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The Rhode Island Labor Market in Recovery: Where is the Skills Gap?

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Abstract:

This paper assesses the extent to which Rhode Island's workforce lacks skills that are in demand among the state's current and potential employers and, if so, whether such a skills gap or labor market "mismatch" significantly restrains employment growth in the state. Using an index developed by Sahin et al. (2014), we find that occupational mismatch in Rhode Island increased leading up to and during the Great Recession and fell back to pre-recession levels by mid-2013. In 2015:Q2, occupational mismatch restrained quarterly employment growth in Rhode Island by an estimated 0.03 percentage points. However, since 2013 Rhode Island's employment growth rate has exceeded its long-run average, suggesting that the current extent of mismatch in the state is no greater than its long-run average level. Nonetheless, the share of Rhode Island-based jobs filled by out-of-state workers has increased significantly since 2001, a trend driven by jobs that employ college-educated workers. This evidence agrees with some Rhode Island employers' claims that they have trouble filling skilled jobs with Rhode Island resident workers. While this finding suggests that at the broader regional level, occupational mismatch is not a serious problem, regional welfare might yet be improved by training Rhode Island workers to fill such positions.

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"How can it be that Rhode Island has a stubbornly high unemployment rate, yet there are employers every day saying they have jobs open that they can't fill? The problem is that not enough Rhode Islanders have the skills they need to succeed in 21st century jobs."

Scott Jensen, Director, Rhode Island Department of Labor and Training[1]

1. Introduction

This quotation represents just one piece of anecdotal evidence for the existence of a so-called skills gap in Rhode Island—numerous other examples could be cited. Recent economic trends also support the possibility that a skills gap might have emerged in Rhode Island during the past few decades. For example, employment in Rhode Island's manufacturing industry contracted by 57 percent between 1990 and 2015, and these job losses were heavily concentrated among workers with a high school education or less. At the same time, demand for highly-skilled workers (relative to middle-skill workers) has been on the rise nationally since the early 1980s, and despite increases in U.S. college enrollment in recent decades, the supply of highly-educated workers has not kept pace with demand (Autor 2010).[2] Nonetheless, beyond anecdotal accounts such as the one quoted above, data-based evidence of a skills gap in Rhode Island is lacking. This paper assesses the extent to which Rhode Island's workforce lacks the skills that are in demand among the state's current and potential employers and, if so, whether such a skills gap or labor market "mismatch" significantly restrains employment growth in the state. The findings are germane to current policy debates related to workforce development and job creation, both in Rhode Island and other parts of New England.

The paper's key findings are as follows:

- The share of college-educated workers in Rhode Island's labor force is slightly greater than the corresponding share of the U.S. labor force during the 2001 through 2015 period, but significantly less than the college-educated share of the Massachusetts labor

[1] "Real Jobs Rhode Island Puts Employers at the Center of Job Training," July 31, 2015 Press Release. Cranston, RI: Rhode Island Department of Labor and Training. Available at http://www.ri.gov/press/view/25467.

[2] Since the 1990s, demand for low-skilled workers—primarily in services occupations—has also increased relative to demand for middle-skill workers, and this increase may have helped to absorb displaced manufacturing workers in Rhode Island and elsewhere.

force. Over this 14-year period, the college-educated share of the labor force increased at roughly the same pace in Rhode Island and the United States, and increased at a slightly faster pace in Massachusetts.

- A quantitative index of occupational mismatch suggests that Rhode Island experienced an increase in mismatch between 2006:Q2 and 2009:Q3, but that this mismatch has since abated. At its peak in 2009:Q3, labor market mismatch may have restrained new hires by about 4 percent and shaved roughly 0.4 percentage points off of employment growth for that quarter. In 2015:Q2, however, mismatch restrained hires by an estimated 0.4 percent and blunted employment growth for the quarter by just 0.03 percentage points. As a point of comparison, as of 2006:Q2—prior to the recession—mismatch restrained hires in Rhode Island by roughly 2 percent.
- The share of employed Rhode Island residents commuting to Massachusetts for work increased between 2010 and 2013, but primarily among those with less than a bachelor's degree. During the same time period, the share of Rhode Island-based jobs filled by workers commuting from Massachusetts increased, mainly among jobs requiring at least a college degree. These facts suggest that occupational mismatch in Rhode Island—as well as geographic mismatch across states in the region—was alleviated in part as a result of worker "trades" between Rhode Island and Massachusetts.
- An upward trend in nonresident employment in Rhode Island since 2001 is documented; this trend is steepest for jobs filled by college-educated workers. This trend suggests that over the last 14 years, employers in the state may have found it increasingly difficult to fill high-skilled positions with resident Rhode Island workers, consistent with anecdotal evidence.
- Following an increase in occupational mismatch, wage growth by occupation should be positively correlated with employment growth by occupation. In Rhode Island, for the years 2006 through 2014, wage growth and employment growth by occupation exhibit a positive correlation only intermittently. The average correlation is either zero or negative depending on the level of occupational aggregation.

- Between 2006 and 2014, the average year-over-year wage growth in Rhode Island is higher among jobs requiring a bachelor's degree or more than among jobs requiring less education. However, between 2013 and 2014 alone, jobs requiring less than a college education experienced faster wage growth than those requiring a college degree or more.
- The increase in occupational mismatch between 2006 and 2009 and its subsequent decline—an increase observed within Rhode Island as well as for the United States as a whole—coincide closely with the onset of the Great Recession and the subsequent recovery. Previous research argues that the appearance of structural mismatch can arise in response to a negative aggregate demand shock when the impact of such a shock on labor demand varies across occupations or industries. These facts suggest that recent increases in aggregate demand also helped to alleviate mismatch and that the apparent mismatch was not primarily a structural phenomenon—at least not when considering the broader regional labor market as a whole as opposed to the Rhode Island labor market alone.

2. Aggregate Labor Market Mismatch

Before turning to a more detailed examination of Rhode Island's labor market, some background information about labor market mismatch is in order. Regardless of the economic circumstances at hand, labor market mismatch occurs when the characteristics of unemployed job seekers—in terms of their occupational or industrial qualifications or their geographic location—do not match those in demand by employers seeking to fill job vacancies. Occupational mismatch is often referred to colloquially as a "skills gap." In response to the observation that beginning in mid-2009, job vacancies had increased without a corresponding decline in the unemployment rate, various researchers have examined the question of mismatch in the U.S. labor market in the wake of the Great Recession. Sahin et al. (2014) find that the contribution of occupational mismatch to the increase in the U.S. unemployment rate between 2006 and October 2009 was significant but not overwhelming, and that the contribution of geographic mismatch was negligible. However, Dickens and Ghayad (2012) argue that the data

did not support the presence of occupational mismatch. To make this case, they show that the decline in labor-market efficiency did not differ across different occupational groups, as should occur with occupational mismatch, but instead was driven by the low job-finding rate among the long-term unemployed, whose employment prospects were hampered (arguably) by the stigma of long-term unemployment itself. Abraham (2015) also contends that recent U.S. labor market data, considered along various dimensions, do not support the presence of significant labor market mismatch in the aggregate.

According to Sahin et al.'s (2014) upper-bound estimates, between 2006 and October 2009, occupational mismatch restrained the monthly hiring rate in the United States by an additional 4 percent (compared with the impact of mismatch on hiring in 2006), and added a total of 1.6 percentage points to the U.S. unemployment rate.[3] As of mid-2011, the additional restraint on hiring amounted to just 0.5 percent, but the estimated contribution of mismatch to the unemployment rate remained unchanged.[4] As of October 2015, the U.S. unemployment rate stands at 5.0 percent, equal to the Congressional Budget Office's estimate of 5 percent for the long-run NAIRU (nonaccelerating inflation rate of unemployment).[5]

If it is true that labor market mismatch was, at worst, a modest problem during and shortly after the recession, but has since abated considerably, why does the conversation about a skills gap persist in Rhode Island as well as in other parts of New England and the United States?[6] One explanation is that skills mismatch persists within some local labor markets, but that these markets are too small to have a significant impact on aggregate estimates of mismatch. Another possibility is that labor markets are tight for all occupations, such that all or most employers are having difficulty filling vacancies. A third is that the available measures of mismatch are not

[3] These estimates pertain to mismatch at the level of the 3-digit occupation and are not adjusted for differences in matching efficiency by occupation.

[4] According to Sahin et al. (2014), the more persistent effect of mismatch on unemployment (relative to its effect on hiring) relates to feedback effects from mismatch unemployment to the job-finding rate.

[5] The NAIRU refers to the lowest unemployment rate that will not spark an increase in inflation.

[6] The existence of a skills gap has been discussed recently in regard to labor markets in Maine, New York, and nationwide. See Dudley 2015, Manpower Group 2014, and John Haskell, "Is There a Skills Gap in Maine?,"Pine Tree Economics, July 9, 2014, http://pinetreeconomics.bangordailynews.com/2014/07/09/home/is-there-a-skills-gap-in-maine/.

accurate and/or reliable. Each of these three possibilities is addressed in the following discussions.

3. Rhode Island's Current Employment Situation in Recent Historical Perspective

It is important to describe Rhode Island's current employment situation in relation to its situation prior to and during the Great Recession, and to put the state's labor market conditions into regional and national perspective. As discussed in depth in a previous paper (Burke 2014), during the Great Recession Rhode Island suffered the most severe downturn in the New England region along numerous dimensions—such as payroll job losses and peak unemployment rate. In describing Rhode Island's economic recovery, it is possible to take either a "glass half-empty" or "glass half-full" approach, depending on whether one compares the state's current situation to its pre-recession status or to its mid-recession status. Along a number of indicators, such as the nonfarm payroll employment level, Rhode Island's economy continues to fall short of pre-recession peak readings, but at the same time employment and many other indicators have improved significantly since the depths of the recession. Because the state's economy fell farther to begin with, achieving a full recovery has simply been a larger task for Rhode Island compared to other states in the region and the United States as a whole. To gauge the current health of Rhode Island's economy, it is therefore important to consider recent trends—such as the employment growth rate—rather than only comparing the levels of various indicators—such as employment—to their pre-recession peaks.

As of October 2015, Rhode Island's payroll employment level remains about 2.5 percent below its pre-recession peak (Exhibit 1), the largest such shortfall among the New England states. (All figures are seasonally adjusted unless indicated otherwise.) Viewed more positively, since its employment level bottomed out in July 2009, Rhode Island has recovered 5.5 percentage points of the roughly 8 percent employment decline experienced during the recession. (These percentages are calculated in relation to Rhode Island's pre-recession peak employment level, reached in December 2006.) This employment recovery figure of 5.5 percentage points is significantly larger than the comparable figure for Maine (3.4 ppt) and only

slightly less than the comparable figures for New Hampshire (5.7 ppt) and Connecticut (5.9 ppt).

Since August 2009, the state's unemployment rate (Exhibit 2) has fallen from its recession high of 11.3 percent to 5.3 percent (October 2015). Between October 2014 and October 2015, Rhode Island experienced the largest unemployment rate decline of any state in the nation (–1.7 percentage points). Although its current unemployment rate remains highest among the New England states, the gap between Rhode Island's unemployment rate and Connecticut's (the second-highest in region for most of the recession and recovery period) is now a scant 0.2 percentage points, down from a maximum of 3.4 percentage points observed in April 2009. Furthermore, according to the Bureau of Labor Statistics (BLS), Rhode Island's 5.3 percent unemployment rate for October 2015 was not significantly different from the national unemployment rate of 5.0 percent for the same month.

Overall declines in the unemployment rate are seen as good news, but the actual improvement depends on how many formerly unemployed people found jobs as opposed to leaving the labor force. Exhibit 3 shows, for all six New England states and the United States as a whole, the net changes in the unemployment rate, the employment-to-population ratio, the labor-force-participation rate, and the adult population size[7] over the period between the month of peak unemployment rate in each state and October 2015.[8] Rhode Island ranks second in the region (after Massachusetts) in terms of the net increase in the employment-to-population ratio, with an increase more than double the national gain. However, the increase in the number of employed Rhode Island residents fell short of the decline in the number of unemployed persons in the state, suggesting that some (or possibly all) of the formerly unemployed individuals dropped out of the labor force (or moved out of state) rather than finding work.[9] Not

[7] The population numbers refer to the civilian noninstitutional population 16 years of age and over as produced jointly by the BLS and the Census Bureau.

[8] Rhode Island's unemployment rate peaked in June 2009 at 11.3 percent and stayed at 11.3 percent through August 2009. The numbers in Exhibit 3 use June 2009 as Rhode Island's peak unemployment month; numbers in the table would not differ significantly if we used either July 2009 or August 2009 instead.

[9] Due to data limitations, it cannot be determined exactly how many of the formerly unemployed dropped out of the labor force as opposed to how many found jobs or moved out of state. Since the

surprisingly, then, Rhode Island's labor force participation rate fell by more than 2 percentage points over the same time period, although this decline was roughly on par with the U.S. decline in labor force participation over the analogous period. Within the region, since their respective peak unemployment dates, Vermont's labor force participation rate fell by more than 3 percentage points and Massachusetts's rate declined by just 0.1 percentage points.

During the recovery period, the fact that Rhode Island's labor force participation rate fell more sharply than that of Massachusetts's participation rate cannot readily be explained by changes in the age composition of their respective populations. As seen in Exhibits 4A and 4B, recent trends in the age composition of the population are not significantly different between these two states, nor do trends in these states differ significantly from those for the United States as a whole. In particular, the share of population aged 65–85 years did not increase faster in Rhode Island than in Massachusetts in recent years.[10]

4. Changes in Rhode Island's Labor Force, 2005–2015

Because employers lament the lack of skilled workers in Rhode Island, the first step is to look for evidence that the average skill level of workers in the state has deteriorated in recent years. To this end, we first describe changes in the educational composition of Rhode Island's labor force between 2001 and 2015 and compare these to educational changes in the aggregate U.S. labor force and the Massachusetts labor force for the same time period, using microdata from the Current Population Survey (CPS). Exhibit 5 shows the shares of the labor force in each of two education groups—those with a high school diploma or less, and those with a bachelor's degree or better. The sample is restricted to labor force members aged 25–64 years in order to

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population size increased over the time period, it is possible that the decline in labor force participation was driven at least partly by an influx of new, nonparticipating residents.

[10] Two age trends that might have contributed to a larger decline in labor force participation in Rhode Island are (1) since 2011, Rhode Island's population share aged 25–44 years has declined modestly, while the share in the same age group in Massachusetts has been roughly flat, and (2) the population share aged 45–64 years increased more sharply in Rhode Island than Massachusetts between 2014 and 2015. While 45–64 year-olds have a lower labor force participation rate than 25–44 year-olds in both states, the differences in the recent age trends between Massachusetts and Rhode Island are not statistically significant, and therefore we cannot say with confidence whether demographics contributed to Rhode Island's larger decline in participation in recent years.

focus on prime-age workers whose education is probably complete. The share with only some college (but not a completed bachelor's degree) is omitted because it was relatively constant over the time period (for Rhode Island, Massachusetts, and the United States) and it can be backed out by summing the shares shown and subtracting the resulting sum from one. The series are quite noisy at the state level; these are smoothed by taking 12-month moving averages and using just the June figure for each year.

During the 2001–2015 period, the share of Rhode Island's labor force (aged 25–64 years) with a college degree or higher is greater, by an average of roughly 3 percentage points, than the corresponding share of the U.S. labor force. For both Rhode Island and the United States, the share of workers with a college degree exhibits a significant upward trend over the period. Rhode Island's college share increases by 9 percentage points between June 2001 and June 2015 and the college share in the United States increases by 7 percentage points.[11] Even allowing for the noisiness of the Rhode Island data, it can safely be said that the labor force share with a college degree increased by at least as much in Rhode Island as it did in the United States over this time period. Based on this evidence, Rhode Island's labor force does not appear deficient relative to the overall U.S. labor force in terms of the share that has completed college.

The exhibit also shows that the share of the labor force with a high school diploma or less declined in both Rhode Island and the United States between 2001 and 2015. While the shares in this less-educated group are roughly equal between Rhode Island and the United States during most years of this time interval, in 2014 and 2015 Rhode Island's share appears to dip below that of the United States, although the difference is not statistically significant. The changes in labor force shares by education group may reflect a number of forces, including the longitudinal increases in educational attainment among stable members of the labor force, the replacement of older and less-educated cohorts with younger, more-educated cohorts, and the self-selective exit of less-educated individuals from the labor force. This last possibility would be consistent with the fact that during the Great Recession, job prospects for less-educated workers declined

[11] The difference between these increases is not statistically significant. If a linear trend line is fitted to the Rhode Island college share series, the trend line rises by roughly 7 percentage points over the time period.

more sharply than did opportunities for more-educated workers, an issue that is revisited below in the discussions of labor market mismatch.

