2012 | volume 14 issue 1

Mass Benchmarks

A JOURNAL OF THE MASSACHUSETTS ECONOMY

A publication of the University of Massachusetts in cooperation with the Federal Reserve Bank of Boston

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2012 | volume 14 issue 1

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

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

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

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FROM THE PRESIDENT

This issue of *Mass*Benchmarks arrives at a time of cautious optimism and much uncertainty. In many respects, things are looking up in Massachusetts. But as can be seen throughout this issue, there are clearly a number of troubling risk factors and emerging challenges that pose serious threats to our recovery.

In their assessment of the state of the state economy, UMass Amherst Professor Robert Nakosteen and the UMass Donahue Institute's Martin Romitti document the important role that the Massachusetts "Innovation Economy" has played in spurring and shaping the Bay State's recovery and highlight the threats presented by the ongoing debt crisis in Europe, turmoil in the Middle East, and the potential economic impact of scheduled federal budget cuts.

While the Commonwealth's leaders cannot control international financial markets or global geopolitical developments, we can work together to ensure that the over 50,000 jobs that Nakosteen and Romitti's analysis estimates would be lost as a result of these budget cuts are avoided or at least minimized.

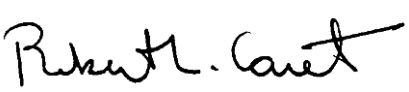
Former Executive Vice President of the Federal Reserve Bank of Boston and Founding Editor of *Mass*Benchmarks Lynne Browne reminds us in her insightful reflection on the past four decades of our economic history that the Commonwealth's reliance on innovation is not new and has been growing. This underscores that the stakes for Massachusetts in the upcoming debates over the federal budget are very high indeed.

Elsewhere in this issue, UMass Amherst's Henry Renski and Ryan Wallace present the results of their research into the changing skills requirements of Massachusetts workers and offer important lessons that deserve the attention of the Commonwealth's workforce and educational policymakers. As they conclude,

> The primary lesson for policy makers is to understand that success in today's workforce is both a technical and social enterprise. While most think of the new economy in terms of emerging technologies, the skills that are most highly associated with growing jobs are not purely science and math skills. Rather it is the combination of social, communicative, and learning skills that appear to be driving the growth of high skilled occupations in management, healthcare, software development, and numerous other expanding fields.

It is both in our short- and long-term interest to prioritize critical investments in our capacity to be innovative and to renew and fully support our commitment to extending economic opportunities to every resident of our great state.

As the sole research and educational institution with a presence in every corner of the Commonwealth, the University of Massachusetts remains committed to doing its part in collaboration with our partners in state government, the business community, and organized labor.



Robert L. Caret, President

EXCERPTS FROM THE BOARD

Following a year when the state's rate of economic growth first exceeded and then fell short of national growth, the Massachusetts economy is expected to track national growth in the coming months. For both the nation and the state, there is cause for cautious optimism arising from a number of recent positive indicators. For the state, the unemployment rate is down, and well below the national rate. Gross state product has grown at above or near the national rate for many quarters. Initial claims for unemployment compensation are falling. The *Mass*Benchmarks Leading Economic Index anticipates faster growth in the months ahead. Nationally, most indicators of the labor market — employment growth, the unemployment rate, initial claims for unemployment compensation — are headed in the right direction. Retail sales are strong. Housing is showing some tentative signs of improvement. All these factors suggest modest but improving economic growth during 2012.

Caution must be exercised, however, due to threats beyond the state's borders. The impact of events in Europe could affect the state both through a decline in exports and through financial contagion. Forty percent of international exports from the Commonwealth have a European destination. A slowdown in Europe or a recession there will negatively impact these export flows. A full-blown financial crisis originating in Europe, as recent history shows us, can rapidly spread throughout the global economy. The recent creep in oil prices and the possibility of supply disruptions also remain a concern. For example, if Iranian oil supplies needed to be replaced, there would be little buffer production capacity left to moderate further price increases. Other risks include further fiscal tightening from the federal government, further household deleveraging, and continuing high levels of uncertainty among households and businesses.

If these sources of caution can be navigated without mishap, economic growth is expected to continue at a modest pace. And unless labor productivity growth turns out to be more moderate than historical norms lead us to expect, a modestly growing economy will bring down the unemployment rate only very slowly. To date, the falling unemployment rate in the state masks continuing distress in some segments of its labor market and regions. Many discouraged workers have left the labor force entirely; others are working part time involuntarily. For skilled and unskilled blue collar workers alike, construction workers, and young workers in virtually every occupation, unemployment far exceeds job openings. The plight of younger workers is especially worrisome and is the result of a weak economy that is experiencing reduced job turnover due in part to older workers postponing retirement. One consequence of this is a household formation rate at an all-time low, as young adults increasingly lack the economic wherewithal to form new families. The present economy is creating a legacy of lost potential and increasing income inequality.

Massachusetts faces a future that is hopeful, cautionary, and painful. The state has many sources of strength, but pockets of weakness and severe hardship remain in many of our older cities, in segments of our labor market, and in sectors such as housing. We can only hope that a continuing economic recovery is strong and broad enough to encompass all segments of the economy.

To help identify industries and occupations in which jobs are available — and to detect emerging labor and skills shortages — Massachusetts developed a statewide job vacancy survey beginning in 2002. Regrettably, this survey was discontinued in 2010. The Mass*Benchmarks Editorial Board calls upon state officials to reinstate this survey or to develop an alternative strategy for providing critical labor supply and demand data for Massachusetts and its regions.*

Prepared by Executive Editor Robert Nakosteen. *February 17, 2012*

An Era of Economic Recovery Amid High Risk

MASSACHUSETTS' ECONOMIC RECOVERY HAS EXPERIENCED TEN CONSECUTIVE QUARTERS OF INCREASING GROSS STATE PRODUCT AND A STEADY DROP IN ITS UNEMPLOYMENT RATE. IN SPITE OF THESE GAINS, THE BAY STATE SAW A SIGNIFICANT SLOWDOWN LAST YEAR AND FACES RISKS AHEAD FROM FEDERAL BUDGET CUTS, FRAGILE EURO ZONE ECONOMIES, SLOWER ASIAN ECONOMIC GROWTH, AND INTERNATIONAL CONFLICTS.

Robert Nakosteen
Martin Romitti

Introduction

Following a rapid recovery from the recession in 2010, the Massachusetts economy experienced a significant slowdown last year. Faster-than-national growth in 2010 continued in 2011, but only just. Overall, national Gross Domestic Product (GDP) grew by 1.6 percent in 2011, whereas the state grew by 1.8 percent. While the state's unemployment rate remained well below the national rate, employment grew very slowly during the year. House prices and construction have both stabilized, albeit at considerably below prerecession levels. The state now seems to be matching a lackluster national growth pattern.

This analysis is clouded by recent major, and downward, payroll employment data revisions for the state. While it is straightforward to incorporate revisions into our analysis, there continues to be uncertainty regarding the veracity of the revisions. Only adding to the ambiguity, the recent release of "benchmarking" data suggests that much or all of the downward revision will be reversed when the benchmarking process is complete.[1]

This growth slowdown has been taking place in a national and global setting that is fraught with risks, virtually all of them on the downside. Domestically, the federal government budget is under great pressure. With the failure of the congressional supercommittee to agree on a better than $1 trillion budget deficit cut over the next decade, the resulting budget sequestration will bring draconian cuts to budget categories that are of great impact on the state economy.

Globally, the sovereign debt and banking crisis in the Euro Zone economies, which could result in a European financial crisis and a renewed European recession, threatens to transmit both those events across the Atlantic to the United States and to Massachusetts. China, an increasingly important trading partner for the state, is experiencing an economic slowdown and some financial sector problems as well, and all of Asia is undergoing an economic slowdown. Europe and Asia have become increasingly important trading partners for the state. A slowdown in their economies will have damaging impacts on our own. And now, the stronger possibility of an Israeli attack on Iran is fueling added political and economic uncertainty.

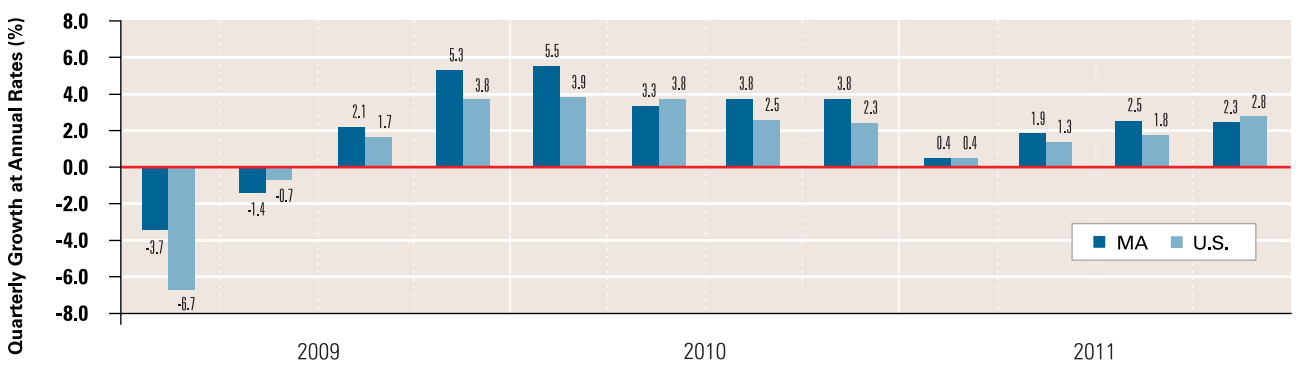
Our Current Condition

While we have reservations about the extent to which these revised employment data are accurately describing current and historical economic conditions, the economic analysis that follows necessarily relies in important ways on the "official" data. Not only are state employment data analyzed in their own right, but they are also one of the components of our gross state product estimates. It is largely the magnitudes of state economic performance that we believe are different from what the official data show. The broad patterns, especially comparative patterns between the state and the nation, as well as the major forces influencing our economy, are described here as we believe them to be. It is our judgment that the data revisions (and therefore the data reported here) have been revised downward too far, and that when the dust settles recent state economic performance will be seen as stronger, especially during 2011, than current data describe.[2]

Massachusetts' gross state product, the most comprehensive measure of economic activity, has been growing, though somewhat erratically recently, since the second quarter of 2009. In all but two of the quarters, the state exhibited faster growth than the nation, though one of those quarters was the fourth quarter of 2011. Growth slowed considerably during 2011.

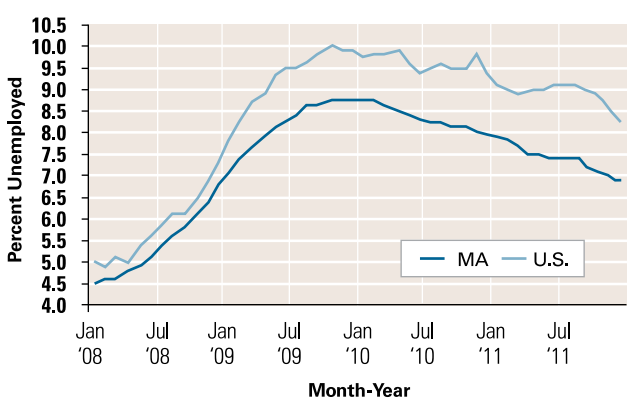
During this period there was a steady drop in the unemployment rate as well as initial claims for unemployment compensation. In addition, the state experienced a

Growth in Real Product, Massachusetts vs. U.S.

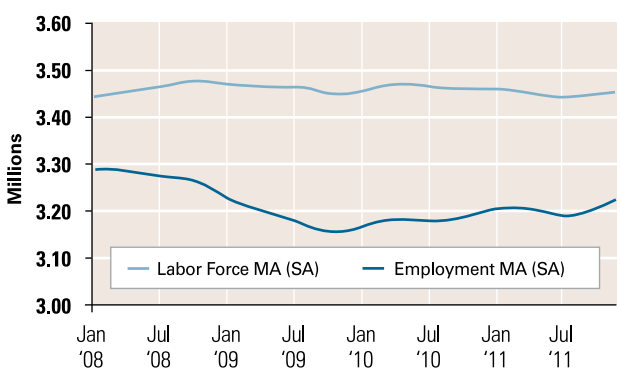


Source: U.S. Bureau of Economic Analysis (US); *Mass*Benchmarks (MA)

Monthly Unemployment Rate, 2008–2011
Massachusetts and United States
(seasonally adjusted)



Massachusetts Labor Force and Employment, 2008 – 2011
(monthly)



Source: Massachusetts Division of Unemployment Assistance; U.S. Bureau of Labor Statistics. LAUS series.

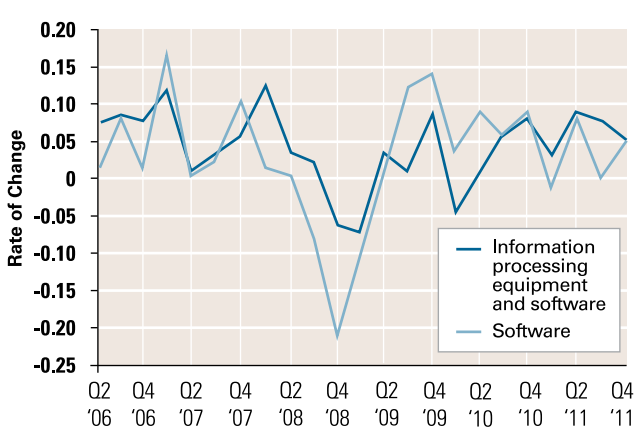
consistently lower unemployment rate than the nation as a whole. This contrasts with past recessions, during which Massachusetts customarily suffered from higher unemployment rates and a longer recovery time than for the nation. This has held true for the state, even though the size of the labor force has been fairly steady through the recession and up to the present.

The reason for this altered pattern can be found in the structure of national and global demand during the recovery. Unlike many past national recoveries, which have been led by housing and durable product consumption as well as inventory replenishment, this one has been driven by business demand for the types of products arising from the state's innovation economy. This innovation economy has been a major growth driver for the Commonwealth in recent decades and during the current recovery. Massachusetts is home to world-class research universities and other institutions that are a magnet for public and private investment. These institutions have helped the Bay State to incubate and grow a wide variety of technology and knowledge-intensive enterprises in diverse areas.

These include information technology, life sciences, and a wide variety of advanced manufacturing sectors that contribute to and benefit from a robust industrial and economic ecosystem that has made Massachusetts a world leader in many advanced technology fields.

The Bay State's knowledge-intensive industries have been the recipients of substantial investment and the beneficiaries of growing demand for their productivity-enhancing products and services. This has been largely responsible for the Commonwealth's growth premium of late. The firms and workers most directly benefitting from this growth are largely in eastern Massachusetts, primarily in the Greater Boston region.

Investment in Information Processing Equipment & Software Growth at Annual Rates, U.S.
(Nominal SA Dollars)



Source: U.S. Bureau of Economic Analysis, National Income and Product Accounts, Table 5.3.5

In the state, these sectors experienced a significant turnaround and recent growth. This growth is qualified because these sectors have expanded without making large additions to their workforce. These are high value-added sectors and add high value per employee as well. They are not, however, especially elastic in adding jobs as value-added increases. In other words, the increase in value added in these sectors does not necessarily lead to increases in employment.

Whither the Information Sector?

