



Mass Benchmarks

A JOURNAL OF THE MASSACHUSETTS ECONOMY

The Massachusetts Economy
in a Time of Transition

Educational Requirement Markup
and Credential Mismatches in the
Greater Boston Labor Market

Does a Skills Gap Exist
in U.S. Manufacturing?

Meeting the Needs
of Manufacturers
in Massachusetts



MassBenchmarks

2014 | volume 16 issue 2

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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The Advanced Manufacturing Collaborative is supporting manufacturing in the state by coordinating policies, strategies, and empowering regional partnerships.

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FROM THE PRESIDENT



This issue of *MassBenchmarks* takes stock of economic conditions in Massachusetts during a time where there are a number of important transitions looming for the Commonwealth, including the election of a new governor, treasurer, and attorney general. As it has since its founding over 15 years ago, *MassBenchmarks* will continue to provide critical insights and data to inform evidence-based policymaking throughout this transitional period and beyond.

According to UMass Dartmouth Professor Michael Goodman and UMass Amherst Professor Robert Nakosteen, the state economy is on a steady growth track and continues to be in a period of expansion that is now in its sixth year. While state employment is at record levels and housing prices are approaching their pre-recession peak, Professors Goodman and Nakosteen highlight what is arguably the largest economic development challenge facing the Commonwealth and its incoming leaders, the persistent gap between the performance of the Greater Boston region and the rest of the state. This problem is not new but it is also clear it is not going away absent serious and sustained action.

This issue's two feature articles take a close look at two critical issues that offer key insights into employer needs and behavior. In the first, the UMass Donahue Institute's Mark Melnik examines the growing employer demand for postsecondary educational credentials, even for occupations that do not appear to require high levels of formal educational attainment. As Dr. Melnik documents, what he terms the "college mark-up" has significant implications for our educational institutions and workforce development system.

In the second feature article, MIT doctoral candidate Andrew Weaver critically assesses the evidence surrounding the debate over the oft-heard complaint that there is a "skills gap" in the manufacturing workforce. While he finds that the evidence clearly shows that this problem is significantly smaller than many have claimed, he identifies a clear need for improved coordination of our educational and workforce institutions, and between our workforce system and the employer community. This theme is elaborated upon in this issue's Endnotes, where UMass Amherst alumnus and Assistant Secretary of Housing and Economic Development Eric Nakajima describes a series of important policy initiatives that are clearly designed to help meet the challenge identified by Weaver and to position the Bay State to be a global manufacturing leader for years to come.

Taken together, the information and insights contained in this issue of *MassBenchmarks* highlight several key challenges that will require sustained and coordinated action on the part of our public, private, and labor leaders. If Massachusetts is to preserve its hard-earned position as a leading state, we must find ways to extend economic opportunities to every corner of the Commonwealth. As the research presented in this issue makes clear, doing so will require, among other things, a renewed effort to improve the alignment between our educational and workforce development institutions and the evolving needs of our employers.

A handwritten signature in black ink that reads "Robert L. Caret". The signature is written in a cursive, flowing style.

Robert L. Caret, President

EXCERPTS FROM THE BOARD

Both Massachusetts and the nation are on track to experience solid growth for the balance of 2014 and through the first quarter of 2015. Since the state recovery began in the summer of 2009, employment and economic activity have grown steadily and consumer spending as measured by state sales tax receipts has been strongly positive in recent quarters. The state's innovation economy, composed of a diverse array of high-technology and knowledge-intensive industries, continues to be a growth driver, fueled in part by strategic public investments and the Commonwealth's highly educated labor force.

But serious challenges remain. Long-term unemployment remains high and the rising tide of the state's labor market recovery has yet to lift the boat of tens of thousands of workers who continue to be unable to find work. Growth in the innovation economy continues to be largely concentrated in the dynamic Metro Boston region and the benefits of this growth have yet to be felt in many areas, especially urban communities commonly referred to as the Gateway Cities. A number of these communities continue to experience difficult economic conditions, including unemployment rates approaching double-digits, stagnant incomes, and significant fiscal challenges.

Notwithstanding these continued regional imbalances, the economic outlook for the state remains positive. But there continue to be significant risks to the downside. Most notably, the Middle East and Eastern Europe continue to be highly volatile and constitute major sources of geopolitical and economic risk. The Eurozone economy has yet to fully recover and its near-term prospects are not good. And the Chinese economy is growing more slowly than in recent history. All of these developments are exerting downward pressure on global growth and represent serious risks to the global, national, and Massachusetts economy. And the apparent decoupling of U.S. and world growth patterns also has significant implications for how we assess the state's economic performance.

Along these lines, one issue that received considerable attention by the Board concerns the state's recent international export performance. Since the end of the recession, state exports to destinations outside the U.S. have not grown as fast as those of the nation as a whole. Even when we exclude energy and automobile exports, which have played a large role in recent U.S. performance, and consider the influence of the service exports, the nation still appears to be outpacing the state. Given the ongoing struggles of some of the Commonwealth's most important trading partners, there is reason to believe that out-of-state domestic markets, shipments to which are not captured in the available export data, may be gaining importance.

Overall, the Board remains cautiously optimistic about the near-term future of the state economy. The consensus view that is barring unforeseen developments, the Massachusetts economy has enough momentum to continue on a moderate growth track for the foreseeable future.

*Prepared by Executive Editor Robert Nakosteen,
September 26, 2014*

WITH THIS ISSUE OF *MASSBENCHMARKS*,
*Professor Catherine Mann is stepping down from
our Editorial Board to assume her new role as
Chief Economist with the Organization of Economic
Cooperation and Development (OECD) in Paris.
We are grateful to Professor Mann for her contributions
and insights to this journal and congratulate her on
her prestigious appointment.*

THE STATE OF THE STATE ECONOMY
ECONOMIC CURRENTS



The Massachusetts Economy in a Time of Transition

THE MASSACHUSETTS ECONOMY CONTINUES TO GAIN STEAM IN A RECOVERY THAT IS ENTERING ITS SIXTH YEAR. DURING THE MOST RECENT QUARTER, THE STATE'S REAL PRODUCT GROWTH CONTINUED TO OUTPACE THE NATION'S. IN SPITE OF ITS STRONG PERFORMANCE, MASSACHUSETTS STILL FACES CONTINUING IMBALANCES BETWEEN ECONOMICALLY THRIVING AND STAGNANT COMMUNITIES.

MICHAEL GOODMAN AND ROBERT NAKOSTEEN

Data from the second quarter of 2014 make it evident that the state economy is bouncing back from a first-quarter temporary reversal of fortune. The Commonwealth's economy is now estimated to have grown at an annualized rate of 4.9 percent in the second quarter following a revised decline of 0.3 percent in the first quarter. In contrast, the nation is estimated to have contracted at a 2.1 percent annual rate in the first quarter, followed by an increase of 4.2 percent in the second quarter. There is good reason to believe that the nation's performance in the first quarter was an aberration that was partly the result of a very difficult winter season that limited economic activity in key weather-sensitive industrial sectors that the nation is more reliant upon than the state.

There is every indication that the Massachusetts economy is continuing its recovery that is now entering its sixth year. The Commonwealth continues to economically outperform the nation in a number of important respects even if the benefits of that growth premium remain concentrated

in the dynamic Greater Boston regional economy. The *MassBenchmarks* Current Economic Index estimates that the Massachusetts economy grew during 2013 by 4.1 percent, compared with the 2.3 percent experienced nationally. This pattern has continued this year.

Despite the surge in economic activity during the second quarter, a number of headwinds continue to slow the pace of economic activity both in the Bay State and across much of the nation. These include the continued negative impacts of federal budget austerity and a troubling slowdown in business investment and international trade.

Federal fiscal drag continues to weigh heavily on the prospects for Massachusetts institutions that are key players in the state's dynamic innovation industries. Significantly, these industries have been growth drivers for the state economy in recent years. Reduced levels of government spending and investment in research and development continue to negatively impact Massachusetts employers that rely on government contracts and our

world-class universities and other research-intensive organizations. But these institutions appear to be adjusting to what appears to be a new federal budget reality. Anecdotal reports suggest that these adjustments include finding nongovernmental sources of revenue, expanding into international markets and streamlining business processes. Fortunately, to date it appears that the rate of growth of these institutions remains positive, even if it is slower than what would otherwise be expected in a less austere budgetary environment.

A similar pattern can be seen in national business investment, which remains stubbornly below pre Great Recession levels. The Wall Street Journal recently reported that business spending on capital equipment as a share of gross domestic product has averaged 5.2 percent over the past five years, after averaging 6.5 percent over the previous half century. This diminished level of investment has reduced annual national economic activity by an estimated \$220 billion.¹ For a state like Massachusetts, which is a leading provider of industrial and technological business equipment, depressed levels of business investment are a definite cause for concern.

Another area of concern is the slowing pace of international trade. While state merchandise exports have been growing steadily in recent quarters, the state's important trading partners, especially the European Union, continue to struggle and face considerable economic and geopolitical uncertainty. Most notably, the economic fallout from the crisis in Ukraine remains unclear; economic and financial sanctions can be expected to have an impact on European economies at the very least. Among other things, Europe relies heavily on Russia as a source of energy.

While our outlook for the remainder of 2014 and first half of 2015 remains positive, in light of these continuing headwinds and significant risks to the state and national economic outlook, our optimism remains cautious.

STATE LABOR MARKET CONDITIONS

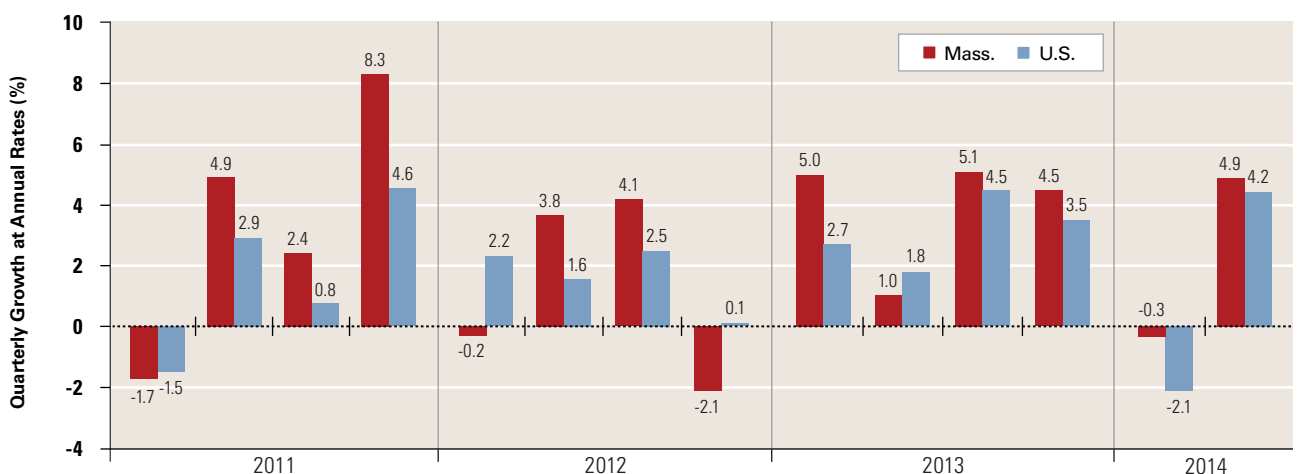
Employment in Massachusetts has been growing more or less steadily since it emerged from the recession five years ago. State employment is now at historically high levels and since October of 2009, when the state started adding employment following the recession, 240,800 jobs have been created, an increase of 7.6 percent. More recently, an estimated 42,200 jobs were created in Massachusetts between January and September of 2014.

The largest absolute employment gains beginning in October of 2009 have taken place in the Education and Health Services sector (just over 72,800 jobs added) and in the Professional and Business Services sector (70,300 jobs were added). Double digit gains were also registered in Leisure and Hospitality; Trade, Transportation, and Utilities; and Construction. Both Manufacturing and Financial Activities experienced employment declines over this period, though of a small magnitude.

The state's unemployment rate, which has consistently been below the national rate, has increased in recent months and is now slightly higher than the U.S. rate. In September 2014 state unemployment was estimated to be 6.2 percent. Nationally, the unemployment rate has fallen from a high of over 10 percent to an estimated 5.7 percent in September 2014.

As can be seen in Figure 2, a striking imbalance in the economic fortunes of regions outside of the Greater Boston area remains in evidence. While unemployment rates across the state have uniformly declined since September 2013, a sizeable gap persists in Southeastern Massachusetts, Northern Worcester County, and in the urban centers of Western Massachusetts. For example, the September 2014 unemployment rate in the New Bedford NECTA, which includes the City of New Bedford and several suburban communities, at 8.9 percent, is 44 percent higher than the state average and 59 percent higher than Greater Boston's rate.

Figure 1. Growth in Real Product, Massachusetts and U.S.



Source: U.S. Bureau of Economic Analysis Real GDP (U.S.); MassBenchmarks Current Economic Index (Mass)

While this troubling imbalance is not new and merits renewed attention from state and regional policymakers and community leaders, there are some positive signs in recent local jobs reports. The labor force grew in each of the Commonwealth's NECTA areas between May and September 2014. This along with local anecdotal reports of improving conditions suggests that the return of discouraged workers to the labor force is partially responsible for stubbornly high unemployment rates in selected areas of the state. But notwithstanding these positive signs, the regions beyond Greater Boston continue to lag. Many have yet to experience their share of the benefits of the state's economic recovery.

EXPORT ACTIVITY

International exports are a key driver of economic growth and represent approximately 12 percent of the Massachusetts economy (combining goods and services exports), according to recent Brookings Institute research.² Exports bring new dollars to the economy and help support numerous other industries, so trade growth trends are critical to the Commonwealth's overall economic growth.

