



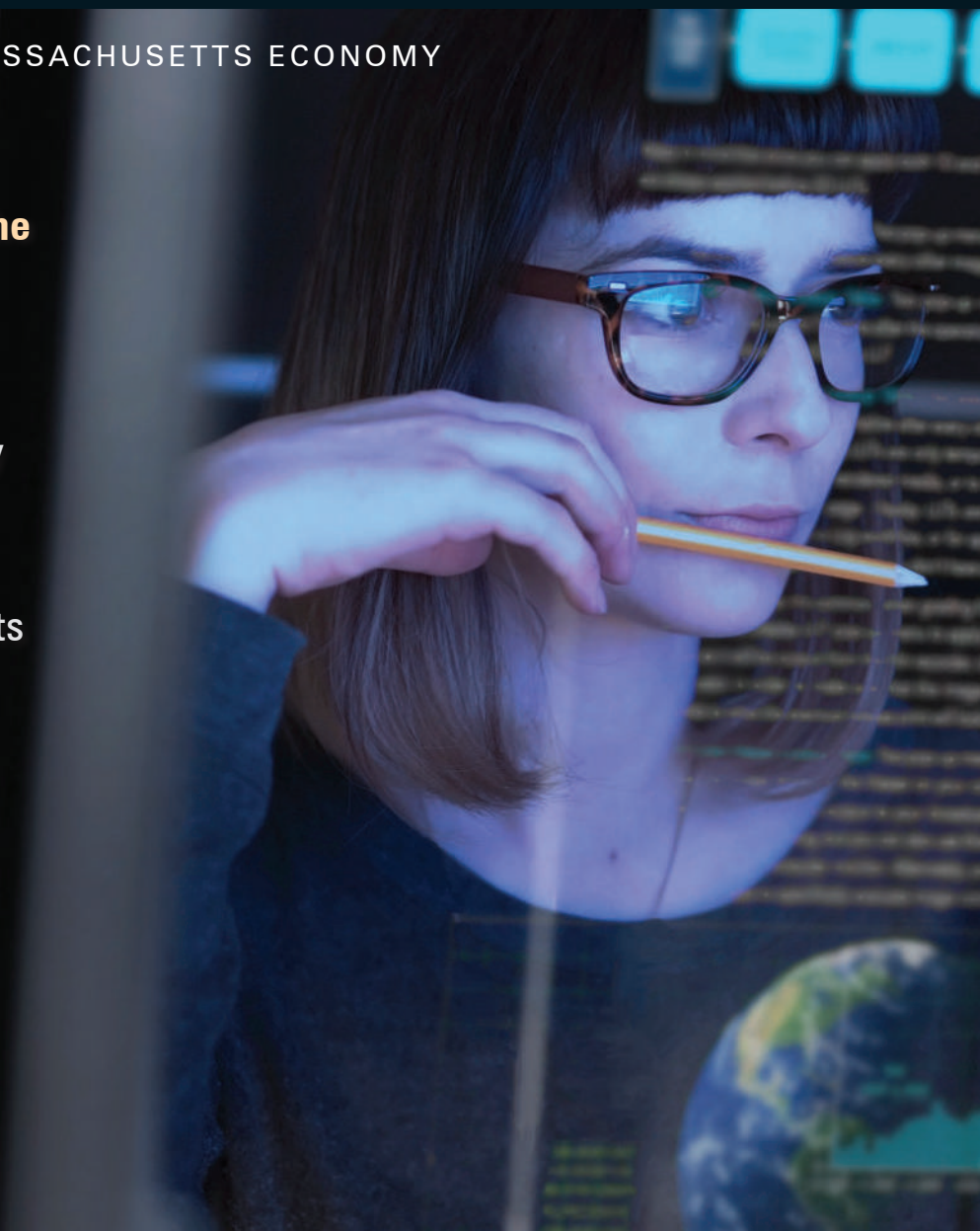
Mass Benchmarks

THE JOURNAL OF THE MASSACHUSETTS ECONOMY

The Future of Work and the Reskilling Revolution: What Role Will Higher Education Play?

Is Massachusetts' Economy Losing Its Steam?

Revisiting the Economic Geography of Massachusetts



MassBenchmarks

2019 | volume 21 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 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. Topical information and a brief biography of the author should be sent to info@donahue.umassp.edu.

Links to past issues, latest news, updates, and additional research on the Massachusetts economy can be found at www.massbenchmarks.org.



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Higher education must take the lead in preparing students—our future workforce—to adapt and thrive in a workplace that embraces disruptive technologies, including robotics, blockchain, and artificial intelligence. To that end, higher education must adapt the content and delivery of its curriculum and credentialing to meet industry's evolving skill requirements, as well as provide the basis for lifelong learning for traditional and non-traditional students.

FROM THE PRESIDENT



This issue of *MassBenchmarks* offers a detailed assessment of state economic conditions and timely insight into a number of key developments with serious implications for the Massachusetts economy. It also highlights important new research being conducted within the UMass system that improves our understanding of the regional economic geography of our Commonwealth, and offers insights into the implications of the rapidly changing world of work for our educational and training institutions.

As always, the issue opens with *Notes from the Board*, an assessment of the prospects for the state economy that summarizes the consensus view of the members of the MassBenchmarks Editorial Board. Despite substantial amounts of economic and policy uncertainty, the latest data suggest that the Massachusetts economy continues to expand, extending a period of economic growth that is now beginning its second decade. The question of how long our economic expansion can last in light of a dwindling labor supply and our aging infrastructure continues to loom large.

The review of the state of the state economy that follows—authored by UMass Amherst Professor and MassBenchmarks Executive Editor Robert Nakosteen and the Donahue Institute’s Branner Stewart—finds both reason for concern and cautious optimism. They review a number of key economic indicators and conclude that while the pace of state and national economic growth has slowed, it remains and is expected to remain positive in 2020.

The issue’s two feature articles focus on our evolving understanding of the regional economic geography of Massachusetts and the pedagogical and programmatic implications of the ongoing technological transformation of the world of work. In the first, Elise Rapoza, a Senior Research Associate from the Public Policy Center at UMass Dartmouth, summarizes the results of recent research that offers new and important insight into our evolving regional economy. Using innovative new methods that consider both the economic and the social and cultural connections between our communities, this article should be of great interest to our policymakers as they continue to work to advance the economic prospects for our state.

The issue concludes with a thoughtful discussion of the ways in which technology and global competition are transforming the workplace and the implications for our educational and training institutions. Authored by UMass Lowell Professor Scott Latham, this article highlights the need for new approaches to post-secondary education and training in response to the changing needs of our employers and the expected impacts of the growing adoption of new technologies. Professor Latham argues that the new skills and competencies that are expected to be in high demand require new approaches to the ways in which our higher educational institutions and workforce development system prepare the future workforce of our Commonwealth.

Taken together, the information and insight contained in this issue of *MassBenchmarks* make it clear that our policymakers, business, labor and community leaders need to both think and act differently if we are to meet the challenges presented by a rapidly transforming economic landscape while preserving the competitive advantage that has for centuries made Massachusetts a center of innovation and economic opportunity.

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

Martin T. Meehan, President
University of Massachusetts

“Uncertainty will continue to be the watchword,” declares MassBenchmarks Editorial Board

At our latest Board meeting, the MassBenchmarks Editorial Board was greeted with a set of much more positive indicators and trends in the regional economy than was the case just three months ago. At our previous meeting the consensus view was that the Massachusetts and U.S. economy continue to expand but there was increasing concern centered mainly around limitations in the available labor supply, softening demand, and considerable national policy and geopolitical uncertainty.

Recently released data reveal stronger growth in gross state product since mid-2017 than previously reported. These revised data improve our understanding of the recent economic history of the Commonwealth. The Bureau of Economic Analysis (BEA) estimates that Massachusetts gross state product expanded in the third quarter of 2019 at 2.2 percent annualized rate, much higher than the *MassBenchmarks* preliminary estimate of Q3 growth of -0.2 percent (released last October).

Additionally, some of the more concerning sources of domestic and international uncertainty appear to have stabilized in recent months. These include the passage of the United States-Mexico-Canada Agreement (USMCA), the evolving impact of the Brexit situation, and a cooling of trade tensions between the U.S. and China. These encouraging signs reduced uncertainty about the future and likely help to explain the strong business confidence in Massachusetts, as reflected in the most recent Associated Industries of Massachusetts Business Confidence Index.

A similar uptick in confidence about prospects for the national economy can be seen in *The Wall Street Journal's* monthly survey of economists, which, among other things, asks about the probability of recession in the next year. This survey documented increasing concern about the prospects for a recession last Summer, a more moderate level of concern last Fall, and diminishing concern in the last two months of the year – another clear indication of rising optimism about the outlook for the national economy.

Massachusetts continues to experience job growth in the education and health services industry and professional and business services. Within professional and business services, accounting, consulting, and scientific research and development stood out as significant employment growth drivers in the second half of 2019. In December the state unemployment rate fell to 2.8 percent.

Despite these encouraging developments, widespread concerns about the available labor supply persist. Unemployment rates by age, education, and ethnicity have fallen to levels not seen since the turn of the century. The state's labor force participation rate has been on the rise since 2018 and stood at just under 68 percent in December. This is over 4 percentage points higher than the national average. The last time Massachusetts experienced a labor force participation rate this high was in November 2003. This suggests labor markets are tighter here than elsewhere in the country.

At the same time, however, the unemployment rate for workers under 25 years of age remains high, hovering around 6 percent. The rate for individuals with less than a high school diploma is just under 8 percent, and both groups experienced a troubling uptick in their rate of unemployment during 2019. As our overall labor reserves are dwindling, skills mismatches represent a significant obstacle to employment for young workers and those with limited formal education and training. These conditions represent a clear impediment to state growth and economic opportunity for younger and less well-educated workers.

The most recent population estimates for Massachusetts document very slow population growth indicating that labor supply is likely to be a problem for years to come. While the state has long relied on a growing immigrant population as a key driver of labor force growth, the most recent population estimates reveal a sharp slowdown in net international immigration into Massachusetts.

Global and political developments since our December meeting reinforce the Board's conviction that "uncertainty" will continue to be the watchword during 2020. The New Year started with a sharp escalation of tensions between the U.S. and Iran. On the domestic front, ongoing impeachment proceedings and the campaign for President are moving into high gear. Internationally, the world economy appears to be slowing and the International Monetary Fund recently downgraded its global outlook for the coming year. Ongoing geopolitical tensions in Eastern Europe and East Asia, as well as the emerging coronavirus epidemic in China, inject additional uncertainty into our assessment of the near-term outlook for the Commonwealth.

These developments, along with our recent history, remind us of the limitations of relying exclusively on economic forecasts for insight into the trajectory for the state economy in the coming year. While the most recent economic data are cause for some optimism, in light of the many downside risks that are beyond the control of state leaders, our optimism remains of the cautious variety.

Prepared by Senior Managing Editor Mark Melnik
February 4, 2020



THE STATE OF THE STATE ECONOMY
ECONOMIC CURRENTS



Is Massachusetts' Economy Losing Its Steam?

