The U.S. Job Ladder in the New Millennium *

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Abstract

The U.S. labor market after the year 2000 has many notable differences from previous decades. First, the rate of growth in high-paying jobs seen in the 1980s and 1990s has not been realized, with job growth occurring disproportionately in low-paying jobs. Second, the rate at which workers switch employers fell after the year 2000, and only experienced a modest increase before plummeting again in the labor market downturn associated with the "Great Recession" of 2007-2009. Third, the employment-to-population ratio has declined from its peak in the year 2000 and, since the most recent recession, stayed at levels not see in the last thirty years. In this paper, after descriptive analysis of these patterns in the U.S. labor market, we explore how changes in labor demand may account for these declines in a model of the labor market with on-the-job search.

*Any opinions and conclusions expressed herein are those of the authors and do not necessarily represent the views of the U.S. Census Bureau, or the views and policies of the Board of Governors of the Federal Reserve System or its staff. All results have been reviewed to ensure that no confidential information is disclosed.

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1 Introduction

The U.S. labor market has performed distinctively worse since the start of the New Millennium. This time period is marked by two distinct downturns in the labor market that are associated with the output contractions in the recession of 2001[1] and the "Great Recession" of 2007-2009. In this paper we wish to highlight three key aspects of this singularity. First, the labor market shifted away from the creation of high-pay jobs, and toward low pay jobs, as documented in Acemoglu and Autor (2010), Autor and Dorn (2013), and Beaudry, Green, and Sand (2013).[2] Second, the two labor market downturns are associated with severe declines in employment reallocation, as shown by Davis, Faberman, and Haltiwanger (2012) and Hyatt and Spletzer (2013).[3] The rates of hiring and job separations, as well as job-to-job transitions exhibited sizable declines, and, indeed, the job-to-job transition rate fell by about half from the late 1990s to the aftermath of the 2007-2009 recession. Third, the employment-to-population ratio reached a peak in the year 2000 and declined by several percentage points in the fifteen years that followed.

In this paper, we characterize some shifts in the labor demand that are consistent with recent changes in the composition of the workforce, the job-to-job transition rate, and the level of employment in the U.S. economy. We present descriptive evidence on the nature of the decline in high-pay employers, occupations, and industries. Our analysis confirms that, starting in the year 2000, high-pay jobs have declined relative to other employment opportunities, regardless of how one ranks jobs. This is coupled with a reversal of the drop in low-pay jobs, which experienced the greatest *increase* as a share of employment. We

[1] While the U.S. recession in 2001 was atypically mild in its output loss, the associated labor market downturn was far worse: the unemployment rate rose from 3.8% in April of 2000 to 6.3% in 2003.

[2] This comes in the context of a decline in historically middle skill jobs. While we and the authors cited above mostly agree with the decline in "middle skill", in this paper we wish to emphasize the reversal in the growth of high vs. low skill jobs.

[3] The overall level of job-to-job flows did not exhibit much change between the years 1980 and 2000; see the annual CPS data presented in Hyatt (2014). Other data sources do suggest either increasing or decreasing trends between 1980 and 2000. For example, occupational mobility appears to have risen from the 1980s to the 1990s; see Moscarini and Thompson (2007) and Kambourov and Manovskii (2008). Longer trend declines are observed in measures of job flows. For example, the Business Dynamics Statistics on job creation and destruction exhibit declines from the late 1970s to the 1990s; see Decker et al. (2014). Evidence from U.S. manufacturing in Faberman (2008) suggests a decline in job reallocation in this sector going back to the 1960s. However, even in the data sources that indicate a trend decline in employment reallocation before 2000, this decline accelerated sharply starting in the year 2000.

also show that, at the same time, the job-to-job transition rate has declined, and that these declines are greater in magnitude for jobs that are at the lower end of the pay distribution. As when people leave one job for another they generally receive a pay increase, it is natural to think that when fewer "good jobs" are created, fewer people will be switching jobs. We also document the trends in the employment-to-population ratio. To make sense of these facts, we conduct two exercises. First, we explore the intrinsic relationship between these components that follows from a stock-flow accounting exercise. Second, we propose a labor market search model with a "job ladder" (i.e., on-the-job search) and perform a numerical analysis to show that many of the qualitative features of the U.S. economy post-2000 appear to be explained by an overall decline in labor demand. This decrease in labor demand is indeed found to reduce employment at the highest-pay jobs more severely.

We begin our paper by documenting changes in the workforce composition and employment transitions in the United States for the years 1994-2014. We use the Current Population Survey (CPS) and the Longitudinal Employer-Household Dynamics (LEHD) matched employer-employee microdata to confirm recent evidence that the growth of high pay jobs declined starting around the year 2000. Prior to that year, there was a distinct pattern of upskilling as low pay jobs declined and high pay jobs expanded. However, after the year 2000, job growth was more evident among the lowest pay jobs. We also confirm, consistent with previous evidence, that middle-pay jobs declined throughout the 1990s and the more recent decades.

At the same time, the job-to-job flow rates declined. The CPS and matched employer-employee data provide different lenses into the nature of the decline in these flows. The CPS contains information on occupation and industry, and permits us to rank workers based on the average pay by those categories. The matched employer-employee data allows us to rank workers based on industry and firm wage. Yet, both datasets tell a similar story. Job-to-job flow rates declined by half, and these declines are concentrated at the low end of the pay distribution whether that is measured by education, occupation, industry, or firm wage. Looking closely at the content of the job-to-job transitions, we find that, after the year 2000, proportionately more movements are to destinations that pay about the same as the origin

job, whereas fewer movements are to jobs with higher pay.

The previous trends are consistent with a decline in a "job ladder". Naturally, when workers change jobs, they receive pay increases: see Burdett (1978) and Jovanovic (1979) for early models of this "job ladder" and Topel and Ward (1992) for empirical evidence. These and other models of on-the-job search formalize the intuition that workers who are unemployed are less picky about the jobs that they take than workers who are employed. Employed workers will require a *better* job than their current one, when deciding to make a job-to-job transition. In that framework, when the number of relatively high-pay jobs decline, it is natural that fewer workers transition from one employer to another as there are less opportunities to move up the "job ladder."

The empirical patterns documented in this paper took place in the context of two labor market downturns that coincided with the 2001 and 2007-2009 recessions. There are natural measures of the health of the labor market that mark these downturns, specifically, the unemployment rate and the labor force participation rate. We explore these channels, and are particularly interested in the declines in the employment-to-population ratio. The decline in the job-to-job flow rate is not surprisingly linked to these measures since it is well known that the job-to-job flow rate is procyclical and driven by quits.[4] Perhaps the changes in the occupation, industry, and firm pay are less naturally associated with the health of the labor market: during expansions in the 1980s and 1990s, the U.S. labor market shed low-wage jobs and created high-wage jobs, but in the last fifteen years, the labor market upswings have been associated with growth in low-wage jobs.[5]

To make sense of this evidence, we interpret our results in the context of a model. In particular, we write down a model that follows the long tradition of job ladder models that begins with Burdett and Mortensen's (1998) seminal wage posting model. Specifically, we consider a model with firm heterogeneity, and because we wish to explore the role of demand we employ a variant of Postel-Vinay and Robin (2002) and Lise and Robin (2013).

[4]Indeed, the job-to-job flow rate produced by the U.S. Census Bureau's LEHD program and the quit rate in the Bureau of Labor Statistics Job Openings and Labor Turnover Survey have a correlation in excess of 0.98, see Hyatt et al. (2014).

[5]Foote and Ryan (2014) explore the relationship between the occupation structure and the labor force participation rate, with a focus on job polarization.

This model is proposed to account for a few stylized facts: (i) the number of high wage occupations, industries, and firms experienced relatively low growth post-2000, (ii) the rate of job-to-job flows declined by half from 2000 to 2012, and (iii) the U.S. employment-to-population ratio declined.

In greater detail, we propose a job ladder model with random search that follows Postel-Vinay and Robin (2002) and Lise and Robin (2014). Offers arrive stochastically from employers who sit at different ranks on the basis of their productivity and so the surplus from a matched firm and worker. There is on-the-job search in the model, as both employed and unemployed workers receive offers. Firm vacancy posting is costly. By comparing steady-states of our calibrated model, we show that a decreasing productivity that differentially affects high productivity firms can generate the qualitative features described above. Subject to lower productivity, the equilibrium has fewer high-pay jobs, a lower job-to-job transition rate, and a lower labor force participation rate. Since the declines are concentrated in recessions from which the U.S. economy appears to never recover, we argue that this is more likely due to changes in the profitability of worker-firm matches, although greater hiring costs may explain some of the trend changes in our measures of interest.

Although this paper is, to the best of our knowledge, the first to link the changing structure of the U.S. workforce to a trend decline in the job ladder, the basic story is similar to that told by Moscarini and Postel-Vinay (2015), who explore the slowdown in the job ladder through a quantitative exercise based on the model of Moscarini and Postel-Vinay (2013), with particular focus on the Great Recession to quantify the cyclical properties of the Burdett and Mortensen (1998) model. Our focus here does not seek to differentiate between the "cycle" relative to the "trend" in the U.S. labor market.[6] This framework brings together several strands of the literature that have been progressing on changes in the task structure as in Autor and Dorn (2013), Jaimovich and Siu (2013), and Cortes et al. (2014), the literature

[6]Indeed, it is difficult to distinguish between trend and cycle, especially for analysis of recent events. Furthermore, trends extracted using conventional procedures are often sensitive to endpoints. For example, Haltiwanger, Hyatt, and McEntarfer (2014) follow standard methods of extracting an H-P trend and find that unemployment in the U.S. labor market was below trend starting in the fourth quarter of 2011, when the unemployment rate was at a rate in excess of 8%, which had only previously been reached in 1975 and 1981-1983, during two of the most severe labor market downturns since the Current Population Survey began to be administered in 1948.

on declining employment reallocation rates as in Hyatt and Spletzer (2013), Cairo (2013), Molloy, Smith, and Wozniak (2013), and Davis and Haltiwanger (2014), and research on the declining labor force participation rate as in Aaronson et al. (2014) and Fujita (2014). Our descriptive evidence shows that each of these measures changes discretely following the 2001 and 2007-2009 recessions, in a way that qualitatively matches what our model predicts.