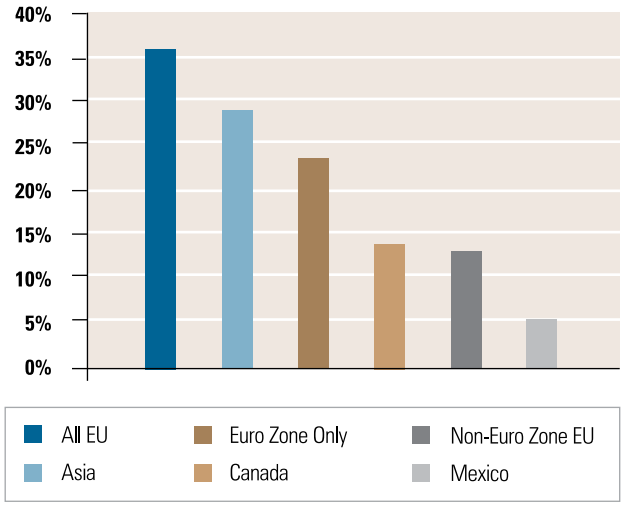
A reasonable proxy for and important component of the economic activity in the state's high-technology sector is dollars invested in the Information Processing and Equipment and Software sector at the national level. As the accompanying graphic illustrates, after a precipitous drop in investment in this sector (and in the narrower Software sector) at the end of 2008 and into 2009, the sector recovered toward the end of 2009, and then was prominent in the state's economic recovery. Growth in the sector, however, has been erratic. In the larger information-processing equipment and software sector, there was considerable variance in investment spending during 2011, even turning negative in the first quarter of the year and approaching zero growth during the third quarter. This pattern of investment spending may well explain the recent slowdown in state economic growth.

The Threat from Europe and Asia

The Euro Zone crisis was triggered by the financial crisis in the United States, as well as current account imbalances in troubled Euro Zone countries. The focal point has become the sovereign debt of the peripheral Euro Zone members, including at first Ireland and Greece, and more recently Italy, Spain, and even Belgium and France. Lenders have sold sovereign debt, and been reluctant to buy new debt, lowering bond prices and raising interest rates to, at times, unsustainable levels for the governments of these countries. Recent actions by the European Central Bank have reduced pressure on these interest rates, but the crisis is far from resolved. At the very least, the European Union countries are entering a period of slow growth at best, and more likely a renewed recessionary contraction. At worst, a full-blown financial emergency could ensue, which could even lead to some countries leaving the Euro Zone. Such a possibility was unthinkable until recently, but is now widely being discussed.

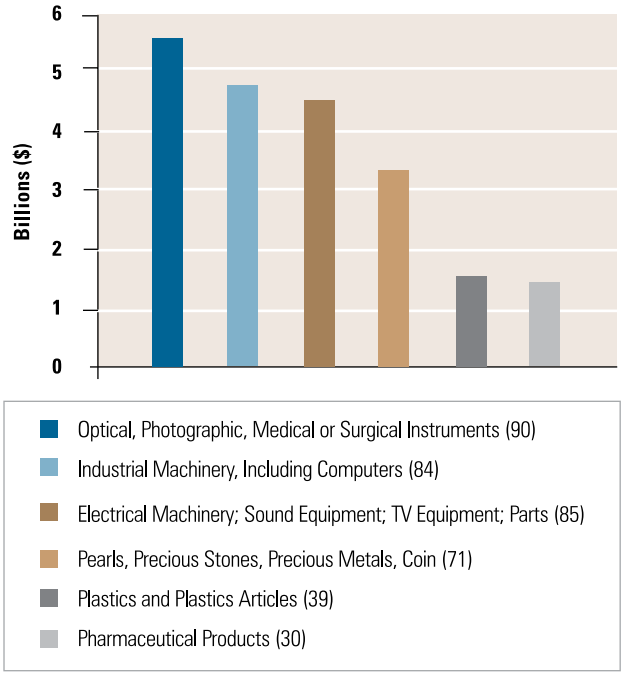
Events across the Atlantic can affect the nation and the Bay State in a variety of ways. Most obviously, the Euro Zone, and the larger European Union are major trading partners for Massachusetts. In 2011, the Euro Zone countries purchased nearly 25 percent of Massachusetts' exports. When the non-Euro European Union countries

Top Export Partners for Massachusetts, 2011



Source: WISERTrade

Top Exports from Massachusetts, 2011



Source: WISERTrade

are added in, Europe accounts for 36 percent of the state's exports. Canada, the state's largest single trading partner, accounts for 13 percent of Bay State exports. A European recession, or a full-blown crisis, would deal a serious blow to the very sectors of the state's economy that have led us out of the recession. Even a decline in the exchange value of the Euro relative to the dollar, which is ongoing as this is written, would damage the state's export volume. The affected industries are high value adding, pay high salaries, and account for approximately 20 percent of the state's jobs. The state's primary export sectors include the vital high-technology industries. At the top of the list are instruments and various kinds of machinery, including computer equipment. Plastics and pharmaceuticals are also important. A serious decline in Massachusetts exports would be transformed quickly into substantial job losses.

In addition to the possible decline of export markets, the state could suffer from a transmission of a Euro Zone crisis through the financial channel. In the event that the Euro Zone enters a genuine financial crisis, the effects would negatively affect financial markets across the globe. The result would be markedly lower stock prices, which would affect the balance sheets of businesses and households. This would result in a reduction of both durable goods purchases and household consumption — especially on housing, which is already in the doldrums. Business investment in plant, equipment, and hiring would also plummet.

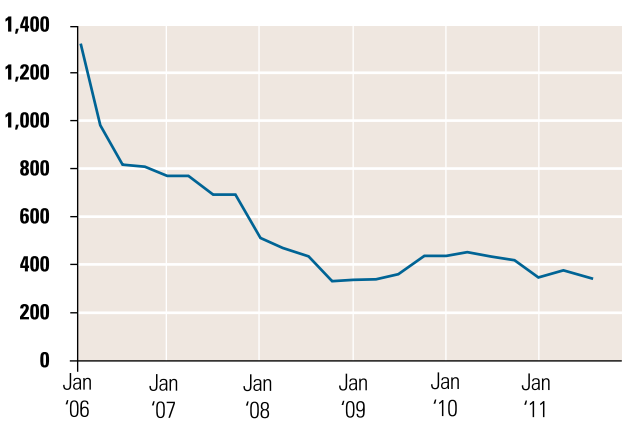
Difficulties among the state's export partners are not limited to Europe. Asia, which ranks just behind the European Union countries as buyers of the state's products, is experiencing its own brand of trouble. China in particular is experiencing a slowdown and may be in the later stages of a property bubble. In the very least, Asia in the near term faces a slowdown in growth. In addition, there is continuing pressure on the Chinese government to allow the Yuan to appreciate on international exchange markets. This would lead to a rise in the price of Massachusetts exports in China.

The Real Estate Industry

While the state avoided the catastrophic decline in house construction experienced in other states, housing has created a drag on our recovery. From their peak in 2006, housing starts in the state declined until the beginning of 2008. Since then, they've continued to stagnate.

An important part of the story is the pattern of price change for repeat house sales, as compiled in the Standard

Massachusetts Housing Starts Quarterly, SA, 2006 – Q3 2011



Source: Federal Reserve Bank of St. Louis

and Poors Case-Shiller Home Price Index. The graph on page eight shows the pattern of indexed house prices for Boston, the nation and for the sake of comparison, Las Vegas, Nevada (probably the hardest hit city in terms of house prices and housing construction). Note that Boston's prices have experienced a more modest decline than either the nation or Las Vegas. Even so, at the moment, there is little evidence that prices are poised to turn around.

Likewise, data from the National Association of Realtors show a stronger commercial real estate market in Massachusetts than in other parts of the country. Available office space for lease in the Boston area is below the national average at 14.7 to 16.7 percent. This is indicative of more businesses wanting space in the city and of the potential need for more commercial construction to follow. Retail space is tight with a 6.9 percent vacancy rate, approximately half the national average. The apartment rental market — multifamily housing — is especially tight in the Boston area, with vacancy rates at 3.9 percent. Multifamily vacancy rates below 5 percent are considered a landlord's market, with high demand leading to higher rents.

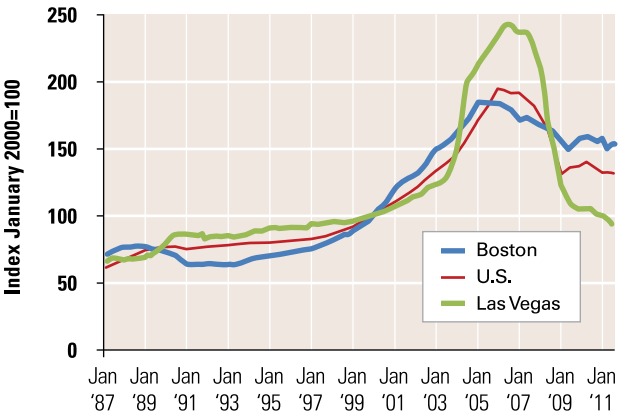
The only exception to the stronger demand for commercial real estate in the Boston area is with industrial properties. The city's 21.1 percent vacancy rate is well above the 12.3 percent national average, a sign of fewer manufacturers looking to be in the city. While the overall commercial real estate market fell flat in the recession, an improving economy brings the prospect of continued positive trends.

Federal Budget Cuts: What Will the Impacts Be?

The Massachusetts economy benefits greatly from the infusion of billions of dollars in direct federal government spending, nearly $84 billion in the most recently reported fiscal year — 2010. A large portion of these funds, over 40 percent, go directly to Massachusetts residents as payments like Social Security. Federal contributions to state and local governments also support a variety of programs and efforts. The salaries of federal workers here top $4.5 billion. Massachusetts is also the fifth-highest recipient of Department of Defense expenditures, at over $14.5 billion, and much of the state's prowess in education and innovation leadership is underwritten by an estimated $7.7 billion in federal funding for research and development activities.

Significant cuts to federal spending would impact the state's economy and jobs. The currently mandated federal budget cuts are set to take effect in 2013 and are legislated to reach $1.2 trillion in savings over ten years. The parameters of the existing plan require equal cuts to defense and non-defense spending along with reductions to Medicare and other mandatory spending programs. As of this writing, various proposals were circulating to circumvent these cuts,

S&P Case-Shiller Home Price Index, 1987–2011



Source: Standard & Poors; Federal Reserve Bank of St. Louis

especially to the defense budget, so the impacts we estimate are not inevitable. Here we analyze the potential impacts of the original sequestration legislation.[3] We modeled the impact of this plan to Massachusetts using REMI, a dynamic forecasting and comprehensive economic tool that answers "what if" questions about the state's economy.

Prior analyses of the impact of budget cuts have focused primarily upon those that result from cuts in the federal defense budget. Our analysis incorporates the across-the-board cuts that would be implemented in all budget areas. We estimate that job losses resulting from the currently mandated federal budget cuts will reach better than 52,000 over the ten years beginning in 2013. This figure is the average difference between an employment forecast in the absence of the impending budget cuts, and the forecast of employment that would ensue following the implementation of budget cuts.

These job losses pale next to the state's total employment of nearly 3.5 million. To put this in perspective, the estimated job loss here is greater than employment growth in the state for the entire year. In other words, the job loss attributable to the federal budget cuts would more than wipe out the entire number of added jobs in the recent period of recovery.

Furthermore, the pattern of these job losses strikes at the heart of the state's innovation economy. In addition to the 13,000+ government and military job losses, the two largest private sector employment cuts are estimated to be in Professional and Technical Services, with a loss of nearly 10,000, and in Health Care and Social Assistance, with a loss of over 6,000 jobs. Most of the former cuts would be due to cuts in the defense budget, while the latter would be due largely to cuts in Medicare provider payments. These two sectors represent much of the innovation economy in the state. Most of these jobs require a highly educated work force, and are high paying and benefitted. Significantly, these are the sectors that have allowed the

Massachusetts economy to outperform the nation in recent years, a fact that underscores the stakes for the Bay State in ongoing federal budget debates. Other job cuts are spread throughout the state's industrial mix.

What is also not captured fully by these numbers is the collateral damage the cuts could trigger. There is no way to conjecture what future innovations would be lost without the support to the state's high-technology sector provided by federal dollars. A large number of important inventions and innovations in modern times can be traced to federal support of research and development. In addition, the numbers by themselves do not capture the importance of industrial clusters in high-technology economic growth. No technology develops on its own, but instead requires the complex interactions of many companies combining their specific technological knowhow to come up with "the next big thing." These clusters require a critical mass of activity to thrive, and large federal budget cuts threaten this diverse community of firms.

These budget and job cuts are not inevitable. Congress and the President could finally agree on a Grand Bargain to rationalize budget cuts and combine them with revenue increases. The allocation of cuts could also be very different than in our assumptions in making these estimates, which are based on the sequestration rules and past patterns of sector-specific expenditures in Massachusetts. It is possible, for instance, and has in fact been speculated that a leaner military could depend on more high-technology support systems, favoring the state's comparative advantage. Still, planned federal budget cuts loom as a Damoclean sword over the state's economy.

Federal Budget Cut Scenario, Average Massachusetts Job Losses, 2013–2022

Sector	Average Job Losses, 2013–2022
Forestry, Fishing, Related Activities, and Other	68
Mining	119
Utilities	62
Construction	1,801
Manufacturing	1,965
Wholesale Trade	1,022
Retail Trade	2,241
Transportation and Warehousing	951
Information	1,075
Finance and Insurance	2,769
Real Estate and Rental and Leasing	1,019
Professional and Technical Services	9,882
Management of Companies and Enterprises	550
Administrative and Waste Services	3,227
Educational Services	2,164
Health Care and Social Assistance	6,238
Arts, Entertainment, and Recreation	841
Accommodation and Food Services	1,396
Other Services, except Public Administration	2,169
State and Local Government	3,055
Federal Civilian and Military	10,379
Total	**52,993**

Source: REMI; Model assumption developed by the authors

Concluding Thoughts

We continue to live in uncertain times, and the state continues to be at the mercy of outside forces beyond its control. Still, the national recovery seems to be firming up, though it is not by any means robust at this point. Massachusetts cannot hope to continue on a growth trajectory without a strong national economic recovery. Largely because of the improving national outlook, economic prospects for the state are positive but guarded and contain some downside risks. Events in Europe, the Middle East — including the precarious relationship between Israel and Iran — Asia, and even Washington, D.C. could have serious adverse effects on the state economy. The state's innovation economy has weathered the Great Recession and is currently pulling the state into a recovery. Let's hope that federal government policy will not undo the basis for Massachusetts' economic recovery along with the fabric of the state's dynamic, knowledge-based economy.

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

MARTIN ROMITTI is Director of Economic and Public Policy Research at the UMass Donahue Institute and Managing Editor of this journal.

Endnotes:

1.) Professor Alan Clayton-Matthews, Senior Contributing Editor of *Mass*Benchmarks, explains and offers commentary on these data revisions in the Endnotes section of this journal.

2.) Our previous assessment of the Massachusetts economy can be seen at Michael Goodman and Robert Nakosteen, "Economic Currents: Diverging Destinies," *Mass*Benchmarks, 2011 Volume 13 Issue 2.

3.) To estimate federal budget-cutting impacts, it was assumed that across-the-board federal government spending cuts would be fully implemented starting in 2013, as legislated. This will entail more than $1 trillion in cuts over a ten-year period. Federal budget documents, as well as data on federal contract outlays, were used to estimate sector-specific cuts in federal spending as they would affect Massachusetts.

