both foreign born and working mainly in an incorporated business of which they are a majority owner. This is an important distinction from the broader self-employed category available from the U.S. Census, because the data set filters out workers such as day laborers and other workers who lack a single, regular employer. This methodology was developed by the Fiscal Policy Institute for the report “Bringing Vitality to Main Street” (Kallick, 2013).

2.) Due to the large margin of error, the data are best presented as a range with a clear median estimate.

3.) Kallick, David. “Immigrant Small Business Owners: A Significant and Growing Part of the Economy.” Fiscal Policy Institute, 2012. Estimates based on 2010 five-year ACS.

4.) Ibid.

5.) Fitz, Marshall. “Immigration for Innovation.” Doing What Works and Science Progress No. 5. Center for American Progress, 2012. https://cdn.americanprogress.org/wp-content/uploads/issues/2012/01/pdf/dwwsp_immigration.pdf
Furchtgott-Roth, Diana. “The Economic Benefits of Immigration.” Issue Brief No. 18. Manhattan Institute for Policy Research, 2013. http://www.manhattan-institute.org/pdf/ib_18.pdf

6.) “Understanding H-1B Requirements.” U.S. Citizenship and Immigration Services, 2015. <http://www.uscis.gov/eir/visa-guide/H-1B-specialty-occupation/understanding-H-1B-requirements>

7.) About a third of the visas are reserved for people with a master’s degree or higher.

8.) Clifford, Robert. “Demand for H-1B Visas in New England: Data Appendix.” Policy Report No. 14-1. New England Public Policy Center, 2014.

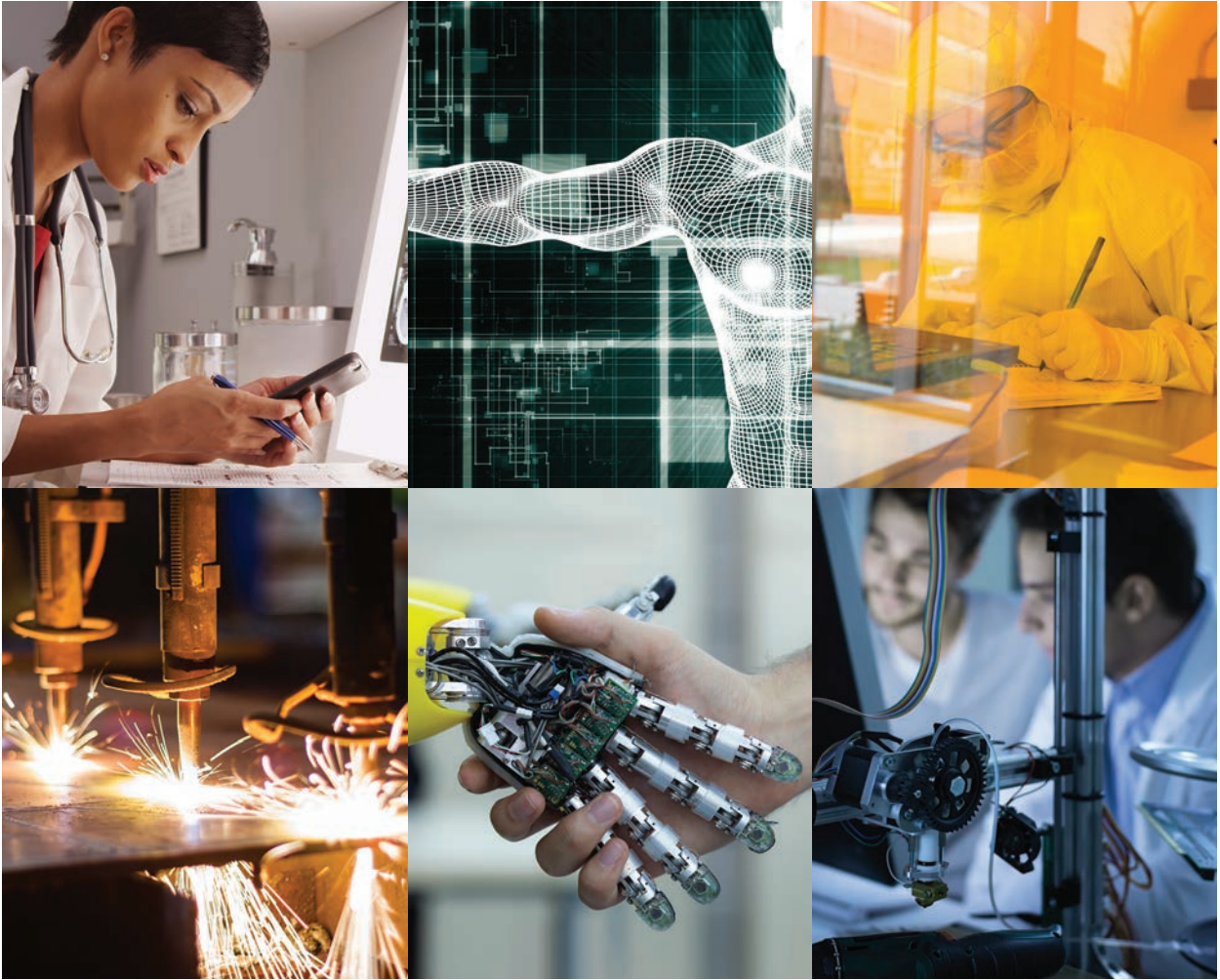
9.) Clifford, Robert. “Demand for H-1B Visas in New England.” Policy Report No. 14-1. New England Public Policy Center, 2014.