While Rhode Island's labor force largely mirrors the aggregate U.S. labor force in terms of educational composition, and has experienced increases in average educational attainment since 2001, the exhibit plainly shows that Massachusetts has a more educated workforce than either Rhode Island or the United States—the Bay State consistently displays a higher labor force share with a college education or better and a lower share with only high school or less. As of June 2015, over 50 percent of the Massachusetts labor force between 25 and 64 years of age has a college degree or better, while just 42 percent of Rhode Island's labor force in the same age range has the same level of education.

Rhode Island's geographic proximity to Massachusetts may heighten the perception that Rhode Island's labor force lacks education and/or skills when it is compared to the Massachusetts labor force. If Rhode Island competes with Massachusetts for employers (and not so much against the other 48 states), then along this dimension at least the state is at a disadvantage to its neighbor in attracting employers seeking well-educated workers. However, the highly-educated workforce in Massachusetts may generate positive spillover benefits for workers in Rhode Island. For example, employers who create jobs in Massachusetts for highly-educated workers might also create complementary jobs within their enterprises, such as administrative positions, that could be filled by less-educated workers, including workers who live in Rhode Island and are willing to commute to Massachusetts. In addition, employment growth in Massachusetts among highly-educated workers stimulates demand for the goods and services purchased by this group, providing another potential source of employment growth in lower-skilled occupations that could benefit Rhode Island residents. To understand how the "trading" of workers between the two states might inform any possible labor market mismatch, commuting patterns between Rhode Island and Massachusetts are examined in detail in Section 8.

As seen in Exhibit 6, between 2001 and 2015 trends in the age composition of the labor force (16 years of age and over) are qualitatively similar between Rhode Island, Massachusetts, and the United States. In both of these states and in the nation overall, the changes in the age

composition of the labor force closely track the changes in the age composition of the population seen in Exhibits 4A and 4B. One common trend is that the share of the labor force aged 25-44 years declined significantly over this 14-year period and the labor force share aged 45–64 years increased significantly.[12] This shift, however, appears more pronounced in Rhode Island than in either Massachusetts or the United States. Within Rhode Island, this relatively large shift toward an older workforce could be consistent with a deterioration in the state's skills distribution—for example, if younger, more recently-educated workers are better equipped to fill existing job openings than older workers, who despite their work experience might have obsolete skills. A possible offset to this disadvantage is the fact that in Rhode Island's labor force, the recent cohorts of 25–44 year-olds are increasingly college-educated.

5. Comparing Vacancy Shares and Unemployment Shares by Occupation

To reiterate, a skills gap or skills mismatch can be loosely defined as a condition in which the skills of unemployed job seekers do not match the skills in demand by employers seeking to fill job vacancies. One way to identify at least preliminary evidence of skills mismatch is to compare the occupational distribution of unemployed workers to the occupational distribution of available job vacancies, as suggested by Sahin et al. (2014), Abraham (2015), and others. This approach assumes that each unemployed worker only searches for job vacancies in a specific occupation. In practice, the sought-after occupation of an unemployed worker is identified based on the occupational category for the most recent job held by the individual by using the Integrated Public Use Microdata Series of the Current Population Survey (IPUMS-CPS)—provided this information is not missing. Labor market mismatch is thought to be minimized when the distribution of unemployed individuals across occupations exactly mirrors the occupational distribution of vacancies. The greater the disparity between these respective distributions, the greater the degree of mismatch.

In this approach, the benchmark situation involving zero mismatch therefore represents an ideal theoretical outcome in which a hypothetical social planner can move people across labor

[12] The groups not included in Exhibit 6—labor force members aged 16–24 years and 65 years and over—together comprised between 18 percent and 22 percent of the labor force in each of the given locations over the time period.

markets at will in order to maximize employment. Of course, in practice matching workers to employers across occupational boundaries might require some type of retraining that each party in the match would like the other party to pay for, even if both parties could benefit from the match on net. Alternatively, workers might have to accept a lower wage in order to get a job in a different field. More generally, the costs of moving individuals across occupational labor markets may exceed the benefits of the match, and therefore some amount of mismatch may be optimal in a second-best or constrained sense. In addition, if the average rate at which matches occur for given numbers of vacancies and job-seekers—a rate termed "matching efficiency"—is inherently greater in some occupations than others, the measure of mismatch should be adjusted to account for such differences, as described below.

Exhibit 7 shows the ratio of the unemployment share to the vacancy share by occupational group in Rhode Island between April 2006 and June 2015. The 2-digit standard occupation codes (or SOC codes) in the CPS is collapsed into six broad occupation groups (referred to as "occupations" for short), in order to merge the unemployment shares with the vacancy shares, which are observed only for the six broad groups.[13] For example, the line for "Management" refers to the series of values of the share of unemployed Rhode Island workers whose previous occupation was part of the "Management" group.[14] Total job vacancies, for each of six broad occupations for each state at a monthly frequency, are observed using the Conference Board's Help Wanted Online Data Series, accessed using Haver. The vacancy shares are calculated as

[13] The BLS offers a guide for aggregating 2-digit SOC codes into five higher-level groups, with an additional group for military-specific occupations. The data on vacancies from Help Wanted Online (HWOL) are divided into six occupational groups, not including military jobs (which are not recorded in that data series). The HWOL data classifies "professional occupations" as a separate category from "management occupations," while the BLS aggregation combines these two types of jobs into a single group. Based on the 2-digit SOC codes available in the CPS data, however, we can assign each of the CPS occupations into one of the six HWOL occupation groups. These groupings differ from the BLS high-level (5-group) classification only in the sense that professional and management jobs are not combined.

[14] In the CPS data, the occupation of the previous job is not observed in a fraction of cases that varies from between roughly 5 percent and 12 percent over the period under consideration. In order to proceed, unemployment shares by occupation are computed using as the denominator the total number of unemployed workers for whom the previous occupation is observed. Calculated in this way, unemployment shares will reflect the true shares if and only if the probability that the previous occupation goes unobserved is the same regardless of what the underlying occupation is—that is, if previous occupations are missing at random such that in expectation the distribution of unobserved occupations is identical to the distribution of observed occupations.

the number of vacancies in a given occupation over the sum of vacancies across all six occupations.

If matching efficiencies are equal across occupations, in the benchmark situation of zero mismatch the unemployment share of each occupation should be equal to its vacancy share, and therefore the ratio of the unemployment share to the vacancy share should equal 1 for all occupations. Exhibit 7 shows, however, that these ratios are consistently greater than 1 in some occupations (production, construction, and services) and consistently less than 1 in others (management and professional). These persistent deviations from the benchmark value of 1 suggest that matching efficiency is higher in some occupations (namely, production and construction) than others (such as management and professional occupations). This issue is discussed in further detail below and is accounted for in estimates of occupational mismatch.

Allowing for the fact that the average or long-run value of the ratio of the unemployment share to the vacancy share may differ across occupations, we nonetheless observe that there were significant movements in the ratios between April 2006 and June 2015, and more so within some occupations than others. For the production occupations, the ratio increases sharply during the latter half of 2006 and continues to trend upward through late 2009, reflecting a combination of increases in the unemployment share and decreases in the vacancy share in this category. The ratio exhibits a significant upward trend for the construction occupations between April 2006 and early 2009, but the increases are more moderate than in the production occupations. The dispersion of the ratios across occupations peaks around July 2009, the end date of the national recession (shaded in gray). Barring fluctuations in the ratio for production occupations between late 2009 and late 2012, the ratios become less dispersed across occupations after the recession, and by June 2015 the ratio for each series is fairly close to its value as of April 2006.

6. Quantitative Estimates of Occupational Mismatch

There are a number of ways to summarize the information contained in the unemployment and vacancy shares into an overall index of labor market mismatch, thus allowing comparisons to be made across time and place. Lazear and Spletzer (2012) use a simple mismatch index that

represents the share of unemployed individuals who are searching in the "wrong" occupational (or industrial or geographical) labor market, in the sense that hires might be increased if excess unemployed workers in a given occupation were to search instead for jobs in an occupation with excess vacancies. The index, which will be referred to informally as the "basic search mismatch index," denoted M^S, is calculated as follows:

$$M_{jt}^S = \frac{1}{2}\sum_i \left| \frac{u_{ijt}}{u_{jt}} - \frac{v_{ijt}}{v_{jt}} \right| . \qquad (1)$$

In equation (1), u_{ijt} refers to the number of unemployed individuals searching in occupation *i* at location *j* and at time *t*, and u_{jt} refers to the total number of unemployed individuals at location *j* at time *t*. Therefore the ratio of these terms represents the unemployment share of occupation *i* at location *j* at time *t*. Similarly, the terms v_{ijt} and v_{jt} refer to vacancies, such that their ratio represents the vacancy share of occupation *i* at location *j* at time *t*. This version of the index assumes that matching efficiencies do not vary across occupations.

If in fact matching efficiencies do differ across occupations, then in order to maximize potential hires it makes sense to have higher unemployment shares (relative to vacancy shares) in some occupations than others. The basic mismatch index above can be readily adjusted to account for differences in matching efficiency by occupation. This is accomplished by multiplying the vacancy share (within the absolute value brackets) in each given occupation by a function of its matching efficiency, but otherwise keeping the formula as it appears in equation (1).[15] The resulting "adjusted search mismatch index" is denoted $\widetilde{M}^S$. The values of matching efficiency by occupation are based on empirical estimates conducted by Sahin et al. (2014). These estimates were made using national data and we assume they apply to occupational labor markets regardless of location.[16] According to the estimates, matching

[15] This function is denoted by $\left(\frac{\varphi_i}{\bar{\varphi}}\right)^2$, in which φ_i stands for the matching efficiency in occupation *i* and $\bar{\varphi}$ is a time-varying weighted average of matching efficiencies across occupations; the weights are the respective vacancy shares by occupation and time period. In principle, matching efficiency by occupation may also vary over time, and we do account for some time variation in our estimates, as described above.

[16] For each of five occupation groups, Sahin et al. (2014) provide an estimated matching efficiency parameter for December 2007 and earlier and another matching efficiency parameter that applies to January 2008 and after. The respective efficiency parameters are applied to the data accordingly. The

efficiency is highest for services jobs and construction jobs, and lowest for professional and management occupations.

Exhibit 8 shows the values of both the basic search mismatch index (M^S) and the adjusted search mismatch index ($\widetilde{M}^S$), separately for Rhode Island, the United States, and Massachusetts, during the period from April 2006 to June 2015. This period begins well before the onset of the Great Recession (December 2007) and terminates well after that recession ended (June 2009), although the recession started up to one year earlier in Rhode Island.[17] All the data series have been smoothed to reduce noise. The basic search mismatch index for Rhode Island increases between April 2006 and April 2008. After April 2008, the value oscillates, but declines significantly between early 2013 and June 2015, ending the period at roughly 27 percent, slightly below its initial level.

The values of the adjusted mismatch index are much lower than the basic mismatch estimates for Rhode Island, Massachusetts, and the United States. Assuming that the matching efficiency parameters are accurate, the difference indicates that a significant portion of the apparent imbalances between the unemployment shares and vacancy shares by occupation actually reflect differences in the matching efficiency across occupations. Even if the parameters are not perfectly accurate, if these at least rank the occupations correctly in terms of matching efficiency, it is safe to say that the basic mismatch index overstates the extent of occupational mismatch. According to the parameters being used, the matching efficiency is relatively high for construction jobs and relatively low for professional jobs. These facts, respectively, help to explain why the vacancy share for construction occupations tends to be lower than the unemployment share, and why the reverse is true for professional occupations—a pattern shown in Exhibit 7.

"professional" and "management" groups are combined into a single category when estimating matching efficiency; therefore, these two groups are given the same matching efficiency parameter in the calculations.

[17] Rhode Island's payroll employment level peaked in December 2006 and its gross state product, as estimated by the Philadelphia Fed's Coincident Index, peaked in February 2007. For more information on the Philadelphia Fed's State Coincident Indexes, see https://www.philadelphiafed.org/research-and-data/regional-economy/indexes/coincident/.

While over the entire period from April 2006 through June 2015, the adjusted mismatch index for Rhode Island is lower in absolute terms than the basic mismatch index, the adjusted index makes Rhode Island look worse compared with Massachusetts and the United States than does the basic index. In the adjusted series, Rhode Island has a higher mismatch reading than either Massachusetts or the United States during most of this time period, while in the basic mismatch series Rhode Island has higher values only for a comparatively brief time period. In both series, Rhode Island displays higher mismatch values between August 2011 and October 2013 than either Massachusetts or the United States.

According to either the basic or adjusted mismatch index, the share of unemployed workers in Rhode Island searching in the wrong occupational labor market is lower as of June 2015 than it was in April 2006. However, it is impossible to confidently state that the extent of search mismatch in Rhode Island is currently lower than its lowest reading prior to the Great Recession because mismatch indexes cannot be calculated at the state level prior to April 2006. Sahin et al. (2014) suggest that labor market mismatch for the United States as a whole started increasing roughly one year prior to December 2007, the official start of the U.S. recession. Since Rhode Island arguably entered a recession well before the nation as a whole did—the state's payroll employment peaked in December 2006—mismatch in Rhode Island may have started rising even prior to April 2006.

A limitation of the search mismatch index is the inability to tell us how much employment growth is held back relative to its potential as a result of having too many unemployed workers searching for some jobs and not enough searching for other jobs. To this end, we use an index employed extensively by Sahin et al. (2014), which for the purposes of this paper we will call the "missed hires" index. This index aims to capture the percentage of total potential hires that are lost as a result of labor market mismatch. Potential hires are those that would occur under the optimal allocation of job searchers across labor markets; in our case these labor markets are segmented by occupation. Again, the index's main inputs are the unemployment shares and vacancy shares by occupation— again, we construct a basic version of the index and an adjusted version that accounts for differences in matching efficiency across occupations. The formulas

are given in an appendix which appears at the very end of the document, following the exhibits.[18]

Exhibit 9 shows the smoothed values of the missed hires index, in both its basic and adjusted versions, for the period between April 2006 and June 2015, for Rhode Island, Massachusetts, and the United States. Unless noted otherwise, the following discussion refers to (smoothed) values from the adjusted mismatch index; the adjusted values are preferred and the basic index is shown to demonstrate the impact of the adjustment on the mismatch estimates. Not surprisingly, because the adjusted missed hires index is based on the same data as the adjusted search index but using a different formula, the qualitative patterns in the adjusted missed hires index are broadly similar to those seen in the adjusted search index in Exhibit 8. The adjusted missed hires index is increasing between April 2006 and July 2009, when it peaks at roughly 4.4 percent. After 2009:Q3 the index begins to trend downward, and despite a temporary upswing in 2011 and 2012, by June 2015 it has fallen back to just 0.4 percent, its lowest value within the period of observation.

The adjusted mismatch index values are significantly lower than the unadjusted values, and Rhode Island's ranking compared with Massachusetts and the United States becomes less favorable. During its peak quarter of 2009:Q3, Rhode Island's (smoothed) adjusted missed hires index value indicates that roughly 4.3 percent of potential hires failed to occur in the quarter because of mismatch between job-seekers and vacancies across these occupation groups.[19] Inversely, there would have been 4.4 percent more hires than actually occurred if mismatch had not been present. Combining this latter figure with data on actual hires and employment for 2009:Q3 as observed in the Quarterly Workforce Indicators (QWI) database, we can calculate counterfactual values for hires and employment growth that represent what might have

[18] To develop this index, one must specify that hires or matches are produced according to a Cobb-Douglas function of the number of unemployed workers and the number of vacancies in the given labor market, with specific assumptions made on the values of the function's parameters. Therefore, while the missed hires index gives values that are more readily interpreted in terms of employment growth, it relies on more specific assumptions than the previous index.

[19] This 4.3 percent figure represents the average missed hires percentage over the three months of 2009: Q3. It is not weighted by the number of hires within each month within the quarter, but the mismatch values do not differ starkly across these three months.

occurred in the absence of mismatch.[20] These calculations suggest that there would have been an additional 1,639 hires in Rhode Island in 2009:Q3. Based on observed total payroll employment as of the previous quarter (2009:Q2), these additional hires would have boosted employment growth between 2009:Q2 and 2009:Q3 by about 0.4 percentage points.[21] Actual employment growth between those two quarters was about –0.8 percent, and therefore the counterfactual (zero-mismatch) over-the-quarter growth rate amounts to –0.4 percent, a considerable improvement over the actual employment growth, although this estimate applies only to this particular quarter.[22]

The latest readings of the adjusted missed hires index, averaged over 2015:Q2, indicate that hiring in the absence of mismatch would be just 0.4 percent greater than the current hiring rate (using either the smoothed or unsmoothed data). Data on actual hires for 2015:Q2 are not available. Instead, three different hypothetical values for hires in 2015:Q2 are used, together with actual payroll employment numbers for 2015:Q1 and 2015:Q2 from the BLS, in order to calculate the counterfactual increase in the employment growth rate in the absence of mismatch. Regardless of which value for hires is assumed—the latest available figure (2014:Q3), the long-run historical average figure (for 1998:Q1–2014:Q3) or the average figure for 2005 (the pre-Great Recession year with the highest average hires)—the boost to hiring is quite small (between 134 and 164 added hires) and would result in an increase in over-the-quarter employment growth ranging from slightly less than 0.03 percentage points to slightly more than that amount. Actual quarterly employment growth in Rhode Island between 2015:Q1 and 2015:Q2 was 0.5 percent, and therefore the counterfactual growth rate of 0.53 percent represents only a modest improvement. Furthermore, the estimated hiring restraint refers only to 2015:Q2; longer-run

[20] The Quarterly Workforce Indicators (QWI) database is a product of the U.S. Census Bureau.