In the context of our job ladder model, the ultimate cause for the documented changes is a decline in demand. Future drafts of this paper may include extensions of the model we present. In principle, it can be used to explore different channels for this decline: (i) there is a natural fluctuation in the relative importance of poaching that follows from Burdett and Mortensen (1998), Postel-Vinay and Robin (2002), Moscarini and Postel-Vinay (2013, 2015) etc., (ii) there is an "extensive margin" effect that may play a role in the context of worker heterogeneity – and clearly the greatest declines in the job-to-job flow rate are found where the declines in the employment rate are greatest in magnitude: first, for those with lowest education, and also among those with the lowest wages, the latter of which is especially more of a Barlevy (2002) story, and (iii) there is a change in the relative demand for high-skill jobs that may have a first-order effect as in Beaudry, Green, and Sand (2013) or Autor and Dorn (2013).

2 Descriptive Evidence

This section contains evidence of the trends in the U.S. labor market, with a particular focus on the years 1994-2014. We show that, starting in the year 2000, the trends in workforce composition changed and the number of high wage jobs stopped its increase. At the same time, job-to-job transition rates declined, especially those associated with movements to jobs on different wage categories. In our analysis, we use data from three different sources. First, the Census IPUMS 5 percent samples for years 1980, 1990, and 2000, and Census American Community Survey for 2008 and 2012. Second, data from the CPS. Third, we also use matched employer-employee data from the U.S. Census Bureau's LEHD program. The source of these data are unemployment insurance wage data collected by U.S. states

and sent to the Census Bureau. The LEHD infrastructure files are described in more detail in Abowd et al. (2009).

2.1 Workforce Composition

We start by presenting evidence on the changes in the composition of the employment pool in the U.S. economy by considering a variety of job ranking. We start by ranking the employed according to their average occupational-wage. Figure 1 presents the results using data from the Census and ACS from 1980 to 2012. This graph updates Figure 10 in Acemoglu and Autor (2010). The 3-digit occupations in the Census are ranked on the horizontal axis by their average wage of workers in the occupation in 1980 from lowest to highest. The vertical axis corresponds to the change in employment at each occupational percentile as a share of total employment during the decade. Figure 1 shows substantial shifts in the composition of employment during the last decades. Prior to 2000, employment growth was concentrated in high pay jobs. Thus, employed workers at high pay occupations represented an increasing share of the employment pool, in detriment of both low and middle wage jobs. However, after the year 2000, job growth was more evident in the low-wage categories. This shift away from the creation of high pay jobs to low pay jobs is the first of the two empirical facts that this paper focuses on.

Similar results are observed using data from the CPS during the period 1994-2013.[7] Figure 2 plots changes in employment shares, when fixing the occupational wage categories in 2012. In particular, we classify 3-digit CPS occupations into three wage groups: low, medium, and high wage occupations. We use terciles of the employment-weighted occupational average wage distribution in each year to split occupations in the three broad categories. The wage measure considered is a consistent hourly wage constructed by the Center for Economic and Policy Research (CEPR) using the CPS Outgoing Rotation Groups (ORG)

[7]We start the analysis in 1994 as job-to-job transitions in the CPS can only be computed starting in 1994. Nevertheless, compositional changes in the employment pool during the full decade of the 1990s show a similar pattern as for the 1994-2000 period. The noticeable break in the series in 2003 is due to a change in the classification system by the Census Bureau.

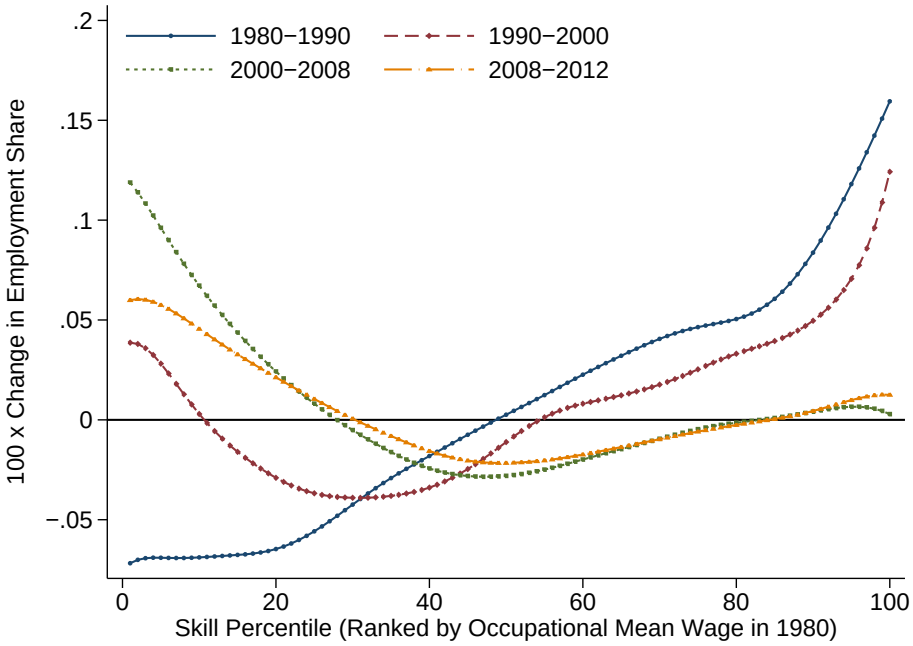


Figure 1: Smoothed changes in employment shares by occupational skill percentile

samples in each year.[8]

Figure 3 shows the change in the employment share by employer characteristics, in this case, the firm wage and the industry wage for 1994-2013. The workforce is again grouped into three categories (low, middle and high) based on the wage that the average worker in the category receives. Earnings are calculated in real 2012 dollars and the 2012 distribution is used as a reference point. Note that for average firm wage, a firm can change its position in the wage distribution every quarter in principle. It can do so as well for its industry, but firm industry does not change as often as the wage that a firm pays.

Similar trends are apparent in the LEHD data as in the CPS, although some differences are to be expected as these are very different series. In the 1990s, there is a clear increase in the share of employment in the high wage firm, especially in the years 1996-2000, but less of

[8]The CEPR constructs several alternative wage variables from the CPS ORG samples based on different combinations of procedure for dealing with top-coding and overtime, tips and commissions. The wage used in this paper is the CEPR preferred wage variable, and considers a top-coding adjustment assuming log normal distribution weekly earnings and standard adjustment for overtime, tips and commissions. Nominal wages are converted to the most recent dollars (i.e. 2013) using the CPI-U-RS. More information available at `http://ceprdata.org`.

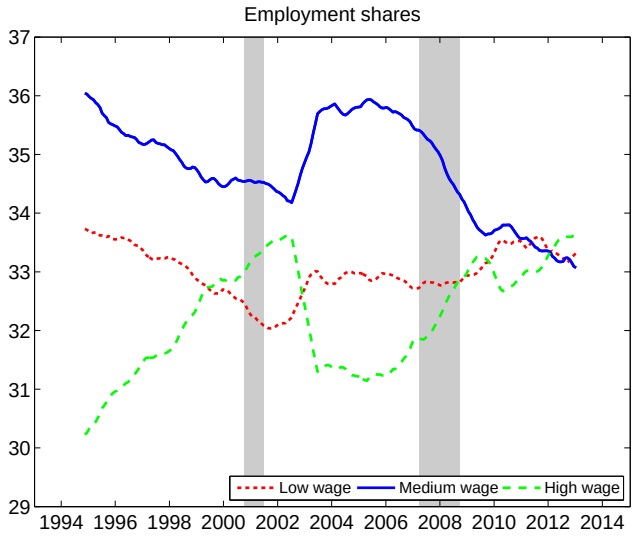
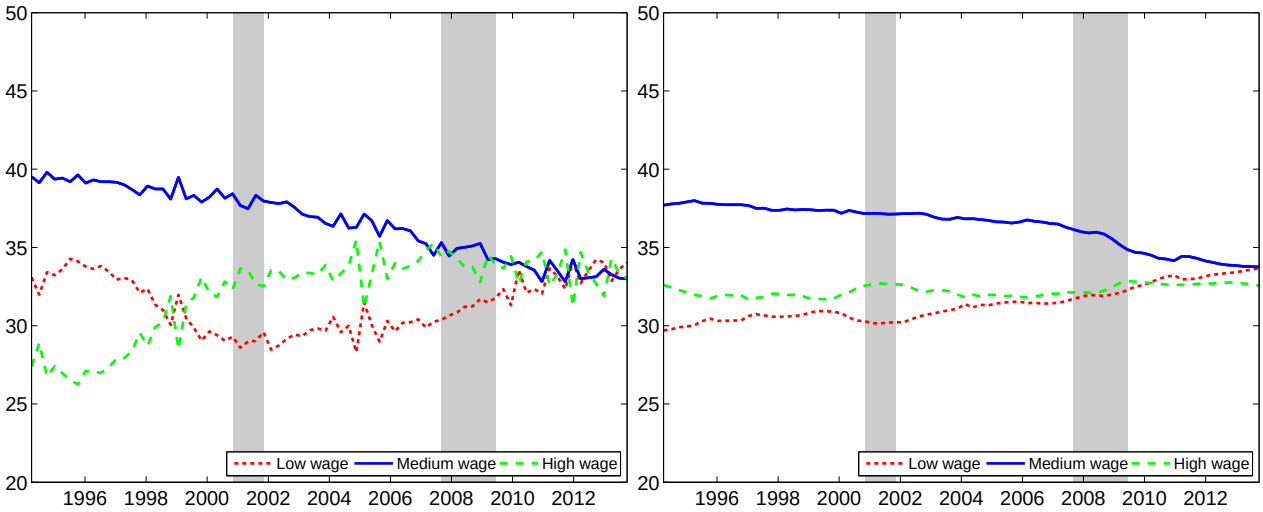


Figure 2: Employment shares by occupational-wage category, CPS data

Notes: Occupations are classified in three wage groups (low, medium and high) using terciles of the employment-weighted occupational wage distribution in 2012. All variables are constructed from CPS microdata.



(a) Firm wage

(b) Industry wage

Figure 3: Employment shares by wage category

an increase in the share of employment at high wage industries. After 2000, there is a clear trend decline in the share of middle pay jobs both by firm wage and industry wage, and a strong increase in low pay jobs, consistent with the story of a "great reversal" as suggested by Beaudry, Green, and Sand (2013).