10.) Ibid.

11.) Ibid.

12.) Across all STEM occupations in Worcester metro, there is a demand of 23.7 H-1B requests for every 1,000 employed in a STEM field, and in the science and engineering fields there is a demand of 23.6 requests for every 1,000 employed. The computer and mathematics fields have the largest concentration of requests. For every 1,000 employees in those fields, there are 100.5 requests for H-1B visas, nearly double the national intensity of 50.7 for this sector.

13.) Norwood, Janet, Carol Carson, Manuel Deese, et al. “Off-Shoring: An Elusive Phenomenon.” Report of the National Academy of Public Administration, January 2006.



Massachusetts' Medical Device Industry: Anatomy of a Business Ecosystem

ROBERT FARRANT

WITH 304 COMPANIES, MASSACHUSETTS' MEDICAL DEVICE INDUSTRY — ONE OF THE NATION'S LARGEST — REMAINS AN ENERGIZING CONTRIBUTOR TO THE STATE'S ECONOMIC GROWTH. THE INDUSTRY'S BROADER ECOSYSTEM INVOLVES SYNERGIES WITH THE STATE'S LIFE SCIENCES AND BIOTECHNOLOGY FIRMS, RESEARCH HOSPITALS AND UNIVERSITIES, AND MATERIALS MANUFACTURERS.

MEDICAL DEVICES: INTRODUCTION TO THE CLUSTER

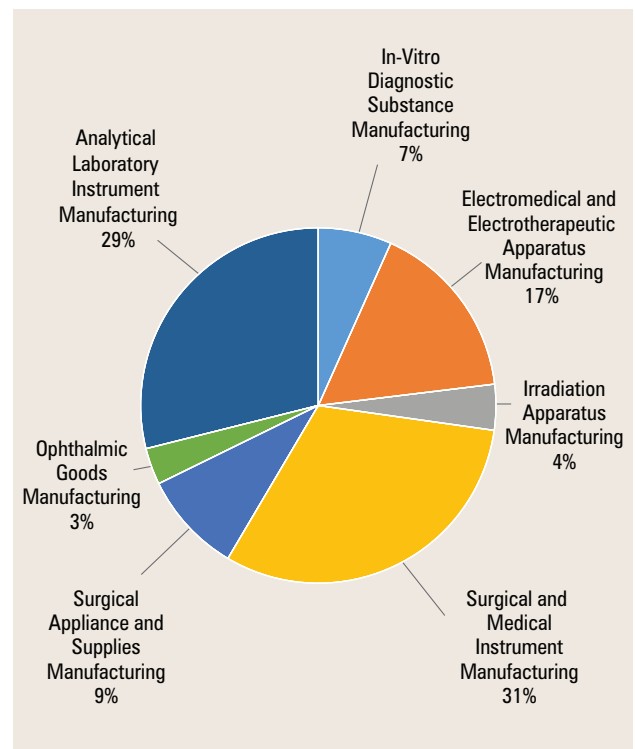
Massachusetts is home to one of the largest and densest biotechnology clusters in the world, with biotechnology defined broadly to include all life sciences product-focused activities excluding healthcare delivery. Well known for its more than 100 universities, the region is also home to five of the United States' top ten research hospitals, including Massachusetts General Hospital, Brigham & Women's Hospital, Beth Israel Deaconess, and Dana Farber Cancer Institute. Massachusetts, a premier R&D center for life sciences, biotechnology, and medical devices, was identified in 2004 by Battelle as ranking second in the nation in the number of biomedical devices and instrumentation companies and fourth in the nation in employment in this industry.