[21] This (rounded) figure is calculated by dividing the additional hires figure by observed employment for 2009:Q2 in the QWI database. Taking the same additional hires figure and dividing instead by payroll employment for the same period as reported by the BLS, we obtain an estimate of 0.35 percentage points rather than 0.42 percentage points; therefore both estimates are close to 0.4 percentage points.

[22] This employment growth figure is calculated using the employment figures for 2009:Q2 and 2009:Q3 observed in the QWI database, and as such it differs from quarterly employment growth for the same period calculated using payroll employment numbers from the BLS. However, as explained above, the absolute increase in employment growth is robust to the data source used for payroll employment.

effects of mismatch on Rhode Island's employment growth rate cannot be readily extrapolated from this figure without further assumptions.

7. Limitations of Mismatch Indexes

Citing measurement issues, Abraham (2015) questions the use of the above mismatch indexes. Her first objection is that the occupational category of a worker's previous job constitutes an imperfect indicator of the specific skills that a worker might have or that employers might desire, and the potential set of jobs a worker might be searching for could be much broader than that indicated by her previous occupation. Regarding the latter point, for example, a displaced manufacturing worker might be willing to accept a job in retail sales simply to pay the bills, at least on a temporary basis. Furthermore, the occupational scope of an individual worker's job search, as well as that of employers' search for workers, may vary over the business cycle. To the extent that workers search outside of the occupational classifications we assign to them, the share of workers searching in the wrong labor market, as well as the predicted restraint on hiring, may therefore be overstated.[23] This critique may apply with somewhat less force in our case, however, because we assign workers to very broad occupational categories rather than to more narrow occupations defined by 2-digit, 3-digit, or 6-digit SOC codes. However, it might still be the case, for example, that some workers are searching for jobs within both the production occupations and the construction occupations, or searching within both the services occupations and the sales/office occupations. If so, even the adjusted mismatch estimates given above could be too high, although it is hard to say by how much.

Abraham's second objection is that vacancy shares by occupation, as observed in the Help Wanted Online Data Series, include only the vacancies that are posted online. There is evidence to suggest that the tendency to post vacancies online (as opposed to advertising in print or other media) differs significantly across occupations, with the result that our vacancy shares will be biased in favor of occupations that are more likely to post vacancies online. If vacancies in production and construction occupations, for example, are less likely to be posted online than

[23] Sahin et al. (2014) attempt to adjust for this possibility by allowing for probabilistic search across multiple occupational labor markets, but data limitations at the state level prevent us from making similar adjustments here.

are vacancies in professional occupations, then the observed vacancy shares in production and construction are lower than the true shares and the observed vacancy shares in professional occupations are higher than what actually occurred. These specific biases could account for some of the apparent excess in unemployment shares relative to vacancy shares in the occupations that do not tend to post job openings online, and some of the apparent excess of vacancy shares relative to unemployment shares in the occupations that do routinely post openings online. Therefore, correcting for measurement error in vacancy shares could further reduce mismatch estimates derived from any of the above indexes. Given the potential limitations of the mismatch indexes, it is important to examine other sources of evidence, as is done below.

A more fundamental concern, voiced by Abraham and Katz (1986), is that indicators of labor market mismatch may arise for cyclical, rather than structural, reasons. While Lilien (1982) argued that a significant portion of cyclical unemployment is caused by structural shifts in relative labor demand across sectors, Abraham and Katz argued that apparent structural shifts may instead represent sector-specific sensitivities to an aggregate demand shock. Both accounts predict an increase in the dispersion of employment growth rates across sectors—and would also predict an increase in imbalances between sectoral unemployment shares and sectoral vacancy shares—but only the differing-sensitivities story of Abraham and Katz predicts the (observed) negative correlation between such dispersion and job vacancies. If in fact a negative shock to aggregate demand drives a spike in apparent labor market mismatch, then the mismatch should be expected to resolve as aggregate demand improves; if instead the mismatch is structural, a recovery of aggregate demand should not be sufficient to alleviate it, and we might observe an increase in the natural rate of unemployment until the structural imbalances are resolved. This issue is discussed further in section 9 within the context of policy implications.

8. Evidence from Commuting Patterns

Much of Rhode Island lies within reasonable commuting distance to the Boston metropolitan area as well as to smaller cities in Massachusetts such as New Bedford, Fall River, and

Worcester. Workers regularly flow across the Rhode Island-Massachusetts border in both directions, as well as across the Rhode Island-Connecticut border.[24] In response to occupational mismatch within a relatively small area such as Rhode Island, displaced workers in locally slack occupations (such as production) might increasingly seek jobs in neighboring states; likewise, employers in locally tight labor markets (such as professional and management occupations) might be more apt to recruit employees from nearby states or even nationwide.[25] A Rhode Island-based maker of biomedical equipment offers the following anecdote: "Employers in the biomedical equipment industry have difficulty finding qualified labor to fill equipment and IT positions. The pool of Rhode Island workers who can meet this demand is insufficient. As a result, these jobs are going to job seekers from out of state."[26]

Increases in interstate job search and recruiting in response to labor market mismatch within Rhode Island might therefore show up as increases in commuting to and from Rhode Island for work. However, in order for fruitful interstate "trades" of workers to take place, there would also have to be geographic labor market mismatch among Rhode Island and its neighboring states. For example, if a given occupation has an equally slack (or equally tight) labor market in all nearby states, interstate job searches and recruiting will prove unsuccessful. Analogous to the definition of occupational mismatch, geographic mismatch consists of an imbalance between the distribution of unemployed individuals across states (rather than occupations) relative to the distribution of job vacancies across states.[27]

Before examining the data on commuting patterns, therefore, it is important to observe what was happening to geographic mismatch within New England for the period from April 2006 to

[24]According to the American Community Survey, in 2013 more than 17 percent of employed Rhode Island residents held jobs outside the state, with more than 12 percent commuting to Massachusetts alone. Also in 2013, more than 5 percent of employed Connecticut residents and roughly 1.3 percent of employed Massachusetts residents commuted to Rhode Island for work.

[25] Abraham (2015) as well as Davis, Faberman, and Haltiwanger (2013) argue that employers will recruit more intensively in tight labor markets.

[26] This statement was taken from a planning grant application made to the "Real Jobs RI" program by Claflin Medical Equipment and strategic partners. See "Real Jobs RI 2015 anning Grant Awardees," July 31, 2015 Press Release. Available at http://www.governor.ri.gov/documents/press/RealJobsRI.pdf.

[27] It is also possible to measure joint mismatch across states and occupations. For our immediate purposes it is most useful to isolate the geographic component, since a joint measure could be elevated primarily because of occupational mismatch within each state.

June 2015. To measure geographic mismatch in New England we use the basic search mismatch index described in equation (1) above, but in place of unemployment shares and vacancy shares by occupation, we use unemployment shares and vacancy shares by state.[28] The baseline assumption is that an unemployed individual only searches for jobs in his or her home state. As such, the mismatch values are interpreted as the share of unemployed persons in New England searching in the wrong state, in the sense that their job prospects would be better if they were to search in the other New England states. Alternatively, on the assumption that employers post vacancies only in the state in which the job is located, one could interpret the index as describing the share of employers posting vacancies in the wrong state, in the sense that they might increase their chances of finding a candidate by posting in other states.

As seen in Exhibit 10, labor market mismatch across the New England states exhibits only a very modest increase prior to and during the Great Recession, beginning in mid-2007 and continuing through August 2008. Geographic mismatch trends upward between late 2009 and late 2012, increasing almost two-fold. Between December 2012 and June 2015 the index is generally declining, but as of June 2015 the measure remains well above its pre-recession levels. The timing of these movements indicates that although the recession's severity differed across the New England states, unemployment shares and vacancy shares by state did not move sharply out of balance in the region during the economic downturn. The increase in geographic mismatch beginning in late 2009 most likely reflects the fact that some states in the region—particularly Massachusetts—started to recover from the recession earlier than did other states, while other states—Rhode Island in particular—experienced high unemployment and weak employment growth for a more extended period.

Although the timing of the most pronounced increase in the geographic mismatch index for New England differs from the timing of the most pronounced increases in the occupational

[28] For each New England state and each month between April 2006 and June 2015, we calculate the total number of the state's employed residents as a share of the total number of unemployed residents/workers in New England, and the total number of job vacancies posted in the state as a share of all job vacancies posted in New England. In adopting the basic (unadjusted) index we assume that the aggregate matching efficiency is equal across the New England states. The unadjusted index should give a qualitatively robust sense of changes in geographic mismatch over time even if matching efficiencies differ across states.

mismatch indexes for Rhode Island, throughout most of 2011 and 2012 occupational mismatch in Rhode Island was increasing at least modestly (referring to either the adjusted search index or the adjusted missed hired index) and geographic mismatch in New England was increasing rather sharply. The geographic mismatch should have spurred workers and/or employers in New England to search for job matches across state lines, and such searches should have found some success. Rhode Islanders in slack occupations such as construction and production should have been most likely to search for jobs in other states, while Rhode Island employers seeking to fill jobs in the professions and management might have been especially likely to recruit job candidates from other states.

The American Community Survey's Integrated Public-Use Microdata Series (ACS-IPUMS) allows us to observe an individual's place of residence as well as his/her place of work, among other characteristics. The series begins in 2001 and currently runs through 2013. Geographic indicators include the state and the public-use microdata area (PUMA), but for now we focus on commuting patterns by state.

Exhibit 11 shows out-of-state commuting rates among employed Rhode Islanders between 2001 and 2013—to Massachusetts alone and to all destinations. Between 2006 and 2009, the net trend in commuting (either to Massachusetts or to all destinations) is roughly flat. Between 2009 and 2010 the commuting rate declines somewhat sharply, especially when considering all destinations. Between 2010 and 2012, commuting from Rhode Island to all destinations increases by about 2.5 percentage points and commuting to Massachusetts alone increases by more than 3 percentage points, but the rates fall in 2013.The period ends with commuting to all destinations roughly level with its 2006 value but still above its 2010 trough, while the period ends with commuting to Massachusetts above both its 2006 level and its 2010 trough. Considered over the entire 2001–2013 period, both trends are close to flat.

Commuting rates from Rhode Island did not go up in response to the state's increase in occupational mismatch between 2006 and 2009. However, the timing of the movements in commuting accords fairly well with the timing of movements in the geographic mismatch index for New England between 2006 and 2013. Commuting and geographic mismatch both exhibit roughly flat net trends between 2006 and 2010, while between 2010 and 2012 commuting out of

Rhode Island increases and so does the geographic mismatch index. In particular, the net increase in commuting to Massachusetts during this latter period likely reflects the fact that Massachusetts recovered from the Great Recession at a much faster pace than Rhode Island did. Between January 2010 and December 2012, the unemployment rate in Massachusetts fell from 8.8 percent to 6.7 percent, while over the same period in Rhode Island unemployment fell from 11.1 percent to 9.8 percent, resulting in a growing unemployment gap between the two states.

The net increase in commuting between 2010 and 2013—or the sharper increase between 2010 and 2012 alone—does not coincide with a significant improvement in household employment in the state. Between January 2010 and January 2013, the number of employed Rhode Island residents (regardless of work location) increased by only 1,611. Over the same period, the state added 11,600 payroll jobs. From January 2015 through August 2015, however, household employment in Rhode Island has increased at a faster pace than payroll employment. The net result is that, since their respective recession troughs, household employment increased by 32,000 and payroll employment increased by 29,000. Lacking more recent data on commuting, however, we cannot say whether an increase in commuting contributed to Rhode Island's larger recent increases in household employment compared with payroll employment.

Professional and management groups—the occupational categories where unemployed workers are scarce relative to vacancies in Rhode Island—comprise jobs that on average are more likely to require a bachelor's degree or more. The production and construction occupations (and possibly the sales and office occupations), which have had relatively slack labor markets in Rhode Island since the recession, are less likely to require this credential. Considering commuting rates by educational attainment between 2010 and 2013, commuting out of Rhode Island to Massachusetts (Exhibit 12) and to all destinations (Exhibit 13) increased (on net) among individuals with some college and among those with high school or less, and decreased among those with a bachelor's degree or higher. Therefore, the overall increase in commuting out of Rhode Island between 2010 and 2013 was driven by noncollege-educated workers.

The extent to which jobs located in Rhode Island are filled by nonresidents represents a potential indicator of shortcomings in the ability of the Rhode Island labor force to meet local employers' needs—another piece of the mismatch story. For the period from 2001 through 2013, Exhibit 14 shows the rates of nonresident employment in Rhode Island calculated, again using the ACS-IPUMS, as the share of those that work in Rhode Island who reside outside of Rhode Island. (We show one series for residing elsewhere in New England and another for residing in Massachusetts.) The share of Rhode Island-based employment coming from all other New England states is generally increasing between 2001 and 2013. The increase is particularly steep in 2010–2011, but nearly half of these gains are reversed in 2013. Similar qualitative statements apply to the share of Rhode Island-based employment filled solely by Massachusetts residents.

On the one hand, movements in Rhode Island's nonresident employment rate between 2006 and 2013 do not closely follow the movements in the occupational mismatch indexes for Rhode Island, nor do these match the movements in the geographic mismatch index for New England over the same period. On the other hand, the upward trend since 2001 indicates that there may have been a longer-term deterioration in the ability of Rhode Island's workforce to fill existing job vacancies. To gain additional insight into this issue, it is useful to decompose the nonresident employment shares by education. Exhibit 15 shows, for each education group, the fraction of individuals who work in Rhode Island and have that education level but who reside in New England, albeit outside of Rhode Island.[29] Considering trends for the entire 2001–2013 period, the nonresident share is increasing on average among those with a bachelor's degree or better. The overall trend is flat among high school dropouts. The trend among those with some college and among those with a high school diploma is modestly positive in both cases.

Exhibit 16 shows the decomposition of all Rhode Island-based employment by educational attainment. The share of jobs filled by those with a bachelor's degree or better (regardless of place of residence) increases fairly steadily between 2001 and 2013, as does the share filled by those with at least some college. However, the share of Rhode Island-based employment filled by individuals with either a high school diploma or less decreases over the period. Therefore,

[29] The patterns are similar for the share of nonresident employment coming from Massachusetts alone by educational attainment; these figures not shown.

between 2001 and 2013 the jobs being created in Rhode Island were increasingly likely to require at least some college or a college degree, and in order to fill such vacancies Rhode Island employers turned increasingly to out-of-state workers. If it is more costly to recruit workers from out-of-state, this latter tendency suggests an increase in recruiting intensity among employers seeking more-educated workers, an explanation that is broadly consistent with the "skills gap" hypothesis.

However, it turns out that the bulk of the nonresidents that commute to jobs in Rhode Island live very close to the state line, which suggests that the recruiting costs to attract such workers may not be especially high. Between 2001 and 2013, more than 80 percent of Rhode Island's out-of-state workers came from Massachusetts. Among this group, for the period as a whole, more than 50 percent commuted from nearby Bristol County, in southeastern Massachusetts, which includes cities and towns such as Fall River, New Bedford, Taunton, and Attleboro. Since 2010, the combined share from other parts of Massachusetts increased but over 40 percent still came from Bristol County. The combined share from the Boston metropolitan area is less than 5 percent over the 2001–2013 period.[30]

9. Evidence from Wage Growth and Employment Growth Rates by Occupation

Abraham (2015) argues that "sector-specific increases in labor demand of the type that create shortages should produce both rising employment and rising wages." She concludes that a positive correlation between employment growth and wage growth by occupation or industry would support (but not prove) the presence of structural labor market mismatch.[31] This hypothesis is tested by using data for Rhode Island on average hourly nominal wages and total employment by occupation from Occupational Employment Statistics. We compute year-over-year percentage growth rates, respectively, for total employment and average hourly nominal

[30] The ACS-IPUMS data for 2001–2011 use the Census year 2000 PUMA boundaries, while the ACS-IPUMS data for 2012 and 2013 use the Census year 2010 boundaries. For some PUMAs in the sample, the boundaries changed. However, the statements above are robust to changes in the PUMA boundaries between the earlier and later ACS data.