Massachusetts over the Past Thirty-Five Years

Lynn Browne

EBBS AND FLOWS IN THE MASSACHUSETTS ECONOMY DURING THE PAST 35 YEARS UNDERSCORE THE COMMONWEALTH'S RESILIENCE AND ADAPTABILITY. THAT SUCCESS STORY, WHICH INCLUDES A PER CAPITA INCOME EXCEEDING THE NATIONAL AVERAGE BY 25%, IS LARGELY ATTRIBUTABLE THE STATE'S INNOVATION ECONOMY FUELED BY EXCEPTIONAL EDUCATIONAL INSTITUTIONS.

I joined the Federal Reserve Bank of Boston as a regional economist in April 1975 and I retired at the end of April 2011. My retirement prompted some reflections about how economic conditions have changed — or not — in New England. These reflections appeared as an essay in the Bank's 2010 annual report.[1] This article focuses on Massachusetts.

The Massachusetts story is very similar to the New England story. This should not be surprising, since Massachusetts accounts for roughly half of New England's population and economic activity and it shares many social and economic attributes and much economic history. But there are also differences. If anything, the Massachusetts story is more dramatic.

MASSACHUSETTS IN THE 1970s

When I joined the Bank in April 1975, the state and the nation were just starting to recover from a very severe recession. At the time, however, there was no clear evidence of recovery. As is often the case, the indicators were confusing and the National Bureau of Economic Research, the official arbiter of business cycle turning points, took roughly a year to determine that the recession trough had occurred in March. The future as seen in 1975 looked very challenging for Massachusetts.

Massachusetts had struggled economically for much of the first half of the 20th century, as its once dominant textiles and shoe industries sought lower cost locations in the southern states (textiles) and northern New England (shoes). While the Cold War and the Vietnam War had provided a boost to newer industries, such as electronics, instruments and aircraft engines, the state performed more poorly than the nation in the recession of 1970 and the ensuing recovery. Massachusetts continued to lose its older industries to the South and, increasingly, overseas. It also faced competition for newer, more sophisticated industries from states like California, Texas and Florida. Massachusetts was seen as a high-cost location — high wages, high energy costs, and high taxes — with a hostile attitude towards business.

On top of these problems came the Arab oil embargo of 1973, which disrupted supplies and caused oil prices to skyrocket.[2] While the embargo itself was short-lived, oil prices remained elevated and many foresaw an extended period of high and rising energy costs. Massachusetts was especially vulnerable to high oil prices, as it was more dependent upon oil for nontransportation purposes than most of the country. Outside New England, reliance on coal and natural gas was much higher.[3]

Finally, the state faced the prospect of bankruptcy. Tax revenues plunged in the 1975 recession, while rising unemployment — the state unemployment rate reached 12 percent in spring 1975 — drove up the demand for public services and financial assistance. Meanwhile, the Commonwealth, which had previously relied on short-term borrowing to hold down interest costs, faced a financial market that was already contending with similar problems in New York City and was highly skeptical of Massachusetts' efforts to resolve its financial crisis.

Thus, Massachusetts in the mid 1970s confronted a long history of economic stagnation, intensified competitive challenges from Sunbelt states, an oil price shock, and a severe fiscal crisis.

Yet 1975 proved to be a turning point. The state recovered from the recession much more vigorously than most observers had expected. It addressed its near-term fiscal problems and began a long process of addressing its image as a state hostile to business. While higher energy prices persisted, the most dire predictions did not come to pass and the consequences of higher oil prices did not prove as debilitating for Massachusetts as many had feared. Massachusetts still faces significant challenges, but the most troubling are national challenges. Perhaps the most pressing state-specific issue, the high cost of housing, is partly a reflection of the state's relative prosperity.

WHAT WENT RIGHT IN MASSACHUSETTS?

A critical change was the emergence of computers and other high technology industries as important forces in the state economy and in the political ethos. Also key was a pronounced increase in the share of the adult population with a college degree, both absolutely and relative to the rest of the country. Both developments boosted the productivity of Massachusetts workers and contributed to a sharp rise in incomes relative to the rest of the country. A slowly growing labor force helped preserve these gains when the impetus from high tech slowed. These developments were reinforced by efforts to rein in high tax burdens and to give business concerns greater heed.

High Technology Industries and Rising Educational Attainment

The growth of high-tech industries in Massachusetts has been told in many places.[4] Despite the prominence of textiles and shoes, the Massachusetts manufacturing base in the first half of the 20th century was quite diverse and the state was engaged in many cutting-edge activities. Some of these more technologically sophisticated activities received a powerful boost from defense expenditures in World War II, the Cold War, and the Vietnam War. Additionally, federally funded research at Massachusetts universities generated insights and technologies with civilian as well as defense applications. Federal procurement was especially important to the growth of defense-oriented firms producing electronics, instruments, and aircraft engines and missiles, while defense research played a key role in the rise of the more civilian-oriented computer companies.

The last played a particularly important role in Massachusetts' recovery from the 1973–75 recession and the state's transformation, both in reality and in perception, from an economic laggard to a leader of the information age. While some of Massachusetts' computer companies were founded as early as the 1950s, they were not significant jobs generators until the early 1970s. At that point, they burst upon the scene, with state-of-the-art new "mini-computers" that were much lower cost than the existing mainframes. Computing power became accessible to a much wider range of users than previously.

Critical to the growth of the minicomputer industry and a force for growth in itself was the entry into the workforce of the highly educated baby boom generation. Baby boomers were much more likely to have gone to college and even to have acquired advanced degrees than their predecessors. Massachusetts universities were regarded among the nation's elite and some were national leaders in federally funded research. Thus, Massachusetts attracted many top students from around the country and even from abroad. But with the winding down of the Vietnam War and the aerospace program, job opportunities at the state's traditional employers were limited. The minicomputer companies and other new high technology companies had their pick of the best.

The minicomputer industry flourished through the late 1970s and early 1980s. A variety of other knowledge-intensive companies also emerged or expanded in this period. Companies that manufactured measuring and controlling devices combined new electronic technologies with traditional metal-working expertise to help customers improve energy efficiency and reduce pollution. In addition, a pick-up in defense spending under President Reagan revived the state's more traditional defense manufacturers.

Massachusetts fared much better than most of the country in the recessions of 1980 and 1982, despite another boost in oil prices in 1979. At the time, it was commonly asserted that high tech was recession-proof. Customers were so eager for the new products that they would make the necessary investments despite a dismal economic environment.

Wages and income levels began to rise. During the 1950s and 1960s, per capita income in Massachusetts had hovered just below 110 percent of the national average.[5] In the mid-1970s, however, it slipped, reaching a

low of 102 percent of the national average in 1978. At the same time, the U.S. Bureau of Economic Analysis published long-term regional and state projections showing Massachusetts falling below the national average by 2000.[6] Instead, wages and incomes rose much more rapidly in Massachusetts than in the nation; by 1988, the state's per capita income was 123 percent of the national average.

Continued advances in educational attainment undoubtedly contributed to the state's high income. After declining in the 1970s, the return to a college degree in the United States started to increase in the 1980s, with college graduates earning increasingly more than those with a high school diploma or less. Meanwhile, the fraction of Massachusetts residents with college degrees surpassed that of the nation by a widening margin, despite rising educational attainment nationwide. In 1970, 12.6 percent of the Massachusetts population 25 and over had a bachelor's degree or better, compared with 10.7 percent nationally. Eleven states had equal or higher shares. By 1990, 27.2 percent of Massachusetts adults had a bachelor's degree or better, compared with 20.2 percent nationally, and only one state, Connecticut, matched Massachusetts' share.[7] (Massachusetts' educational attainment is less impressive if measured by acquisition of a high school degree or better; while ahead of the nation, Massachusetts' advantage has narrowed.)

Political Changes

The growth of new, technologically advanced industries and Massachusetts' increasing prosperity did much for the state's image, both at home and externally. Massachusetts was no longer a has-been. It was on the forefront of the information age. Furthermore, the combination of the state's near-bankruptcy in 1975 and the emergence of new firms investing and creating jobs in Massachusetts seem to have changed the political dynamic in the state. On the one hand, the fiscal crisis made clear that political leaders could not afford to ignore economic conditions in the state; on the other hand, the growth of high technology brought to prominence a number of new business leaders, some of whom proved to be very effective spokesmen for the business community.

In 1978 an aggressively pro-business candidate won the Democratic primary and became governor. He soon launched a campaign — "Make it Massachusetts" — highlighting the state's manufacturing prowess. Shortly thereafter, Route 128, the beltway around Boston where many high tech firms were located, was designated America's technology highway. The 1980 election saw passage of the Proposition 2½ ballot initiative, which limited local property taxes to 2 ½ percent of assessed values and also limited the annual growth in property tax collections. The Massachusetts High Technology Council, a business organization representing high-technology firms, was one of the most influential supporters of Proposition 2½.

The state's increasing prosperity prevented Proposition 2 ½ from forcing the draconian cuts in public services that many opponents had feared. Strong growth in state tax revenues allowed state government to increase aid to municipalities, softening the restrictions on local revenues. Additionally, many communities experienced substantial residential and business development in the 1980s, and this new growth augmented local property tax bases. Nevertheless, Proposition 2½ had real teeth. It also was a powerful signal of voter frustration with the rising tax burdens that had led to Massachusetts being dubbed "Taxachusetts." Public officials listened.

The mid 1980s was a remarkable period for the state, giving rise to the phrase, "The Massachusetts Miracle" and contributing to the selection of Governor Dukakis as the Democratic nominee for president in 1988. But high-tech manufacturing was not the driver. While high-tech manufacturing had helped propel the state's strong recovery from the 1975 recession and had been a key source of support in the early 1980s, manufacturing employment in Massachusetts declined in the mid 1980s. Instead, services — finance, insurance and real estate — trade, and construction were the economic engines in this period.

Financial and other services companies operating in national and even international markets flourished during these years; mutual funds, like Fidelity; consulting firms, like Bain and Boston Consulting Group; and software companies, like Lotus, rose to prominence. At the same time, Massachusetts' renewed prosperity sparked a construction and real estate boom in the state, which in turn spurred growth in such related activities as architectural services, legal services, and banking. Housing prices soared, bolstering household wealth and encouraging consumption.

It did not last. Construction and real estate began to falter in the late 1980s, then imploded. A banking crisis followed, with many banks failing. The survivors tightened lending standards. The 1990–91 recession was much more severe in Massachusetts than for the nation as a whole.[8]

The state's economic problems prompted another fiscal crisis, in which the state's bond rating fell to near "junk" status. However, a new administration was able to work with legislative leaders to restore the state's fiscal status and, over time, to reduce a number of taxes. The lessons learned in that episode, in particular the importance of cooperation, appear to have stuck; as of 2011, Massachusetts elected officials have coped with subsequent economic downturns and the resulting fiscal challenges more successfully than their counterparts in many states.

HOLDING PATTERN

The past 20 years have been characterized by slow employment and population growth and severe economic downturns. Yet, the state has retained its relatively high wages and incomes. Per capita income in 2010 was 128 percent of the national average. The unemployment rate has generally been lower than the national average, despite episodes of severe job loss. Although slow population growth has been a source of concern, it has functioned as a safety valve and contributed to these other relatively favorable economic indicators. In particular, during episodes of severe job loss, Massachusetts experienced net outmigration, blunting the impact of the employment decline on unemployment rates and wage levels.

Further, the state appears to have retained its image as a center of innovation and technologically sophisticated enterprises. Although no new set of businesses has emerged to capture the imagination as the minicomputer companies once did, the state is a national leader in biotechnology and pharmaceutical research, medical devices, computer software and communications services, and asset management and other financial services. All these are characterized by high educational requirements and high wages.

Finally, the availability and cost of energy have not been as severe a competitive disadvantage as many feared they would be back in 1975. To some extent, this is surprising, as energy costs are still about 30 percent higher in Massachusetts than nationally, and for industrial users, energy costs are double those nationally.[9] However, concerns in 1975 focused on shortages as well as prices; and except for very brief periods, these have not materialized. Both energy supply and energy demand have proved more responsive to prices than expected by the conventional wisdom of the 1970s. Globally, new supplies of oil and natural gas have been found; in Massachusetts natural gas has increasingly substituted for nontransportation oil both directly and through the electricity sector. Consumption of energy has also increased much more slowly than before 1975 and much more slowly than economic activity. Indeed, Massachusetts' total energy use (in trillions of BTU) in 2009 was almost the same as in 1975.

But the story is not all positive. Massachusetts has experienced setbacks and continues to face serious challenges on several fronts.

WHAT DID NOT GO SO WELL FOR MASSACHUSETTS?

Severe Recessions

High-technology manufacturing began to stumble in the mid-1980s, as the minicomputer companies were unable to mount an effective response to the personal computer. For a time, a construction and real estate boom obscured the growing problems in manufacturing. But without support from manufacturing or other more fundamental economic drivers, real estate began to falter as well, with ramifications for many related activities. Bank failures were numerous and many small and mid-sized businesses complained of difficulties with obtaining credit. The recession of 1990–1991 was much more severe and prolonged in Massachusetts than in the nation.

The late 1990s saw something of a resurgence in information technology-related activities spurred by the internet, telecommunications, and preparations for the century date change. However, that spurt was short-lived and the 2001 recession was, again, more severe and prolonged in Massachusetts.[10]

Far from being recession-proof, as had seemed to be the case in the recessions of the early 1980s, Massachusetts high-technology industries have been vulnerable to economic downturns. Contributing to this vulnerability have been longer term competitive challenges, from rival technologies as well as from overseas and domestic competitors. Furthermore, the Massachusetts economy does not seem to have become any less prone to recessions, despite major changes in its composition.

Back in 1975, the conventional wisdom was that recessions were generally deeper and longer in Massachusetts than for the country as a whole. This pattern was attributed to the state's relatively large manufacturing sector. Since manufacturing is generally more volatile than service-producing industries, a plausible surmise was that a diminishing share of employment and output in manufacturing would be associated with milder recessions. However, that has not been Massachusetts' experience. Although the share of employment in manufacturing has fallen more sharply in Massachusetts over the past 35 years than in the country as a whole, the state has not become less vulnerable to recessions. The 1990–1991 recession and the 2001 recession were much deeper and longer in Massachusetts than in the nation. The 2007–2009 recession was an exception. The falloff in employment and the rise in the unemployment rate in the most recent recession were less in Massachusetts than the nation, although the general contours of the downturn were similar in both the state and the country as a whole.

In both the 1990–1991 and the 2001 recessions and the sluggish recoveries that followed, Massachusetts experienced substantial net outmigration to other parts of the country which were doing better.[11] This net outmigration and the resulting slow growth in the state's population functioned like a safety valve, helping to maintain the state's high wage level and, especially after 2001, to hold down unemployment.

One can almost think of the past 35 years as two periods. The first, from 1975 to the mid-1980s, is when the real Massachusetts Miracle took place — a burst of prosperity sparked by high technology industries and the entry into the work force of the highly educated baby boomers who drove up wages and incomes in the state relative to the rest of country. However, the late 1980s to the present have witnessed a struggle to maintain these gains. In a sense, the state has been running to stand still. It has remained on the forefront of many innovations. It was a leader in the internet and telecommunications booms in the late 1990s; it is a center for biotech, medical devices and pharmaceutical research; it is home to highly sophisticated financial services enterprises. However, it has not enjoyed an extended period of strong employment or population growth. Indeed, as noted, it has suffered three severe recessions, two of which were much more severe and much longer than in the nation. But wage and income levels remain well above the national average. Through innovation, higher educational attainment, and outmigration in bad times, Massachusetts has maintained its status as a very high-income state.

