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Abstract

The aggregate matching (hiring) function relates gross hires to labor market tightness. Decompositions of aggregate hires show how the hiring process differs across different groups of workers and of firms. Decompositions include employment status in the previous month, age, gender and education. Another separates hiring between part-time and full-time jobs, which show different patterns in the current recovery. Shift-share analyses are done based on industry, firm size and occupation to show what part of the residual of the aggregate hiring function can be explained by the composition of vacancies. The hiring process appears to shift as a recovery starts, coinciding with shifts in the Beveridge curve. The paper also discusses some issues in the modeling of the labor market.

JEL-Codes: E240, J600.

Keywords: beveridge curve, unemployment matching function, hiring function, vacancies, worker flows.

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Introduction

In considering the scope for stimulative and contractionary policies, both analysts and policymakers look at many aspects of the state of the economy. Important among these is the state of the labor market, with particular attention to hiring. While the net change in the level of employment gets considerable attention in the press each month, analysts have found it worthwhile to focus on the gross levels of hires and separations, which are vastly larger than the net change, commonly being 20 times as large in the US, as shown in Figure 1.[1] Attention is paid to a number of the details of the hiring process, in addition to consideration of the aggregate. And attention is paid to the stocks of vacancies and unemployed, and their ratio, commonly referred to as the tightness of the labor market.

The focus of this paper is on gross hires relative to the tightness of the labor market, a topic with a considerable literature, both theoretical and empirical. The paper considers various decompositions of aggregate hires to see how the hiring process differs across different groups of workers and different groups of firms, thereby helping to put the current data in the context of past experiences. At the start, we briefly note that the hiring process appears to shift as a recovery starts, as indicated by shifts relative to tightness at the times when the vacancy rate starts to increase. The presence of such shifts coincides with shifts in the Beveridge curve, which plots the relationship between unemployment and vacancy rates. We note that the Beveridge curve shifts, for which there is a longer history of data, is not a signal of an inability of the economy to reach as low a level of unemployment as before the start of the recession as shown in Diamond and Şahin (2015).

Throughout the paper we maintain an assumption of constant returns in the hiring process. This permits two-dimensional graphical presentations as well as regressions and displays of residuals. Using figures and regressions, we explore some decompositions of aggregate hiring. Section I introduces the aggregate hiring function and looks briefly at shifts in the function as the recovery starts. Section II looks at hiring of the employed, the unemployed, and those not in the labor force. These separate hiring functions have different slopes and different degrees of fit relative to labor market tightness, focusing attention on the level of hiring of the already employed as the central item that varies across business cycles. Low hiring of the

[1] While the US has larger flow rates than elsewhere, that gross flows are much larger than net is widespread (Blanchard and Summers (1986), Blanchard and Wolfers (2000).)

already employed is especially important in the shape of the recovery from the Great Recession. Section III decomposes hires by previous labor force status and by age, gender and education. Section IV separates hiring between part-time and full-time jobs, which show different patterns in the current recovery.

As presented in Davis, Faberman, and Haltiwanger (2013), the speed of filling vacancies varies by industry and by firm size.[2] Section V reports shift-share analyses based separately on these two (overlapping) dimensions of difference and by occupation to show how much of the size of the residual of the aggregate hiring function can be explained by the composition of vacancies across these dimensions. Section VI considers some issues in the modeling of the labor market. In short, the labor market is diverse and complicated.

1. The aggregate hiring function[3]

The *hiring* function, commonly referred to as the matching function, relates the level of new hires to the numbers of unemployed and vacancies. Much of the literature views this relationship as a technical one, looking to refine the measures of workers actively searching for employment and of firms actively searching to fill vacancies. In contrast, we think of hiring relative to measured unemployed and vacancies as a proxy relationship, much as Okun (1962) viewed the relationship between the unemployment rate and the output gap, that the unemployment rate was at best "a proxy variable for all the ways in which output is affected by idle resources" (page 99). So too, hiring depends on more than just the numbers of unemployed and job openings.[4] We use the ratio of unemployed to vacancies as our proxy variable. The high correlation of the unemployment rate with additional measures supports continued use of the simple measure.

Using JOLTS data, Davis, Faberman, and Haltiwanger (2013) found that between December 2000 and December 2006, 41.6% of hires took place at establishments with no recorded vacancy

[2] Davis, Faberman, and Haltiwanger (2013) also report large variation in the speed of filling vacancies across firms by turnover rate.

[3] The term matching function has two distinct meanings in different studies, being meeting in many theoretical studies and hiring in empirical studies, Thus, we use the term hiring function.

[4] Persons are classified as unemployed if they do not have a job, have actively looked for work in the prior 4 weeks, and are currently available for work. Persons who were not working and were waiting to be recalled to a job from which they had been temporarily laid off are also included as unemployed. A vacancy (job opening) is a specific position of employment to be filled at an establishment; conditions include the following: there is work available for that position, the job could start within 30 days, and the employer is actively recruiting for the position.

going into the month.[5] Using a model of daily hiring fitted to monthly data, the paper estimates that 27.4% of hires would have taken place at establishments that filled vacancies too quickly to be in the data. This still leaves considerable hires without a posted vacancy according to the model.[6] Using the 1982 wave of the Employment Opportunity Pilot Project Survey, Faberman and Menzio (2010) estimate that 20% of all new hires involve no formal vacancy or recruiting time by the employer.

Hiring of the unemployed is only around one-third of hires sorted by the previous month's labor force status.[7] As shown in Figure 2, hiring of the nonemployed reporting no job search in the previous month (out of the labor force), regularly exceeds hiring of the unemployed, who do report such search. Beyond the active searchers among both employed and unemployed workers are the varying numbers of workers who respond to a suitable unsolicited offer. Of the employed who moved to a new job, according to the repeated Contingent Worker Supplements to CPS,[8] far more did not search in the previous month than those who moved and did search (see Table 1 from Carrillo-Tudela, et al, 2015). According to surveys in 2013 and 21014, around 25 percent of job offers go to employed workers who have not searched for a job (see Table 2 from Faberman et al, 2016). Thus, beyond the incentives affecting the levels of search, key to hiring, given contacts between firms and workers, is the eagerness to begin an employment relationship, a centerpiece of micro analyses of the reservation willingnesses to enter into an employment relationship on both sides of the market. That is, the gap between meeting and matching is a vital part of the hiring process.

Moreover, there is competition among workers for the same jobs and among firms for the same workers. This competition limits the ability of models with linearly combined pools of differently situated workers to capture the hiring process. If hiring depended on a linear combination of different pools of workers, the relative job-finding rates of the different pools would be a constant (plus noise). As an example of the limitation of this approach, Figure 3 shows the ratio of the job-finding rate of the unemployed with more than six months' duration to

[5] See for example Sedláček (2014) who proposes a method to account for unobserved vacancies in the estimation of the hiring function.

[6] "The establishment-level incidence of vacancies is highly persistent: only 18% of vacancies in the current month occur at establishments with no recorded vacancies in the previous month." (Davis, Faberman, and Haltiwanger, 2013, p.590).

[7] For example, analysis of the Finnish unemployment register "indicates, the non-unemployed job seekers comprise almost 40% of all job seekers" (Kangasharju et al, 2005, p. 116).

[8] Surveys conducted in February of 1995, 1997, 1999, 2001, and 2005.

that of those with less than six months' duration. The variation has a strong cyclic component as shown by the regression on market tightness.[9] Of course, the pursuit of a proxy for tightness does not eliminate having a residual cycle-phase component, as we will see. Nevertheless, the focus of this paper is on the disaggregation of the relationship between overall tightness and hiring.

Using the measures of unemployed and vacancies as proxies and assuming that the hiring function has constant returns to scale relative to these proxies, we can relate the job-filling rate, H/V, to the ratio of unemployed to vacancies, U/V, taking the latter to be the inverse of the tightness of the labor market.[10]

$$\frac{H[U,V]}{V} = A\left(\frac{U}{V}\right)^{\alpha}$$

Figure 4 shows the relationship between job-filling and the inverse of tightness, showing that the aggregate job-filling rate has a strong negative relationship to tightness. Table 3 reports the OLS regressions for the commonly used Cobb-Douglas formulation. We use three different measures of hires: hires calculated from the JOLTS (available starting in 2000) and the sum of unemployment-to-employment, nonparticipation to employment and job-to-job transitions calculated from the matched CPS data starting in 1994 and *imputed* total hires using the CPS starting in 1975.[11] The residuals in this fitted equation are commonly combined with the parameter A and referred to as the efficiency of the hiring function. Below, we return to this regression to examine the residuals in the context of disaggregation.

To note a limitation in the approach of using tightness but ignoring the business cycle phase, Figures 5a and b show the job-finding and job-filling rates relative to the inverse of tightness, distinguishing the times before and after the time when the vacancy rate passes its minimum level. The figures show the common presence of a shift in hiring relative to labor

[9] The regression of the ratio of the job finding rate of the unemployed with more than six months' duration to that of those with less than six months' duration on market tightness has a positive and statistically significant coefficient of 0.075. Regressions in Blanchard and Diamond (1990) showed that short term unemployed affected the hiring of the long-term unemployed but not vice versa.

[10] Constant returns to scale is consistent with much, but not all of the empirical evidence (Petrongolo and Pissarides, 2001, but for the reverse conclusion, see Ellison et al, 2013).

[11] We use the Composite Help-Wanted Index constructed by Barnichon (2010) for vacancies. This index makes use of the historical Help-Wanted Index, which was derived from help wanted advertisements in 51 major newspapers, and the online Help Wanted index. Barnichon uses the HWI for the 1951-1995 period assuming no online advertising and then he estimates the share of print advertising starting from 1995 and uses that for the 1995-2005 period. Both the historical and online Help Wanted Indices are published by the Conference Board. We follow Daly, Hobijn, Şahin and Valletta (2012) and append Barnichon's series with the JOLTS starting from December 2000.

market tightness at this time, one way of marking a transition from recession to recovery. The one exception to a shift is the turning point in 2003, which has been viewed as occurring in an anomalous recession.

Estimates of aggregate hires are only available back to the 1970s, while unemployment and vacancy rates are available back to the 1950s.[12] Figure 6 shows the Beveridge curve around the minimum vacancy points, using a vacancy rate calculated as vacancies relative to the labor force.[13] As with the hiring function, shifts in the Beveridge curve are also common around the minimum vacancy point. The 2000-2003 cycle is an anomaly, with the other cycles showing a drop in the aggregate hiring function relative to market tightness and a rise in the Beveridge curve. While an outward shift in the Beveridge curve at such a time is sometimes cited as a reason to limit expansionary policy,[14] as reported in Table 4 (taken from Diamond and Şahin, 2015) the experiences during the following expansions after the outward shifts have been diverse, sometimes going to a lower unemployment rate than at the previous business cycle peak and sometimes not.[15] [16] In the current recovery, despite the continuing shift in the Beveridge curve, the lowest unemployment rate so far is 4.7 percent, only slightly above the 4.4 percent reached before the Great Recession.

[12] See the appendix for a detailed discussion of our imputation process for aggregate hires.

[13] To see the similarities between the relationships, we redefine the vacancy rate used in the Beveridge curve (vacancies divided by employment plus vacancies) to be vacancies divided by the labor force, to be consistent with the constant returns assumption for the hiring function. That is, in the standard presentation of the Beveridge curve, the unemployment rate is the ratio of the number of unemployed to the labor force, that is, to the sum of the numbers of employed and unemployed. In parallel, the vacancy rate is normally taken to be the ratio of the number of vacancies to the sum of the numbers of filled jobs and of vacancies. Thus, a vacancy rate which is the ratio of the number of vacancies to the labor force has the same denominator as in the definition of the unemployment rate, implying that hires divided by the labor force can be written as a function of the rates, $H / L = H\left[u, v\right]$.

[14] See, for example: "The red dots in Fig.8 depict the Beveridge curve since the U.S. recession was formally declared ended in June 2009. One would normally expect the unemployment rate to decline as economic growth resumes. But here, we see evidence of increased recruiting activity on the part of the business sector together with no apparent decline in the unemployment rate. One interpretation of this recent pattern is that matching jobs with workers has become more difficult in the wake of an exceptionally severe recession. If this is the case, then it is not immediately clear how monetary or fiscal policies might alleviate the problem." (Federal Reserve Bank of St. Louis, 2010).

[15] Earlier work was based on the maximum unemployment rate, rather than the minimal vacancy rate. To extend the vacancy series, Diamond and Şahin (2015) uses the Composite Help-Wanted Index constructed in Barnichon (2010) for the 1951-2000 period, which is available on a quarterly basis.

[16] We are not the first to note the presence of previous shifts. See, for example, Daly, Hobijn, and Valletta (2011) for an earlier analysis. Also Bernanke (2012): "We can see some outward shift in the relationship between job vacancies and unemployment, consistent with some increase in structural unemployment since the onset of the recession. However, a more in-depth analysis of the evidence suggests that the apparent shift in the relationship between vacancies and unemployment is neither unusual for a recession nor likely to be persistent. Research has found that during and immediately after the serious recessions of 1973 to 1975 and 1981 to 1982, the Beveridge curve also shifted outward, but in both cases it shifted back inward during the recovery."

2. Previous Labor Force Status

The focus of this paper is learning about the hiring process by examining the hiring experience differences among workers and among firms. We begin by considering separately the hiring of workers who were unemployed, were out of the labor force, and were employed elsewhere in the previous month.[17] Figure 7 shows the log of job-filling rates relative to the log of the inverse of tightness, separately for hires originating from unemployment, from nonparticipation, and from employment with a different firm, based on month-to-month moves.[18] The figure shows quarterly averages of monthly figures. From the heights of the curves, hiring for the unemployed is typically around a third of total hires. Hires from unemployment has the tightest-looking relationship with the unemployment-to-vacancy ratio and hires from the already employed show the weakest relationship. Indeed, this comparison suggests the importance of EE flows for understanding differences across business cycles.

Moreover, the figures show different slopes relative to tightness. The slope differences are confirmed in the separate hiring regressions shown in Table 5, done for data sets starting in 1975 and 1994 after the revision of the survey. Focusing on the current recovery, Figure 8 shows the same scatter diagrams, but with observations since 2009 Q3 in black. We see that job-filling from the unemployed is a bit below typical, that from those outside the labor force is right on target, and that from those elsewhere employed well below target. The same picture shows up looking at the residuals from the hiring regressions in Figure 9. Another way to see the pattern is in terms of the fractions of job-filling coming from each source, as shown in Figure 10, again with observations since 2009 Q3 in black. We see, again, that with this measure, hiring of the unemployed remains the tightest looking of the relationships to labor market tightness.