[31] Using U.S.-level data on 14 major industries between December 2012 and December 2013, Abraham observes zero correlation between year-over-year employment growth and year-over-year average hourly wage growth.

wages, at the level of the 2-digit SOC code, for each year between 2006 and 2014.[32] Separately for each year, we estimate the simple correlation coefficient between employment growth by occupation and wage growth by occupation.[33] A similar correlation exercise is conducted to classify occupations into five higher-level groups (based on the BLS aggregation described above) instead of 21 lower-level groups.[34]

Exhibit 17 lists the correlation coefficients by year for each exercise. In the left-hand column, which shows the correlations by 2-digit occupation, the average value of the correlation over the time period is negative, with a low absolute value; the correlation is positive in only two out of nine years, and in these cases its value is either modest or close to zero. In the right-hand column, the average correlation by occupation group is positive but very close to zero, and the values are quite volatile from year to year. The higher-level correlation takes a positive value in six of nine years, including 2013, when its value exceeded 0.5. However, the correlation exhibits a negative value on average over the past three years as well as over the past four years. Therefore, neither set of correlations provides consistent evidence that wage growth by occupation has been strongly and positively correlated with employment growth in Rhode Island, whether over the entire period or in recent years.

Exhibit 18 shows the wage growth rate and the employment growth rate in Rhode Island between May 2013 and May 2014 for each of the five higher-level occupation groups. The first pair of bars shows the percentage wage growth and the percentage employment growth, respectively, aggregated over all occupations. Moving to the right, the occupation groups are placed in descending order of wage growth. The negative correlation between wage growth

[32] State-level data for May of each year are available between 2003 and 2014; the 2005–2014 data for Rhode Island are used to construct the year-over-year percentage changes for the period from 2006 to 2014. Average hourly wages at the 2-digit SOC level are provided directly in the OES data. Among the total of 23 2-digit occupations, "Military Specific Occupations" (SOC 55) are omitted due to lack of data, and "Farming, Fishing, and Forestry Occupations" (SOC 45) are omitted because this highly volatile group represents a very small fraction of Rhode Island employment.

[33] Although the wage data are nominal, wage growth over a single twelve-month period within a given state would all be subject to the same deflator, such that the correlation between employment growth and nominal wage growth within a given year is a good proxy for the correlation between employment growth and real wage growth for the same year.

[34] Mean wages for each high-level group represent an employment-weighted average of mean wages at the 2-digit level for the relevant 2-digit occupations.

and employment growth is evident based on visual inspection. Production occupations displayed the highest wage growth rate among the five occupation groups and yet had below-average employment growth. Sales and office jobs also displayed above-average wage growth and below-average employment growth. In contrast, services occupations and construction occupations both experienced relatively rapid employment growth together with below-average wage growth. Management and professional occupations, which are combined in these calculations, saw middling wage growth as well as middling employment growth.

The occupation classifications above, whether at the 2-digit or 1-digit level, may not align well with the relative scarcity of labor, given the diversity of skill levels that might exist across different jobs within a given occupation class. To cut the data based on a proxy for skills, occupations are classified by the BLS on the basis of typical education requirements needed to enter the occupation. The Rhode Island Department of Labor and Training provides the codes for these requirements for most 6-digit occupations that appear in the Occupational Employment Statistics data.[35] There are eight levels of education requirements, ranging from less than high school up to a Ph.D. or other professional degree. The eight education groups can be collapsed into four broader groups, ranging from less than high school to a bachelor's degree or higher. To look for evidence of labor market mismatch by skill level, we test for positive correlations between employment growth and mean hourly wage growth by education requirement, for both the eight-level classification and the four-level classification. [36]

Correlations for each year between 2006 and 2014 are given in Exhibit 19. Under the eight-level classification the average correlation is a small negative number. In 2012 the correlation is positive and close to 1, but in the two subsequent years the values are negative and either small

[35] In the Rhode Island data for years 2012 through 2014, education codes are missing for somewhere between 2.4 and 2.9 percent of 6-digit occupations. For years 2005 through 2011, education codes are missing for somewhere between 10 and 13 percent of 6-digit occupations. When the education code is missing the data for that occupation are dropped. Therefore, estimates of correlations should be considered more reliable for years after 2011.

[36] To obtain year-over-year growth in mean hourly wages by education code, we calculate the employment-weighted average of mean hourly wages across all 6-digit occupations with the same education code. For some 6-digit occupations, only annual wages are observed. In such cases we convert to an hourly wage by dividing by 2,000 hours; this approach assumes a 40-hour work week for 50 weeks per year.

or moderate in absolute value; in 2011 the value is negative and large in magnitude. Under the four-level classification, again the average correlation is negative; considering recent years, the correlation is positive but small in 2013 and in 2014 the value is negative and large in magnitude. Again the data offer little sign of the positive correlation between employment growth and wage growth that is predicted in the presence of a structural skills mismatch.

Regardless of employment growth rates, it is important to determine whether jobs requiring more education (and, presumably, higher skill levels) have recently experienced faster wage growth in Rhode Island than occupations requiring less education (lower skills). We would expect wage growth to be faster for jobs requiring high skills if such workers are in fact relatively scarce. The need to increase wage offers for skilled workers should be reinforced if, as suggested by the commuting data, employers are trying to attract workers to Rhode Island from neighboring states. This is because wages need to compete with the offers these workers are getting in other states in the region (such as Massachusetts), where the cost of living is higher, as well as compensate for a longer commute. Exhibit 20 shows the values of employment wage growth (as well as employment growth) for each of the four education requirement groups for 2014, ranked from left to right in order of highest to lowest wage growth.

Perhaps surprisingly, wage growth is highest for occupations requiring either some college or an associate's degree and lowest for occupations requiring a bachelor's degree or higher. The "some college or associate's degree" group also includes jobs requiring a "postsecondary non-degree award," which includes, among other occupations, nursing assistants and emergency medical technicians, as well as hairstylists. It can be shown that rapid (5 percent) year-over-year wage growth between 2013 and 2014 among these "postsecondary nondegree"-requiring jobs is driving the high wage growth observed for the combined group. This rapid wage growth suggests that labor may be scarce in certain narrowly specialized fields. However, annual wage growth for the "postsecondary nondegree" group was negative to May 2013 (not shown), indicating an inconsistent wage pattern. Also for the period May 2012 to May 2013, jobs requiring a bachelor's degree or higher ranked second in wage growth rather than fourth. This ranking was driven by wage growth in excess of 3 percent among jobs requiring a Ph.D. or professional degree. In sum, wage growth rankings by education requirement are inconsistent

between 2012 and 2014, although they offer some evidence that labor is or was scarce for some occupations requiring specialized skills or advanced degrees.

Looking at wage growth rankings by education requirement over the entire 2006–2014 period, the master's degree group is ranked in first place in three out of these nine years, more than any other education level. In terms of average wage-growth rankings over the period, master's degree is tied for first place with bachelor's degree, and Ph.D.-requiring jobs follow closely behind those two. Jobs requiring a postsecondary nondegree certificate have the lowest average ranking among all eight requirement levels. These longer-term patterns are consistent with longer-term national trends favoring wage growth among more highly-educated workers, but the wage growth premium does not appear especially acute in the recent data for Rhode Island.

10. Summary and Discussion

This paper examines several indicators of possible labor market mismatch in Rhode Island using a number of methods. First, we construct indexes of occupational mismatch that summarize imbalances between vacancy shares and unemployment shares by occupation, following the approaches used by Sahin et al. (2014), Abraham (2015), and others. These indexes suggest that mismatch in Rhode Island increased leading up to and during the Great Recession and since then has abated to below 2006 levels. Based on the adjusted missed hires index as of June 2015, labor market mismatch imposed only a very modest restraint on employment growth in Rhode Island in 2015:Q2, on the order of 0.03 percentage points. Relative to Rhode Island's actual employment growth rate in 2015:Q2, this estimated restraint would have constituted a drag of 6 percent. However, this estimate of drag is calculated in relation to employment growth in a hypothetical (and unrealistic) scenario involving zero mismatch, and furthermore cannot be extrapolated readily to a longer-run estimate of the potential restraint on employment growth imposed by mismatch.

Evidence from commuting patterns shows an increase in the share of jobs based in Rhode Island filled by out-of-state workers, both recently and since 2001, a trend driven by jobs filled by college-educated workers. This evidence fits with anecdotes from employers that they have

trouble filling skilled jobs with workers who reside in Rhode Island, but also suggests that at the broader regional level, mismatch is not a serious problem. This is also seen in the fact that between 2010 and 2013, low-skilled Rhode Islanders increasingly commuted for work out of state to take advantage of better job opportunities. Patterns in wage growth by occupational and educational levels did not reveal any acute labor scarcities, and correlations between wage growth and employment growth by occupation did not support the presence of structural mismatch in the state's labor market.

Occupational mismatch in Rhode Island as measured by the indexes detailed above increased during the Great Recession (peaking shortly after its official end) and declined during the recovery. Similar patterns are seen in the mismatch measures for Massachusetts and the United States, and these suggest that labor market mismatch in recent years was mostly a cyclical rather than a structural phenomenon. However, the presence of elevated labor market mismatch between early 2008 and late 2012, together with overall weak aggregate demand, may have precipitated responses on the part of workers and employers that served to reduce mismatch as measured by the indexes above, and yet without improving the prospects for employment growth. For example, unemployed workers in slack occupations may have given up on searching for work altogether and dropped out of the labor force, especially those nearing retirement age. Employers in markets with labor scarcity might have given up on filling certain vacancies or relocated to a more advantageous labor market.

Selective movements out of the labor force would have reduced the unemployment shares in the slack occupations, bringing them more in line with their vacancy shares, and would of mathematical necessity also have raised the (relatively low) unemployment shares in the tight labor markets. Similarly, if employers in tight markets posted fewer vacancies, this would have reduced the vacancy shares in these occupations and accordingly raised the vacancy shares in the slack markets. All of these changes would have reduced the value of either of the mismatch

indexes used above, without necessarily boosting the state's near-term prospects for employment growth. [37]

However, average employment growth in Rhode Island since 2013 is running above its long-run trend growth rate (1985–2015). This fact suggests that the current extent of structural mismatch in Rhode Island is no worse than its long-run equilibrium level. A certain amount of mismatch may be efficient in the constrained sense that it is too costly to move workers across occupational labor markets. At the same time, it could be the case that the social costs of retraining workers are justified by the gains in terms of additional employment, but private decisions will result in a failure to invest sufficiently in worker training. Abraham (2015) argues that subsidies for worker training are justified when the training promotes broad skills which can be carried across employers, and are less justified socially when the benefits would accrue very narrowly to a single employer. At the same time, it is likely that further increases in aggregate demand could result in further declines in the mismatch indexes, or that faster wage growth in some occupations would alleviate apparent labor scarcities.

The observed increase in nonresident employment may have helped reduce measured labor market mismatch in recent years by helping employers fill vacancies in tight occupations. At the same time, increases in nonresident employment would not have reduced the perception that the resident Rhode Island labor supply is scarce for some fields, thereby helping us to reconcile the empirical data with the anecdotal evidence. Employers are saying that they cannot find qualified employees who live in Rhode Island, but the evidence shows that they do appear capable of finding qualified employees who live quite close to Rhode Island. This finding might also help to explain the fact that evidence from wage growth does not offer strong support for structural mismatch in Rhode Island's labor market at present. From the standpoint of maximizing the welfare of Rhode Islanders, then, there might also be some justification for training Rhode Island residents to fill the jobs that are locally available; this could also save on the social costs of having to import these workers from Massachusetts, even if the commuting distance is fairly short for most Bay State workers.

[37] As explained in Sahin et al. (2014), the job finding rate among those remaining in the labor force would increase if the number of unemployed individuals declines. However, this does not imply that employment growth would necessarily increase.

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Sahin, Aysegul, Joseph Song, Giorgio Topa, and Giovanni L. Violante. 2014. "Mismatch Unemployment." *American Economic Review* 104(11): 3529–3564.

Exhibit 1

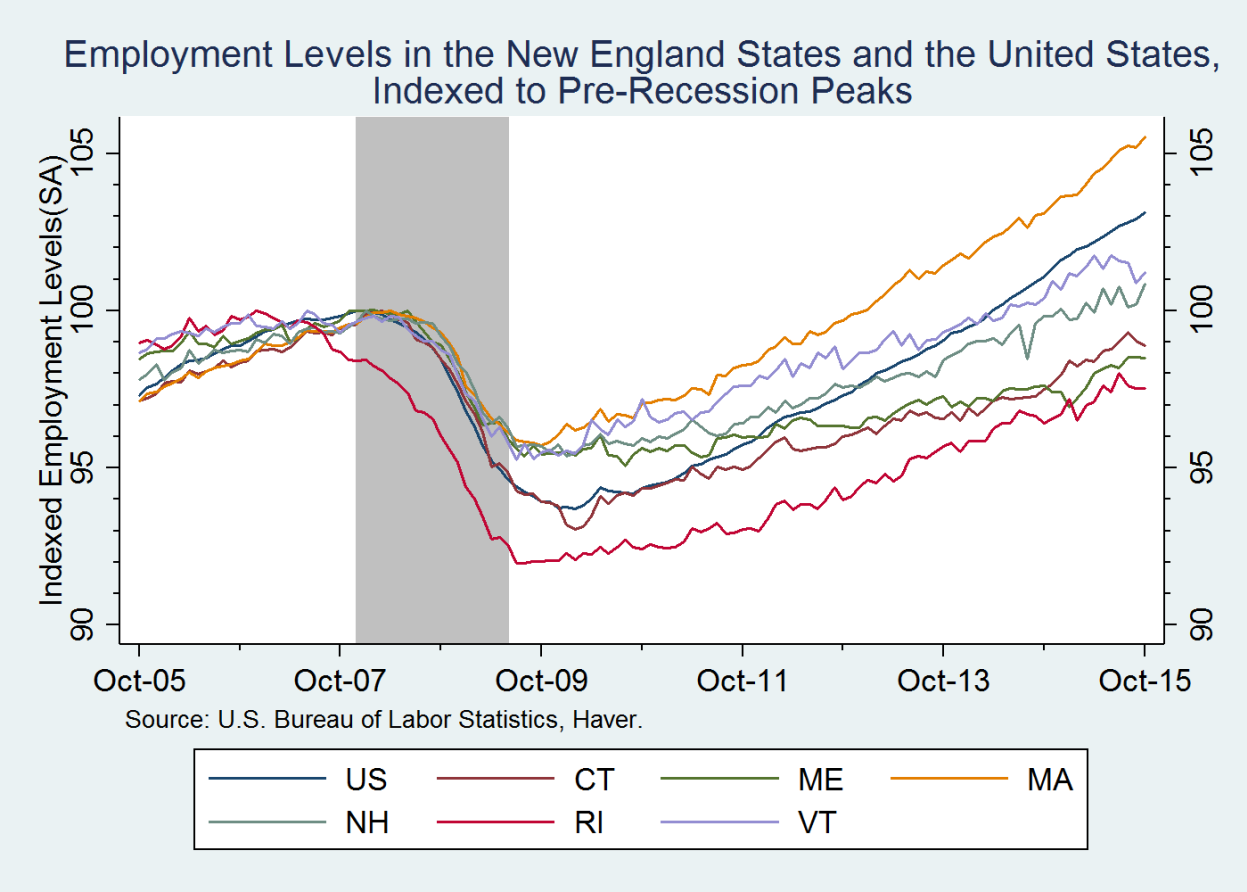

Employment Levels in the New England States and the United States, Indexed to Pre-Recession Peaks
Indexed Employment Levels(SA)
90
95
100
105
Oct-05
Oct-07
Oct-09
Oct-11
Oct-13
Oct-15
Source: U.S. Bureau of Labor Statistics, Haver.
US
CT
ME
MA
NH
RI
VT

