Job Ladders and Growth in Earnings, Hours, and Wages*

Joyce K. Hahn† Henry R. Hyatt‡ Hubert P. Janicki§

December 2017

Abstract

We consider the role of employment transitions on the evolution of earnings, hours, and wages in the U.S. economy from 1996 to 2015 using matched employer-employee data. We highlight the role of particular employer-employee matches whose "match effects" are estimated using a fixed effects regression. We find little evidence of excess wage cyclicality for new hires relative to job stayers that are not accounted for by these cyclical match effects. A formal accounting exercise allows us to measure the role of the cyclical job ladder in the evolution of average earnings, hours, and wages. Workers entering employment from nonemployment have low earnings, hours and wages and these workers move into jobs with higher values of each through employer-to-employer transitions. More frequent movements into employment from nonemployment during expansions tends to lower each average, while at the same time more frequent employer-to-employer transitions provide an offsetting effect. We show that the effects of nonemployment and employer-to-employer transitions are driven by our estimated employer-employee match effects.

*We thank Mary Daly, Kyle Herkenhoff, Bart Hobijn, Marianna Kudlyak, André Kurmann, Erika McEntarfer, Kevin McKinney, Benjamin Pugsley, Benjamin Schoefer, James Spletzer, Stephen Tibbets, Lars Vilhuber, Alexandria Zhang, and participants in the 2016 NBER Summer Institute CRIW workshop, Fall 2016 Midwest Macro Conference, 2017 American Economic Association Conference, 2017 LEHD Summer Workshop, and U.S. Census Bureau Center for Economic Studies seminar for helpful comments and suggestions. Opinions and conclusions expressed in this paper are those of the authors alone and do not necessarily represent the views of the U.S. Census Bureau. All results have been reviewed to ensure no confidential data are disclosed.

†Center for Economic Studies, U.S. Census Bureau. E-mail: joyce.key.hahn@census.gov

‡Center for Economic Studies, U.S. Census Bureau. E-mail: henry.r.hyatt@census.gov

§Center for Economic Studies, U.S. Census Bureau. E-mail: hubert.p.janicki@census.gov

1 Introduction

Over the course of their careers, workers often change jobs. These voluntary quits lead to jobs with higher earnings, improved benefits, and longer tenure, and move at a pace that is procyclical, rising during expansions and falling sharply during recessions.[1] Despite a growing body of evidence that the job ladder is important for worker outcomes, there has not yet been an attempt to measure how cyclical moves from worse to better job matches affect earnings, hours, and wages in the aggregate.

In this paper, we estimate the earnings, hours, and wages associated with particular employer-employee matches and show how these match effects contribute to aggregate growth in the average of each. We then examine how these contributions vary with the unemployment rate from 1996 to 2015. To do so, we take universe-level, matched employer-employee data and use a simple linear regression framework to estimate the relationship between earnings, hours, and wages and the unemployment rate while controlling for time-invariant effects associated with particular employer-employee matches. We then propose a decomposition method that differentiates changes in average earnings, hours, and wages accounted for by workers who change employers, those who stay at the same employer, and those who transition into and out of employment from nonemployment. We distinguish between the contemporaneous effect of the unemployment rate on earnings, hours, and wages and its longer lasting effects via the matches that form by extending this decomposition to account for components estimated in the regression model.

We find job match effects matter in the evolution of earnings, hours, and wages. New hires from nonemployment have low match effects relative to incumbents, and workers obtain higher match effects via employer-to-employer transitions. The pace of this process is procyclical and a simple extension of the Bils (1985) framework to control for match effects produces substantially different results than conventional specifications that control for person-level fixed effects or use a first differenced framework. In fact, much of the measured excess cyclicality of new hire earnings documented in previous studies is accounted for by cyclical match effects, confirming the predictions of recent studies and the previous findings of Gertler and Trigari (2009). A paper by Hagedorn and Manovskii (2013) documents an empirical relationship between wages and cumulative labor market tightness over the life of a particular employer-employee match. The authors conclude that since workers move from worse to better matches more quickly in better labor markets, much of the measured cyclical relationship between unemployment and wages is driven by match quality. A similar argument is

[1] Barlevy (2002) called the lower likelihood of moving to improved job matches during recessions a "sullying effect" and recent evidence in Cairo, Hyatt, and Zhao (2016), Haltiwanger et al. (2017), and Crane, Hyatt, and Murray (2017) show that, during and after recessions, employment share at the low end of the job ladder where workers receive lower earnings increases.

made by Gertler, Huckfeldt, and Trigari (2016), who find employer-to-employer transitions, rather than hires from nonemployment, account for the excess cyclicality in new hire wages.[2] We also document how the importance of match effects for earnings extends to hours and wages as well. The larger impact of hours suggests incremental improvements in match effects driven by employer-to-employer transitions result in hours growth more often than wage growth.

An additional contribution of this paper is that we propose and implement an accounting method that builds on Topel and Ward (1992) and Daly and Hobijn (2016) by separating the influences of different labor market transitions and documenting the channels through which earnings, hours, and wages evolve. Following Topel and Ward (1992), we compare earnings before and after employer-to-employer transitions to measure their effects and distinguish between earnings growth that occurs while an employee works for a particular employer and earnings changes that occur when a worker switches jobs. While they only consider a set of continuously employed male workers, we propose an extension of their method that follows Daly and Hobijn (2016) by accounting for entry from and exit to nonemployment. This allows us to account for the channels through which average earnings, hours, and wages evolve over time.

Our decomposition shows most of the variation across time in average earnings, hours, and wages is associated with employer-to-employer transitions and transitions into and out of nonemployment. In particular, employer-to-employer transitions contribute to growth in average earnings, hours, and wages while net employment flows contribute to decreases. Moreover, the contribution of these transitions to the overall average is larger during expansions than recessions. The match effects associated with moving into and out of nonemployment, as well as through employer-to-employer transitions, vary with the unemployment rate. This is more pronounced for hours than wages, as most of the earnings gains associated with employer-to-employer transitions are due to changes in hours rather than wages. Our decomposition results also highlight the existence of a cyclical hours job ladder as workers leave low-hours jobs for ones that offer greater hours much more frequently than the reverse. Our finding echoes earlier work by Altonji and Paxson (1986) who highlight how frictions within job matches restrict the feasible choice of hours. An implication of this finding is that the abstraction from an hours choice on on-the-job search in the literature that follows Burdett (1978) and Jovanovic (1979) is a significant limitation. Workers are willing to take jobs without any meaningful wage changes but provide the worker with a preferred hours allocation.

This analysis provides facts that are important for understanding the sluggish growth in real wages

[2]Note that while we find different results regarding the role of nonemployment hires in wage cyclicality, the authors' proposal that cyclical match effects lead to much of the apparent excess cyclicality of new hire wages is certainly confirmed here.

and earnings that the U.S. has exhibited since the start of the new millennium and its relationship with recent changes in employment reallocation rates.[3] We document the gains to earnings, hours, and wages that come from employer-to-employer transitions. While it is well-known that employer-to-employer transitions are procyclical and dropped to historic lows following the 2007-2009 recession, our work shows this decline led to lower match effects over the life of a job spell, with necessarily long lived consequences. We also find the earnings changes associated with increased job match quality have an important role to play in determining earnings growth and offer a couple of observations on the causes and consequences of changes in employment reallocation rates that have generally been ignored in the literature. Specifically, we find the nonemployment margin has an offsetting effect on earnings growth that is roughly equal in magnitude to the earnings gains provided by more rapid movement up the job ladder.

This paper proceeds as follows. In Section 2, we describe the matched employer-employee data and how we prepare that data for analysis. In Section 3, we present evidence from a regression framework that extends Bils (1985) to include job-level match effects. In Section 4, we document how earnings, hours, and wages evolve in the U.S. over the years 1996-2015, highlighting the separate roles of match quality, observable characteristics, and the unemployment rate. A brief conclusion follows in Section 5.

2 Data

The data come from the infrastructure files maintained by the U.S. Census Bureau's Longitudinal Employer-Household Dynamics (LEHD) program and are described in Abowd et al. (2009). They consist of total quarterly earnings reported by employers to states, who in turn provide these data to the U.S. Census Bureau as part of the Local Employment Dynamics federal-state partnership.

Development of the LEHD data has allowed for the integration of job-to-job flows and their associated earnings, as defined in Hyatt et al. (2017). A job is included in the job-to-job flows universe if an individual received wage and salary compensation for that job for at least two consecutive quarters and the sum of earnings in those quarters is greater than the sum of earnings received for any other job held during the same two quarters. We call these jobs "dominant among consecutive quarter jobs". Instances when a worker changes the employer that is dominant among consecutive quarter jobs by leaving a job with one employer and starting a job with another employer in the same quarter are

[3] Previous studies such as Faberman and Justiniano (2015), Molloy et al. (2016), Hyatt and Spletzer (2016), and Hyatt and McElroy (2017) suggest a relationship between labor reallocation and worker compensation through a variety of mechanisms.

called employer-to-employer transitions. These employer-to-employer transitions exclude spurious identifier changes identified using the methodology outlined in Benedetto et al. (2007) and Abowd et al. (2009). We also identify workers who transition into and out of nonemployment and call them employment-to-nonemployment and nonemployment-to-employment flows, respectively.[4]

2.1 Data on Earnings, Hours, and Wages

As mentioned above, the LEHD infrastructure files include data on total quarterly earnings reported by employers. However, they do not include the total number of hours worked. As a result, we cannot calculate worker wages directly.[5] Moreover, we do not know if total quarterly earnings were received for work completed during the entire quarter, or simply a portion of it. To associate earnings with a job, we therefore rely on a "full quarter" earnings concept that underlies the published LEHD data; see Abowd et al. (2009), Hahn et al. (2017), and Hyatt et al. (2017). When jobs span three consecutive quarters, we assume employees worked the entire middle quarter and the total earnings from that quarter are their quarterly earnings rate. We refer to this quarterly earnings rate as "full quarter earnings."

While LEHD full quarter earnings are obtained when jobs span at least three quarters, job-to-job transitions as in Hyatt et al. (2017) are determined based on dominant among consecutive quarter jobs which span at least two quarters. While there is mostly overlap, there are instances when the latter does not have the former. Earnings are therefore attached to job-to-job flows in the following manner. For jobs that span two quarters, earnings are deemed missing. For jobs that span three quarters, we use earnings from the middle quarter. For jobs that span four quarters, we average earnings from the middle two quarters. For jobs that span more than four quarters, we average the pair of full quarter earnings closest to the quarter of interest.

This corresponds to the full quarter earnings definitions for job-to-job flows specified in Hyatt et al. (2017) and can additionally be applied to job stayers as well as transitions into and from nonemployment. Formal definitions are presented in Appendix A, but an overview is as follows. If the maximal source of earnings for worker i comes from employer j at time t, then we say $d_{ijt} = 1$,

[4] Note this means, relative to the definitions in Hyatt et al. (2017), our employer-to-employer transitions only include those that are "within-quarter" where workers receive earnings from both the old and new dominant employer in the quarter of transition. Transitions where employees separate from jobs with one employer and start jobs with another employer in the subsequent quarter, called "adjacent-quarter" job-to-job transitions, are categorized as flows into and from nonemployment since they generally include a short spell of nonemployment. However, the findings reported here are not sensitive to whether adjacent-quarter flows are categorized as employer-to-employer transitions or transitions into and from nonemployment.

[5] See Kurmann and McEntarfer (2017).

otherwise $d_{ijt} = 0$. We define transition types by comparing the dominant employer at time t, d_{ijt}, with the dominant employer at time $t-1$, d_{ijt-1}. If $d_{ijt-1} = d_{ijt} = 1$, then worker i is a job stayer and $s_{it} = 1$. If worker i has two distinct employers j and k (i.e., $j \neq k$) such that $d_{ijt-1} = 1$ and $d_{ikt} = 1$, then that worker made an employer-to-employer transition (usually a voluntary quit) from employer j to employer k and $q_{it} = 1$. Some workers are employed at time t but not at time $t-1$ and so $d_{ikt} = 1$ for some k but $d_{ijt-1} = 0\ \forall j$. Such nonemployment-to-employment transitions are denoted by $n_{it} = 1$. Likewise, some workers are employed at time $t-1$ but not at time t. For such workers transitioning from employment to nonemployment, $d_{ijt-1} = 1$ for some j but $d_{ikt} = 0\ \forall k$ and $r_{it} = 1$.