Slow Population Growth

Today, many observers of the Massachusetts economy are concerned that the state's slow population growth will be — and perhaps already is — a competitive disadvantage. Shortages of workers, it is argued, will discourage firms from expanding and locating in Massachusetts. To some degree, this line of reasoning is puzzling, given the severity of the recessions in Massachusetts over the past two decades and the high rates of outmigration in response to economic distress. Before the most recent downturn, the state had not recovered the wage and salary jobs lost in 2001 and its aftermath.[12] The problem would seem to be too few jobs — or more precisely, the loss of jobs — rather than too few workers.

Those concerned about the consequences of slow population growth generally focus on the high cost of living in Massachusetts and particularly, the effects of high housing costs on migration patterns. Certainly, high housing and other living costs undermine the attraction of the state's high wages. A 2009 research paper by Federal Reserve Bank of Boston economist Alicia Sasser shows that housing affordability has played an increasing role in shaping migration patterns and that since the mid-1990s housing costs have been about equal in importance to labor market conditions in explaining outmigration from Massachusetts.[13] Nevertheless, a lack of jobs has also been an important contributor to Massachusetts' slow population growth over the past 20 years. In the most recent recession, Massachusetts fared somewhat better than the nation and notably better than some states that have traditionally been destinations for Massachusetts' migrants — and it did not experience the outmigration that followed the two earlier recessions.

Many blame the high cost of housing in Massachusetts on restrictive local land use practices, such as zoning regulations requiring large lots. But high housing costs are also a reflection of the state's prosperity, and specifically the Massachusetts Miracle. In the early 1980s, housing prices were higher in Massachusetts than nationally, but not strikingly so. However, the improvement in the state's economic performance boosted the demand for housing and prices picked up — and then kept rising, despite a surge in construction. The median sales price of family homes in the Boston metropolitan statistical area increased from about 20 percent above the national average in 1983 to twice the national average in 1988.[14] In the construction and real estate bust that followed the boom, housing prices in Massachusetts declined but did not retrace all the previous increase. Massachusetts housing prices remained high. So when the latest round of rapid house price appreciation began, Massachusetts started from a position of relatively high housing costs. And that remains the case.

The housing price boom of the 2000s started somewhat earlier in Massachusetts than the nation and the bust began somewhat earlier, but the general contours of rise and fall have been similar for the state and the nation. Home prices are lower in Massachusetts than they were a few years ago, but not lower relative to the nation. As of 2010, the median price of existing homes in the Boston area was still roughly twice that in the nation.[15]

Related to concerns over the generally slow growth in population are those that a shortage of younger workers and, specifically, highly educated younger workers, may crimp the state's dynamism in the future. Massachusetts is an older state, with a median age of 39.1 in 2010 compared with 37.2 for the nation. However, the explanation is not so much a large fraction of older people as a smaller fraction of the population under 18.[16] This, in turn, reflects a lower birth rate in Massachusetts than in much of the country. This is not a new development. Birth rates fell more sharply in Massachusetts and its New England neighbors beginning in the 1970s, and the region has been contending with the consequences for the labor force for the last 20 years. To some extent, the effect of a smaller flow of young people into the labor force on the

supply of *college educated* young adults has been offset by rising educational attainment.[17] Looking ahead, however, further educational gains may be difficult to achieve.

Like the nation as a whole, Massachusetts is becoming more diverse. While this diversity has many positive aspects, minority populations are generally less well educated than native born whites; and despite advances, projections of future levels of educational attainment indicate that tomorrow's young adults will not be better educated than today's.[18] Massachusetts will probably still surpass most of the country by a considerable margin — as most states face the same issue. But Massachusetts will not continue to improve its educational attainment relative to the past. This is potentially worrisome, as a younger, highly educated population seems likely to be receptive to new technologies and to contribute to a climate of innovation.

As noted previously, Massachusetts' own history, specifically the high-tech boom of the 1970s and early 1980s, highlights how a large cohort of younger workers, trained in state-of-the-art technologies, can reinforce the emergence of new industries. That Massachusetts will likely retain an edge over the rest of the country is somewhat cold comfort, given educational advances that are occurring in other parts of the world. While the United States is standing still educationally, many countries are making rapid strides, with young people far more highly educated than their parents and increasingly matching the United States in completing college.[19]

Massachusetts does have a potentially important advantage over much of the country in addressing this challenge. Its institutions of higher learning attract students from all over the nation and the world. Its elite research institutions are viewed as the world's best. If Massachusetts could boost its retention rate for graduates of its great universities, it might be able to offset the tendency for educational attainment to level off.

Geographic Disparities

Within Massachusetts, not all areas have fared equally well. Rising income levels have been most pronounced in the Greater Boston area. Western Massachusetts and the southeastern part of the state have not kept up. And a number of older industrial cities throughout the state have very high concentrations of poverty.

The Massachusetts poverty rate is well below the national average: 7 percent of families in the state were below the poverty level in 2009 compared with 10.5 percent nationally.[20] However, poverty rates in some Massachusetts communities are extremely high. In 2009 25.8 percent of families in Lawrence were below the poverty level, 21.5 percent in Springfield, and close to 20 percent in New Bedford. Creating opportunities for residents of these cities is a challenge to which a satisfactory answer has not yet been found. Efforts to halt and reverse the physical deterioration of these cities have had limited success, although some encouraging examples do exist. Basically, a significant portion of Massachusetts is still coping with the threats that seemed so overwhelming in the 1970s. The competition from low-cost production centers, first in the United States and increasingly abroad, has severely impacted communities that were heavily dependent upon manufacturing production and that have not successfully made a transition to the elusive information, knowledge-based, innovation economy.

If anything, disparities between rich and poor, both people and communities, seem more pronounced than 35 years ago. Highly educated, technologically sophisticated individuals have done well in the information age and in life sciences and financial services. Meanwhile, the decline of manufacturing has meant fewer opportunities to earn high wages for those without college degrees. And the gap between rich and poor carries over to the communities in which they live. Successful households cluster together in a varied set of beautiful cities and towns within an hour or so from Boston. One of the great appeals of Massachusetts and also one of its great challenges is its multitude of 351 cities and towns. For the affluent, there truly is a community for every taste — from the lively urban experience of downtown Boston, to upscale suburbs with stately homes and great schools, to bucolic villages surrounded by horse farms. The poor gravitate to the older industrial cities, which provide important public and private services and where housing is comparatively less expensive. But with large populations of poor residents and low value properties, these lower income old industrial communities struggle to generate adequate revenues to support needed services.

ASSESSMENT

All in all, my judgment is that Massachusetts has fared pretty well over the past 35 years. Looking ahead, I see the biggest challenges being national rather than state-specific issues.

The past 35 years have highlighted that growth does not always follow a steady upward trajectory. Thirty-five years ago, Massachusetts was struggling. Older industries like textiles and shoes were a heavy drag on the state economy, while more innovative industries and industries dependent upon specialized skills, like electronics, aircraft engines and metal working were contending with the fallout from defense cutbacks. Sunbelt states of the South and West were poised for prosperity. In the South, historically low wages for low-skill labor had become an even more potent competitive advantage, as the interstate

highway system and the spread of air conditioning made feasible previously unappealing locations. The unexpected surge in oil prices strengthened energy-rich Texas and other southwestern states, while disadvantaging Massachusetts and other states with a high reliance on oil. California was the destination with perfect weather, an innovative culture and educational levels well ahead of those in Massachusetts.

But Massachusetts was on the cusp of its own renaissance. The emergence of computers and high technology industries transformed the state, setting in motion a process of ongoing innovation — bright, energetic people figuring out ways to sustain their high standards of living — that has continued to this day, as well as recasting the state's image from old and stodgy to state-of-the-art, even if still chronologically old. Other parts of the country have not fared so well. It is not the point of this essay to point out the problems in other parts of the country. But for Massachusetts to enjoy a per capita income that is more than 25 percent above the national average speaks not only to Massachusetts' success but also to other states' weakness. In the author's judgment, education is the key. Massachusetts has coped by increasing its educational margin even as educational attainment has advanced nationally. Looking ahead, continued educational progress is by no means assured. Projections of future educational attainment show a leveling off. While Massachusetts will probably retain a substantial edge over much of the country, increasingly the United States is seeing its educational superiority challenged from abroad, as educational attainment is rising rapidly in many countries.

The bottom line is that Massachusetts seems to have adapted to difficult challenges over the past 35 years more successfully than much of the country. But large challenges lie ahead.

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Endnotes

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3.) The cost of energy to all users, including transportation, increased from about 15 percent above the national average in 1970 to almost 25 percent above in 1975; and for industrial energy from almost 30 percent above to more than 50 percent higher. Source: Calculations from U.S. Energy Information Administration, State Energy Data System, (SEDS), at http://205.254.135.24/state/seds/on October 13, 2011.

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7.) U.S. Bureau of the Census, Census 2000 PHC-T-41. "A Half Century of Learning: Historical Statistics on Educational Attainment in the United States," Tables 5a and 6a at http://www.census.gov/population/phct41/table5a.xls on October 20, 2011 and the *Statistical Abstract of the United States 2012*, Table 233. Educational Attainment by State: 1990 to 2009, at http://www.census.gov/compendia/statab/2012/tables/12s0233.pdf on October 13, 2011.

8.) Wage and salary employment in Massachusetts fell 10 percent from 1988 to 1992, while wage and salary employment in the United States peaked in 1990 and reached its low in 1991, falling less than 2 percent. From U.S. Bureau of Economic Analysis, Regional Economic Accounts, Interactive Data as found at http://www.bea.gov/regional on November 2, 2011. The Massachusetts unemployment rate rose from the low side of 3.5 percent in 1988 to 9 percent in the fall of 1991, while U.S. unemployment rate rose from 5 percent in March 1989 to almost 8 percent in June 1992. From Federal Reserve Bank of Boston, *New England Economic Indicators*, Database at http://www.bostonfed.org.economic.neei/neeidata/ur.csv on November 2, 2011.

9.) Calculated from data in the U.S. Energy Information Administration State Energy Data System (SEDS) as found at http://205.254.135.24/state/seds/ on October 3, 2011; relevant tables are those on prices and use for Massachusetts and the United States.

10.) Wage and salary employment in Massachusetts fell 4 percent from 2000 to 2004, while nationally wage and salary employment fell just over 1 percent from 2000 to 2003. From U.S. Bureau of Economic Analysis, Regional Economic Accounts, Interactive Data at http://www.bea.gov/regional/ on November 3, 2011. The unemployment rate in Massachusetts rose from 2.9 percent at the end of 2000 to 6 percent in the summer of 2003, while the U.S. rate rose from 3.9 percent to 6.3 percent over the same period. From Federal Reserve Bank of Boston, *New England Economic Indicators*, Database at http://www.bostonfed.org.economic.neei/neeidata/ur.csv on November 3, 2011.

11.) See Figures 5 and 7 in Alicia Sasser, "Voting with Their Feet: Local Economic Conditions and Migration Patterns in New England," Federal Reserve Bank of Boston, New England Public Policy Working Paper No. 09-1, 2009. Available at http://bos.frb.org/economic/neppc/wp/2009/neppcwp0901.htm on October 24, 2011.

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14.) National Association of Realtors, Median Sales Price of Existing Single Family Homes as found in Federal Reserve Bank of Boston, *New England Economic Indicators*, First Quarter 1990, Historical Data, p.31.

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16.) Lindsay M. Howden and Julie A. Meyer, "Age and Sex Composition: 2010," U.S. Census Bureau, *Census Briefs*, Table 3. Available at http://www.census.gov/prod/cen2020/briefs/c2020br-03.pdf on November 3, 2011.

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19.) See Chapters 1 and 2 of National Science Board, *Science and Engineering Indicators: 2010* available at http://www.nsf.gov/statistics/seind10/start.htm on November 4, 2011 and Lynn Browne's "Observations on Science and Engineering Indicators 2010" on http://www.amorevitaleconomy.com/Page_2.html#SE_Indicators on November 4, 2011.

20.) U.S. Census Bureau, "The 2012 Statistical Abstract," Incomes, Expenditures, Poverty and Wealth, Tables 708 and 709. Available at 4 on November 4, 2011.

Workforce Skills and the Changing Knowledge Economy in Massachusetts

Henry Renski and Ryan Wallace

ALTHOUGH THE MASSACHUSETTS ECONOMY HAS CLEARLY BECOME MORE KNOWLEDGE- AND TECHNOLOGY-INTENSIVE OVER THE PAST TWO DECADES, JOBS IN KEY AREAS LIKE INFORMATION TECHNOLOGY, HEALTH CARE, AND EDUCATION REQUIRE HYBRID SKILL SETS. THESE INCLUDE MATH AND SCIENCE SKILLS ALONG WITH SOCIAL, COMMUNICATIVE, AND LEARNING SKILLS.

Introduction

The new economy represents a major transformation in the industrial structure of Massachusetts and the nation. Driven by the widespread proliferation of new information technologies and globalization, the new economy is characterized by the decline of manufacturing as the primary domestic economic base to be replaced by emergent strengths in information technology, biotechnology, and value-added services ranging from corporate management to multinational finance and logistics. The common thread linking these emergent sectors is their emphasis on continual learning, adaptation, innovation, and strong ties to basic science and applied research. Thus, while many associate the new economy with specific tech-oriented products and services, it is really the abilities, skills and knowledge embedded in the workforce that provide the glue bridging these highly diverse sectors and drive regional competitiveness.

Massachusetts has been among the greatest beneficiaries of the rise of the new economy. Massachusetts has consistently ranked first among the states in the Kauffman Foundation's Index of the New Economy, since its first publication in 1999, scoring particularly well in its depth of managerial professionals, high-tech jobs, and higher education infrastructure.[1] But while the Commonwealth and the nation continue to actively pursue technology-based economic development, policy makers struggle to find ways to improve the prospects for those lacking the education or training to fully participate in the new economy. In particular, there is growing concern whether technological change is polarizing the labor force into a group of highly-paid knowledge elites on one end of the skills spectrum, and low-wage service and retail workers on the other, with a disappearing middle that was once populated by production workers and back-office staff.

Traditionally, state and regional economic analysis has focused on understanding questions of regional industrial composition and structure: What are the leading industries in a region? What are their prospects for continued growth? Are these industries associated with well-paying jobs? The insights gleaned from this line of inquiry have informed policies and strategies to address the needs of particular industries. Less attention has been given to how the structural shifts of the new economy have influenced the workforce, including changing skill and education requirements. And while economic developers have become increasingly aware of the interconnections among education, workforce development, and economic growth, the tools and information sources that we use to shape our understanding of such forces are still mired in an industry-based mindset.

This study takes a different approach to understanding the evolution of the Massachusetts economy and how this

compares to the nation. Specifically, we examine how the occupational mix of the Commonwealth has changed in the new economy, and what this suggests about changes in the education and skill requirements of the 21st Century workforce. This paper opens with a review of occupational growth in the Commonwealth over the past 17 years — a period coinciding with the ascension of the new economy. We examine whether the new economy actually favors more science and technology-oriented occupations, as commonly assumed. The next section looks at growth among occupations with different levels of post-secondary education and occupation-relevant experience. We address whether growing occupations require more education and experience compared with declining or stagnant ones, and whether there is evidence of skills polarization — the bifurcation of high- and low-education jobs and the disappearance of mid-education jobs — in the Massachusetts labor force. In the final section, we consider differences in the specific skill sets of occupations that are growing, compared with those that are stagnant or in decline.