Overall hiring is below the historical pattern for current tightness. That this does not show up in hiring of those outside the labor force (a positive residual in the hiring regression) is possibly a partial reversal of the response of the pattern of labor force participation triggered by the Great Recession. The share of hiring from the unemployed is on target, but the share coming

[17] The focus is month to month changes, not an attempt to derive a continuous time measure. This approach is in keeping with the view expressed in Beveridge, 1945, p. 18 – 20: "Full employment means that unemployment is reduced to short intervals of standing by, with the certainty that very soon one will be wanted in one's old job again or will be wanted in a new job that is within one's powers … it means, by consequence, that the normal lag between losing one job and finding another will be very short."

[18] Unemployment is measured in the same survey as hiring, while vacancies are measured at the end of the previous month.

from the already employed is low. Combined with the fact that the vacancy rate is high, a possible interpretation is that the eagerness of firms to hire has not risen fully in step with their willingness to post vacancies. This would fit with the observation that business investment is viewed as low during the recovery. While the already employed may be less expensive to train and/or more productive, they also have a stronger bargaining positon. And, as noted in Akerlof, Rose and Yellen (1988), the hiring of a worker away from another firm will often lead to a replacement hire, and some of those will be hires from employment elsewhere, what they referred to as a vacancy chain. Given the link between hires of the already employed and wage increases, this pattern is also relevant for the slow response of wages to labor market tightening we have experienced.

3. Hiring by Demographics and Previous Labor Force Status

We next consider separate hiring functions by gender, age, and education for each previous labor force status. Figure 11 shows the job-filling rates by gender and previous labor force status relative to the inverse of labor market tightness. As with the aggregates, hires from unemployment has the tightest looking relationship with the unemployment-to-vacancy ratio and hires from the already employed show the weakest relationship for both men and women. Not surprisingly the hiring of both employed and unemployed men is larger than the hiring of women in those categories and the reverse holds for hiring of those outside the labor force. One surprising difference is that hiring of men from outside the labor force shows far less of an impact from the recession during the recovery than the hiring of women from outside the labor force.

Figures 12a and b show the time series of the shares of hires from the 3 worker statuses separately for men and women. For each gender the time series shape is similar, although differing in how much they vary over the cycle. Figure 13 shows the share of the hires from each status coming from men. Consistent with the earlier figures, women play a larger role in NE flows, which then affects the patterns relative to tightness and the hires from unemployment show the most variation over the cycle.

Figures 14a, b, and c show the job-filling rates by age and previous labor force status, relative to the inverse of labor market tightness. For the two younger groups, we have the same appearance relative to tightness across the three statuses as has the aggregate. The pattern for those 55 and over is different in that the EE flows have a similar appearance of tightness compared with the two younger groups, but with a different slope. Figure 15 shows the fraction of hires by age in the 1994-2016 period, indexed to January 1995. Consistent with the much noted difference in trends of both labor force participation rates and demography, as the figure shows, the fraction hires of workers older than 55 years old has been trending up, with the other two both trending down.

Figures 16a, b, and c show the job-filling rates by education and previous labor market status relative to the inverse of labor market tightness. Comparing this recovery with earlier data, for all three previous-month labor force statuses, there is the unsurprising pattern that the impact has been smaller for the better educated. Only with hiring of the previously employed do we see all four groups being below previous experience during this recovery.

4. Full-time and Part-time Jobs

A natural question is whether the hiring patterns generally, and particularly their cyclic patterns, are different between hiring for part-time and full-time work. As a signal of basic differences between these two types of employment, note that part-time employment accounts for roughly twice the fraction of hires as it accounts for employment, as seen in Figures 17 and 18, reflecting the greater turnover in part-time employment. This difference reflects two issues. One is the differences, on average, in both firms and workers who rely heavily on part-time work/workers. Secondly it reflects the fraction of part-time workers who want full-time jobs, which varies strongly over the cycle and is one of the signals of the state of the economy.

In examining the mix between full-time and part-time hiring, we continue to use the overall tightness measure as a proxy relevant for both types of jobs. Indeed, we do not have extended time series for vacancies for part-time and full-time separately.[19] Figures 19a and 19b show the hiring of the nonemployed relative to overall labor market tightness. The current recovery shows a sharply lower full-time hiring of the unemployed, which is not present for part-time

[19] Recently, there are online vacancies divided among part-time, full-time and unspecified.

employment. The picture is more complex for those coming from outside the labor force. Figures 20a and b show the time series for the flow rates from unemployed and outside the labor force into the two types of employment. It shows the continued relatively low full-time hiring in the recovery compared with earlier. In contrast, the flow rates of those outside the labor force has shown a different pattern, reflecting also the longer trends.

Figure 21 shows the fraction of those working part-time who are categorized as part-time for economic reasons. [20] The direct movement from part-time to full-time employment occurs in two different ways, with some workers having hours increased with the same employer while others shift employers while going from part time to full time. Figures 22a and 22b show the rates of moving between employers from both part-time and full-time jobs to both part-time and full-time relative to aggregate vacancies, plotted against tightness. Vacancy filling from part-time workers shows a bit more movement to full time than part time. In contrast, the difference in vacancy filling from full-time workers is overwhelmingly concentrated in movements to a full-time position. The figures reflect the much larger number of full-time workers than part-time workers. All four EE flows to and from part-time and full-time are low currently.

Table 6 reports the hiring regressions with separate equations for moving to part-time and full-time employment. Recalls are included in the hiring regressions while those increasing hours from part time to full time with the same employer are not. Part-time shows a higher coefficient for the log of U/V.

Figure 23 contrasts movements to new employers of part-time workers who are holding their jobs for economic and non-economic reasons. It reports probabilities of a change of employer which is a transition from part-time to full-time work. There is a much higher probability of moving for those in part-time for economic reasons and with more cyclical sensitivity.

It should be remembered that much of the movement from part-time to full-time happens with the same employer. Figure 24 shows the movement from part time to full time with the same employer in successive months. Compared with Figure 23, we see much higher rates. This

[20] BLS definitions involving the reasons for part time:
Refers to those who worked 1 to 34 hours during the reference week for an economic reason such as slack work or unfavorable business conditions, inability to find full-time work, or seasonal declines in demand.
Refers to persons who usually work part time for noneconomic reasons such as childcare problems, family or personal obligations, school or training, retirement or Social Security limits on earnings, and other reasons. This excludes persons who usually work full time but worked only 1 to 34 hours during the reference week for reasons such as vacations, holidays, illness, and bad weather.

is similar in its role in the economy as the recall of workers who were laid off and had a spell of unemployment – it does not involve the steps associated with new hires.

As with the discussion of different flows by source, the disaggregation to part-time and full-time jobs adds to the sense of continuing weakness in the labor market associated with slow filling of vacancies. As it is more pronounced with full-time than part-time, this adds to the sense that vacancies are high relative to the eagerness to expand production. We also note that the fraction of part-time who are for economic reasons remains high.

5. Hiring functions by employer characteristics

While the literature has mostly focused on the changes in the composition of jobseekers,[21] starting with the work by David, Faberman and Haltiwanger (2013), there has been an emphasis on how the composition of vacancies is important for the speed of hiring. Looking at averages over the then-available data, they show that the job-filling rate falls with employer size, rises with worker turnover rates, and varies by a factor of four across major industry groups. Of course these divisions strongly overlap. In this section, we do a shift-share analysis to discuss how changes in the composition of vacancies are related to the measured aggregate job-filling rate, with the job-filling rate defined as hires during a month per vacancy at the end of the previous month.[22]

We can decompose the aggregate job-filling rate as the weighted sum of market-specific job-filling rates:

$$JF_t = \frac{H_t}{V_t} = \sum \frac{H_{it}}{V_{it}} * \frac{V_{it}}{V_t}$$

Where $\frac{V_{it}}{V_t}$ is the vacancy share of each specific market. We consider three different margins along which the job-filling rates vary: industry, establishment size and occupation. Of course, these do not have independent impacts on overall hiring, but represent the divisions we can explore with existing available data. We next quantify how much changes in the composition of

[21] For a recent contribution see Hall and Schulhofer-Wohl (2015).

[22] They also show that the job-filling rate rises steeply with (positive) employer growth rates in the cross section, an issue we do not explore.

vacancies along each of these three margins explains the evolution of the aggregate job-filling rate by computing a composition-adjusted job-filling rate which keeps the composition of vacancies at its 2006 shares:

$$JF_t^c = \frac{H_t}{V_t} = \sum \frac{H_{it}}{V_{it}} * \frac{V_{i,2006}}{V_{2006}}$$

These counterfactual series are then compared with the actual job-filling rate and examine how much of the deviation in the recent years is due to these changes. To make this comparison, we fit a Cobb-Douglas matching function to the pre-recession data on unemployment and vacancies from 2001 through 2007 and plot the matching-function implied hires.

Industry: Table 7 shows the average job-filling rates for broad industries for the 2000-2016 period using the vacancy and hires series in the JOLTS. In general job-filling rates are higher in sectors that are more cyclically sensitive. Construction, leisure and hospitality, and trade, transportation, and utilities typically have higher job-filling rates than sectors like government and education and health. Figure 25 shows the composition adjusted and actual job-filling rates. During the Great recession, industry composition of vacancies explains as much as half of the shortfall relative to the matching function implied by the composition of vacancies and job-filling rates but its effect disappears as the recovery continues and vacancy shares normalize by 2014. The matching function specification that provided the best fit to pre-recession data is $H = .991V^{.617}U^{.383}$.

Establishment size: Table 8 shows the average job-filling rates by establishment size for the 2000-2016 period using the experimental vacancy and hires series in the JOLTS. In general, job-filling rates are higher for small establishments. Figure 26 shows the composition adjusted and actual job-filling rates. During the recent period, establishment size composition of vacancies explains very little of the shortfall of the job-filling rate. The matching function specification is identical to that used above.

Occupation: Table 9 shows the average job-filling rates by occupation for the 2005-2016 period using the HWOL vacancy series and hires constructed in the CPS. Manual jobs have a higher job-filling rate. Since these jobs are more likely to be cyclical, a decline in hires in this category

affects the job-filling rate adversely. While this effect is important in the 2008-2011 period, its effect is negligible since 2012. Note that the matching function specification we use with the HWOL data on vacancies is $H = 1.124V^{.577}U^{.423}$.[23] Figure 27 shows the composition adjusted and actual job-filling rates.

Our analysis has shown that the industry and composition of vacancies contributed to the shortfall in the aggregate job-filling rate relative to what is implied by the matching function during the recession. However, it cannot explain the persistence of this deviation all the way to today. In both cases, the gap is significant around the time of peak job-filling rate, and slowly shrinks after that, disappearing slowly, but completely. That the job-filling rate estimated from the matching function continues to show a gap above the actual rate calls for further study. Particularly important is whether this represents primarily a recovery from an unusual recession in magnitude, speed of recovery and the presence of a financial crisis or whether this is a reflection of the evolution of the economy in terms of labor supply and demand.

6. Modelling

The decompositions of hiring presented above provide valuable information on the workings of the labor market that are not apparent from just looking at aggregate hires. The analyses reflect the need to consider both trend and cycle effects when examining the current and prospective position of the economy. The interactions cut both ways. For example, demographic trends in the makeup of the adult population continue through a business cycle and are largely expected to continue after a recovery. Thus, some of what has happened to employment and unemployment should be viewed as trend and not simply expected to reverse as the recovery continues. Conversely, some of what has happened reflects how the hiring process is different in recession and recovery from that with full employment and therefore likely to reverse as a recovery continues. How much reversal and how soon are important topics. Indeed, some of the shift-share analysis has shown effects which were present in the recession and are no longer present. These issues also raise some concerns about modeling and the use of models in light of the patterns shown by the decompositions. Two issues stand out that have not received as much attention in the literature as their importance warrants. One is the relatively small role that search

[23] We fit the matching function on data from January 2007-January 2008 for this sample.

per se and search costs play in the hiring decisions; another is the nature of the direct competition among different workers for individual jobs.

Our underlying picture of the labor market starts with viewing hiring as an investment decision reflecting the costs associated with launching a new employment relationship.[24] While there is some cost to the processes of identifying job openings and job candidates, that cost seems generally to be unimportant compared with the costs of evaluating alternative candidates and training one of them.[25] Some evaluations of the hiring process and its substantial costs are shown in Tables 10 and 11, which draw on surveys between 1980 and 1993.[26] The presence of multiple competing applications is shown in Table 12 , which is based on a recent online analysis. Further support for the focus on evaluation rather than search for possible jobs comes from the conclusion that "Exploiting the sharp geographic and temporal variation in the availability of online search induced by Craigslist, we produce three key findings: Craigslist significantly lowered classified job advertisements in newspapers, caused a significant reduction in the apartment and house rental vacancy rate, and had no effect on the unemployment rate." (abstract, Kroft and Pope, 2014).

The economy is diverse and complicated. Beyond the richness in the meeting process, there is diversity in the wage determination process as part of going (or not going) from a meeting to a matching. Hall and Krueger (2012) found that 36.9 percent of workers engaged in bargaining for their most recent job, while the rest of the respondents did not. And looking at workers moving directly from their current job to a new one, 41.5 percent reported that they could keep their previous job and of these 45.1 percent said the new employer knew what they were making in their old job. Studies of employers in the 80's and 90's found that employers receive lots of applications on average and interview roughly half a dozen applicants per hire (Barron, Berger and Black, 1997). Large numbers of applicants per job are also apparent in studies of online job sites.[27] And, as noted above, training of new workers is expensive , in contrast to being much

[24] The much lower costs of recalling a previous worker is part of the importance of recall in the hiring process (Fujita and Moscarini, 2015)

[25] The internet has greatly reduced the cost of signaling the availability of potential employment for some jobs and some workers (Stevenson, 2009). And recalling workers is a low cost way of expanding employment.

[26] Studies of different recruitment channels show significant differences between formal and informal channels (see, e. g., Gorter et al, (1996) and Gorter and Van Ommeren (1999) for analysis of Dutch data). Bishop (1984) reports on an employer survey finding 41 percent of new hires being friends or relatives of the owner, a current employee, or referred by a friend or relative and a household survey finding that friends and relatives suggested 8.8 percent of employer contacts, which were responsible for 17.6 percent of hires.