Exhibit 2

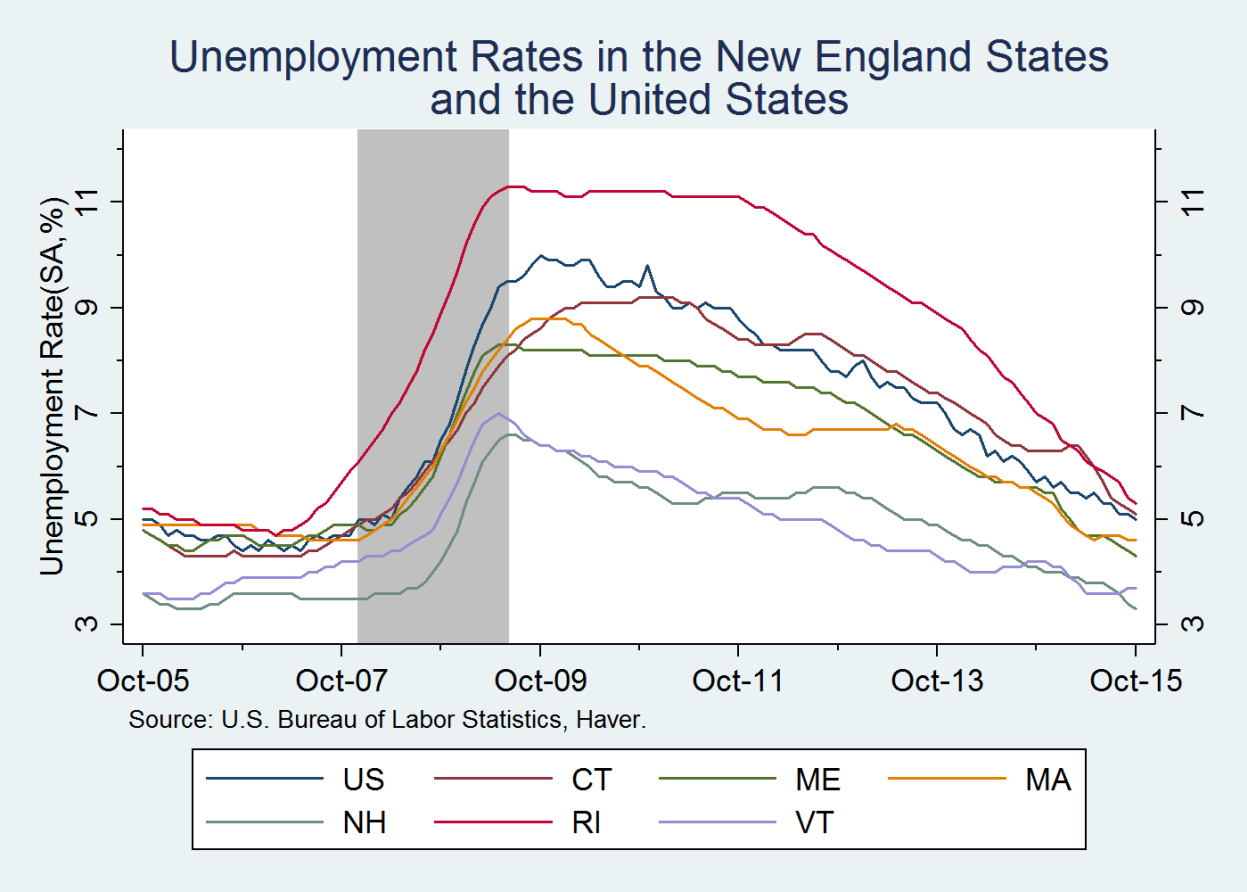

Unemployment Rates in the New England States and the United States
Unemployment Rate(SA,%)
3
5
7
9
11
Oct-05
Oct-07
Oct-09
Oct-11
Oct-13
Oct-15
Source: U.S. Bureau of Labor Statistics, Haver.
US
CT
ME
MA
NH
RI
VT

Exhibit 3

Changes in Labor Market Trends since Peak Unemployment (through October 2015)

	Net Change in Unemployment Rate (ppt)	Net Change in Percent of Population Employed (ppt)	Net Change in Labor Force Participation Rate (ppt)	Percent Change in Population
US	–4.721	0.807	–2.388	6.056
CT	–3.808	0.989	–1.694	2.163
ME	–3.691	0.290	–2.233	2.726
MA	–4.101	2.594	–0.113	4.468
NH	–2.850	0.514	–1.554	2.744
RI	–5.504	1.687	–2.151	1.902
VT	–3.421	–0.823	–3.379	1.578

Source: Author's calculations, based on data from the U.S. Bureau of Labor Statistics, collected with Haver.

Exhibit 4A

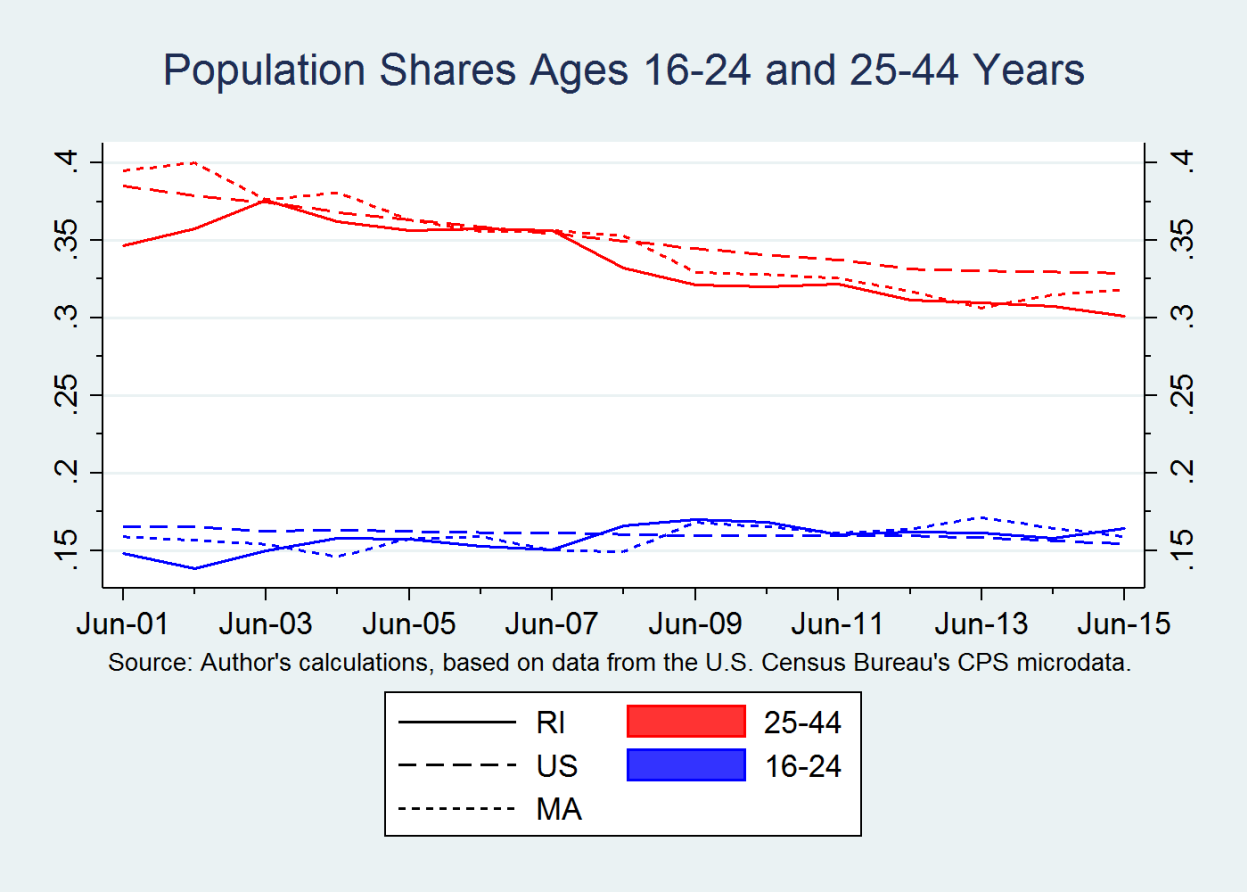

Population Shares Ages 16-24 and 25-44 Years
.15
.2
.25
.3
.35
.4
Jun-01
Jun-03
Jun-05
Jun-07
Jun-09
Jun-11
Jun-13
Jun-15
Source: Author's calculations, based on data from the U.S. Census Bureau's CPS microdata.
RI
US
MA
25-44
16-24

Exhibit 4B

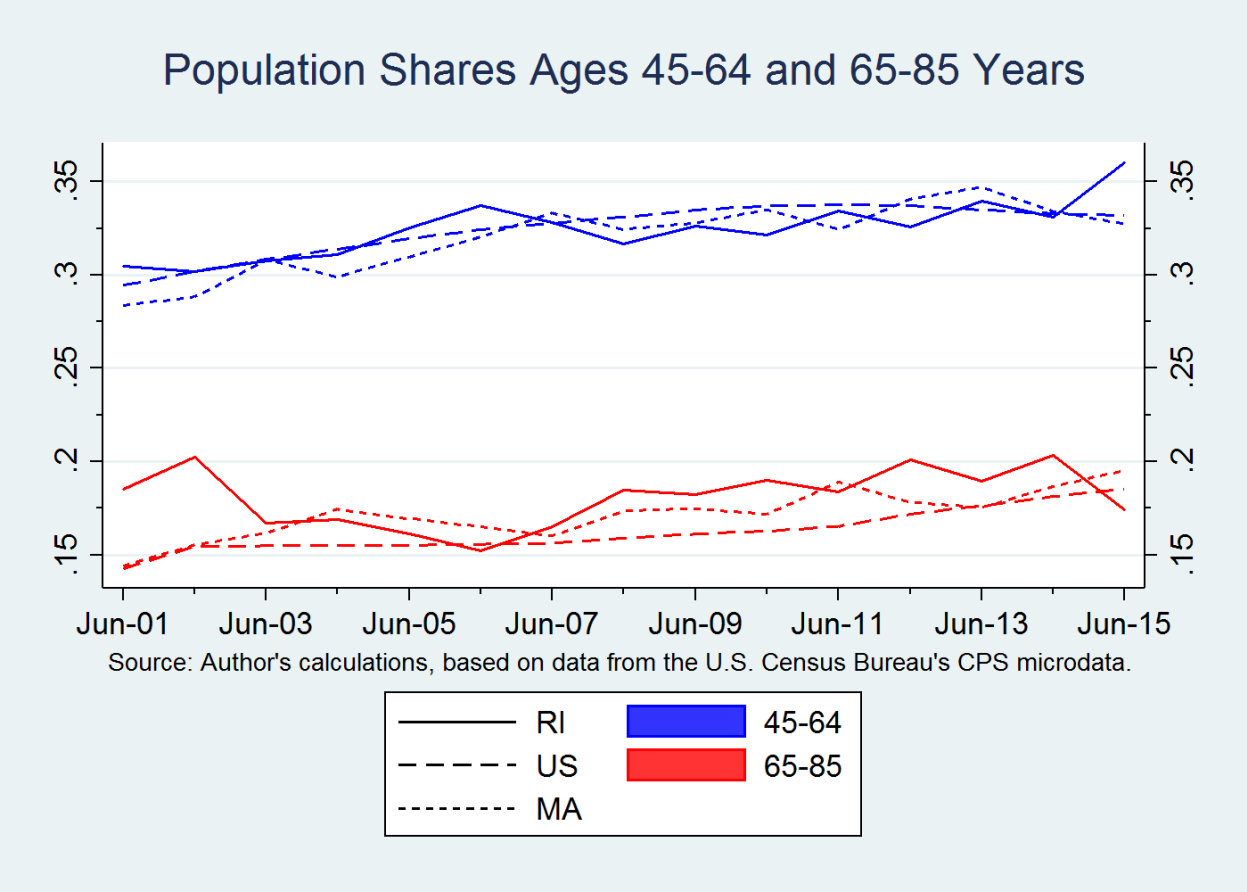

Population Shares Ages 45-64 and 65-85 Years
.15
.2
.25
.3
.35
Jun-01
Jun-03
Jun-05
Jun-07
Jun-09
Jun-11
Jun-13
Jun-15
Source: Author's calculations, based on data from the U.S. Census Bureau's CPS microdata.
RI
US
MA
45-64
65-85

Exhibit 5

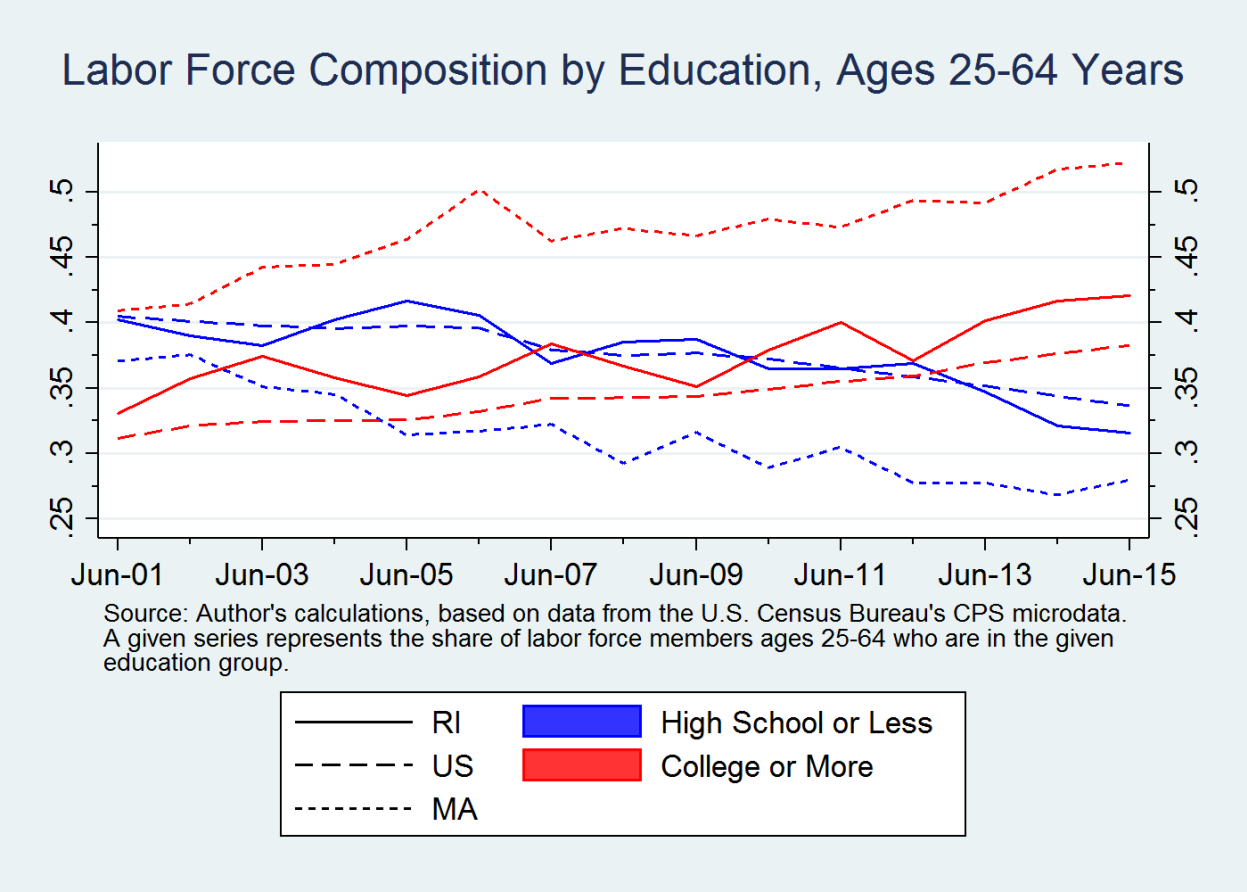

Labor Force Composition by Education, Ages 25-64 Years
.25
.3
.35
.4
.45
.5
Jun-01
Jun-03
Jun-05
Jun-07
Jun-09
Jun-11
Jun-13
Jun-15
Source: Author's calculations, based on data from the U.S. Census Bureau's CPS microdata.
A given series represents the share of labor force members ages 25-64 who are in the given education group.
RI
US
MA
High School or Less
College or More