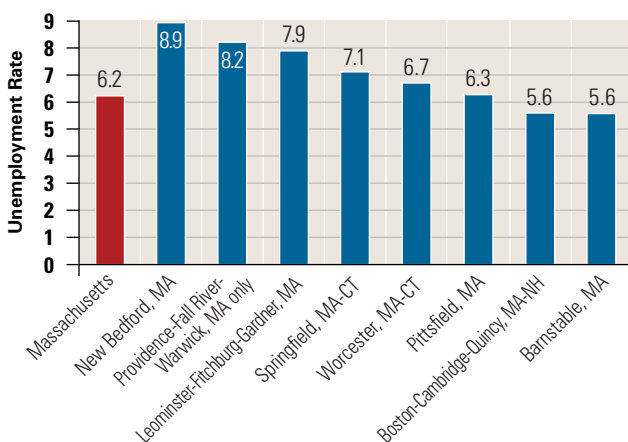
So it is undeniably good news that Massachusetts merchandise exports grew by 10 percent between July 2013 and June 2014 on a year-to-date basis. Despite the uncertainty surrounding the economic outlook for some of our key trading partners in Europe, our trade with both the

Table 1. Employment in Massachusetts by Industry, Beginning of the Economic Recovery through September 2014

Industry Super-Sectors	Employment at Beginning of Recovery (October 2009)	Employment in Most Recent Month (September 2014)	Employment Change	Employment Percentage Change
Natural Resources and Mining	1,300	1,000	-300	-23.1%
Construction	106,700	124,200	17,500	16.4%
Manufacturing	253,300	248,300	-5,000	-2.0%
Trade, Transportation & Utilities	539,300	569,500	30,200	5.6%
Information	86,100	92,700	6,600	7.7%
Financial Activities	210,300	209,100	-1,200	-0.6%
Professional and Business Services	452,100	522,400	70,300	15.5%
Education and Health Services	679,900	752,700	72,800	10.7%
Leisure and Hospitality	299,400	339,200	39,800	13.3%
Other Services, Excluding Public Administration	118,500	125,900	7,400	6.2%
Public Administration	437,300	440,000	2,700	0.6%
Total, All Industries	3,184,200	3,425,000	240,800	7.6%

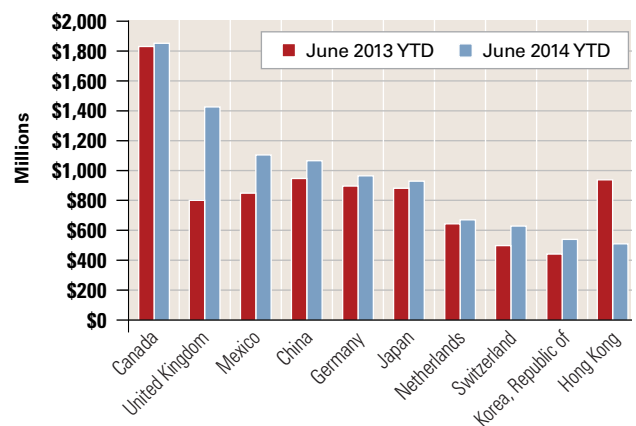
Source: Massachusetts Dept. of Labor and Workforce Development (MADLWD), Current Employment Statistics (CES-790) data; Calculations by authors

Figure 2. Unemployment by NECTA, September 2014 (Not seasonally adjusted)



Source: MADLWD, Local Area Unemployment Statistics, Metropolitan NECTAs

Figure 3. Top Ten Trading Partners June 2013 YTD vs. June 2014 YTD



Source: WISERTrade, U.S. State Exports

Eurozone and Asia increased over this same period. In fact, exports to all but one of the state's most important trading partners increased over the twelve-month period ending in June, compared with the previous twelve-month period.

As Figure 3 illustrates, Canada retains its long-held position as the state's most important trading partner, followed by the United Kingdom, China, Mexico, and Germany. Of the state's top-ten export destinations, two are border countries, four are in Europe, and four are in Asia. Exports to all but Hong Kong have grown over the past 12 months, compared with the previous twelve-month period.

The recent growth in state exports masks a potentially troubling longer-term pattern. Since 2010, state exports have grown at a considerably slower pace than national exports. As can be seen in Figure 4, the state's export performance has also been considerably more volatile than the nation's, where merchandise exports have grown steadily since early 2009. Part of the explanation for this pattern has been the recent domestic energy boom, which has helped to fuel national export growth in recent years.

Despite these recent improvements in national and state export activity, in recent years it has become evident that the link between global economic growth and global trade has weakened. According to the OECD, global trade in the decade prior to 2008 grew at nearly double the rate of global GDP growth. Since then, global trade has more closely tracked the rate of GDP growth, reflecting a substantially lower level of international trade growth. As the fortunes of the Massachusetts export economy cannot be decoupled from global economic conditions and trade patterns, this trend is worrisome. With European growth remaining modest, and continuing concern that Asian growth may be moderating, a further slowing of global trade could be on the horizon. If this scenario materializes, the Commonwealth's exporters will be in for a tough time, with predictable negative effects on state economic growth.³

THE STATE OF THE STATE HOUSING MARKET

The Commonwealth continues to experience a housing recovery which began in early 2012 and which has firmly taken hold in Greater Boston, where the number of available properties for sale remain below levels required to meet demand and ensure price stability. Rising rents and incomes in the immediate Boston area along with low interest rates continue to exert upward pressure on housing prices, which in some of the hottest markets in Eastern Massachusetts are substantially above their pre-housing downturn peaks.

In high-demand communities, there are widespread anecdotal reports and journalistic accounts of above-asking-price offers and other clear market signals that the demand for housing is outstripping the supply of available properties for sale in select communities. These commu-

nities offer potential buyers ready access to the dynamic Greater Boston job market and highly valued amenities, including quality public schools and convenient commuting options. But in these communities, this rising tide is pricing out all but the highest-income households.

A recent Boston Globe analysis of data compiled by the Warren Group⁴ clearly illustrates this pattern. Between 2005 and 2013, it reported that the median single-family house price in Newton grew 17 percent from \$760,000 to \$889,000. In stark contrast, prices fell nearly 35 percent in Brockton during the same period.

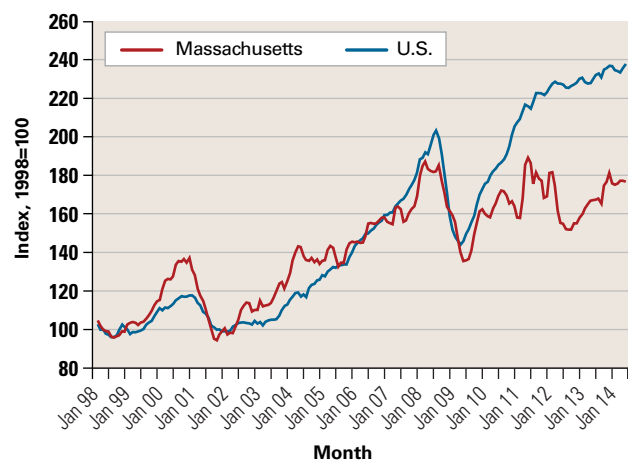
Thus, the solid overall recovery described in statewide housing price data continues to mask dramatic differences across local and regional housing markets across the Commonwealth. As can be seen in Figure 5, home prices in Greater Boston, as measured by the Case-Shiller Index, are approaching their late 2005 peak.⁵ This is excellent news for home sellers in this region, especially those in high-demand communities. But if prices continue to rise more rapidly than incomes, recent modest improvements in housing affordability — a silver lining of sorts during the downturn — will quickly evaporate.

A Widening Development Gap

While the nature of the recovery in state housing prices highlights the troubling pattern of regional inequality that has characterized the state's recovery from the Great Recession,⁶ prices alone do not offer us a complete picture of the state-of-the-state housing market.

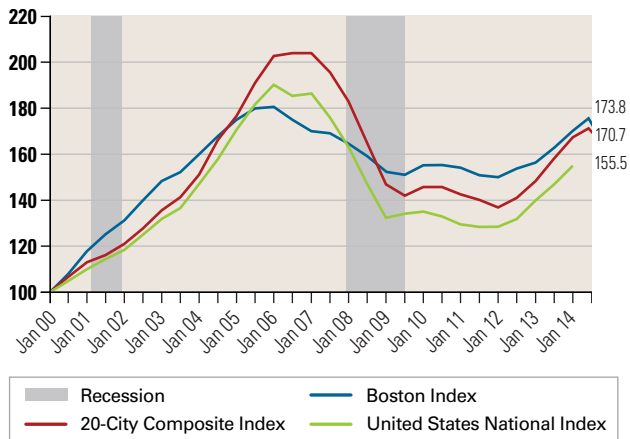
Housing production, as measured by both permits issued and housing starts, can provide us with some insight into how the housing recovery is impacting the larger state economy, including important housing-sensitive industrial sectors such as construction and build-

**Figure 4. Massachusetts Merchandise Exports
Three-Month Moving Average
January 1998 – June 2014
(Seasonally adjusted)**



Source: U.S. Department of Commerce; WISERTrade; Seasonal adjustments by author

**Figure 5. S&P Case-Shiller Home Price Indices
Boston, 20-City Composite and U.S. National
January 2000 – June 2014
(Seasonally adjusted)**



Source: S&P Dow Jones Indices LLC, S&P/Case-Shiller Home Price Indices; recession dates obtained from the National Bureau of Economic Research (NBER). Both data sets obtained through Federal Reserve Bank of St. Louis (FRED).

ing trades. These sectors suffered mightily following the bursting of the housing bubble and throughout the Great Recession that followed. While construction employment in Massachusetts has been recovering in recent years, it remains well below pre-recession levels. Construction employment in the state peaked at 145,000 in April 2006 and declined to 106,500 in February 2010. Construction employment has generally been recovering since but, as of September 2014, it stood at just over 124,000 — 20,800 jobs below the 2006 peak.

Notwithstanding the visible return of construction cranes to the Boston skyline, statewide housing permits remain below pre-recession levels (Figure 6). One notable feature of this recovery has been the growing share of permits granted to multifamily housing developments. Since 2012, multifamily units have represented just over half

(51.2 percent) of all housing permits issued in Massachusetts. In contrast, between 2003 and 2006, multifamily permits represented just over one third of all housing permits (35.4 percent).

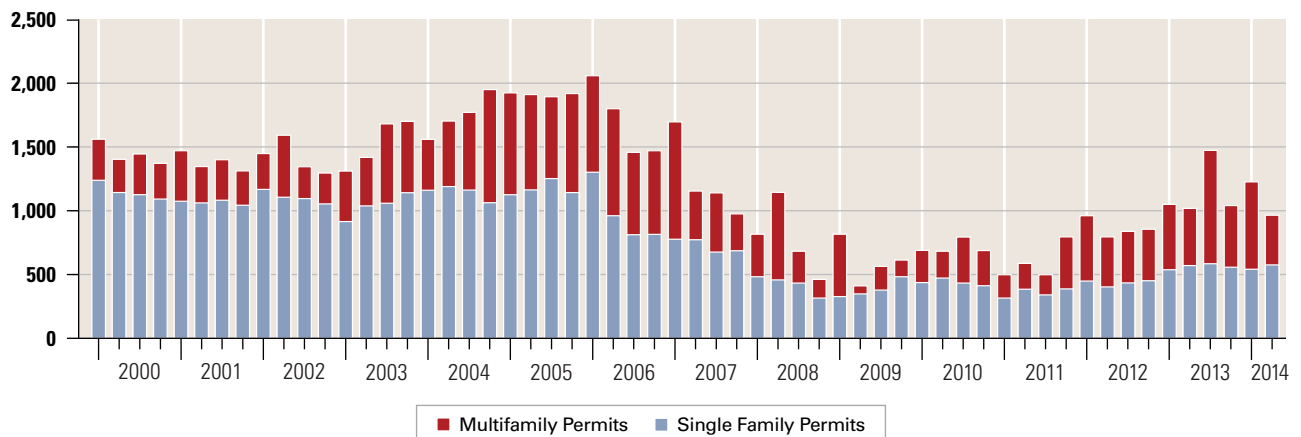
Another striking feature of the current housing recovery is the growing concentration of the state’s housing development activity in the Greater Boston region. While this is not terribly surprising given the disproportionate demand for housing in the region as reflected by rising prices, it makes it clear that the impacts of the regional imbalance in the housing recovery are being felt by more than simply homeowners and municipal governments whose fiscal health is highly dependent on property values. As can be seen in Figure 7, over the past decade the share of state housing permits located in the Greater Boston region — defined here as the Boston-Cambridge-Quincy MSA⁷ — has grown from 50 to between 80 and 90 percent. This widening gap in housing development activity is yet another illustration of how regionally imbalanced the state’s economic recovery has been to date.

Foreclosure Activity and Distressed Properties

One of the legacies of the extended housing downturn has been a significant pipeline of homes that remain in distressed condition, defined by the Massachusetts Housing Partnership (MHP) as “properties where a foreclosure petition has been filed or an auction has been scheduled in the previous year, or is bank held.”

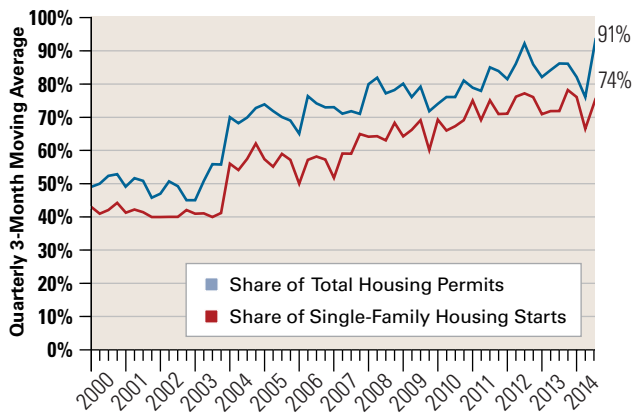
According to the May 2014 edition of MHP’s invaluable *Foreclosure Monitor*,⁸ between April 2013 and April 2014, distressed properties in Massachusetts declined from 8.8 units per 1000 to 3.8. This significant improvement was led by the City of Boston, which has seen its ratio decline by nearly two-thirds (a reduction of 64.4 percent) during the past year. While this clear improvement is undeniably good news, MHP’s analysis also highlighted

**Figure 6. Housing Permits in Massachusetts by Type, Three-Month Moving Averages
January 2000 – June 2014**



Source: Department of Commerce Census of Construction data, seasonally adjusted by the Federal Reserve Bank of Saint Louis (FRED); calculations by the authors

Figure 7. Boston-Cambridge-Quincy MSA's Share of Massachusetts Housing Permits and Starts January 2000 – July 2014



Source: Department of Commerce Census of Construction data seasonally adjusted by FRED; calculations by authors

the challenges in facing persisting issues, including those in the state's 26 so-called Gateway Cities. While MHP reports that every one of these communities experienced a decline in the number of distressed properties between April 2013 and April 2014, it noted that "these communities represent just 26.7 percent of the state's housing units, but account for 40 percent of the state's foreclosure distress."⁹

CONCLUSION

In the coming months, the Bay State will face a number of important decisions and transitions. In November, Massachusetts voters will elect a new governor and legislative class, and decide, among other things, whether the current plans to develop casinos and index the gas tax to inflation will be implemented. These are important decisions that will have a major impact on state policies and fiscal capacity.

Thus, in both political (note the small p) and economic terms, the Commonwealth finds itself at a crossroads. However the Massachusetts electorate decides to proceed, it is clear that the next generation of the Bay State's elected officials and its business and labor leaders will continue to face daunting challenges presented by the striking imbalances between those Massachusetts communities that are again thriving and those that have been largely left behind.