[27] E. g., Marinescu, I.E. and Wolthoff, R.P., 2015.

less so for recalls, which are an important fraction of hires (Fujita and Moscarini, (2015). To gain insights from a modeling effort, some of this diversity and complexity is omitted. That suggests both a role for multiple models and a need for caution in drawing inferences.

Thus, good policy design needs to reflect multiple dimensions of the economy's response to policy actions. This recognition fits with Marshall's view of analyzing the economy.

> it [is] necessary for man with his limited powers to go step by step; breaking up a complex question, studying one bit at a time, and at last combining his partial solutions into a more or less complete solution of the whole riddle. ... The more the issue is thus narrowed, the more exactly can it be handled: but also the less closely does it correspond to real life. Each exact and firm handling of a narrow issue, however, helps towards treating broader issues, in which that narrow issue is contained, more exactly than would otherwise have been possible. With each step ... exact discussions can be made less abstract, realistic discussions can be made less inexact than was possible at an earlier stage. [Alfred Marshall, *Principles of Economics*, eighth edition. New York: The Macmillan Company. 1948, page 366.]

Marshall's view seems appropriate both for consideration of short-run (stimulus) policies and long-run (structural) policies. Indeed, in examining the extent of slack in the labor market, policymakers look at many details of the market as well as at aggregate variables. For example, a 2016 speech by Chair Yellen included mention of the increase in jobs, the unemployment rate, the jobs-opening rate, the quits rate, change in labor force participation, the increase in average hourly earnings, new claims for unemployment insurance, and the public's perception of the health of the labor market. She also cited a "broader measure of labor market slack that includes workers marginally attached to the workforce and those working part-time who would prefer full-time work was unchanged." Without the details, we see the same mindset in this speech by Chair Yellen (2014):

> The Federal Reserve's monetary policy objective is to foster maximum employment and price stability. In this regard, a key challenge is to assess just how far the economy now stands from the attainment of its maximum employment goal. Judgments concerning the size of that gap are complicated by ongoing shifts in the structure of the labor market and the possibility that the severe recession caused persistent changes in the labor market's functioning.

> These and other questions about the labor market are central to the conduct of monetary policy, … monetary policy ultimately must be conducted in a pragmatic manner that relies not on any particular indicator or model, but instead reflects an ongoing assessment of a wide range of information in the context of our ever-evolving understanding of the economy.

In going from observations of various outcomes in the labor market to inferences about policies to affect the aggregate, one is inevitably relying on underlying theories, both explicit ones and implicit ones. Indeed, macro forecasters, both inside and outside government, regularly report on many facets of the economy. Formal models of aspects of the labor market help interpret the available data on the economy. The shift-share analysis and other decompositions above were done to help with drawing inferences from the patterns in the data. We view these calculations as useful insight into effects that might be missed as a consequence of working only with aggregate data, but not, by themselves, as an approach to having a full understanding of the roles of different firms and different workers in affecting hiring.

Implicit in the shift-share calculation is an assumption that the relative weights in determining hiring remain constant over the period examined. This assumption is also implicit in the common practice of relating aggregate hires to a fixed-weight combination of differently situated workers. Taken literally, this would imply that job-finding and job filling do not depend on the relative sizes of the distinct types of workers or firms. Figure 3 showed the ratio of the job-finding rates of long- and short-term unemployed. There is considerable movement in the ratio with timing clearly affected by the cycle. An approach to examining the limits in a fixed-weight approach would consider the role of competition between different workers for some jobs and competition between different firms for some workers.

The standard model with pairwise matching for firms and workers has competition for each of that pairing based on the statistical anticipation of future worker and job opportunities. The literature has two approaches to direct competition among workers for jobs through urn-ball models and competitive directed search.[28] The typical urn-ball model has a distribution of applicants across jobs derived from having workers applying randomly to all jobs. In contrast, the competitive wage-posting directed-search model has workers knowing not only the wage

[28] For example, see the urn-ball model in Blanchard and Diamond (1994) and the discussion of directed search, and the cited references in Rogerson, Shimer and Wright (2005).

associated with every job but also the probability of getting the job if applying.[29] The information assumptions of these approaches are polar opposites, each seeming to capture some of what happens in the economy. Sometimes firms choose from their stock of applicants and sometimes they wait for more applications (van Ours and Ridder, 1992). And indeed there is a stock-flow element to the labor market, much as is present in the housing market, as the application process involves applying to additional job openings, some new and some old and being newly explored.[30] Much of the literature ignores training costs as well.[31]

Another approach that has been used as part of disaggregated analysis is to assume separate labor markets, functioning independently and based on location and firm and worker characteristics. Movement among the markets between periods is part of the analysis. This literature has made use of both competitive submarkets and search submarkets, with the latter having matching functions dependent just on the participants in that market. Implicitly this approach assumes that what happens in one labor market is independent of what is happening in another, although recognizing movement between markets between periods.[32]

The focus of this paper has been on the determination of hires, not the determination of wages. Yet the decompositions matter for wages as well. And there is a considerable literature using models with the approaches we have detailed and focusing on wages. Some of the decompositions are particularly important for wages. Wages vary systematically across industries, and firm sizes. They are less per hour for part-time work than full-time. Average wages vary systematically by age, gender and education. Wage growth is particularly affected by movements from job to job, the EE flows discussed above, which have been relatively low in the Great Recession and recovery. Movements between markets imply that even uniform aggregate changes will have differing impacts across markets. For example, Sattinger (2006) examines overlapping market steady-state models with two types of workers and two types of jobs. Some workers can work at either job (with different outputs) while others can only work at the less productive job. Firms can hire just one type of worker or can be open to hiring both types. Each submarket has the same standard matching function. Equalized expected outcomes determines the division of firms and workers between submarkets. With an equal proportional increase in

[29] And both approaches typically consider one application at a time to avoid the complication of simultaneous job offers to a single worker.

[30] For examples of stock-flow modeling see Taylor (1995), Coles and Smith (1998), and Ebrahimy and Shimer (2010).

[31] For a recent exception, see Silva and Toledo (2009).

[32] See, for example, Shimer (2007) and Barnichon and Figura (2015).

the numbers of both types of jobs, the proportional wage increase varies across submarkets with the submarket tightness ratio. Moreover, the effects of aggregate changes should vary with the nature of the hiring process, and so differ across parts of the economy with different organization of hiring.

Vacancies and Partial and General Equilibrium

When considering the business cycle through a search perspective, a key question is the determination of vacancies. Modeling of the labor market incorporates the dynamics of the response of employment to changes in vacancies and the feedback from those dynamics to the level of vacancies. The relative emphasis on these two dimensions varies in the literature, particularly between (macro-oriented) models looking at cyclic patterns that focus on the effects of assumed vacancy patterns and (micro-oriented) ones looking at steady states that pay more attention to the feedback on vacancies.

In the standard steady-state model, there is a flow cost of having a vacancy posted, but no cost from the process of filling it. The discussion above suggests taking the opposite approach, ignoring the cost of posting job availability, but considering the costs of evaluating job applicants and of training new workers. Both of these costs disappear when there is recall, which gives the timing of the availability of previously laid-off workers an important role in how hiring varies over the cycle. As a recall can be made without posting a vacancy, these hires increase the measured efficiency of the aggregate hiring function. Where recall is not an option, the profitability of a new hire and the cost of training combine to determine the reservation match quality of a firm. Thus we think of hiring as an investment decision rather than a flow decision.

Similar to recalls being hires not connected to measured vacancies, so too are hires organized more than 30 days in advance. The latter may be largely removed by seasonal adjustment of hires data, but may still have a business cycle legacy.

The standard labor market model is a partial equilibrium model. That model is also used as the labor market portion of some DSGE models. Following Shimer (2005) and Hall (2005), there has arisen a literature examining the extent to which such a model can mimic empirical findings over a cycle when putting in place a sequence of shocks (as in DSGE models) or a change in the basic underlying dynamic parameters (as in Blanchard and Diamond, 1989, 1990).

These two approaches have different implicit connections to the state of the markets for sales of the output produced for sale using employed labor.

Following a common DSGE approach, Shimer (2005) considers the labor market subject to a stochastic process applying to productivity. Implicit in this approach is that measured productivity matches with the profitability of production, an assumption that fits with competitive modeling in the output market. This match between productivity and profitability is not present when the labor market is embedded in a new Keynesian model with downward sloping demand curves and sticky prices. It also may not be present in a model with shifts in output demand curves in response to aggregate demand shifts, such as from expectations about future incomes, or with alternative models of firm behavior in good and bad times.[33]

Also present in Shimer is a horizontal supply of vacancies, with the value of a vacancy reflecting both the profitability of new or reopened production possibilities (incorporating expectations about future productivity) and the functioning of the labor market (incorporating the timing and quality of expected hiring). In contrast, Blanchard and Diamond (1989) have an inelastic supply of new production opportunities from an implicit link to the output market captured by the assumed dynamics of the rate of newly created vacancies and the rate of termination of existing production relations. (That paper had quits going into unemployment, not employment, and ignored the dynamics of the quit rate over the business cycle.) The role of the labor market in determining employment is then through the speed of filling vacancies given the aggregate hiring function and the rate of entry of profitable production possibility entrants.

A central difference between the approaches in these two sets of models is in their goal. The macro approach views labor market modeling as part of informing the dynamics of the business cycle, with vacancy incentives as a driving macro force and insight into the functioning of the overall economy as the target. The micro approach is looking at the fit to macro data to inform the description of the workings of the labor market. An issue with both approaches is the diversity in labor market arrangements, which questions whether modeling of the entire economy as if it fit with the modeling of part of the economy is a good way to draw inferences from aggregate data.

[33] For example, consider this quote from Alfred Marshall (1948, p. 498): If trade is brisk all energies are strained to their utmost, overtime is worked, and then the limit to production is given by want of power rather than by want of will to go further or faster. But if trade is slack every producer has to make up his mind how near to prime cost it is worth his while to take fresh orders. And here there is no definite law, the chief operative force is the fear of spoiling the market; and that acts in different ways and with different strengths on different individuals and different industrial groups.

With the increasing presence of data about the functioning of markets, particularly through online data, there is great potential in informing our understanding of the labor market and how to interpret its condition as an input to monetary and fiscal policies.

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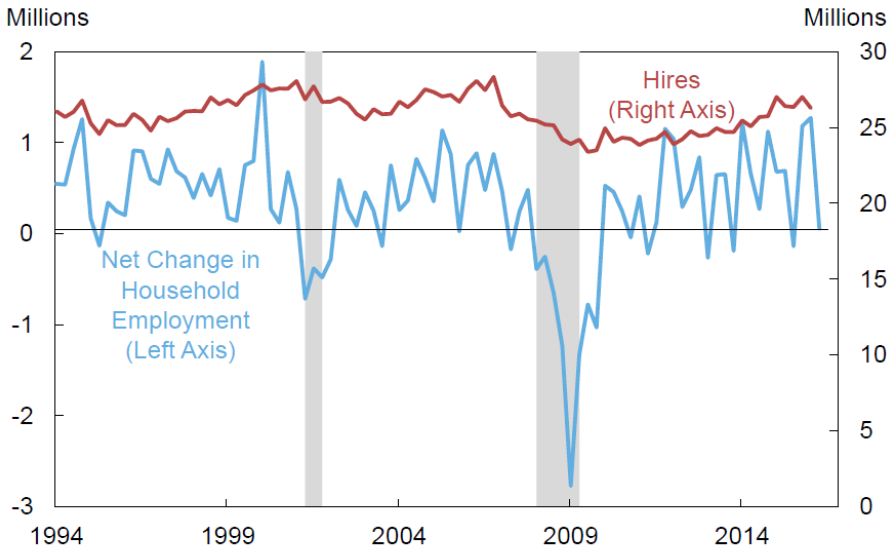
Figures and Tables

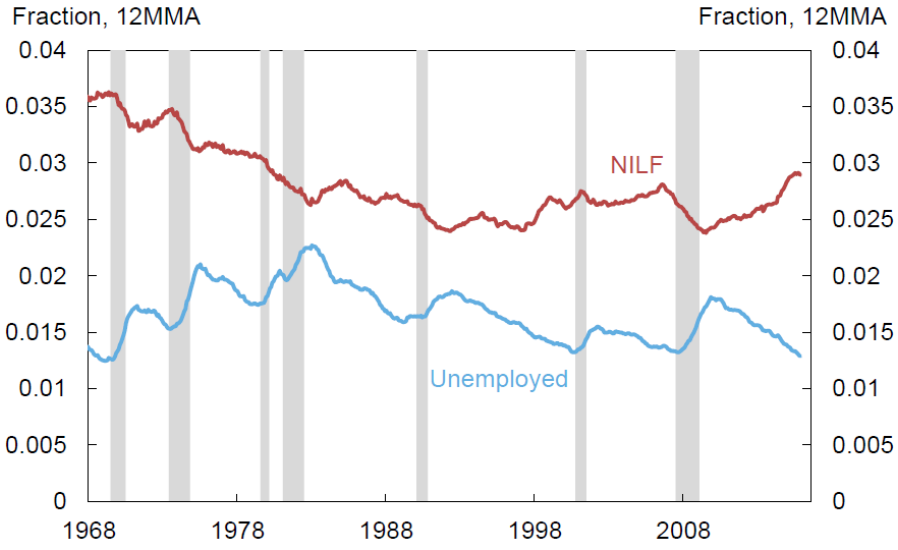
Figure 1. Net Change in Household Employment and Gross Hires



Source: Current Population Survey

Note: Shading shows NBER recessions.

Figure 2. Hires from Unemployment and Not in the Labor Force as a Fraction of Employment



Source: Current Population Survey

Note: Shading shows NBER recessions.