From defibrillators to angioplasty stents, to arthroscopic surgery devices, the medical device industry provides the everyday tools that doctors, surgeons, hospitals, and home health aides rely on. The United States remains the largest medical device market in the world, with a market size of around \$110 billion, and it is expected to reach \$133 billion by 2016. U.S. market value represented about 38 percent of the global medical device market in 2012. U.S. exports of medical devices in key product categories identified by the Department of Commerce (DOC) exceeded \$44 billion in 2012, a more than 7 percent increase from the previous year.

In *Medical Devices: Supporting the Massachusetts Economy* (2004) Alan Clayton-Matthews and Rebecca Loveland found that the medical device industry was "important beyond its size, from several perspectives."¹ They pointed out that the industry required a highly educated workforce and cutting-edge technical components. They noted that the industry's impact extended "beyond the employment and earnings of medical device workers: every hundred jobs is associated with another 79 jobs in Massachusetts, and every dollar of medical device output is associated with an additional 45 cents of outputs from Massachusetts firms." Industry success, they determined, required strong collaboration among manufacturers, researchers, and medical staffs (2004). A recent update to the study using current industry conditions found that every hundred jobs is associated with 92 additional jobs in Massachusetts and every dollar of medical device output spins off an additional 70 cents of economic activity by other firms.

The Massachusetts life sciences labor force numbers approximately 73,313 workers. Firms are found in various sectors and venues, including biotechnology, pharmaceutical and medical devices, academic medical centers, academic research institutions, independent clinical research organizations, and a broad range of functional

Figure 1. Employment in 2014



Source: U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages (QCEW)

areas and occupations. According to the 2014 Quarterly Census of Employment and Wages data from the Bureau of Labor Statistics, the most recent employment count available for the medical device industry in the Commonwealth was 22,775.²

Despite the state economy's vicissitudes, the Massachusetts medical device industry maintained its position as the second-biggest cluster in the country, behind California, according to a report prepared by KPMG LLP for the Massachusetts Medical Device Industry Council. KPMG determined that medical device exports from Massachusetts represented 19 percent of the state's exports in 2014, up from 14 percent 2011. The value of exports climbed from \$4.72 billion in 2005 to \$5.82 billion in 2014. Also, the number of medical device companies grew 20 percent in that period.³

There are some 6,500 medical device companies in the U.S. The Commonwealth is home to approximately 304 such firms. Leading companies include well recognized giants like Johnson & Johnson, General Electric, Medtronic Inc., and Siemens AG. However, more than 80 percent of firms nationwide have fewer than 50 employees, and many (notably innovative start-up companies) have little or no sales revenue. Medical device companies are mainly concentrated in regions known for other high-technology industries, such as

microelectronics, nanotechnology, and biotechnology. States with the highest number of medical device companies include California, Florida, New York, Pennsylvania, and Massachusetts (selectusa.commerce.gov). For 2013, Massachusetts ranked third per capita in employment and second per capita in annual payroll nationally. The Commonwealth's strength in the sector stems in part from its competitive advantage in several industries that device makers utilize, including precision machining, microelectronics, instrumentation, biotechnology, and software development.

INDUSTRY SYNERGIES

Medical devices as a category includes seven NAICS industries — ophthalmic goods, surgical appliances and supplies, surgical and medical instruments, laboratory apparatuses and analytical instruments, irradiation apparatuses, electromedical apparatuses, and in-vitro diagnostic substances. The broadest description of the life sciences cluster comprises 1,888 firms in Massachusetts, many of them in Middlesex, Essex, Norfolk, and Worcester Counties. In the narrower category of medical device makers, there were 304 firms and approximately 22,700 jobs in Massachusetts as of 2014. Similarly, many medical device firms are in Middlesex, Essex and Worcester counties, as are their key suppliers. Currently in Massachusetts, sheet-metal boxes and plastic parts from neighboring small firms are embedded just-in-time in thousands of high-tech devices. Carefully engineered gears and sophisticated electronic switches produced in shops along Route 114 in Middleton or Route 128 in Beverly turn up in aircraft engines built at General Electric and Pratt and Whitney. Perfectly designed molds built in tiny metalworking companies in Leominster are finding their way into machinery used to produce medical equipment parts.