2.2 Worker Flows

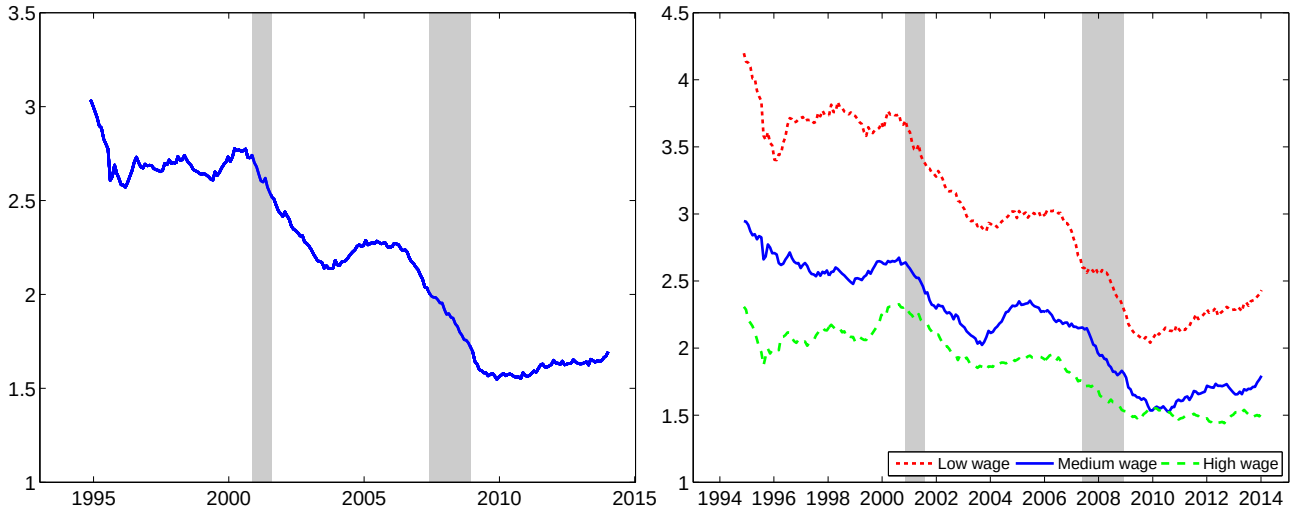
2.2.1 Job-to-Job Transitions

The second empirical fact of interest in this paper is the decline in job-to-job transitions. Figure 4 depicts the evolution of the employer-to-employer hazard rate computed from the CPS data, using the methodology proposed by Fallick and Fleischman (2004).[9] As it can be seen in Panel A of Figure 4, the decline in the employer-to-employer hazard rate for the aggregate economy during the last two decades is substantial. Additionally, declines are also observed for each wage category (panel b), when considering the wage category in the origin occupation. Interestingly, the decline is more acute at the low end of the occupational wage distribution.

The declining job-to-job transition rate that is apparent in the CPS is also apparent in the LEHD data, as documented by Hyatt and Spletzer (2013). Figure 5 shows the quarterly job-to-job transition rate in the LEHD data, as well as flows of workers to and from nonemployment, and is taken from Hyatt (2014). The job-to-job transition rate is rising during the 1990s, peaks at around 9% in the year 2001, declines to around 6% in the year 2005, rises modestly to 7.5% in the year 2007, and then declines again after the recession of 2007-2009 and reaches a series low of 4.5% in the year 2010, and rises modestly thereafter. Movements into nonemployment rise during recessions, and movements into employment from nonemployment decline, and both these series show a declining trend.

Although the usual data series for measuring job-to-job transition rates for the U.S.,

[9] In Figure 4 we adopt a dynamic approach, by reclassifying occupations in each period, such that in each year we split occupations in terciles of the employment-weighted distribution. Similar results are obtained when classifying occupations according to their wage in 1994, and keeping this ranking fixed over time.

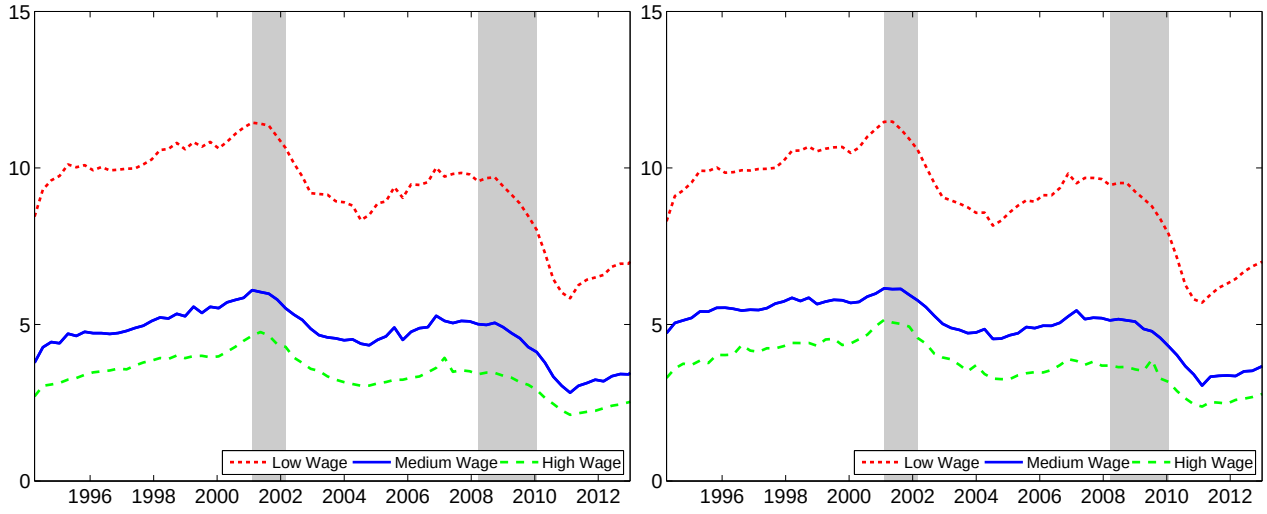


(a) Aggregate economy

(b) By wage category

Figure 4: Job-to-job hazard rates

Notes: We plot twelve-month moving averages of monthly data. The sample period is 1994:01 - 2014:09. All variables are constructed from CPS microdata. In Panel B, occupations are classified in three wage groups (low, medium and high) using terciles of the employment-weighted occupational wage distribution in each year.



(a) By Firm Wage

(b) By Industry Wage

Figure 5: Separation to J2J Rate in the LEHD

Source: Hyatt (2014).

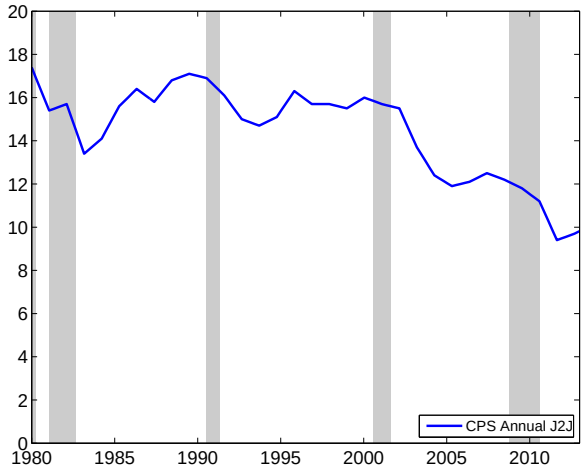


Figure 6: CPS Annual J2J Rate

the CPS and the LEHD, both begin in the 1990s, it is possible to make a comparison to the 1980s as well. In Figure 6, we show the job-to-job transition rate using the method proposed by Stewart (2007) using the question in the CPS that asks respondents how many jobs they worked in the last year. The figure shows the rate for the years 1980-2012. The job-to-job transition rate implied by the annual data is clearly procyclical: there is a marked decline during the recessions of 1980 and 1981-1982. Like the CPS monthly and the LEHD quarterly job-to-job transitions series, there is a steep decline after the year 2000 that is concentrated in the time of and following each of the recessions in 2001 and 2007-2009.

2.2.2 Job-to-Job vs. Nonemployment

We wish to give a comprehensive account for how the shares of the workforce in low vs. high wage occupations, firms, and industries changed over time. Job-to-job flows are only one type of employment transition. Broadly, complementary set of transitions is movements between employment and nonemployment, and in the CPS and other household surveys that asks respondents about unemployment, it is possible to distinguish between unemployment and whether a person is out of the labor force. We explore this distinction in this section, as it will be the case that these transitions into and from employment explain many of these

movements.[10]

First, we show the monthly flows into and from nonemployment in the CPS, and, for comparison, the job-to-job transition rate in Figure 7. All transitions are calculated as a share of the employed population, rather than state-specific transition rates (so transitions from nonemployment into employment are divided by the total number employed rather than nonemployed). Movements into and out of nonemployment are roughly twice as common as movements between jobs in the CPS. In the 1990s, slightly less than 5% of the workforce was churning into and from nonemployment, and this declines during the 2000s roughly in tandem with the job-to-job transition rate until the 2007-2009 recession when the job-to-job transition rate falls but the movements into and from nonemployment are relatively stable at around 4%.

The quarterly transition rates into and from nonemployment in the LEHD data are shown in Figure 8. Because these flows are calculated on a quarterly rather than a monthly basis, they are higher than those in the CPS. Note that these transition rates follow the methodology for the public-use J2J statistics in Hyatt et al. (2014), and so allow each worker to have only up to one transition during a quarter, and so these rates are less than three times the transition rates in the CPS. Also, the job-to-job transition rate is roughly the same level as the movements into and from nonemployment in the LEHD. This is because we are using a method of identifying job-to-job transitions that is relatively inclusive, in that it includes both those transitions where employment occurs at both the old and new employers in the same quarter ("within-quarter" job-to-job flows) and those where the old job ends in the quarter that precedes the quarter that contains the start of the job at the new employer ("adjacent quarter" job-to-job flows).[11]

The LEHD trends in movements into and out of nonemployment is similar in trend to

[10]Cortes et al. (2014) consider this nonemployment margin in its unemployment vs. not in the labor force dimension to explaining the changing occupation distribution in the CPS among routine/nonroutine cognitive and noncognitive jobs.

[11]See Haltiwanger, Hyatt, and McEntarfer (2014) for a time series analysis using data for a larger set of states for the years 1998-2012. The within-quarter and adjacent quarter job-to-job series, comparable to the one in this paper, is very highly correlated with a series of within-quarter flows alone, and a series constructed using an earnings threshold, this last series of which is found to be the closest to the CPS job-to-job transition rate.

the CPS series but evidences much more cyclicality. The series of transitions into nonemployment is distinctly countercyclical, with an especially large rise just after the 2007-2009 recession, when the movements into employment from nonemployment also drops. This sort of dip and spike is also apparent just after the 2001 recession, but is smaller in magnitude. The general downward trend in the levels of transition into and from nonemployment as seen in the CPS is also apparent in the LEHD data, although the LEHD nonemployment transition rates have a bit more of a "stair-step" pattern with level shifts that are apparent after each of the two recessions in this time series.