Figure 3. Ratio of Long-term Unemployed Job-finding Rate to Short-term Unemployed Job-finding Rate

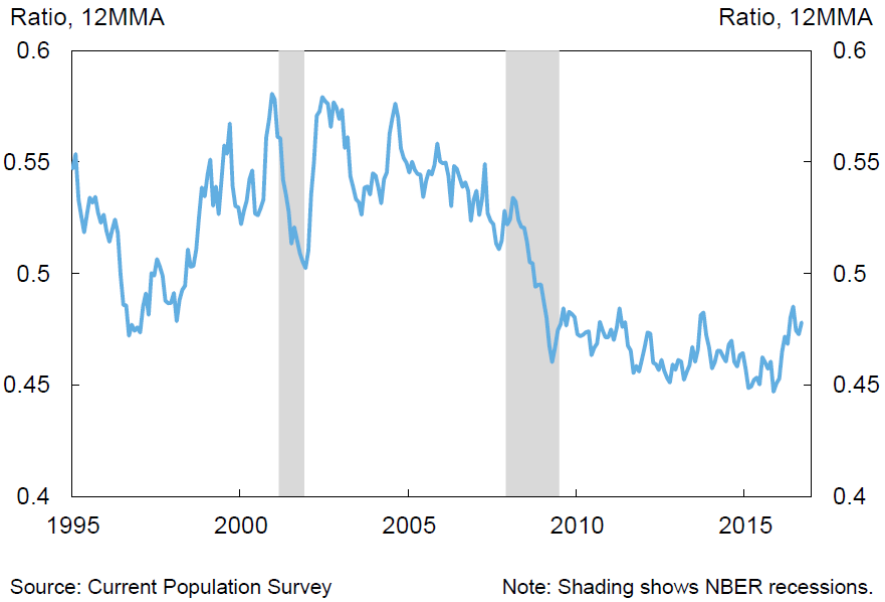


Figure 4. Log Job-filling Rate vs. Log Unemployment/Vacancies (Quarterly Data, 1975Q3-2016Q1)

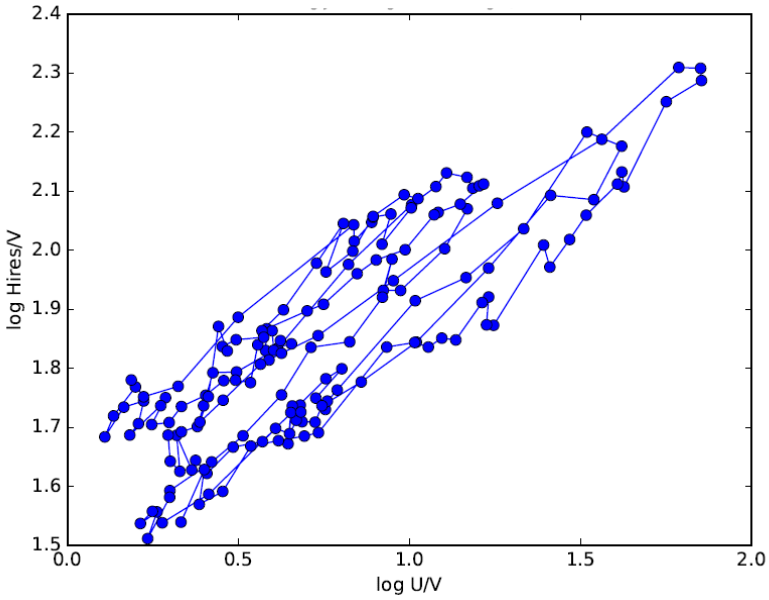
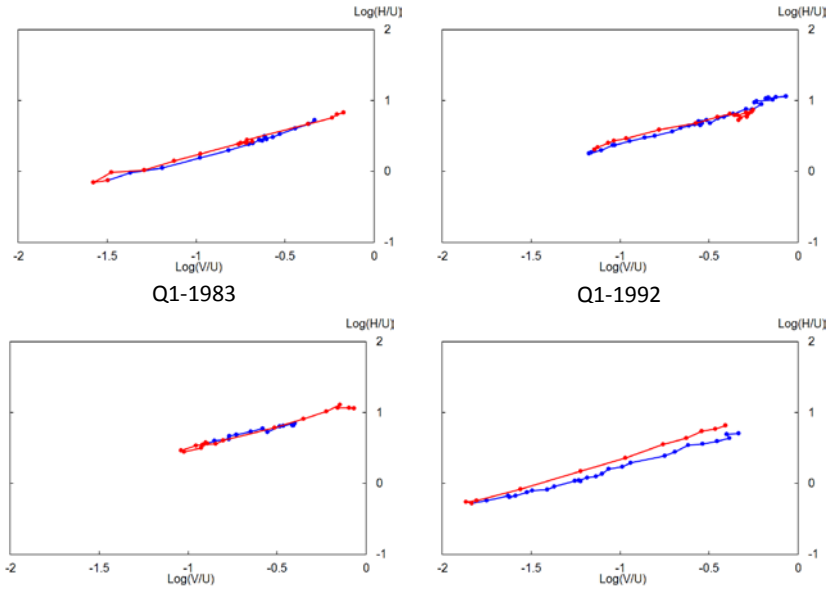
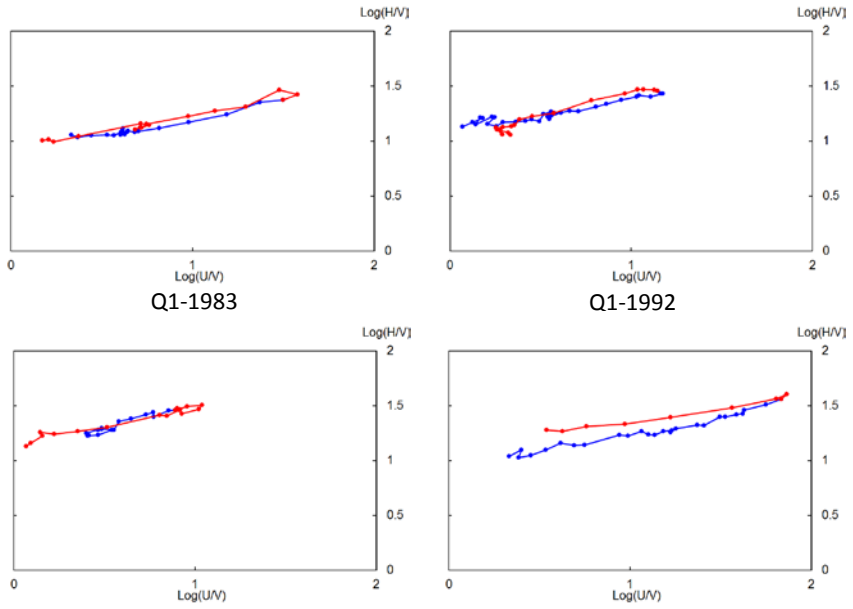


Figure 5a. Log Job-finding Rate vs. Log Vacancies/Unemployment around Minimum Vacancy Rate.



Note: Red=Max V to Min V
Blue=Min V to Max V

Figure 5b. Log Job-filling Rate vs. Log Unemployment/Vacancies around Minimum Vacancy Rate



Note: Red=Max V to Min V
Blue=Min V to Max V

Figure 6. Beveridge Curves around Minimum Vacancy Rate, Observations before Minimum Vacancy Rate in Red and after Minimum Vacancy Rate in Blue

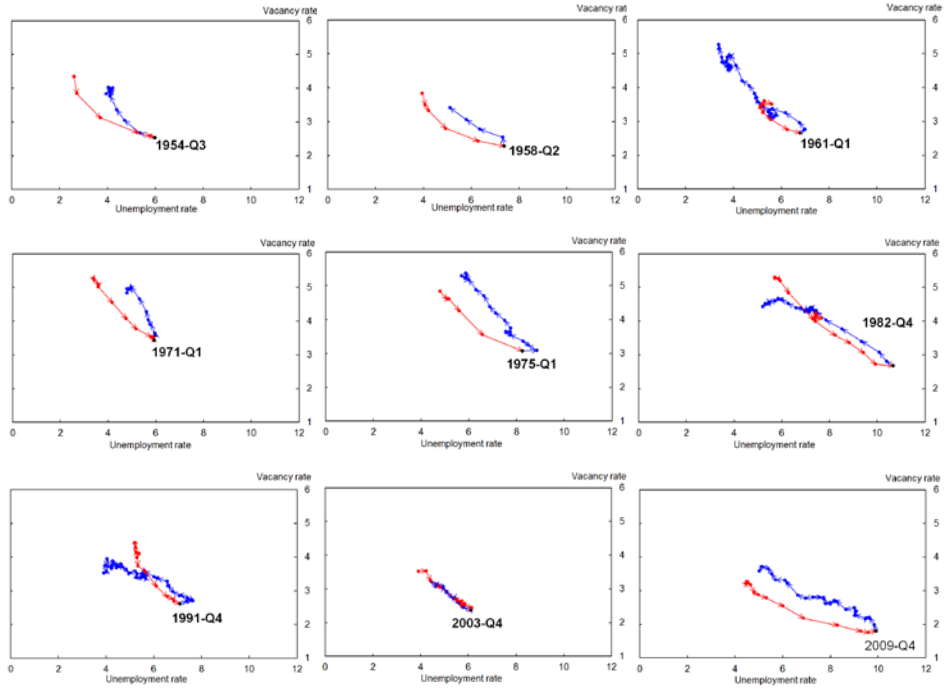


Figure 7. Log Job-filling Rates by Source vs. Log Unemployment/Vacancies (Quarterly Data, 1975Q3-2016Q1)

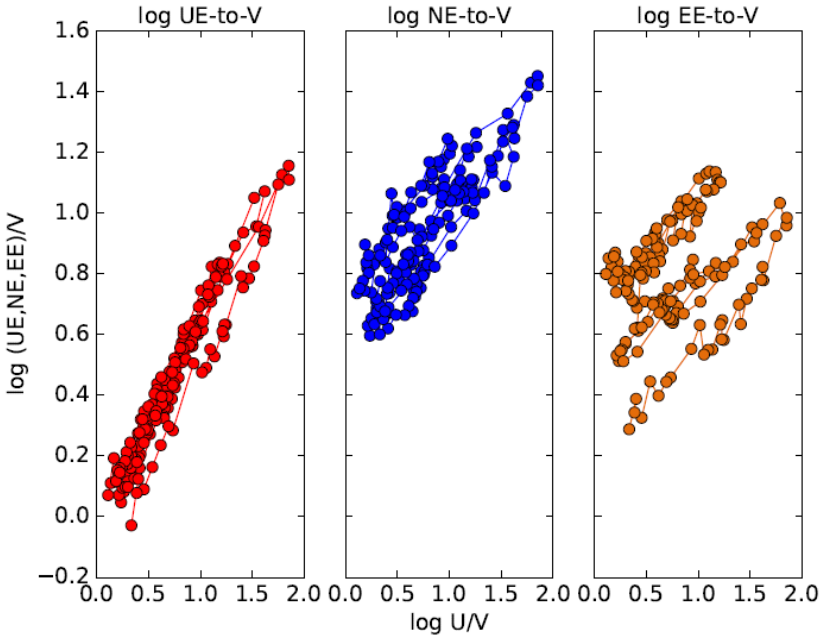


Figure 8. Log Job-filling Rates by Source vs. Log Unemployment/Vacancies, Observations Since 2009 Q3 in Black

(Quarterly Data, 1975Q3-2016Q1)

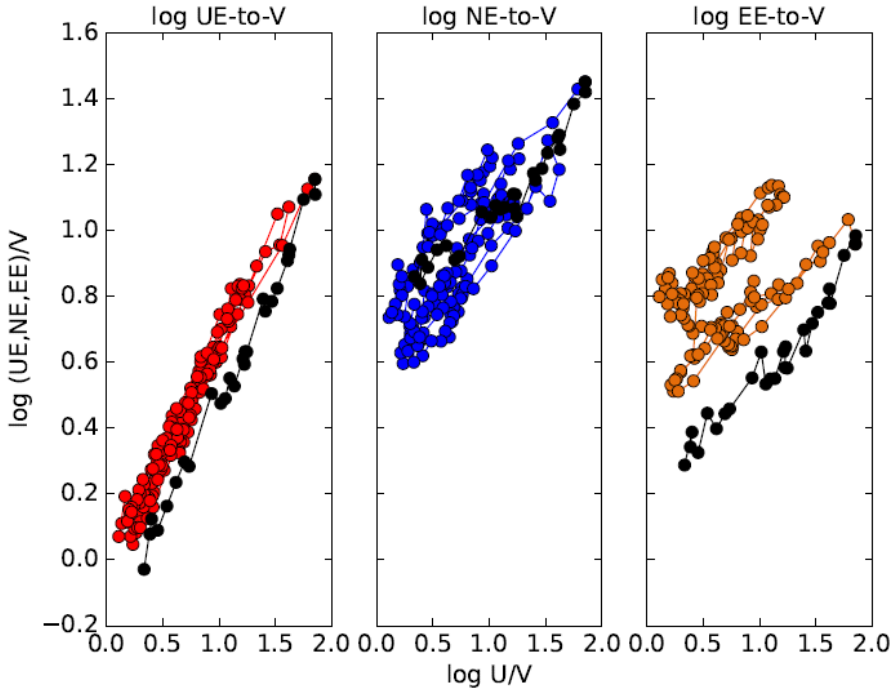


Figure 9. Matching Function Regression Residuals

(Quarterly Data, 1975Q3-2016Q1)

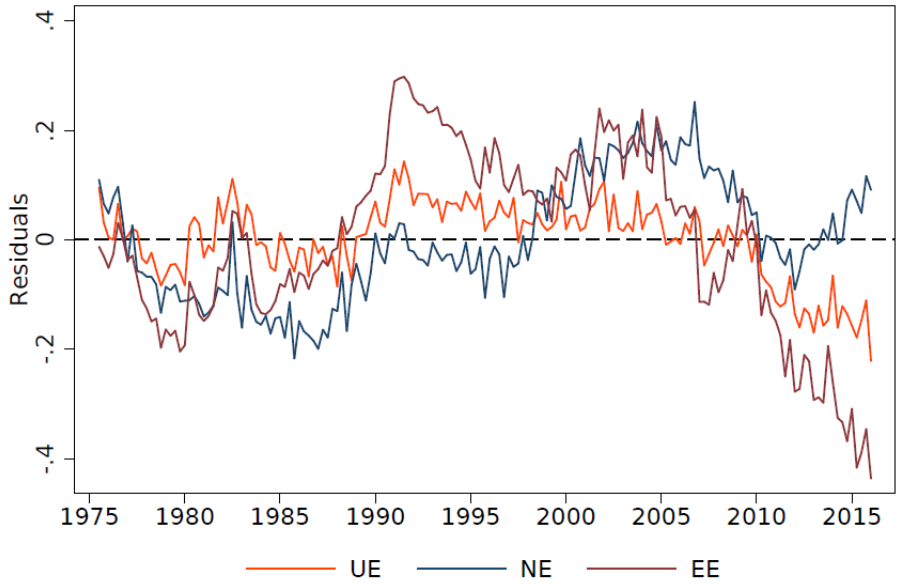


Figure 10. Fraction of Hires by Source vs. Log Unemployment/Vacancies, Observations Since 2009 Q3 in Black