This transition is taking place alongside improving macroeconomic conditions, both in the state and the nation. Gross domestic product has bounced back nicely from the first quarter and employment continues to grow. Households continue to shed debt and the annual federal budget deficit has been declining rapidly. Improving economic and fiscal conditions should give policymakers greater flexibility to deal more directly with some of these troubling inequalities.

Extending the opportunity to fully participate in the economic recovery to every corner of the Commonwealth

will not be easy and it will not happen overnight. But the patterns of social and economic development that have characterized the state's economic fortunes and failures in recent years make it clear that doing so will require sustained attention, wise strategic investments, and the development of the physical, technological, human capital, and civic infrastructure that is at the heart of the Commonwealth's true competitive advantage. ◀

MICHAEL GOODMAN is an associate professor of public policy and Director of the Center for Policy Analysis at UMass Dartmouth. He is Coeditor 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.

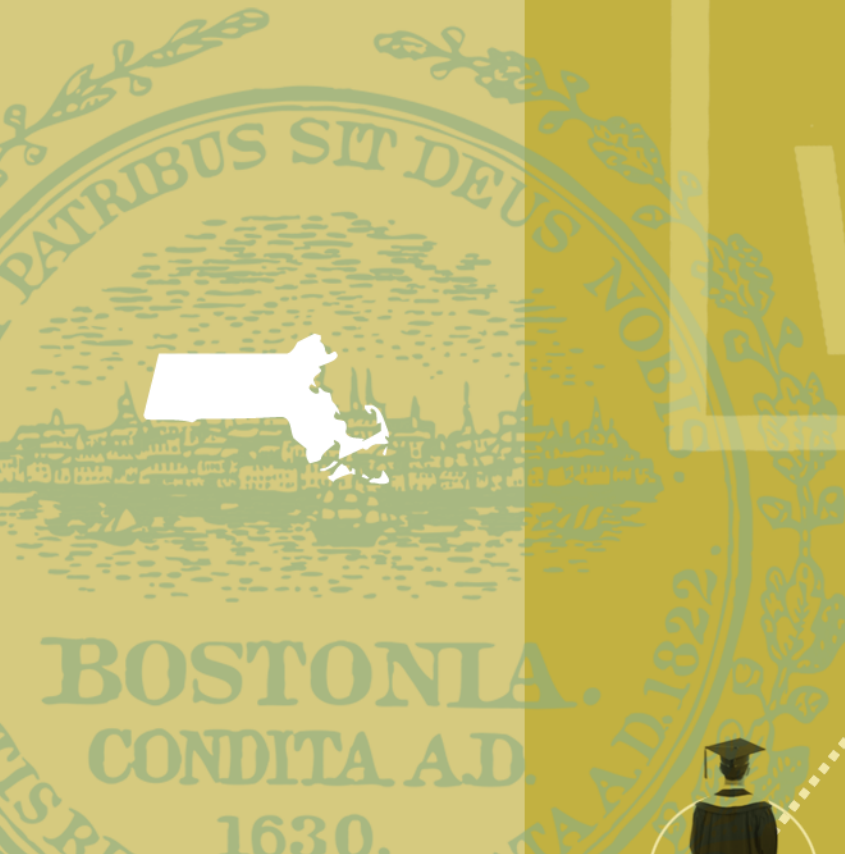
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We would also like to extend our gratitude to REBECCA LOVELAND not only for her critical role in this article, but also the work she does on the entire publication. She is truly irreplaceable.

Endnotes

- 1.) Neil Irwin. "Businesses Need to Spend More. The Future of the Economy Depends on It." *The New York Times*. July 21, 2014.
- 2.) The Brookings Institute supplies an interactive data page and reports to download. See *Export Nation 2013*. Brookings Institute. <http://www.brookings.edu/research/interactives/export-nation>
- 3.) The authors wish to thank Editorial Board members Professor Catherine Mann and Dr. Chris Probyn for drawing their attention to these issues.
- 4.) Jay Fitzgerald. "Home buyers face tight inventories, rising prices this spring." *Boston Globe*, April 6, 2014.
- 5.) Indices used with permission. The S&P/Case-Shiller Boston Home Price Index, S&P/Case-Shiller 20-City Composite Home Price Index, and S&P/Case-Shiller U.S. National Home Price Index are proprietary to and are calculated, distributed and marketed by S&P Opco, LLC (a subsidiary of S&P Dow Jones Indices LLC), its affiliates and/or its licensors and has been licensed for use. S&P® is a registered trademark of Standard & Poor's Financial Services LLC; Dow Jones®, is a registered trademark of Dow Jones Trademark Holdings LLC and Case-Shiller® is a registered trademark of CoreLogic Case-Shiller, LLC. © 2014 S&P Dow Jones Indices LLC, its affiliates and/or its licensors. All rights reserved.
- 6.) We've discussed this at length in Michael Goodman and Robert A. Nakosteen. "Diverging Destinies: The Commonwealth's Relatively Robust but Imbalanced Economic Recovery" *MassBenchmarks* 13.2 (2011): 4-13.
- 7.) This definition of the Greater Boston MSA includes two counties in New Hampshire (Rockingham and Strafford). County-level housing permit data for these two counties in the U.S. Department of Housing and Urban Development's State of the Cities Data Systems (SOCDS) indicate that the share of permits issued in the MSA that can be attributed to these two counties has been declining. Consequently, their inclusion cannot explain the trend reported here.
- 8.) *The Foreclosure Monitor* is published by the Massachusetts Housing Partnership and is prepared by Tim Davis, an independent research consultant.
- 9.) Op. cit.

Help Wanted



12

BOSTON
STBOROUGH WEYMOUTH WINTHROP WOBURN ALLSTON ARLINGTON BELMONT BOSTON BRAINTREE BRIGHTON BROOKLINE CAMBRIDGE CANTON
CHARLESTOWN CHELSEA CHESTNUT HILL DEDHAM EVERETT FRAMINGHAM HYDE PARK JAMAICA PLAIN LOWER MILLS MALDEN MEDFORD MILTON
ROXBURY SAUGUS SOMERVILLE SOUTH BOSTON WALTHAM WATERTOWN WELLESLEY WEST NEWTON WEST

1.) Credentials



2.) Job Opening



Educational Requirement Markup and Credential Mismatches in the Greater Boston Labor Market

GREATER BOSTON'S HIGHLY EDUCATED WORKFORCE IS A COMPETITIVE ASSET, BUT IT ALSO CONTRIBUTES TO A "COLLEGE MARK-UP," WHERE EMPLOYERS IMPLICITLY RAISE THE EDUCATIONAL REQUIREMENTS FOR JOB OPENINGS. THIS CREATES EVEN GREATER CHALLENGES IN THE LABOR MARKET FOR THOSE WITH LESS EDUCATION AND HAS POLICY IMPLICATIONS FOR MIDDLE SKILLS TRAINING INITIATIVES.

MARK MELNIK

INTRODUCTION

The Greater Boston labor market is often celebrated for its high concentration of knowledge- and innovation-based industries.¹ It is this mix of industries, particularly around health care, education, and professional services that often receive credit for why the region suffered less than most of the United States during the recent recession. Associated with Greater Boston's mix of knowledge-based industries is the region's well-educated labor force. With approximately 43% of the population 25 or older holding at least a bachelor's degree, Greater Boston ranks 3rd among the 30 largest metropolitan areas in the U.S., trailing only Metropolitan Washington D.C. and San Francisco (48.2% and 45%, respectively). Typically, we think of these well-educated workers as filling high-skill occupations throughout the knowledge economy. A less highlighted feature of having a well-educated labor force is what it means for job

slotting throughout the regional labor market and how this impacts workers on the lower end of the education and skill scale. In particular, are there enough college-level jobs to go around for all the college educated workers? If not, where do the excess college-educated workers get slotted in the labor market? Even in an economy with a high concentration of knowledge-based industries, there are still a significant number of middle-to-low skill occupations. These would include support occupations within knowledge industries, as well as occupations in the service, manufacturing, and construction sectors. This raises the following questions: In a labor market with a high concentration of college-educated workers, what factors influence job matching in traditionally low and middle-skill occupations? What are the low- and middle-skill job opportunities in a labor market with a significant concentration of high-skill workers?

The first thing to consider is that all labor markets are regional. Industries are attracted to places where they feel their labor needs can be adequately met. Workers compete against one another for the best available jobs in their local labor market. The most attractive job candidates, those with advanced education and desired skills, typically get the best job opportunities. The least attractive job candidates, those with limited education and skills, tend to end up with less desirable positions or, in many cases, with no job at all.

In short, in a labor market like Greater Boston, where nearly half of the adult labor force has earned at least a bachelor's degree, college-level workers not only fill in high skill occupations, but also positions that in other labor markets may require an associate's degree or only some college courses. Employers in Greater Boston can opt to increase the educational requirements for job openings, in part, because of the region's well-educated labor force. Put another way, a significant number of college-level workers in Greater Boston filter down to occupations that do not typically require a college degree. The general makeup of the regional labor force puts low- and middle-skill workers in a difficult position when competing for available job openings because of the sheer mass of college-educated workers. This article takes a close look at what appears to be the college markup that occurs in Greater Boston as the percentage of college-educated workers in occupations tends to outstrip what national data would suggest is needed for these positions, particularly in low- and middle-skill jobs.

The role of credentialing in securing a job has significant ramifications on the unemployed and underemployed. While there was general agreement among economists and labor market experts that deficient demand was the primary reason for high unemployment rates during and immediately following the Great Recession, some have suggested that skill deficiencies among the unemployed explain why some individuals continue to struggle to find work, even after the economic downturn abated.² The data in this article suggest that unemployed and underemployed workers in the region may not only have to contend with skills mismatch concerns, or instances where the skills of potential workers do not line up with what industries and occupations need, but also with credentials mismatch issues, as employers appear to favor candidates with a college degree, even in positions that typically do not require a high level of education.³

EDUCATIONAL ATTAINMENT VS. EDUCATIONAL REQUIREMENTS: GREATER BOSTON

To look at skills and credential matches in the labor market, it is necessary to have data on the educational attainment

of the labor force as well as on the educational requirements for occupations. Our research uses data from the American Community Survey (ACS) to measure the educational attainment of workers in Greater Boston. To estimate educational requirements for positions, the research utilized a computer program called the Labor Market Assessment Tool (LMAT), developed by the Northeastern University Dukakis Center for Urban and Regional Policy and the Boston Redevelopment Authority Research Division. LMAT uses industry/occupation matrices provided by the Massachusetts Department of Workforce Development and the Bureau of Labor Statistics (BLS). These matrices are used to estimate the distribution of occupations by industry. These occupations are then linked to BLS data from the Occupational Employment Statistics (OES) and the Occupational Information Network (O*NET) to give key job characteristics data, including wages, educational and skill requirements, and training time. The occupational characteristic data in LMAT are based on a national survey of employers, job incumbents, and labor analysts. Used together, data from the ACS and LMAT can give a full picture of the educational attainment of workers in the region while at the same time providing information on the typical education and training requirements for occupational titles in the labor market.

While educational attainment is not a perfect proxy for labor force skill, it is the most commonly used measure for human capital and worker attributes. As Figure 1 shows, lack of educational attainment relative to typical occupational requirements is not an issue in the Metropolitan Boston labor market. In fact, if anything, local workers are overeducated for the mix of occupations in the region. This, of course, is a type of skills mismatch. Workers in Greater Boston tend to have education skills beyond what is typically required for the mix of occupations in the regional labor market. As we will see later in this article, the Greater Boston labor market has numerous instances where college-educated workers end up in positions below their actual attainment level.

Close to 50 percent of employed workers in Greater Boston have earned at least a bachelor's degree. Comparatively, LMAT data suggest that approximately 30 percent of jobs in the region *require* at least a bachelor's degree. Educational requirement data in O*NET are a combination of incumbent and analyst rankings on a sample of workers in occupations across the country. Raters are asked, "What level of education is required to perform this job?" As a result, the educational attainment of a worker does not have to match the actual requirements of the occupation. These data show that employers in Greater Boston are selecting workers with higher levels of educational attainment than occupations typically require. This situation distinguishes Greater Boston and other regional

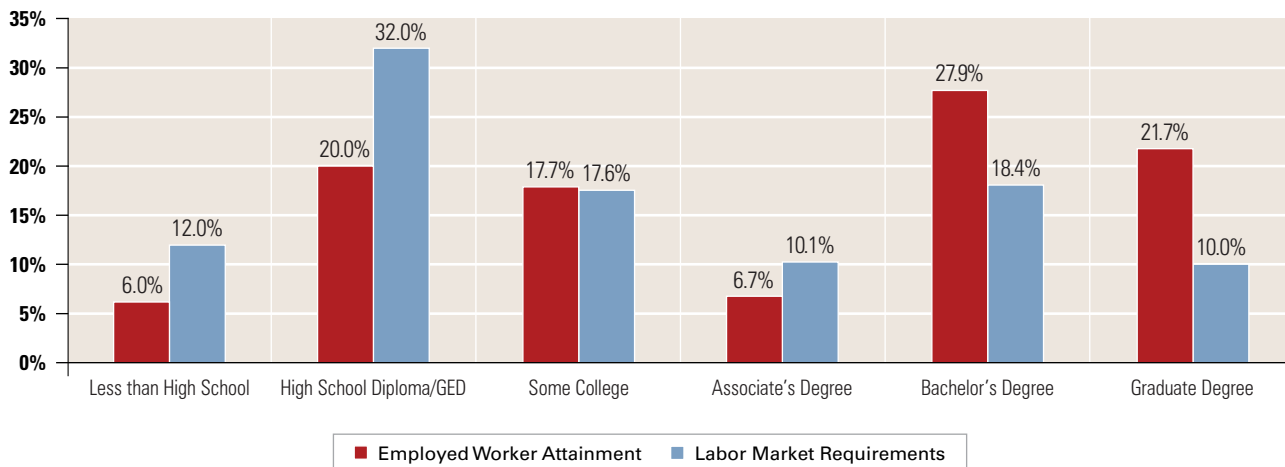
labor markets with well-educated populations from the U.S. overall. As Figure 2 shows, educational attainment and job requirements for workers and occupations are more closely aligned at the national level than they are in Greater Boston.