2.3 Changes in the Terciles: Job-to-Job and Nonemployment Transitions

We want to relate the changes in the shares of the three sets of terciles above, by CPS occupation wage, as well as LEHD firm wage and industry wage, to the different transition rates available from the CPS and LEHD. To do so, we begin by considering the net changes from each flow type by tercile, see Figure 9 for results from the CPS. In panel (a), we show the net change in employment from job-to-job flows for each of the wage categories, scaled by the number of people employed in occupations in each such category. Overall, the net change within each occupation tercile associated with job-to-job transitions is consistent with the cyclical job ladder by firm wage documented in Haltiwanger, Hyatt, and McEntarfer (2014). The low wage category consistently loses workers, on net, through poaching. In the 1990s, in a given month, low-wage employers would lose 0.05% to 0.2% of their workers through poaching, while in the years preceding the 2007-2009 recession, this is lower, at only 0.5% to 0.1%, and is at its lowest in magnitude during and after the 2007-2009 recession, when the job ladder stalled, as argued by Moscarini and Postel-Vinay (2015). In contrast, middle-wage occupations gain workers, on net, through job-to-job transitions, and the magnitude of these shares mimics that of the low wage occupations: these net gains are less than 0.15% throughout the time period, and are generally lower following the year 2000 than in the 1990s.

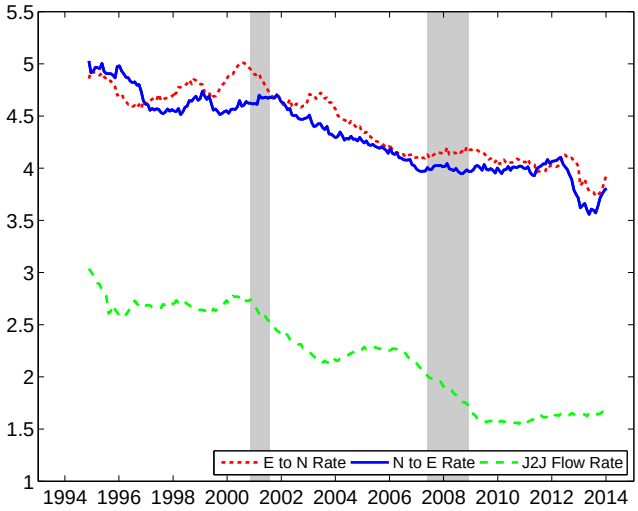


Figure 7: Transition Rates into and from Employment, also across employers in CPS

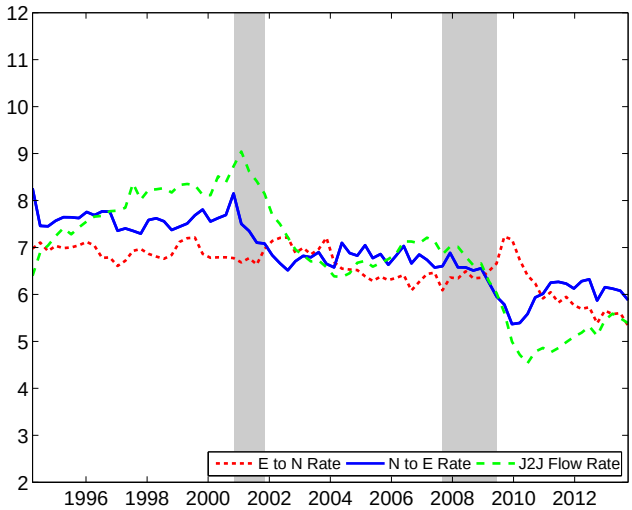
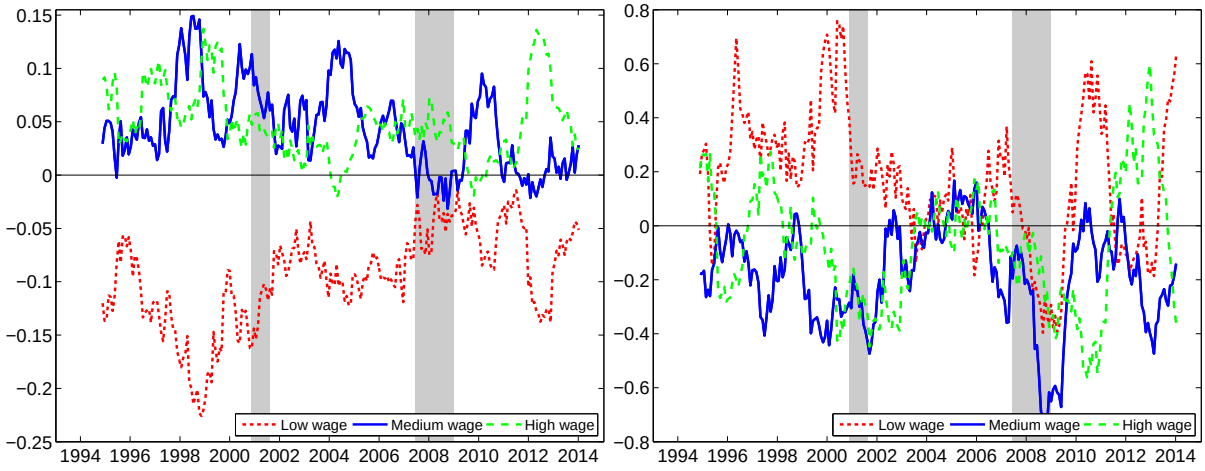
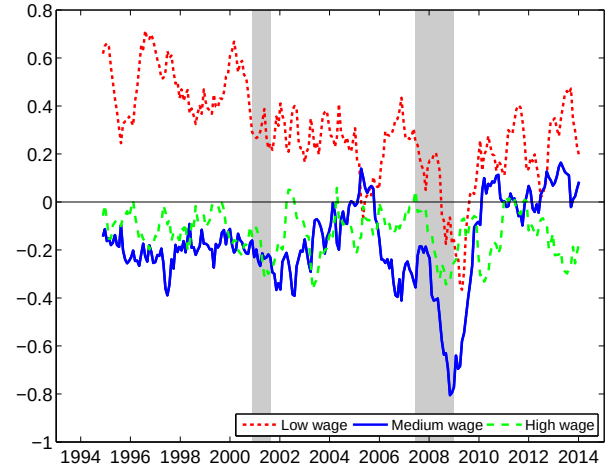


Figure 8: Transition Rates into and From Employment, Also Across Employers (J2J) in LEHD