(Quarterly Data, 1975Q3-2016Q1)

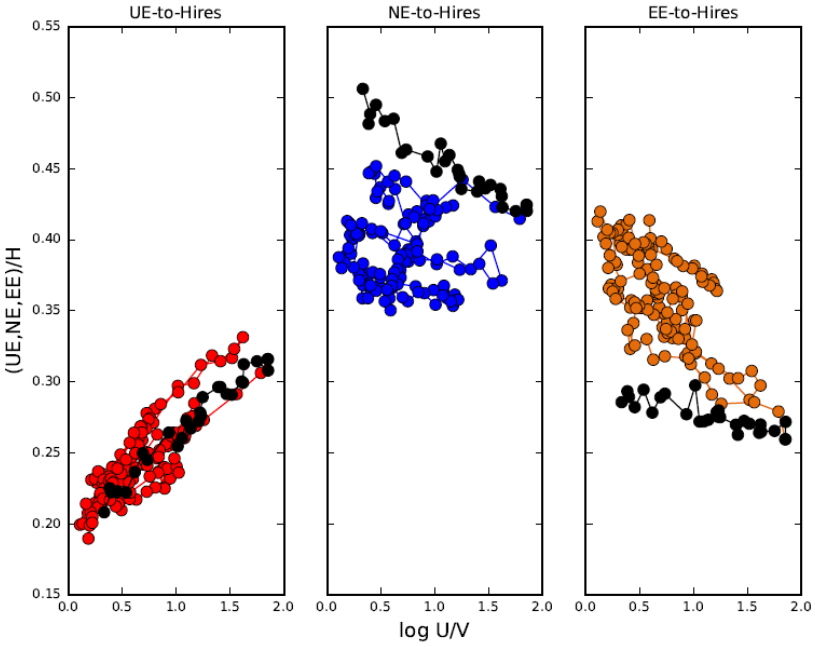


Figure 11a. Log job-filling rate from unemployment by gender vs. log unemployment-vacancy ratio, Observations Since 2009 Q3 in Black

(Quarterly Data, 1994Q3-2016Q1)

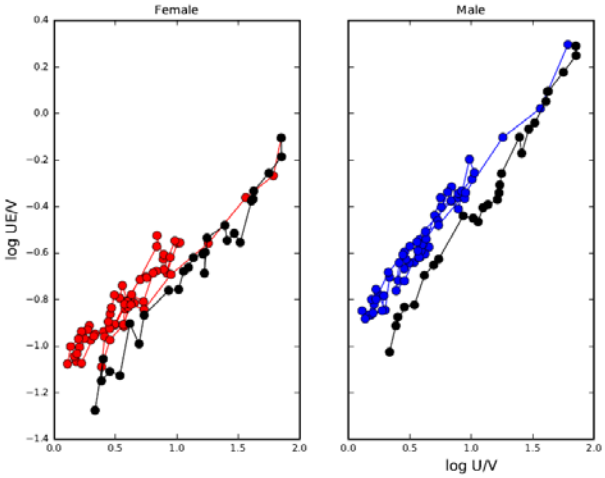


Figure 11b. Log job-filling rate from nonparticipation by gender vs. log unemployment-vacancy ratio, Observations Since 2009 Q3 in Black

(Quarterly Data, 1994Q3-2016Q1)

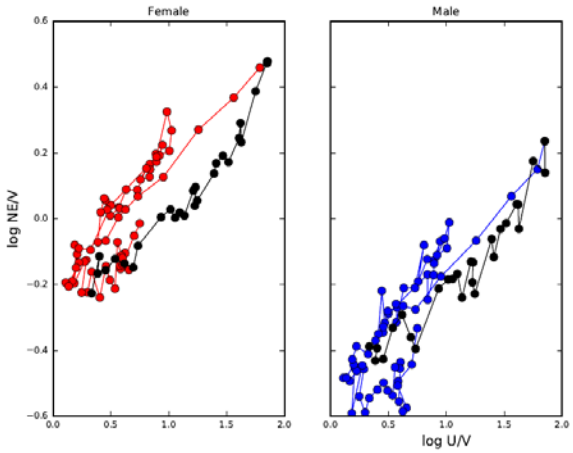


Figure 11c. Log job-filling rate from employment by gender vs. log unemployment-vacancy ratio, Observations Since 2009 Q3 in Black

(Quarterly Data, 1994Q3-2016Q1)

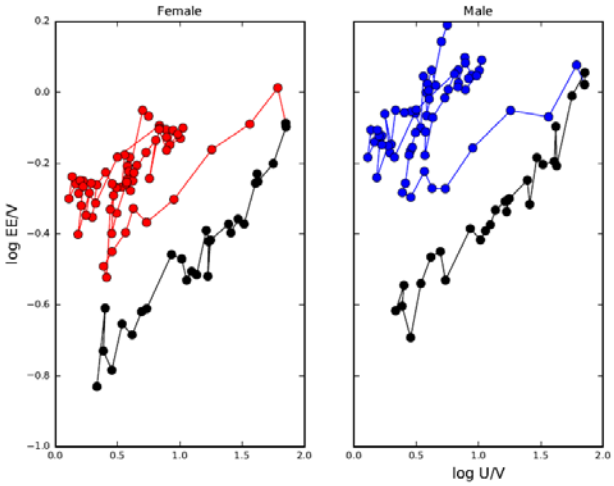
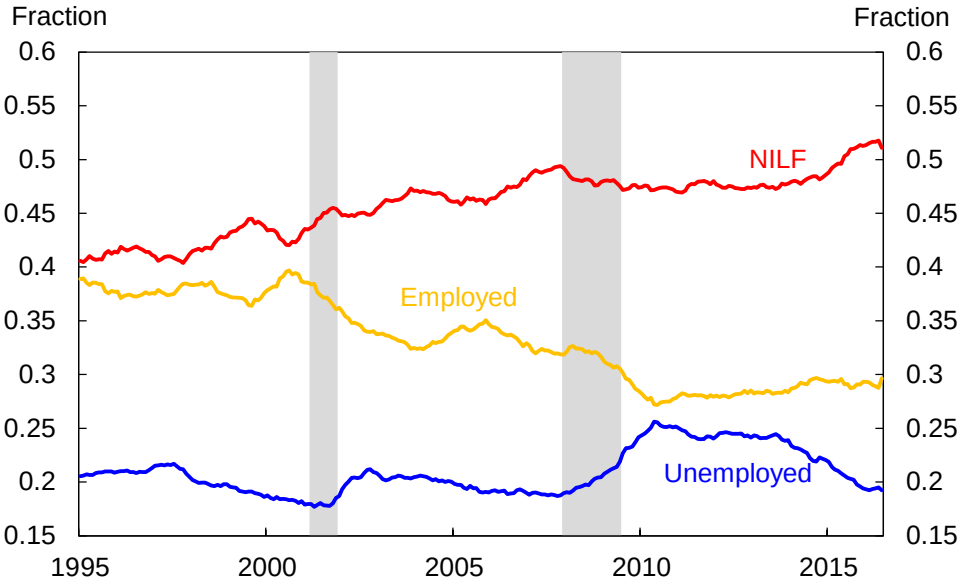


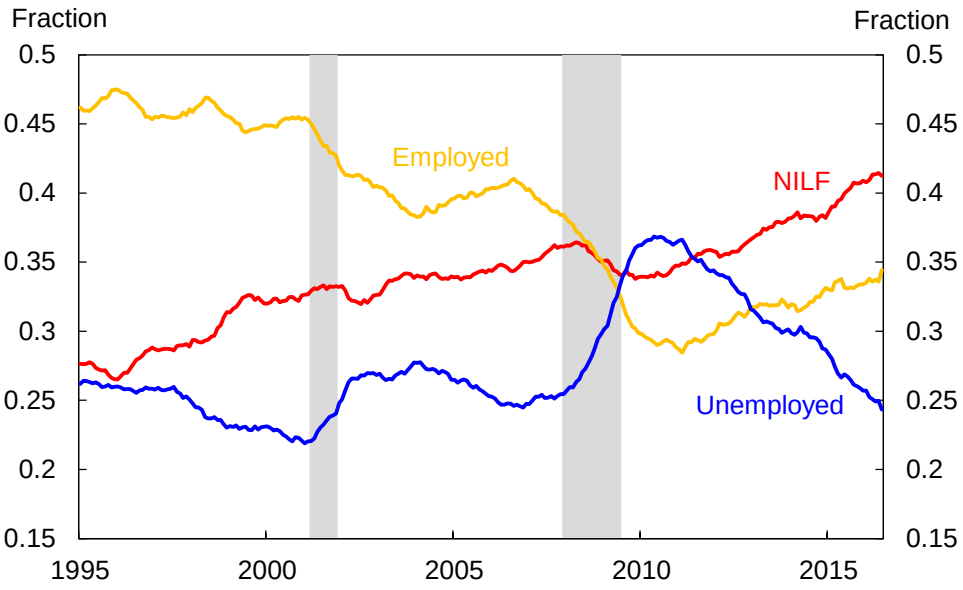
Figure 12a. Fraction of hires by labor force status, Female



Source: CPS

Note: Shading shows NBER recessions.

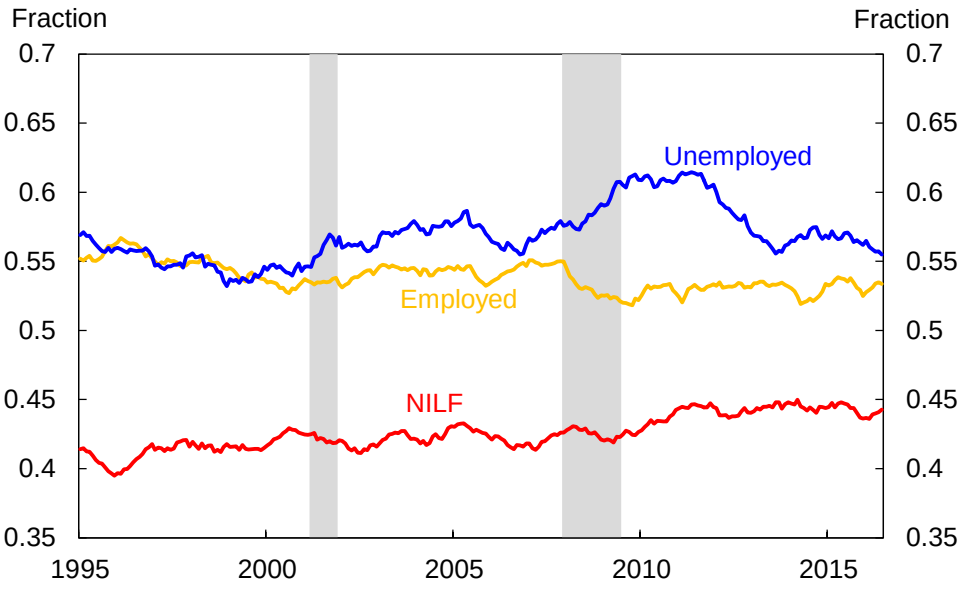
Figure 12b. Fraction of hires by labor force status, Male



Source: CPS

Note: Shading shows NBER recessions.

Figure 13. Fraction of hires that are male by prior labor force status



Source: CPS

Note: Shading shows NBER recessions.

Figure 14a. Log job-filling rate from unemployment by age vs. log unemployment-vacancy ratio,

Observations Since 2009 Q3 in Black

(Quarterly Data, 1994Q2-2016Q1)

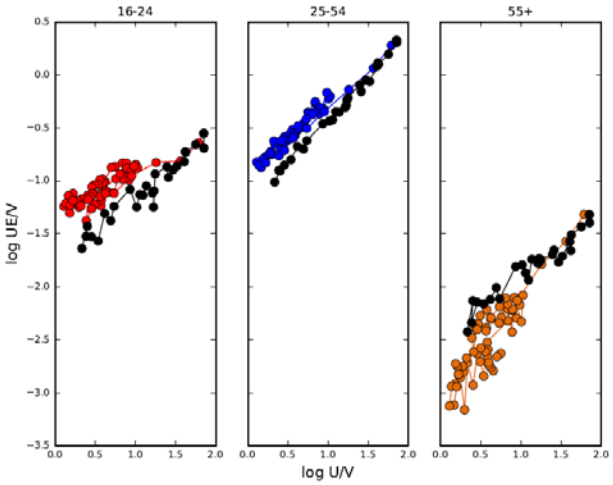


Figure 14b. Log job-filling rate from nonparticipation by age vs. log unemployment-vacancy ratio,

Observations Since 2009 Q3 in Black

(Quarterly Data, 1994Q2-2016Q1)

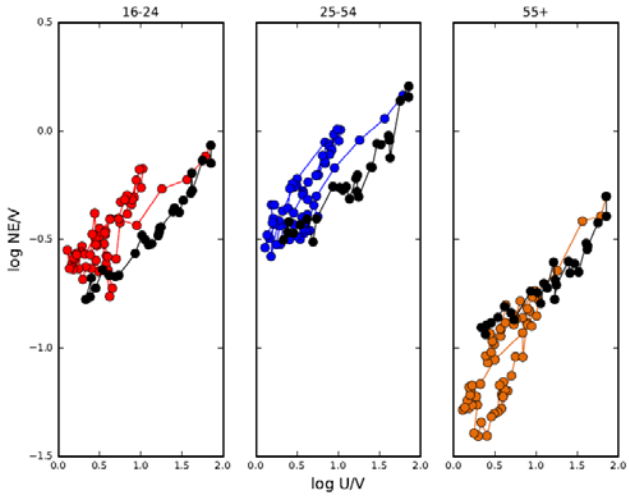


Figure 14c. Log job-filling rate from employment by age vs. log unemployment-vacancy ratio,

Observations Since 2009 Q3 in Black

(Quarterly Data, 1994Q2-2016Q1)