ROBERT NAKOSTEEN AND BRANNER STEWART

A slowdown is underway, highlighted by the latest *MassBenchmarks* Current Economic Index, which slowed appreciably starting in the second quarter of 2019. Departing from a long-standing pattern, the state has recently experienced slower GSP growth than the nation. Massachusetts, in fact, may have hit a binding constraint of slower labor force growth. With that said, the state's prosperity continues to rely on a critical supply of highly educated workers. That supply, in fact, is not entirely supported by the state's own labor market. It also depends on workers commuting from other states.

INTRODUCTION

Is the long economic expansion nearing an end? A slowdown is underway, highlighted by the latest *MassBenchmarks* Current Economic Index release, which reported only modest growth in gross state product (GSP) for last year's fourth quarter. The state's slow labor force growth seems finally to be binding on economic growth. On the other hand, the state economy remains vibrant by many measures, in spite of an ongoing national economic slowdown. We should, of course, interpret any one period's economic report with caution, as we await additional data to determine if a new trend has been established.

The question on the minds of many is whether the long economic expansion is nearing an end. While the numbers are still positive—GSP, employment, and unemployment are all still headed in the right direction—a slowdown seems underway. The slowdown at the national level is of utmost importance to the Bay State's economy; the slowdown in Massachusetts is even more prominent.

At the national level, there are concerns along a number of dimensions. The trade war with China as well as other ongoing trade disputes put complex supply chains in jeopardy and generate uncertainty. An inverted yield curve, where short-term interest rates are higher than long-term rates, has accompanied every postwar recession, and reemerged in the second quarter. Both business and consumer confidence are down. Manufacturing activity, a bellwether for the economy, is slowing appreciably. The Federal Open Market Committee of the Federal Reserve System is in the process of lowering its short-term interest rate target, a sure sign of concern for the economic expansion.

In Massachusetts, a long-standing pattern of gross state product growth matching national growth has, at least for now, come to an end. The state has recently experienced slower growth than the nation. Employment growth has stalled and the labor force constraint may have become binding. House prices continue to climb, making it ever more difficult for young workers to establish themselves in the state.

STATE OF THE ECONOMY

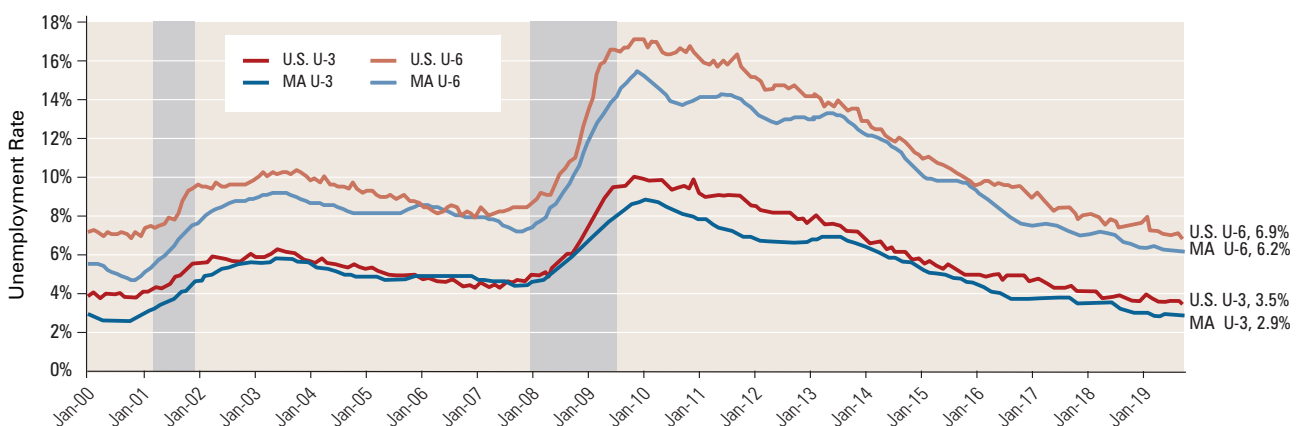
Gross state product is the most comprehensive measure of the status of the economy. While GSP continues to grow, for the last year and a half Massachusetts growth no longer reliably exceeds national growth, a break with the previous consistent pattern between Massachusetts and the nation.

MassBenchmarks estimates rapidly decelerating levels of Massachusetts state GSP growth starting in the second quarter of 2019. Little growth is projected for the next six months.

State payroll employment growth is still positive and workforce conditions continue to improve, though there has been a marked deceleration of job growth more recently. In the third quarter of this year, payroll employment in Massachusetts grew at a 0.6 percent annual rate versus 1.2 percent for the U.S. Since the third quarter of last year, the number of jobs expanded by 1 percent in Massachusetts versus 1.4 percent in the U.S.

By industry, Education and Health Services experienced the largest gain in employment during the September-to-September interval, adding 18,400 jobs, an increase of 2.3 percent. The Professional and Business Services sector, Public Administration, and the Information sector followed with employment increases.

**Figure 1. U-3 and U-6 Unemployment Rates, Massachusetts and the United States
January 2000 – September 2019**



Source: Massachusetts and United States U-3 from the Massachusetts Executive Office of Labor and Workforce Development (EOLWD), Local Area Unemployment (LAU) Statistics, Massachusetts and United States U-6 rates from the U.S. Bureau of Labor Statistics, Current Population Survey (CPS) and Alan Clayton-Matthews. Shaded areas indicate periods of recession.

Both Manufacturing and Construction, among others, lost jobs.

At the state level, both unemployment and under-employment continue to decline (Figure 1). The story for cities remains one of labor market improvement (Figure 2). In September, Boston had the lowest unemployment rate at 2.8 percent. Springfield continues to have the highest rate among the state’s major cities at 5.8 percent. This is a tight band of unemployment rates from lowest to highest, reflecting the State’s ever-tightening labor market. Massachusetts has reached the point that the labor force constraint has become binding on the state’s further economic expansion. As Professor Alan Clayton-Matthews wrote in a recent *MassBenchmarks* Index report:¹

The Massachusetts economy is at full employment with little capacity for labor force and employment growth. The demographic constraints of an aging population are increasingly slowing the state’s growth potential. This can be seen in the consistent deceleration in employment growth over the last several years. State payroll employment between 2012 and 2016 grew between 1.7 percent and 2 percent each year. Employment growth slowed to 1.3 percent in 2017 and 0.9 percent in 2018.

The state may be reaching the upper limit on economic growth associated with the growth in workforce employment. Growth in GDP and GSP is the combined effect of growth in employment and growth in labor productivity, so “running out of workers” does not mean the end of economic growth. However, given the long-term

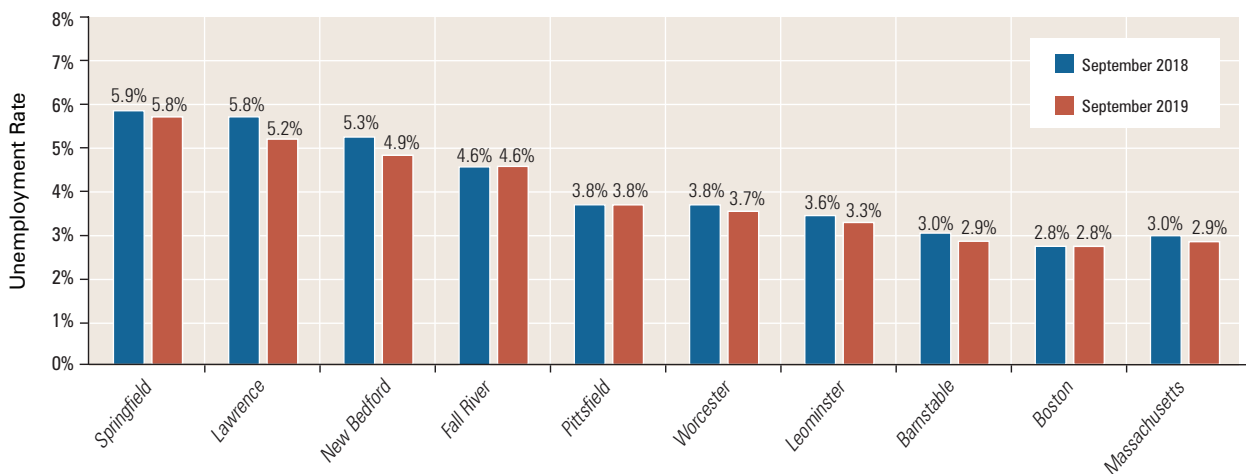
slowdown in productivity growth, achieving rapid secular (rather than cyclical) economic expansion may no longer be possible.

THE ROLE OF COMMUTING IN THE STATE’S LABOR FORCE GROWTH

Given these developments in the labor market, an open question on the minds of many is, “Where are the workers coming from?” New workers can enter the labor force in a limited number of ways, including raising the labor force participation rate, the migration of workers from other states and countries, and positive demographics (namely more young people entering the labor force than older people leaving). Another way for Massachusetts to increase its labor pool is the rise in people working in Massachusetts but living out of state, including commuters from New Hampshire and Rhode Island. The changes among out-of-state individuals working in Massachusetts will be looked at in two ways: first, analyzing growth of the non-resident workforce using the U.S. Census Bureau’s Longitudinal Employer-Household Dynamics (LEHD) program; second, analyzing traffic flow data from border states to Massachusetts in recent years.

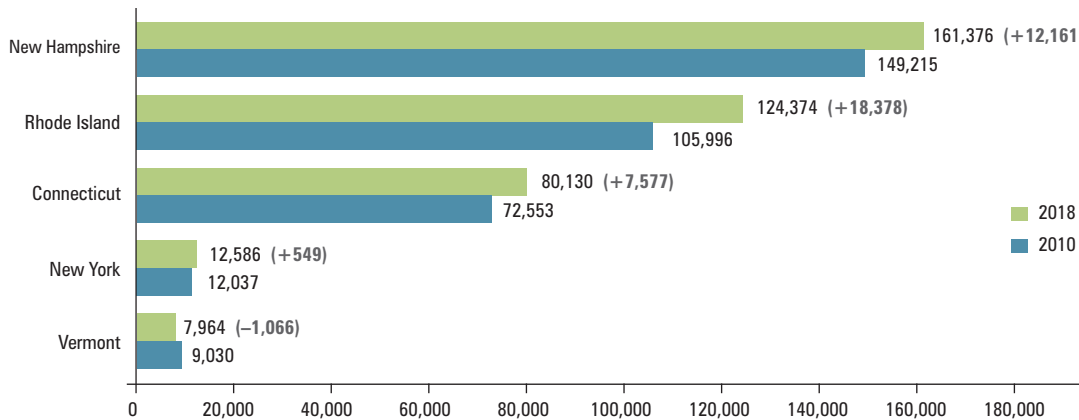
The LEHD program is a new initiative of the U.S. Census Bureau that combines multiple administrative records (e.g., Unemployment Insurance, Quarterly Census of Employment and Wages, the Internal Revenue Service, U.S. Postal Service, and others) to discern where people live and where they work. For Massachusetts, these data indicate that a substantial number of people, nearly 281,000, lived in other states in 2017 while working in Massachusetts. The overwhelming majority of these people live in the closest bordering states, primarily New Hampshire and Rhode Island. That indicates that