These results also suggest that more workers have college education than are required in the U.S. labor force. However, this phenomenon is far more pronounced in Greater Boston. As noted earlier, while nearly 50% of employed workers in Greater Boston have a college degree, less than 30% of jobs in Greater Boston require a college degree. Comparatively, in the U.S. nearly 33% of workers have a college degree, while just over 20% of the jobs require a college degree. Both of these statistics suggest a college markup in the labor market, the extent of which is much more significant in Greater Boston. These data also provide at least some challenge to the prevailing argument

that the current labor force has skill deficiencies. These data do not show the types of degrees earned or direct technical skill, but they do demonstrate that the number of workers with at least some college education is greater than the number of jobs requiring that level of education. Regardless, these results are consistent with the proposition that workers are ranked in a local labor market *relative* to other workers. As long as potential employees are sufficiently skilled, employers can adjust the educational requirements for occupations based on the available pool of labor in the region.

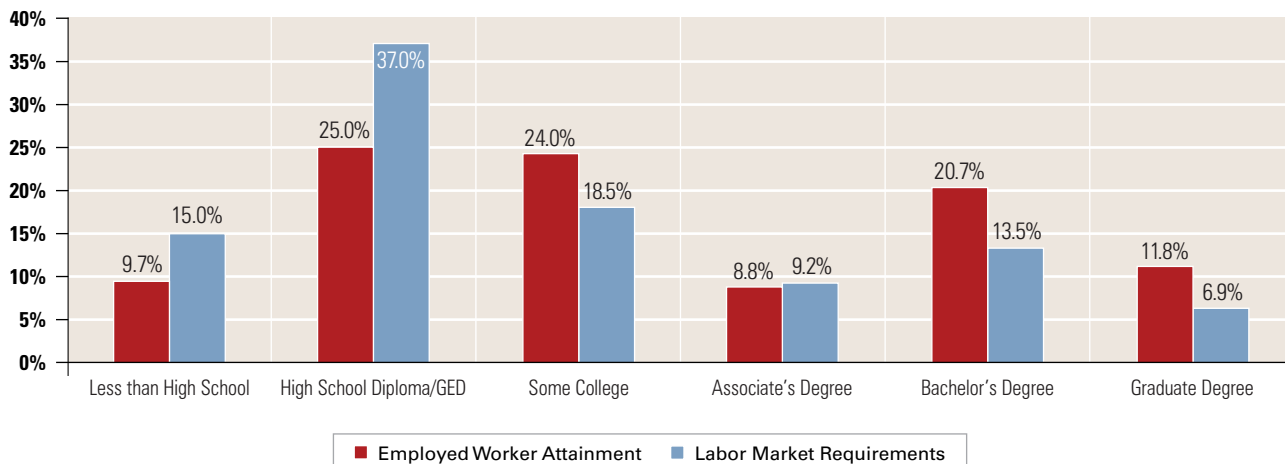
Of course, educational attainment is just one part of the total human capital package that workers bring to the labor market. A worker's human capital also includes specific skills, previous work experiences, and other personal characteristics. The inability to match a particular worker with a job opening may not solely be related to educational

Figure 1. Worker Educational Attainment vs. Labor Market Requirements in Metro Boston Labor Market, 2012



Source: Labor Market Assessment Tool, 2012 American Community Survey Public Use Microdata Sample (PUMS)

Figure 2. Worker Educational Attainment vs. Educational Requirements, U.S. Labor Market, 2012



Source: Labor Market Assessment Tool, 2012 American Community Survey Public Use Microdata Sample (PUMS)

attainment, but due to specific skill and competency deficiencies. Education, however, allows for an apples-to-apples comparison when looking at attributes and requirements. Moreover, as we will see there is a close connection between educational attainment and employment.⁴ Workers with advanced education are much more likely to be employed than their less-educated counterparts, even within occupational titles.

To clarify, when using data from O*NET to describe educational requirements for jobs, it is assumed that the skills required for an occupation are the same throughout the country. While some jobs may require more education in Greater Boston than in other parts of the U.S. (e.g., some production occupations in advanced manufacturing), it is generally speaking, unlikely that a particular job would actually *require* more education and skill in Greater Boston than elsewhere. More likely, firms in Greater Boston can require more education because of the available labor force. That makes a college degree de rigueur for an occupation, even if that level of education is not necessary to perform the tasks associated with the job. The data above suggest that employers in Greater Boston may use college education as a signal that a potential worker possesses desirable characteristics, even if the job does not require advanced education.

Figure 3 demonstrates where occupational filtering down occurs among Greater Boston’s workforce. Overall, the educational attainment of workers exceeds the educational requirements for job titles among all major occupational groupings.⁵ This is most noticeable in managerial and professional occupations. Where close to 65% of the managerial and professional occupations require a bachelor’s degree or more, nearly 80% of managerial and professional jobs in Greater Boston are held by a person

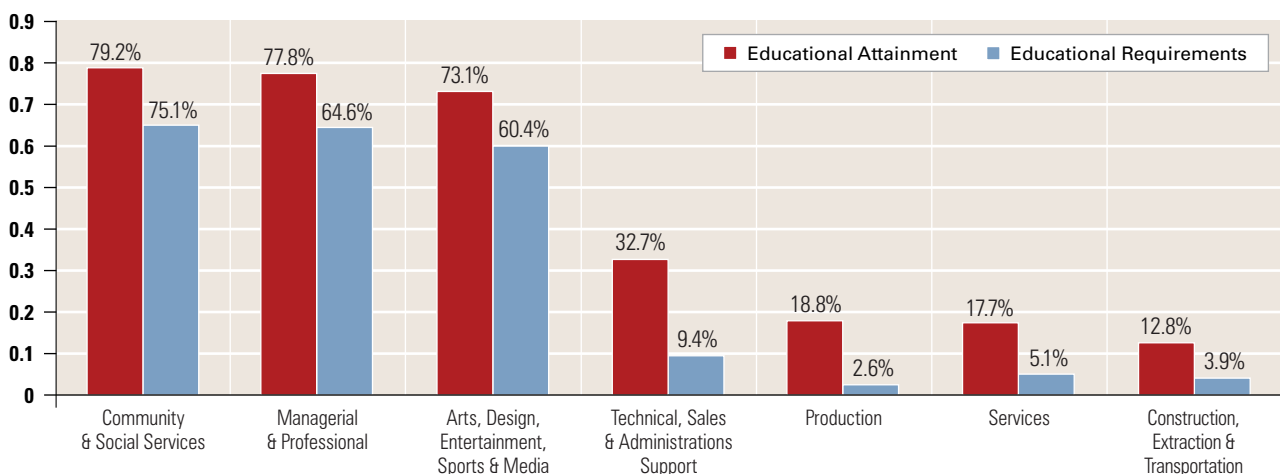
with at least a bachelor’s degree. Less than 10% of technical, sales, and administrative support occupations require a college degree, but nearly 33% of those job holders have at least a bachelor’s degree.

These data show that employers in Greater Boston tend to hire workers with an advanced education, even for occupations that do not *require* a college degree. In this case, it is the *relative* amount of education that counts, not its absolute level. If the job distribution did not change at all in terms of education and skill requirements, but individuals competed for these jobs by getting more education in an attempt to move to the front of the labor queue, you would likely find that the level of education required to perform the work and the level of education of workers would continue to diverge over time.

Table 1 shows the college markup for an expanded list of occupational categories.⁶ College markup is calculated as the percentage of workers with at least a bachelor’s degree divided by the percentage of jobs that require at least a bachelor’s degree. As the table below demonstrates, there is a greater proportion of workers with a college degree in the vast majority of occupational classifications than is typically required. In addition, the markup of college workers is higher in Greater Boston when compared with the U.S. for all occupational groupings.

Food preparation and healthcare support occupations both stand out as occupations with much higher concentrations of college educated workers than what is typically required. This trend is much more pronounced in Greater Boston as the proportion of college educated workers in these two fields is over nine times what BLS requirement data would suggest. Typically higher skill positions, such as life, physical, and social science occupations; education, training, and library occupations; and legal occupations

Figure 3. Educational Requirements vs. Educational Attainment in Greater Boston
(Percent of jobs requiring bachelor’s degrees or higher versus percent of workers with bachelor’s degrees or higher)



Source: Labor Market Assessment Tool, 2012 American Community Survey Public Use Microdata Sample (PUMS)

Table 1. Concentration of College-Educated Workers in Occupations Relative to Job Requirements in Metro Boston and U.S., 2012

Occupation	College Markup - Greater Boston	College Markup - U.S.
Food Preparation and Serving Related	9.33	4.19
Healthcare Support	9.11	6.71
Production	7.28	3.23
Protective Services	6.23	4.33
Transportation and Materials Moving	5.82	2.24
Installation, Maintenance, and Repair	5.67	3.50
Office and Administrative Support	4.44	3.09
Sales and Related	2.27	2.01
Healthcare Practitioners and Technical	1.78	1.40
Construction and Extraction	1.42	0.97
Personal Care and Services	1.37	1.15
Business and Financial Operations	1.32	1.16
Arts, Design, Entertainment, Sports and Media	1.21	1.04
Building and Grounds Cleaning and Maintenance	1.20	1.07
Legal	1.15	1.03
Computer and Mathematical	1.15	1.02
Education, Training, and Library	1.07	1.19
Community and Social Services	1.05	0.99
Management	1.05	0.84
Architecture and Engineering	1.03	0.96
Life, Physical, and Social Sciences	1.02	0.95
Farming, Fishing, and Forestry	0.91	0.70
Total Economy	1.75	1.59

Source: Labor Market Assessment Tool, 2012 ACS Public Use Microdata Sample (PUMS), author's calculations

all have college markup scores just slightly over 1.0. This makes sense as close to 75% or more of each of these occupational groupings require at least a bachelor's degree in Greater Boston. There simply is not much room for a college markup in traditionally high-skill positions. In that, these data show that the excess supply of college educated workers filters down into traditionally middle- and low-skill positions throughout the labor market.

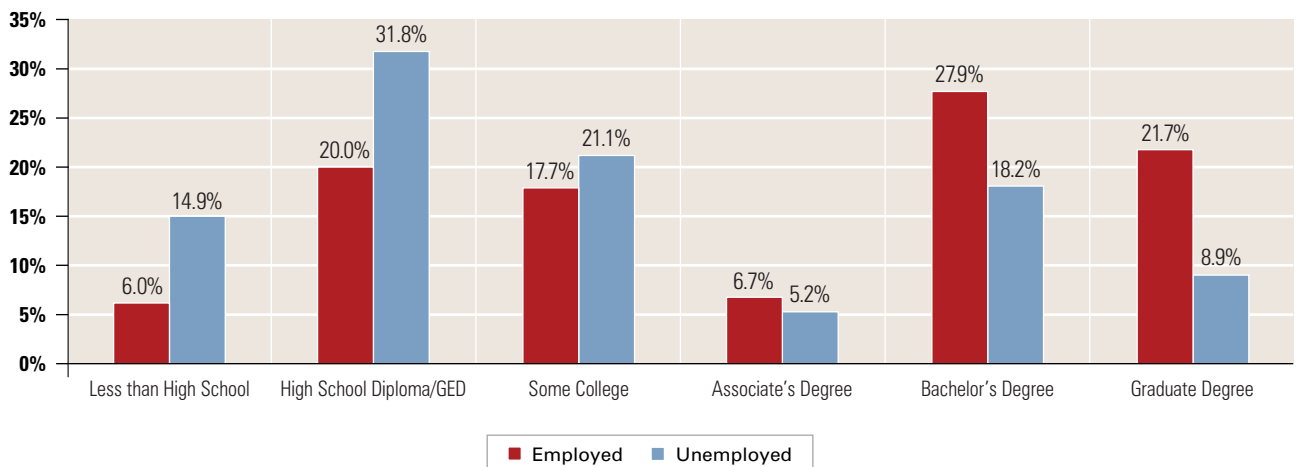
As noted, the data above refer specifically to individuals currently employed within occupational titles. These data raise questions about individuals who are not selected for available openings and remain unemployed. In particular, how do low and middle-skill workers compete in a labor market like Greater Boston where nearly half of the jobs are being filled by individuals with a college degree?

COMPARING EDUCATIONAL ATTAINMENT OF EMPLOYED AND UNEMPLOYED WORKERS IN GREATER BOSTON

Not surprisingly, the unemployed population in the region looks quite a bit different than the employed population in terms of educational attainment. Approximately 27% of the unemployed population in Greater Boston has earned at least a bachelor's degree, compared with close to half of the employed population. On the other hand, nearly 47% of the unemployed have achieved no more than a high school diploma, compared with just a quarter of the employed population.

Of course, it is not surprising to see a correlation between educational attainment and employment status. Generally speaking, unemployment rates decrease as educational attainment increases. The unemployed population in Greater Boston is fairly well-educated when compared with the U.S. overall. Over 28% of the unemployed in Greater Boston have a bachelor's degree or higher, compared

Figure 4. Educational Attainment, Employed and Unemployed Populations in Metro Boston, 2012



Source: 2012 American Community Survey (ACS) Public Use Microdata Sample (PUMS)

with 33% of the employed and 15% of the unemployed populations in the U.S. In short, the unemployed in Greater Boston have a fairly similar education profile to the employed in the U.S. and are far more educated than the unemployed population overall.

As noted earlier, educational attainment alone does not define whether or not a worker has the proper skills to fill an available position. Table 2 shows the number of job vacancies by occupational category and the number of currently unemployed workers who recently held a corresponding job title. Overall, there are roughly three unemployed workers per job vacancy in Greater Boston. However, some occupations have a much higher ratio of unemployed workers-to-job vacancies. For example, there are over 30 unemployed construction and extraction workers per vacancy in the region. Building and grounds maintenance (7.6), production (7.3), legal (5.5), and installation, maintenance, and repair (5.3) occupations all have more than five unemployed workers per vacancy in Greater Boston. Interestingly, the number of vacancies to unemployed workers is

fairly similar in healthcare practitioner occupations. In addition, there are actually more vacancies than unemployed workers for community and social service occupations and computer and mathematics occupations.

Unemployed Workers by Occupation

In the aggregate there are enough unemployed workers to fill most job vacancies in the region, in terms of count, educational requirements, and previous work experience. If the unemployed population is more than three times larger than the number of vacancies, has education levels comparable to standard job requirements and has worked in similar jobs in the past, why do these vacancies persist?