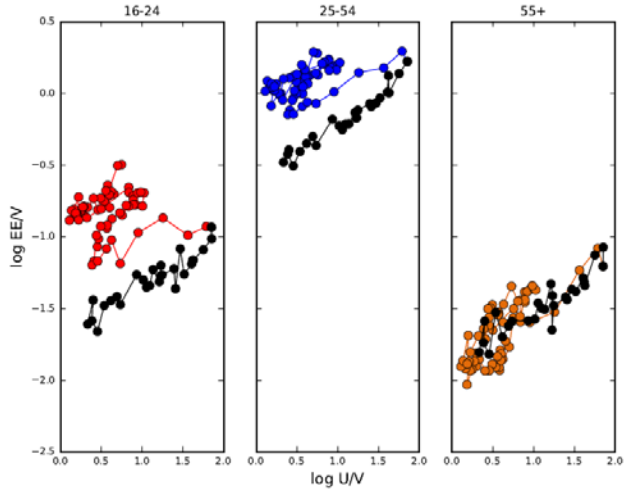


Figure 15. Fraction of hires by age (indexed to January 1995)

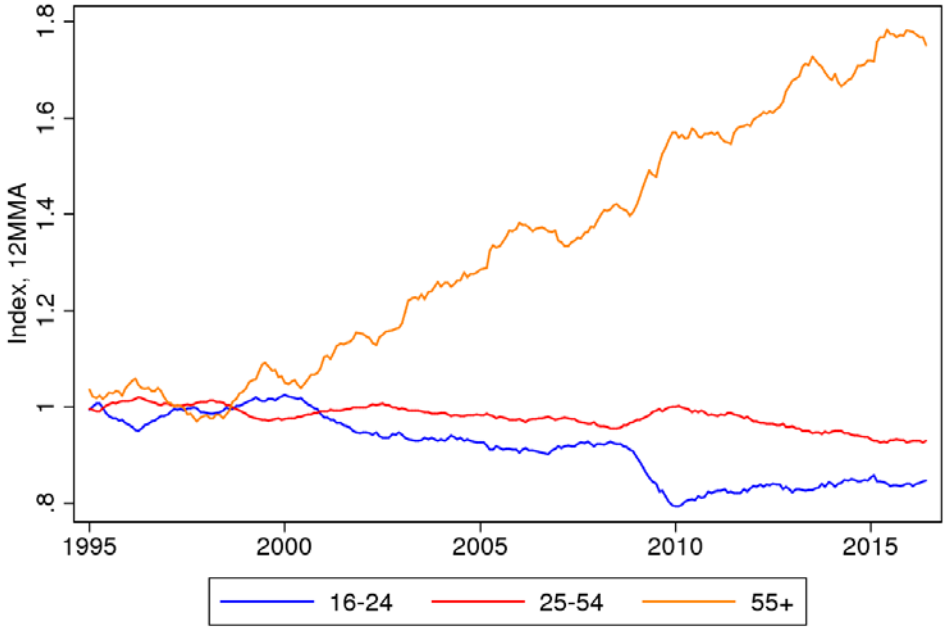


Figure 16a. Log job-filling rate from unemployment by education vs. log unemployment-vacancy ratio,

Observations Since 2009 Q3 in Black

(Quarterly Data, 1994Q2-2016Q1)

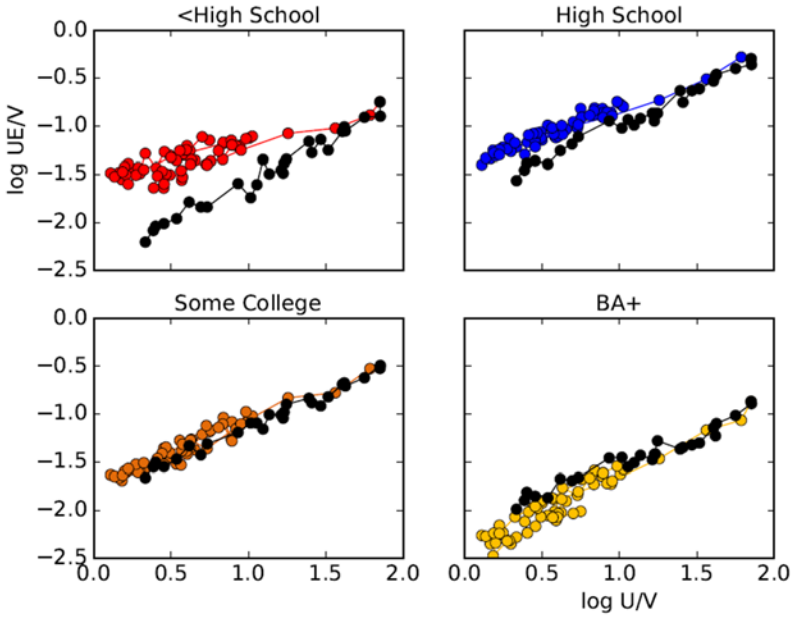


Figure 16b. Log job-filling rate from nonparticipation by education vs. log unemployment-vacancy ratio,

Observations Since 2009 Q3 in Black

(Quarterly Data, 1994Q2-2016Q1)

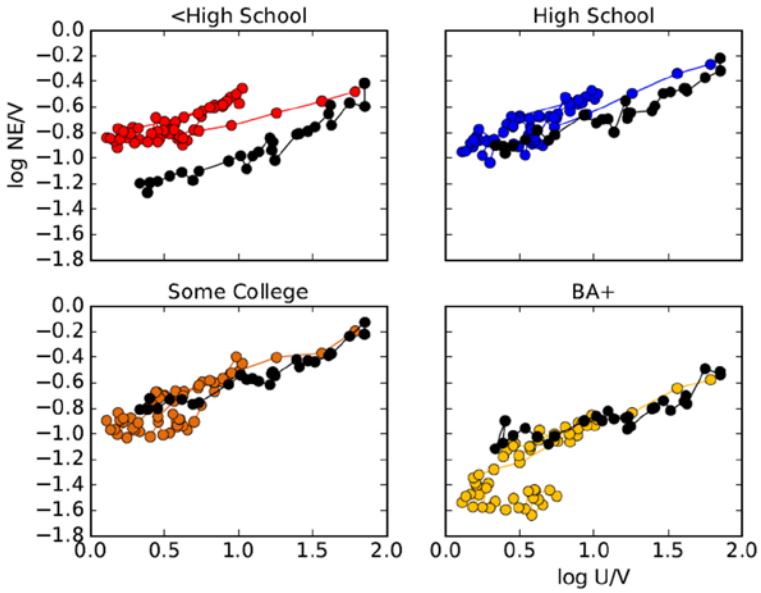


Figure 16c. Log job-filling rate from employment by education vs. log unemployment-vacancy ratio,

Observations Since 2009 Q3 in Black

(Quarterly Data, 1994Q2-2016Q1)

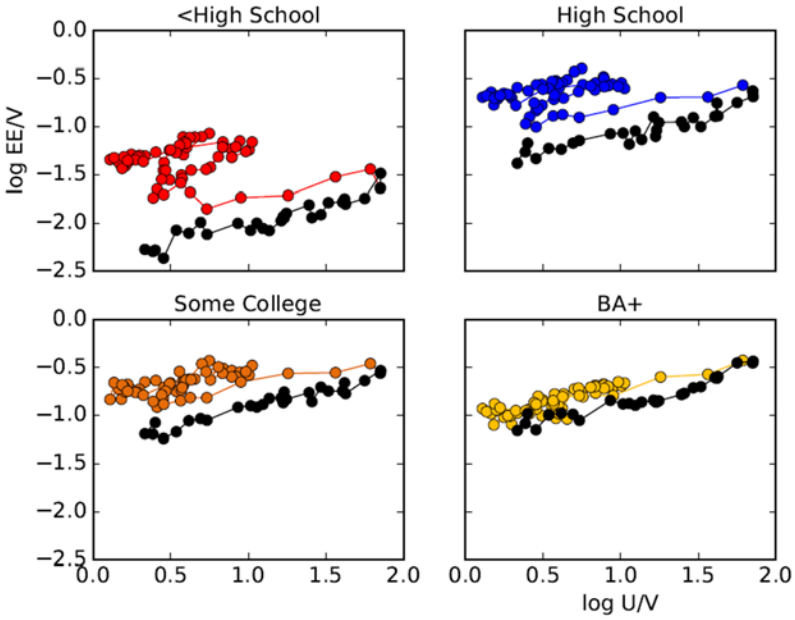


Figure 17. Fraction of Hires into Part-time Employment

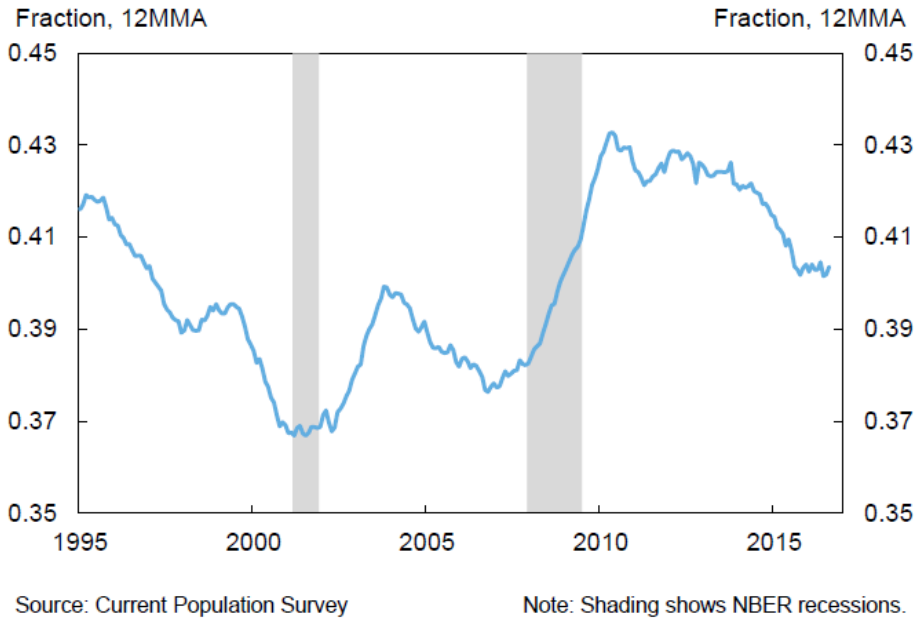


Figure 18. Fraction of Total Employment that is Part-time

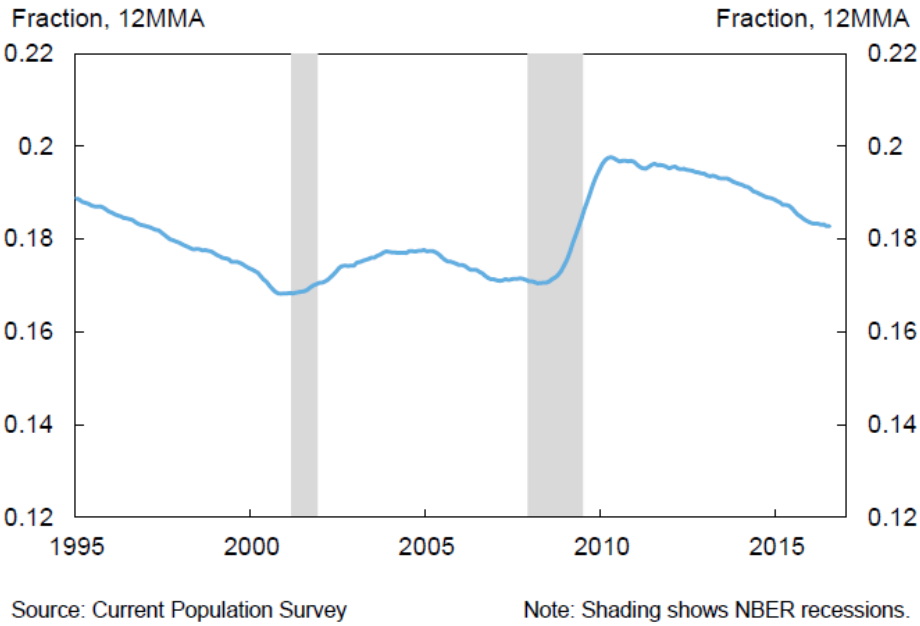


Figure 19a. Log Part-time and Full-time Hires from Unemployment vs. Log Unemployment/Vacancies (Quarterly Data, 1994 Q2-2016 Q1)

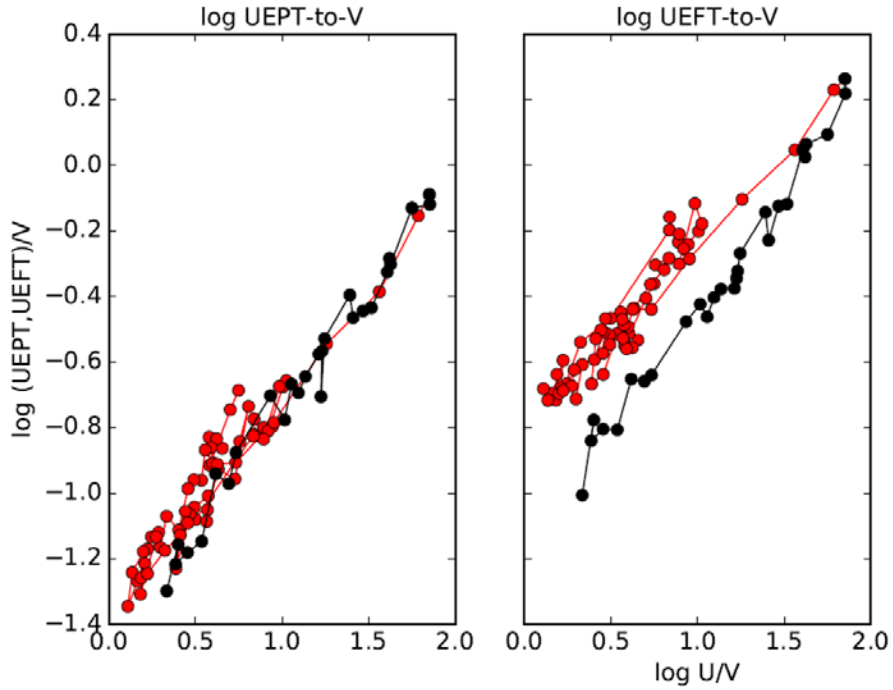


Figure 19b. Log Part-time and Full-time Hires from Nonparticipation vs. Log Unemployment/Vacancies (Quarterly Data, 1994 Q2-2016 Q1)