Exhibit 6

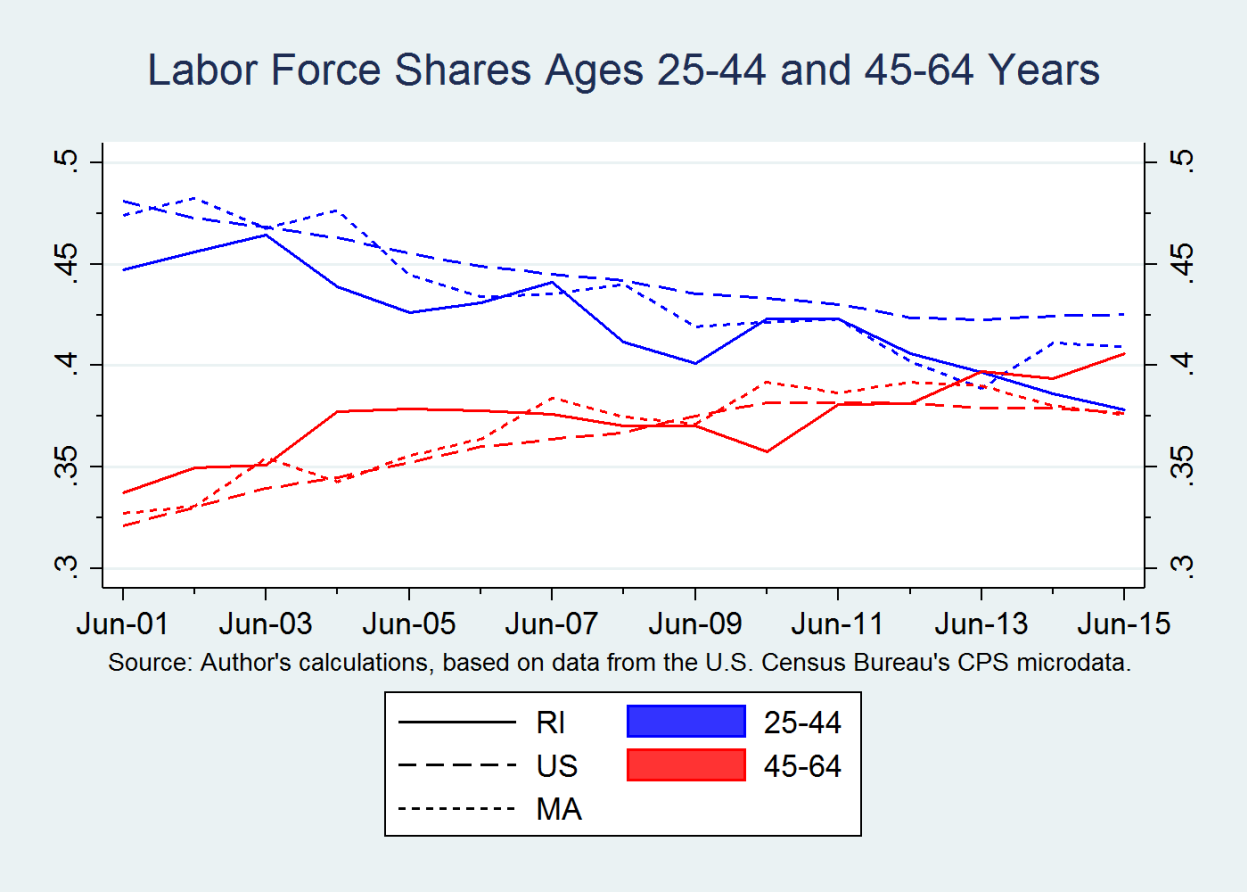

Labor Force Shares Ages 25-44 and 45-64 Years
.3
.35
.4
.45
.5
Jun-01
Jun-03
Jun-05
Jun-07
Jun-09
Jun-11
Jun-13
Jun-15
Source: Author's calculations, based on data from the U.S. Census Bureau's CPS microdata.
RI
US
MA
25-44
45-64

Exhibit 7

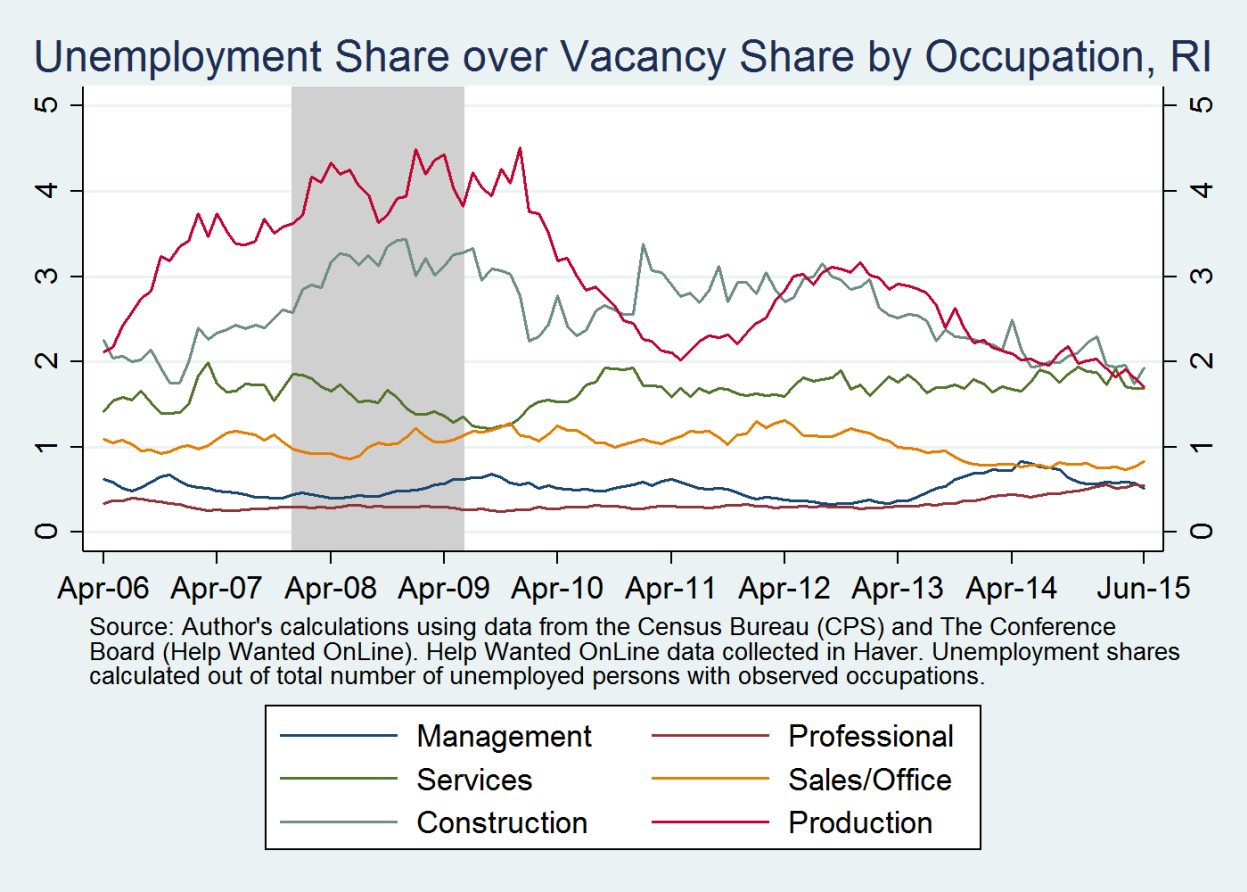
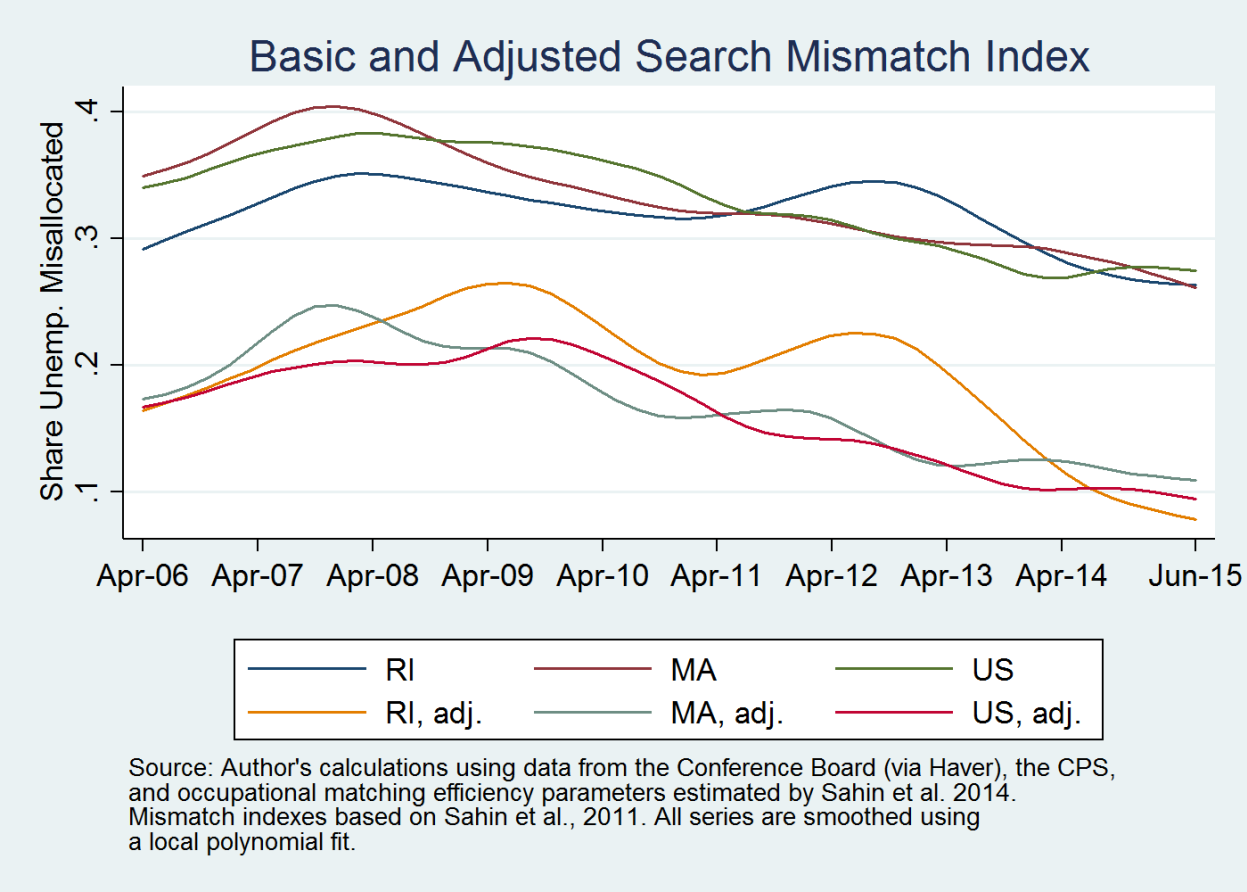
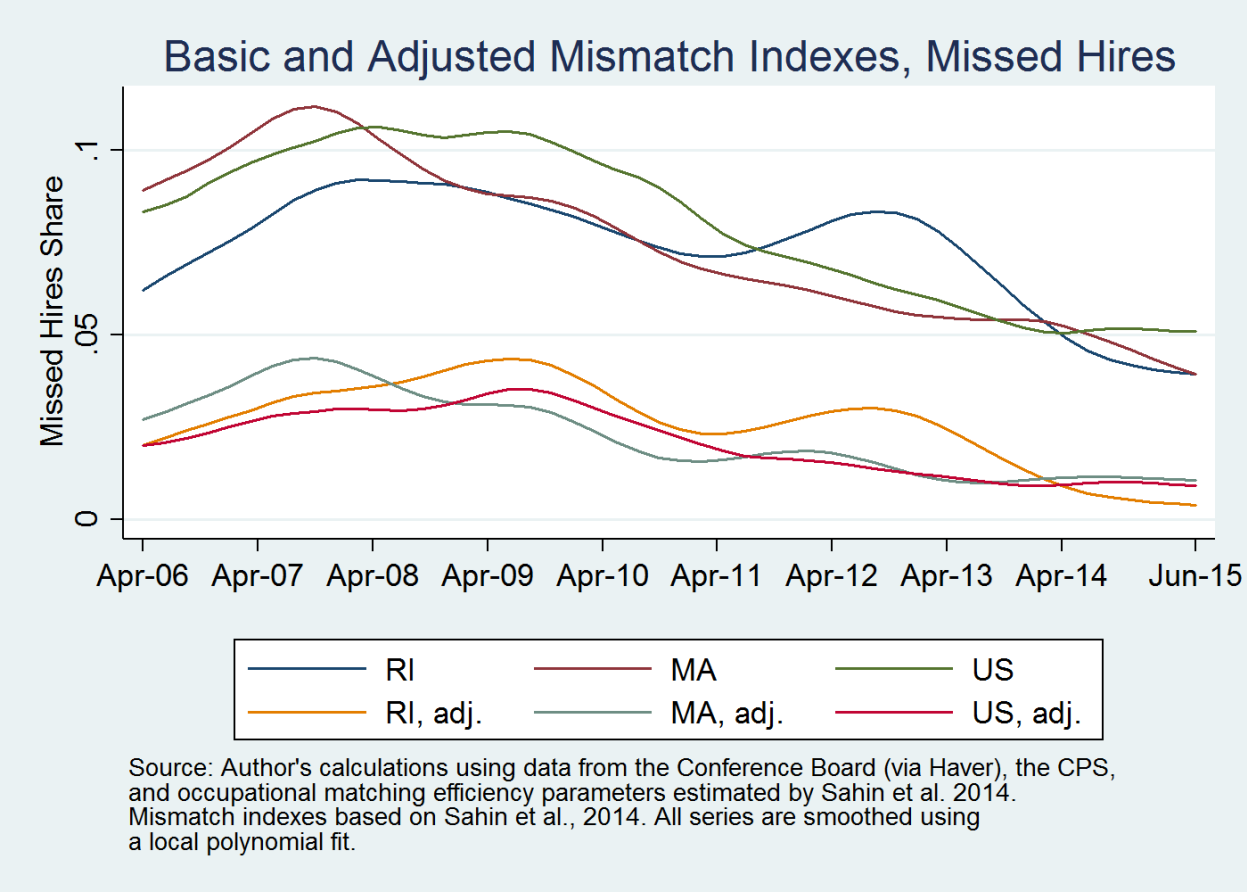

Unemployment Share over Vacancy Share by Occupation, RI
0
1
2
3
4
5
Apr-06
Apr-07
Apr-08
Apr-09
Apr-10
Apr-11
Apr-12
Apr-13
Apr-14
Jun-15
Source: Author's calculations using data from the Census Bureau (CPS) and The Conference Board (Help Wanted OnLine). Help Wanted OnLine data collected in Haver. Unemployment shares calculated out of total number of unemployed persons with observed occupations.
Management
Professional
Services
Sales/Office
Construction
Production

Exhibit 8



Source: Author's calculations using data from the Conference Board (via Haver), the CPS, and occupational matching efficiency parameters estimated by Sahin et al. 2014. Mismatch indexes based on Sahin et al., 2011. All series are smoothed using a local polynomial fit.

Exhibit 9



Source: Author's calculations using data from the Conference Board (via Haver), the CPS, and occupational matching efficiency parameters estimated by Sahin et al. 2014. Mismatch indexes based on Sahin et al., 2014. All series are smoothed using a local polynomial fit.