There are several reasons why vacancies can exist alongside unemployment,⁷ one potential explanation being the college markup discussed earlier. Overall, the Greater Boston labor force (both employed and unemployed) has education attainment levels aligned with or beyond what is typically required for occupations in the labor market. Additionally, employed workers *within* occupational categories

Table 2. Unemployed Workers per Vacancy in Metro Boston, 2012

Occupation	Unemployed	Vacancies	Unemployed per Vacancy
Construction and Extraction	10,143	330	30.7
Building and Ground Cleaning and Maintenance	6,132	811	7.6
Production	4,208	578	7.3
Legal	1,297	235	5.5
Installation, Maintenance, and Repair	3,026	576	5.3
Office and Administrative Support	17,198	3,513	4.9
Transportation and Materials Moving	6,777	1,753	3.9
Arts, Design, Entertainment, Sports and Media	2,714	727	3.7
Education, Training, and Library	4,295	1,343	3.2
Personal Care and Services	4,836	1,555	3.1
Protective Services	1,103	392	2.8
Healthcare Support	3,294	1,243	2.6
Sales	10,949	5,217	2.1
Management	7,378	3,542	2.1
Architecture and Engineering	2,302	1,157	2.0
Food Preparation and Serving	9,585	6,118	1.6
Business and Financial Operations	4,111	2,914	1.4
Life, Physical, and Social Sciences	1,213	1,041	1.2
Healthcare Practitioner and Technical	2,079	2,003	1.0
Community and Social Services	655	889	0.7
Computer and Mathematics	1,967	3,890	0.5
Farming, Fishing, and Forestry	409	—	—
Military	63	—	—
NA	19,798	3	—
Total	125,531	39,830	3.2

Source: 2012 American Community Survey, 2012 ACS Public Use Microdata Sample (PUMS); 2012 Massachusetts Job Vacancy Survey; author's calculations

A Closer Look at Metro Boston's College Markup by Occupation

Table 3 shows that in almost every occupational job category, a larger share of employed workers have a bachelor's degree or higher than their unemployed counterparts. This is not a surprising result when comparing employed and unemployed workers within an occupation as those with more training are more likely to hold a job. This finding is actually even stronger at the U.S. level than in Metro Boston on average across all occupations (2.21 compared to 1.83).

The college markup shows the percentage of employed workers with a bachelor's degree or more over the percentage of jobs that require a bachelor's degree or more. In the Metro Boston area, the educational markup compared to stated educational requirements is particularly strong with an average ratio of 1.75 compared to 1.59 for the U.S. These aggregate

numbers hide the occupation by occupation differences as the Metro Boston markup is higher than the U.S. markup for all categories except for education, training, and library workers.

Note that the percentage of jobs requiring a bachelor's degree or more for each occupational grouping is different for the U.S. than for Metropolitan Boston. This is attributable to variations in employment within the occupational groupings themselves. In most cases, the percentage of jobs requiring a bachelor's degree or more is higher within an occupational grouping in Metro Boston than in the U.S. itself. This is because Metro Boston has higher concentrations of occupations requiring advanced education. In the Metro Boston employment-education ecosystem, the stature of both factors appears to reinforce one another.

Table 3. College Education within Occupational Groups in Metro Boston and U.S., 2012

	Metro Boston					U.S.				
	College Attainment			Education Requirement	College Markup	College Attainment			Education Requirement	College Markup
	Employed Workers	Unemployed Workers	Ratio			Employed Workers	Unemployed Workers	Ratio		
Management	72.1%	60.1%	1.20	68.7%	1.05	54.5%	43.3%	1.26	64.5%	0.84
Business and Financial Operations	80.8%	74.6%	1.08	61.4%	1.32	66.1%	52.7%	1.25	56.8%	1.16
Computer and Mathematical	80.3%	62.1%	1.29	69.9%	1.15	67.4%	50.5%	1.33	65.9%	1.02
Architecture and Engineering	74.9%	59.9%	1.25	72.9%	1.03	66.2%	46.9%	1.41	69.0%	0.96
Life, Physical, and Social Sciences	92.1%	78.4%	1.17	90.7%	1.02	80.3%	67.7%	1.18	84.1%	0.95
Community and Social Services	79.2%	68.3%	1.16	75.1%	1.05	72.6%	58.4%	1.24	73.5%	0.99
Legal	88.9%	71.5%	1.24	77.5%	1.15	79.6%	62.7%	1.27	77.3%	1.03
Education, Training, and Library	81.8%	63.7%	1.29	76.6%	1.07	77.3%	55.0%	1.41	65.2%	1.19
Arts, Design, Entertainment, Sports, and Media	73.1%	59.6%	1.23	60.3%	1.21	58.6%	45.3%	1.29	56.2%	1.04
Healthcare Practitioners and Technical	72.3%	66.2%	1.09	40.6%	1.78	57.1%	34.4%	1.66	40.8%	1.40
Healthcare Support	17.2%	12.2%	1.41	1.9%	9.11	11.2%	7.5%	1.48	1.7%	6.71
Protective Services	36.6%	13.2%	2.77	5.9%	6.23	23.9%	11.9%	2.01	5.5%	4.33
Food Preparation and Serving Related	14.0%	15.0%	0.93	1.5%	9.33	8.5%	6.1%	1.39	2.0%	4.19
Building and Grounds Cleaning and Maintenance	6.7%	8.5%	0.79	5.6%	1.20	5.8%	3.8%	1.50	5.4%	1.07
Personal Care and Services	21.2%	10.9%	1.94	15.5%	1.37	15.1%	10.4%	1.46	13.1%	1.15
Sales and Related	40.8%	31.3%	1.30	18.0%	2.27	27.3%	15.0%	1.81	13.6%	2.01
Office and Administrative Support	29.1%	24.8%	1.17	6.6%	4.44	20.3%	15.1%	1.34	6.6%	3.09
Farming, Fishing, and Forestry	10.3%	52.4%	0.20	11.3%	0.91	5.6%	2.7%	2.06	8.1%	0.70
Construction and Extraction	10.6%	4.4%	2.44	7.5%	1.42	6.3%	3.8%	1.66	6.5%	0.97
Installation, Maintenance, and Repair	12.4%	4.0%	3.08	2.2%	5.67	7.5%	6.7%	1.12	2.1%	3.50
Production	18.8%	2.1%	9.02	2.6%	7.28	7.7%	4.9%	1.56	2.4%	3.23
Transportation and Material Moving	15.2%	12.1%	1.25	2.6%	5.82	7.5%	4.2%	1.77	3.4%	2.24
Military Services	—	0.0%	—	—	—	—	14.2%	—	—	—
Total Economy	49.6%	27.1%	1.83	28.3%	1.75	32.5%	14.7%	2.21	20.4%	1.59

Source: Labor Market Assessment Tool, 2012 American Community Survey (ACS) Public Use Microdata Sample (PUMS), author's calculations
Note: The term college in this table refers to a bachelor's degree or higher.

have higher levels of educational attainment than their unemployed counterparts. While this also occurs nationally, the Greater Boston labor market stands out in some significant ways when compared with the U.S. in the role of educational attainment in job matching.

The college markup and differences in educational attainment between the employed and unemployed within occupational categories both stand out in Greater Boston relative to the U.S. First, while workers in the U.S. also have educational attainment levels beyond what is required for their occupations, the factor is much higher in Greater Boston (1.59 to 1.75, respectively). This occurs even considering that the occupational structure in the Metropolitan Boston labor market is more heavily skewed towards the high end of the educational continuum. Second, the college attainment ratio between employed and unemployed workers nationally is higher than in Greater Boston (2.21 to 1.83). This indicates that, much like in Greater Boston, national employers are opting to hire

workers with educational attainments that exceed job requirements. The difference in educational attainment between the employed and unemployed is actually more pronounced nationally than in Greater Boston. This is driven mainly by the fact that the unemployed population nationally has such low levels of educational attainment when compared with the employed population. Some of this, of course, could be related to somewhat loose labor market conditions. Employers can afford to be more selective when there is deficient demand for labor in the economy. That said, in terms of educational attainment and requirements, it is much easier to make the case at the national level that unemployed workers lack necessary skills to fill jobs than is the case in Greater Boston.

These data suggest that unemployed workers in Greater Boston generally have the educational skill and previous experience to fill job vacancies. Compared with employed workers, the unemployed do lack more advanced educational credentials. So, while there may be skills mis-

Applying LMAT to Understand the Labor Market for College Graduates

The UMass Donahue Institute and the Boston Redevelopment Authority's Research Division used similar LMAT data and methods as in this current article to examine college student retention in Greater Boston. As is well-known, Greater Boston is home to a high concentration of college students, yet a common concern is that the region has trouble retaining these students after they graduate. Since the availability of job opportunities is the most important factor in retaining graduates,^{*} part of our research considered how many newly minted college graduates could reasonably be absorbed based on the region's labor market conditions.

This research estimated that in 2011 over 153,000 college degrees were awarded at schools in Greater Boston. Applying the LMAT model, we estimated that between 2011 and 2012, there were approximately 71,000 job openings in the region. Nearly 33,000 of these jobs were attributable to job growth, with another 38,000 estimated replacement openings attributable to people permanently leaving their positions (for context, there were close to 1.7 million jobs in Greater Boston in 2012). So, on sheer number of job openings alone, it is unlikely that

Greater Boston will retain more than half of its college graduates in a given year. The number of potential openings gets smaller, however, if you further limit the number of openings to college level positions. First, we accounted for the college markup in the Greater Boston labor market, or the increased number of college-level workers in each occupational title that naturally occurs in the region due to the well-educated labor force. Next, we eliminated from the list jobs that decidedly do not entail college level work. For example, some percentage of taxi drivers have a college degree. No recent college graduate, though, would consider that the kind of opportunity they were looking for after graduation. We estimated that between 20,000 and 27,000 of the openings in Greater Boston are college-level opportunities in this labor market. These data highlight that, while it may be possible for Greater Boston to retain more of its college graduates, economic and labor market factors limit just how many students the region can reasonably expect to retain without significant economic growth, particularly in high-skill industries and occupations. An expanded report was recently published by the BRA Research Division.

^{*}Alicia Sasser Modestino, *Retaining Recent College Graduates in New England: An Update on Current Trends*, Policy Brief 13-2, New England Public Policy Center at the Federal Reserve Bank of Boston, May 2013.

match and atrophying issues holding back unemployed workers, this population also appears to be suffering from credential mismatch issues as well. Workers compete with one another in terms of their relative ranking in the labor queue. Employers in Metropolitan Boston are able to effectively increase the educational requirements for occupations because of the region's highly educated labor force. This leads to a credentials mismatch between currently unemployed workers and available positions in Greater Boston. While unemployed workers in Greater Boston may have appropriate levels of educational attainment for current vacancies, in many cases their attainment levels do not compare well with the academic credentials of workers currently in these positions. In other words, unemployed workers could fill current vacancies, but are not selected due to the educational standards set by current employees.

PUBLIC POLICY IMPLICATIONS FOR LOW AND MODERATELY EDUCATED WORKERS

Employers in Greater Boston appear to use college education as a signal that a worker generally has desirable characteristics. Essentially, college education becomes a defensive good. You do not necessarily need advanced education to do a particular job, but you need it to get to the front of the job queue. Viewed in another way, in Greater Boston the excess supply of college-educated workers relative to the number of jobs that require advanced training leads to high-skilled workers filtering down into positions below their education level. The end result is more limited job prospects for low- and moderately educated workers in the region.

This process of job matching in Greater Boston poses some difficult challenges for public policy-makers and job training professionals, particularly with so-called middle-skill jobs.⁸ Current research raises the question of how increased credential requirements in Greater Boston impacts slotting modestly skilled workers into middle-skill jobs. With many calling on the community college system to help unemployed workers fill middle-skill job opportunities, the findings in this article raise some doubt about whether or not community colleges can help modestly skilled workers compete for middle-skill opportunities against individuals with more advanced education. These data suggest the importance of strategizing job training and postsecondary education opportunities for modestly skilled workers towards job opportunities that are truly attainable for middle-skill workers in the regional labor market.

In particular, public policy makers and job training professionals should examine how best to forge relationships between employers and training programs to slot middle-skill workers into middle-skill positions. This could include developing customized training programs

based on employer demand. In addition, programs should focus training around middle-skill job opportunities that require unique and specific skills that may be difficult for an individual with a four-year college degree to readily fill over a candidate with focused training and an associate's degree or a postsecondary certificate. This may include training around potential openings in semiskilled occupations. Many of these positions require familiarity with particular types of processes and machinery that would be difficult for a generic college graduate to fill. In addition, a number of such opportunities are becoming available as baby boomers approach retirement age.

While a community college education or job-training certificate can help an individual acquire needed skills or get on a path to a four-year degree, they do not directly address the internal educational requirement markup in the region. This issue is not being acknowledged in most of the research focused on the regional economy, particularly as public policy makers underscore the potential opportunities in so-called middle-skill jobs. Public policy makers and job training experts need to take a closer look at the unique characteristics of our regional labor market and its skill and credential requirements to better understand what unemployed and underemployed workers need to do to advance in the labor queue. It is clear that the hiring requirements for occupations are not static across all regions in the U.S. and perhaps even within the states themselves. A thoughtful analysis of hiring requirements as well as strategic efforts in developing job-training programs are needed to provide middle- and low-skill adults in Greater Boston with the best opportunities to succeed in a highly competitive labor market. ◀

MARK MELNIK is Senior Research Manager with the Economic and Public Policy Research group at the UMass Donahue Institute. He holds a Ph.D. in sociology from Northeastern University and formerly worked as Deputy Director for Research at the Boston Redevelopment Authority.

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Endnotes

- 1.) Greater Boston and Metro Boston are interchangeable in this article.
- 2.) Narayana Kocherlakota. 2010. "Inside the Federal Open Market Committee." Edited by Federal Reserve Bank of Minneapolis.
- 3.) This article is an update of a section from my dissertation, "Assessing the Role of Industrial and Demographic Change in Regional

Economic Health — A Case Study of Greater Boston.” Completed in 2012, the dissertation drew conclusions in part on job matching in the Greater Boston labor market using 2009 data. Using similar methods, this article updates the analysis using 2012 data. The trends observed in this update are generally the same as observed using 2009 data. According to the 2012 American Community Survey, unemployment in Greater Boston stood at 7.6% with nearly 126,000 unemployed workers. The Massachusetts Department of Workforce Development reported just under 40,000 job vacancies in the region for the second quarter of 2012.

4.) For a recent conversation regarding the relationship between educational attainment and employment, see the *MassBenchmarks* article by Alan Clayton-Matthews entitled “Endnotes: Benchmarking the Massachusetts Unemployment Rate,” <http://www.mass-benchmarks.org/publications/issues/vol16i1/6.pdf>.

5.) The occupational groupings used here are a consolidation of the 23 groupings used in the Standard Occupational Classification (SOC) system. The occupations grouped together are all similar in terms of educational requirements and training time.

6.) The groupings used here are the more common 23-category SOC system, used here to see if there were more specific trends within occupational groupings.

7.) There are other explanations as to why job vacancies and unemployment can occur at the same time that could operate in concert with a college markup. Frictional unemployment can be understood as the joblessness that results from people searching for employment or being between jobs. Vacancies can also exist with high unemployment because of the lack of perfect information in the labor market. Employers may not know how to reach available workers and available workers may not know of possible job opportunities in the labor market. In addition, it is possible that employers are offering jobs below the reservation wage of workers, in which case workers would either need to accept a lower salary or employers would need to raise their hiring salary to fill available positions.