Figure 2. Unemployment Rates by City, September 2018 and September 2019
Not seasonally adjusted



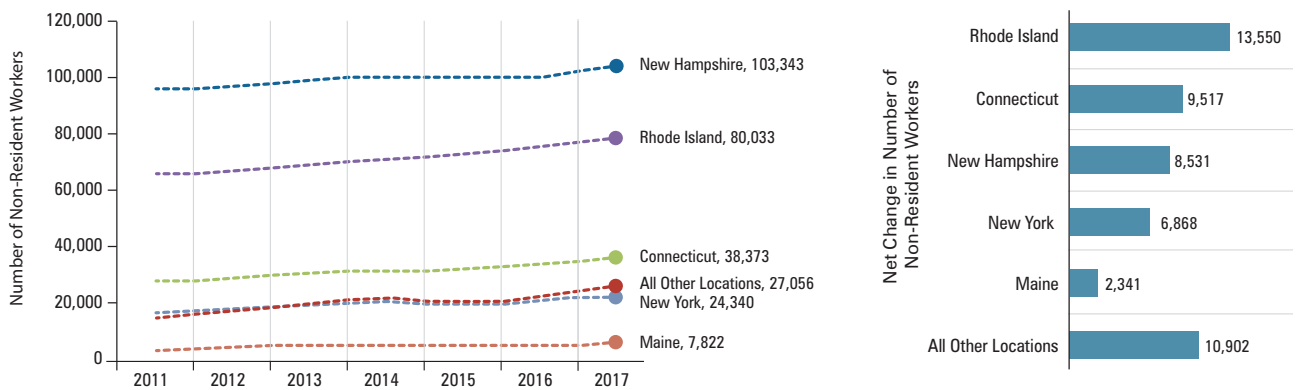
Source: Massachusetts Office of Labor and Workforce Development (EOLWD), Local Area Unemployment Statistics (LAU)

Figure 3. Inbound Daily Traffic Counts to Massachusetts, Major Highways, 2010 – 2018
Annual Average Daily Traffic (AADT)



Source: Massachusetts Department of Transportation Traffic Count Locations

Figure 4. Out-of-State Residents with Jobs in Massachusetts, 2011 – 2017



Source: LEHD OnTheMap, calculations by authors. Includes telecommuters. The category "All Other Locations" is an aggregate of all other states, with New Jersey, Vermont and Pennsylvania as the top three contributors.

they likely work physically in Massachusetts and commute by either personal vehicle or rail. More remarkably, over 27,000 people live beyond the border states and work in Massachusetts firms. This group is more likely to comprise remote workers as they live beyond reasonable commuting distances. The number of individuals living out of state but working for a Massachusetts establishment increased substantially in recent years by nearly 52,000 workers between 2011 and 2017. The largest increase come from Rhode Island. This upward trend in out-of-state individuals working at Massachusetts firms demonstrates that the state's job growth has benefitted from labor from beyond the state's borders during the current economic expansion.

While not as precise as the U.S. Census Bureau's LEHD series in measuring the flow of workers into Massachusetts, a proxy indicator is the daily traffic flow

coming in from bordering states. Available from the Massachusetts Department of Transportation (MassDOT), traffic flow data show that about 386,000 inbound vehicles, representing all trip types, enter Massachusetts every day from neighboring states. Contributing to the congestion levels in Massachusetts, traffic volumes coming in from adjoining states have increased by 11 percent since 2010. Although a very distinct data series, growth in traffic volume from Rhode Island, as seen in the MassDOT data, is remarkably similar to changes seen in worker flows shown in the Census Bureau's LEHD data, growing 17 percent and 20 percent respectively. (Time periods differ slightly.) Either way, it is clear that recent job growth in Massachusetts is not entirely supported by the state's own labor market, depending on workers coming in from other states.

MERCHANDISE EXPORTS

In 2018, Massachusetts exported just over \$27 billion worth of merchandise. While this is less than five percent of the state’s gross state product, trade data attract significant attention. Perhaps this is because some of the sectors doing the exporting are bellwether industries for the state’s high technology economy. Out of the \$27 billion in total exports, computer and electronic products accounted for \$7.67 billion, just over 28 percent of the total (Table 1). Other sectors, such as machinery, are producing high-technology products. Machinery, for example, includes products used in the manufacture of wafer processing equipment, as well as semiconductor assembly and packaging equipment, and other aspects of

semiconductor manufacturing. Machinery accounts for just over \$4 billion of exports annually. Total exports in the state have remained stable within the band of \$26 billion to \$30 billion. If anything, there has been a mild downward trend in total exports starting in 2014.

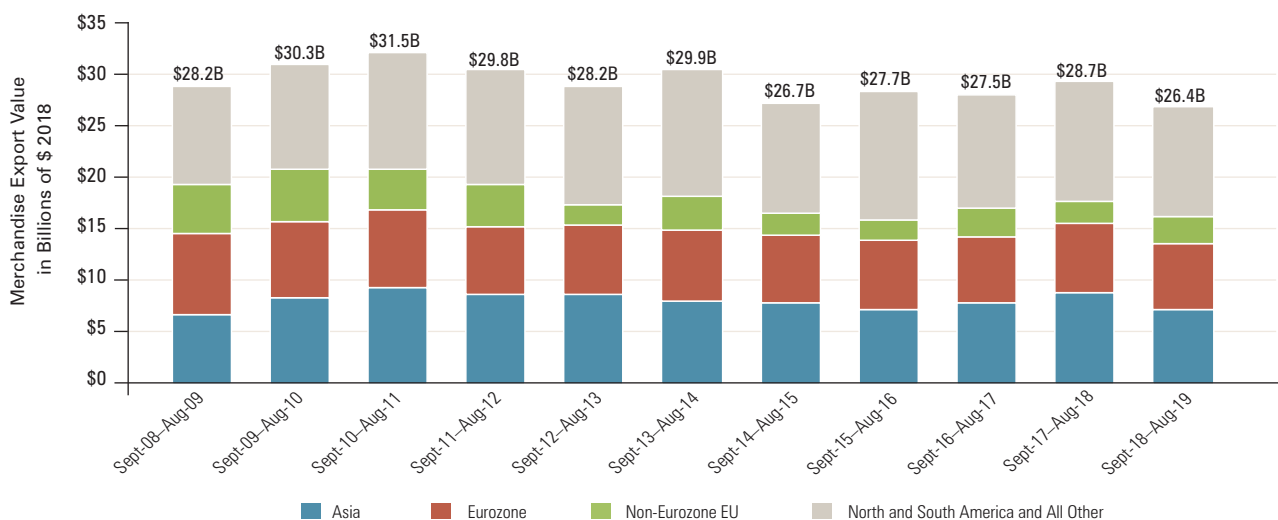
By broad international region, the largest proportion of Massachusetts exports go to North American countries (Figure 5). The state’s most important individual trade partner has long been Canada, with China, Mexico, Germany, and the United Kingdom rounding out the top five export recipients. These five countries account for 43.7 percent of all state exports. Trade partners that rely on exports (China, Germany) are experiencing economic slowdowns as global exports slow.

Table 1. Top Merchandise Exports by Industry, Massachusetts, 2018

Rank	Major Industry Group	2018
1	Computer and Electronic Products	\$7,670,229,803
2	Machinery, Except Electrical	\$4,108,965,658
3	Chemicals	\$3,106,036,782
4	Miscellaneous Manufactured Commodities	\$3,077,091,509
5	Primary Metal Manufacturing	\$1,935,069,781
6	Electrical Equipment, Appliances, and Components	\$1,519,765,403
7	Transportation Equipment	\$980,042,532
8	Plastics and Rubber Products	\$821,108,409
9	Waste and Scrap	\$740,482,579
10	Fabricated Metal Products, not elsewhere specified	\$604,280,949
	All Other Exports	\$2,594,903,376
	Total Exports	\$27,157,976,781

Source: WISERTrade State NAICS Database; Data from U.S. Census Bureau Foreign Trade Division. The State Exports by NAICS data series does not contain imputations for missing states and industries.

**Figure 5. Massachusetts Merchandise Exports by Partner Region
September 2008 – August 2019**



Source: WISERTrade State HS Database; Data from U.S. Census Bureau Foreign, Trade Division. Dollars have been adjusted for inflation (\$2018). Calculations by the authors.

HOUSING CONSTRUCTION

New housing construction appears to have plateaued. Following the strong bounceback from the Great Recession of 2008-2009, the number of housing permits issued has remained relatively stable since 2015. There is certainly a pressing need for more housing supply in the eastern part of the state, and the slowdown in permits may reflect local resistance to new building. The plateau in permitting may also be part of a larger slowdown in the state, national, and global economies.

Note that the pattern of more multi-family units versus single-family units is continuing. First noticeable in 2013, when the housing construction recovery was still underway, the trend reverses a long-standing pattern of more single-family permits being issued.

CONCLUSION

Much of the global economy is now in recession, especially countries that depend on exports. The nation’s economy is experiencing a slowdown in growth, which is projected to continue. In Massachusetts, the GSP

numbers are weakening, but it is too early to draw conclusions about a possible downturn. We will all be monitoring the situation closely. ◀

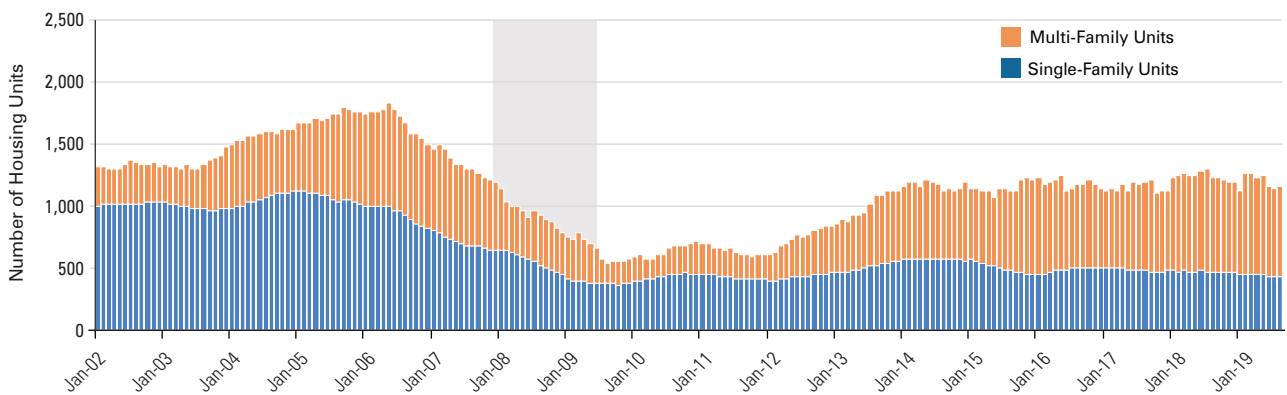
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Endnote

1.) Clayton-Matthews, Alan. *Massachusetts Current and Leading Economic Indices*, June 2019, MassBenchmarks Project. http://www.donahue.umassp.edu/documents/Index_Jun-2019.pdf

Figure 6. Single-Family and Multi-Family Housing Units Authorized by Building Permit in Massachusetts
January 2002 – August 2019
12-Month Moving Average



Source: U.S. Housing & Urban Development, State of the Cities Data System (SOCDS) Building Permits Database. Calculations by authors. Preliminary data for 2019 are subject to subsequent monthly revisions throughout the remainder of the year.