Among precision metalworking customers, surgical/medical equipment grew by 34% from 2000 to 2007. Middlesex County now accounts for about 30% of the state's metalworking employment. While employment has dropped with the current recession, there are still many metalworking firms that can work with medical device innovators. While it is true that high-tech districts such as the Route 128/I-93/I-95 and Interstate 495 areas in Massachusetts are often unique in terms of their technologies and research agenda, metalworking firms in these districts exhibit the innovation characteristics common to a sustainable regional-growth approach to development. While a vertically integrated company can carry out experiments at each stage of production, in a well-coordinated district, dozens of simultaneous experiments take place through a series of relationships with enterprises with complementary capabilities, such as in the

The synergies between metalworking companies, plastics companies, and medical device makers are critical for the state to maintain some level of manufacturing vibrancy.

medical device cluster. This concentration of firms allows them to enjoy the benefits of large scale industrial production and of technical and organizational innovations beyond the scope of any individual small and medium-size firm.

There are large concentrations of metalworking and plastics firms in Middlesex and Worcester counties. Many of these firms specialize in prototype manufacturing and build the precision tools, molds, fixtures, and machine attachments used by producers of final goods. They also build specialized production machines for printing, paper, textile, electronics and plastics firms. In addition, approximately two hundred companies perform services like heat treating, painting, testing, and plating. Despite macro data showing declines in employment in most precision metalworking categories, the significance of these firms to the health of the Commonwealth's economy should not be underestimated. With over 2,300 firms and close to 62,000 well-paying jobs, these firms are intricately connected with what many economic pundits consider the "next big things" in the Bay State, including measuring and controlling devices, environmental cleanup equipment, and medical devices.

The synergies between metalworking companies, plastics companies, and medical device makers are critical for the state to maintain some level of manufacturing vibrancy. While figures on firms and employment vary from one data source to another, the state's plastics cluster contains approximately 700 firms and 24,000 employees, with total sales of roughly \$4 billion. The plastics cluster comprises an important manufacturing concentration in Worcester County. There are 62 plastics firms in the Leominster-Fitchburg-Gardner area, a figure that jumps to 90 when Clinton and Worcester are included. With related mold makers, machinery builders, and materials makers included, the five communities contain approximately 120 firms and almost 4,000 jobs. The long-run success of plastics firms is predicated on three factors: their ability to develop new products; their capacity to work with new materials; and their ability to

train a new generation of workers in advanced technologies. Linking these firms with emerging medical device companies is thus critically important.

For specialty producers in the medical device field, the challenge is to be able to engage in rapid new product development using state-of-the-art materials and to work to extremely high quality and delivery standards. Success is contingent upon the ability of these firms to tap into a network of service providers and a rich constellation of production partners. In many respects this is a highly localized process, one built on long-standing relationships.