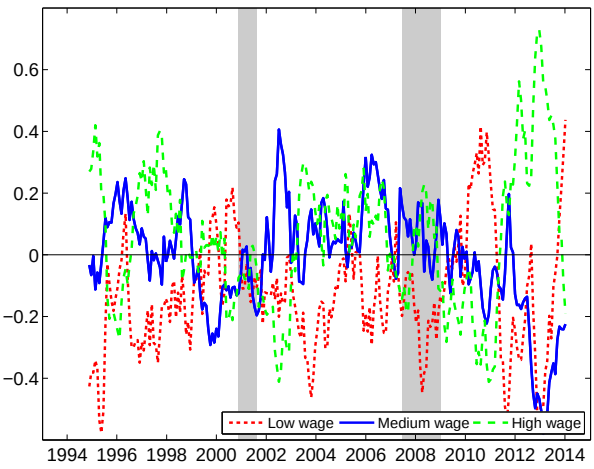


(a) Net job-to-job flows

(b) Net Non-Employment Flows



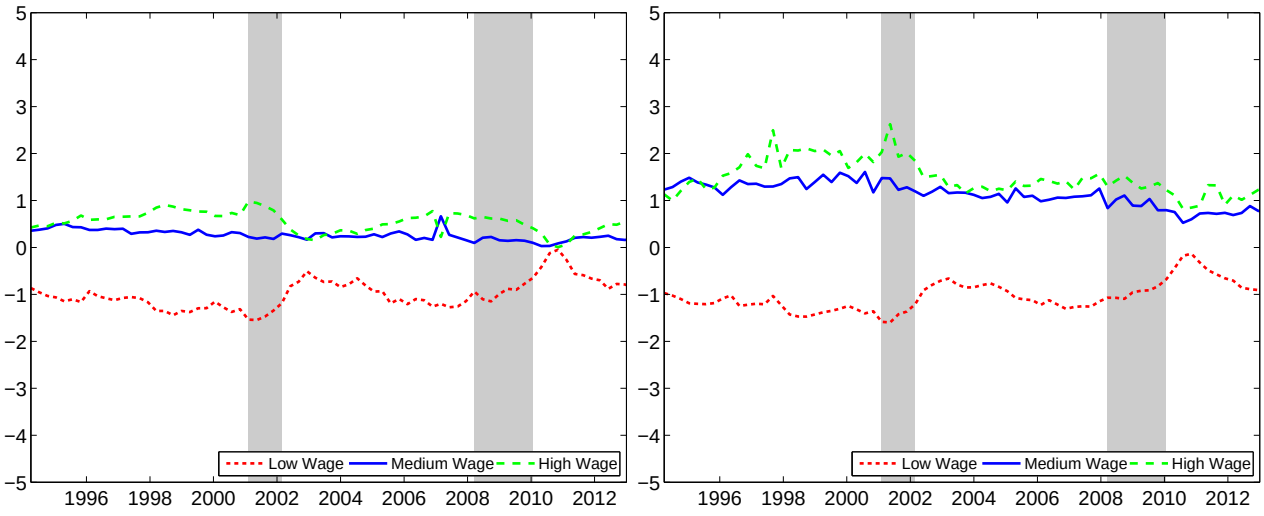
(c) Net unemployment flows



(d) Net Inactivity Flows

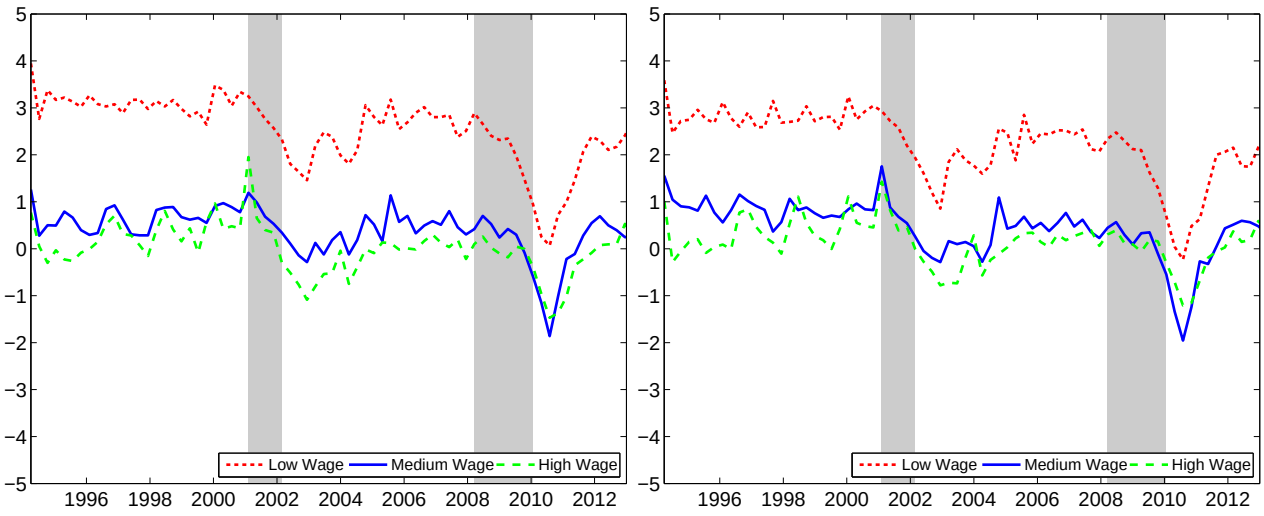
Figure 9: Net Flows (as % of employment in each wage category)

Panel (b) shows the net nonemployment flows for each of these CPS occupation wage terciles. Although the lowest wage tercile loses workers on net through job-to-job transitions, it gains workers through nonemployment transitions in nearly all months except those during and immediately following the 2007-2009 recession, as these gains appear to be quite procyclical. There is more volatility to the net changes through nonemployment, where the low wage terciles gain workers through nonemployment at a magnitude constituting 0.8% of its employment. Middle wage and high wage occupations, that tend to gain workers through job-to-job transitions, lose workers through these nonemployment transitions, and



(a) Employer Wage (b) Industry Wage

Figure 10: Net J2J Flows, by Employer Wage and Industry Wage



(a) Employer Wage (b) Industry Wage

Figure 11: Net Nonemp Flows, by Employer Wage and Industry Wage

these losses are countercyclical, and, again, more volatile than the job-to-job transitions series.

The remaining panels (c) and (d) decompose these net changes from nonemployment into the fraction that comes from unemployment and not in the labor force, respectively. The gains from unemployment are much less noisy than the gains from those not in the labor force. The net gains of workers from nonemployment seen among the low-wage occupations are clearly driven by the net hires to and from unemployment: low wage occupations tend to lose workers to not in the labor force. Likewise, the net losses from nonemployment appear concentrated among the unemployed. Furthermore, most of the cyclicality evidenced in the net changes through nonemployment is apparent in the net changes associated with unemployment: the large loss to nonemployment in the wake of the 2007-2009 recession is clearly associated with workers moving from each tercile into unemployment. One additional noteworthy item is that movements from not in the labor force to middle and high wage occupations appears to be procyclical, and the temporary deviations from net loss through nonemployment to net gain for these two terciles are clearly associated with these transitions, whereas net moves from unemployment are consistently negative for the middle and high tercile.

We also explore the relative roles of job-to-job vs. nonemployment transitions in the LEHD data. First, we present the net changes through job-to-job transitions by firm wage and industry wage in Figure 10. The LEHD data are quarterly, and so the net changes are greater in magnitude than in the monthly CPS data. Low wage businesses lose workers on net through job-to-job transitions, while medium and high wage employers gain such workers. Especially for the low and high wage terciles, these net reallocation rates appear procyclical, with steep contractions in magnitude in the quarters of and following the 2001 and 2007-2009 recessions. Overall, job-to-job transitions reallocate on the order of 2% of workers from lower wage to high wage jobs every quarter.

The net changes through nonemployment are shown in Figure 11. Low wage firms and industries tend to gain workers on net through nonemployment hiring. Middle and high wage firms and industries gain fewer and in many quarters lose workers through this

nonemployment margin. All terciles are procyclical and evidence declines in net hires through nonemployment in the 2007-2009 recession.

The evidence from the CPS and LEHD is clearly consistent with the notion of job ladders in the labor market as formalized by Burdett (1978), Jovanovic (1979), and Burdett and Mortensen (1998). The basic intuition for the job ladder is that workers without jobs are less picky about the wage offered than employed workers, who will tend to move toward jobs where they will receive a higher wage. Therefore, the low wage end of the labor market should lose a disproportionate share of its workers through poaching. By contrast, separating workers at high wage jobs should be relatively less likely to have received a better wage offer, and so should be more likely to move into nonemployment if leaving their jobs at all. This job ladder model framework, a variant of which we will propose below, is clearly consistent with the evidence we have presented by the wage associated with occupations, firms, and industries.

To quantify the relationship between the job-to-job flows, the flows into and from nonemployment, and the composition of the workforce by the terciles we have been considering up to this point, we conduct a simple accounting exercise. Specifically, we compare the total percentage change in employment in each category to the change that is identified as coming from net poaching, the change that comes from net hiring from nonemployment, and a residual. The residual represents different elements in different datasets, but includes margin error in the CPS, missing data values, and composition changes not specifically linked to the flows. Examples of this include workers who switch wage categories in the CPS but do not change employers, and firms that switch industry or the average wage paid to workers in the LEHD data.

The change in employment in the CPS for each occupation tercile, and the portions that can be attributed to the different components, are shown in Table 1. Overall, as suggested in the figures concerning the occupation composition of the workforce, there was substantial growth in high wage jobs between 1994 and 2000, but considerably less in the years that followed. By contrast, low wage and middle wage jobs grew moderately during the 1990s, and exhibit greater increases from 2000 to 2007 than from 1994 to 2000. All three

Table 1: CPS Occupation Wage Tercile Changes: Job-to-Job vs. Nonemployment

	Change in Employment	**Change from Job-to-Job**	**Change from Nonemp.**	**Residual**
Low Wage				
1994-2000	9.2	−11.9	33.4	−11.4
2000-2007	11.6	−9.4	11.9	2.4
2007-2014	4.3	−5.0	4.1	5.2
Medium Wage				
1994-2000	8.2	5.5	−15.4	16.6
2000-2007	9.0	5.8	−10.2	13.4
2007-2014	−4.4	0.9	−18.6	13.3
High Wage				
1994-2000	22.0	6.6	−2.5	18.3
2000-2007	8.3	3.3	−12.7	17.7
2007-2014	0.3	3.8	−5.6	2.2

Notes: All values are cumulative percentage changes for the years under consideration.

occupation categories exhibit declines in the wage of the 2007-2009 recession, with declines apparent in the medium wage occupation, a fact consistent with Cortes et al. (2014).

At this point, we can take stock of how the net reallocation through poaching and nonemployment hiring is related to the change in the shares. In the years 1994-2000, many workers were entering low wage occupations from nonemployment, and a brisk job ladder brought them to medium and high wage occupations. Such flows are considerably lower during the year 2000. Net hiring from nonemployment into low wage occupations slows considerably, from 33.4% to 11.9% for 1994-2000 vs. 2000-2007, while the net change through poaching, which takes workers out of low wage occupations declines but by less, from -11.9% to -9.4%. Medium and high wage occupations gain jobs on net through poaching and lose them through nonemployment. Medium wage occupations remain relatively stable from the years 1994-2000 and 2000-2007 in both poaching and nonemployment, but high wage occupations have a decline in the gains made through poaching and increasingly lose jobs to nonemployment.

Similar evidence by firm wage and industry wage in the LEHD data is shown in Table 2. As in the CPS occupations, the high wage firms and industries gain many more jobs

during the 1990s than in the 2000s, although the stark decline in the growth of high wage jobs present in the high wage CPS occupations is seen more in the LEHD data by firm wage than by industry wage. All LEHD terciles except low wage firms lose employment from the years 1994-2000 to 2006-2012. Low wage firms do not increase employment during the 1990s but increase employment consistently thereafter. Again, the middle wage jobs by firm wage or industry wage fare the worst in the recession years 2007-2009, with declines of 7.9% in middle wage firms and 8.5% in middle wage industries, which is qualitatively similar but larger in magnitude than the 4.4% decline in the CPS medium wage occupations.

The net hiring from nonemployment and poaching are also qualitatively similar in the LEHD categories to the CPS occupation terciles, but are larger in magnitude, with the strongest changes coming from the firm wage division. Low wage firms and industries lose jobs through poaching and gain them through nonemployment. Both the changes through nonemployment and the changes through poaching lessen from the 1994-2000 time period to the 2000-2007 period.

This simple framework provides a powerful tool for analyzing flows that we will explore further in future versions of this paper. For example, one can decompose the decline of the gains in firms through the wage into the portion that comes from poaching, that which comes from nonemployment, and that which comes from the residual. In the case of these high wage firms, whose employment grew by 35.5% from 1994-2000 but only by 8.2% from 2000-2007 (a decline of 27.3%), 16.2% (16.6%-12.2%, divided by 27.3%) comes from poaching, 38.8% comes from nonemployment, and 45.0% from the residual.

2.4 Labor Force Participation

Finally, we note that the labor force participation rate in the U.S. peaked in the year 2000, and declines in the recessions that follow, a pattern that mimics the declining job-to-job transition rate. This is shown for the years 1976-2015 in Figure 12, which contains data from the BLS seasonally adjusted labor force participation rate for individuals age 16 and over. The labor force participation rate exhibits a clear decline in the 2001 downturn,

Table 2: LEHD Firm Wage and Industry Wage Tercile Changes: Job-to-Job vs. Nonemployment

	Change in Employment	**Change from Job-to-Job**	**Change from Nonemp.**	**Residual**
		By Firm Wage		
Low Wage				
1994-2000	−0.1	−29.2	77.9	−48.8
2000-2007	7.5	−25.0	61.7	−29.2
2007-2012	7.6	−20.2	50.1	−22.3
Medium Wage				
1994-2000	9.9	8.9	16.1	−15.2
2000-2007	−1.1	6.3	9.1	−16.5
2007-2012	−7.9	4.6	3.2	−15.7
High Wage				
1994-2000	35.5	16.6	6.4	12.5
2000-2007	8.2	12.2	−4.2	0.2
2007-2012	−0.5	11.5	−4.4	−7.6
		By Industry Wage		
Low Wage				
1994-2000	18.4	−30.9	70.6	−21.3
2000-2007	7.6	−26.0	52.5	−18.8
2007-2012	5.2	−20.8	43.2	−17.2
Medium Wage				
1994-2000	15.2	10.3	21.5	−16.6
2000-2007	3.0	8.5	8.2	−13.8
2007-2012	−8.5	6.0	1.7	−16.2
High Wage				
1994-2000	12.3	15.3	8.6	−11.6
2000-2007	3.5	13.2	−0.3	−9.3
2007-2012	0.7	12.3	−0.2	−11.4

Notes: All values are cumulative percentage changes for the years under consideration.