Revisiting the Regional Economic Geography of Massachusetts

New Data Sets and Methods Yield Improved Delineation of Regions

ELISE RAPOZA

Regions are geographic areas demarcated to support analysis, planning, and public policy. Until recently, the analytical techniques available to define regional boundaries were very limited. We now have data at greater levels of granularity and the ability to develop computational systems for delineating geographies that better capture regional attributes.

BACKGROUND

Economic geography can enhance our understanding of regions and their boundaries. Generally, regions are understood to be geographic areas demarcated to support analysis, planning, or public policy. That is, regions provide neat groupings of geographically contiguous populations that enable governments, and even organizations in the private and nongovernmental sectors, to better understand common attributes or functional connections in contained geographic areas. The cities and towns of Massachusetts are divided up in many different ways, for different purposes—for regional planning, regional economic development, workforce development, tourism, and policy analysis. Regional boundaries also vary in the ways in which they're defined. These sometimes included a formal process, but were often developed as a consequence of regional identity, historical linkages, or—at worst—political convenience. One example of a formal process for regional delineation is the New England City and Town Areas (NECTAs), based on commuting data. Economic development areas, on the other hand, have tended to arise independently, with the regional territory decided in conversation with local cities and towns.

Until recently, the analytical techniques available to support regional delineation were very limited. Before computers were widely available and advanced computational techniques were developed, the analytical basis for joining cities and towns had to be based on a simple heuristic that was easy to calculate. Furthermore, the data sets that we have access to are continuously expanding and improving. We now have more data at greater levels of granularity, as well as the ability to develop systems for delineating geographies that do a better job of capturing the full complexity of human geography. Presented here is one way to start thinking differently about how we define the regions of the state, summarizing the work detailed in the working paper, *The Economic Geography of SouthCoastal New England*, prepared at the Public Policy Center (PPC) at UMass Dartmouth.¹

COMMUTING ZONES: METHODOLOGY

Our development of an improved regional delineation method was motivated by the need to understand Massachusetts' economic regions. While there is no universal approach to defining economic regions, most definitions rely on analyses of commuting data, and thus incorporate the geographic boundaries of the local labor markets. This analysis is consistent with other approaches since it takes commuting as the foundational element of the grouping process.

Until recently, commuting data for Massachusetts were publicly available only at the county level. The use of city and town data is preferable since counties are quite

large in most parts of the state and because government in New England is organized at the local level more so than at the county level. In 2010, Massachusetts joined the Local Employment Dynamics Partnership, and later began making data available to the U.S. Census Bureau's Longitudinal Employer-Household Dynamics (LEHD) program, which publishes the Origin-Destination Employment Statistics (LODES) dataset. The LEHD program matches employment data collected from unemployment insurance filings with survey data and other administrative records collected through the Statistical Administrative Records System (StARS) database. This allows the Census Bureau to match residential addresses to work addresses on an individual basis. The data are then anonymized and noise is added to protect confidentiality. This analysis was undertaken when LODES data for Massachusetts were first published, so 2014 data are used.

Many key decisions were made on how best to group cities and towns into commuting zones—also sometimes referred to as labor market areas. Most labor market areas that analysts work with on a daily basis can be defined as nodal (i.e., core-based). Nodal regions are built by starting with a major center, which is then connected to other smaller communities. Depending on the degree of interdependence, nodal regions may have multiple nodes. For example, the Greater Boston labor market area includes the city of Boston, as well as surrounding economic centers along the route 128/95 corridor, many of which are economically tied to industry based in Boston, as well as their surrounding suburbs. In the U.S., metropolitan statistical areas (MSAs), as defined by the Office of Management and Budget (OMB) and the Bureau of Economic Analysis's Economic Areas, are both core-based. The only exception is the Department of Agriculture's (USDA) Commuting Zones, which takes a non-core-based, non-metropolitan approach to allow for a unique identity for the country's more rural areas. Believing that different types of areas (e.g. rural vs. non-rural) require different economic strategies, and finding that the core-based approach often produces regions too large for many practical purposes, the commuting zones and economic regions defined in this analysis are non-core-based.

Consistent with the USDA's approach, an agglomerative hierarchical clustering approach was used to combine cities and towns into commuting zones. Agglomerative clustering is a bottom-up approach, in which each city and town starts off as its own cluster. During each iteration of the algorithm, clusters merge with the cluster with which they have the strongest commuting relationships. However, this analysis deviates from the USDA's approach in a couple of ways. First, it incorporates both a different measure of commuting interchange

to determine which cities and towns are most highly connected; and second, a custom algorithm was developed to improve on existing clustering techniques.

Methodologies used by the federal government employ two different measurements of commuting interchange: the proportional flow measure used by the USDA and the employment interchange measure (EIM) used by the OMB. Conceptually, the EIM measure appears to be superior to the proportional flow measure, since unlike proportional flow, it includes both the number of residents and the number of jobs in the smaller community, thereby limiting the confounding influence of bedroom communities on the data. Both measures were tested and the EIM resulted in more coherent regions. Given these results and the better conceptual match, the EIM was selected as the better approach for measuring the strength of commuting relationships between regions.

In the jargon of cluster analysis, the EIM is a measure of the “distance” or “similarity” between clusters. The most common clustering algorithms use pairwise comparisons between individual cluster members. So, for example, the distance between clusters might be determined by the pair of towns, one from each cluster, that have the weakest or the strongest commuting linkage.

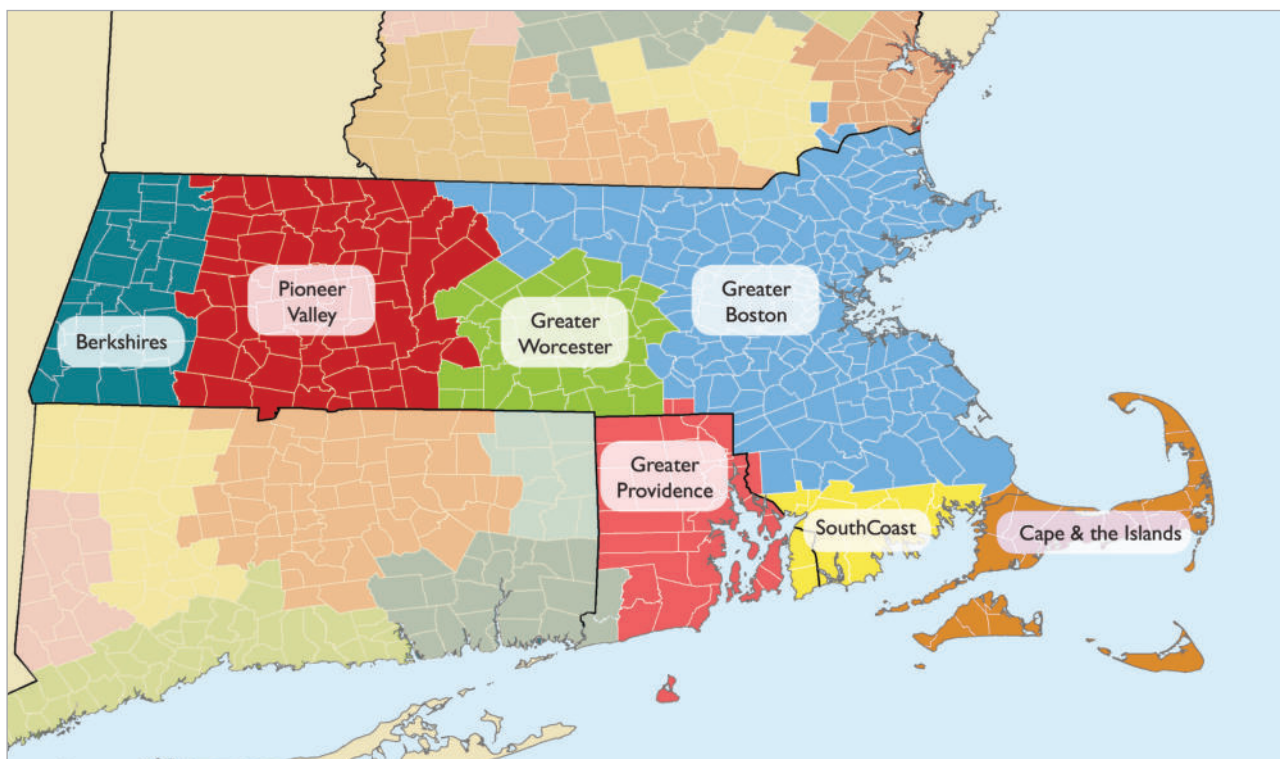
Another common option is to look at the average distance, but this is not possible for relational data like the EIM. The custom algorithm used for this analysis improves on these methods by aggregating the data up to the cluster level during each iteration. This enabled assessments of the relationship between clusters, rather than between cluster members. In addition to being arguably more valid, this approach has the added benefit of smoothing out the effect of outliers. Additional information about the grouping process can be found in the PPC Working Paper, *The Economic Geography of South-Coastal New England*.

COMMUTING ZONES: RESULTS

Using the custom algorithm, it was determined that Massachusetts’ cities and towns can be divided into six commuting zones: the Berkshires, the Pioneer Valley, Greater Worcester, Greater Boston, the SouthCoast, and Cape Cod & the Islands. Our results provide insight on the geographic dynamics of commuting in the region. Interestingly, these zones mostly follow state lines. The exceptions include Plaistow, Newton, and Danville, New Hampshire, which are grouped with Greater Boston; Millville, Blackstone, and Seekonk, Massachusetts, which

Figure 1. Commuting Zones In and Around Massachusetts

Commuting zones mostly follow state lines and Greater Boston is larger than previously understood.



Source: Author’s analysis

Note: Data for the other neighboring states of New York and Vermont were excluded due to low total flows over those borders. Of all people who work in Massachusetts, 0.7% come from New York and 0.1% come from Vermont. Likewise, of all people who live in Massachusetts, 0.8% commute to New York and 0.1% commute to Vermont. In both cases, a large proportion of the New York commuters are going to or from New York City. The remaining percentage of people commuting to or from Albany or Rensselaer Counties is less than 0.1%.

are grouped with Greater Providence; and Tiverton and Little Compton, Rhode Island, which are grouped with the SouthCoast.