We also explore the contribution of hours and wage changes to earnings growth. Since the states in our sample do not have hours data for the entire time period, we rely on an imputation of hours to obtain an hours time series for the years 1996-2015.[6] To do so, we use data from four LEHD states that collect employer-reported data on employee hours.[7] Note that employers report *hours paid* rather than *hours worked* so the cyclicality of hours may not line up exactly with measures from household surveys such as the Current Population Survey. For a comparison of our data series to other available data on earnings, hours, and wages, see Appendix C.

2.2 Analysis Datasets

We use two analysis datasets.[8] The first uses a one percent sample of a set of four states that have data on worker hours, whenever available, from 1996 to 2015.[9] While this dataset does not rely on imputation, it is an unbalanced panel of states that over-represents more recent years due to data availability. The second dataset uses a one percent sample of a set of eleven states that have data available consistently from 1996 to 2015.[10] Although hours are mostly imputed for this dataset, it possible to present time series evidence for this set of states. All figures in this paper therefore use the eleven state dataset. It is possible that labor force composition effects bias the results for the four states relative to the country as a whole or the business cycle. This is not an issue with results for the eleven states as our hours imputation relies on a missing conditionally at random assumption that essentially reweights the observed data by the likely hours associated with workers who have a given set of observable characteristics.

[6]For details of our imputation of hours, see Appendix B.

[7]These states are Minnesota, Oregon, Rhode Island, and Washington.

[8]Basic summary statistics are available in Table D1 of Appendix D.

[9]The data use agreement under which this research was conducted places restrictions on the release of state-specific results, so results for our four states with hours data are always pooled overall states, and only regression output is shown.

[10]These states are California, Colorado, Idaho, Illinois, Kansas, Maryland, Montana, North Carolina, Oregon, Washington, and Wisconsin.

In what follows, we present evidence from both datasets whenever possible. Comparison of point estimates from both data sources should provide a range of estimates on the cyclicality of earnings, hours, and wage growth in the presence of uncertainty from labor market composition and imputation.

3 Regression with Employer-Employee Match Effects

We now introduce employer-employee match effects into a regression framework that measures how earnings, hours, and wages, generically denoted by y_{it} for worker i at time t, vary with the unemployment rate u_t. We follow the empirical specification of Bils (1985) and the literature that follows in assuming individual change in earnings, hours, or wages can be captured by the following reduced-form statistical framework:[11]

$$y_{it} = u_t(\gamma_1 + q_{it}\gamma_2 + n_{it}\gamma_3) + x_{it}\beta + \upsilon_{it}. \tag{1}$$

Parameter γ_1 captures how the dependent variable changes with the unemployment rate in a manner that is common to all workers with earnings at time t. We also include parameters that capture the extent to which workers who are newly hired in quarter t may have earnings that change differentially with the unemployment rate, as most studies that regress earnings or wages on the unemployment rate have found new hire earnings respond more to the unemployment rate. Following Haefke, Sonntag, and van Rens (2013) and Gertler, Huckfeldt, and Trigari (2016), we distinguish between new hires coming from another employer (employer-to-employer or "job-to-job" transitions) q_t or nonemployment n_t. The variables q_t and n_t are dummy variables as defined in the previous section and have marginal effects γ_2 and γ_3, respectively. Note these interaction terms mean γ_1 can be interpreted as the change specific to job-stayers while γ_2 and γ_3 are measures of excess cyclicality relative to job stayers. We also include a row vector of time-varying observable characteristics x_{it} with marginal effects given by the vector β, which include age, job tenure, and dummy variables that indicate whether a worker is newly hired from another employer or nonemployment, whether it is the last quarter of a specific employer-employee match by type of new hire, as well as time trends and seasonal effects that are specific to particular transition types. The residual υ_{it} is assumed to be additively separable into two components:

$$\upsilon_{it} = \alpha_{it} + \varepsilon_{it}, \tag{2}$$

[11] See Abraham and Haltiwanger (1995) for a survey of measurement of wage cyclicality.

ε_{it} is the i.i.d. error term and α_{it} is an effect that persists over time. We allow α_{it} to take one of two forms. In our first set of specifications, we follow Bils (1985) and most of the related literature and assume $\alpha_{it} = \alpha_i$, that is, each person has a time-invariant effect. In this case, an empirical strategy that uses either person-specific fixed effects or estimates the first difference of equation (1) will yield unbiased estimates of the parameters of interest γ_1, γ_2, and γ_3. In our second set of specifications, we allow $\alpha_{it} = \alpha_{ij}$ for any match between person i and employer j that exists at time t, a method previous explored by Gertler and Trigari (2009).

The latter set of specifications allows any particular employer-employee match to have its own effect. Under the assumption of this specification, the standard specification can be biased if the deviation of the estimated person effect from the true match effect $\hat{\alpha}_i - \alpha_{it}$ is related to the dependent variable of interest y_{it} and the unemployment rate. This would mean conventional estimates of γ_1, γ_2, and γ_3 from a person-specific fixed effects or first difference strategy are biased. There is reason to believe this is the case. First, match effects are, by assumption, related with the dependent variables of our regressions. Second, there is ample recent evidence from Haltiwanger et al. (2017) and related studies that find movement from worse to better job matches is procyclical, suggesting average match effects may be higher when the unemployment rate is lower. Nevertheless, match effects will pick up a variety of effects, including match quality and any persistent effects of labor costs as in Kudlyak (2014). In practice, we will not be able to distinguish among these mechanisms.

In Table 1, we show the main results of our regressions of earnings, hours, and wages on the unemployment rate, using person-specific and match-specific effects as well as a first difference specification. We find the earnings, hours, and wages of job stayers are procyclical across all model specifications and datasets (see rows labeled Baseline),[12] with earnings increasing by 0.8% to 1.8% and hours and wages growing 0.2% to 0.9% in response to a one percent increase in the unemployment rate. Moreover, the proportionate cyclicality of earnings is greater than either of its components. While not the focus of Bils (1985) and related literature, the finding that job stayer wages respond to the unemployment rate is consistent with previous findings, which also report results of similar magnitudes.

Cyclicality of new hires from another employer q_{it} or nonemployment n_{it} can be expressed by summing the parameter estimate for job stayers with their respective parameter estimate for excess cyclicality. All specifications indicate the earnings, hours, and wages of new hires are procyclical, but we find very different estimates across our various specifications. Most studies following Bils (1985)

[12]Because we are interested in estimating an effect associated with each employer-employee match for our later work, our results in Table 1 use all workers. However, most of the literature impose a maximum nonemployment duration when including hires from nonemployment. We do this in Appendix Table E1, and obtain results similar to thsoe in Table 1.

Table 1: Earnings, Hours, and Wages Regressed on the Unemployment Rate

	First Difference			Person-specific Fixed Effects			Match-specific Fixed Effects		
	Earnings	Hours	Wages	Earnings	Hours	Wages	Earnings	Hours	Wages
				Four States with Observed Hours Data, Unbalanced Panel of States					
Baseline	-0.009^{***}	-0.007^{***}	-0.002^{***}	-0.018^{***}	-0.009^{***}	-0.009^{***}	-0.009^{***}	-0.005^{***}	-0.004^{***}
(γ_1)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
New hire:	-0.035^{***}	-0.014^{***}	-0.020^{***}	-0.019^{***}	-0.013^{***}	-0.006^{***}	-0.003^{***}	-0.005^{***}	0.003^{***}
Emp. (γ_2)	(0.004)	(0.004)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
New hire:	-0.090^{***}	-0.060^{***}	-0.026^{***}	-0.016^{***}	-0.012^{***}	-0.003^{***}	-0.004^{***}	-0.005^{***}	0.002^{***}
Nonemp. (γ_3)	(0.004)	(0.004)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)
				Eleven States with Earnings 1996-2015, Mostly Imputed Hours and Wages					
Baseline	-0.008^{***}	-0.003^{***}	-0.006^{***}	-0.014^{***}	-0.006^{***}	-0.009^{***}	-0.009^{***}	-0.002^{***}	-0.007^{***}
(γ_1)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
New hire:	-0.062^{***}	-0.029^{***}	-0.033^{***}	-0.018^{***}	-0.012^{***}	-0.006^{***}	-0.003^{***}	-0.004^{***}	0.000
Emp. (γ_2)	(0.002)	(0.002)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
New hire:	-0.068^{***}	-0.023^{***}	-0.038^{***}	-0.013^{***}	-0.010^{***}	-0.004^{***}	-0.004^{***}	-0.004^{***}	0.000
Nonemp. (γ_3)	(0.001)	(0.002)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Regressions were run using two analysis datasets. The top set of results are from regressions using non-imputed, disaggregated earnings, hours, and wages data from four states. The bottom set of results are from regressions using non-imputed, disaggregated earnings data and mostly imputed, disaggregated hours and wages data from eleven states. Regressions were run using a first difference specification as well as with person-specific fixed effects and match-specific fixed effects. Additional control variables for all three specifications include age, job tenure, and various dummy variables that indicate whether a worker is newly hired from another employer or nonemployment, whether it is the last quarter of a specific employer-employee match by type of new hire, and specific time trends and seasonal effects that are specific to particular transition types. Earnings and wages series are presented in log 2014 constant dollars. γ_1 is the parameter estimate for the seasonally-adjusted national unemployment rate u_t, and provides the responsiveness of job stayers. γ_2 is the parameter estimate for the interaction term of the seasonally-adjusted national unemployment rate and a flag for a new hire from an employer-to-employer transition $u_t q_{it}$, i.e., the responsiveness of employer-to-employer transition hires relative to stayers. γ_3 is the parameter estimate for the interaction term of the seasonally-adjusted national unemployment rate and a flag for flows from nonemployment to employment $u_t n_{it}$, i.e., the responsiveness of new hire from nonemployment relative to stayers * denotes statistical significance at the 10% confidence level, ** at the 5% confidence level, and *** at 1%.

employ a first difference specification, and such estimates were surveyed by Pissarides (2009) who concludes wages of new hires decline by three percent for every one percentage point increase in the unemployment rate. Our finding that wages respond from 2.2% (2.6% + 0.2%) to 4.4% (3.8% + 0.6%) aligns with the literature, although this is on the higher end of the range of surveyed estimates. The response of hours to the unemployment rate has fewer reference points in the prior literature for comparison, but we find hours respond to increases in the unemployment rate in a somewhat lower range of 1.3% to 3.2%. The change in earnings is approximately the sum of the response of hours and wages, and is larger than each. Using person-specific fixed effects generally yield lower estimates of the wage and hours cyclicality of new hires than the first difference specification, which is the most commonly used strategy, with point estimates ranging from 1.2% to 1.5% for wages and 1.6% to 2.2% for hours. Nevertheless, estimates with person-specific fixed effects still suggest substantial excess cyclicality of new hires relative to job stayers, both for new hires from employer-to-employer transitions as well as hires from nonemployment.

Controlling for employer-employee match effects yield very different estimates of the excess cyclicality of new hires relative to the first difference and person-specific fixed effects specifications, consistent with the previous findings of Gertler and Trigari (2009). In our four state dataset, which does not have imputed hours or wages, new hire wages are less cyclical than job stayers, although still slightly procyclical. In our eleven state specification, new hire wages are found to be no different than those of job stayers. In contrast, hours are still more cyclical for new hires relative to job stayers, although the magnitude is lower in the range of 0.6% to 1.0%. The differences in the responsiveness of hours versus wages suggest the excess cyclicality of the earnings of new hires is driven by hours.

These results indicate match effects account for the excess cyclicality of new hire wages in the empirical work that follows Bils (1985). Interpreting these findings requires consideration of some technical nuances, which we describe here. After controlling for a time-invariant effect that persists throughout an employer-employee match, excess cyclicality of new hire wages necessarily reflects earnings responses to the unemployment rate that are transitory. Any transitory effect of the unemployment rate at the start of the job match has either no effect or an offsetting effect on wages.[13] This means all of the measured excess cyclicality of new hires relative to job stayers reflects a relationship between the unemployment rate at the start of the job match and the permanent component of wages that persists throughout the employer-employee match.