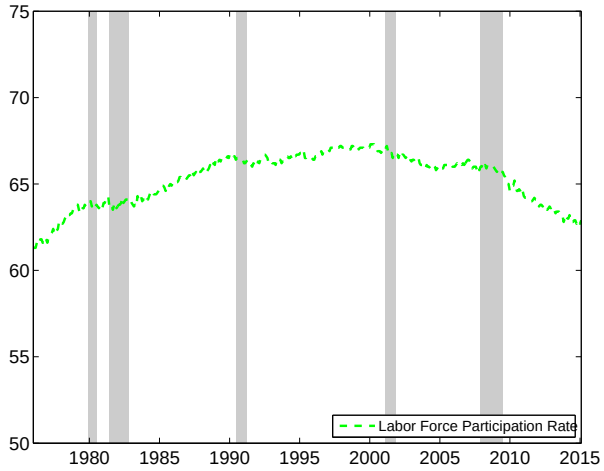


Figure 12: Labor Force Participation Rate, Age 16+

having previously peaked at 67.3% in 2000 to 65.8% 2004, and it only recovered to 66.4% by December of 2006, at which time it declined to 62.8% in 2013, and was measured at 62.9% in January of 2015, the most recent data available at the time of this writing. Although factors such as the aging of the U.S. workforce explain a substantial amount of this decline, for example, Aaronson et al. (2014) suggest that half of the decline in labor force participation from its peak can be explained by aging, there is an additional component that affects all subdivisions of the workforce. As with the declines in the job-to-job flow rates, it is difficult to describe the changes in the labor force participation rate as purely "cyclical," the declines in employment after the year 2000 are concentrated in the years immediately following recessions, from which employment recovers much slower than in previous recessions.

3 Model

In this section, we develop a model to qualitatively understand the link between changes in labor productivity and changes in employment shares and how they affect job-to-job transitions. Specifically, we consider a random search model where firms are ex-ante heterogeneous in their labor productivity and workers can participate in on-the-job search. Firms can counter outside wage offers from poaching firms through the wage setting procedure of Postel-Vinay and Robin (2002).

3.1 The Environment

The economy is populated by two types of agents, workers and firms. All agents are risk-neutral, infinitely-lived, and discount future payoffs at rate $r > 0$. Time is discrete and there is no idiosyncratic or aggregate uncertainty.

Workers There is a continuum of homogeneous workers, who seek to maximize the discounted stream of expected lifetime income. These workers can either be unemployed and receive unemployment benefits b, or they can be matched to a firm and producing and receiving a wage w. Both unemployed and employed workers participate in search, but with different degrees of search efforts, s_0 and s_1, respectively.

Firms There is also a continuum of firms that are heterogeneous along a single dimension, indexed by $y \in [0, 1]$. These firms have access to a production technology $f(y)$ and seek to maximize the discounted stream of expected profits. Each period, firms engage in recruiting new workers by posting vacancies $v(y)$ at a convex flow recruiting cost $c(v(y))$. In addition to recruiting new workers, firms can counter offers received by their existing employees from competing firms.

Matches Let $W(w, y)$ be the value to a worker of being employed at firm y, being paid wage w, and let B denote the value of unemployment. Let $\Pi(w, y)$ denote the expected profit to a firm y employing a worker at wage w. Assuming free entry so that the value of a vacancy to a firm is zero, total surplus of a match is defined as follows:

$$S(w, y) = W(w, y) - B + \Pi(w, y) \tag{1}$$

Under the assumption of transferable utility, the wage does not affect the size of the surplus: $S(w, y) = S(y)$. For a worker and firm pair, a match is feasible and sustainable if the surplus is nonnegative, $S(y) \geq 0$.

Matches are destroyed exogenously with probability δ. Aggregate number of meetings

between vacancies and searching workers is determined through a standard matching function $M(L, V)$, where L is the total amount of effective job searchers and V is the total number of vacancies.

3.2 Timing

Within a period t, we will assume the following intra-period timing protocol:

1. *Production*: Unemployed workers receive unemployment benefits and employed workers produce and receive their wage payment.
2. *Separation*: Current matches dissolve at an exogenously rate δ.
3. *Matching*: All workers participate in search. In particular, we assume that workers who have just separated from their employers *can* search within the same period as unemployed workers.

3.3 Wage Determination

Wage Negotiation with Unemployed Workers When an unemployed worker matches with a vacancy, the firm offers wage $w = \phi_0(y)$ such that the worker is made indifferent between taking the job and being unemployed:

$$W(w, y) - B = 0 \tag{2}$$

In other words, for new matches, the firm receives all of the surplus from the match and the worker is made indifferent between employment and unemployment.

Wage Renegotiation: Poaching Workers are allowed to search while employed and the incumbent employer can counter outside offers. Suppose a worker, currently employed at firm y, meets another potential employer y'. Depending on the total surplus this new match can generate, the worker may have the opportunity to renegotiate his wage. In particular, there are three cases that need to be considered.

1. First, if the surplus of this new job is greater than his current job, $S(y') > S(y)$, the worker moves to the poaching firm and is paid a wage $w' = \phi_1(y', y) = \phi_1(y, y)$ such that

$$W(w', y') - B = S(y) \tag{3}$$

   In other words, he is paid the wage that would make him indifferent between staying with his current employer y or moving to the new firm y'.

2. Second, if the surplus at the poaching firm is less than the surplus at his current employer but greater than the worker's value of the current job, $W(w, y) - B \leq S(y') \leq S^i(y)$, the worker will use the outside offer to renegotiate his wage up to $w' = \phi_1(y, y') = \phi_1(y', y')$ such that

$$W(w', y) - B = S(y') \tag{4}$$

   Once again, the worker is paid a wage that makes him indifferent between quitting and staying. In this case, the wage is set such that the worker receives the total surplus of the poaching firm.

3. Lastly, if the surplus at the poaching firm is less than the worker's value at the current job, $S(y') < W(w, y) - B$, the worker does not have a credible threat to leave, so the wage does not change.

Notice that in both cases (1) and (2), when an employed worker acquires an outside offer that gives him a credible threat to leave, he matches with the higher surplus firm and uses the lower surplus job as the outside option when bargaining. This means that he will receive the entire surplus from the lower surplus match, making him indifferent between the two job offers.

3.4 Matching Technology

Let u denote the measure of unemployed workers, and let $n(y)$ denote the measure of workers employed at firm y.

Job Separations After production, separations are realized. Therefore, a fraction δ of the current matches are exogenously destroyed, and the measure of unemployed and employed workers are updated. The stock of unemployed workers is:

$$u + \int \delta n(y) \mathrm{d}y$$

The stock of employed workers at firm y is:

$$(1 - \delta) n(y)$$

Meeting technology Given these updated stocks, workers search and firms post vacancies. All workers participate in search with effort varying across employment states. Specifically, s_0 and s_1 are the relative search efforts of unemployed and employed workers, respectively. Together they produce effective search effort L.

$$L = s_0 \left(u + \int \delta n(y) \mathrm{d}y \right) + s_1 \int (1 - \delta) n(y) \mathrm{d}y \tag{5}$$

Let V denote the aggregate number of vacancies posted by the firms.

$$V = \int v(y) \mathrm{d}y \tag{6}$$

The aggregate number of meetings between vacancies and searching workers is determined through a standard aggregate matching function $M(\cdot, \cdot)$ that takes the total number of vacancies and the total amount of effective job searchers as inputs. Following the literature, assume that the aggregate meeting function is Cobb-Douglas:

$$M = M(L, V) = \min\{\omega L^{\gamma} V^{1-\gamma}, L, V\} \tag{7}$$

where $\omega > 0$ and $\gamma \in [0, 1]$.

Note that while $M(\cdot, \cdot)$ governs the aggregate number of meetings, whether or not a meeting translates into a match will be determined by the decisions of workers and firms.

Therefore, define $\lambda_0 = \frac{s_0 M}{L}$ as the probability an unemployed worker contacts a vacancy and $\lambda_1 = \frac{s_1 M}{L}$ as the probability an employed worker contacts a vacancy. And let $q = \frac{M}{V}$ be the probability per unit of recruiting effort $v(y)$ that a firm contacts a worker. The effective probabilities are:

– Unemployed worker meeting a vacancy from firm y

$$\left[\frac{s_0 M(N,V)}{N}\right]\left[\frac{v(y)}{V}\right] = \lambda_0 \frac{v(y)}{V} \tag{8}$$

– Employed worker meeting a vacancy from firm y

$$\left[\frac{s_1 M(N,V)}{N}\right]\left[\frac{v(y)}{V}\right] = \lambda_1 \frac{v(y)}{V} \tag{9}$$

3.5 Value Functions

Value of Unemployment Let B be the value of unemployment for a worker, and let $W(w,y)$ be the value of employment for a worker matched to firm y, being paid a wage w. Then, the value of unemployment B solves the following Bellman equation:

$$B = b + \frac{1}{1+r}\int \left\{ \left(1 - \lambda_0 \frac{v(y)}{V}\right) B + \lambda_0 \frac{v(y)}{V} \max\left[W(\phi_0(y), y), B\right] \right\} \mathrm{d}y \tag{10}$$

An unemployed worker receives unemployment benefit b and the expected discounted value of his payoff tomorrow. In the next period, the worker can either meet a suitable vacancy and choose whether or not to match with the firm or he can not find a job opening and remains unemployed. The first term in the expectation captures the situation where the worker does not meet a suitable vacancy and continues to be unemployed in the next period. The second term captures the situation where the worker meets a vacancy from some firm y and must choose whether to accept or reject this offer. If the match is productive, the worker enters and employment contract with firm y.