Trends in Occupational Growth, 1990 to 2007

Over the past 17 years, the Massachusetts employed labor force expanded at a constant annual growth rate of .2%. This compares with the much higher national rate of 1.2% over the same period.[5] Job growth was much faster during the 1990s than since 2000, even after accounting for the shorter time period.

Given a considerably lower rate of overall employment growth, it is not surprising that Massachusetts lagged national growth rates in nearly all occupational classes. The lone exception where Massachusetts growth rates exceeded the nation was life, physical, and social science occupations, although the state was nearly on a par with U.S. growth in personal care and services, and education, training and library occupations. The largest gaps between Massachusetts and the U.S. were in extraction, production, and protective services-related occupations.

Figure 1 breaks down employment growth by 24 major occupational classes. The fastest job growth occurred among computer and mathematical occupations for both Massachusetts and the nation. Most of the jobs created within this occupation class were among computer software engineers, computer support specialists, and computer scientists and systems analysts. Combined, these occupations added more than 50,000 net jobs to the Massachusetts economy between 1990 and 2007. While they did not add as many new workers, network systems and data communications analysts, network and computer systems administrators, and database administrators were among the

Data Sources

The data fueling this analysis come from two primary sources. Estimates of employment by occupation come from the 5% Public Use Micro-sample (PUMS) files associated with the U.S. decennial censuses of 1990 and 2000 and the equivalent 3% PUMS file from the American Community Survey (ACS) covering 2006–08. PUMS is a representative sample of the entire population that includes highly detailed data on the primary occupations of the employed labor force. The unemployed or those out of the labor force are not included.

Information about occupational characteristics comes from the Occupational Information Network (O*NET) database developed by the U.S. Department of Labor Employment and Training Administration. O*NET contains a wealth of information that can be used to profile occupations, everything from typical worker characteristics such as required or preferred worker abilities to common occupation-specific requirements such as the types of tools and technologies frequently encountered by workers in each occupation.[2] For this analysis we limit our attention to an examination of educational, experience, training, and skill requirements.

While the combination of PUMS and O*NET provides a rich source of information on changing workforce requirements, they are subject to several limitations. Most importantly, O*NET data are only available from the mid-2000s onward. Therefore, we cannot examine changing job requirements within occupations, only whether the economy has shifted towards occupations requiring more education or experience according to recent standards.[3] It should also be remembered that PUMS data are based on a national sample of the employed labor force and not a universal census. Estimates derived from PUMS are subject to a degree of sampling error and not reflective of the skill sets of either the unemployed or those who are not in the labor force.[4]

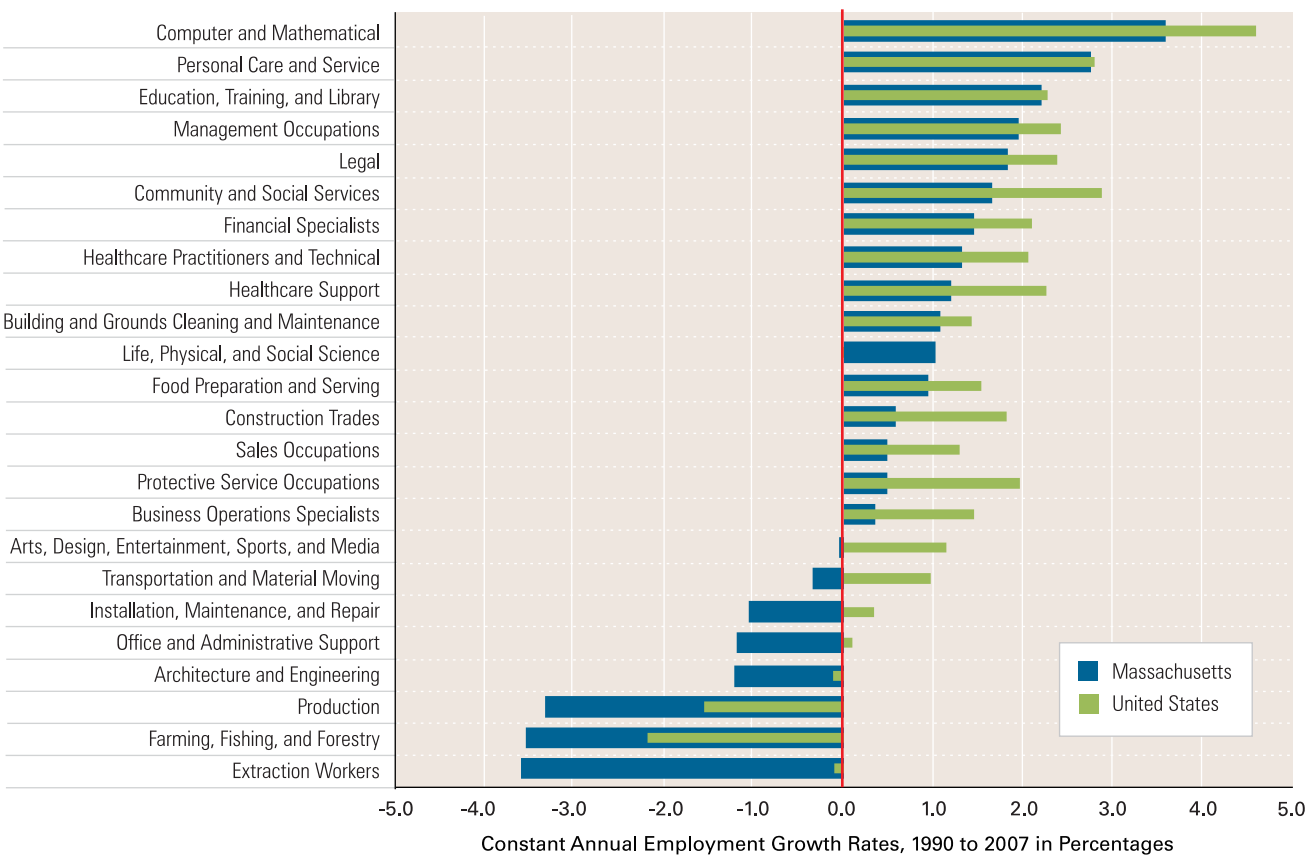
fastest growing occupations. These gains were somewhat offset by a net decline of over 10,000 computer programmers over the same period, reflecting the general shift of the industry toward digital-media and consumer and business services and the evolution of friendlier end-user software.

Following computer and mathematical occupations, the second fastest growing occupation class was personal care and services workers — a diverse collection that includes expanding occupations such as personal care attendants, child care workers, and recreation and fitness workers. Education, training and library occupations were the third fastest growing class. Growth within this class was dominated by the increasing number of teacher's aides and, other teachers and instructors — a residual category of jobs that do not fit in standard teaching occupations. There was also relatively fast growth in special education and preschool/kindergarten teachers. Job losses in this occupational class were concentrated among librarians, library technicians, and archivists/curators.

The fastest rates of job losses in Massachusetts occurred among extraction; farming, fishing and forestry; and production workers. Continued job losses in production (i.e., manufacturing) is of particular concern because they still represent a large, but shrinking, portion of the state's overall jobs base — roughly 5% in 2006/08, down from nearly 10% in 1990 — and have historically represented a path to middle class earnings for workers without college degrees. Losses are widespread among the occupations within the production class. Of the 72 production occupations listed, all but six have shed jobs since 1990, with the biggest losses occurring in the "other" production workers category (-17,650 jobs), sewing machine operators (-14,198), and miscellaneous assemblers and fabricators. Among the six growing production occupations, only computer control programmers and operators expanded significantly (from 176 jobs in 1990 to 1,655 jobs in 2007). Somewhat surprisingly, we also see significant net job losses in architecture and engineering. Unlike production, the performance of particular occupations in the architecture and engineering class was mixed, with seven of the 17 listed occupations adding net jobs since 1990, although most by only small amounts. There was notable growth among miscellaneous engineers (+2,798 jobs) and to a lesser extent computer hardware engineers (+848). Job losses within architecture and engineering were concentrated among drafters and engineering technicians, which declined by 4,193 and 13,057 jobs, respectively.

Figure 2 compares the growth rates before and after year 2000 for each occupational class within Massachusetts. The most dramatic differences were in computer

Figure 1. Employment Growth by Occupation Class, 1990 to 2007



Source: U.S. Office of the Census, Decennial Public Use Micro-sample (PUMS) 1990 and 2000 and American Community Survey 2005–2007 PUMS equivalent; authors' calculations

and mathematical occupations, where nearly all of the employment gains during the past 17 years were made during the 1990s. In the years since 2000, computer and mathematical occupations have declined by roughly 1% per year. Although far less dramatic, a similar trend is apparent among business operations specialists, which saw expansion in the 1990s and contraction since 2000. Other occupational classes showing notably faster growth in the 1990s include management, legal, and community and social services. The pace of decline in production and installation, maintenance and repair occupations has also accelerated since 2000.

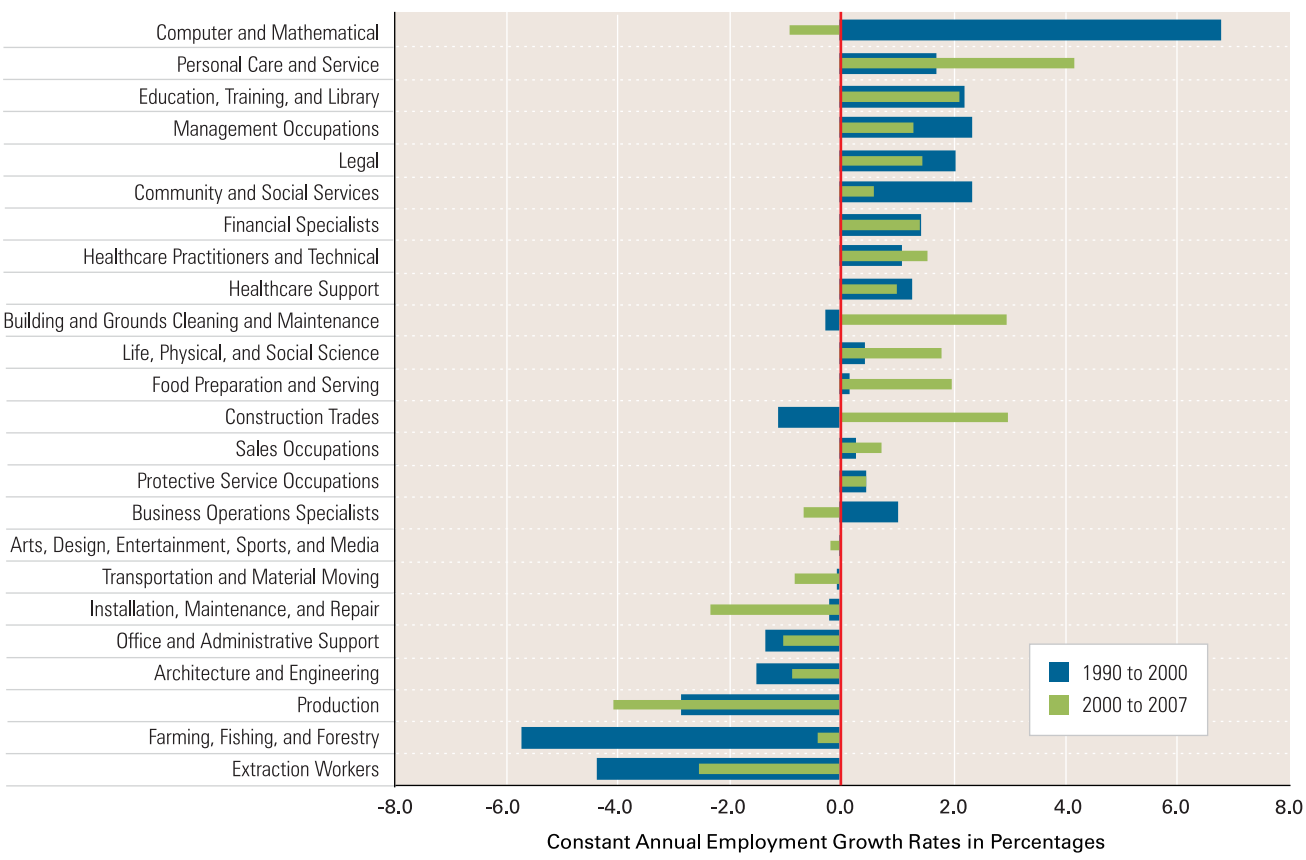
The second fastest growing occupational class, personal care and services, shows the opposite trend of accelerated growth since 2000. Growth in the number of personal and home care aides is driving much of this trend, reflecting the aging population and increasing preferences for outpatient care. Other similarly situated occupational classes include: building and grounds cleaning and maintenance occupations; life, physical, and social science occupations; food preparation and serving; and construction trades — although construction occupations have been greatly affected by recent events such as the housing market bust and offsetting economic stimulus-induced construction, neither of which is fully captured by our data.

As mentioned previously, it is difficult to directly compare national and state growth rates of specific occupations because overall employment growth in Massachusetts is far below national rates. Figure 3 puts national and statewide occupational shifts in the labor force on more even ground by showing the percentage change in the share of each occupational class between 1990 and 2007. Figure 3 also emphasizes structural changes in the composition of the workforce relative to the nation.

Figure 3 provides further supporting evidence of a shifting Massachusetts economy that is evolving away from traditional production and distribution activities and toward service and knowledge-based occupations. Moreover, Massachusetts has been outpacing the rest of the nation in this transition, as indicated by trends in bellwether knowledge occupations such as management, education, and computer and mathematical occupations, and greater relative losses in production.