It is somewhat surprising that the Hartford-Springfield region known as the Knowledge Corridor and the Lowell-Lawrence-Nashua-Manchester region known as the Merrimack Valley are not apparent in these commuting zones. There are large cross-border flows of commuters at these locations, but they are counterweighted by internal connections. For example, many more New Hampshire residents than Massachusetts residents cross the northern border, with 19.8 percent of residents of the Manchester-Nashua, New Hampshire MSA commuting into Massachusetts for work. In addition, since the EIM includes commuting flows both into and out of a region, most New Hampshire cities and towns are more highly connected to communities within the same state, with which they share a more mutual relationship. The boundary along the Connecticut border is unusually clean cut. For all the border towns in Hamden County, Massachusetts, the strongest commuting relationship is always with other cities and towns in Massachusetts.

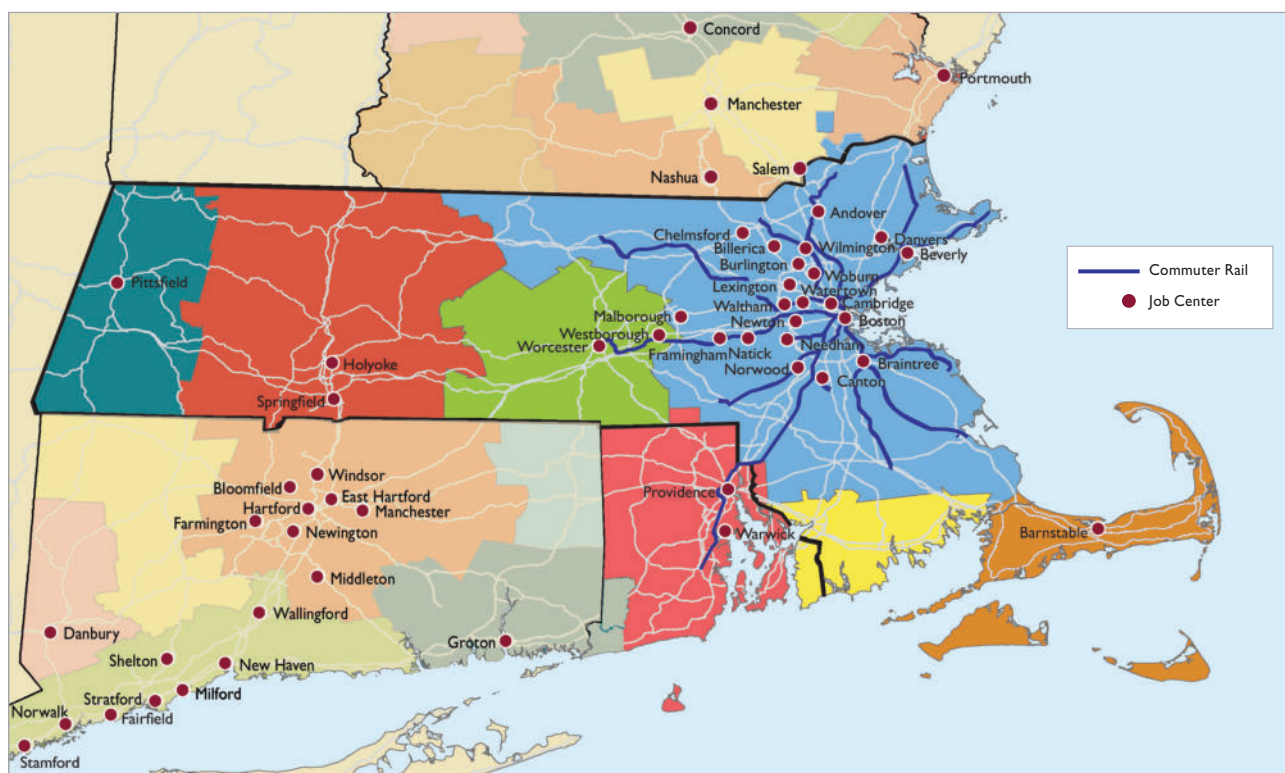
All of the commuting zones contain at least one job center,² with the exception of the SouthCoast. Including job centers and commuter rails on the same map

reveals an important pattern: the majority of the job centers in Massachusetts have commuter rail access to the city of Boston. Critically, the outer boundary of the Greater Boston commuting zone is shaped by the presence of commuter rail service. For example, the towns of Lakeville and Middleborough, which are home to the southernmost commuter rail station in Massachusetts, are at the southern boundary of Greater Boston as defined by the clustering algorithm. Nearly eleven percent of Lakeville workers (568 out of 5,190) and nearly twelve percent of Middleborough workers (1,285 out of 11,072) commute to the city of Boston for their primary job. Moving just one town further to the south, these numbers are cut in half. Just 4.5 percent of Freetown workers (170 out of 3,820) and 4.7 percent of Rochester workers (111 out of 2,372) commute to the city of Boston for their primary job.

FUNCTIONAL ECONOMIC REGIONS

A second phase of analysis incorporated additional economic factors to refine the economic regions. For regional economic planning—the motivation driving our analysis presented here—functional economic regions (FERs) are the most informative. FERs are connected by economic linkages, such as labor markets or industry supply chains,

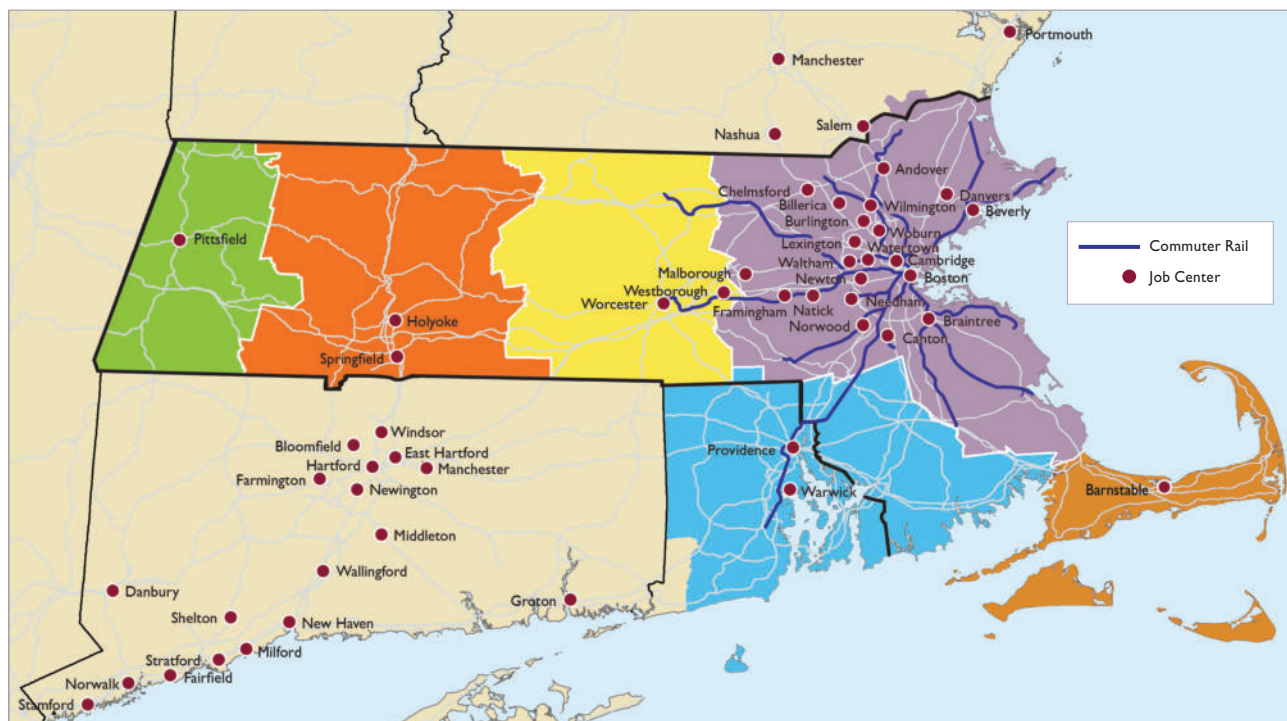
Figure 2. Commuting Zones with Job Centers and Transportation Networks
The majority of job centers in Massachusetts have commuter rail access to the city of Boston.



Source: Author's analysis

Figure 3. Massachusetts' Functional Economic Regions with Job Centers and Transportation Networks

Economic and cultural patterns further refine the economic geographies of the state.



Source: Author's analysis

Note: The ArcGIS Grouping Analysis Tool was used to group cities and towns based on commuting zones, media markets, and industrial composition. Given the number of groups to create, this software looks for a solution that minimizes the differences between cities and towns within a group and maximizes the differences between groups. A contiguity constraint guaranteed that only adjacent cities and towns were joined in a group (adjustments for islands were made after the fact). A Pseudo F-statistic was calculated in order to determine the optimal number of groups. We chose the number of groups with the largest F-statistic without producing groups of very small size (three or fewer communities).

and are defined using the best available data on economic conditions and relationships. In contrast, administrative regions, are delineated for policy purposes and are often simply the product of historical accident, though they may show consideration of both the relative degree of homogeneity and functional economic linkages.

The first stage of creating FERs was the determination of commuting zones, using the improved methodology described here. Most empirical regional definitions only go this far. Our method expands on existing methodologies in the second stage, by also incorporating industrial agglomeration, as measured by industry cluster location quotients, as well as cultural identity, as measured by media market areas (DMAs). The presence of similar industries in neighboring cities or towns is evidence that they share economic connections between businesses through supply chain interactions or other ties. DMAs were added as an indicator of the major city the people in an area identify with for local news and entertainment.


The ArcGIS Grouping Analysis Tool was used to group cities and towns based on commuting zones,

media markets, and industrial composition. The results suggest that Massachusetts comprises six FERs: the Berkshires, the Pioneer Valley, Central Massachusetts, Greater Boston, Cape Cod & the Islands, and a cross-border region composed of southeastern Massachusetts and most of Rhode Island, which is referred to here as SouthCoastal New England. Every FER contains at least one job center, which adds to the validity of the regions. Greater Boston contains the greatest number of job centers by far, with 21 out of the 29 job centers in Massachusetts FERs. The SouthCoastal New England region is home to two job centers: Providence and Warwick, Rhode Island, making it Massachusetts' only economic region where no Massachusetts cities are job centers.³ The lack of accessible rail service into the economically dynamic Greater Boston region may help to explain the comparatively low economic performance on the Massachusetts side of this region. Similar to the commuting zones, commuter rail access to the Greater Boston area is coterminous with the eastern boundary of the SouthCoastal New England region.

CONCLUSION

In many ways these economic regions look similar to the traditional regions described by analysts of the Massachusetts economy, but there are some notable differences. For example, Greater Boston is much larger than it is often defined to be (although smaller than defined by federal agencies' labor market and metropolitan regions), which reflects the large volume of commuters travelling throughout the Greater Boston region.

This analysis also has implications for state planning, such as how we define the service territories for transportation and workforce planning.