[13]We concede that an offsetting transitory effect of the unemployment rate is somewhat surprising. We can only speculate as to the mechanisms that might lead to this potential effect, but if the frequency and magnitude of hiring bonuses are not in general directly tied to salaries or economic conditions, then this would lead to a transitory offsetting effect of the unemployment rate. Given data limitations, we are unable to test that mechanism here.

Recall these employer-employee match effects may be driven by two mechanisms. One mechanism is the fundamental quality (or productivity) of particular employer-employee matches, emphasized in the recent work of Hagedorn and Manovskii (2013) and Gertler, Huckfeldt, and Trigari (2016). During recessions, workers may be less likely to move into matches that are a better fit for them. On the other hand, it may be that labor is simply less costly during recessions due to labor market slack and diminished worker bargaining power, and so if there is a long-term contract for compensation at the start of a job, then the quality or productivity of the match does not necessarily have an explanatory effect. The latter mechanism has recently been explored by Shimer (2005) and Pissarides (2009) as a method of resolving the employment-volatility puzzle, highlighting how labor market search models struggle to have employment rather than wages respond to changes in economic conditions.

On their own, our results do not allow us to distinguish between match quality and bargaining power associated with labor market tightness. One test, proposed by Gertler, Huckfeldt, and Trigari (2016), is to measure whether new hire wages of workers in employer-to-employer transitions are more responsive to the unemployment rate than those of workers hired from nonemployment. They argue that, if wage cyclicality is driven by employer-to-employer transitions, then this indicates the cyclical job ladder, which is generally understood to move workers from less productive to more productive matches, explains measured wage cyclicality. Gertler, Huckfeldt, and Trigari (2016) implement this test using data from the Survey of Income and Program Participation and find the excess wage cyclicality of new hires is driven by employer-to-employer transitions rather than hires from nonemployment. Our matched employer-employee data does not confirm their results and we find instead that the wage response of hires from nonemployment is similar to that of workers undergoing an employer-to-employer transition. Nevertheless, if new hires from nonemployment have higher earnings, hours, and wages during expansions relative to contractions, this does not rule out a strong role for a cyclical job ladder, which we explore in the accounting framework that follows.

4 Match Effects and Average Earnings, Hours, and Wages

We now turn to the evolution of earnings, hours, and wages in aggregate. Here, we propose and implement a method of accounting for each of these that distinguishes changes associated with job stayers from changes associated with employer-to-employer transitioners and nonemployment entrants and exiters. We then further decompose each of these into components that are associated with changes in the unemployment rate, match effects, and other observable characteristics, using our estimation of equation (1). Note estimates in Table 1 show the cyclicality in equation (1) relative to overall cyclicality.

4.1 Accounting Method

Consider the evolution of an average related to dominant employers from time $t-1$ to time t. Recall that by comparing dominant employer status d_{ijt-1} at time $t-1$ and d_{ikt} at time t, workers are in one of four categories $c_{it} \in \{s_{it}, q_{it}, r_{it}, n_{it}\}$, which denote binary indicator variables where s_{it} indicates a job stayer who remains employed by the same employer, q_{it} indicates a worker who has an employer-to-employer transition between times $t-1$ and t, r_{it} indicates a worker has left employment for nonemployment, and n_{it} indicates a previously nonemployed worker entered employment. Since an average equals the weighted sum of its components' averages, we can express the change in the average of our variables of interest from time $t-1$ to time t, $\Delta\bar{y_t} = \bar{y_t} - \bar{y}_{t-1}$, in terms of the share of employment for each type and its average for times $t-1$ and t. Let the total number of job stayers, employer-to-employer transitions, separations to nonemployment, and entrants from nonemployment be S_t, Q_t, R_t, and N_t, respectively. Then the number of workers employed is $D_{t-1} = S_t + Q_t + R_t$ at time $t-1$ and $D_t = S_t + Q_t + N_t$ at time t. All changes in employment are consequently due to net entry from nonemployment. If $N_t > R_t$, then entrants from nonemployment outnumber separators and employment increases. Likewise, if $N_t < R_t$, employment decreases. Given this notation, we can express the change in average as:

$$\Delta\bar{y_t} = \underbrace{\frac{\Sigma_i s_{it} y_{it} + \Sigma_i q_{it} y_{it} + \Sigma_i n_{it} y_{it}}{D_t}}_{\text{earnings at time } t} - \underbrace{\frac{\Sigma_i s_{it} y_{it-1} - \Sigma_i q_{it} y_{it-1} - \Sigma_i r_{it} y_{it-1}}{D_{t-1}}}_{\text{earnings at time } t-1} \tag{3}$$

Separating counts by transition type gives us:

$$\Delta\bar{y_t} = \frac{S_t}{D_t}\frac{\Sigma_i s_{it} y_{it}}{S_t} + \frac{J_t}{D_t}\frac{\Sigma_i q_{it} y_{it}}{Q_t} + \frac{N_t}{D_t}\frac{\Sigma_i n_{it} y_{it}}{N_t} - \frac{S_t}{D_{t-1}}\frac{\Sigma_i s_{it} y_{it-1}}{S_t} - \frac{J_t}{D_{t-1}}\frac{\Sigma_i q_{it} y_{it-1}}{Q_t} - \frac{R_t}{D_{t-1}}\frac{\Sigma_i r_{it} y_{it-1}}{R_t}$$

Since job stayers and workers undergoing employer-to-employer transition are employed in time $t-1$ and time t, we can regroup terms by separating their relative contribution to the change in the average from the relative change in their shares. This allows us to consider growth in our variables of interest due to factors other than changes in labor market composition. We call the change in the category average the "intensive margin" and the change in the category share the "extensive margin." We then have:

$$\Delta\bar{y_t} = \underbrace{\frac{\frac{S_t}{D_t}+\frac{S_t}{D_{t-1}}}{2}\frac{\Sigma_i s_{it}\Delta y_{it}}{S_t} + \frac{\frac{Q_t}{D_t}+\frac{Q_t}{D_{t-1}}}{2}\frac{\Sigma_i q_{it}\Delta y_{it}}{Q_t}}_{\text{intensive margin}} +$$

$$\underbrace{\left(\frac{S_t}{D_t}-\frac{S_t}{D_{t-1}}\right)\frac{\Sigma_i s_{it}(y_{it}+y_{it-1})}{2S_t} + \left(\frac{Q_t}{D_t}-\frac{Q_t}{D_{t-1}}\right)\frac{\Sigma_i q_{it}(y_{it}+y_{it-1})}{2Q_t} + \frac{N_t}{D_t}\frac{\Sigma_i n_{it} y_{it}}{N_t} - \frac{R_t}{D_{t-1}}\frac{\Sigma_i r_{it} y_{it-1}}{R_t}}_{\text{extensive margin}}.$$

We can now express the change in the aggregate as the sum of the contribution associated with job stayers, the contribution associated with employer-to-employer transitions, and the sum of the movements into and out of nonemployment plus the change in shares for job stayers and employer-to-employer transitions, such that:

$$\Delta\bar{y_t} = \underbrace{\frac{\frac{S_t}{D_t}+\frac{S_t}{D_{t-1}}}{2}\frac{\Sigma_i s_{it}\Delta y_{it}}{S_t}}_{\text{job stayers}} + \underbrace{\frac{\frac{Q_t}{D_t}+\frac{Q_t}{D_{t-1}}}{2}\frac{\Sigma_i q_{it}\Delta y_{it}}{Q_t}}_{\text{emp.-to-emp.}} + \underbrace{\frac{N_t}{D_t}\left(\frac{\Sigma_i n_{it} y_{it-1}}{N_t}-\tilde{y}_t\right) - \frac{R_t}{D_t}\left(\frac{\Sigma_i r_{it} y_{it-1}}{R_t}-\tilde{y}_t\right)}_{\text{nonemp.-to-emp. and emp.-to-nonemp.}} \quad (4)$$

where $\tilde{y}_t$ is the weighted average for job stayers and workers undergoing an employer-to-employer transition, i.e.

$$\tilde{y}_t = \frac{S_t}{S_t+Q_t}\left(\frac{\Sigma_i s_{it}(y_{it}+y_{it-1})}{2S_t}\right) + \frac{Q_t}{S_t+Q_t}\left(\frac{\Sigma_i q_{it}(y_{it}+y_{it-1})}{2Q_t}\right).$$

The formulation for the growth in $\bar{y_t}$ in equation (4) has an intuitive distiction between the respective contributions of job stayers, workers undergoing employer-to-employer transitions, and workers transitioning into and out of nonemployment. Essentially, each component contributes a weighted difference. For job stayers, the change in the average is multiplied by the average share of job stayers. Similarly, for employer-to-employer transitions, the change in the average is multiplied by its average share. Nonemployment transitioners move from having no earnings and not contributing to the average to having earnings and contributing to the average, or vice versa. Their impact is therefore related to how different they are from workers who are continuously employed in times t and $t+1$. The frequency of entry from or exit to nonemployment is the scale of this difference.

4.2 Job Stayers, Employer-to-Employer Transitions, and Nonemployment

In this section, we consider the time series properties of overall growth in earnings, hours, and wages and examine the contribution made by each type of labor market transition weighted by the average share of that category.[14] Results from decomposing earnings, hours, and wage changes in this manner are shown in Figure 1. We find all three variables exhibit similar patterns and trends and the relative contributions of stayers, employer-to-employer transitioners, and movements into and from nonemployment vary significantly over the time period.

We first consider earnings growth, shown in Panel 1(a).[15] At the beginning of the time series, earnings increased by 0.5% to 1.0% every quarter until the 2001 recession when growth fell to just above zero.[16] It hovered there until the 2007-2009 recession when it dropped even further to -0.5%. Earnings growth has since became positive, even reaching 1.0% in recent years.

Looking at the contribution made by each type of labor market transition, we find earnings growth for job stayers exhibits the same trend and magnitude as overall growth. Earnings growth for employer-to-employer transitions, however, accounts for a large, positive share that adds 1.0% to 1.8% to overall growth each quarter.[17] This growth occurs even though less than ten percent of workers change jobs because the earnings contribution approximately quantifies not only frequencies but also earnings changes of each job transition type and job-to-job flows have proportionately higher earnings changes, generally in the high single digits or low double digits.

Meanwhile, the extensive margin - net flows into and from nonemployment - has a strong, negative contribution, subtracting between 0.5% and 1.8% from earnings growth each quarter. It is the most negative during the expansion years of the late 1990s, when employment growth was the most rapid. Interestingly, earnings changes from job-to-job flows typically contribute a similar absolute magnitude to overall earnings growth as nonemployment flows, but have a different direction of effect. Since both are roughly procyclical, the nonemployment flows subtract less from earnings when job-to-job flows are contributing less. The relative balancing of these two factors suggests stayers drive the shift in overall earnings growth during the late 1990s. However, since the overall amount of change in log earnings is smaller than the proportionate change in levels, there is less growth to explain.

[14] Formally, this is presented in equation (4).

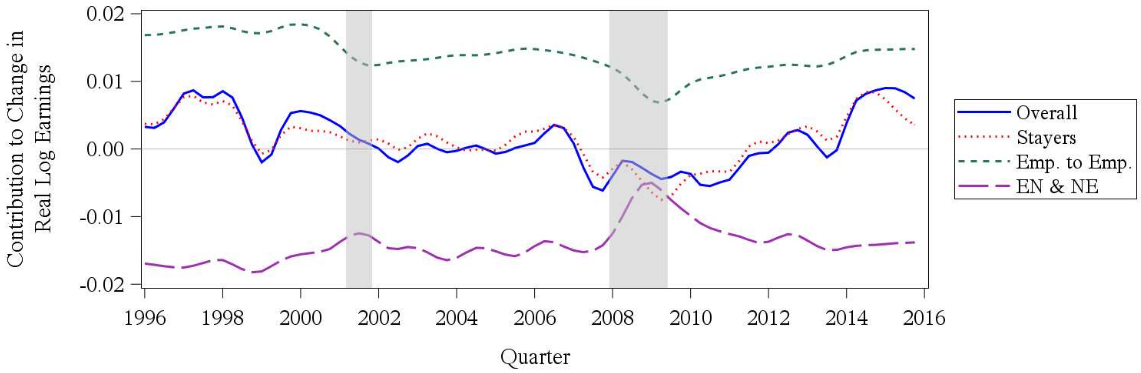
[15] We examine the change in log earnings. Since log earnings are approximately equal to percentage changes, this aids in the interpretation of these results. A log transformation reduces the influence of very high earners and describes changes closer to changes in median earnings.