This shift does not purely favor high-tech over low-tech jobs, but also represents a shift upward within the corporate hierarchy favoring Massachusetts as a location

Figure 2. Employment Growth by Occupation Class in Massachusetts, 1990 to 2000 vs. 2000 to 2007



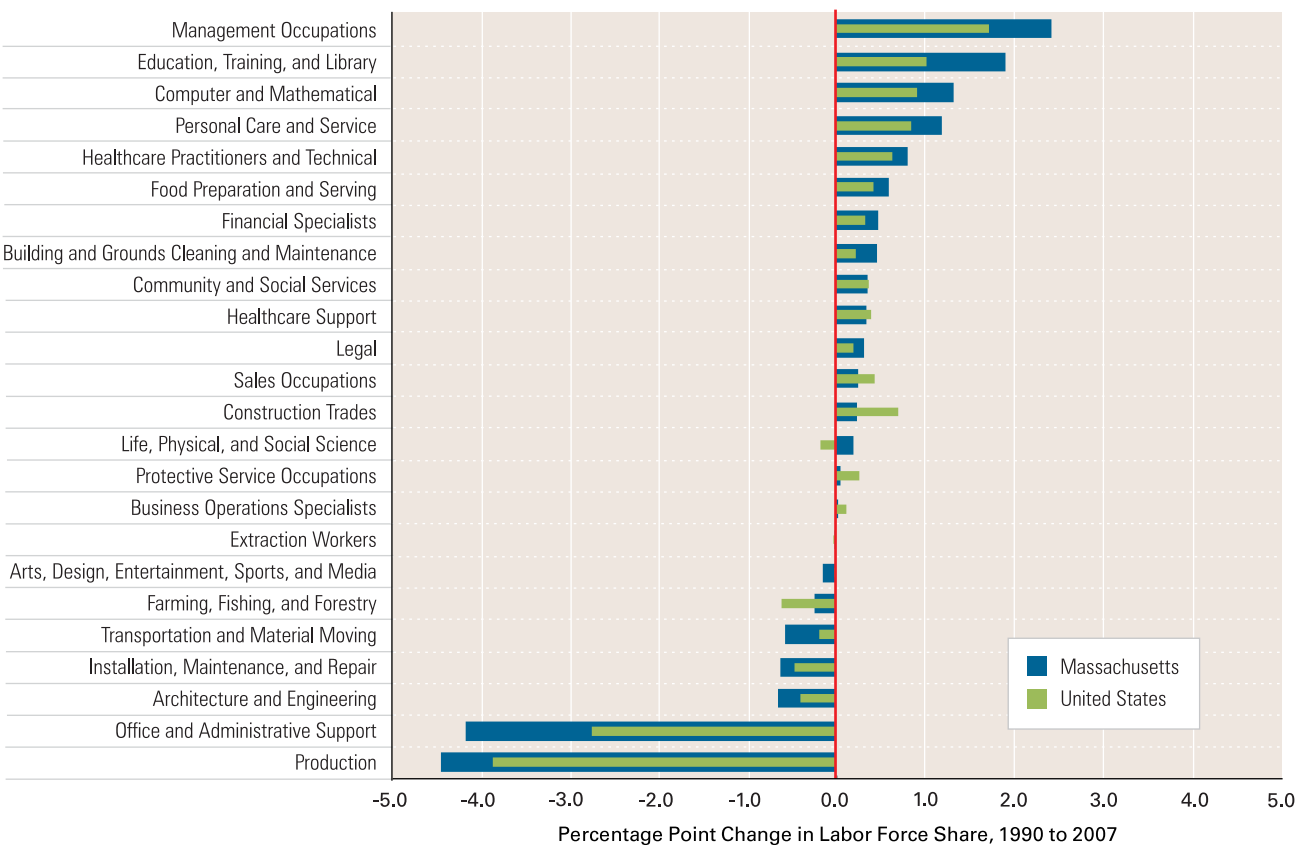
Source: U.S. Census, PUMS and ACS; authors' calculations

for corporate management and R&D functions. Consider managerial occupations, which had the largest percentage increase in their share of the Massachusetts economy from 1990 (7.6%) to 2006/08 (9.9%). Within this broad occupational class, the fastest job growth was for computer and information systems managers followed by chief executives. Contrast this with large relative losses in back-office and clerical functions and production. While this reflects the continued substitution of clerical and other routine office functions by personal computers and of production line jobs through automation, it is also consistent with globalizing trends leading to the spatial decoupling of production, back-office, customer support, R&D, and corporate headquarters. It is also consistent with growing numbers of new and small businesses, which typically have a higher ratio of owners/executives to employees.

Postsecondary Schooling and Experience

Thus far, our findings are consistent with the conventional wisdom that the modern economy favors workers with higher levels of formal education. For both Massachusetts and the nation, the fastest growing occupations tend to be those associated with education-intensive fields such as computers and education. However, it is worth examining the relationship between educational requirements and occupational growth in further depth. First, broad occupation classes, such as management or production, hide considerable variation and typically include high education occupations alongside those with more modest educational requirements. Even jobs associated with science and technology do not necessarily require advanced degrees. Consider the health industry, where some of the fastest-growing occupations are not Ph.Ds or M.D.s but technicians, home health aides, and medical assistants — all which typically do not require a bachelor's degree. A second issue is that formal schooling is not the only way to acquire the skills needed on the job. Past experience is also a form of education, in that it conditions how we acquire and apply new knowledge, and may be more or less highly valued than formal schooling, depending on the job. A final issue is whether more education is associated with faster job growth across the board, or whether there is a threshold after which the returns on additional schooling taper off. There may also be counterexamples of growing occupations that require little formal education, such as those in personal services and retail.

Figure 3. Change in the Shares of Employment by Occupation Class, 1990 to 2007



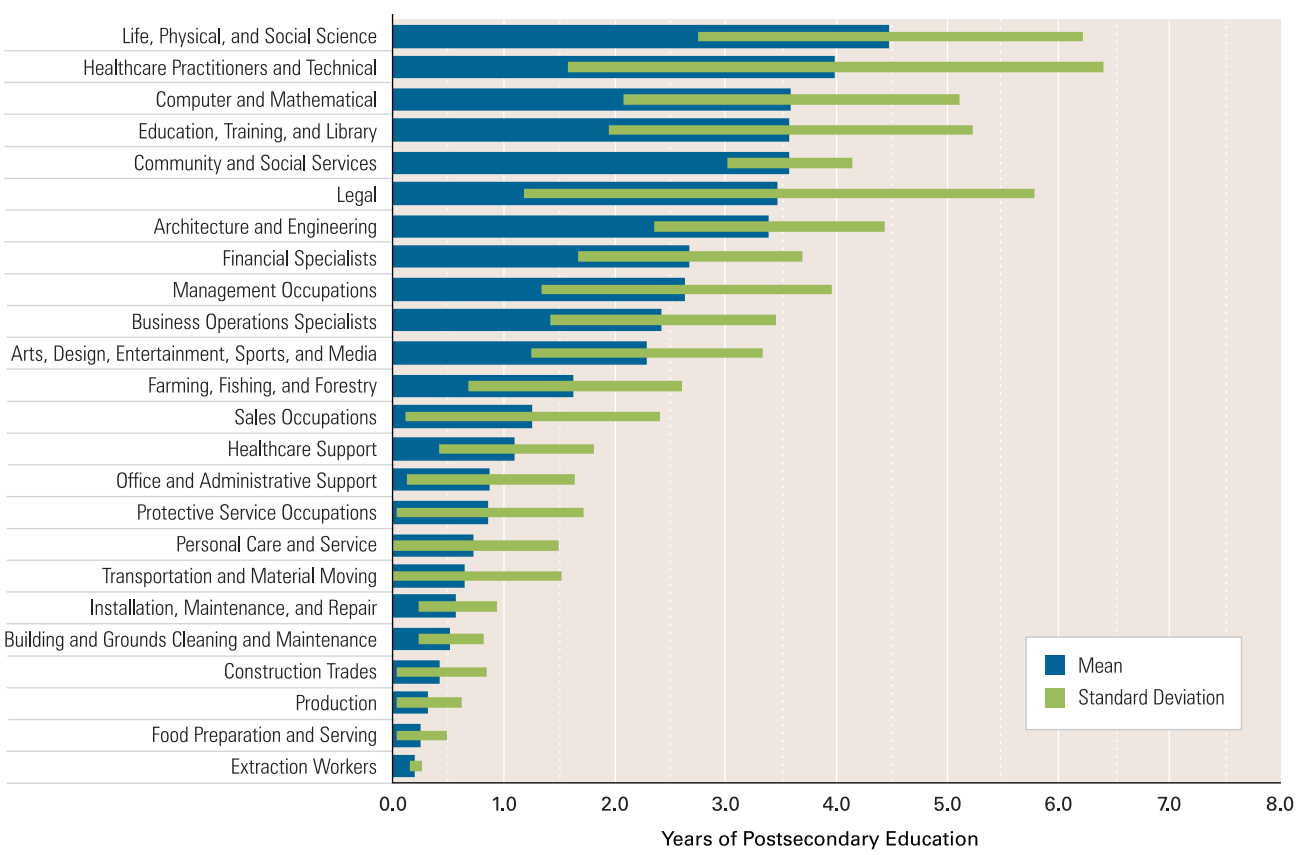
Source: U.S. Census, PUMS and ACS; authors' calculations

This section looks at distributional shifts among occupations with different education and experience requirements. For most every occupation, O*Net provides estimates of the typical number of years of postsecondary schooling and related experience expected as a condition of hire.[6] Note that hiring expectations are not the same as requirements for an entry-level position. Many of the occupations listed in O*NET (for example, chief executives) are not entry-level positions. Instead, these ratings reflect the expectations of employers when hiring workers in each occupation, regardless of whether it is an entry, intermediate, or senior level.

Figures 4 and 5 present the average levels of post-secondary schooling and experience requirements for occupations within each occupation class, ordered left to right from highest to lowest. We also include standard deviations to indicate the spread of requirements among the occupations classified within each class. Life, physical, and social scientists and healthcare practitioners top the list in terms of postsecondary schooling, with respective averages of 4.5 and 4.0 years (Figure 4). However, occupations within the healthcare practitioner class represent a far greater spread — ranging from podiatrists and physicians and surgeons requiring an average 8.7 years of postsecondary education to emergency medical technicians/paramedics that typical require less than a year of postsecondary education. There is a secondary grouping of relatively high-education occupation classes requiring between 3.4 and 3.7 years of postsecondary schooling, including computer and mathematical; education, training, and library; community and social services; legal; and architecture and engineering. At the low end of the spectrum are extraction workers, food preparation and serving, production occupations, and construction trades, which typically require less than a half year of postsecondary education as a condition of hire.

Comparing experience to post-secondary education, we find similarities and differences in the relative rankings of occupations. Education and experience are related, but not the same, as evidenced by a moderate correlation coefficient of .51. Using average occupational experience requirements as the barometer, we see architecture and engineering and management occupations moving to the top of the list from their former position in the upper-middle tier under education. Arts, design, entertainment and media occupations and construction trades workers have also moved much higher up in their relative rankings —requiring considerably more experience than formal education, per se. Healthcare practitioners have moved far

Figure 4. Average Postsecondary Educational Requirements for Broad Occupational Classes



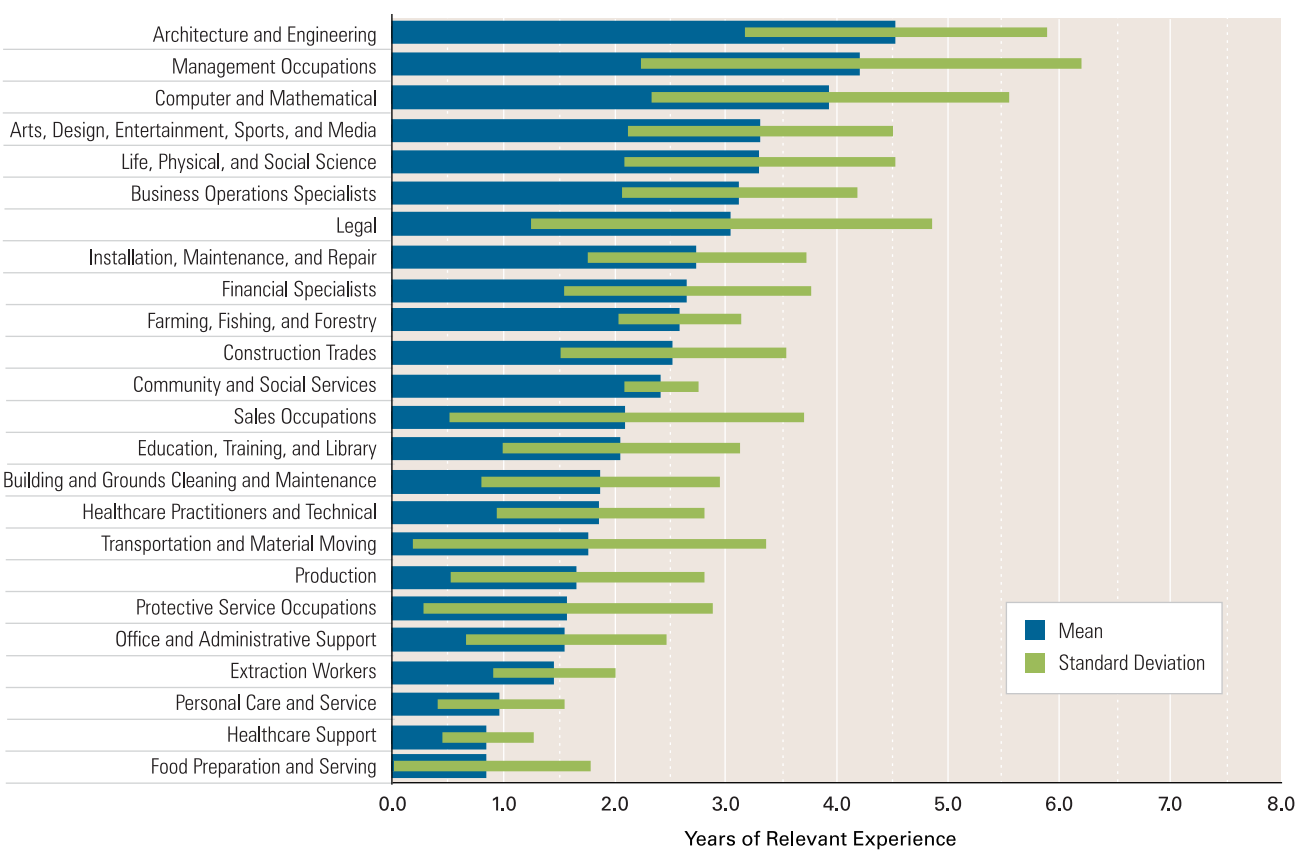
Source: U.S. Census, PUMS and ACS; Bureau of Labor Statistics Occupational Information Network (O*NET); authors' calculations

down on the list; in general, these occupations are characterized as requiring considerable schooling but only modest levels of relevant experience. This may be because of the recent upswing in demand for such jobs, or that their educational curriculum requires a strong residency or clinical component. Aside from construction, most of occupation classes found at the low-end of the experience spectrum also had fairly low education requirements, most notably food preparation and serving, personal care and service, extraction workers, and office and administrative support.

To investigate structural changes in the occupational mix, we rank each occupation by its education and experience requirements (horizontal axis) plotted against its percentage change in the share of employed labor force from 1990 to 2007 (vertical axis).[7] Figure 6 shows a major shift in the labor force toward occupations requiring more postsecondary schooling. Occupational changes in the Commonwealth largely mirror those for the nation, although the shift toward high-education occupations is much more dramatic in Massachusetts.[8] Occupations above the 75th percentile (i.e., requiring roughly three or more years of postsecondary schooling) clearly gained in their relative share of the workforce with expansion tapering among occupations above the 85th percentile (just under four years of postsecondary schooling). Unlike the U.S., Massachusetts did not show any gains among occupations in the middle of the educational spectrum. However, there were slight gains among occupations requiring virtually no postsecondary schooling. This is consistent with a weak polarizing trend with considerable demand for highly educated workers and some growing demand in jobs lacking a formal education, although nearly all of these gains at the low end are attributable to expansion in three occupations: cashiers, counter attendants, and restaurant hosts and hostesses. Growing demand for low-education workers is not widespread beyond these three occupations.

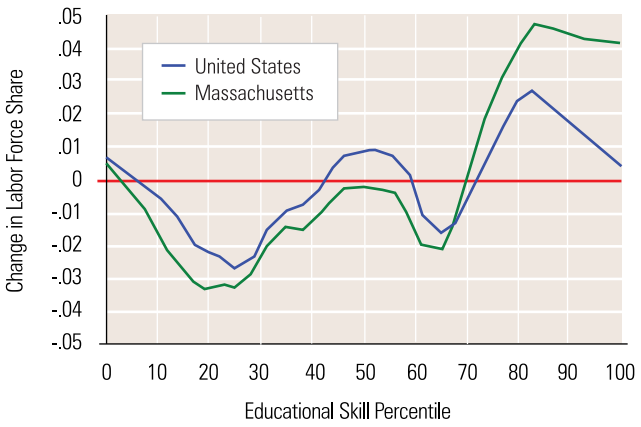
Similar to education, recent changes in the Massachusetts economy have also favored occupations requiring a high level of experience, with relative stability among low-experience positions (Figure 7). Likewise, the shift favoring high-experience jobs is even more profound in Massachusetts than for the U.S. — consistent with the view of the state economy shifting toward higher-order managerial and R&D functions. But while the state economy has shifted toward more experienced positions, there were relatively fewer opportunities in entry level positions or among occupations requiring a modest degree of experience.