This analysis does not preclude subregional identities, such as the North Shore. For example, this analysis includes all traded industries in which Massachusetts specializes, but the map may look different for specific sectors of the economy. Ultimately, this analysis is meant to demonstrate that we can think more empirically about how we divide up the state. Other groups can improve or augment these methods or customize them for specific purposes. This analysis also has implications for state planning, such as how we define the service territories for transportation and workforce planning. Given that economic conditions change over time, and given advancements in our ability to make sense of that change, it may be time to revisit some of these service areas. It is also interesting that one of the economic regions, referred to here as SouthCoastal New England, crosses state borders. This underscores the need to think differently about our regions and collaborate in ways that transcend administrative boundaries. 

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Endnotes

1.) Elise Rapoza and Michael Goodman et al. (2019) *The Economic Geography of SouthCoastal New England*. The Public Policy Center at UMass Dartmouth. <http://publicpolicycenter.org/wp/wp-content/uploads/2019/08/TheEconomicGeographySCNE.pdf>

2.) Defined as being in the top 10 percent of communities by population and being the location of more jobs than employed residents (they must import labor to meet demand).

3.) Other cities in the region meet the size threshold, but must export labor and are therefore not considered to be job centers. In other words, they are home to fewer jobs than employed residents.



The Future of Work and the Reskilling Revolution: What Role Will Higher Education Play?

SCOTT LATHAM

Industry leaders anticipate a rapidly emerging mismatch between the skills that workers currently have and the skills that they will need to thrive with disruptive technologies including robotics, blockchain, artificial intelligence, and other transformational factors. In this future, education itself must become increasingly adaptive. It must take the lead in preparing students—tomorrow’s workers—with competencies that allow them to integrate new technologies into their day-to-day jobs. These include competencies with digitalization, data, and interfaces—the latter which entail working firsthand with AI and robots. In addition, higher education must consider credentials that serve the needs of non-traditional students across their professional life span.

INTRODUCTION

Industry workforce needs are rapidly evolving as the future of work unfolds. That future portends that disruptive technologies, such as robotics, blockchain, and artificial intelligence (AI) will alter the structure and nature of work in unprecedented ways. In the next two decades, the economy will witness wide-scale labor displacement across industry sectors from retail to healthcare, from biotech to financial services. No sector will be untouched by this next industrial revolution.

Industry leaders anticipate a rapidly emerging mismatch between the skills that workers currently have and the skills that will be necessary to tackle this new world of work. In response to the pending crisis, policymakers, business leaders, and economists are calling for a ‘reskilling revolution’ to help individuals adapt to the future of work.¹ While some large organizations, such as Amazon and IBM, are attempting to meet the call internally, higher education’s role in the reskilling revolution is uncertain.

Historically, higher education has played a key role in helping individuals adapt to industrial and technological revolutions. The Morrill Act supported land grant colleges in the 1800s that subsequently fueled agricultural and engineering education. And after World War II, the GI Bill sent a generation of workers to trade schools and universities. Both of these initiatives fueled

unprecedented innovation and economic growth. However, it is unclear whether higher education can meet the needs of the 21st century workforce. Colleges and universities must begin thinking about new, potentially disruptive models that address evolving workforce needs.

DEFINING THE FUTURE OF WORK AND ITS IMPACT

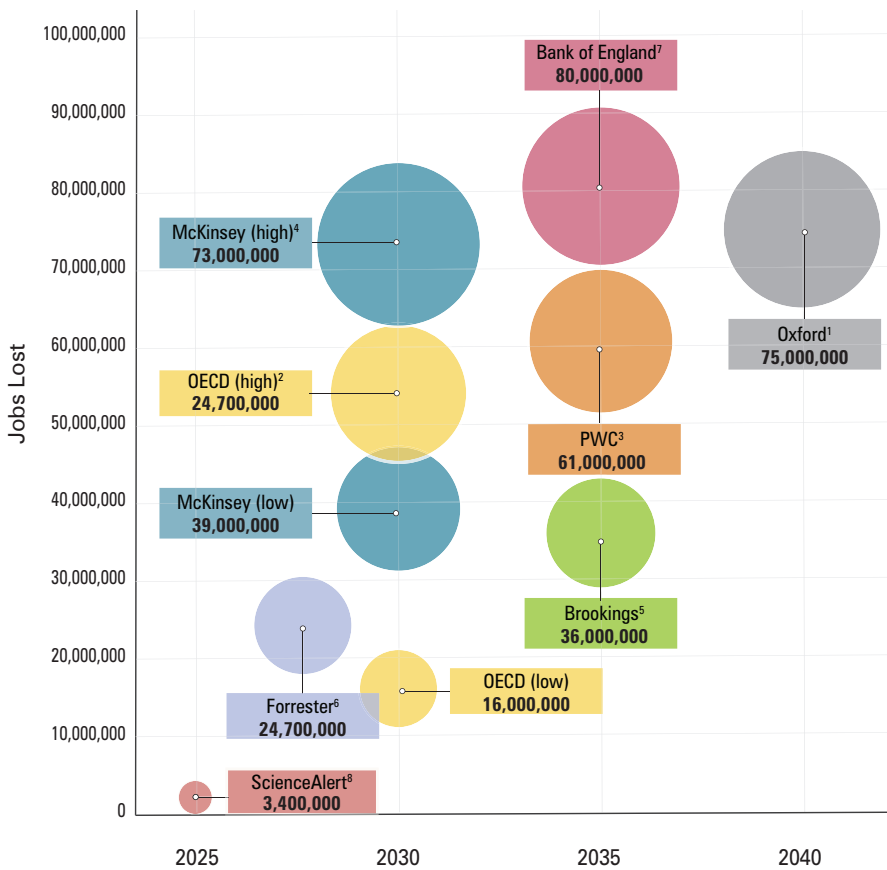
As Figure 1 details, this is not the first ‘future of work’ disruption. Historically, we have seen several other large-scale technological disruptions that have changed the structure and nature of work. Analysts have coined the current disruption Industry 4.0 or the new industrial revolution.²

In the context of such disruption, economists wrestle with the ‘job ledger’—an accounting of whether or not more jobs will be created than destroyed. Past disruptions have created more jobs than have been destroyed—a dynamic referred to as creative destruction. However, in the current disruption, economists are skeptical that such a dynamic will hold. Given the nature of the new technologies, which are likely to replace human workers as opposed to simply augmenting their efforts, the expectation is that Industry 4.0 may destroy more jobs than it creates. Think tanks, universities, and consultancies have offered job loss projections that capture the extent of the potential destruction in the future of work (Figure 2).

Figure 1. Timeline of Future of Work Disruptions
Including Industry 4.0



Figure 2. U.S. Jobs Predicted to be Lost to Automation



Notes

1. Oxford Study: Based on .47 at risk displacement rate applied to 160 Million U.S. Workforce
2. OECD: High risk of displacement (10%); Significant Risk of displacement (40%)
3. PWC: 38% * 160,000 = 61,000,000
4. McKinsey: 39 million at midpoint adoption; 73 million by rapid adoption
5. Brookings: 25% or 36 million jobs. High risk of automation
6. Forrester: 17% loss by 2026, offset by 10% growth of automation economy
7. Bank of England: Classifies probability of automation for various jobs: high (66% or more), medium (33-66%) or low (less than 33%) and applies to total occupational employment
8. ScienceAlert: Based on MIT Center for Digital Business study—predicted jump of 1.75 robots per 1,000 human workers to 5.25 robots per 1,000 humans by 2025

Source: Author’s analysis

The predictions are fueling several workforce policy concerns. First, is the sheer magnitude of displacement in the U.S. economy in the next two decades, and the fact that anticipated job losses will not be isolated to certain industry sectors. While displacement is already impacting jobs like retail associates, taxi drivers, and warehouse workers, it is expected to spread soon to jobs in knowledge-intensive industries, such as healthcare information technology, information technology, and the life sciences.³ Displaced workers will need to be reskilled into new jobs, new organizations, and new industries.

Secondly, jobs that are not outright destroyed will be irreversibly altered by technology. Workers fortunate enough to avoid complete displacement by technology will still need to learn to work with these technologies. Recently, an IBM think tank predicted that 120 million people will need training in artificial intelligence and smart automation.⁴

Finally, in addition to concerns specific to job loss and labor transformation, we also need to prepare for jobs that will be created based on these enabling technologies—jobs that we have yet to envision. Analysts predict

that 85 percent of the jobs ten years from now have not yet been created.⁵

Massachusetts will be ground zero in experiencing these impacts. Automation and artificial intelligence are already beginning to alter the processes that are central to the Commonwealth’s industries. (See Table 1.)

Earlier this year, State Street Corporation, in Boston, laid off 1,500 employees, specifically citing automation as a key driver of that cost-cutting measure. Indeed, this is the tip of the iceberg in financial services—a recent report predicted that close to a quarter of a million jobs will be lost in the next decade.⁶ The future of work is here. The worst-case scenario is that disruption will destroy millions of more jobs than it creates; the best-case scenario is that the disruption will create millions of more jobs than it destroys. Regardless, the sheer scale of the change is triggering a reskilling revolution: the recognition that industry, higher education, and government need to formulate a coordinated, multifaceted approach that will help workers adjust and adapt to the future of work.

Table 1. Early Future of Work Impact on Key Commonwealth Industries

Industry	Technology Impact
Healthcare	<ul style="list-style-type: none"> • Various functional areas affected, including artificial intelligence in medical coding and diagnostics • Robotic process automation in patient care working side by side with clinicians
Financial services	<ul style="list-style-type: none"> • Initial investments in artificial intelligence in customer service, portfolio management
IT	<ul style="list-style-type: none"> • Programming, system integration
Hospitality	<ul style="list-style-type: none"> • AI and automation affecting reservations, booking, and housekeeping
Manufacturing	<ul style="list-style-type: none"> • Intelligent automation encroaching at the line level with computer numerical control, as well as design tasks
Biotech/Pharmaceutical	<ul style="list-style-type: none"> • Organizations utilizing AI to accelerate drug discovery
Construction	<ul style="list-style-type: none"> • AI used in design, safety and risk management in projects

Source: Author’s analysis

UNDERSTANDING THE RESKILLING REVOLUTION

The reskilling revolution calls for dramatically different skill sets than those found in the current labor market. But what skills does this entail and how are these skills unique to the future of work? Answering this question is critical to moving forward, especially as we consider the role of higher education. Figure 3 assigns the unique, necessary elements of the reskilling revolution to three areas: technology skills, cognitive skills, and relational skills. As detailed below, this framework focuses specifically on new and *emerging* skills required for success in the future of work.

Technology Skills

In an age of technological disruption, workers will need competencies adapted to the new technologies themselves. However, this is not the same as the software training of the past. The requisite skills here address the ways that disruptive technologies will affect work on the occupational level; in short, workers must develop a set of competencies that allow them to seamlessly integrate technology into their day-to-day jobs.

- **Interface competency**

Interface competency recognizes that every job—large and small—will need to interface, i.e., work with future of work technologies, such as AI, in a symbiotic fashion.⁷ For example, radiologists are increasingly working with AI to improve diagnostic accuracy,⁸ utility workers are deploying drones to work on power grids,⁹ and surgeons are utilizing robots to do surgery across continents.¹⁰ The ability to interface seamlessly with these technologies is central to the future

of work, but more importantly, workers will need to negotiate with these active technologies.