[16] One exception is a decline in earnings in the first quarter of 1999.

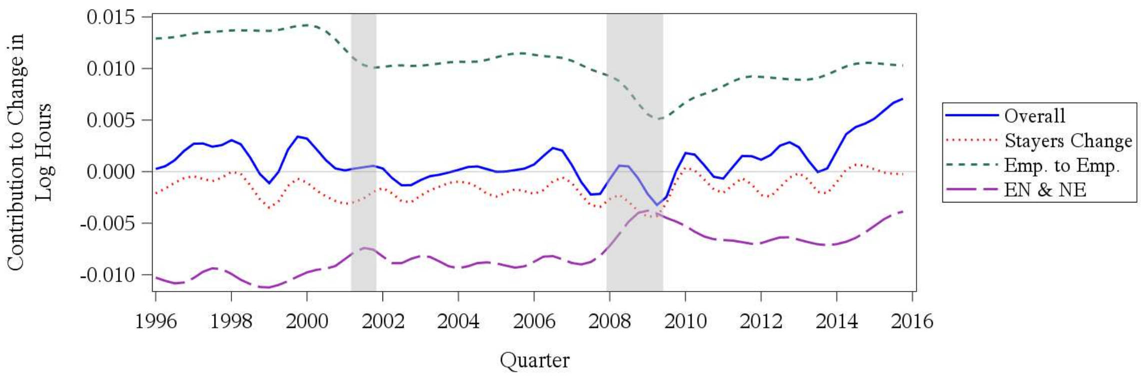
[17] Of the series displayed in Figure 1, the job stayers and overall earnings growth series demonstrate significant noise, especially when compared to the job-to-job flows and net employment margin series. This volatility is seemingly absent in series showing average compensation and earnings in the U.S. However, such a comparison is misleading as the former is a log series while the latter are typically levels series. Moreover, both are usually seasonally adjusted.

Figure 1: Average Change and Contribution by Component

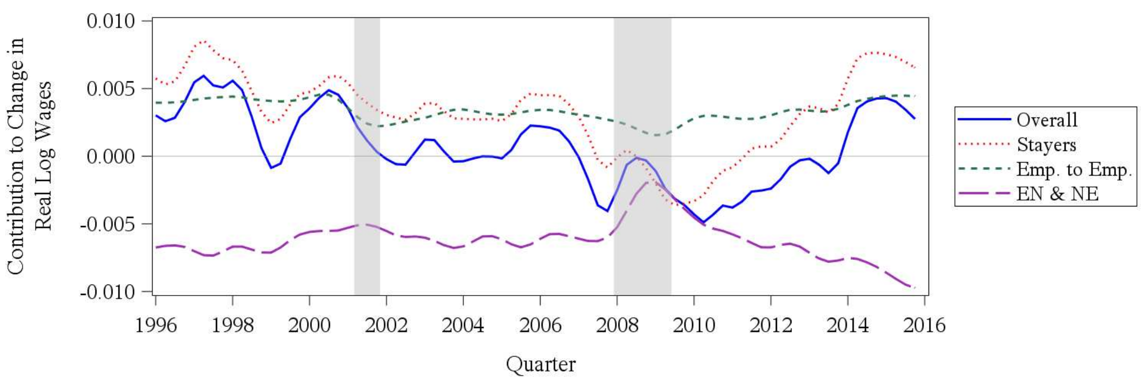
(a) Log Earnings



(b) Log Hours



(c) Log Wages



Notes: All series are log series that have been seasonally-adjusted and Henderson-filtered using x12. Earnings and wages series are presented in log 2014 constant dollars. Shaded areas indicate recessions. Overall indicates the total change. Stayers indicates the component attributable to the change for job stayers multiplied by the average share of job stayers. Emp. to Emp. indicates the component attributable to the change for employer-to-employer transitions multiplied by the average share of employer-to-employer transitions. EN & NE indicates the sum of the component attributable to the difference between entrants and exiters multiplied by the average share of entrants and exiters and the change in share of employment where data are observable multipled by the average for that quarter.

The pattern of hours and wage growth is qualitatively similar to that of earnings growth and the time series for both are shown in Panels 1(b) and 1(c). Specifically, note how employer-to-employer transitions contribute positively to overall growth in hours and wages throughout both time series. Their hours consistently increase by 0.5% to 1.5% per quarter with wages increasing substantially less at 0.25% to 0.5%. This is a striking finding and suggests employer-to-employer transitions are associated with substantial hours increases that are larger than wage gains. As a consequence, it appears earnings gains for employer-to-employer transitions are accompanied by growth in hours that surpasses growth in wages. The net employment contribution to hours and wage growth is consistently negative and has a comparable pattern to that of earnings.

There are some differences among the three panels. Earnings growth of job stayers become positive following the 2007-2009 recession in 2012. This contribution was accompanied by wage increases around the same time, but not a substantial hours increase. It is critical to note that, in contrast, the earnings growth observed in 2012 in the aggregate was accompanied by hours growth, not wage growth which did not become positive until 2014. More broadly, wages increased by as much as 0.5% in the late 1990s and then experienced no sustained growth following the 2001 recession until 2014. Job stayers played a prominent role in reducing wage losses and contributing positively to overall wage growth since 2010. This growth is even more stark considering movements into and out of nonemployment, which continued to contribute negatively, with decreases of 0.2% to 1.0%. Once again, this negative impact broadly offsets the positive contribution of stayers and job-to-job flows wage growth, except in the late 1990s and after 2014 where wage growth was positive overall.

In all of the Figure 1 panels, the net contribution of nonemployment is negative. Quarterly decreases can be close to zero during downturns but grow in magnitude during expansions. For earnings, this is because those entering nonemployment tend to earn much more than those exiting nonemployment; see Daly and Hobijn (2016).[18] Interestingly, the same relationship holds for hours. Entrants work fewer hours than exiters suggesting an active hours job ladder.

This countercyclical dampening effect is also apparent for wage growth, as fewer entrants enter and relatively high-wage exiters contribute less to wage growth. This extensive margin calculation is the closest in this paper to the extensive margin wage accounting exercise of Daly and Hobijn (2016). Our results are similar but somewhat less cyclical.[19] Daly and Hobijn find the extensive margin from the CPS subtracts slightly more than 2.0% from wages on an annual basis, which is roughly four times what we find. Moreover, instead of becoming slightly positive in the wake of the 2007-2009

[18] Recall the number of entrants exceeds the number of exiters because the number of employed is increasing.

[19] See Daly and Hobijn (2016), page 30, Figure 4. Note Daly and Hobijn (2016) are interested in median earnings, hours, and wages, while we are interested in the average of each.

recession, we find the quarterly net subtraction reaches 1.0% and does not make a material positive contribution to wages.[20]

4.3 Merging Results from an Unemployment Regression into the Decomposition

We now measure the extent to which match effects, the unemployment rate, and other observable characteristics account for growth in earnings, hours, and wages. To do so, we substitute our estimated parameter vectors of these components from equation (1) into equation (4). The average change for job stayer can be expressed as follows:

$$\frac{\frac{S_t}{D_t}+\frac{S_t}{D_{t-1}}}{2}\frac{\Sigma_i s_{it}\Delta y_t}{S_t}=\frac{\frac{S_t}{D_t}+\frac{S_t}{D_{t-1}}}{2}\frac{\Sigma_i s_{it}\Delta x_{it}\hat{\beta}}{S_t}+\frac{\frac{S_t}{D_t}+\frac{S_t}{D_{t-1}}}{2}\frac{\Sigma_i s_{it}\Delta u_{it}\hat{\gamma}}{S_t}+\frac{\frac{S_t}{D_t}+\frac{S_t}{D_{t-1}}}{2}\frac{\Sigma_i s_{it}\Delta\hat{\varepsilon}_{it}}{S_t} \tag{5}$$

where $\Delta x_{it} = x_{it} - x_{it-1}$ is the change in the vector of observable characteristics from time $t-1$ to time t, $\Delta u_{it} = u_{it} - u_{it-1}$ is the analogous change in the unemployment vector $u_{it} = \{u_{it}, q_{it}u_{it}, n_{it}u_{it}\}$, and $\Delta\bar{\hat{\varepsilon}}_{it} = \bar{\hat{\varepsilon}}_{it} - \bar{\hat{\varepsilon}}_{it-1}$ is the change in the estimated residual. Note that, by construction, stayers never have any change in match effects (since they are constant for any employer-employee combination), so this line is equal to zero throughout the time series. The contribution of job stayers to the overall average defined in equation (4) requires the term $\frac{\frac{S_t}{D_t}+\frac{S_t}{D_{t-1}}}{2}$, which denotes weighting by their average share of total transitions.

We can write a similar expression for growth associated with employer-to-employer transitions weighted by their transition shares:

$$\begin{aligned}\frac{\frac{Q_t}{D_t}+\frac{Q_t}{D_{t-1}}}{2}\frac{\Sigma_i q_{it}\Delta y_t}{Q_t}=&\frac{\frac{Q_t}{D_t}+\frac{Q_t}{D_{t-1}}}{2}\frac{\Sigma_i q_{it}\Delta x_{it}\hat{\beta}}{Q_t}+\frac{\frac{Q_t}{D_t}+\frac{Q_t}{D_{t-1}}}{2}\frac{\Sigma_i q_{it}\Delta u_{it}\hat{\gamma}}{Q_t}+\frac{\frac{Q_t}{D_t}+\frac{Q_t}{D_{t-1}}}{2}\frac{\Sigma_i q_{it}\Delta\hat{\alpha}_{it}}{Q_t}+\\&\frac{\frac{Q_t}{D_t}+\frac{Q_t}{D_{t-1}}}{2}\frac{\Sigma_i q_{it}\Delta\hat{\varepsilon}_{it}}{Q_t}\end{aligned} \tag{6}$$

where the change in estimated match effects is denoted by $\Delta\hat{\alpha}_{it} = \hat{\alpha}_{it} - \hat{\alpha}_{it-1}$.