Lastly, these vacancies may not be positions that employers need to fill immediately. The number of vacancies relative to the number of unemployed workers, however, suggests something more than just frictional and information issues. The length of the economic downturn makes it hard to imagine a large number of workers opting to not take open positions in their respective fields because of low wages. Together, these factors suggest that employers are unwilling to move from their hiring requirements. Of course, if desperate enough to fill a position, an employer would either raise wages, reduce hiring requirements, or both. In reality, frictional unemployment, lack of perfect information, wages, and worker/job matching issues all play a role in the significant number of coexisting job vacancies and unemployment.

8.) Middle-skills jobs are often described as positions requiring more than a high school diploma, but less than a four-year college degree. Such requirements might entail an associate’s degree, some college, or a postsecondary certificate.



Illustration by: Christine Murphy

Does a Skills Gap Exist in U.S. Manufacturing?

ANDREW WEAVER

NATIONAL SURVEY DATA AND CASE STUDIES SUGGEST THAT THE FREQUENT CLAIMS OF A MAJOR MANUFACTURING SKILLS GAP ARE OFTEN OVERSTATED. POLICY RECOMMENDATIONS SHOULD PLACE GREATER EMPHASIS ON FOSTERING COMMUNICATION AND COORDINATION AMONG NETWORKS OF EMPLOYERS, TRADE ASSOCIATIONS, WORKFORCE TRAINING AGENCIES, COMMUNITY COLLEGES, LOCAL GOVERNMENT OFFICIALS, AND OTHER KEY PARTICIPANTS.

One of the persistent themes in the business press is the presence of a skills gap in America. Although these claims appear compelling on the surface, closer analysis of a particular industry sector — manufacturing — reveals a more complex picture. Recent survey data, along with strategic case studies, indicate that manufacturing skills gaps are at most a limited phenomenon. Ultimately, the skills gap

formulation is misleading. Skills are critical for America's economic success, but policymakers would do better to think about the quality of labor market institutions and intermediaries — the connective tissue linking supply and demand — rather than decrying an inadequate workforce.

In any given week, you can read confident assertions that American workers do not have the skills to compete

in the global economy. On an intuitive level, these claims seem to make a lot of sense. Global competition has intensified over the past two decades, and American competitiveness depends on increasing skill levels and productivity. At the same time, the growth in technology has seemingly made the workplace more complex.

Many economists argue that technological growth increases the demand for highly skilled workers.¹ The high payoff to a college education would appear to confirm the value the market places on higher skill levels, while at the same time U.S. postsecondary educational attainment since 2000 has grown more slowly than in other advanced industrial countries.²

Despite this seemingly plausible narrative, when we look at more fine-grained industry data, a puzzle emerges. Manufacturing is a good case for investigation as it is subject to global pressures, sensitive to technology shocks, and the subject of many economic development efforts. Consistent with conventional wisdom, commentators and industry trade groups frequently assert that hundreds of thousands of manufacturing jobs are going unfilled despite high levels of unemployment and thousands of laid off production workers.³ In a 2011 manufacturing trade association survey, 83% of respondents said that they experienced a moderate-to-severe shortage of skilled production workers.⁴ A 2014 report sponsored by the same association asserted that 79% of manufacturers have a general shortage of skilled human resources.⁵ And yet the economic data we have do not quite match up with these claims. A skills gap is a situation where the demand for a particular skill exceeds the supply for an extended period of time. Anytime that demand outstrips supply in a market economy, we would expect to see the price of the scarce good rise. In this case, this means that wages for a class of skilled manufacturing workers — say workers with a community college degree — should be increasing compared with wages for less skilled workers. We can test this proposition

by examining the wages of young workers entering the manufacturing labor market. As we can see from Figure 1, the wage premium earned by individuals aged 25-34 with an associate’s degree from a community college relative to individuals with only a high-school degree shows no upward trend since 2000 — if anything, the premium has been declining. This result holds for both the manufacturing sector and for all other industries.

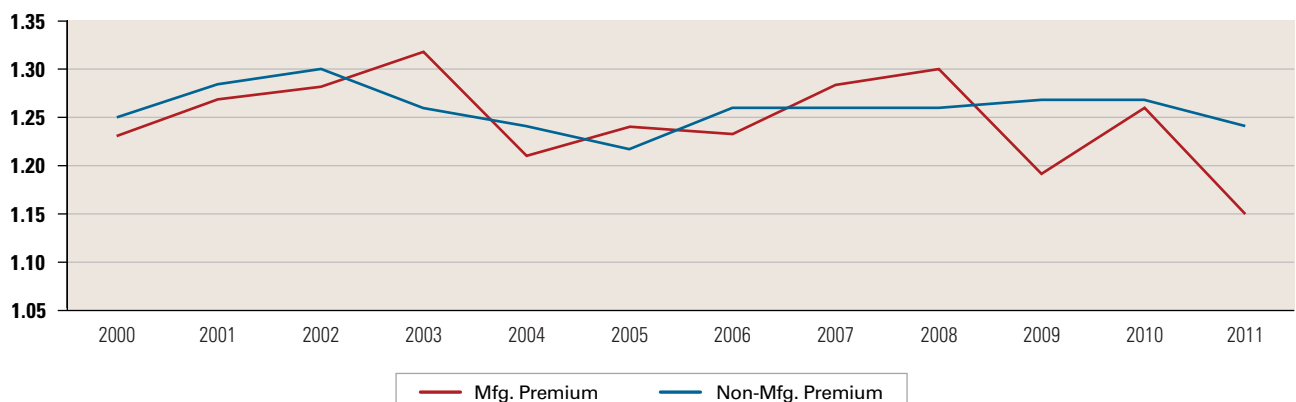
So how can we make sense of this puzzle? We start by reviewing where the current claims of the skill mismatch come from. We then examine what happens when more detailed data enter the picture.

WHAT IS THE EXISTING EVIDENCE?

The evidence regarding skill mismatch comes from two sources: academic studies and anecdotal reports of employer complaints in the media. On the academic side, researchers employ a couple of strategies to estimate the mismatch. One method is to compare the relationship between the unemployment rate and the job openings (vacancy) rate. This is referred to as the Beveridge curve. If the number of vacancies for a given unemployment rate rises above historical norms, then it could be that employers are increasing their job openings but are unable to fill them due to inadequate worker skills. The data show that the vacancy/unemployment rate ratio did indeed rise in the wake of the Great Recession.⁶ A second method is to estimate the supply of and demand for skills, and then subtract one from the other. This method has also revealed an undersupply of skills.⁷

We should take the results of these valuable techniques seriously. However, there are a few reasons to dig deeper. First, any number of mechanisms could be responsible for the shift in the Beveridge curve, including geographic and industry dynamics that are not the result of inadequate worker skills. In addition, these vacancy/unemployment measures are highly cyclical, casting some

Figure 1. Community College Wage Premium by Industry Sector, Workers Aged 25–34



Source: Census Bureau’s Current Population Survey (CPS) merged outgoing rotation groups (MORG) data as compiled by the National Bureau of Economic Research (NBER)

doubt on whether they are really measuring structural skill mismatch problems.⁸ The supply-demand method would seem to do a better job of zeroing in on skills, but unfortunately, due to data limitations, it does not directly measure skills. Rather, it uses educational attainment as a proxy for skill. If more college-educated workers take jobs as baristas, this method will consider it a sign that the skill demands for coffee shop workers have risen. Furthermore, since most employers fill jobs by choosing between two different workers with similar educational backgrounds (say, two different college-educated workers), this method misses much of the relevant skill variation in the economy.

Although the media reports of employer complaints about skills gaps do not have statistical methods behind them, we should still take them seriously. Such complaints are pervasive and deserve an explanation.⁹ In my own fieldwork I have frequently come across employers who have made sincere comments about difficulties in recruiting workers. As with many puzzles that appear in aggregate economic data, the key to making progress is often to gather detailed data close to the source. We cannot understand the dynamics of specific industries and occupations by simply imposing aggregate data patterns and interpretive frameworks on them. Rather, we need to build our knowledge from the ground up. To shed light on the issue, Paul Osterman and I conducted a national survey of manufacturers that directly measures employer skill demands and hiring outcomes. This survey is the first of its kind to employ a nationally representative random sample and to ask detailed questions about employer skill demands. In addition to gathering survey data, we conducted extensive fieldwork with manufacturers in North Carolina, New York State, Ohio, and Massachusetts.

Based on both the quantitative and qualitative evidence, we think that the debate's current skills-gap framing is misleading. Skills are critical, but there is a better way to think about the challenges that they pose. Skill demands are frequently more modest than skills gap proponents assume. At the same time, real challenges stem from the disaggregated nature of America's skill production system. A focus on communication, coordination, and the quality of labor market intermediaries is a more productive approach to raising skill levels than decrying the inadequacy of the supply side of the labor market.

SURVEY METHODOLOGY AND RESULTS

As part of the Massachusetts Institute of Technology's Production in the Innovation Economy (PIE) project, we developed and administered an original survey instrument to a random sample of 2,700 nationally representative manufacturing establishments with at least 10 employees in late 2012 and early 2013.¹⁰ Excluding the ineligible establishments, incorrect addresses, and unusable surveys,

the response rate was 35.7 percent, yielding 903 completed surveys. The survey respondents were typically plant managers, and the survey questions referred to a plant's core workers, defined as the workers most central to the production process.

We had several goals. First, we wanted to measure what skills employers actually demand, particularly higher-level skills. Second, we wanted to measure hiring difficulties that might imply skills gaps. Finally, we wanted to explore what employer characteristics, including skill demands, are predictive of these hiring difficulties.

For the first goal, we did not want to rely on opinion questions. Instead of asking whether a given skill was important or relying on an abstract rating scale, we asked respondents whether core production jobs required a range of detailed skills. For example, with regard to math we asked questions such as: Does this job require addition and subtraction? For reading, we asked whether the job required reading basic manuals. We asked about both basic levels of skills and higher-level skills that we refer to as extended skills. Here we asked respondents whether core jobs involved math skills such as geometry and calculus. For extended reading, we asked about requirements to read complex technical manuals or documents longer than five pages. We asked a battery of more than thirty skill-related questions. We also included questions about various soft skills and critical thinking/problem-solving skills that are often thought to be critical for modern high-performance manufacturing systems.

In other work we have shown that demand for basic skills is widespread.¹¹ Roughly three quarters of manufacturing establishments require basic reading and math (addition up through fractions). Over 80% require the ability to cooperate with other employees, and a little under two thirds require the ability to work in teams. For this article, we concentrate on how pervasive the demands for higher-level skills are, as these are the types of skill demands that are thought to drive skills gaps. Table 1 contains the results for extended skills.

Given the conventional wisdom that America's skill problems relate mainly to science, technology, engineering, and math (STEM) skills, the fact that extended reading is the only higher-level skill demanded by more than half of manufacturing establishments is notable. Nevertheless, the other extended skill demands are modest. Only 38% of plants require a higher-level math skill such as algebra or statistics, and only 42% require a higher-level computer skill. The archetypal story about skills gaps in manufacturing is one in which a manual machine operator cannot adapt to requirements for programming computer numerically controlled (CNC) machine tools.¹² It is thus somewhat surprising that less than one in five American manufacturing establishments require core production

Table 1. Extended Skill Demands for Core Production Jobs

Industry Super-Sectors	Percentage of Surveyed Manufacturing Firms
Extended reading (ability to read complex technical documents, any document longer than 5 pages, or articles in trade journals/publications)	52.6%
Extended writing (ability to write documents that are one page or longer)	22.1%
Extended math (ability to perform one or more of the skills below)	38.0%
Algebra, geometry or trigonometry	31.7%
Probability or statistics	14.0%
Calculus or other advanced mathematics	7.3%
Extended computer (ability to perform any of the skills below)	41.9%
Use CAD/CAM	28.4%
Use other engineering or manufacturing software	29.2%
Ability to write computer programs (such as program a CNC machine for a new piece, etc.)	18.6%
Any extended skill	72.9%
Two or more extended skills	45.0%
Three or more extended skills	27.0%

Source: PIE Manufacturing Survey

workers with the ability to write computer programs. We also see that extended skill demands tail off as we measure cumulative demands. While over 70 percent of establishments demand one extended skill, less than half demand two such skills, and less than a third demand three extended skills.

Based on these results, it would appear that American manufacturing skill demands are generally targeted at levels attainable by a well-trained high-school student and certainly by a community college graduate. This is not to say, however, that employers do not have trouble accessing these skills. To test whether manufacturers face persistent recruitment problems, we examine data on hiring outcomes.

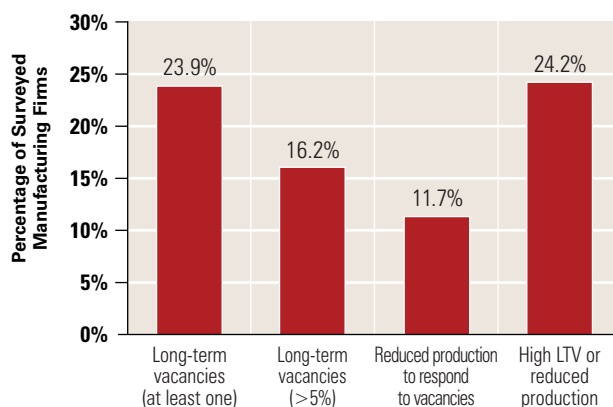
To measure hiring difficulty, we asked employers about the number of vacancies that had persisted for three months or more. Some level of vacancies is necessary for a well-functioning labor market. However, vacancies that linger over an extended period are a potential sign of a wedge between supply and demand in the labor market.

The first column of Figure 2 shows that a little less than a quarter of manufacturing establishments have at least one long-term vacancy. This figure contrasts sharply with trade association survey results that do not come from random samples. The second column shows that about 16% of establishments have long-term vacancies that amount to more than five percent of the establishment’s total core workforce. This implies a more severe recruitment problem. Figure 2 also presents an additional measure of the severity of hiring difficulties. We asked respondents whether they had ever had to reduce production to manage the problem of vacancies. Twelve

percent of the plants at some point had to take this step. If we combine these last two measures, just under a quarter of plants either have high levels of long-term vacancies or have had to reduce production. Although this statistic is not a measure of the current skill mismatch, it shows that even if we incorporate an alternative measure of past distress, the problem remains bounded. In other analyses, we have examined different measures of workforce difficulties, such as high involuntary turnover. It turns out that plants that demand advanced skills actually have lower rates of involuntary turnover. Overall, these data imply that skills gaps are limited to 16-25% of manufacturing establishments.