Figure 5. Average Experience Requirements for Broad Occupational Classes



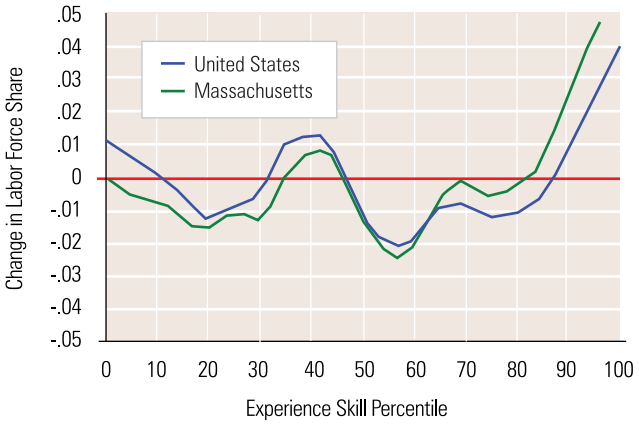
Source: U.S. Census, PUMS and ACS; BLS O*NET; authors' calculations

Figure 6. Changes in the Educational Requirements of the Labor Force, 1990 to 2007



Source: U.S. Census, PUMS and ACS; BLS O*NET; authors' calculations

Figure 7. Changes in the Experience Requirements of the Labor Force, 1990 to 2007



Source: U.S. Census, PUMS and ACS; BLS O*NET; authors' calculations

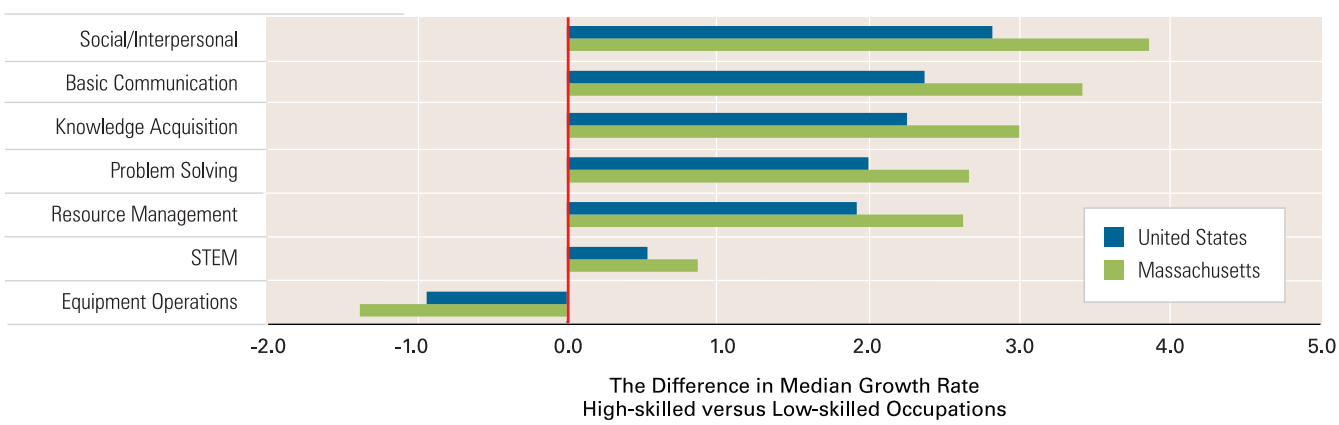
Changes in the Skill Content of Occupations

This final section looks at changes in the Massachusetts labor force mix from yet another perspective — the types of skills associated with growing occupations versus those required by stable or declining occupations. O*Net defines skills as procedures used for working with or acquiring knowledge. It classifies each occupation into 35 skill detailed categories. For the present study, we classified the 35 skills into seven skill groups: basic communication, equipment operations, knowledge acquisition, problem solving, resource management, social/interpersonal, and STEM (science, technology, engineering, and math). See Appendix 1, which lists the 35 O*Net skill categories within these seven groups. To examine the relationship between skills and growth, we classify each occupation by whether it requires a high or a low level of each skill, and measure the median growth rate of the occupations within each skill group. The difference in the growth rates of high and low skilled occupations highlights skills that may be becoming more or less important in the evolving economy. Figure 8 summarizes the key results according to the seven skill groups with a full analysis for all 35 skill types provided in Appendix Table 1.

Several general trends stand out from Figure 8. The fastest growing jobs in the Massachusetts economy tend to require high levels of social/interpersonal skills — social perceptiveness, service orientation, negotiation and persuasion — as well as basic communications skills such as speaking and writing. These are common traits shared by many occupations in the expanding service economy that transcend different education and experience requirements. A high level of communicative and social skills is also characteristic of occupations in the expanding managerial and health/medical fields.

We also see high growth among occupations requiring a high level of skills that facilitate the acquisition of new knowledge and transmission of information — such as active listening, reading comprehension, and learning strategies — along with problem-solving skills such as critical thinking. This highlights a second key feature of work in the new economy — adaptability and the ability to quickly adjust to a very fluid work environment where

Figure 8. Employment Growth in Occupations Requiring a High Versus Low Level of Skill, 1990 to 2007



Source: U.S. Census, PUMS and ACS; BLS O*NET; authors' calculations

Occupations and Wages

Massachusetts has long had an income advantage relative to the nation as a whole. Seen through the lens of the state's occupational mix, two patterns, not mutually exclusive, can support higher incomes in the state in contrast with the nation. The state's occupational mix can either comprise generally higher-paying occupations, and/or the state can offer workers more pay than is the case for the occupations generally.

In fact, it turns out that most of the occupational contribution to our state's higher income levels stems from a preponderance of high-paying occupations in the state and a relative dearth of low-paying ones. The accompanying table displays, for 22 occupational groups, the average annual wage for U.S. workers, for Massachusetts workers (U.S. wages have been adjusted to reflect the cost of living in Massachusetts), and a location quotient (LQ). The LQ shows the relative share of employment in an occupation in Massachusetts (numerator) versus that for the nation (denominator). For ease of interpretation, the LQ has been standardized to zero. This means that any LQ of more than zero reflects a higher proportion of Massachusetts employment in the occupation than in the nation. An LQ less than zero means that the state has less than its pro rata share, compared with the nation.

Note that for the first seven highest-paid occupations, the state has more than its share of employment. Massachusetts, in other words, has an occupational structure that is top heavy with well-paying occupations. The state has a lower share of lower-paying occupations as well. For each of the bottom ten occupations ranked by annual average wage, the state has a smaller share of workers than does the nation. So Massachusetts has an occupational mix that favors higher-paying occupations rather than lower-paying ones.

The picture becomes a bit mixed with regard to wage levels within occupational groups. Of the seven highest-paying occupations (nationally), the state pays above the national average wage in four of them, below the national average in three. To an extent, this counters the impact on state income of the presence of a higher share of higher-paying occupations. At the other end of the pay scale, in all of the ten lowest-paying occupations, the state averages higher pay.

Overall, then, the picture in the state is that we employ a larger fraction of high-paying occupations than does the nation, and smaller fractions of low-paying occupations. And while the state has a mixed record with higher-paying occupations — higher pay in the state for some, lower for others — there is an unmixed record of the state paying more than the national average for lower-paying occupations.

Concentration and Average Annual Wage of Occupational Groups in Massachusetts, May 2010

Occupational Group	U.S. Average Annual Wage, adjusted to MA urban dollars	Average Annual Wage, MA	Location Quotient for MA (standardized to zero)
Management	$115,060	$120,570	0.244
Life, Physical, and Social Science	$105,784	$73,700	0.669
Business and Financial Operations	$84,276	$77,110	0.153
Computer and Mathematical	$82,443	$88,020	0.551
Legal	$77,783	$103,280	0.017
Architecture and Engineering	$73,866	$81,230	0.252
Community and Social Service	$72,447	$43,590	0.541
Protective Service	$57,061	$46,260	-0.041
Healthcare Support	$55,042	$31,830	-0.029
Arts, Design, Entertainment, Sports, and Media	$47,872	$57,710	0.329
Education, Training, and Library	$47,119	$58,290	0.060
Healthcare Practitioners and Technical	$46,716	$80,400	0.236
Food Preparation and Serving Related	$46,366	$25,600	-0.033
Installation, Maintenance, and Repair	$40,146	$49,030	-0.194
Personal Care and Service	$36,851	$29,910	-0.034
Building and Grounds Cleaning and Maintenance	$36,524	$31,380	-0.052
Office and Administrative Support	$35,640	$38,650	-0.048
Sales and Related	$29,376	$43,100	-0.039
Construction and Extraction	$27,608	$54,160	-0.268
Production	$26,833	$36,800	-0.221
Farming, Fishing, and Forestry	$26,550	$29,440	-0.849
Transportation and Material Moving	$23,178	$34,200	-0.275

Notes: U.S. average annual wage has been adjusted by the MA CPI-U to compare equal purchasing power.

Location Quotient of zero means that the occupation is as common in MA as it is nationwide; a higher LQ means people in MA are more commonly employed in that occupation than nationwide.

Source: U.S. Bureau of Labor Statistics, Occupational Employment Statistics (OES) Survey

technology and competition are continually rewriting the rules of the game. Time management skills also fit into the growing emphasis on adaptability, in that the increasing complexity of work requires the ability to rapidly shift focus and direct attention to new problems as they arise.

Occupations requiring a high level of skill in the operation of equipment and machinery are on the wane. This includes skills traditionally associated with production occupations and skilled trades such as repairing, operation and control, operation monitoring, installation of equipment and maintenance.

Somewhat surprising, many of the hallmark skills associated strictly with science, technology and mathematics (STEM) occupations (e.g., science, programming, operations analysis, systems evaluation and mathematics) have experienced little overall growth. In part, this is because many STEM-related occupations have witnessed relative decline over the study period, including economists, astronomers and physicists, and mechanical and environmental engineers. These are balanced by many fast-growing occupations in STEM fields, namely in software, life sciences, and medicine. Science and math skills also tend to be rather specialized, with relatively few occupations that require a high level of mastery. That means that the top 25th percentile of occupations requiring science and math skills is highly diverse, and includes not only the commonly associated STEM occupations such as biological technicians and software engineers, but more science-oriented occupations in farming, fishing, forestry, production, transportation and materials moving, and installation, maintenance, and repair.

This is not to say that STEM skills are not important. While they may not have the fast growth associated with service-industry skills, scientific discoveries, and the creation of new knowledge create a disproportionate share of regional wealth. However, for the labor market as a whole, the common denominator of growing occupations is not their high science or math content, per se, but interpersonal and learning skills. In fact, key STEM occupations often require a high degree of social perceptiveness, reading comprehension, time management and active learning, and critical thinking.

National trends in changing skill requirements largely mirror Massachusetts, although the national patterns are more subtle. The Commonwealth has seen larger differences between high- and low-skill growth across the board. In part, this is because the U.S. is larger and more diverse, thus muting some of the swing found in smaller and more specialized state economies. As shown previously, the occupational structure of Massachusetts has also made a much more dramatic structural shift toward occupations requiring a higher formal educational and experience content than the nation. Similarly, the relative decline in equipment operations occupations has been far slower for the U.S. than in Massachusetts.

Summary and Conclusions

This study documents changes in the Massachusetts labor force coinciding with the rise of the new economy. Massachusetts has clearly become more knowledge- and tech-intensive over the past two decades — with fast-growing occupations in information technology, health care, and education. The economy has also become more service-oriented with considerable expansion in the number of managerial workers, and declining employment in production and back-office administrative workers.

The Massachusetts workforce has also become considerably more education and experience intensive. Changes in the U.S. occupation mix have clearly favored jobs requiring more education and experience, but in Massachusetts this shift has been more dramatic. Additionally, there is some evidence of a mild polarization of skills in the job market, characterized by slight growth among jobs requiring very little postsecondary education or prior experience, such as cashiers, sales clerks, roofers, and construction laborers. Although these jobs may require little formal education, they are difficult to automate or outsource because they involve nonroutine work tasks that are nontransferrable in that they often demand a physical presence or have a high tacit knowledge component that cannot be easily learned or taught from a distance.

The primary lesson for policy makers is to understand that success in today's workforce is both a technical and social enterprise. While most think of the new economy in terms of emerging technologies, the skills that are most highly associated with growing jobs are not purely science and math skills. Rather it is the combination of social, communicative, and learning skills that appear to be driving the growth of high-skilled occupations in management, healthcare, software development, and numerous other expanding fields. More than anything, the highly fluid landscape of the new economy favors adaptability. While science and innovation help create the new technologies that give rise to new industries and transform the way we live and work, it is skills related to the acquisition, processing, and dissemination of new knowledge that condition our ability to effectively adapt to these changes. We need to nurture both to remain vital in the new global economy of the 21st century.

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Appendix Table 1. Annual Employment Growth of Occupations Requiring a High, Medium or Low Level of Each Skill

(Median growth rates are used)

		MASSACHUSETTS				UNITED STATES			
Skill Number	Skill Group and Types of Skill	High Skill	Mid Skill	Low Skill	Difference High-Low	High Skill	Mid Skill	Low Skill	Difference High-Low
	Basic Communication								
9	Instructing	0.64	-1.10	-2.32	2.96	1.48	0.55	-0.86	2.34
29	Speaking	0.27	-0.83	-3.01	3.28	1.14	0.77	-1.13	2.27
35	Writing	0.33	-1.00	-2.72	3.05	1.10	0.71	-1.01	2.11
	Equipment Operations								
6	Equipment Maintenance	-2.08	-0.88	-0.11	-1.96	-0.16	0.53	0.89	-1.05
7	Equipment Selection	-0.94	-1.03	-0.69	-0.25	0.57	0.38	0.54	0.03
8	Installation	-2.09	-0.75	-0.11	-1.98	0.01	0.69	0.89	-0.89
18	Operation Monitoring	-2.10	-0.93	0.08	-2.18	-0.33	0.58	1.11	-1.44
19	Operation and Control	-2.11	-1.08	0.08	-2.19	-0.28	0.48	1.18	-1.45
25	Repairing	-2.61	-0.52	0.05	-2.67	-0.63	0.75	1.09	-1.72
34	Troubleshooting	-1.59	-0.92	-0.15	-1.44	-0.02	0.51	1.00	-1.02
	Knowledge Acquisition								
1	Active Learning	0.40	-1.17	-2.34	2.74	1.14	0.51	-0.80	1.94
2	Active Listening	0.48	-1.04	-3.00	3.47	1.30	0.75	-1.14	2.44
11	Learning Strategies	0.69	-1.25	-2.23	2.92	1.76	0.40	-0.63	2.39
24	Reading Comprehension	0.64	-0.95	-2.62	3.25	1.14	0.80	-1.10	2.24
	Problem Solving								
3	Complex Problem Solving	0.24	-0.95	-2.00	2.24	1.16	0.59	-0.63	1.78
5	Critical Thinking	0.39	-0.97	-2.52	2.91	1.18	0.71	-0.95	2.14
10	Judgment and Decision Making	0.17	-0.87	-2.71	2.88	1.18	0.66	-0.78	1.96
	Resource Management								
12	Management of Financial Resources	0.24	-0.53	-2.83	3.07	1.10	0.77	-1.03	2.13
13	Management of Material Resources	-0.73	-0.64	-1.74	1.01	0.78	0.75	-0.46	1.24
14	Management of Personnel Resources	-0.14	-0.45	-2.34	2.20	1.11	0.75	-0.80	1.91
16	Monitoring	0.75	-1.25	-2.09	2.83	1.74	0.22	-0.49	2.23
33	Time Management	0.82	-1.10	-2.72	3.54	1.43	0.70	-1.07	2.50
	Social/Interpersonal								
4	Coordination	0.24	-0.58	-2.54	2.78	1.16	0.74	-0.86	2.01
17	Negotiation	0.21	-0.34	-3.18	3.38	1.12	0.81	-1.30	2.42
21	Persuasion	0.62	-0.87	-2.83	3.44	1.59	0.73	-1.08	2.66
27	Service Orientation	0.75	-0.26	-3.64	4.39	1.76	0.75	-1.55	3.30
28	Social Perceptiveness	1.12	-0.97	-3.27	4.39	1.89	0.51	-1.22	3.11
	Science, Technology, Engineering and Mathematics (STEM)								
15	Mathematics	-0.62	-0.98	-0.74	0.12	0.66	0.48	0.19	0.46
20	Operations Analysis	-0.39	-0.90	-1.46	1.07	0.83	0.63	-0.16	0.99
22	Programming	-0.84	-0.58	-1.88	1.04	0.50	0.70	0.21	0.28
23	Quality Control Analysis	-1.52	-1.06	-0.24	-1.28	-0.20	0.54	0.88	-1.09
26	Science	0.10	-1.21	-1.00	1.10	0.78	0.38	0.29	0.49
30	Systems Analysis	-0.40	-1.39	-0.49	0.08	0.51	0.39	0.51	0.00
31	Systems Evaluation	-0.15	-1.04	-1.09	0.94	0.60	0.61	0.19	0.41
32	Technology Design	-1.02	-0.92	-0.72	-0.30	0.18	0.70	0.39	-0.21

Source: U.S. Census, PUMS and ACS; BLS O*NET; authors' calculations

Endnotes:

1.) http://www.kauffman.org/uploadedfiles/snei_2010_report.pdf.