Recall that when a worker is hired from unemployment, the firm receives the entire surplus of the new match. This means that the worker is paid a wage $w = \phi_0(y)$ such that

$W(\phi_0(y), y) - B = 0$. Using this relationship, the above equation simplifies to:

$$\begin{aligned} B &= b + \left(\frac{1}{1+r}\right) B \\ B &= \left(\frac{1+r}{r}\right) b \end{aligned} \tag{11}$$

Value of Employment The value of employment $W(w, y)$ for a worker employed by a firm of type y, paid wage w satisfies the following Bellman equation:

$$\begin{aligned} W(w,y) = w + \frac{1}{1+r}\Bigg\{ \delta B + (1-\delta)\Bigg[&\int_{\{y':S(y')>S(y)\}} \lambda_1 \frac{v(y')}{V} W(\phi_1(y',y),y')\mathrm{d}y' \\ &+ \int_{\{y':S(y)\geq S(y')\geq W(w,y)-B\}} \lambda_1 \frac{v(y')}{V} W(\phi_1(y,y'),y)\mathrm{d}y' \\ &+ \left(1 - \int_{\{y':S(y')\geq W(w,y)-B\}} \lambda_1 \frac{v(y')}{V}\mathrm{d}y'\right) W(w,y)\Bigg]\Bigg\} \end{aligned}$$

In a period, a worker employed at firm y is paid his wage and the expected discounted value of his payoff in the next period. The first term is the case where the match exogenously dissolves and the worker enters unemployment. If the match continues, then the worker can receive an outside offer that induces a wage change. In particular, he can either be poached away by a competing firm or renegotiate his wage at his current firm because his threat to quit is now credible. In the last term, the worker does not receive a vacancy that will induce a wage change so he just simply continues with his current match.

Subtracting B from both sides, the Bellman equation for the value of employment simplifies to:

$$\begin{aligned} W(w,y) - B = w - b + \frac{1-\delta}{1+r}\Bigg\{ &\int_{\{y':S(y')>S(y)\}} \lambda_1 \frac{v(y')}{V} S(y)\mathrm{d}y' \\ &+ \int_{\{y':S(y)\geq S(y')\geq W(w,y)-B\}} \lambda_1 \frac{v(y')}{V} S(y')\mathrm{d}y' \\ &+ \left(1 - \int_{\{y':S(y')\geq W(w,y)-B\}} \lambda_1 \frac{v(y')}{V}\mathrm{d}y'\right)[W(w,y) - B]\Bigg\} \end{aligned} \tag{12}$$

Value of a Filled Job Assuming that the firm receives no value from posting a vacancy, the value of a filled job $\Pi(w, y)$ at firm y, employing a worker at wage w satisfies:

$$\begin{aligned}\Pi(w,y) = f(y) - w + \frac{1}{1+r}\Bigg\{\delta \cdot 0 + (1-\delta)\Bigg[&\int_{\{y':S(y')>S(y)\}} \lambda_1 \frac{v(y')}{V} \cdot 0 \mathrm{d}y' \\ &+ \int_{\{y':S(y)\geq S(y')\geq W(w,y)-B\}} \lambda_1 \frac{v(y')}{V} \Pi(\phi_1(y,y'),y) \mathrm{d}y' \\ &+ \left(1 - \int_{\{y':S(y')\geq W(w,y)-B\}} \lambda_1 \frac{v(y')}{V} \mathrm{d}y'\right) \Pi(w,y)\Bigg]\Bigg\}\end{aligned}$$

In a period, the firm receives the profits from the match with a worker: the output produced from the match net the wage paid to the worker. In the next period, the match could dissolve because of exogenous separation, as captured in the first term or the match can continue. If the match survives, then one of the following three situations could occur. First, the worker could receive an outside offer such that he is poached away by a competing firm. In this case, the match at firm y dissolves and the firm receives nothing. Second, the worker could receive an outside offer such that firm y must increase the worker's wage to convince him to stay in the match. Third, the worker does not meet a vacancy that can induce a wage change so the match continues unchanged.

Simplifying the above equation gives us:

$$\begin{aligned}\Pi(w,y) = f(y) - w + \frac{1-\delta}{1+r}\Bigg\{&\int_{\{y':S(y)\geq S(y')\geq W(w,y)-B\}} \lambda_1 \frac{v(y')}{V} \left[S(y) - S(y')\right] \mathrm{d}y' \\ &+ \left(1 - \int_{\{y':S(y')\geq W(w,y)-B\}} \lambda_1 \frac{v(y')}{V} \mathrm{d}y'\right) \Pi(w,y)\Bigg\}\end{aligned} \tag{13}$$

Total Surplus Combining the above equations (12) and (13) results in the following equation for total surplus:

$$\begin{aligned}S(y) &= W(w,y) - B + \Pi(w,y) \\ &= f(y) - b + \left(\frac{1-\delta}{1+r}\right) S(y)\end{aligned}$$

Thus, given a worker and a firm y, we can already deduce the optimal behavior of match formation:

$$S(y) = \left(\frac{1+r}{r+\delta}\right)[f(y) - b] \tag{14}$$

3.6 Vacancy Posting

Since vacancies do not have a continuation value, as in they only last one period, the firm's vacancy posting problem becomes the following:

$$\max_{v(y)} \Bigg\{ -c(v(y)) + qv(y) \Bigg(\frac{\lambda_0 \left(u + \int \delta n(y) \mathrm{d}y\right)}{M} \max\{S(y), 0\} + \int \frac{(1-\delta)\lambda_1 n(y')}{M} \max\{\Pi(\phi_1(y, y'), y), 0\} \mathrm{d}y' \Bigg) \Bigg\}$$

where $c(v(y))$ is the convex cost the firm must pay to post vacancies, with $c(0) \geq 0$, $c'(\cdot) > 0$, $c'(0) = 0$, and $c''(\cdot) > 0$.

Recall that if a firm hires a worker from unemployment, then the firm receives the entire surplus. However, if a firm manages to poach an already employed worker, then the worker uses his previous job as an outside option and receives a wage such that he receives the total surplus of his previous job. Thus, the above problem simplifies to:

$$\max_{v(y)} \Bigg\{ -c(v(y)) + qv(y) \Bigg(\frac{\lambda_0 \left(u + \int \delta n(y) \mathrm{d}y\right)}{M} \max\{S(y), 0\} + \int \frac{(1-\delta)\lambda_1 n(y')}{M} \max\{S(y) - S(y'), 0\} \mathrm{d}y' \Bigg) \Bigg\}$$

Define $J(y)$ as the expected value of a new match:

$$J(y) = \frac{\lambda_0 \left(u + \int \delta n(y) \mathrm{d}y\right)}{M} \max\{S(y), 0\} + \int \frac{(1-\delta)\lambda_1 n(y')}{M} \max\{S(y) - S(y'), 0\} \mathrm{d}y' \tag{15}$$

The firm will post vacancies $v(y)$ up to the point where the marginal vacancy makes zero

expected profit. In other words, the optimal number of vacancies $v(y)$ firm y posts solves:

$$c'(v(y)) = qJ(y) \tag{16}$$

Assume that the flow cost of posting vacancies is assumed to have the following functional form:

$$c(v(y)) = \frac{c_0 v(y)^{1+c_1}}{1+c_1} \tag{17}$$

with $c_0 > 0$ and $c_1 > 0$. Thus, we can rewrite the first order condition as:

$$c_0 v(y)^{c_1} = qJ(y) \tag{18}$$

4 Steady State Equilibrium

We will analyze the steady state equilibrium, where flows into and out of unemployment and employment at a firm y are equalized.

Law of Motion for Unemployment The flows into unemployment consists of workers who have separated from their employers and could not find a job within the period:

$$\delta \left(1 - \int \lambda_0 \frac{v(y)}{V} \mathrm{d}y\right) \left(\int n(y) \mathrm{d}y\right) = \delta \left(1 - \lambda_0\right) \left(\int n(y) \mathrm{d}y\right)$$

The flows out of unemployment are:

$$\left(\int \lambda_0 \frac{v(y)}{V} \mathrm{d}y\right) u = \lambda_0 u$$

In a steady state equilibrium, the flows into and out of unemployment must be equalized. Without loss of generality, we normalize the measure of workers to 1: $u + \int n(y) \mathrm{d}y = 1$. Thus, we can solve for the unemployment rate:

$$u = \frac{\delta(1-\lambda_0)}{\delta(1-\lambda_0) + \lambda_0} \tag{19}$$

Law of Motion for Employment Similarly, the flows into employment at a firm y must be equal to the flows out of employment. The flows into firm y come from two sources. First, workers can move from unemployment into firm y. These consist of unemployed and recently separated individuals who meet a vacancy posted by firm y. Second, firm y can also poach workers from lower productivity firms. Thus, the flows into firm y are:

– flows into firm y from unemployment:

$$\lambda_0 \frac{v(y)}{V} \left(u + \int \delta n(y) \mathrm{d}y \right)$$

– flows into firm y from poaching:

$$\int (1-\delta)\lambda_1 \frac{v(y)}{V} \mathbb{1}\left\{ S(y) > S(y') \right\} n(y') \mathrm{d}y'$$

The flow of workers out of firm y also consists of two parts: workers moving to unemployment and workers poached away by other firms.

– flows out of firm y to unemployment:

$$\delta n(y)$$

– flows out of firm y from poaching by other firms:

$$\int (1-\delta)\lambda_1 \frac{v(y')}{V} \mathbb{1}\left\{ S(y') > S(y) \right\} n(y) \mathrm{d}y'$$

Equating the inflows and outflows gives us the following relationship for steady employment at firm y:

$$\begin{aligned} \lambda_0 \frac{v(y)}{V} \left(u + \int \delta n(y) \mathrm{d}y \right) + \int (1-\delta)\lambda_1 \frac{v(y)}{V} \mathbb{1}\left\{ S(y) > S(y') \right\} n(y') \mathrm{d}y' \\ = \delta n(y) + \int (1-\delta)\lambda_1 \frac{v(y')}{V} \mathbb{1}\left\{ S(y') > S(y) \right\} n(y) \mathrm{d}y' \end{aligned}$$

The left-hand side of the above equation are the flows into firm y. The first term is the measure of new workers hired by firm y from unemployment. The second term is the measure of new hires from poaching. The right-hand side are the flows out of firm y. The first term is the measure of matches that are destroyed exogenously. The second term is the measure of workers that are poached away by other firms.