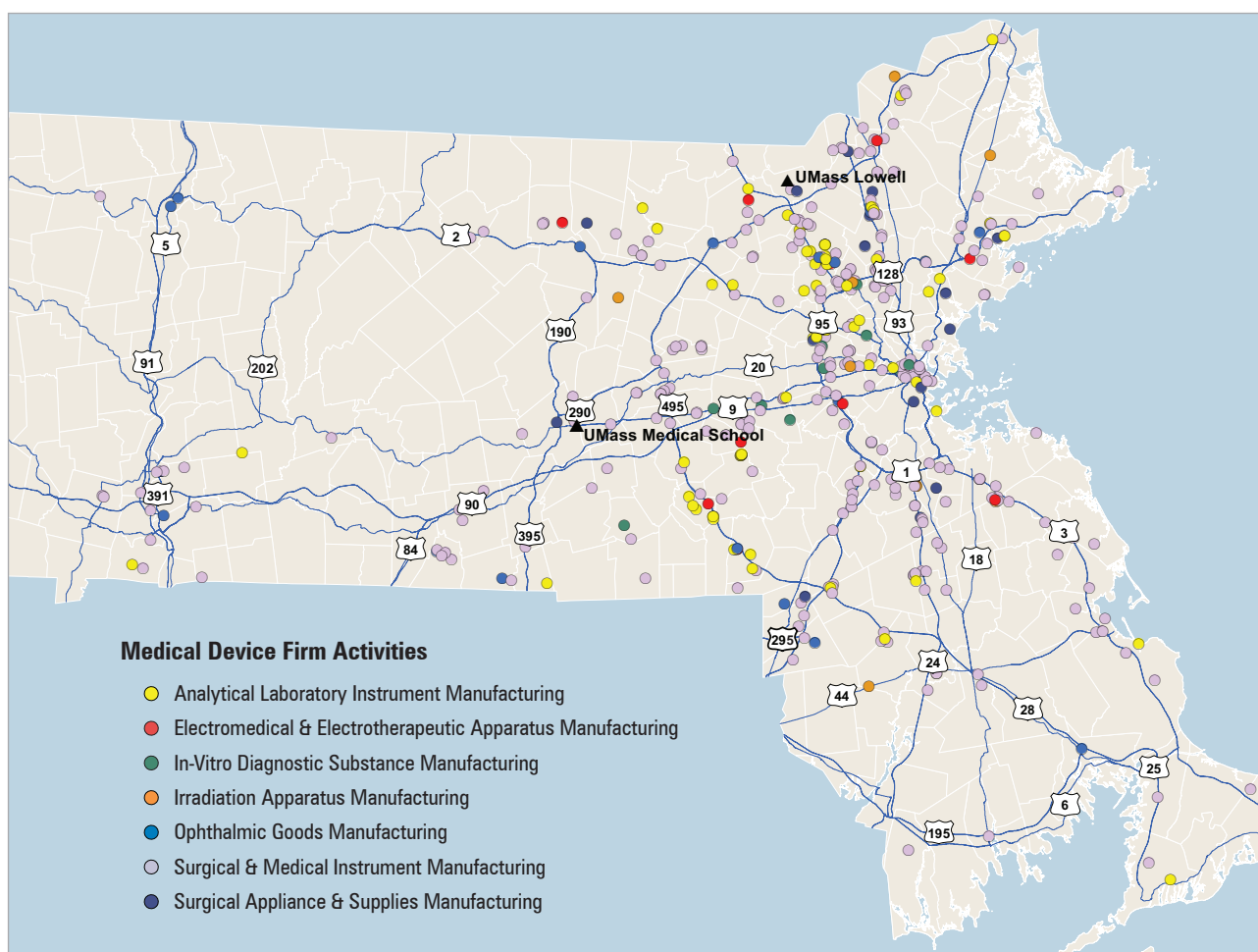
A CLOSER LOOK AT THE UMASS LOWELL-UMAASS MEDICAL CENTER CONNECTION

A large number of the Commonwealth’s medical device firms conduct business activities in or near the fifty-mile corridor between Lowell and Worcester. This cluster differs from the life science one in the greater

Boston-Cambridge area in that the Lowell-Worcester corridor has a greater concentration of materials and manufacturing companies than exists in the Boston-Cambridge area. In addition, UMass Lowell’s Massachusetts Medical Device Development Center (M2D2) is in the cluster, harnessing the medical and engineering capabilities of UMass Medical and UMass Lowell with the specific mission of assisting the industry. Collaborations with the medical school in Worcester and the UMass Lowell M2D2 are critical. They provide a scope of services available to startups beyond UMass Lowell’s engineering and business strengths to the clinical and regulatory expertise available at the medical school. Life science startups need the medical team’s feedback and expertise at the medical school in developing products that both treat the problem and serve medical professionals.

Calling itself “a lifeline for the state’s smaller medical device companies,” M2D2 assists entrepreneurs in the medical device and biotech sector, with all aspects

Figure 2. Medical Device Industries in Central and Eastern Massachusetts



Source: ReferenceUSA.

Note: The map depicts the approximately 50-mile corridor between UMass Lowell and the UMass Medical Center in Worcester. The dots on the map represent medical device firms across this region, which contains the largest cluster of medical devices firms in the Commonwealth outside of the Greater Boston area. InfoGroup reports that medical device companies conduct business activities at 441 locations across the Commonwealth.

of the process of moving new products from concept to the marketplace. Services include engineering and design assistance; prototype design and development; consultation for clinical pathway studies; and access to patient population for clinical trials. The Center also offers referrals to a rich network of private sector design, fabrication, and testing firms. Since its founding in 2007, M2D2 has worked with more than 100 client companies, which in turn have secured more than \$40 million in external funding for their ventures. Additionally, 57 start-up companies received services such as medical and market analyses and prototype development, moving them farther down the product pathway, and helping them to attract private and federal funding.