This result does not mean that skills are unimportant. For one thing, we should not ignore the challenges faced by one out of every four or six manufacturing employers.

Figure 2. The Incidence of Hiring Difficulties



Source: PIE Manufacturing Survey

Note: Long-term vacancies are defined as vacancies lasting three months or more.

More to the point, the importance of skills does not depend on the existence of skills gaps. Just as we should be concerned about the minority of employers who may have recruiting difficulties, we should also be concerned that more manufacturers are not demanding the types of higher-level skills that can both enhance American competitiveness and support higher wages for workers. The key point is that supply and demand are part of a system. Any effort to raise the level of skills deployed in industry should focus on both sides of the equation: skills are not produced by unilateral investments in education made on blind faith. Rather, they are the product of a skill production system that involves students, workers, educational institutions, labor market intermediaries, and employers. One of the flaws of the skills gap formulation is that it focuses attention exclusively on problems with workers and the supply side of the market, while ignoring the necessary interplay between supply and demand. These data make clear that the market is not necessarily sending a signal that, say, computer programming skills should become a standard part of every worker's tool kit.

We believe there is a better way to think about the challenges of producing the type of skilled workforce that can both enhance competitiveness and earn higher wages. Economic globalization and technology shocks pose real challenges. However, they are not the result of workers and schools that mysteriously just don't get the clear signals that employers are sending. Rather, they relate to the challenges of what we call the new American skill production system.

THE NEW AMERICAN SKILL PRODUCTION SYSTEM

For much of the post-World War II era, American manufacturing was defined by large firms and large factories. Iconic plants like the Bethlehem Steel Sparrows Point plant in Maryland employed thousands of workers. Although deindustrialization and the decline of traditional manufacturing in America have been exhaustively documented, one aspect of this economic change has often been overlooked. It is not just that manufacturing plants went out of business and manufacturing declined as a percentage of total employment. In addition, the American system of producing industrial skills changed. Once upon a time, large U.S. plants had significant economies of scale in training their workers. Large manufacturers like Timken in northeast Ohio offered apprenticeships. When these employers relied on the local school system to access skills, be it local high schools or community colleges, the conversation between the company and the educational system was straightforward. Local officials knew the large employers, where the jobs were, and they were primed to respond.

This dynamic has changed radically in recent years. The average size of a manufacturing plant has declined

by over 40 percent in recent decades. In the 1970s, the average manufacturing worker had over 1,500 coworkers. By 2006, this figure had fallen to 760.¹³ Large-scale plants all but disappeared. In 2007 there were only 47 manufacturing plants in all of America that employed more than 5,000 workers, half as many as a decade earlier.¹⁴ These changes have had a significant impact on the American skill production system. Where once larger plants internalized many of the challenges of training workers, there are now smaller, more disaggregated factories with fewer economies of scale in training. Companies such as Timken have eliminated their American apprenticeship programs as hiring has moved overseas and the volume at domestic plants has stabilized.¹⁵ At the same time, job tenure has fallen, reducing the amount of time that companies can recoup investments in their workers.¹⁶ External entities such as community colleges have become more important in the skill-training system as companies try to hire workers who already have the requisite skills. As these educational institutions, trade associations, nonprofit training providers, and other labor market intermediaries become more important, the potential for communication and coordination failures multiplies. To illustrate this, we examine the optics industry in Rochester, NY.¹⁷

Rochester is home to one of the most sophisticated optics clusters in the world. From the late 19th century to the late 20th, firms such as Kodak, Bausch and Lomb, and Xerox dominated Rochester's economy through the production of innovative optical products backed by cutting-edge research and development. By the early 1980s, Kodak employed over 60,000 workers in Rochester. In the 1960s, Kodak began working closely with Monroe Community College (MCC) to develop a two-year associates program to produce optics technicians for the company. The program provided training in physics and engineering related to optics, and it prepared workers to perform jobs such as the operation of sophisticated lens grinding and polishing equipment. The relationship was symbiotic. Kodak basically underwrote the program, filling the classes with Kodak apprentices. MCC did not have to struggle with curriculum content: Kodak clearly communicated its needs. In addition, the entire region benefited from the program's spillovers. Highly trained workers were available for other optics firms, and a number of MCC graduates went on to found other optical manufacturing companies. However, due to a combination of technology and competitive shocks, along with the results of various business decisions, Kodak began a precipitous decline. Today, the company employs a little over 5,000 workers in Rochester. As Kodak declined, it pulled back its support for the MCC optics program. By the mid-2000s, the program had empty seats and lacked direction. MCC announced that it was thinking about terminating it.

The irony was that, despite Kodak's woes, the optics cluster in Rochester was thriving. Over the past two decades, numerous small, innovative optics manufacturers have grown up to fill the void left by Kodak's decline. These include firms that make products such as the lenses for 3-D movie projectors or optical polishing machine tools that can yield unique spherical surfaces. These small firms need skilled optical workers, but are generally too small to run dedicated internal training programs in core optical skills. No individual firm was large enough to organize the market for training and hiring optical workers. The small firms were alarmed at the prospect of MCC shutting the program down, but they had trouble speaking with one voice about their needs and concerns. The disaggregation of the industry was generating communication failures.

The outcome of this dilemma highlights the different types of players that are needed to make the new industrial skill production system work. Shortly before MCC pulled the plug on the optics program, a dynamic industry veteran took over the leadership of the Rochester Regional Photonics Cluster (RRPC), a trade association. This individual joined together with a forward-looking CEO from one of the small optics firms, mobilizing the other small firms. The initiative resulted in MCC creating an advisory board, which selected a new director for the MCC program, a physicist with industry experience. The RRPC began working with local high schools to help secure a pipeline of students for the program. The RRPC helped convince Corning to donate \$500,000 to the MCC program, and one of the other small manufacturers followed with \$250,000. At about the same time, the forward-looking CEO helped create another industry intermediary, the Finger Lakes Advanced Manufacturing Enterprise (FLAME). This intermediary also convened industry firms and communicated their needs. Today, the program is again successful, with healthy demand for its graduates. Ultimately, the Rochester optical skill production system nearly broke down not because there was no demand, but because the industry's disaggregated firms suffered from communication and coordination failures. The solution was the intervention of labor market intermediaries that could help coordinate the supply and demand sides of the market.

As manufacturing becomes more synonymous with small plants that attempt to hire externally trained workers, the potential for systemic breakdowns in skill production increases. Simply exhorting workers to "get more education" is not effective here. The firms on the demand side, the educational institutions on the supply side, and the labor market intermediaries in between must all be in constant contact. Furthermore, the conversation runs two ways. As we have seen from our analysis, manufacturing skill demands are not necessarily high and worker capa-

bilities low. Rather, without constant communication and feedback, employers may fail to create production systems that utilize cutting-edge, high-productivity skills. The supply and demand sides of the market can get caught in a low-road equilibrium.

So given the challenges posed by disaggregation, is there hope that localities and regions can systematically adapt? Or is the solution always dependent on a few idiosyncratic leaders stepping forward? The good news is that some regions are demonstrating how to thrive with the new American skill production system. One promising example is the biomanufacturing cluster in Raleigh-Durham in North Carolina.

If there is any industry that one would expect to suffer from skills gaps and hiring problems, it is biotechnology/biomanufacturing. The skills required for core production workers — called process technicians — are highly specialized. Workers must follow exacting aseptic technique standards, in addition to having knowledge of biology and chemistry. The technology that the industry depends on is relatively new (in industrial terms) and changes frequently. And yet, in interviews with numerous biomanufacturing firms in the Raleigh-Durham/Research Triangle, almost all of them sing the praises of the region's labor market and say that they are able to access the skills that they need.

How is Raleigh-Durham able to accomplish this? The complete story is too long to tell here, but the short answer is that the region has institutions, labor market intermediaries, and norms of cooperation that make the disaggregated skill production system work.¹⁸ The North Carolina Biotechnology Center conducts research on industry needs, including personnel and training requirements. The center has spearheaded initiatives to develop skill and curriculum standards. Below the level of an associate's degree, the state has a widely recognized BioWork certificate with training delivered by multiple institutions. Community colleges like Wake Tech and Durham Tech have biotech training expertise, and a statewide BioNetwork system supplies training capabilities to community colleges that lack these resources. North Carolina State University operates an applied biomanufacturing training center called BTEC, and North Carolina Central University operates industry-focused biomanufacturing and drug discovery programs. An industry trade association called NCBIO communicates industry needs. All of these players constantly communicate with one another and collaborate on workforce-related issues, thus creating a thick network that fills in the gaps in the skill production system. The result is a system that aligns worker skills and industry demands while raising the sophistication of production on the demand side of the market and skills on the supply side. One major biotech firm with operations in multiple states reports that it can hire a process technician in a couple

of days in North Carolina while hiring an equivalent worker in a plant in another East Coast state takes weeks.

These case studies are meant to be suggestive rather than definitive. However, when combined with our statistical survey data, several clear messages emerge. Our national survey data show that skill mismatches are limited to a quarter or less of manufacturing establishments. At the same time, skills are critical to America's economic future, and there are many reasons to be concerned about how workers are trained and skills are produced. Unfortunately, the current formulation of a skills gap and the resulting debate shed little light on the challenges of the new disaggregated American skill production system.

The skills gap misleadingly focuses attention on flaws on the supply side of the labor market, while ignoring the complex interplay of supply and demand and the potential for communication and coordination failures.

These results have clear policy implications. In practice, policymakers should focus on creating and supporting labor market intermediaries that institutionalize communication and coordination between employers, trade associations, community colleges, technical and vocational training programs, local government officials, unions, and other key participants. The form of these intermediaries will vary by market. In some cases they may be private entities closely affiliated with industry trade associations,

The Advanced Manufacturing Skills Challenge: The View from Massachusetts

This spring, UMass Dartmouth and the UMass Donahue Institute conducted a comprehensive survey of 1,350 Bay State manufacturing firms for the Advanced Manufacturing Regional Partnership Academy (AMRPA). The survey assessed the extent of the manufacturing workforce challenge in Massachusetts. In response to this survey 1 in 3 manufacturers (33%) reported having a difficult time hiring needed production workers.

These survey results reveal that this challenge is present in each of the six major sectors that make up the state's larger advanced manufacturing industry. The challenge appears particularly acute in the Fabricated Metals and Machinery sector, where 42% of firms surveyed reported difficulty in sourcing the workers that they need. When firms in this sector, which is largely composed of small- and medium-sized machine shops, were asked whether the availability of a skilled workforce was a cause for concern for their firm when considering their future prospects in Massachusetts, 70% answered in the affirmative. This is striking, especially when one considers that Massachusetts has lost over 50,000 manufacturing jobs in the past decade and we have yet to see the kind of wage increases we would expect if there were a true labor shortage.

A closer look at these findings and the recent MIT research described in this article suggest that part of the explanation for this apparent disconnect involves the ways in which educational and training institutions engage with manufacturers in their

efforts to ensure that students develop the necessary skills and experience to excel on the modern shop floor. Large majorities of the firms that responded to the survey reported that they have never worked with their local comprehensive high schools (73%), community colleges (69%), four-year universities (76%), and workforce investment boards (83%). Only 10 percent reported that they work closely with a vocational high school.

While it appears that the scale of this challenge is more modest than some have claimed, taken along with other research conducted by the AMRPA, findings clearly suggest that we can strengthen the connections between those employers with very real workforce needs and our vocational high schools, community colleges, and workforce development agencies.

Successful efforts in Western and Central Massachusetts clearly demonstrate that this challenge can be met if employers are effectively engaged, educational and training programs are grounded in an evidence-based understanding of employer needs, and key public institutions — armed with the necessary resources — successfully align their programs in the service of a common goal. Employers also need to be willing to invest the time and energy to engage with these institutions and to regularly and clearly communicate their workforce needs.

For more information on this survey and the work of the AMRPA, see www.umassd.edu/amrpa.

while in other cases they may be more public entities. However, it is critical that they participate in meaningful decision making. The example of Rochester employers actively selecting the director of the optics program at MCC is instructive. Ultimately, the answer to industry's skill challenges is not to sound alarm bells about a vague skills gap but to create the dense web of cooperating institutions that meet current demand and raise performance.

ANDREW WEAVER is a Ph.D. candidate at the MIT Sloan School of Management. He is a former vice president of NCB Capital Impact.

Endnotes

- 1.) Goldin and Katz (2008).
- 2.) Autor (2014), OECD (2013).
- 3.) Portman 2013, Emanuel 2011; Hemphill and Perry 2012, Friedman 2012, Baden 2011.
- 4.) Deloitte (2011).
- 5.) Accenture (2014).
- 6.) Hobijn and Sahin (2012); Canon, Chen, and Marifian (2013).
- 7.) Estevau and Tsounta (2011); Rothwell (2012).
- 8.) Lazear and Spletzer (2012).
- 9.) Krouse 2013, Maltby and Needleman 2012, Whoriskey 2012, Woellert 2012
- 10.) For more information on the PIE project and its overall results, see Suzanne Berger, "Making in America," Cambridge, Mass.: MIT Press, 2013.
- 11.) Osterman and Weaver (2014).
- 12.) Whoriskey (2012), Davidson (2012).
- 13.) Henly and Sanchez (2009).
- 14.) Holmes (2011).
- 15.) January 2012 interview.
- 16.) Farber (2008).
- 17.) A version of this case study first appeared in Weaver and Osterman (2014). Information is based on interviews conducted in October 2012.
- 18.) Information based on interviews conducted in January 2012.