To obtain the contribution of nonemployment, we compare earnings, hours, and wages of these transitioners with those of all other workers. For workers going from having no earnings to positive earnings in time t, we have the following relationship for average growth weighted by their transition

[20] Some of this may be accounted for by the fact that our time series analysis involves a Henderson filter that takes a moving average across quarters.

shares:

$$\frac{N_t}{D_t}\left(\frac{\Sigma_i n_{it} y_{it-1}}{N_t} - \tilde{y}_t\right) = \frac{N_t}{D_t}\left(\frac{\Sigma_i n_{it} x_{it-1}}{N_t} - \tilde{x}_t\right)\hat{\beta} + \frac{N_t}{D_t}\left(\frac{\Sigma_i n_{it} u_{it-1}}{N_t} - \tilde{u}_t\right)\hat{\gamma} + \frac{N_t}{D_t}\left(\frac{\Sigma_i n_{it} \hat{\alpha}_{it-1}}{N_t} - \tilde{\alpha}_t\right) + \frac{N_t}{D_t}\left(\frac{\Sigma_i n_{it} \hat{\varepsilon}_{it-1}}{N_t} - \tilde{\varepsilon}_t\right) \tag{7}$$

where $\tilde{x}_t$ is a row vector of average observable characteristics, $\tilde{u}_t$ is a row vector of unemployment interacted with job transition type, $\tilde{\alpha}_t$ is an average of fitted match effects, and $\tilde{\varepsilon}_t$ is an average of fitted residuals, where the average of each element generically denoted by $\tilde{g}_t$ is

$$\tilde{g} = \frac{S_t}{S_t + Q_t}\left(\frac{\Sigma_i s_{it}(g_{it} + g_{it-1})}{2S_t}\right) + \frac{Q_t}{S_t + Q_t}\left(\frac{\Sigma_i q_{it}(g_{it} + g_{it-1})}{2Q_t}\right).$$

For employment-to-nonemployment transitions, we have the following relationship for average growth weighted by their transition shares:

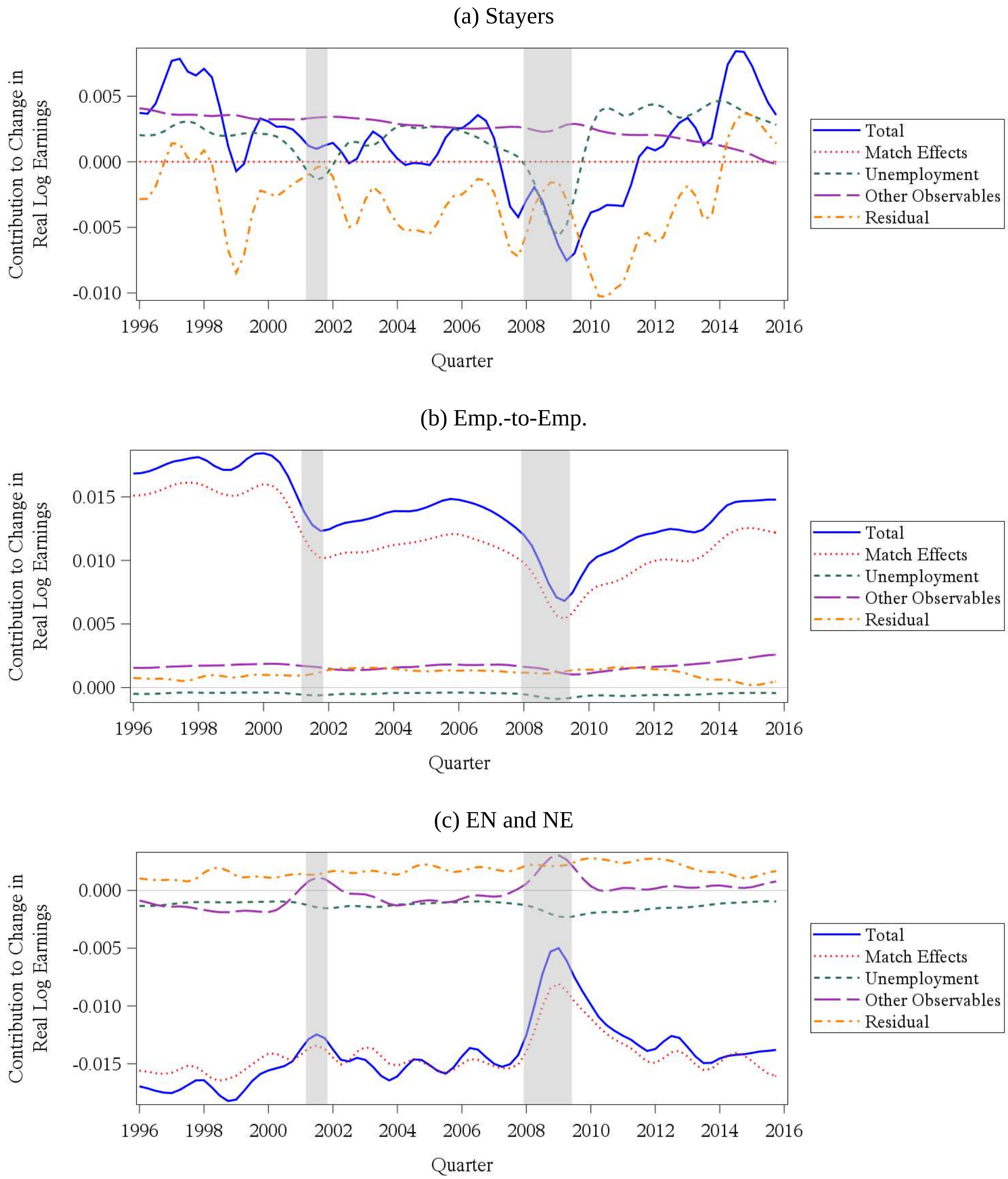
$$\frac{R_t}{D_t}\left(\frac{\Sigma_i r_{it} y_{it-1}}{R_t} - \tilde{y}_t\right) = \frac{R_t}{D_t}\left(\frac{\Sigma_i r_{it} x_{it-1}}{R_t} - \tilde{x}_t\right)\hat{\beta} + \frac{R_t}{D_t}\left(\frac{\Sigma_i r_{it} u_{it-1}}{R_t} - \tilde{u}_t\right)\hat{\gamma} + \frac{R_t}{D_t}\left(\frac{\Sigma_i r_{it} \hat{\alpha}_{it-1}}{R_t} - \tilde{\alpha}_t\right) + \frac{R_t}{D_t}\left(\frac{\Sigma_i r_{it} \hat{\varepsilon}_{it-1}}{R_t} - \tilde{\varepsilon}_t\right) \tag{8}$$

4.4 The Role of Match Effects, the Unemployment Rate, and Other Observable Characteristics

The results of this decomposition for earnings, hours, and wages are shown in Figures 2, 3, and 4, respectively. We show this decomposition for job stayers (equation (5)), employer-to-employer transitions (equation (6)), and net employment flows (equation (7) minus equation (8)). Each type has a panel comparing its time series from the baseline decomposition in Figure 1, labeled “Total,” to lines showing the contribution of match effects, the unemployment rate, other observable characteristics, and a residual. Each of these four components are equal to the total, prior to seasonal adjustment and taking a moving average, and differences due to these *ex post* adjustments are small.

First, consider how earnings for stayers evolve in Panel 2(a). The unemployment rate contributes procyclically, adding 0.2% to 0.4% to earnings growth during expansions but subtracting 0.1% to 0.5% during recessions. Meanwhile, changes in observable characteristics always contribute positively, about 0.3% to 0.4%. This is natural since job tenure and age for stayers go up over time and both are associated with earnings increases. There is also cyclicality in this line as it falls to 0.0% after the 2007-2009 recession. This is a longer-term consequence of the decline in hiring rate that occurs

Figure 2: Earnings Growth: Regression-Based Decomposition



Notes: All series are log series that have been seasonally-adjusted and Henderson-filtered using x12. Earnings series are presented in log 2014 constant dollars. Shaded areas indicate recessions. Total indicates the total change for the given job transition type. Match Effects the component attributable to employer-employee match effects. Unemployment the component attributable to the seasonally-adjusted national unemployment rate. Other Observables the component attributable to other observable characteristics, including age, job tenure, and dummy variables that indicate whether a worker is newly hired from another employer or nonemployment, whether it is the last quarter of a specific employer-employee match by type of new hire, as well as time trends and seasonal effects that are specific to particular transition types. Residual the component attributable to the remainder.

during and persists after recessions: since recessions lead to fewer low-tenure workers (see Hyatt and Spletzer 2016) and returns to job tenure are greatest early in a job spell, stayers as a group accumulate less returns to job tenure during downturns.

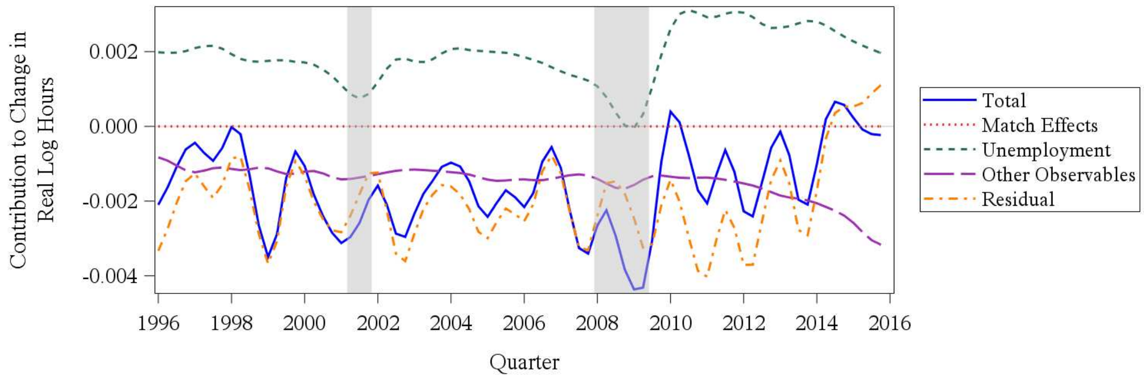
The residual, which necessarily includes anything not captured in equation (1), also plays an important role. It is persistently negative from 0.0% to 1.0%, offsetting much of the earnings increases associated with changes in the unemployment rate and other observable characteristics. It appears earnings growth following the 2007-2009 recession is due to residual factors.[21] In the previous section, we noted earnings growth among stayers was accompanied by wage and not hours growth. In comparing the panels for stayers in Figures 2-4 (Panels 2(a), 3(a), 4(a)), it appears observed earnings growth was accompanied by wage growth that was also due to residual rather than cyclical factors. In contrast, any persistent increase in hours growth appears to be due to cyclical factors following the 2007-2009 recession with substantial transitory effects due to residual sources of variation as seen in Figure 3(a).

The evolution of earnings when workers undergo an employer-to-employer transition is quite different from that of job stayers and is shown in Panel 2(b). This is largely due to earnings changes associated with increased match effects, which explain about 80% of the level and variation in the overall contribution to total earnings change. On average, match effects contribute about 1.0% throughout the time series, going as high as 1.5% in the late 1990s. This declines to 0.5% during recessions with no recovery to pre-recession levels after the 2001 recession but a recovery to pre-recession levels after the 2007-2009 recession. This procyclical behavior is due both to workers changing jobs more rapidly during expansions and match effects resulting in larger increases during expansions. Unemployment slightly offsets these gains: when a worker begins a new job, we allow for new hires to have excess sensitivity to the unemployment rate and have a persistent negative effect by construction. However, this contribution is typically near zero so not much is offset. Increases associated with other ob-

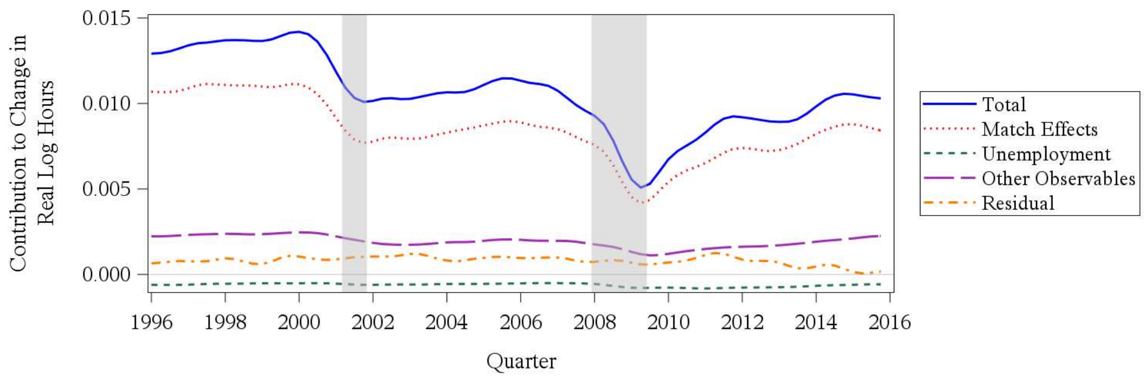
[21] While an exhaustive attempt to model cyclical earnings changes is beyond the scope of this paper, it may be useful to provide some guidance for the level and time series properties of the residual line. As stated above, these necessarily capture features of the process that determines earnings (which are unobservable to an econometrician) but are not captured in the empirical specification in equation (1). The persistent level difference most likely reflects the fact that we only allow returns to job tenure to increase, and do not have a corresponding "time from exit" series, as well as any failure to capture the true polynomial to capture returns to job tenure itself. Furthermore, we only allow for excess sensitivity to the unemployment rate in the first quarter of a particular job, and there may be analogous earnings changes that occur at the end of a job spell. Temporary increases may be due to omitted variables and model misspecification. The temporary increases in the unemployment rate may be due to earnings adjustment being nonlinear in the unemployment rate: for example, an adjustment from 7% unemployment to 6% may not cause wages to increase much, but when the unemployment rate changes from 5.5% to 4.5%, the labor market might be quite tight and so job stayers may accumulate additional earnings. The earnings increase in the late 1990s may also be associated with increases in labor productivity. Finally, we would expect to see countercyclical increases in the residual if the unemployment rate affects earnings in an asymmetric manner, specifically, if earnings increase more as the unemployment rate decreases than they fall when it rises, which would occur if there are some downward rigidities in the wage and hours setting process.