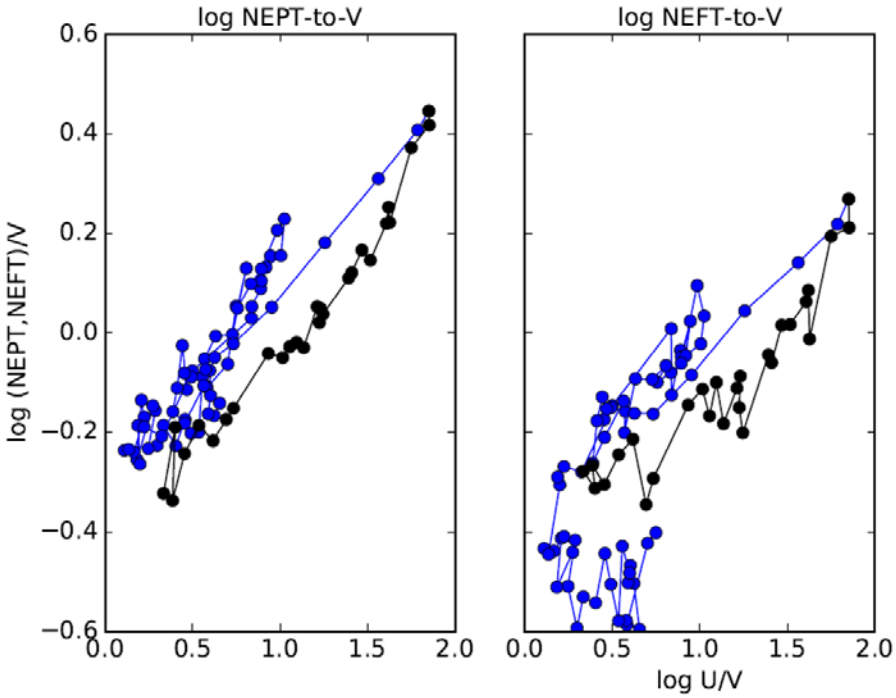
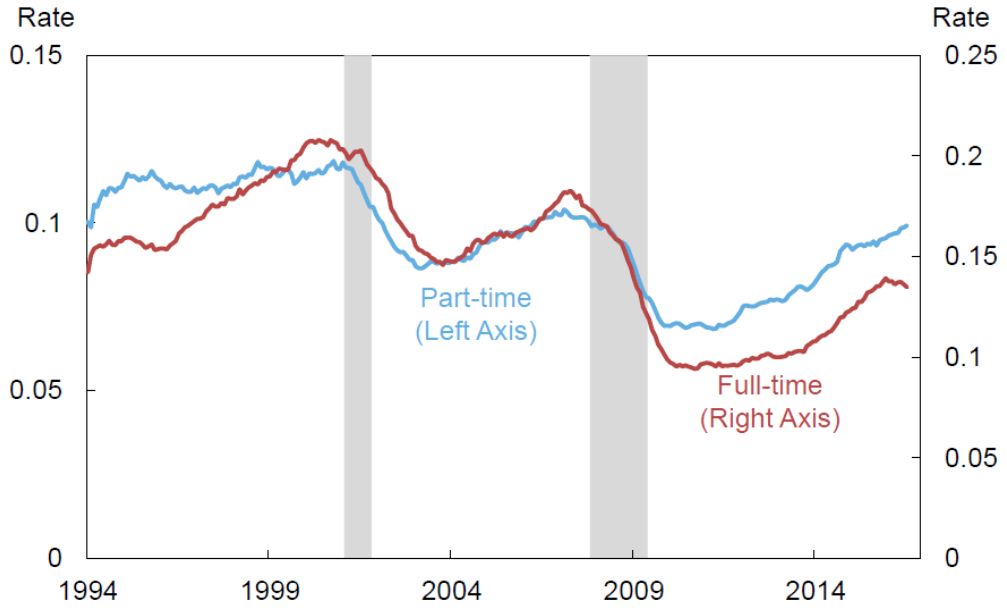


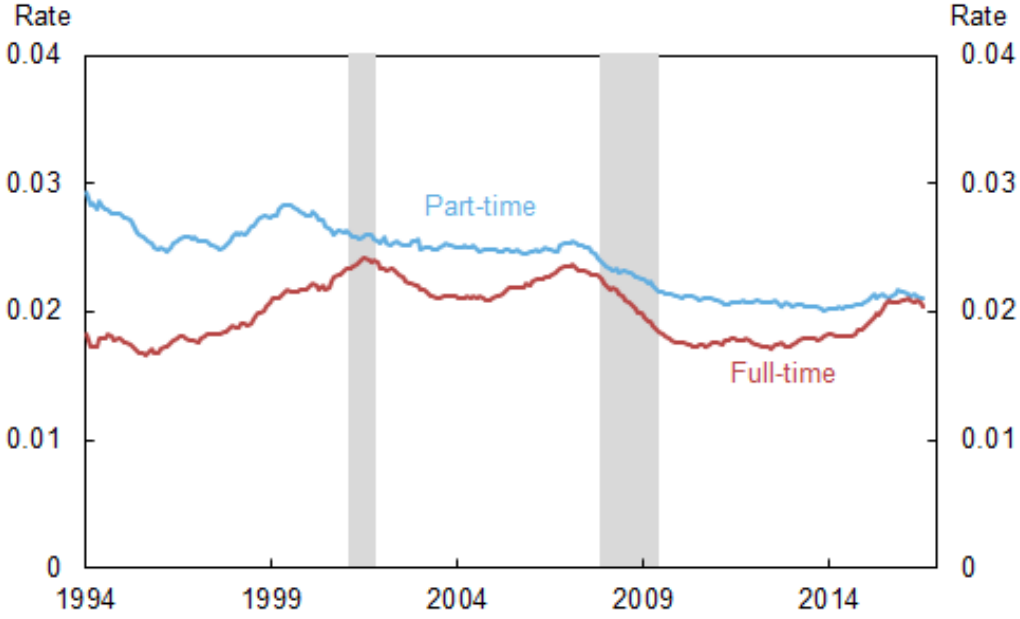
Figure 20a. Unemployed to Employed Flow Rates, Part-time and Full-time



Source: Current Population Survey

Note: Shading shows NBER recessions.

Figure 20b. Nonparticipant to Employed Flow Rates, Part-time and Full-time

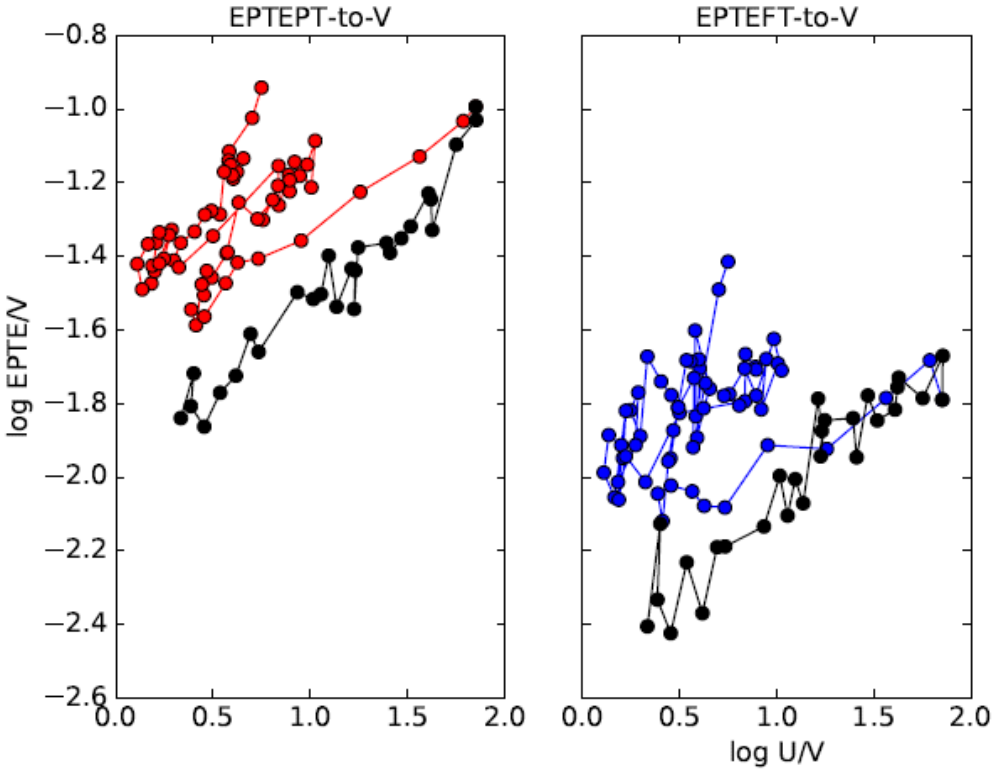


Source: Current Population Survey

Note: Shading shows NBER recessions.

Figure 21. Part-time for Economic Reasons as a Fraction of Part-time Employment

Figure 22. Log Vacancy Filling from Employment by Part-time/Full-time vs. log Unemployment/Vacancies (Quarterly Data, 1994 Q2-2016 Q1)



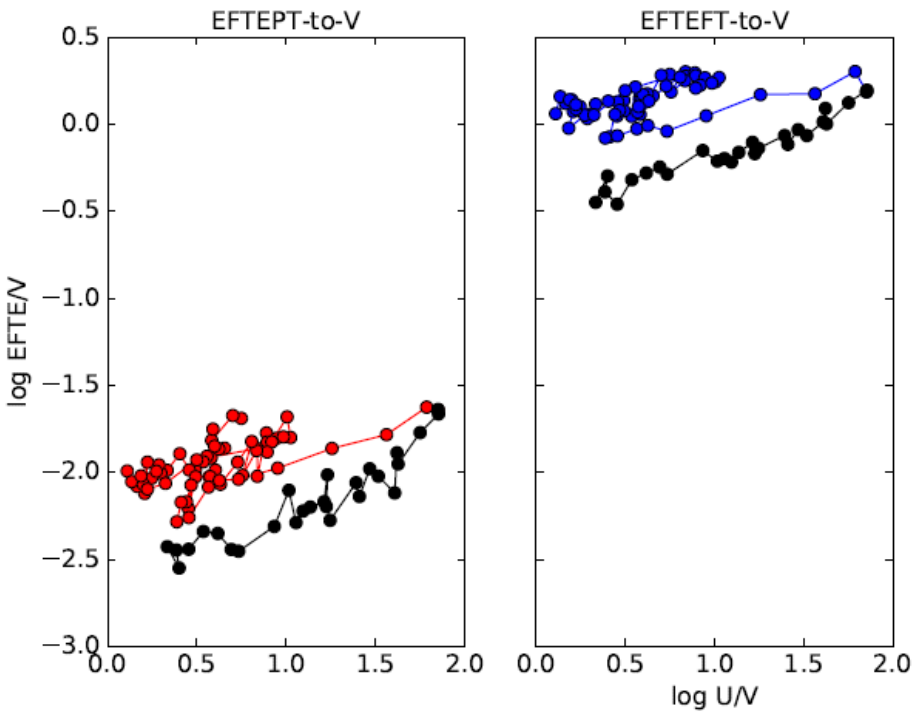


Figure 23. Part-time to Full-time Flow Rate with Change of Employer by Reason for Part-time Employment

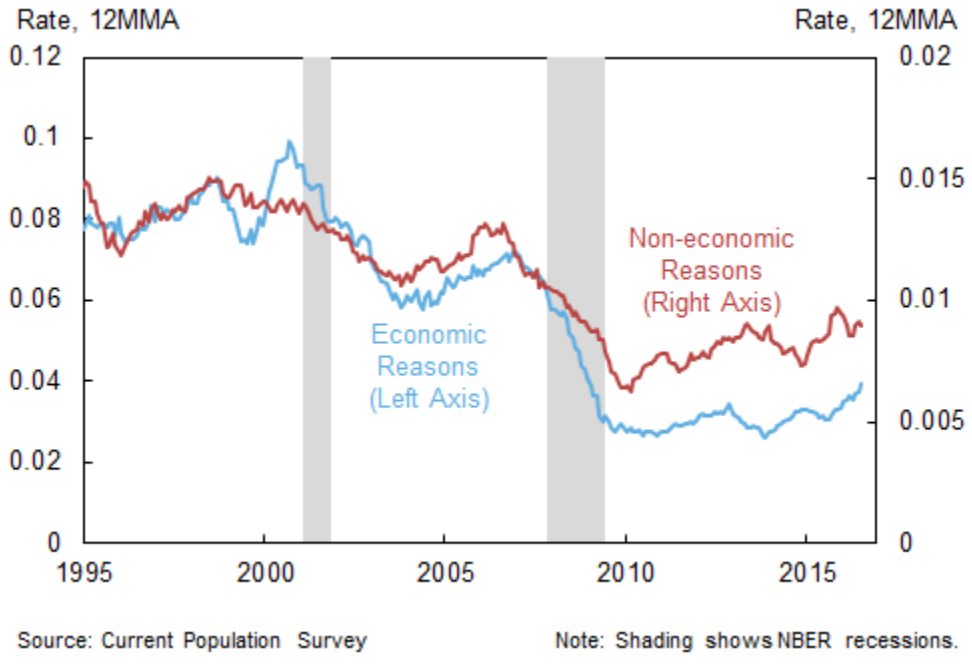


Figure 24. Transition Rate from Part-time to Full-time Employment with the Same Employer

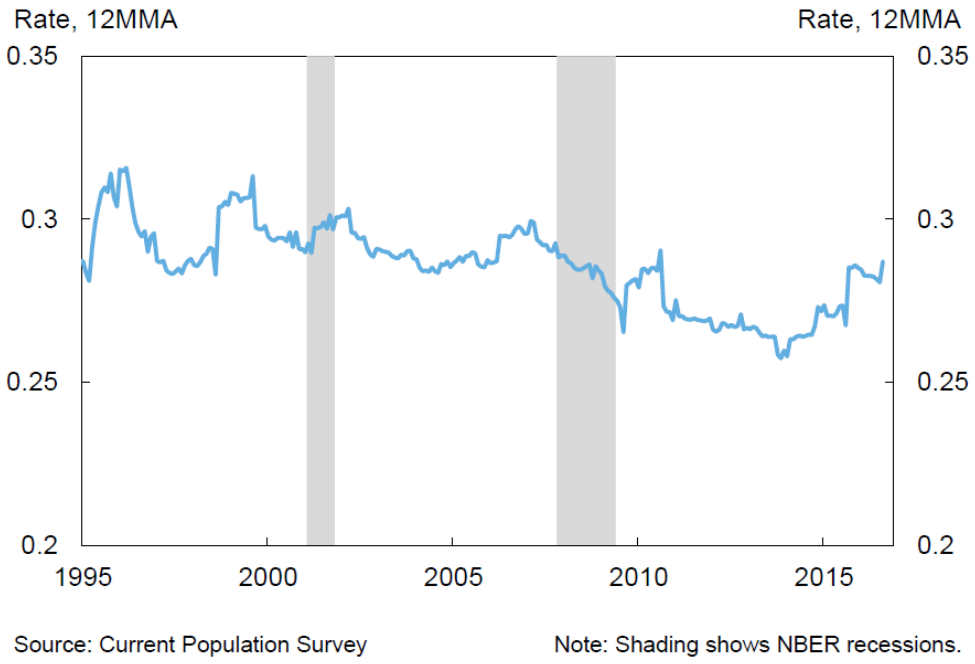


Figure 25. Actual, matching-function implied and industry-composition adjusted matching efficiency