Bibliography

Accenture and the Manufacturing Institute. 2014. *Out of Inventory: Skills Shortage Threatens Growth for U.S. Manufacturing.*

- Autor, David. 2014. "Skills, Education, and the Rise of Earnings Inequality among the 'Other 99 Percent.'" *Science*, 344(6186): 843-851.
- Baden, Ben. 2011. "Skills Gap Plagues U.S. Manufacturing Industry." *U.S. News & World Report*, October 24, 2011.
- Berger, Suzanne. 2013. *Making in America*. Cambridge, Mass.: MIT Press.
- Canon, Maria E., Mingyu Chen, and Elise A. Marifian. 2013. "Labor Mismatch in the Great Recession: A Review of Indexes Using Recent U.S. Data." *Federal Reserve Bank of St. Louis Review*, May/June 2013.
- Davidson, Adam. 2012. "Making it in America." *The Atlantic Monthly*, January/February 2012.
- Deloitte and the Manufacturing Institute. 2011. *Boiling Point? The Skills Gap in U.S. Manufacturing.*
- Emanuel, Rahm. 2011. "Chicago's Plan to Match Education with Jobs." *The Wall Street Journal*, December 19, 2011.
- Ezell, Stephen J. and Robert D. Atkinson. 2011. *The Case for a National Manufacturing Strategy*. Washington, D.C.: Information Technology and Innovation Foundation.
- Estevau, Marcello and Evridiki Tsounta. 2011. "Has the Great Recession Raised U.S. Structural Unemployment?" IMF Working Paper WP/11/105.
- Farber, Henry. 2008. "Employment Insecurity: The Decline in Worker-Firm Attachment in the United States." CEPS Working Paper No. 171.
- Friedman, Thomas L. 2012. "If You've Got the Skills, She's Got the Job." *The New York Times*, November 17, 2012.
- Goldin, Claudia and Lawrence Katz. 2008. *The Race between Education and Technology*. Cambridge, Mass.: Harvard University Press.
- Hemphill, Thomas A. and Mark J. Perry. 2012. "U.S. Manufacturing and the Skills Crisis." *The Wall Street Journal*, February 27, 2012.
- Henly, Samuel E. and Juan M. Sanchez. 2009. "The U.S. Establishment-Size Distribution: Secular Changes and Sectoral Decomposition." *Federal Reserve Bank of Richmond Economic Quarterly*, 95(4): 419-454.
- Hobijn, Bart and Aysegul Sahin. 2012. *Beveridge Curve Shifts across Countries since the Great Recession*. Paper presented at the 13th Jacques Polak Annual Research Conference.
- Holmes, Thomas J. 2011. "The Case of the Disappearing Large-Employer Manufacturing Plants: Not Much of a Mystery after All." Federal Reserve Bank of Minneapolis Economic Policy Paper 11-4.
- Krouse, Peter. 2013. "Help Wanted: Local Manufacturers Have Jobs They Can't Fill Because of Skills Gap." *Cleveland.com*, September 13, 2013, accessed on 11/1/2013 at http://www.cleveland.com/metro/index.ssf/2013/09/skills_gap.html.
- Lazear, Edward P. and James R. Spletzer. 2012. "The United States Labor Market: Status Quo or a New Normal?" NBER Working Paper 18386. Cambridge, Mass.: National Bureau of Economic Research.
- Maltby, Emily and Sarah E. Needleman. 2012. "Small Firms Seek Skilled Workers but Can't Find Any." *The Wall Street Journal*, July 31, 2012.

Organization for Economic Co-operation and Development (OECD). 2013. *Education at a Glance*.

Osterman, Paul and Andrew Weaver. 2014. "Skills and Skill Gaps in Manufacturing." in *Production in the Innovation Economy*, edited by Richard Locke and Rachel Wellhausen. Cambridge, Mass.: MIT Press.

Portman, Robert. 2013. "Closing the Skills Gap." *Chillicothe Gazette*, May 10, 2013.

Rothwell, Jonathan. 2012. "Education, Job Openings, and Unemployment in Metropolitan America." Washington, D.C.: Brookings Institution.

Weaver, Andrew and Paul Osterman. 2014. "The New Skill Production System: Policy Challenges and Solutions in Manufacturing Labor Markets." in *Production in the Innovation Economy*, edited by Richard Locke and Rachel Wellhausen. Cambridge, Mass.: MIT Press.

Whoriskey, Peter. 2012. "U.S. Manufacturing Sees Shortage of Skilled Factory Workers." *The Washington Post*, February 19, 2012.

Woellert, Lorraine. "Companies Say 3 Million Unfilled Positions in Skill Crisis: Jobs." *Bloomberg News*, July 25, 2012.



Meeting the Needs of Manufacturers in Massachusetts

ERIC NAKAJIMA

ONGOING EFFORTS TO PROMOTE ADVANCED MANUFACTURING IN MASSACHUSETTS HAVE EMPHASIZED IMPROVED COLLABORATION BETWEEN EDUCATIONAL AND WORKFORCE DEVELOPMENT INSTITUTIONS AND THE EMPOWERMENT OF EMPLOYER-DRIVEN REGIONAL PARTNERSHIPS.

Massachusetts Governor Deval Patrick has described the state’s advanced manufacturing industry as experiencing “a quiet renaissance.”¹ To a generation of families across the state that lived through the wrenching and dramatic decline of traditional manufacturing in the U.S., that statement may seem surprising. But it is true. Since the year 2000, the state’s manufacturing output has grown even as the state has lost 150,000 manufacturing jobs. But since 2009, output has continued to grow and production employment has stabilized, reflecting the fact that increased productivity has not come at the expense of jobs in recent years.

Only a few years ago, manufacturing was viewed as a sunset industry in Massachusetts and across America. Today, over 7,000 Massachusetts manufacturers employing over 250,000 people² and manufacturing contributes 10.5 percent of GSP, ahead of health care and finance.³ There is reason to believe that advanced manufacturing

will continue to be a critical part of the state’s economy in the years to come.

In 2011, Governor Patrick launched the Massachusetts Advanced Manufacturing Collaborative to help the state’s manufacturers, educators and policymakers build a 21st century manufacturing strategy attuned to the industry’s current needs and competitive conditions. The primary focus of the Advanced Manufacturing Collaborative is rebuilding the fragmented educational and workforce development system for training workers and correcting the misperception that the industry isn’t a source of satisfying careers.

As Andrew Weaver demonstrates in his article in this edition of *MassBenchmarks*, the loudest voices in manufacturing policy debates claim a major skills gap in the U.S. labor force that is confounded by close analysis of the data. Does that mean there is no problem? No. There are

two significant real challenges, both of which correspond nicely to Andrew Weaver's analysis.

First, historically, large manufacturing companies provided training and apprenticeships that served as a de facto regional system for preparing workers for a local labor market. Area technical colleges and vocational schools, as well as small manufacturers, followed the lead of the major employers. Across the U.S., that old training model is gone. In its place, colleges, schools and workforce investment boards are often disconnected from each other and from the needs of small and medium-sized manufacturers. In the current system, manufacturers legitimately experience a workforce crisis because there is no reliable and transparent means of meeting their hiring needs.

The second challenge for small and medium-sized manufacturers is the increasing demand from major multinational companies for improvements in cost, quality, and product innovation throughout their supply chains. The surest path for small companies to address quality and cost is through improving the skills of their workforce. In Massachusetts, a major impediment to meeting the incumbent worker training needs of companies is the small average firm size (over 90 percent of manufacturers employ fewer than 100 workers).⁴ It is hard to organize training programs if demand presents itself in ones and twos and very small companies lack the time and resources to engage the local workforce system at all.

The Massachusetts Advanced Manufacturing Collaborative has listened to the state's manufacturers and learned from excellent regional employer-workforce partnerships in the state that have implemented novel solutions to rebuild the workforce training system and promote manufacturing careers. The Patrick Administration has worked with the legislature and a range of state agencies to align resources and programs to streamline support for regional manufacturing partnerships that implement a best-practices approach to education and incumbent worker training.

One model for the regional manufacturing partnerships is the Precision Manufacturing Regional Alliance Project (PMRAP) in Hampden County, Massachusetts. PMRAP was created in 2006 by the Western Massachusetts Chapter of the National Tooling & Machining Association and the Hampden County Regional Employment Board. From the beginning, the regional partnership received state support and advice from Mass Tech Collaborative, an innovation-based state economic development agency, and from Commonwealth Corporation, the state's workforce training agency. Both agencies had a ringside seat to follow PMRAP's evolution.

PMRAP organizes the region's educational and training system to effectively engage with local manufacturers to provide incumbent worker training and a pipeline of new workers. Employers validate the curriculum and equipment at the region's schools, raise funds for new equipment,

and provide regular feedback on their hiring needs. The region's seven vocational schools and two community colleges with UMass Amherst share facilities, instructors and curricula. They also share data on enrollment, completions and hiring. PMRAP was recognized as a national model for workforce coordination by MIT's Production in the Innovation Economy (PIE) report in 2013.⁵

In Worcester County, a partnership of statewide and regional organizations launched a parallel effort to engage employers, articulate training and educational needs, and align vocational schools and colleges around those needs. Principally sponsored by the Massachusetts Manufacturing Extension Partnership (MassMEP) with employers, the program — the Massachusetts Advancement Center Workforce Innovation Collaborative (MACWIC) — has developed industry-validated career pathways and curricula. MACWIC started with a partnership of MassMEP with Quinsigamond Community College, Worcester Technical High School and Worcester Polytechnic Institute. It has since expanded to partner with other vocational schools and community colleges in the region.

The Advanced Manufacturing Collaborative drew lessons from these regional manufacturing partnerships as well as independent research and analysis from state and national sources. In 2012, the Patrick Administration joined eight other states in a policy academy sponsored by the National Governors Association Center for Best Practices. The states studied with national manufacturing experts and officials from the National Institute of Standards and the Economic Development Administration. Locally, MIT launched its manufacturing initiative, PIE, and partnered with the Commonwealth to use the state as one of its research sites. And the Patrick Administration cosponsored research by Northeastern University Professor Barry Bluestone in 2007 and 2012 that provided a baseline for understanding industry trends.

In general, the body of research validated a few key findings. First, manufacturing in Massachusetts is very healthy, with growth in output and productivity, and for several years, steady employment.⁶ Second, while there is not a great labor shortage, regions struggle to meet the existing needs of employers.⁷ Third, with 20 percent of the manufacturing workforce reaching retirement age in the next ten years, a replacement worker challenge will significantly strain the existing system.⁸

Armed with this analysis, the Patrick Administration has launched a comprehensive strategy to respond to manufacturing's challenges. The Commonwealth's Housing and Economic Development Secretary Greg Bialecki established key principles for state support for manufacturing education and workforce development. The first principle is that manufacturers, small and large, must be engaged in the design and implementation of training programs to ensure they meet their needs. The second principle is that education and training organizations must

collaborate to share facilities and resources and provide a seamless pathway for workers to develop careers. The third principle, which follows the first two, is that partnerships that include the workforce system and employers must be organized at the regional level.

The emphasis on regional partnerships has two practical consequences for the Patrick Administration and the Advanced Manufacturing Collaborative. First, the state has to coordinate its policies and programs to effectively respond to regional needs that will increasingly cross bureaucratic silos. Governor Patrick addressed this concern by appointing Marybeth Campbell to a new position, Director of Education and Workforce Development, which jointly coordinates policy for the Secretaries of Education, Labor & Workforce Development, and Housing & Economic Development. Also, by design, the Advanced Manufacturing Collaborative includes the director of every state agency that touches manufacturing from a policy or funding perspective. The agencies meet regularly to share information, coordinate investments and develop new initiatives.


The second consequence is that the state's manufacturing strategy is only as effective as its regional partners. There are many great organizations in Massachusetts working with manufacturers but the development of regional partnerships has been ad hoc and uneven. To respond to this need, the Advanced Manufacturing Collaborative launched the Advanced Manufacturing Regional Partnership Academy (Academy) in 2013. Led by UMass Dartmouth Professor Michael Goodman and a team of experts across the UMass system, the Academy engaged the state's seven regional manufacturing partnerships in a peer learning environment supported by best-practice case studies, surveys and independent research. The Academy completed its first year in June 2014.

In 2014, the Patrick Administration, working with the Massachusetts State Legislature, greatly expanded the resources available to fully implement its advanced manufacturing strategy. Based on its experience with PMRAP and other regional partnerships, the Patrick Administration knows that regions need new capital equipment to modernize training centers, and funds to expand training for new and incumbent workers. Governor Patrick's FY 2015 Capital Spending Plan includes, for the first time, an allocation of \$10 million to invest in manufacturing training equipment at vocational schools and community colleges. The funds will be focused on shared facilities utilized by new or existing regional partnerships.

The state's economic development law, signed by Governor Patrick in August 2014, establishes a \$12.3 million workforce training fund, administered by Commonwealth Corporation, focused on expanding the pipeline of workers in high-demand sectors, including manufacturing. In addition, Commonwealth Corporation has adopted new rules for its \$23 million Workforce Training Fund, to better enable small and medium-sized

manufacturers to pool demand for incumbent worker training programs.

The state's new resources complement an existing major effort to change perceptions of advanced manufacturing and promote manufacturing careers. In 2012, MassDevelopment launched AMP it up!, which supports regional career campaigns through grants and multimedia promotional materials. AMP it up! supported 21 local campaigns in 2012 and 2013.⁹ MassDevelopment also promotes manufacturing statewide, with support for events during National Manufacturing Day and the Advanced Manufacturing Collaborative's statewide manufacturing summit, held in 2013 and 2014.

As Governor Patrick notes, manufacturing is experiencing a quiet renaissance that follows a much louder and longer stretch of decline that challenged the nation's identity as a foundry for things as well as ideas. Today, Massachusetts has embarked on an effort to remake how government — state and local — can effectively match the needs of today's advanced manufacturing. That effort can only succeed with industry's partnership and it can only flourish with the creativity and commitment of us all. 

ERIC NAKAJIMA is Assistant Secretary for Innovation Policy in the Massachusetts Executive Office of Housing & Economic Development. He serves as co-chair of the Massachusetts Advanced Manufacturing Collaborative.

Endnotes

- 1.) Remarks, delivered by Governor Patrick at the Massachusetts Advanced Manufacturing Summit, Worcester, Mass, April 29, 2014.
- 2.) Average monthly employment in Massachusetts in 2013 from Massachusetts Office of Labor and Workforce Development Employment and Wages series (ES-202).
- 3.) *The Massachusetts Economic Due Diligence Report, Fourth Quarter, FY 2014.* University of Massachusetts President's Office Donahue Institute.
- 4.) Page 52, Staying Power II: A Report Card on Manufacturing in Massachusetts 2012, prepared by the Dukakis Center for Urban and Regional Policy, Northeastern University, September 2012.
- 5.) Page 28, a Preview of the MIT Production in the Innovation Economy Report, Massachusetts Institute of Technology, February 22, 2013.
- 6.) Executive Summary, Staying Power II; and, pages 5 & 6, A Profile of Advanced Manufacturing in the Commonwealth: Key Industry and Occupational Trends, prepared by Professor Henry Renski and Ryan Wallace, UMass Amherst Center for Economic Development, July 2014.
- 7.) Precision Manufacturing Regional Alliance Project/2.0 (PMRAP 2.0) Workforce Development Report, Findings and Recommendations, Hampden County Regional Employment Board, April 2012. <http://www.wmntma.org/new-initiatives/pmrmap20/>.
- 8.) Executive Summary, A Profile of Advanced Manufacturing in the Commonwealth, Renski and Wallace.
- 9.) AMP it up! website, News and Events Section, downloaded August 8, 2014, <http://ampitupma.com>.

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Art Director: Chris Bell

Print Production Artist: Christine Murphy

Production Editor: Rebecca Loveland

Economic and Demographic Data Analyst: Andrew Hall

Senior Editor and Writer, Isenberg School of Management:
Louis Wigdor

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Daniel Hodge, *Director*
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