- **Digitalization competency**

Digitalization is the dynamic that every aspect of work has been integrated through technology at the job level, process level, and value system level. Workers must develop a deep understanding of how the cloud, cybersecurity, and pervasive computing are changing the nature of the job. Fifteen years ago, almost 50 percent of full-time entry-level jobs required medium to advanced digitalization skills; today 90 percent of jobs require strong digitalization skills.¹¹ There is no better example than the healthcare industry, where electronic medical records have affected every worker—from clinician, to coder, to medical assistant, to office manager.

- **Data competency**

Recent Wharton research shows a massive skills shortage relative to data fluency,¹² stating that, “Every worker is a ‘data worker’—not just in offices, but in oil fields, hospitals, schools, and more.” Tomorrow’s workforce needs to understand and manage data at every level—from data capture, data cleaning, data integration, and data analytics. Glassdoor recently released its roster of the fastest growing jobs; the overwhelming majority are data-related.¹³

Cognitive Skills

Just as 150 years ago we may have stopped and asked, “How is the railroad going to change commerce?” workers must now consider how this wave of technologies is changing work. Cognitive skills are about just that: developing a big-picture perspective that allows workers

to understand the impact of technology on their organization, industry, and jobs.

• **Systems thinking**

More and more aspects of our life will be connected through technology platforms (e.g., the Internet of Things, autonomous vehicles, automated delivery systems). As organizations demonstrate a much tighter degree of integration, individuals will need to develop skills in systems thinking—an understanding of the way humans, machines, and data interplay.

• **Critical thinking**

Organizations will also require workers to utilize the next wave of technologies to improve processes, develop new competencies, and drive new, value-generating business models. As we enter a new industrial revolution, critical thinking will not be a one-off response when problems arise, but rather a skill for working effectively in the future of work. In fact, it continuously ranks as a skill that employers are looking for during this time of transition.

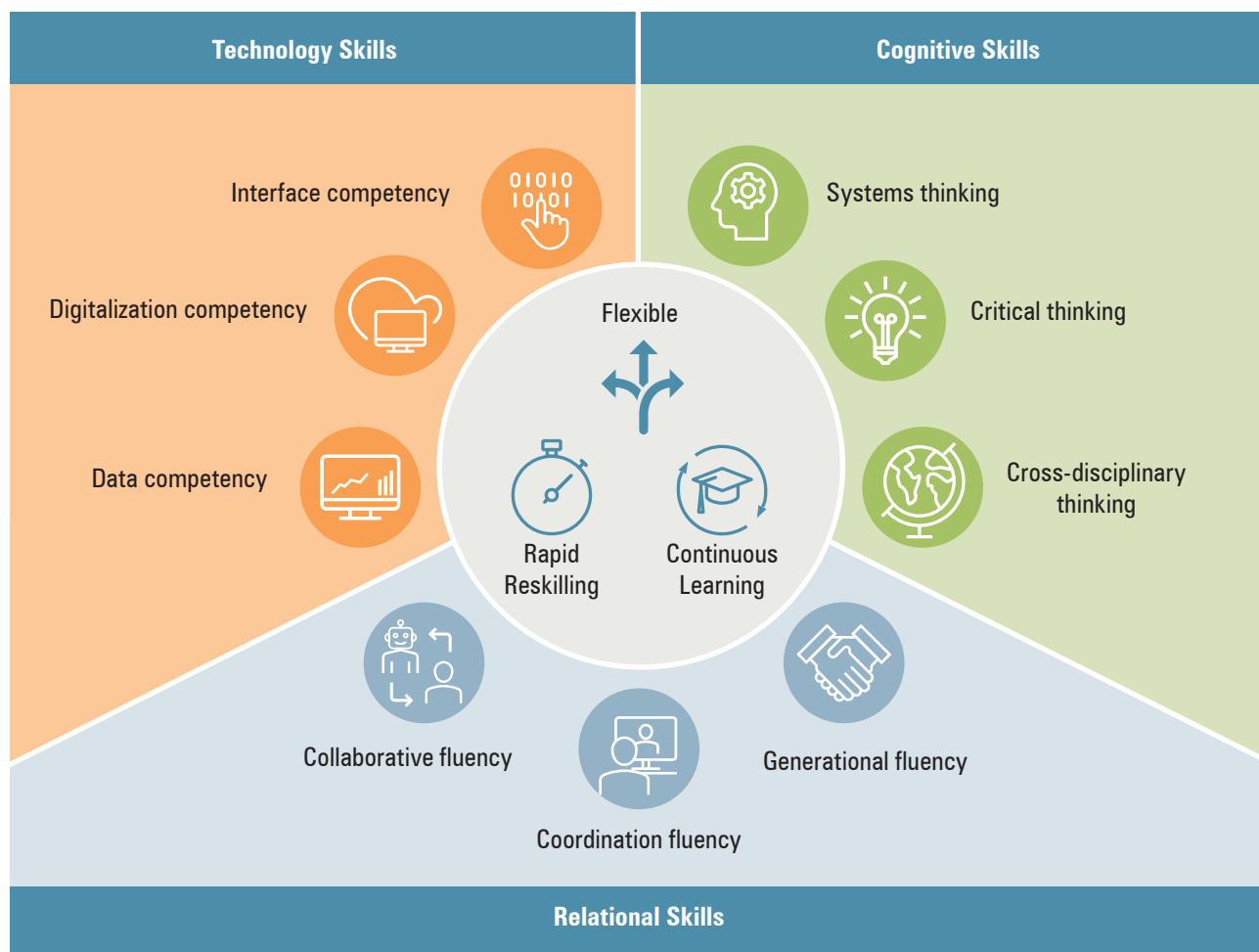
• **Cross-disciplinary thinking**

Organizational boundaries are breaking down between functional areas¹⁴ more than ever before. Cross-disciplinary thinking pertains to the way individuals understand the interplay of pathbreaking work technologies and systems within and across the organization.¹⁵ For example, one of the fastest growing fields is user design and interface. Workers in these roles need expertise in computer science, design, and human behavior—they need to work across silos.

Relational Skills

Inevitably, work technologies will alter key relationships in the workplace. Fifty years ago, early stage telecomm technologies, the PC, and the cubicle altered relationships in the workplace. Today, relationships will be altered by AI, smart automation, blockchain, 5G, and AWS. Understanding and managing those relationships will require new relational skills.

Figure 3. New and Emerging Skills of the Reskilling Revolution



- **Collaborative fluency**

While AI, robots, automation, and other technologies will certainly change jobs themselves, these disruptive technologies will also change the fabric of most organizations. In the very near future, AI and robots will be team members in organizations. Workers will need to develop collaborative fluency to work effectively with an AI team member, to manage AI team members, and, at some point, to potentially work for an AI manager.

- **Coordination fluency**

Traditional structures and flows for managing processes may no longer work so well in the future of work. The last decade has seen the rise of team-based organizing, virtual collaboration, and flatter organizations. Some statistics suggest that less than 25 percent of large organizations exist in a traditional functional structure. Further changes to work will require workers who can adapt to work flow and processes that go well beyond traditional isolated, cubicle-bound work arrangements. Indeed, the gig economy today represents a third of the U.S. workforce and requires a much different type of worker.¹⁶

- **Generational fluency**

With four generations in the workplace—Baby Boomers, GenX, Millennials, and GenZ—today’s workplace requires that workers gain much greater cultural and demographic understanding.¹⁷ The average 20 year-old assimilates technology at work much differently than the average 60 year-old. Not only will working with technology be critical, but we must also understand its conception, integration, and deployment across generations.

How do we get there?

While technology, cognitive, and relational skills are central to the reskilling revolution, we must ask: How do we get there? First, the revolution requires a much faster cycle of knowledge and skill development than in the past—the former often referred to as real time or *rapid reskilling*. Second, industry needs workers to adopt *continuous learning* or lifelong learning.¹⁸ Industry needs workers who don’t view education as a static undertaking, but rather as a dynamic, evolving central part of their professional path. The U.S. Bureau of Labor Statistics predicts that the average college-age student will have 10 jobs by their 40th birthday. That requires consistent evaluation and updating of workforce skills. And finally, industry needs a *flexible workforce*. Increasingly, singular job titles are eroding as job duties change more frequently with the ebb and flow of company needs. Zappos, the online shoe retailer, requires its workers to span

different jobs regardless of title. This is the new reality in the future of work.

HIGHER EDUCATION’S CENTRAL ROLE IN THE RESKILLING REVOLUTION

Given the rapidly evolving skill sets required in the future of work, the larger question is whether or not higher education still adequately prepares people for jobs. It is unreasonable to believe that businesses or individuals can address the larger workforce changes by themselves. Yet, to play its part in the reskilling revolution, higher education must itself undergo much-needed disruption. It needs to bring the bachelor’s degree into the 21st century as well as broaden the scope of its credentials to meet the needs of lifelong learners and non-traditional students. Accordingly, we offer three strategic imperatives:

Ensuring bachelor’s degree credentialing that adequately prepares early-stage careers for the future of work

The bachelor’s degree will continue to be the foundation for lifelong learning. However, as the average graduate leaves college with \$30,000 in debt,¹⁹ colleges and universities must provide the necessary skills to enter the workforce.

- **Improving the pace of completion**

The average completion time for a bachelor’s degree is five years. Consider a computer science major entering college this fall and graduating in 2024, when researchers expect AI to be capable of coding in computer languages like Python. By the time the student graduates, not only will she be competing against humans for jobs, she’ll be going up against a more efficient and cheaper AI bot.

- **Ensuring technical literacy in core disciplines**

No college student should leave an institution without taking a course in artificial intelligence, automation, big data, etc., regardless of their discipline. Technical skills will touch every job, across every organization, every industry. Students don’t need to program an AI bot, but they do need technical literacy that enables them to understand how such technologies will affect work.

- **Committing to more responsive program development**

As the future of work unfolds, the next decade should be a time of exciting and innovative program development on college campuses. Yet, it often takes years for new programs to be approved. If as predicted 85 percent of the next decade’s jobs haven’t been realized, then higher education needs to be more responsive by offering new, innovative programs.

• Adopting flexibility and open path options

In an era of choice, students are still hamstrung in customizing their degrees, as well as pursuing nonlinear paths. For example, the University of New Haven and the Ohio State University offer degrees in eSports, a growing field in information technology and entertainment. Institutions need to make it easier for students to develop tailored degrees, pursue experiential learning outside the classroom, and work across disciplines.

• Practicing big picture thinking

Bachelor’s degrees must incorporate a higher degree of germane cognitive skills, especially critical thinking and systems thinking. Whether it be the humanities, professional schools, or the sciences, young adults must be prepared to answer the big questions associated with the broader societal implications that will accompany rapid changes in technology. The core of critical thinking skills entails bringing wisdom to the machines. Tomorrow’s workers should continuously ask, Why? when it comes to emerging paradigms in the future of work. This is consistent with a recent survey by the Association of American Colleges and Universities, the primary liberal arts advocacy organization.²⁰

None of preceding recommendations poses different agendas between liberal arts and professional schools, regardless of discipline. All students need to prepare for the technological disruption represented by the future of work. For example, artificial intelligence ethicist is an emerging career path.