Exhibit 10

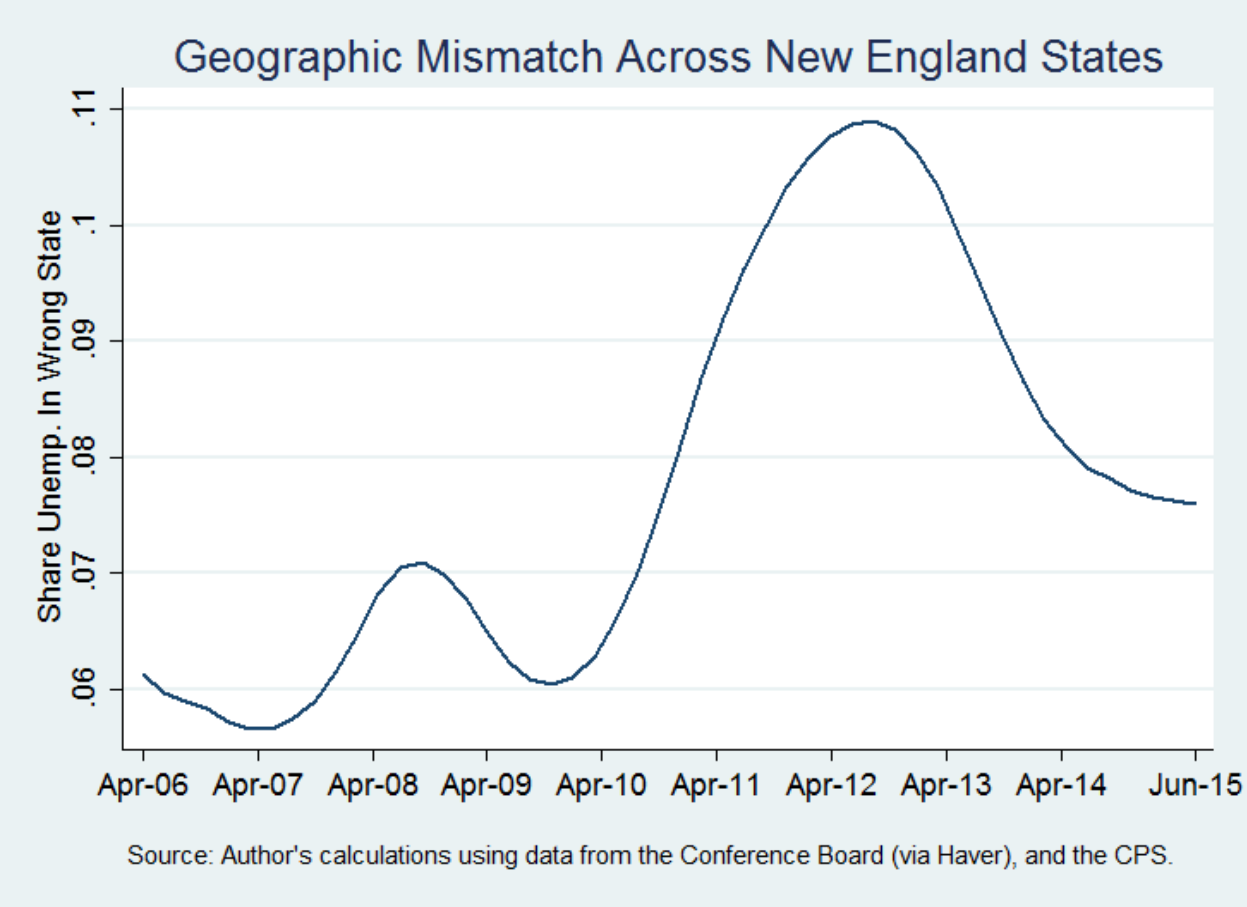
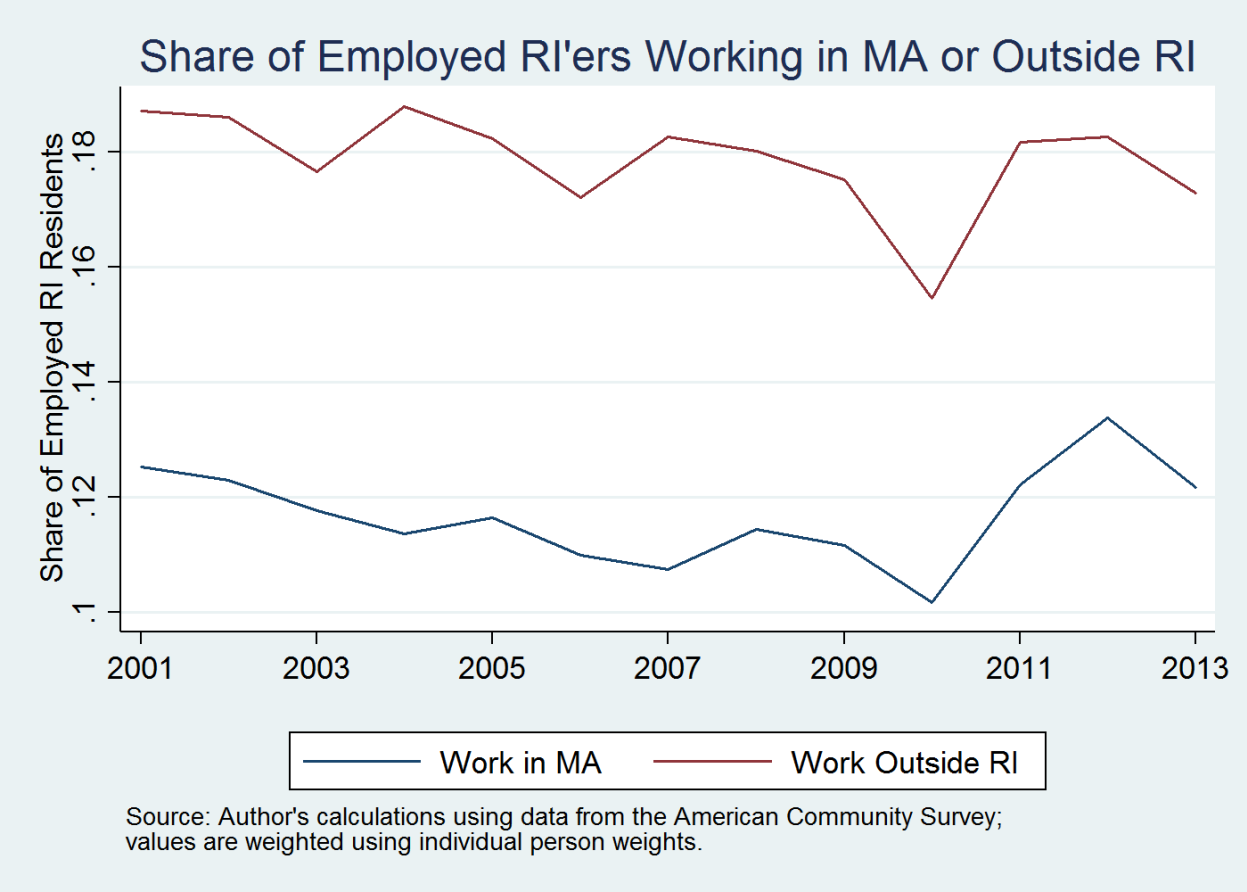
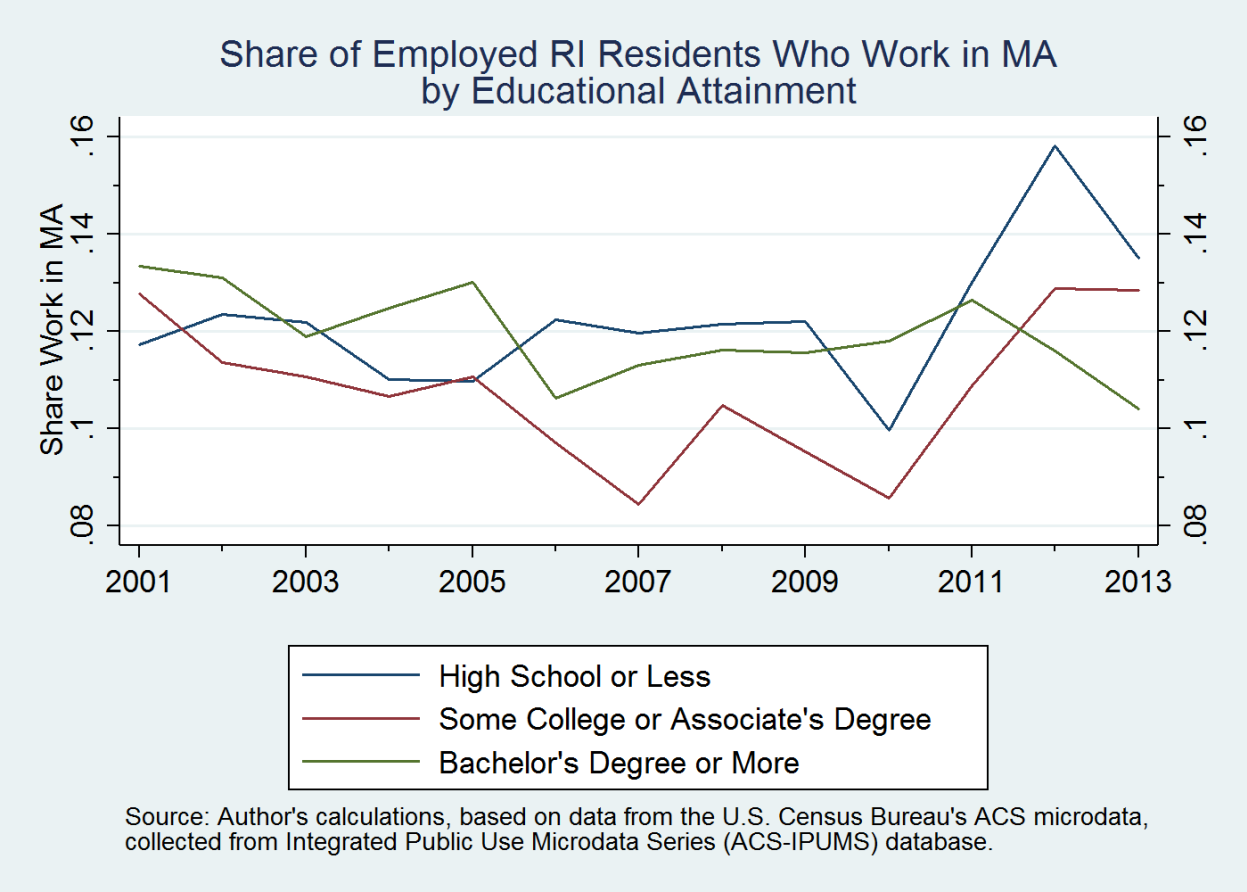

Geographic Mismatch Across New England States
Share Unemp. In Wrong State
.06
.07
.08
.09
.1
.11
Apr-06
Apr-07
Apr-08
Apr-09
Apr-10
Apr-11
Apr-12
Apr-13
Apr-14
Jun-15
Source: Author's calculations using data from the Conference Board (via Haver), and the CPS.

Exhibit 11



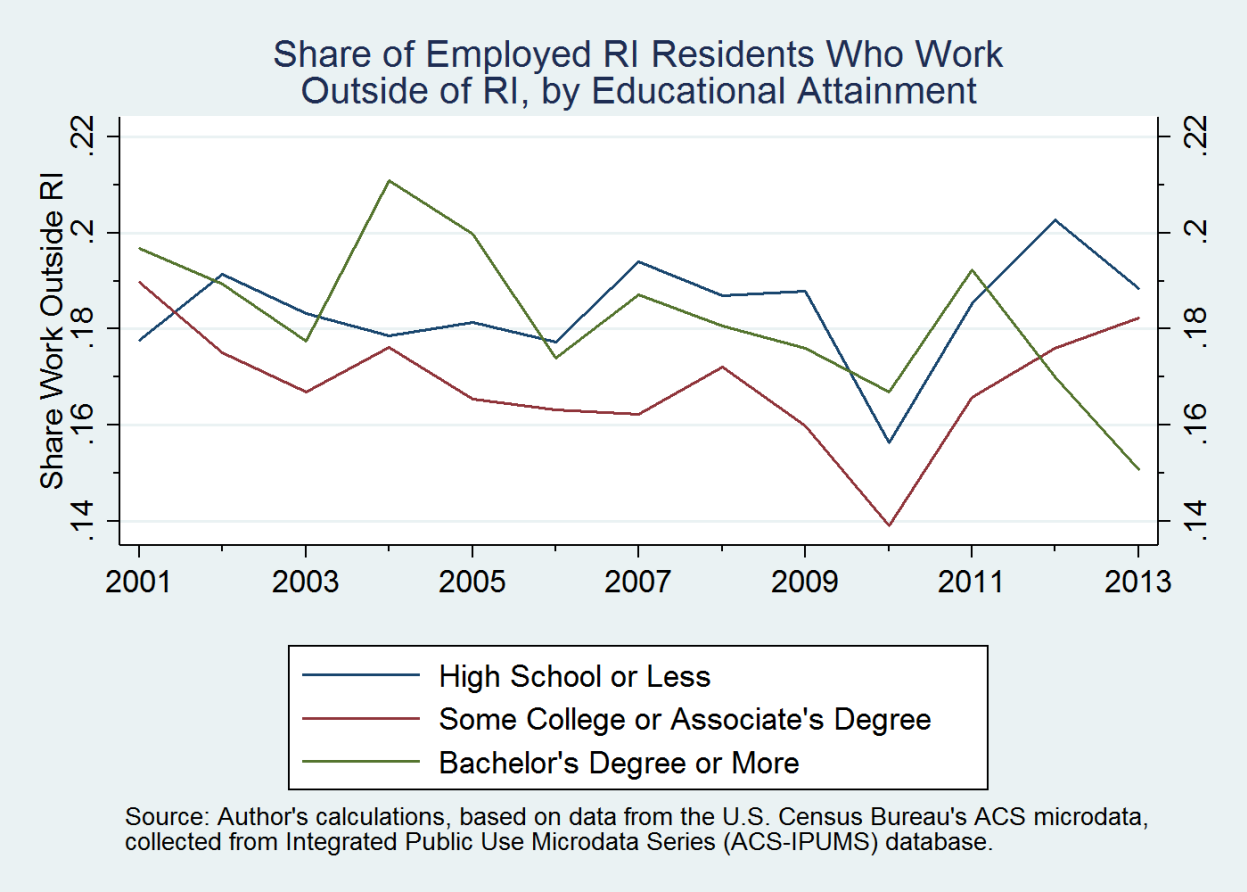
Source: Author's calculations using data from the American Community Survey; values are weighted using individual person weights.

Exhibit 12



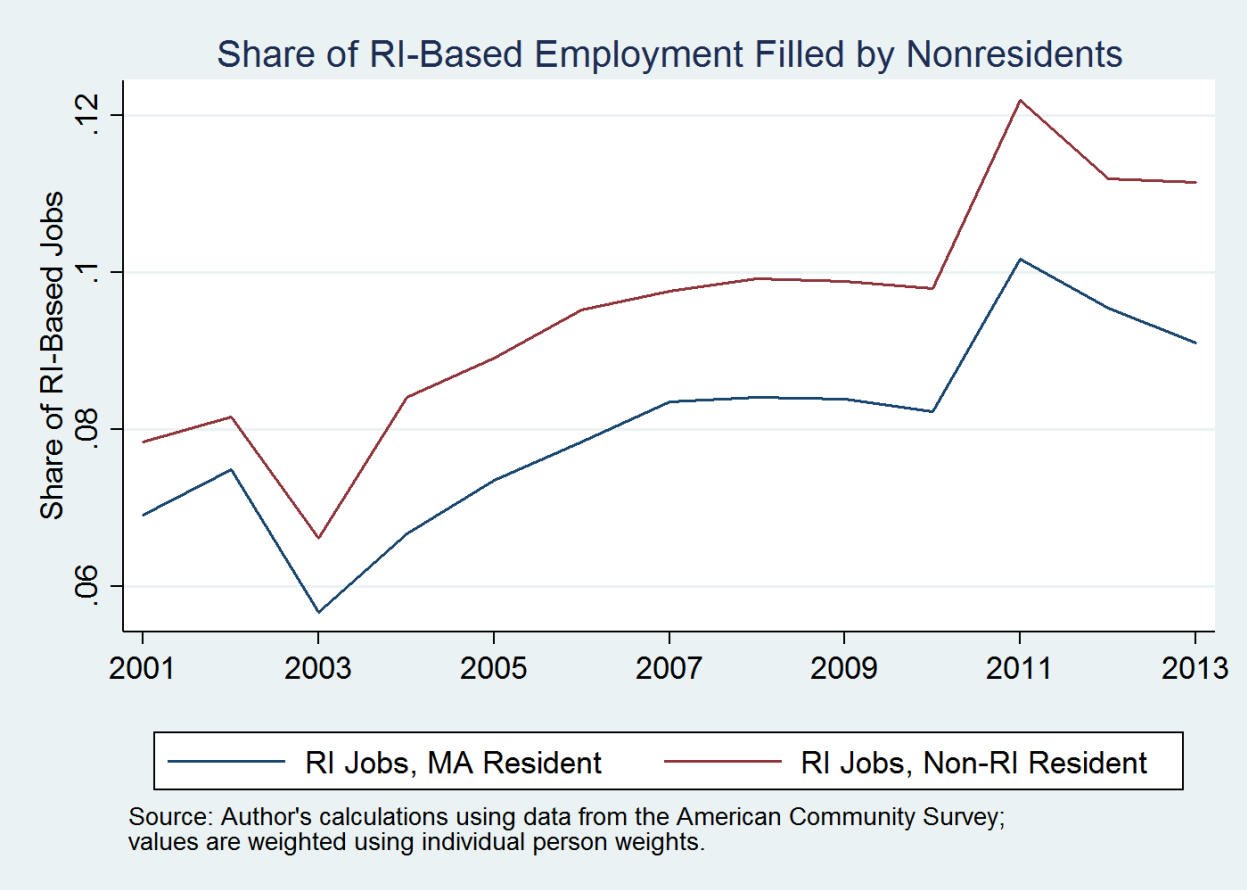
Source: Author's calculations, based on data from the U.S. Census Bureau's ACS microdata, collected from Integrated Public Use Microdata Series (ACS-IPUMS) database.