Figure 3: Hours Growth: Regression-Based Decomposition

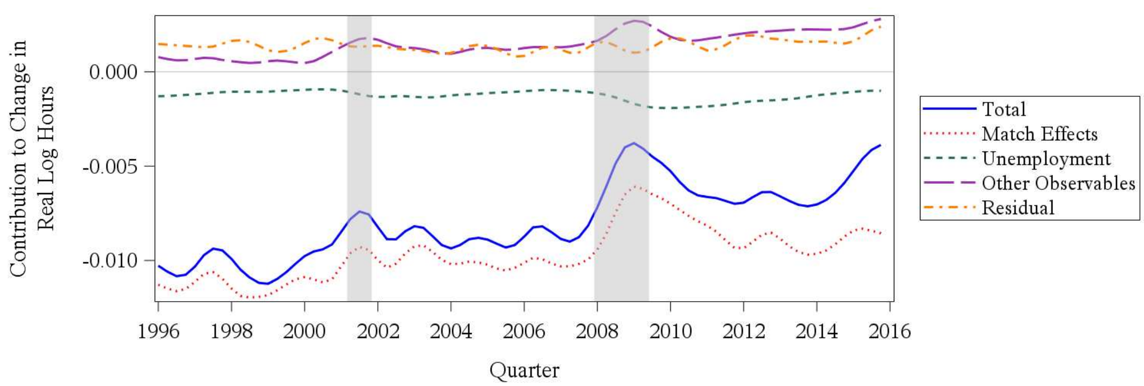
(a) Stayers



(b) Emp.-to-Emp.



(c) EN and NE



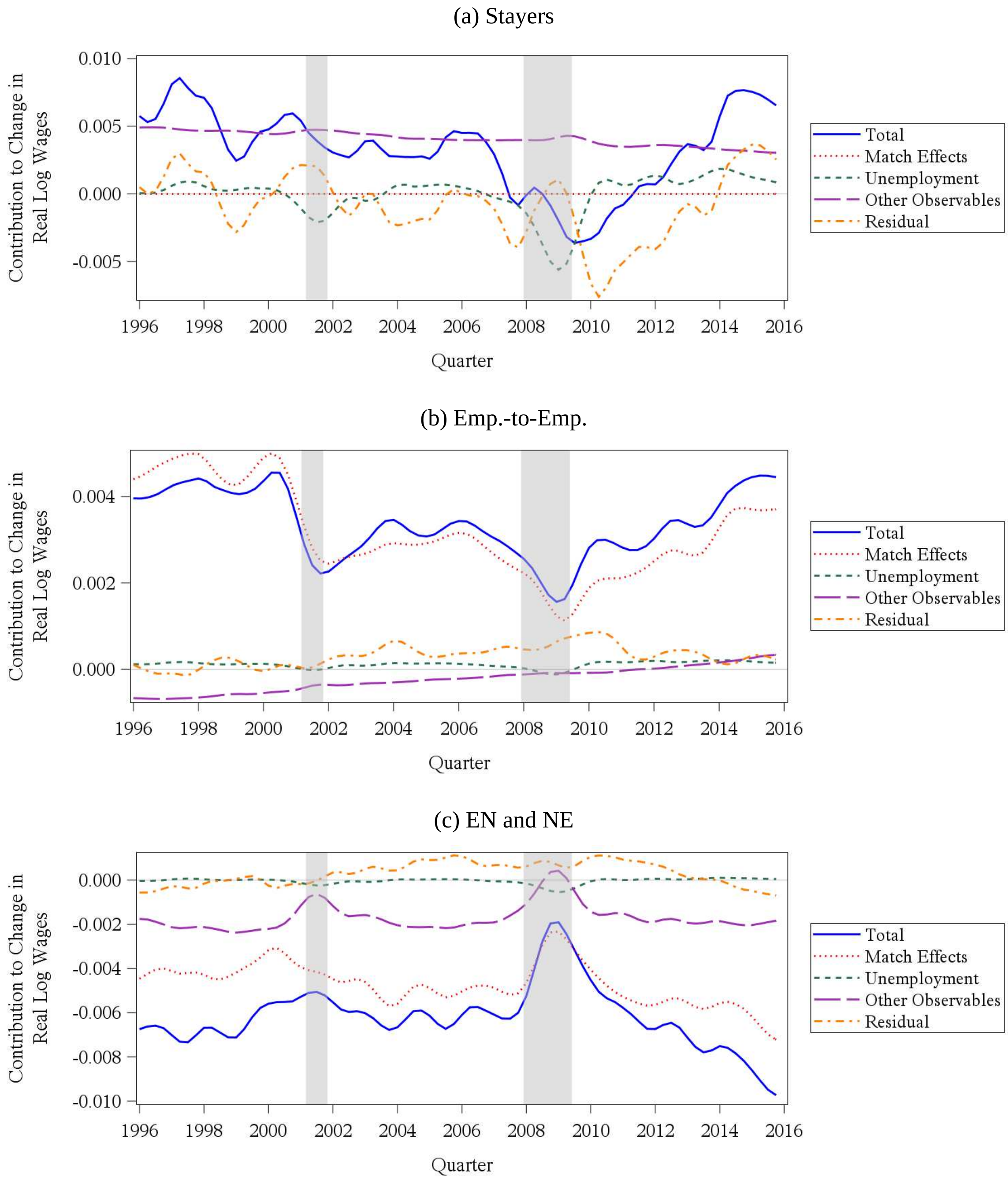
Notes: All series are log series that have been seasonally-adjusted and Henderson-filtered using x12. Shaded areas indicate recessions. Total indicates the total change for the given job transition type. Match Effects the component attributable to employer-employee match effects. Unemployment the component attributable to the seasonally-adjusted national unemployment rate. Other Observables the component attributable to other observable characteristics, including age, job tenure, and dummy variables that indicate whether a worker is newly hired from another employer or nonemployment, whether it is the last quarter of a specific employer-employee match by type of new hire, as well as time trends and seasonal effects that are specific to particular transition types. Residual the component attributable to the remainder.

servable characteristics are approximately 0.1% to 0.2% and are procyclical. This procyclicality is primarily due to workers aging as well as our inclusion of a one-quarter penalty associated with the last quarter of a particular job for all new hires and the substantially higher seasonality associated with the earnings of job changers since different transition types were allowed to have different seasonal effects. The residual line is small but also generally positive at 0.0% to 0.2% with occasional short-term declines.

In comparing earnings growth to the time series for hours and wages in subsequent figures, it is clear both wages and hours are sources of earnings growth for employer-to-employer transitioners. In particular, Figure 3(b) and 4(b) show match effects are key in accounting for hours and wage growth following the 2007-2009 recession. We interpret these results as follows. Employer-to-employer transitions constitute a substantial portion of earnings growth in the aggregate economy. These transitions are accompanied by both wage and hours increases, but hours gains are substantially larger in magnitude. In attempting to account for these increases, we find hours gains for employer-to-employer transitioners are accounted for by improvements in time invariant match effects across employer pairs that result in increases in hours for transitioning workers. These increases in hours appear larger than any associated increases in wages and represent a channel for earnings growth that is usually not considered in search and matching models. In particular, we argue this represents evidence of a job ladder in hours that has typically been ignored in the literature.

Panel 2(c) shows the contribution of movements to and from nonemployment to growth. Like employer-to-employer transitioners, earnings changes associated with match effects for exiters and entrants tract the overall contribution quite closely and explain most of the level and intertemporal movement. However, rather than being positive, they have an offsetting effect, subtracting around 1.5% from earnings change on average. Only during the 2007-2009 recession does this decrease in magnitude to 0.75%. However, it returns to 1.5% by 2012 and remains there. All other mechanisms have a much smaller role. The unemployment rate has a persistently negative effect of 0.1% to 0.2%, mostly due to new hires - in this case, new entrants - having excess sensitivity to the unemployment rate. There are two main channels for the small increase in the role of the unemployment rate during and after recessions. First, the (albeit small) excess sensitivity of new hires increases during recessions even as such workers enter less frequently. To understand the second channel, recall the unemployment penalty for exiters relative to all workers enters the decomposition with a negative sign; see equation (4). Since we do not allow for excess sensitivity of exiters to the unemployment rate in equation (1), exiters look more like other workers during recessions via this channel so the general intuition that more exiters increases the average does not apply. Other observable characteristics have

Figure 4: Wage Growth: Regression-Based Decomposition



Notes: All series are log series that have been seasonally-adjusted and Henderson-filtered using x12. Wage series are presented in log 2014 constant dollars. Shaded areas indicate recessions. Total indicates the total change for the given job transition type. Match Effects the component attributable to employer-employee match effects. Unemployment the component attributable to the seasonally-adjusted national unemployment rate. Other Observables the component attributable to other observable characteristics, including age, job tenure, and dummy variables that indicate whether a worker is newly hired from another employer or nonemployment, whether it is the last quarter of a specific employer-employee match by type of new hire, as well as time trends and seasonal effects that are specific to particular transition types. Residual the component attributable to the remainder.

a negative effect of 0.1% to 0.2% during expansions but a positive one of 0.0% to 0.3% during and immediately following the two recessions. Finally, we note that workers see hours gains over the life of the employment spell.

Figure 3(c) highlights how hours of new workers are lower than hours of exiting workers. At the same time, Figure 3(b) shows subsequent employer-to-employer transitions see further hours growth. We interpret these results as evidence of a job ladder in hours where hours of new hires from nonemployment are typically higher than those of exiters and subsequent employer-to-employer transitions increase worker hours further. What drives the increase in hours? The decomposition graphs show a large role for match effects. The contribution of entrants and exiters to overall hours growth is largely due to differences in match effects between entrants and exiters. Notice that, like employer-to-employer transitions, there is substantial contribution to wages, as seen in Figure 4(c). In particular, match effects are particularly important in accounting for wages among entrants being lower than exiters.

4.5 Average Earnings, Hours, and Wages and the Unemployment Rate

In the previous section, we looked at changes in hours and wages to inform which drives earnings change in the time series. A related analysis can be made by calculating the covariance between the unemployment rate and each term in equations (5), (6), (7), and (8). This section presents such an analysis. Table 2 shows regression terms and results for earnings, hours, and wages, found in the three columns. There are two types of correlations in the table: one takes into account changes in the composition of transition types over time while the other divides each term in the regression equations by the transition weight to recover the unweighted change. For the former, we show the correlation of the contribution of growth by transition type found in equation (4). For the latter, we examine the covariance of *unweighted* growth in each variable along with the decomposition by observables and unemployment from equation (1). To simplify the analysis, we do not include the transition weight since we find variation in employment shares over time for some transitions.

When the unemployment rate increases, overall earnings, hours, and wages (denoted by $\Delta\bar{y_t}$ in the first row) all decline, but the change is quite small. A one percentage point increase in the unemployment rate causes earnings to decline by about 0.4%, of which almost 60% is accounted for by hours and the remainder by wages. Looking at this by transition type, we find evidence consistent with Figures 2 to 4. The contribution of stayers $\frac{\frac{S_t}{D_t}+\frac{S_t}{D_{t-1}}}{2}\frac{\Sigma_i s_{it}\Delta y_t}{S_t}$ and employer-to-employer transitions $\frac{\frac{Q_t}{D_t}+\frac{Q_t}{D_{t-1}}}{2}\frac{\Sigma_i q_{it}\Delta y_t}{Q_t}$ are generally procyclical increases for earnings, hours, and wages. Meanwhile, the nonemployment margin, defined as the sum of entrants $\frac{N_t}{D_t}\left(\frac{\Sigma_i n_{it} y_{it-1}}{N_t} - \tilde{y}_t\right)$ and exiters $\frac{R_t}{D_t}\left(\frac{\Sigma_i r_{it} y_{it-1}}{R_t} - \tilde{y}_t\right)$, is always countercyclical and offsets more than 60% of these increases.