2.) For more information on the O*NET content model, please visit http://www.onetcenter.org/content.html.

3.) We measure occupational requirements using a version of O*Net coinciding with the terminal year of our study period (O*NET v. 11 released in 2006). As O*Net is constantly being updated and expanded, more recent releases contain greater coverage of occupations than early models. The content model of O*NET is also updated on a three-year rolling basis, meaning that the data included in the 2006 release reflect occupation skills measured between 2004 to 2006.

4.) Also note that these ratings are based on a national sample and may not reflect state-specific occupational requirements, as would be the case if Massachusetts employers typically required more or less education for the same occupation than did other employers in the U.S.

5.) Because of the different time spans between 1990 to 2000 and 2000 to 2007, we calculate annual growth rates as the implied annual rate, assuming that growth was constant over the study period.

The constant annual growth rate is calculated as $CGR = \sqrt[n]{Emp_t / Emp_b} - 1$, where n is the number of annual intervals between the terminal period (t) and the base period (b). The advantage in calculating constant annual growth rates is that they can be directly compared between study periods of different lengths, whereas percentage change growth rates or annual average growth rates are dependent upon the length of the study period.

6.) O*Net includes categorical measures of degree requirements (e.g., associates degree, bachelor's degree), which we converted into equivalent years of postsecondary schooling by assuming typical years for completion. For example, associates degrees were assumed to be 2 years of postsecondary education, bachelor's degrees require four years of postsecondary education, etc.

7.) The education, experience and training requirements are ranked as percentiles to space them evenly across the distribution, using a kernel-based weighted moving average that smooths over individual points and emphasizes the overall trend.

8.) Although not shown, a breakdown of the study period into its 1990 to 2000 and 2000 to 2006/08 components shows that the same general pattern holds for both sub-periods, although the shifts toward education-biased occupations were faster during the 1990s.

ENDNOTES

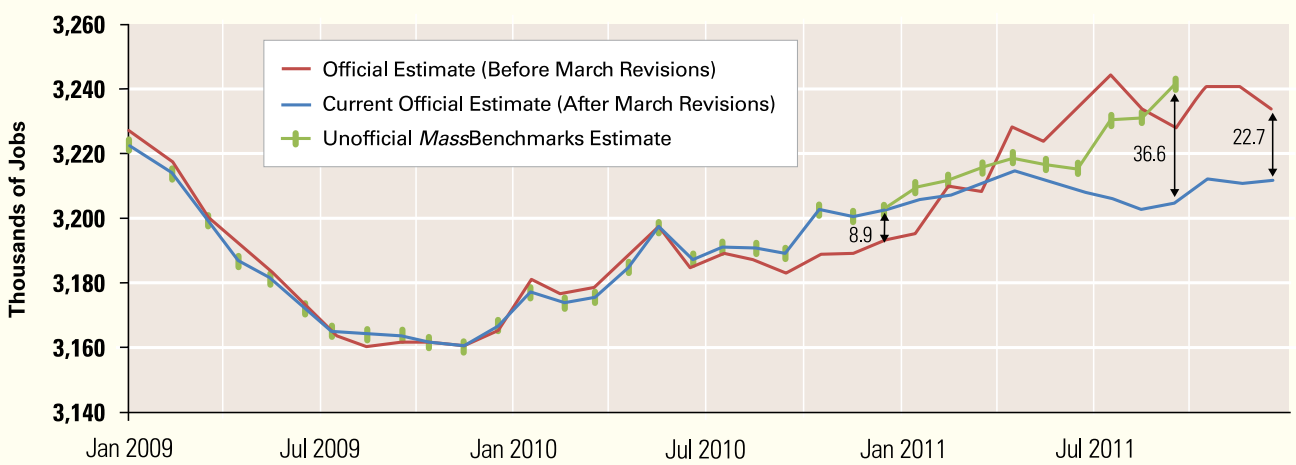
Newly Released Data Change Our Understanding of Job Growth in 2011

Alan Clayton-Matthews

Editors' Note:
A major revision in payroll employment data was recently released by the Bureau of Labor Statistics. Given the significance of the revision, this journal has reassessed and rewritten its comments on the recent history of the state economy. In this Endnotes, Professor Alan Clayton-Matthews describes the nature and source of the payroll data that we use, and the reasons behind the revisions. He notes that although these revisions are only performed once a year, the major source data for these revisions, the Quarterly Census of Employment and Wages (aka ES-202) are released each quarter, enabling one to update and revise the payroll employment estimates each quarter. The most recent release of this data was on March 28th, and a summary of *Mass*Benchmark's revisions are included in the last section of this endnote.

Each year in early March the Massachusetts Executive Office of Labor and Workforce Development, in conjunction with the U.S. Bureau of Labor Statistics, releases benchmark revisions to the establishment survey (CES-790) payroll jobs estimates reflecting job counts from the Quarterly Census of Employment and Wages (QCEW, aka ES-202). The ES-202 is essentially a quarterly census of employers belonging to the Unemployment Insurance system that employ approximately 97 percent of non-farm workers covered by the 790 survey. Each quarter, employers subject to the UI law are required to report to the state workforce agency employment and wage information, including monthly payroll employment by month and wages and salaries paid during the quarter. The ES-202 provides a nearly accurate job count that is used to update the history of the less reliable CES-790 survey, which is subject to substantial sampling and non-sampling error. Since the ES-202's are released with a lag of seven months (the ES-202 for the second quarter of 2011 was released on January 10, 2012), the revised CES-790 is nearly accurate through June of 2011. The estimates for July 2011 and later are updated with revised statistical estimates of employment due to net firm births and updated seasonal factors, but substantial errors may remain. Those errors will be corrected next year with the next annual benchmark procedure.[1]

Figure 1. A Tale of Three Estimates



Source: Massachusetts Executive Office of Labor and Workforce Development; U.S. Bureau of Labor Statistics; *Mass*Benchmarks journal; Prepared by Alan Clayton-Matthews

The Benchmark Revisions

Figure 1 graphs the pre- (i.e., old) and post-benchmarked ES-790 payroll employment estimates for Massachusetts. The new estimated number of jobs for December 2011 is 22,700 less than previously published. The revisions of note go back to July 2010, since June 2010 was the last date of ES-202-based estimates from last year's annual benchmark procedure.[2] Note that employment in the second half of 2010 was revised upward, so that the nearly accurate measure of December 2010 employment is now 8,900 more than previously published. This means that the revised estimate of job growth during 2011 (from December 2010 through December 2011) is 31,600 less than previously reported, so job growth in 2011 is now estimated to have been only 9,100 (0.3 percent) versus the 40,700 (1.3 percent) previously published.[3]

The (net) change of 22,700 jobs for December 2011 is the sum of changes in both directions in the NAICS super sectors. Six of these major industrial categories reported changes of more than 4,000 jobs in magnitude. On the upside, Professional and Business Services jobs in December are now (estimated to be) 4,300 more than previously, with job growth of 2.1 percent in 2011. Within this sector, Professional, Scientific, and Technical Services grew 2.6 percent. On the downside, Education and Health Services jobs are now 5,900 fewer than previously, with virtually no job growth (0.04 percent) in 2011. Within this sector educational service jobs declined 3.8 percent in 2011.

Why Is the CES-790 Subject to Error?

The CES-790 is a survey that faces enormous challenges to its accuracy due to the dynamics of the economy, as well as to due to "typical" sampling error. As surveys go, it is large. The active CES sample includes approximately one-third of nonfarm employment. All firms with 1,000 or more employees are asked to participate, and a rotating sample of the remaining firms is in the survey for two years or more at a time. The monthly employment estimates are based on firms that report in both the reference month and the prior month, using a sample link procedure. New firms do not get into the sample frame for approximately a year, so their employment is not captured in the current estimates. Offsetting this, firms that go out of business are ignored and treated the same as firms that do not report. Since employment due to births and deaths of firms do not exactly offset each other, a statistical model is used that estimates net employment due to births and deaths using historical data from the ES-202's. So the major sources of error are sampling error, non-participation of firms that were asked to be in the survey, non-reporting or attrition of firms from the survey, and error in predicting the net of employment change due to firm births and firm deaths. Added to this is error due to seasonal adjustments. To make employment levels comparable from month to month, employment is seasonally adjusted using standard statistical procedures. When seasonal patterns are unstable from year to year, this adds additional intra-year errors.

Table 1. *Mass*Benchmarks Revisions to September 2011 Payroll Employment, by Sector

Sector	Revision
Natural Resources and Mining	500
Construction	4,200
Manufacturing	-2,200
Wholesale Trade	-600
Retail Trade	2,800
Transportation, Warehousing, and Utilities	0
Information	700
Finance and Insurance	1,700
Real Estate and Leasing	1,100
Professional and Technical Services	1,700
Management of Companies and Enterprises	800
Administrative and Waste Services	1,900
Educational Services	7,100
Health Care and Social Assistance	4,500
Arts, Entertainment, and Recreation	4,600
Accommodation and Food Services	5,600
Other Services	-1,200
Federal Government	-300
State Government	3,800
Local Government	-500
Total Nonagricultural Payroll Employment	**36,600**

Notes: These estimates are based on the March 28 release of the ES-202 by the U.S. Bureau of Labor Statistics and represent the difference between *Mass*Benchmark's estimates of September 2011 payroll employment and the current official estimates. The sum does not equal total because of rounding. The standard error for the total is +/- 4,000 jobs.

Source: *Mass*Benchmarks journal; Prepared by Alan Clayton-Matthews

The Benchmarking Procedure

In the annual benchmark procedure, historical data covered by the ES-202 are adjusted using this virtual census of employers. For employment estimates after this period (July 2011 through December 2011), the sample-based monthly changes from the CES-790 are applied to the new June 2011 benchmark level using the sample link procedure. New projections of the net employment change due to births and deaths are made, and newly estimated seasonal adjustments are applied to the historical data. These updates to the estimates mean that the pattern of monthly changes in employment in July through December 2011

can and do change. Payroll employment in the second half of 2011 (June through December) is now estimated to have grown by 2,600 instead of 400 as previously reported.

What's Next?

Accurate estimates of CES-790 payroll employment for the second half of 2011 will not be officially published until March of next year, because the U.S. Bureau of Labor Statistics only performs the benchmark revisions once per year. However, the ES-202 data from which these revisions are derived are released each quarter. The ES-202 for the third quarter of 2011 was released on March 28th, providing the first available UI-based job counts for July-September 2011, as well as minor revisions to job counts in the first six months of 2011. We calculated a simplified version of BLS's process to estimate what the revised CES-790 job counts would be for January-September 2011 if the BLS were to have performed the benchmarking process. The standard (typical) error in our calculation of the total job count is 4,000 jobs, with a 95% probability that the error is less than 8,000 jobs. A complete description of our methodology is available on the *Mass*Benchmarks website.[4]

The revisions for job growth in the third quarter of 2011 are as dramatic as those in the first half of 2011, but are in the opposite direction. The official, post-benchmark CES-790 job counts have employment declining from 3,209,200 in June 2011 to 3,205,000 in September 2011, a loss of 4,200 jobs. In contrast, our unofficial revised job counts have employment increasing from 3,215,500 in June to 3,241,600, an increase of 26,100 jobs. The difference in the June job counts is due to a revision in the ES-202 data for the first six months of 2011 that increased the job count in June by 7,235 on a not seasonally-adjusted basis. Our best estimate of job growth in the first nine months of 2011, from December 2010 to September 2011, is now 38,900 instead of the official CES-790 estimate of only 2,300.

The difference in job counts in September 2011 represents an upward revision of 36,600 in that month (Figure 1 and Table 1). The largest revisions were in Leisure and Hospitality; and Educational Services, with upward revisions of 10,200 and 7,100 respectively. Construction was revised up by 4,200 jobs. Manufacturing was revised down by 2,200 jobs. Most other sectors had small to moderate upward revisions. The full set of revisions and monthly job estimates are available on-line.

When the fourth quarter 2011 ES-202 data are released on June 28th, *Mass*Benchmarks will re-estimate CES-790 job counts for all of 2011. As each new quarter of data become available, *Mass*Benchmarks will provide updated estimates.

In early March of next year, the Bureau of Labor Statistics will provide the official ES-202-based job counts for the CES-790 series through the second quarter of 2012, and its benchmarked estimates for the second half of 2012. Stay tuned for future *Mass*Benchmarks releases.

ALAN CLAYTON-MATTHEWS, an associate professor of Economics & Public Policy in the School of Public Policy and Urban Affairs at Northeastern University, is Senior Contributing Editor of this journal.

Endnotes:

1.) This note provides brief, simplified explanations of the estimation and benchmark procedures for the CES-790. A fuller documentation is available from the U.S. Bureau of Labor Statistics at http://www.bls.gov/web/empsit/cestn1.htm.

2.) Pre-July 2010, the minor revisions are essentially due to new seasonal adjustments.

3.) Job growth in 2010 (December 2009 through December 2010) is now accurately estimated to be 35,800 rather than the 28,200 previously published.

4.) The methodology is simple. We adjust for differences in coverage between the ES-202 series and the CES-790 series (on a not-seasonally-adjusted basis) by using the actual difference in the prior year, and seasonally-adjust using the prior year's actual seasonal adjustment factor. These two assumptions of stable year-over-year differences in coverage and seasonal variations are reasonable but result in a difference between our estimates of the job count and what the BLS would have estimated using their more-involved and more-accurate procedure. We estimate the typical magnitude of the difference (standard error) between our estimates and those of the BLS to be 4,000. A full explanation of the methodology and our estimates of adjusted CES-790 job counts by sector are available on-line at http://www.massbenchmarks.org/news/01_data_revisions/data_revisions.htm.

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