As institutions alter the bachelor’s degree, they also need to consider the following recommendations:

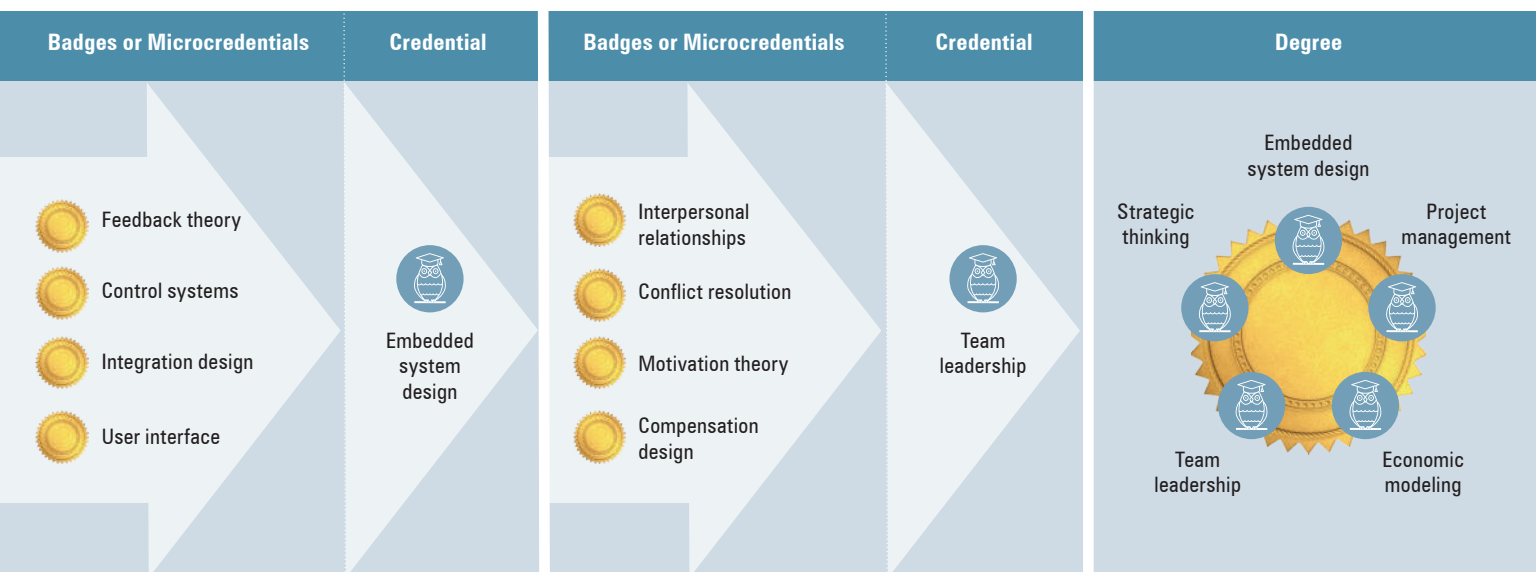
Develop modular, competency-based credentialing as the basis of lifelong learning

Higher education needs to assist individuals with lifelong learning. As currently structured, colleges and universities tend to be career front-loaded in their training: the average undergraduate and graduate degrees are awarded to students in their early 20s and early 30s. While the bachelor’s degree, if properly structured, will continue to get students ‘out of the gate’, the master’s degree as the next and final stop in skill development is antiquated. That is especially relevant when you consider that the average 18 year old may work 60 years.

The notion of a 60-year curriculum is emerging,²¹ based on lifelong, constant learning, which requires updating skills, competencies, and perspectives—not just at two points, i.e., bachelor’s and master’s programs. To deliver lifelong learning based on a 60-year curriculum, colleges and universities are beginning to experiment with modular, competency-based programs. These initiatives entail traditional or shorter courses that offer explicitly detailed skills represented by badges or micro-credentials. These milestones are then bundled, comprising larger competencies. The competencies can then contribute to a larger degree.

Figure 4 offers an example in which students earn badges or microcredentials in specific skills, such as feedback theory, control systems, integration design, and user interfaces. These build to a competency-based credential in embedded system design. Then, over time as

Figure 4. A Modular, Competency-Based Credentialing Model



their career progresses and they are promoted into management, they pursue badges, i.e., skills, toward a recognized competency-based credential in team leadership. Depending on the institution, field, and accreditation, other competencies in project management, economic modeling, and strategic thinking could build towards a larger degree, as depicted in Figure 4.

Boston University, in fact, just launched a new online, competency-based MBA. The program provides the timely, innovative credentialing that will improve employee adaptability and market value later in their careers.

Increase and assess educational options for non-traditional students through certificate pathways

Degree-based credentialing can seem insurmountable to non-traditional students, such as mid- and late-career-displaced workers, veterans, first-generation students, and workers without a college education. As the future of work intensifies, and large-scale displacement occurs, we need options for disaffected workers to return to the workforce.

Certificate pathways based on skills required in specific industries, technologies, or trades offer such an option. Certificates have been shown to address the needs of non-traditional learners. And individuals with

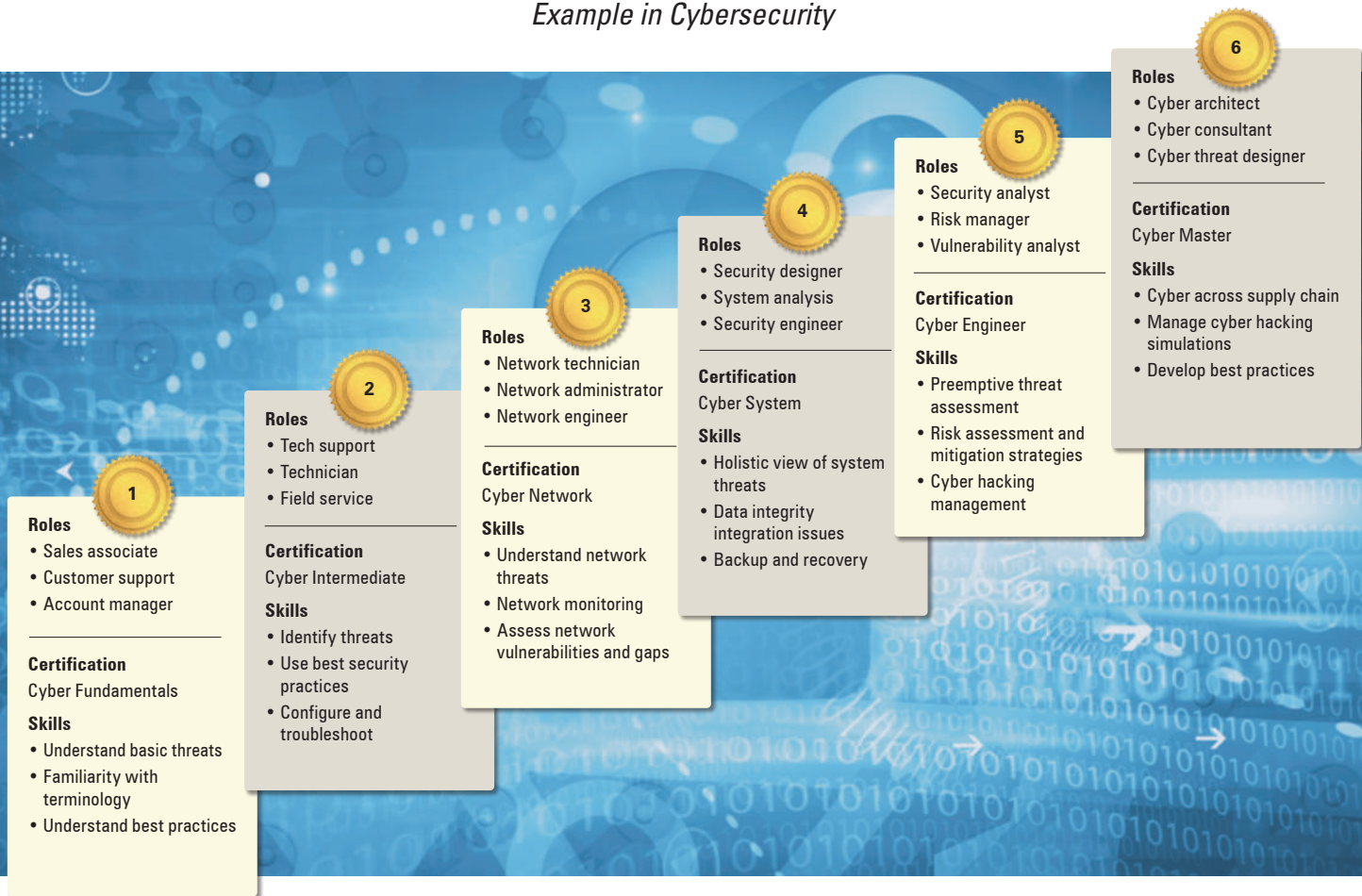
certificates can meet or exceed earnings and mobility compared with their counterparts with partial college degrees.²² Certificates are no longer exclusive to trade schools, community colleges, and adult education. Top tier institutions, such as Harvard and MIT, now offer certificates in cutting-edge topics, such as AI in strategy. And certificate pathways offer rapid reskilling that will prove central to the entire workforce.


Figure 5 offers a mock pathway for cybersecurity; initial skills help secure employment and could be the basis for future skill development.

THE FUTURE OF WORK IS AN OPPORTUNITY FOR HIGHER EDUCATION

Every aspect of our daily lives has changed in the last quarter century. The way we make phone calls, pursue relationships, watch movies, find jobs, buy homes, use automobiles, order food, rent cars, walk pets, socialize with friends, and vacation has been disrupted. Yet, higher education has largely remained immune from such disruption, appearing much the same as it did 100 years ago. Online education, while innovative a decade ago, to a large degree has not changed the nature or structure of higher education—it still revolves around traditional degrees.

Figure 5. A Stackable Certificate Pathway Model
Example in Cybersecurity



While declining enrollments and student debt are fueling a higher education bubble, the largest driver of change will likely be industry's increasing disillusionment that higher education fails to meet industry's evolving workforce needs. Earlier this year, Amazon announced that it was retraining 100,000 workers in STEM disciplines; one of the more telling aspects of its announcement was that it plans to use its own programs to retrain employees, such as Amazon Technical Academy and Machine Learning University. It didn't partner with higher education. Similarly, Google, IBM, Microsoft, and other major companies have also announced reskilling initiatives, either internally or with new, higher-education companies. IBM's planned initiative on 'new collar' jobs focuses on skills, not degrees.²³ Such market signals should be of concern to higher education leaders. If as predicted, the future of work displaces tens of millions of workers over the next decade, higher education should consider alternative structures and innovative approaches that allow individuals to engage in learning at various career stages. Many higher education leaders will view the future of work as a crisis. Given the imperative for massive reskilling, it should be viewed as an opportunity. 

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