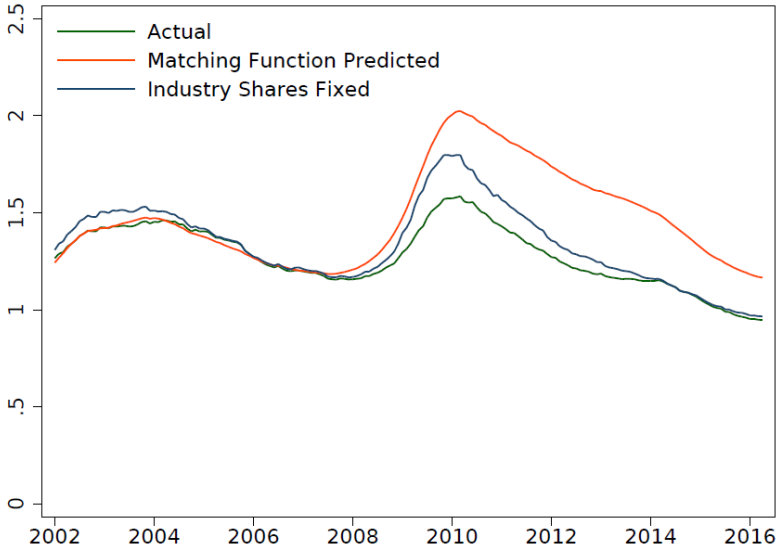


Figure 26. Actual, matching-function implied and establishment-size composition adjusted matching efficiency

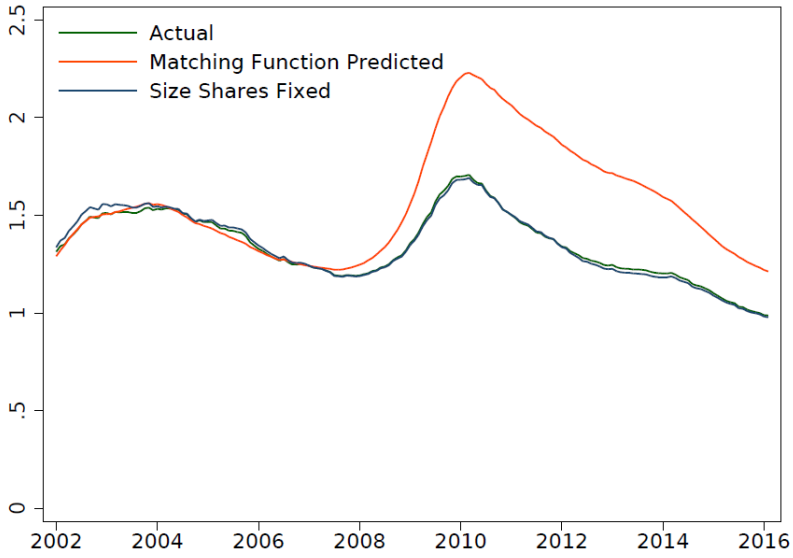


Figure 27. Actual, matching-function implied and occupation-composition adjusted matching efficiency

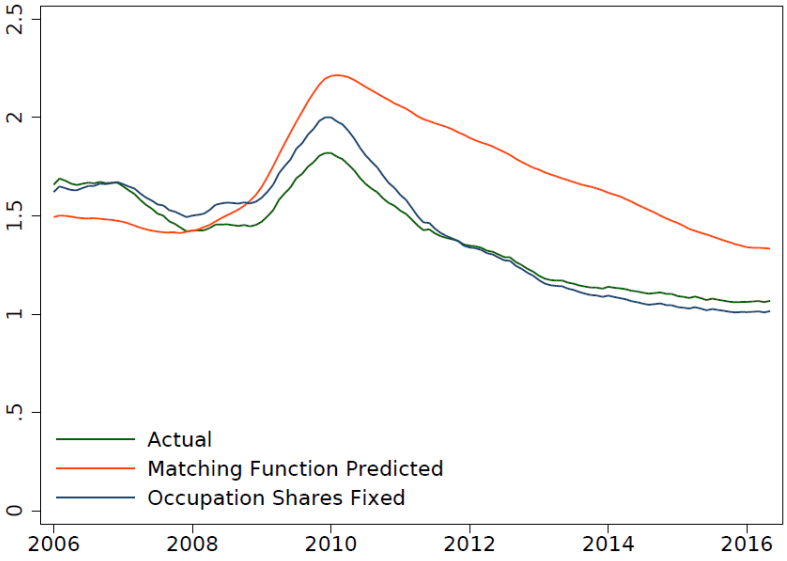


Table 1. Hiring probability, hires by job status and search effort

Job status	Search activity	Percent hired	Hires, by job status	Hires, overall
Employed	No search	1.8%	77.6%	25.7%
	Search	11.3%	22.4%	7.4%
Not employed	Not in labor force (no search)	4.9%	63.1%	42.2%
	Unemployed (search)	29.1%	36.9%	24.7%

Note: Hires in March of survey years by February employment and search status. Surveys conducted in 1995, 1997, 1999, 2001, and 2005

Source: Carrillo-Tudela, C., Hobijn, B., Perkowski, P. and Visschers, L., 2015. Majority of hires never report looking for a job. FRBSF Economic Letter, 10. Table 1.

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Table 2. Search Effort and Outcomes by Labor Force Status

	Employed				
	Wants New Job	**Wants Addl. Job**	**Not Looking**	**Unemployed**	**OLF**
Pct. of population	11.6	7.3	56.3	5.0	19.7
Pct. of offers received	26.3	21.2	28.1	13.1	11.3

Note: Estimates come from authors' tabulations from the SCE Labor Supplement for October 2013 and 2014, restricted to individuals aged 18-64.

Source: Faberman, R.J., Mueller, A., Sahin, A. and Topa, G., 2016. Job Search Behavior among the Employed and Non-Employed. *Federal Reserve Bank of New York, mimeo*. Table 5.

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Table 3. Matching Function Regressions

Hires	Start Date	A	α	R^2
UE+NE+EE	1975Q3	4.80	0.37	0.88
UE+NE+EE	1994Q1	5.16	0.31	0.92
JOLTS Hires	2001Q1	3.14	0.20	0.92

Table 4. Beveridge Curve shifts, minimum unemployment, and length of expansions for different business cycles

Min V	**Experiences Shift**	**Min U(Recovery)<Min U(Previous Expansion)**	**Length of Expansion**
Q3-1954	YES	NO	11
Q3-1958	YES	NO	5
Q2-1961	YES	YES	32
Q1-1971	YES	NO	10
Q1-1975	YES	NO	17
Q4-1982	YES	YES	26
Q4-1991	YES	YES	34
Q3-2003	NO	NO	15
Q3-2009	YES	#N/A	#N/A

Table 5. Separate Hiring Regressions

Hires	Start Date	A	α	R^2
UE+NE+EE	1975Q3	4.80	0.37	0.88
UE	1975Q3	0.98	0.63	0.82
NE	1975Q3	1.89	0.40	0.84
EE	1975Q3	1.96	0.15	0.81
UE+NE+EE	1994Q1	5.16	0.31	0.92
UE	1994Q1	1.02	0.57	0.86
NE	1994Q1	2.07	0.36	0.92
EE	1994Q1	2.11	0.06	0.84

Table 6. Hiring Regressions with Separate Equations for Part-time and Full-time

Hires	Start Date	A	α	R^2
All PT Hires	1994Q1	1.33	0.39	0.91
All FT Hires	1994Q1	2.19	0.27	0.89

Table 7. Vacancy yield by industry

Industry	Vacancy Yield	Vacancy Share
Construction	3.65	.033
Education and Health	.756	.193
Financial Activities	.844	.069
Government	.789	.111
Information	.816	.027
Leisure and Hospitality	1.8	.13
Manufacturing	1.25	.071
Professional and Business Services	1.34	.192
Trade, Transportation, and Utilities	1.59	.174

Table 8. Vacancy yield by establishment size

Establishment Size	Vacancy Yield	Vacancy Share
1-9	1.44	.134
10-49	1.6	.255
50-249	1.46	.313
250-999	1.13	.174
1000-4999	.721	.101
5000+	.552	.023

Table 9. Vacancy yield by occupation

Occupation Group	Vacancy Yield	Vacancy Share
Cognitive Nonroutine	.715	.526
Manual Nonroutine	3.09	.101
Cognitive Routine	1.29	.24
Manual Routine	3.01	.133

Table 10. Employer Search, Vacancy Duration, and Training Variables by Size
1980 EOPP; 1982 EOPP; 1992 SBA; 1993 Upjohn Surveys

Survey Employer Size	Number of interviews per offer	Number of applicants per offer	Total training (hours first month of first 3 months)	Number of observations
EOPP,1980	5.69	NA	33.71	2994
1-99	5.38	NA	32.91	2552
100-299	7.02	NA	37.87	300
300+	8.79	NA	39.33	142
EOPP,1982	5.91	9.87	136.15	1270
1-99	5.79	8.85	131.99	1083
100-299	6.94	11.24	123.30	118
300+	5.94	23.42	223.33	69
SBA,1992	5.58	14.08	168.43	859
1-99	5.32	9.72	152.72	428
100-299	5.96	13.48	161.35	102
300+	5.81	19.93	191.07	329
Upjohn,1993	6.02	22.94	83.42	210
1-99	8.39	15.68	81.10	30
100-299	5.66	18.82	78.40	58
300+	5.64	27.17	86.38	122

Source: Selected columns from Table 1., BARRON, J. M., BERGER, M. C. and BLACK, D. A. (1997), EMPLOYER SEARCH, TRAINING, AND VACANCY DURATION. Economic Inquiry, 35: 167–192. doi:10.1111/j.1465-7295.1997.tb01902.x

Table 11. Training and Productivity Growth of Typical New Employees by Occupation

	Profes-sional	Mana-geral	Sales Not Retail	Retail Sales	Clerical	Blue Collar	Service
Hours Spent in Training in First 3 Months							
Watching others do the job	60.0	65.0	82.8	39.2	50.4	48.1	32.7
Formal training programs	9.1	12.1	23.9	8.2	13.5	9.1	5.7
Informal training by management	76.6	80.4	71.8	48.5	54.6	49.3	35.1
Informal training by co-workers	31.8	23.0	33.9	23.9	26.2	26.8	16.7
Investment in Training Time	293	295	350	185	235	200	130
Weeks to become fully trained if no previous experience	11.1	13.4	9.2	6.5	6.7	9.0	3.4
Increase in Reported Productivity (%)							
Between first 2 weeks & next 10 weeks	28%	32%	50%	30%	40%	32%	28%
Between first 3 mo. & end of year 2	38%	33%	56%	25%	32%	23%	17%
Increase in Real Wage in First 2 Years (%)	5.0%	7.7%	22.6%	9.7%	11.5%	11.5%	3.7%
Number of cases	95	112	76	203	429	649	334

NOTE: Tabulation of the EOPP Employer Survey. The sample is limited to jobs for which all the necessary questions on wage rates, training time, and productivity were answered.

Source: Table 1., Bishop, J. H. (1996). *What we know about employer-provided training: A review of literature* (CAHRS Working Paper #96-09). Ithaca, NY: Cornell University, School of Industrial and Labor Relations, Center for Advanced Human Resource Studies. http://digitalcommons.ilr.cornell.edu/cahrswp/180

Table 12. Data from Careerbuilder.com

	obs.	mean	s.d.	min	max
Outcome variables					
Number of views	61,135	6,084.02	6,133.50	0	262,160
Number of clicks	61,135	280.97	312.11	0	7,519
Number of applications	61,135	59.35	121.68	0	4,984
Firm Characteristics					
Number of employees	61,135	18,824	59,280	1	2,100,000
Job Characteristics					
Yearly wage	11,715	57,323	31,690	13,500	185,000

Source: Table 1. Marinescu, I.E. and Wolthoff, R.P., 2015. Opening the black box of the matching function: The power of words.

Appendix

A. **Construction of a JOLTS-type Measure of Hires for 1976-2000**

As is well known in the literature that total hires measured from the households' perspective (sum of unemployment-to-employment (UE), nonparticipation-to-employment (NE) and job-to-job (EE) flows computed using CPS data) do not line up with the hires measured from the employers' perspective, especially in levels.[34] Moreover, while UE and NE flows can be computed from the CPS micro data starting in 1976 and are readily available, a monthly measure of job-to-job flows is only available after the CPS redesign in 1994.[35] To obtain a JOLTS-type measure of hires going back to 1976, we first use the methodology developed in Blanchard and Diamond (1990) and construct annual job-to-job transition measures using the Annual Social and Economic (ASEC) Supplement of the CPS (also known as March Supplements). We then use linear interpolation to create quarterly measures of job-to-job transitions. We find that, while the levels of job-to-job transition measures we obtain are lower than the ones computed using the basic monthly files for 1994-2010, they follow a very similar cyclical pattern. With the quarterly estimates of the job-to-job transitions in hand, we regress JOLTS hires on UE, NE, and job-to-job (EE) flows for 2000-2010. We then use the historical time series for these three flows, along with the coefficients from the regression to construct a JOLTS-type measure of hires back to 1975. [36] We use the published JOLTS measure starting in 2001Q1.

[34] See, for example, Davis, Faberman, and Haltiwanger (2006).

[35] See for example Fallick and Fleischman (2004).

[36] Davis, Faberman and Haltiwanger (2012) use the Business Employment Dynamics (BED) data to construct a JOLTS-type hires measure starting in 1990. Our measure of hires line up well with theirs for the overlapping sample.