Exhibit 13



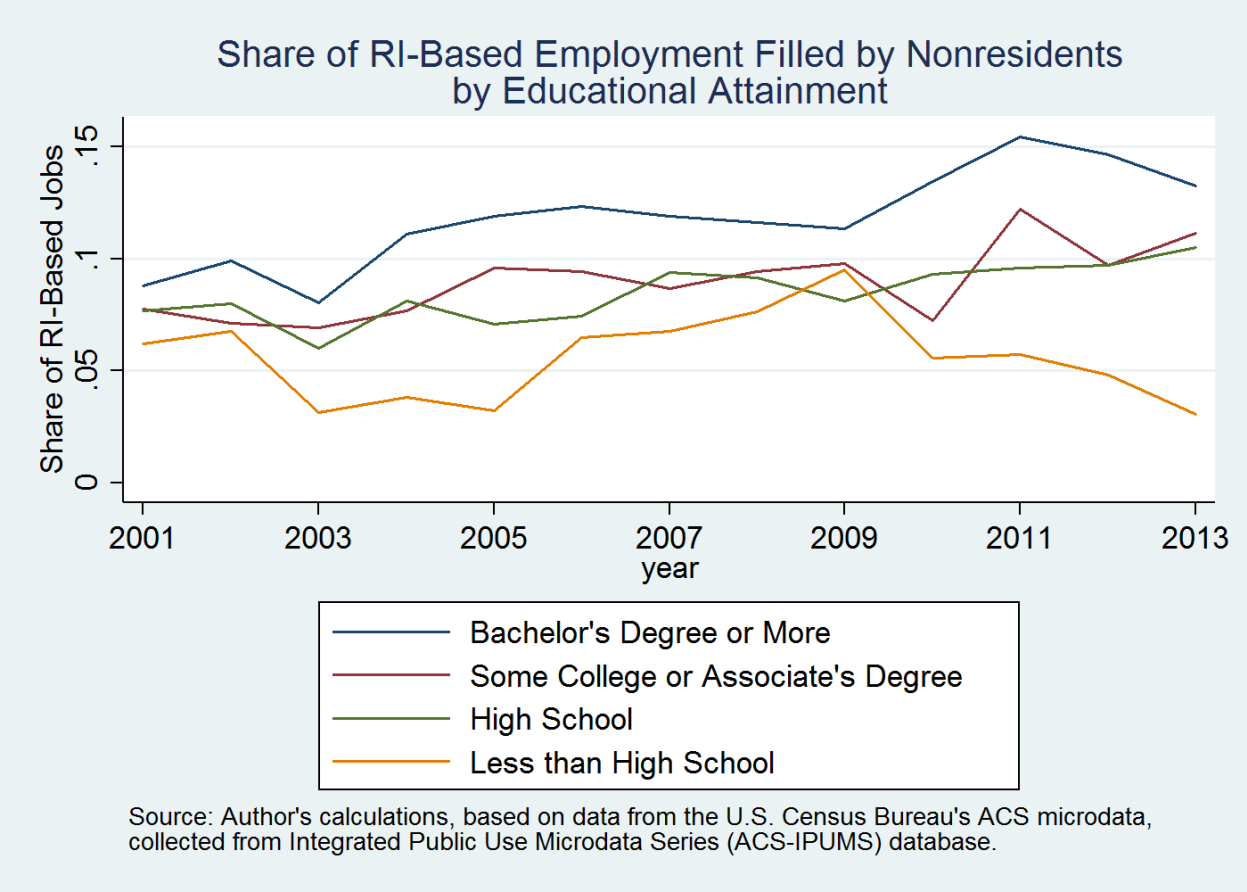
Source: Author's calculations, based on data from the U.S. Census Bureau's ACS microdata, collected from Integrated Public Use Microdata Series (ACS-IPUMS) database.

Exhibit 14



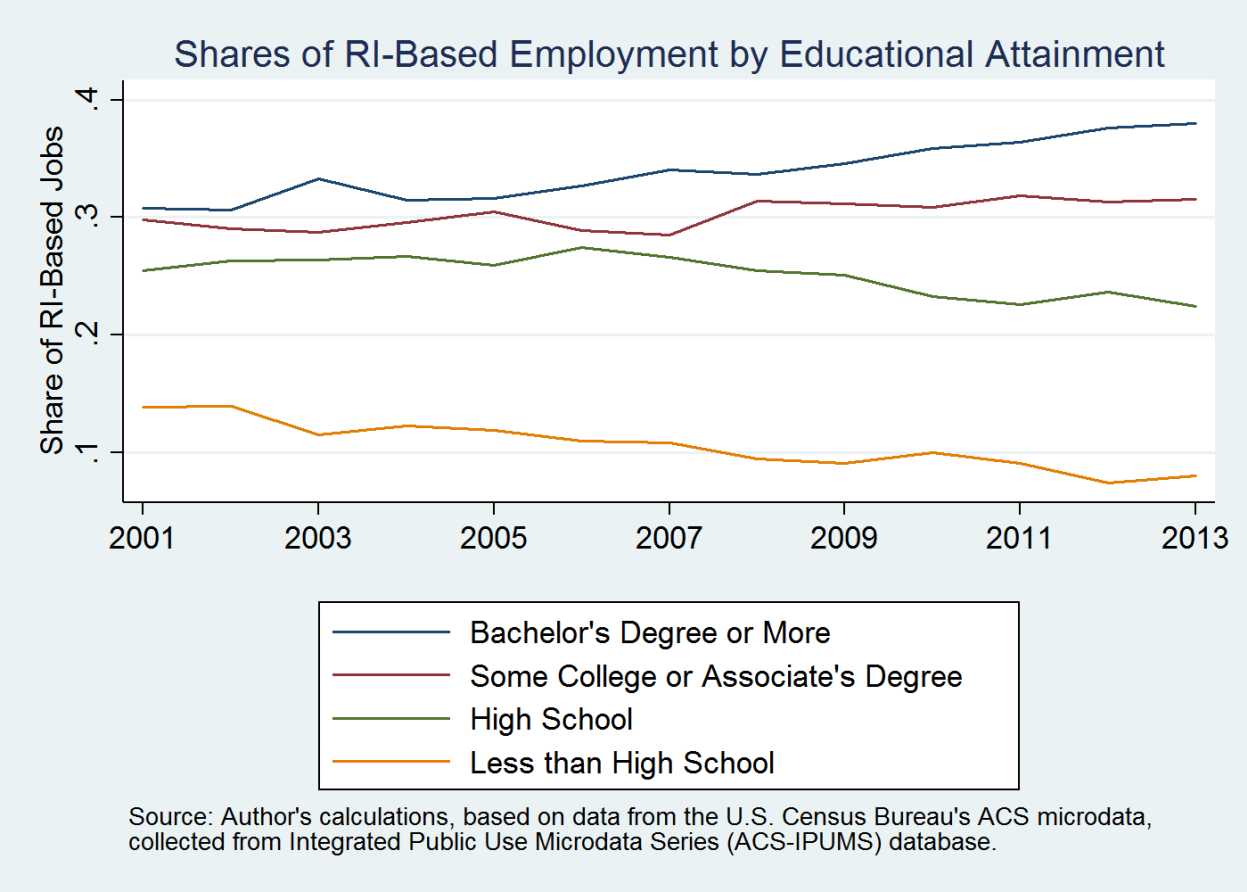
Source: Author's calculations using data from the American Community Survey; values are weighted using individual person weights.

Exhibit 15



Source: Author's calculations, based on data from the U.S. Census Bureau's ACS microdata, collected from Integrated Public Use Microdata Series (ACS-IPUMS) database.

Exhibit 16



Source: Author's calculations, based on data from the U.S. Census Bureau's ACS microdata, collected from Integrated Public Use Microdata Series (ACS-IPUMS) database.

Exhibit 17

Correlations between Employment Growth and Wage Growth by Occupation for Rhode Island

Year	2-Digit SOC Codes	1-Digit Occupation Codes
2006	0.175	0.780
2007	–0.031	0.149
2008	–0.174	–0.741
2009	–0.395	0.313
2010	–0.189	0.378
2011	–0.270	0.217
2012	–0.115	–0.606
2013	0.077	0.636
2014	–0.346	–0.812
Average, 2006–2014	–0.141	0.035

Exhibit 18

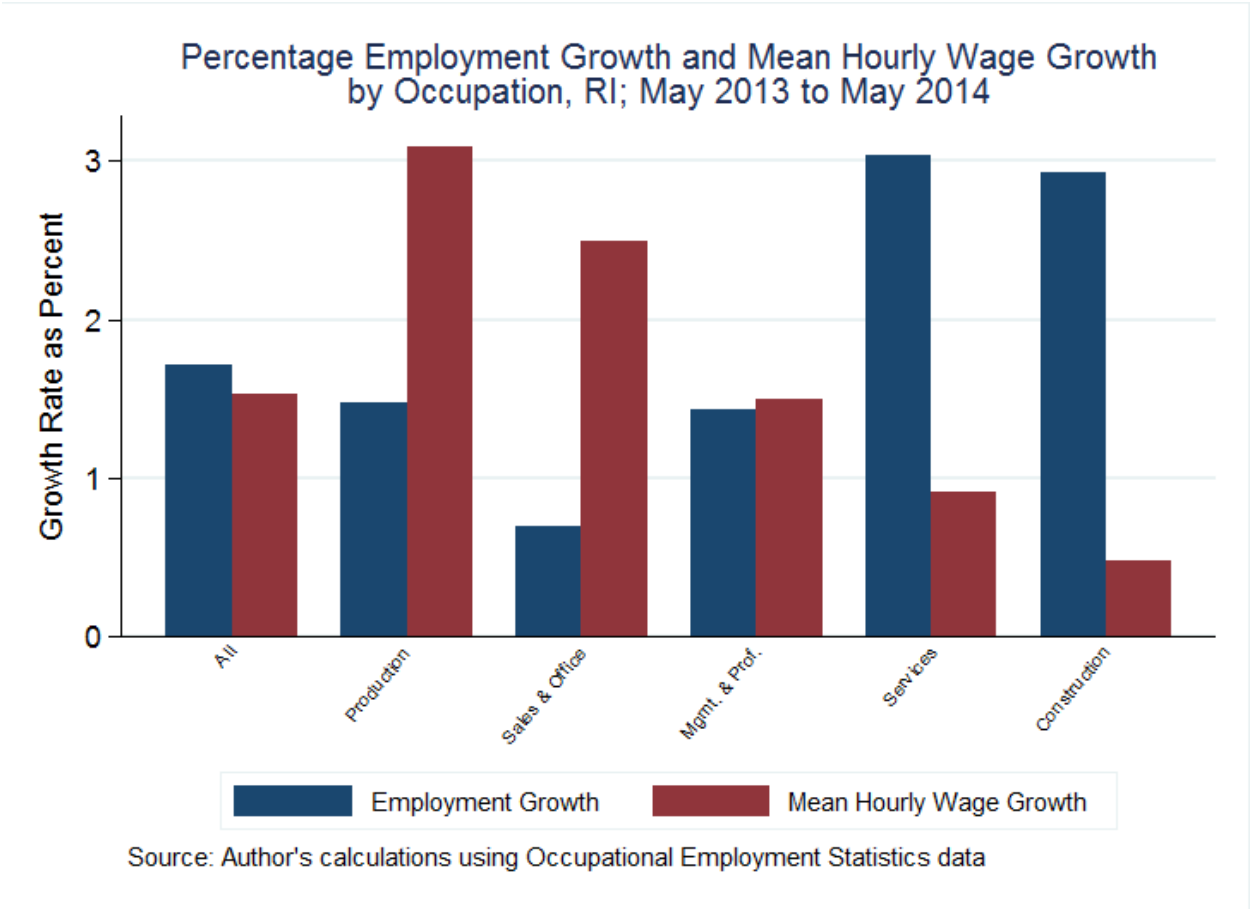
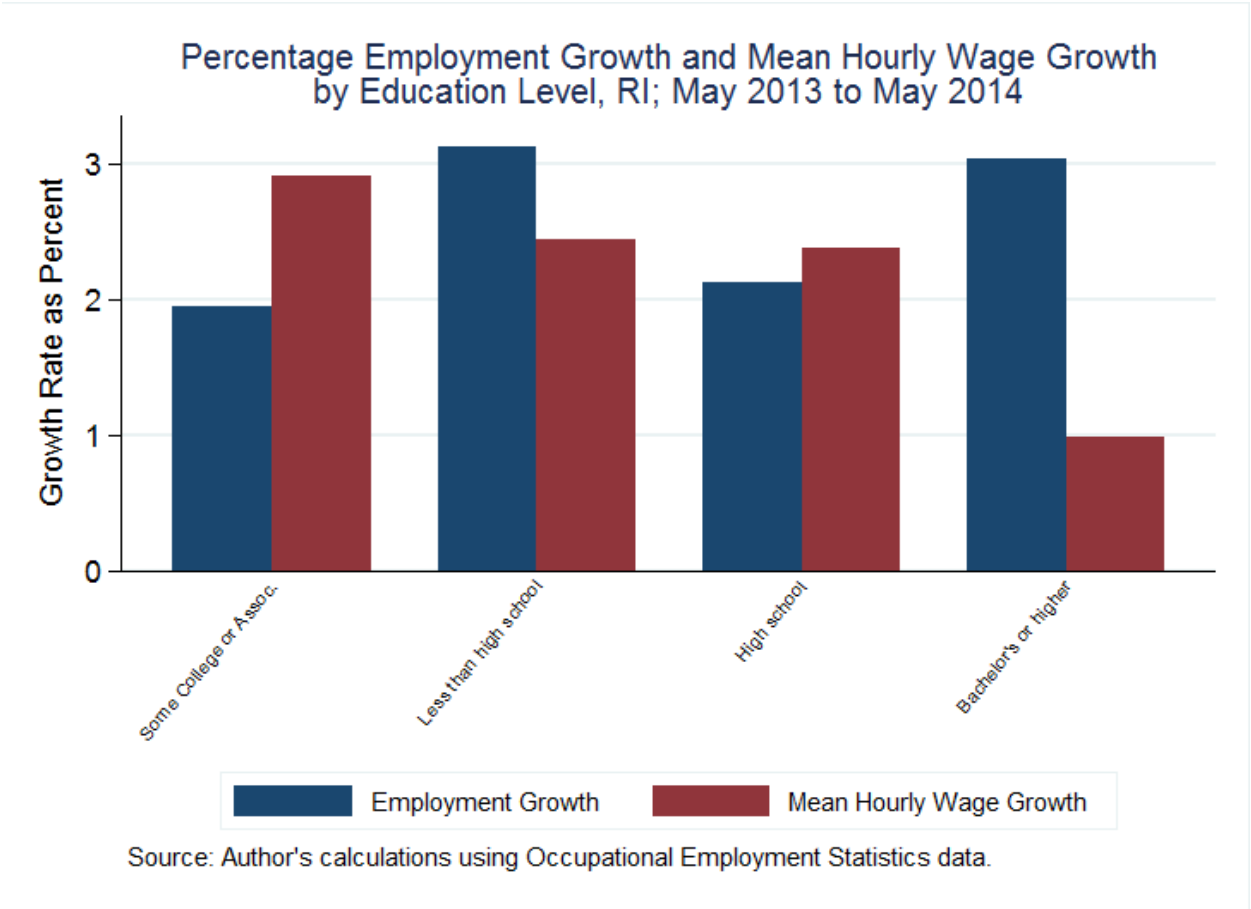

Percentage Employment Growth and Mean Hourly Wage Growth
by Occupation, RI; May 2013 to May 2014
Growth Rate as Percent
0
1
2
3
All
Production
Sales & Office
Mgmt. & Prof.
Services
Construction
Employment Growth
Mean Hourly Wage Growth
Source: Author's calculations using Occupational Employment Statistics data

Exhibit 19

Correlations between Employment Growth and Wage Growth by Education for Rhode Island

Year	Eight Education Groups	Four Education Groups
2006	0.607	–0.690
2007	–0.010	–0.849
2008	–0.760	0.118
2009	0.006	0.041
2010	–0.475	–0.356
2011	–0.859	0.410
2012	0.917	–0.826
2013	–0.454	0.202
2014	–0.016	–0.632
Average, 2006–2014	–0.116	–0.287

Exhibit 20



Source: Author's calculations using Occupational Employment Statistics data.

Appendix: Missed Hires Mismatch Index (Basic and Adjusted)

The following expression represents the formula for the (unadjusted) "missed hires" mismatch index, denoted M^h :

$$M^h = 1 - \sum_{i=1}^{I} \left(\frac{v_{it}}{v_t}\right)^{\alpha} \left(\frac{u_{it}}{u_t}\right)^{1-\alpha}.$$

In the above equation, all symbols to the right of the equals sign have the same meaning as in equation (1) in the main text, except that the location subscript, *j*, has been dropped here for convenience.

The following expression represents the formula for the adjusted missed hires mismatch index, M^{ha} :

$$M^{ha} = 1 - \sum_{i=1}^{I} \left(\frac{\phi_i}{\overline{\phi}_t}\right) \left(\frac{v_{it}}{v_t}\right)^{\alpha} \left(\frac{u_{it}}{u_t}\right)^{1-\alpha}.$$

In the above, the term ϕ_i refers to the matching efficiency of occupation *i*, and the term $\overline{\phi}_t$ is defined as follows:

$$\overline{\phi}_t = \left[\sum_{i=1}^{I} \phi_i^{\frac{1}{\alpha}} \left(\frac{v_{it}}{v_t}\right)\right]^{\alpha}.$$

All remaining terms are again the same as in equation (1) in the main text.