5 Calibration

5.1 Parameterization

We approximate the continuous heterogeneity of firms by a grid of linearly spaced points $y_1, y_2, ..., y_{N_y}$ on $[0, 1]$, where $N_y = 150$. Output from a match is assumed to be linear in labor productivity:

$$f(y) = Ay \tag{20}$$

For completeness, recall that the aggregate meeting technology is assumed to be Cobb-Douglas:

$$M = M(L, V) = \min\{\omega L^{\gamma} V^{1-\gamma}, L, V\}$$

where $\omega > 0$, $\gamma \in [0, 1]$, and L is the effective amount of worker search effort given by a weighted average of unemployed and employed worker search:

$$L = s_0 \left(u + \int \delta n(y) \mathrm{d}y \right) + s_1 \int (1 - \delta) n(y) \mathrm{d}y \tag{21}$$

where $s_0 > 0$ and $s_1 > 0$.

Finally, we assumed that the cost of posting a vacancy has the following functional form:

$$c(v(y)) = \frac{c_0 v(y)^{1+c_1}}{1 + c_1}$$

where $c_0 > 0$ and $c_1 > 0$.

From the above parameterization this results in 10 parameters that need to be calibrated:

$$\{\omega, \gamma, s_0, s_1, c_0, c_1, \delta, b, A, r\}$$

We set the elasticity of the matching function, γ, to 0.5.[12] We normalize a time period to be a quarter, and set the discount rate such that the annual discount factor is equal to 0.95. We will normalize $s_0 = 1$ and estimate the relative search effort of employed workers to unemployed workers. Finally, we will normalize average output to be equal to 1.

This leaves 7 parameters that still need to be pinned down for each subgroup we calibrate the model to. Table 3 lists the calibrated parameter values, and table 4 lists the targeted moments used for calibration.

The solid line in figure 13 presents the basic intuition behind the model. First, notice that the only viable matches in this economy are those that are able to generate positive surplus. Therefore, firms with no potential of meeting viable matches do not post any vacancies. Since flow output, and hence total surplus, is increasing in firm productivity, posted vacancies and employment are concentrated at more productive firms. Lastly, on-the-job search and the wage determination mechanism in this model imply that workers will move towards the firm with the highest surplus. This means that at higher surplus firms, a larger fraction of hires will come from poaching.

6 Decline in High Productivity Jobs

To qualitatively analyze the impact of a change in labor demand for high productivity jobs, we will compare the baseline case to a new steady state where all firms face a decline in labor productivity. However this decline differentially impacts the firms at the top of the productivity distribution with high productivity firms facing the greatest decline. Specifically, A falls to 0.5, but total surplus in the new steady state is shifted up such that the marginal firm that chooses to match with workers is the same in the baseline and in the new steady state.

[12] This is following much of the equilibrium search literature, for example, Hagedorn and Manovskii (2008), Lise, Meghir, and Robin (2013), and Lise and Robin (2013).

Table 3: Parameter Values

Matching Function	ω	0.1221
$M = \min\{\omega L^{\gamma} V^{1-\gamma}, L, V\}$	γ	0.5000
Search Intensity	s_0	1.0000
	s_1	0.0097
Exogenous Separation	δ	0.0353
Vacancy Posting Costs	c_0	0.1813
$c(v(y)) = \frac{c_0}{1+c_1} v(y)^{1+c_1}$	c_1	1.7220
Production	b	0.4316
	A	1.3679
Discount Rate	r	0.0129

Notes: γ is fixed at 0.5; r is set such that the annual discount factor is 0.95; s_0 is normalized to 1.

Table 4: Targeted Moments

Moments	**Data**	**Model**
$\mathbb{E}(U)$	0.0576	0.0533
$\mathbb{E}(U2E)$	0.4331	0.3853
$\mathbb{E}(E2U)$	0.0334	0.0353
$\mathbb{E}(J2J)$	0.0462	0.0467
$J2J_{\text{low}}$	0.2644	0.1198
$J2J_{\text{middle}}$	0.4070	0.3318
$\mathbb{E}(f(y))$	1.0000	0.9671

Notes: The average unemployment rate is calculated from data available from BLS. The average job finding and separation rates are calculated from data available from Shimer (2012). The average job-to-job transition rate is calculated from data available from Fallick and Fleischman (2004). The firms are grouped into low, middle, and high by terciles of the employment weighted distribution of jobs. $J2J_{\text{low}}$ is the fraction of job-to-job transitions from low productivity firms, and $J2J_{\text{middle}}$ is the fraction of job-to-job transitions from middle productivity firms. The last element of the table is a normalization.

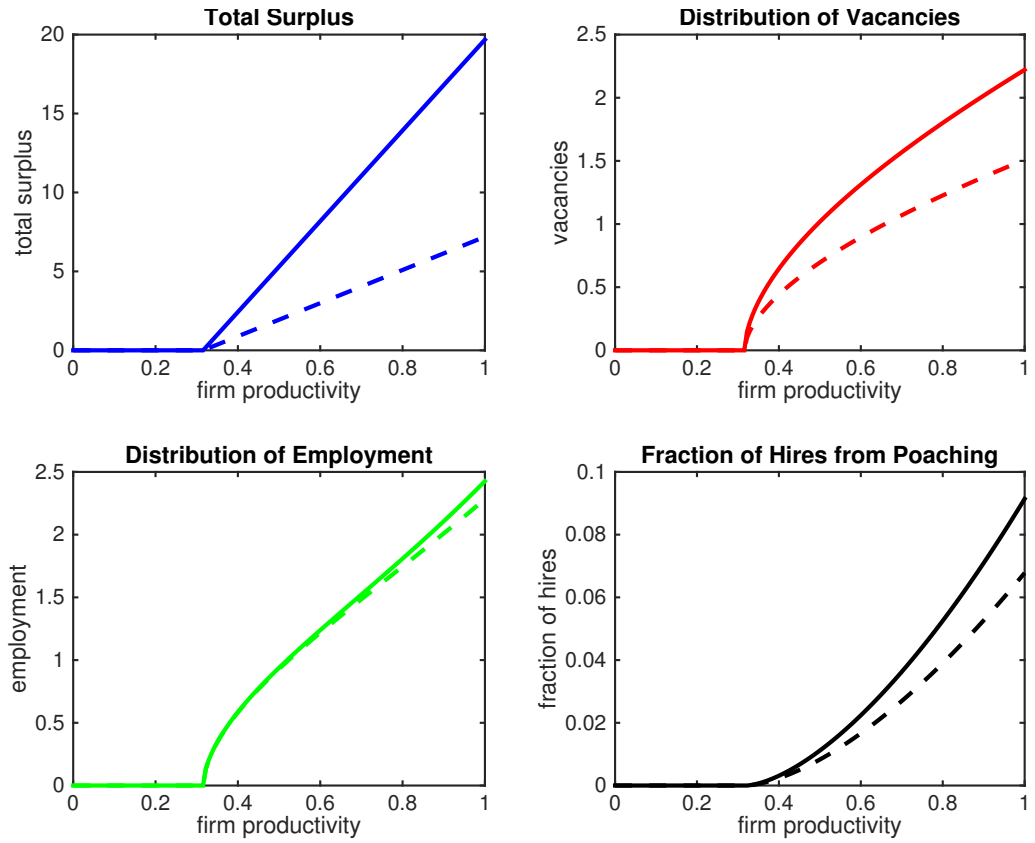


Figure 13: Steady State Equilibrium

Notes: This figure plots the total surplus function, the distribution of vacancies and employment, and the fraction of hires from poaching. The solid line represents the baseline model where the parameter values are set to those specified in Table 3. The dashed line represents the new steady state after a decline in labor productivity that leaves the marginal entrant unchanged. Specifically $A = 0.5$ and total surplus is shifted upwards.

While this decline is excessively large and will have large implications for the wages workers will earn in the model, this does not particularly affect flows since movements of workers to and from unemployment and between firms is determined by the sign and monotonicity of the surplus function. This large decline in productivity will have a large effect on the measure of vacancies posted by firms, which is the channel the qualitative exercise is meant to highlight.

Figure 13 compares the new steady state distributions to the baseline, and table 5 presents statistics on the baseline and new steady state. Notice in figure 13 that the decline in total surplus in the new steady state increases with firm labor productivity y. This translates into higher productivity firms seeing the largest declines in vacancy posting and

Table 5: Decline in Labor Productivity

	Baseline	**Low Productivity**
unemployment rate	0.0533	0.0838
job-to-job transition rate	0.0467	0.0345

	Low	**Middle**	**High**
Δ *employment shares*	0.00644	0.00002	-0.00646
Δ *vacancy posting shares*	0.00067	-0.00003	-0.00064
Δ *fraction of hires from poaching*	-0.00455	-0.01262	-0.01998
Δ *fraction of separations due to poaching*	-0.02000	-0.01237	-0.00456

Notes: In the low productivity steady state, $A = 0.5$. Further, surplus is shifted upwards such that the marginal firm that enters the market is the same in the baseline and the new steady state. The firms are grouped into low, middle, and high by terciles of the employment weighted distribution of jobs in the baseline steady state. These cutoffs are maintained in the new steady state.

employment when compared to the baseline. In particular, if we group the firms in the baseline steady state equilibrium into low, middle, and high by terciles of the employment weighted distribution of jobs, we can compute the change in key statistics of interest between the two steady states. Specifically, table 5 highlights an increase in the share of employment attributed to low productivity jobs with a nearly symmetric decrease in the share of employment at high productivity jobs. This is driven by the differential decline in vacancy postings that is concentrated among high productivity firms. With fewer vacancies being posted by high productivity firms, we see a decline in job-to-job transitions rates throughout the entire distribution of firms. In particular, low productivity firms are losing fewer workers to poaching as hiring declines at high productivity firms.

7 Conclusion

The year 2000 marks a turning point in the U.S. labor market. We have explored three key ways in which this decline is evident: the failure of the economy to produce as many high paying jobs as in previous decades, the lower rate of employer-to-employer transitions, and

an overall decline in the labor force participation rates. These declines were observed to be the largest at the lower ends of the pay distribution. A model was proposed to account for these phenomena.

The most natural explanation for this decline is that there was a shift in the relative demand for different types of work in the U.S. While some of these phenomena might follow naturally from the cyclical Burdett and Mortensen (1998) model, we believe that other issues may be of first-order importance. First, as Autor and Dorn (2013) argue, the U.S. economy was impacted by globalization increasingly during the 1990s and through the subsequent decade, and the relatively high pay manufacturing jobs declined. Furthermore, as argued by Beaudry, Green, and Sand (2013), the demand for higher skill jobs brought about by the computer and internet revolution had largely run its course in the U.S. labor market.

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