M2D2 assists startups in developing prototypes, defining the clinical regulatory path, providing business guidance, and connecting them to needed resources. According to Steven Tello, UMass Lowell Associate Vice Chancellor of Entrepreneurship and Economic Development, "This service is critical to nurturing the startups that are helping to support the state's economy. Without places like M2D2, companies will tend to flounder — spending a lot of time chasing resource needs, rather than focusing on product and business development." When asked about the challenges faced by companies like her own, Nancy Briefs of Infobionic, an M2D2 resident company, noted: "Entrepreneurs are faced with a myriad of challenges building their companies. One of the important considerations is where to locate. InfoBionic is fortunate enough to be a client company at M2D2. We are able to leverage both the physical network at the accelerator as well as numerous state and regional services."

As a case in point, in January 2016, M2D2 announced its fifth annual \$100,000 Challenge, a nationwide competition that showcases the innovative ideas of early-stage medical device, diagnostic, and biotech companies. For Stephen McCarthy, a UMass Lowell professor and co-director of M2D2, the goal of the initiatives "is to help entrepreneurs gain valuable services needed during the tenuous stages of early product development. Expert advice, mentoring, and access to facilities can be the difference between failure and success." Albert Lauritano, director of strategic technology partnerships for Becton Dickinson and Company — a sponsor of the Challenge — remarked: "To develop new solutions to the challenges facing health-care delivery, it will take innovation and partnership; participating in the M2D2 \$100K Challenge provides both for BD. He added, "We get to collaborate with startup entrepreneurs and their cutting-edge technologies by providing BD's global market and product development expertise. It is a winning combination for the startup, BD and, ultimately, the health-care system."⁴

*Competing for space and talent
in the Boston-Cambridge area is
a challenge for small companies.*

UMass can help with that.


For UMass Lowell's Tello, the business climate in the Commonwealth for medical device companies is improving. Howard Loree of Flow Forward Medical, another M2D2 resident company, agrees: "My sense is that the medical device industry in general in the U.S., and specifically in Massachusetts is healthy and growing." There has been an increase in venture capital investment over the last several years. The Patrick Administration supported growth of the life science industry through the Massachusetts Life Science Center and encouraged the emergence of a startup culture around the state through support of incubator and accelerator programs. Suppliers, contract manufacturers, and service providers are all benefitting from the pace of startup activity in the state. Competing for space and talent in the Boston-Cambridge area is a challenge for small companies, something that UMass can help with. Tello notes, "Clinical and regulatory processes are most challenging for medical device/biotech companies. This path is complex, expensive, and full of uncertainty. This, however, is a federal challenge, not a problem particular to Massachusetts."

To reach additional firms, M2D2 opened in October 2015 what it calls an Innovation Hub, which already has several tenants. In an article about the opening, *Lowell Sun* reporter Amelia Pak-Harvey found scientist Catherine Pujol-Baxley already hard at work in one of the lab spaces, where she's developing a single-cell protein for fish, a project of the small company, KnipBio.⁵ "It's a brand-new space and you have all this equipment that you basically cannot find anywhere else," said Pujol-Baxley, the start-up's director of research and development. "The location is amazing, and then you're very close to facilities such as UMass Lowell, so we're going to have some collaborations." The new space is a potentially cheaper option for the M2D2 space at Wannalancit Mills, where tenants have to buy their own equipment. "What we think is that these companies that are very, very small and have very little money can move in to the upstairs on the fourth floor with very little capital," said M2D2 co-director Professor Steve McCarthy.⁶

According to Steve Lufkin, CEO of Vantix Diagnostics (www.vantidx.com), Massachusetts has made it

a priority to create an environment favorable for medical device companies evidenced by the large investments in the new UMass Innovation Hub and M2D2, and the alignment of state, academic, and business needs. The firm relocated to Massachusetts from New Hampshire because of those initiatives and the strong talent pool. When asked about the challenges confronting medical device or biotechnology firms, Lufkin stated: “From our perspective as an early-stage company, we see the challenges as attracting funding and continuing to attract a highly qualified talent pool. Having recently moved from New Hampshire to Massachusetts, we feel the state has made it a high priority to create a business environment that is attractive to medical device companies.”