Table 2: Regression of Components with Changes in the Unemployment Rate

Component	Formula	Earnings	Hours	Wages
Overall	$\Delta\overline{y}_t$	-0.448	-0.257	-0.192
Stayers	$\frac{\frac{S_t}{D_t}+\frac{S_t}{D_{t-1}}}{2}\frac{\Sigma_i s_{it}\Delta y_{it}}{S_t}$	-0.665	-0.231	-0.434
Outcome Change	$\frac{\Sigma_i s_{it}\Delta y_t}{S_t}$	-0.749	-0.261	-0.488
Observables	$\frac{\Sigma_i s_{it}\Delta x_{it}\hat{\beta}}{S_t}$	-0.081	-0.019	-0.063
Unemployment	$\frac{\Sigma_i s_{it}\Delta u_{it}\hat{\gamma}}{S_t}$	-0.926	-0.265	-0.661
Emp.-to-Emp.	$\frac{\frac{Q_t}{D_t}+\frac{Q_t}{D_{t-1}}}{2}\frac{\Sigma_i q_{it}\Delta y_{it}}{Q_t}$	-0.455	-0.307	-0.147
Outcome Change	$\frac{\Sigma_i q_{it}\Delta y_t}{Q_t}$	-6.982	-4.252	-2.730
Observables	$\frac{\Sigma_i q_{it}\Delta x_{it}\hat{\beta}}{Q_t}$	-0.525	-0.361	-0.165
Match Effects	$\frac{\Sigma_i q_{it}\Delta\hat{\alpha}_{it}}{Q_t}$	-6.610	-4.100	-2.510
Unemployment	$\frac{\Sigma_i q_{it}\Delta u_{it}\hat{\gamma}}{Q_t}$	-1.122	-0.486	-0.636
Nonemp.-to-Emp.	$\frac{N_t}{D_t}(\frac{\Sigma_i n_{it} y_{it-1}}{N_t})$	0.583	0.179	0.405
Outcome Change	$\frac{\Sigma_i n_{it} y_{it-1}}{N_t} - \tilde{y}_t$	-0.694	-2.687	1.993
Observables	$\left(\frac{\Sigma_i n_{it} x_{it-1}}{N_t} - \tilde{x}_t\right)\hat{\beta}$	-0.484	-0.318	-0.166
Match Effects	$\frac{\Sigma_i n_{it}\hat{\alpha}_{it-1}}{N_t} - \tilde{\alpha}_t$	1.191	-0.657	1.848
Unemployment	$\left(\frac{\Sigma_i n_{it} u_{it-1}}{N_t} - \tilde{u}_t\right)\hat{\gamma}$	-0.678	-0.344	-0.333
Emp.-to-Nonemp.	$-\frac{R_t}{D_t}(\frac{\Sigma_i r_{it} y_{it-1}}{R_t})$	0.088	0.103	-0.015
Outcome Change	$\frac{\Sigma_i r_{it} y_{it-1}}{R_t} - \tilde{y}_t$	5.866	2.779	3.088
Observables	$\left(\frac{\Sigma_i r_{it} x_{it-1}}{R_t} - \tilde{x}_t\right)\hat{\beta}$	0.179	0.263	-0.085
Match Effects	$\frac{\Sigma_i r_{it}\hat{\alpha}_{it-1}}{R_t} - \tilde{\alpha}_t$	5.997	3.319	2.678
Unemployment	$\left(\frac{\Sigma_i r_{it} u_{it-1}}{R_t} - \tilde{u}_t\right)\hat{\gamma}$	0.554	0.222	0.332

Notes: Bivariate regression of the changes in the components on the unemployment rate on percentage point changes in the unemployment rate. All point estimates were multiplied by 100 to reduce the number of significant digits.

We see little difference between the contribution of job stayers and their unweighted change in earnings, hours, and wages (denoted by the term $\frac{\Sigma_i s_{it}\Delta y_t}{S_t}$). Since most employees are job stayers in any given quarter, the variation of its share over time $\frac{1}{2}(\frac{S_t}{D_t}+\frac{S_t}{D_{t-1}})$ is small but always in the range of 85 to 91%. As a result, the contribution of job stayers is only about ten percent smaller than its unweighted counterpart.[22] Nevertheless, both the weighted and unweighted contributions of job stayers to earnings growth are driven by wages rather than hours, with the former contributing almost

[22]For rates at which workers stay at the same employer, move into and out of nonemployment, and transition between employers, see Figure D in Appendix D.

twice as much as the latter. We see the overwhelming majority of this is due to cyclical factors captured by changes in the unemployment rate $\frac{\Sigma_i s_{it}\Delta u_{it}\hat{\gamma}}{S_t}$ rather than other observable characteristics $\frac{\Sigma_i s_{it}\Delta x_{it}\hat{\beta}}{S_t}$. For earnings alone, a one percentage point increase in the unemployment rate is associated with a decline of 0.9%, 70% of which comes from wages rather than hours.

For employer-to-employer transitions, the weighted and unweighted earnings changes are drastically different in magnitude, suggesting job changers see large increases in earnings after they make the transition but their contribution to the overall average is not as large due to their small share of the labor market. Looking at the unweighted earnings change alone, it appears to be mostly driven by cyclical changes in hours, with 60% of earnings changes accounted for by hours changes rather than wage changes. This again confirms our striking finding of a job ladder in hours among workers that change employers. Moreover, our results show match effects play a large role in this, as they account for 95% of the unweighted change in earnings. In contrast, cyclical factors summarized by the unemployment rate and other observables amount to 8% and 16%. Similar results are obtained for hours and wages.

For completeness, we also show covariance calculations for entrants and exiters. One key result is match effects largely account for earnings changes in both of these transition types. They are likewise important when accounting for observed hours and wages changes. Notice weighted and unweighted covariances differ in both magnitude and sign among entrants and exiters. For example, entrants see a countercyclical earnings contribution of 0.6%, but unweighted earnings for entrants are procyclical at -0.7%. This suggests differences in covariance structure in transition shares ($\frac{N_t}{D_t}$ for entrants and $\frac{R_t}{D_t}$ for exiters) and unweighted earnings changes.

5 Conclusion

We use matched employer-employee data to demonstrate the importance of job match effects in the evolution of earnings, hours, and wages. We show that new hires from nonemployment have low match effects relative to incumbents and workers obtain higher match effects via employer-to-employer transitions. The frequency at which workers transition into employment from nonemployment is procyclical, as are starting match effects and their improvement via employer-to-employer transitions. These patterns are consistent with a cyclical job ladder that moves workers into improved jobs more quickly during expansions. Consideration of the cyclical job ladder and its associated match effects is therefore important for understanding how earnings, hours, and wages vary over time.

These cyclical match effects also matter when estimating regression specifications that relate earnings, hours, and wages to the unemployment rate in panel microdata. We find that compared to specifications that control for person-specific fixed effects or use a first-difference framework, our specification which controls for match effects results in lower overall cyclicality, as well as reduced excess cyclicality of new hire earnings, hours, and wages. This suggests that at least 90% of excess cyclicality of new hire wages, as surveyed in Pissarides (2009), are caused by persistent effects that occur throughout the job spell. At the same time, we also find evidence that a small portion of the excess cyclicality does go away quickly. This finding is consistent with the usual interpretation that the excess cyclicality of new hire earnings is indicative of wage rigidity in the labor market. We hope this will lead future researchers to give more explicit consideration to employer-employee match effects in the estimation of new hire earnings.

We furthermore characterize how average earnings, hours, and wages evolve as the sum of components that are themselves cyclical. While changes associated with job stayers naturally explain much of the evolution of each average, the correlation between these changes and the unemployment rate is low. Moreover, time-invariant match effects for job stayers contribute nothing, by construction. In contrast, the contribution of employer-to-employer transitions are driven by a procyclical transition rate as well as by procyclical match effects. The contribution of nonemployment exiters is also driven by changes in match effects. For nonemployment entrants, contributions to the average are negative, primarily due to the frequency of their occurrence and the offsetting effect created by the difference in their average earnings from those of incumbents. Half of the cyclicality of this offsetting effect is explained by match effects. Despite being able to explain most of the variation in earnings, hours, and wages and how each varies with the unemployment rate, we find a substantial residual remains.

Taken as a whole, these findings underscore the importance of the cyclical job ladder and associated match effects in the evolution of earnings, hours, and wages. This paper does not explore the mechanisms that generate match effects; we leave formal modeling to future research. However, we hope, this paper provides moments that can be used to estimate models of the cyclical job ladder and serves as motivation for considering the nature of longer-lived effects of job matches, which vary with the labor market and economic conditions more generally. Our accounting method provides a helpful starting point for documenting the different channels through which earnings, hours, and wages evolve.

References

[1] Abowd, John, Bryce E. Stephens, Lars Vilhuber, Fredrik Andersson, Kevin L. McKinney, Marc Roemer, and Simon Woodcock. 2009. "The LEHD Infrastructure Files and the Creation of the Quarterly Workforce Indicators." In *Producer Dynamics: New Evidence from Micro Data*, ed. Timothy Dunne, J. Bradford Jensen, and Mark J. Roberts. Chicago, IL: University of Chicago Press:149-230.

[2] Abraham, Katharine, James Spletzer, and Jay Stewart. 1998. "Divergent Trends in Alternative Wage Series." In: *Labor Statistics Measurement Issues*, ed. John Haltiwanger, Marilyn Manser, and Robert Topel. Chicago, IL: University of Chicago Press: 293-325.

[3] Altonji, Joseph G. and Christina H. Paxson. 1986. "Job Characteristics and Hours of work" in Ronald Ehrenberg (ed.), *Research in Labor Economics*, Vol. VIII (Part A), Greenwich, CT: JAI Press.

[4] Benedetto, Gary, John Haltiwanger, Julia Lane, and Kevin McKinney. 2007. "Using Worker Flows to Measure Firm Dynamics." *Journal of Business and Economic Statistics* 25(3): 299-313.

[5] Bils, Mark. 1985. "Real Wages over the Business Cycle: Evidence from Panel Data." *Journal of Political Economy* 93(4): 666-689.

[6] Burdett, Kenneth. 1978. "A Theory of Employee Search and Quits," *American Economic Review*, 68(1): 212-220.

[7] Champagne, Julien, André Kurmann, and Jay Stewart. 2016. "Reconciling the Divervence in Aggregate U.S. Wage Series." Unpublished draft, Drexel University.

[8] Daly, Mary, and Bart Hobijn. 2016. "The Intensive and Extensive Margin of Real Wage Adjustment." Federal Reserve Bank of San Francisco Working Paper #2016-04.

[9] Faberman, R. Jason, and Alejandro Justiniano. 2015. "Job Switching and Wage Growth." Chicago Fed Letter #337.

[10] Sarah Flood, Miriam King, Steven Ruggles, and J. Robert Warren. Integrated Public Use Microdata Series, Current Population Survey: Version 5.0. [dataset]. Minneapolis: University of Minnesota, 2017.

[11] Gertler, Mark, Christopher Huckfeldt, and Antonella Trigari. 2016. "Unemployment Fluctuations, Match Quality, and the Wage Cyclicality of New Hires." Unpublished draft, New York University.

[12] Gertler, Mark, and Antonella Trigari. 2009. "Unemployment Fluctuations with Staggered Nash Wage Barganining." *Journal of Political Economy* 117(1): 38-86.

[13] Hagedorn, Marcus, and Iourii Manovskii. 2013. "Job Selection and Wages over the Business Cycle." *American Economic Review* 103(2): 771-803.

[14] Hahn, Joyce, Henry Hyatt, Hubert Janicki, and Stephen Tibbets. 2017 "Job-to-Job Flows and Earnings Growth." *American Economic Review: Papers & Proceedings 2017* 107(5): 358-363.

[15] Hyatt, Henry, and James Spletzer. 2016. "The Shifting Job Tenure Distribution." *Labour Economics* 41(1): 363-377.