When asked about the importance of research centers like M2D2, he indicated that they provide firms like his with three major benefits: “1.) *Flexibility*. It is extremely helpful to be able to pay as we go for what we need without having to commit to a 5- to 10-year lease. This way we can expand as we are ready to expand as opposed to paying for space we don’t need yet. 2.) *Access*. At the Innovation Hub and M2D2, we have access to equipment and expertise through our membership fees. This equates to being able to dedicate more funds to the critical R&D effort. 3.) *Expertise*. As a medical diagnostic company, being able to connect with the experts at the medical school is very valuable as we develop a device for physician offices.”⁷

The medical device industry has achieved consistent growth and operating margins for two decades. However, recent reports by global consulting firms A.T. Kearney and KPMG suggest that the years of steady growth may well be over. In *Collaboration — The future of innovation for the medical device industry* (2015), KPMG suggests that “medical device companies need to embrace more inclusive innovation models, collaborate more frequently and with a broader range of partners, and pursue greater integration with suppliers, development partners, and healthcare providers.”⁸ Many of the Commonwealth’s small and medium-size medical device firms and start-ups in the 50-mile corridor between UMass Lowell and the UMass Medical Center in Worcester are already behaving in this way, a prescription for future success. 

Endnotes

- 1.) Alan Clayton-Matthews and Rebecca Loveland, *Medical Devices: Supporting the Massachusetts Economy*, University of Massachusetts Donahue Institute, May 2004.
- 2.) Life sciences definition is based on Massachusetts Technology Collaborative’s Bio/Pharmaceuticals, Medical Devices & Hardware Sector, see *Massachusetts Innovation Economy Annual Index*. Medical device sector definition is based on Clayton-Matthews/MassMEDIC definition
- 3.) Priyanka Dayal McCluskey, “State remains strong in medical-gear field: Exports, companies, funding grew while workforce dipped,” *The Boston Globe*, May 6, 2015.
- 4.) Christine Gillette, “Medical Device, Biotech Startups Invited to Apply by January 29 for Competition,” January 13, 2016 (uml.edu).
- 5.) Amelia Pak-Harvey, “Newly Christened M2D2 Hub in Lowell’s Hamilton Canal Already Humming,” *Lowell Sun*, Oct. 7, 2015.
- 6.) Ibid.
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ENDNOTES



UMass Center Energizes Development of Medical Device Prototypes

STEVEN TELLO

SINCE 2007, THE MASSACHUSETTS MEDICAL DEVICE DEVELOPMENT CENTER — A STATEWIDE SERVICE PARTNERSHIP BETWEEN THE UNIVERSITY OF MASSACHUSETTS LOWELL AND WORCESTER CAMPUSES — HAS HELPED MEDICAL DEVICE STARTUPS WITH PROTOTYPE DEVELOPMENT. THE CENTER'S SERVICES INCLUDE ASSISTANCE WITH PROTOTYPE FUNDING AND DESIGN AND COMPETITIVE BUSINESS ANALYSIS.

How does a public research university support regional economic development? By investing in and then sharing the resources needed to convert intellectual property — ideas, innovations — into successful new products, services, and business. The Massachusetts Medical Device Development Center (M2D2) is one example of how the University of Massachusetts' Lowell and Worcester

campuses are assisting the region's medical device entrepreneurs to bring new products to market. Founded in 2007 by UMass Lowell Plastics Engineering Professor Stephen McCarthy and Dr. Sheila Noone, former Director of Clinical Research at UMass Worcester, M2D2 focused on the medical device development "Valley of Death" — that period of time when a startup has a good

medical device concept but no funds to develop a prototype. Without a prototype, a startup is unlikely to attract private investment funding that will then support its product development and growth. But without funding it cannot develop a prototype — a bit of a “Catch 22” for med device startups.

M2D2 addresses this challenge by leveraging University knowledge and facilities resources along with state and federal grant funds to help med device startups with the design and development of prototype devices. UMass Lowell provides engineering design and development expertise while staff at the UMass Medical School provide critical clinical knowledge and perspective. The Massachusetts Technology Collaborative Innovation Institute provided early-stage development grants to a select group of startups while additional funds were secured by assisting startups in writing and securing federal SBIR funding for product development. From 2007 through 2010, M2D2 staff worked closely with over 50 medical device startup companies, providing assistance with prototype design, clinical pathways and competitive business analysis (with participation from the University’s Manning School of Business in Lowell). During this period, M2D2 affiliated companies raised approximately \$20 million in private investment capital and an additional \$5 million in state and federal grant funds.

Raising funds alone, however, does not guarantee that a new medical device product will come to market. M2D2 also assists in connecting these startup companies to the medical device value chain in Massachusetts, the suppliers and contract shops that assist medical device entrepreneurs in manufacturing and distributing products. These companies include machine shops, product development companies, plastics mold design and manufacturing companies, electronics design and assembly companies, and service companies that assist in the business aspects of operations (e.g., accounting and finance firms, insurance companies, regulatory consulting groups).

Historically, the medical device industry in Massachusetts is a driver of the state’s innovation economy. Every 100 jobs created in medical device companies is associated with the creation of an additional 92 jobs in Massachusetts, while every dollar of medical device output spins off an additional 70 cents of output from other firms (Hall, 2016 update of Clayton-Matthews and Loveland, 2004). The economic well-being of these supply chain companies is related to the region’s ability to bring innovative new products and companies to market. The medical device industry, then, plays neatly to the Commonwealth’s technology-based design and manufacturing base.


Without a prototype, a startup is unlikely to attract private investment funding that will then support its product development and growth. But without funding it cannot develop a prototype — a bit of a “Catch 22” for med device startups.

As demand for the services offered by M2D2 increased, it became increasingly apparent that medical device startups also required specialized space in which to work. Medical device development often requires both chemistry and engineering, wet labs where work with materials and chemicals can safely take place, and prototype labs where materials can be tooled and machined. While the University could accommodate tooling and machine work in existing campus facilities, wet labs were a limited and scarce resource. In addition, in the early startup phase, where financial resources are limited and company future is uncertain, it is difficult for startups to commit to multi-year, market-rate leases. The medical device companies that M2D2 works with require specialty lab space with flexible lease terms and rates. They also need office and conference space, where entrepreneurs can convene partners and investors as they develop the business path for their respective ventures. In 2011, with the support of the Executive Office of Housing and Economic Development, M2D2 opened a 14,000 sq. ft. facility in Lowell that provides private wet lab space, office space, conference space, and areas for open collaboration.

As the physical footprint of M2D2 grew, so did its critical resource network for entrepreneurs. Established life science companies like Smith & Nephew and Boston Scientific, along with respected service providers such as Mintz Levin and MPR, have stepped forward to provide sponsorship funds and mentoring services to the startups in M2D2. Most recently, the startups in M2D2 have attracted the attention of the region’s angel investment community. A series of investment pitch events and the annual M2D2 \$100K Challenge have helped M2D2 companies raise over \$50 million in private investment funds and \$7 million in state and federal grants. In addition to the client companies housed in the M2D2 labs, the M2D2 Virtual Member Network represents over 100

medical device startup companies and dozens more supply and value chain partners.

While initially focused on providing prototype development services to aid medical device startups in crossing the Valley of Death, M2D2 has evolved into a full-service, life science startup facility and program. The 2015 opening of an 11,000 sq. ft. shared wet lab and biotech facility in Lowell's Hamilton Canal District, through the support of the Massachusetts Life Sciences Center, increases the facility footprint of M2D2 and expands resources available to the region's biotech companies. M2D2 is about connecting medical device and biotech startups to the resources needed to bring their new products to market.

Note that the companies served by M2D2 are not typically based on University of Massachusetts inventions, but rather are attracted to Lowell from other cities and states to leverage resources offered by participation in M2D2. It is reasonable to ask why the University has invested staff and facilities resources in a program that is outward facing — serving the needs of life science startups rather than specific academic programs. The short answer is that the University of Massachusetts is committed to economic development in the Commonwealth. A 2015 Donahue Institute study estimates the annual total economic contributions of M2D2 companies on the regional economy at \$75 million. But beyond this, the companies in M2D2 provide research and learning opportunities for our faculty and our students. Over forty students have worked in M2D2-affiliated startups through the support of the Massachusetts Life Sciences Center Internship Challenge. Faculty from UMass Lowell and UMass Worcester have partnered with these startup entrepreneurs to assist in the development of new products, new intellectual property, and new companies. M2D2 helps connect our students and researchers to the real-world needs of Massachusetts' growing life sciences sector, while linking the region's life science entrepreneurs to the resources needed to launch their new ventures. 

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