[16] Hyatt, Henry, Erika McEntarfer, Kevin McKinney, Stephen Tibbets, Douglas Walton, Joyce Hahn, and Hubert Janicki. 2017. "Job-to-Job (J2J) Flows: New Labor Market Statistics From Linked Employer-Employee Data." *Technical Report* U.S. Census Bureau, `https://lehd.ces.census.gov/doc/jobtojob_documentation_long.pdf`

[17] Jovanovic, Boyan. 1979. "Firm-specific Capital and Turnover," *Journal of Political Economy*, 87(5): 972-990

[18] Karahan, Fatih, Benjamin Pugsley, Ryan Michaels, and Aysegul Sahin. 2016. "Do Job-to-Job Transitions Drive Wage Fluctuations Over the Business Cycle?" Unpublished draft, Federal Reserve Bank of New York.

[19] Kudlyak, Marianna. 2014. "The Cyclicality of the User Cost of Labor." *Journal of Monetary Economics* 68(1): 53-67.

[20] Kurmann, André and Erika McEntarfer. 2017. "Downward Wage Rigidity in the United States: New Evidence from Worker-Firm Linked Data." Unpublished draft, Drexel University.

[21] Molloy, Raven, Christopher Smith, Riccardo Trezzi, and Abigail Wozniak. 2016. "Understanding Declining Fluidity in the U.S. Labor Market." Paper presented at the Brookings Papers on Economic Activity Spring 2016 Conference.

[22] Pissarides, Christopher A. 2009. "The Unemployment Volatility Puzzle: Is Wage Stickiness the Answer?" *Econometrica* 77(5): 1339-1369

[23] Rubin, Donald B. 1987. *Multiple Imputation for Nonresponse in Surveys*. Wiley-Interscience Press.

[24] Solon, Gary, Barsky, Gary, and Jonathan Parker. 1994. "Measuring the Cyclicality of Real Wages: How Important is Composition Bias." *The Quarterly Journal of Economics*, 109(1): 1-25.

[25] Topel, Robert, and Michael Ward. "Job Mobility and the Careers of Young Men." *Quarterly Journal of Economics* 107(2): 439-479.

Appendices

A Definitions

This appendix provides definitions of employment and earnings concepts used in this paper and follows the notation in Abowd et al. (2009) and Hyatt et al. (2017). Let w_{ijt} denote earnings for individual i from employer j in quarter t. If an individual has reported earnings from an employer in a given quarter and $w_{ijt} > 0$, then we infer the individual worked for the employer and call this employment relationship a job.

A.1 Basic Employment Concepts

Following Hyatt et al. (2017), we consider the subset of jobs that span two consecutive quarters. Formally, these are:

$$b_{ijt} = \begin{cases} 1, & \text{if } w_{ijt-1} > 0 \text{ and } w_{ijt} > 0 \\ 0, & \text{otherwise.} \end{cases}$$

Moreover, we only allow workers to have at most one job per quarter. Since LEHD administrative records lack employment start and end dates, we cannot distinguish between a worker holding multiple jobs and a worker transitioning between jobs in a given quarter. We therefore determine where workers are earning the most and call this the dominant job. Formally, this is:

$$d_{ijt} = \begin{cases} 1, & \text{if } b_{ijt} = 1 \text{ and} \\ & w_{ijt} + w_{ijt-1} > w_{ikt} + w_{ikt-1} \forall k \\ & \text{s.t. } b_{ikt} = 1 \text{ and} j \neq k \\ 0, & \text{otherwise.} \end{cases}$$

We then compare dominant employers across quarters and identify when a job transition has occurred.

For the study of earnings, it is also useful to introduce the concept of full quarter jobs. Full quarter jobs span three consecutive quarters, such that:

$$f_{ijt} = \begin{cases} 1, & \text{if} w_{ijt-1} > 0 \text{ and } w_{ijt} > 0 \text{ and } w_{ijt+1} > 0 \\ 0, & \text{otherwise.} \end{cases}$$

For these jobs, we assume employees worked the entire middle quarter and use total earnings from that quarter as their quarterly earnings rate.

We can now define four employment concepts: job stayers, employer-to-employer transitions, flows into nonemployment, and flows from nonemployment. We can also define earnings associated with these concepts. Note that while all full quarter jobs are consecutive quarter jobs, not all consecutive quarter jobs are full quarter jobs. We therefore restrict our employment concepts to subsets where full quarter earnings are available for times $t-1$ and t for job stayers and employer-to-employer transitions, time $t-1$ for workers exiting employment, and time t for workers entering employment.

A.1.1 Job Stayers

Job stayers are workers who do not change employers and thus have the same dominant job in times t and $t+1$. Formally,

$$s_{ijt} = \begin{cases} 1, & \text{if } domb_{ijt} = 1 \text{ and } domb_{ijt+1} = 1 \\ 0, & \text{otherwise.} \end{cases}$$

Since job stayers are employed by the same employer in times $t-1$, t, and $t+1$, they at minimum have full quarter earnings observations in time t. For our analysis, we consider job stayers with at least four quarters of consecutive earnings. This means at the very least we have full quarter earnings observations in times t and $t+1$.

A.1.2 Employer-to-Employer Transitions

Workers undergoing an employer-to-employer transition exhibit a change in dominant job, moving from an old employer in time t to a new employer in time $t+1$. Note that in time t, they are receiving earnings from both employers, suggesting they separated from the old employer and started employment with the new employer in the same quarter. Hyatt et al. (2017) consequently refer to these transitions as "within-quarter" job-to-job flows. [23] For this paper, we consider the subset of these transitions where full quarter earnings are available for both the old and new dominant job. Formally, our employer-to-employer transitions are those where:

$$q_{ijkt} = \begin{cases} 1, & \text{if } domb_{ijt} = 1 \text{ and } domb_{ikt+1} = 1 \\ & \text{and } f_{ijt-1} = 1 \text{ and } f_{ikt+1} = 1 \\ & \text{and } j \neq k \\ 0, & \text{otherwise.} \end{cases}$$

A.1.3 Nonemployment Transitions

There are two types of nonemployment transitions. If a worker had a dominant job in time t but not in time $t+1$, then the worker transitioned from employment to nonemployment. Likewise, if a worker does not have a dominant job in time t but does in time $t+1$, then the worker transitioned from nonemployment into employment during time t. For this analysis, we consider the subset of nonemployment transitions that have full quarter earnings observations.

Flows into nonemployment in quarter t are those where:

[23] Note we consider transitions where earnings from the old employer are observed in the quarter immediately preceding the first quarter when earnings at the new employer are observed to be flows into and out of nonemployment since they commonly contain short spells of nonemployment. Hyatt et al. (2017) refer to these transitions as "adjacent-quarter" job-to-job flows.

$$r_{ijt} = \begin{cases} 1, & \text{if } domb_{ijt} = 1 \text{ and } f_{ijt-1} = 1 \\ & \text{and } domb_{ilt+1} \neq 1 \forall l, \\ 1, & \text{if } domb_{ijt} = 1 \text{ and } f_{ijt-1} = 1 \\ & \text{and } domb_{ikt+1} = 1 \text{ and } f_{ikt} = 0 \text{ and } f_{ikt+1} = 0 \\ 0, & \text{otherwise.} \end{cases}$$

Flows from nonemployment into employment in quarter t have full quarter earnings when:

$$n_{ikt} = \begin{cases} 1, & \text{if } domb_{ikt+1} = 1 \text{ and } f_{ikt+1} = 1 \\ & \text{and } domb_{ilt} \neq 1 \forall l \\ 1, & \text{if } domb_{ijt} = 1 \text{ and } f_{ijt-1} = 1 \\ & \text{and } domb_{ikt+1} = 1 \text{ and } f_{ikt} = 0 \text{ and } f_{ikt+1} = 0 \\ 0, & \text{otherwise.} \end{cases}$$

A.2 Earnings

When both quarters in a consecutive quarter pair have full quarter earnings, we use the average of the two as earnings for that job. Otherwise, if only one has full quarter earnings, then we use that quarterly earnings rate. Earnings are defined as follows:

$$e_{ikt} = \begin{cases} \frac{w_{ikt}+w_{ikt+1}}{2}, & \text{if } d_{ikt} = 1 \text{ and } f_{ikt} = 1 \text{ and } f_{ikt+1} = 1 \\ w_{ikt}, & \text{if if } d_{ikt} = 1 \text{ and } f_{ikt} = 1 \text{ and } f_{ikt+1} = 0 \\ w_{ikt+1}, & \text{if if } d_{ikt} = 1 \text{ and } f_{ikt} = 0 \text{ and } f_{ikt+1} = 1 \\ 0, & \text{otherwise.} \end{cases}$$

This helps to ensure symmetry. Consider the following example. For a job stayer in time t whose dominant job spans four quarters from time $t-2$ to time $t+1$, we calculate earnings change from time t to time $t+1$ as the difference between the average of full quarter earnings from times t and $t-1$ and the average of full quarter earnings from times $t+1$ and t. Since full quarter earnings for time t cancel, earnings change ends up being the difference in full quarter earnings between quarters $t+1$ and $t-1$, divided by two. Now, take the case of an employer-to-employer transition where the old job spans from time $t-2$ to time t and the new job spans from time t to time $t+2$. Earnings change is equal to the difference between the full quarter earnings for the new job in time $t+1$ and the old job in time $t-1$. Both calculations thus use full quarter earnings from the same quarters to estimate earnings growth, despite being for different types of job transitions.

Finally, we note that each definition presented in this section has an hours analogue, which we do not list here to save space and avoid redundancy. Each definition also has a wage analogue. To calculate wages, each positive earnings measure is divided by hours.

B Imputation of Hours Worked

For states that do not have hours data in our eleven state data set, hours observations are imputed based on models estimated on observations from four states with data on hours *paid* between 1994 and 2016. This is done separately for each job transition type c. The model is then simulated from the posterior predictive distribution of parameters and imputed values of hours are drawn, see Rubin (1987).

The model takes the following form:

$$h_{itc} = Z_{itc}\sigma_Z^c + M_{itc}\sigma_M^c + G_{itc}\sigma_G^c + Q_{itc}\sigma_Q^c + \mu_{itc}^c$$

where h_{itc} denotes log hours worked for individual i estimated for quarter t and job transition c. The matrix Z_{itc} is a vector of individual-specific characteristics (sex, age, age-squared, education, race, and ethnicity) with marginal effects σ_Z^c, M_{itc} is a vector of employment characteristics (industry group, firm age group, and firm size group) and worker earnings (and earnings-squared and -cubed) with marginal effects σ_M^c, G_{itc} is a vector of destination geography characteristics (average hours worked in state and state unemployment rate) with marginal effects σ_G^c, Q_{itc} is a vector of calendar quarter characteristics (quarter dummies and the number of Fridays in quarter with a lead and a lag) with marginal effects σ_Q^c, and μ_{itc} is an i.i.d. error term. All continuous variables are defined in logs.

The point estimates from a diagnostic regression are provided in Table B1 where c is defined over stayers, employer-to-employer transitions, and entrants for exposition. The regressions estimated in the model are done on a finer level of disaggregation before any averaging is done as detailed in Appendix A. These disaggregated regressions are not reported here since our three labor transition types already show evidence of substantial explanatory power.

It is important to point out some limitations in our hours impute. We do not allow for any state-fixed effects that account for systematic differences in hours paid across states beyond those accounted for by observable explanatory variables such as worker demographic and firm characteristics. Furthermore, if states have idiosyncratic components that have an effect on cyclical fluctuations on earnings, hours, and wages, then these components are magnified through the hours impute. In Appendix C, we further evaluate the quality of our hours impute by comparing our hours and wage series with those available from other available sources.

Table B1: Destination Hours Impute - Point Estimates

	Stayers	**Emp. to Emp.**	**Entrants**
Destination Earnings	-0.502^{***}	-0.246^{***}	-1.143^{***}
	(0.012)	(0.067)	(0.037)
Destination Earnings^2	0.281^{***}	0.235^{***}	0.367^{***}
	(0.001)	(0.009)	(0.005)
Destination Earnings^3	-0.017^{***}	-0.014^{***}	-0.021^{***}
	(0.000)	(0.000)	(0.000)
Tenure	-0.020^{***}	0.000	0.000
	(0.000)	-	-
Age	-0.011^{***}	-0.023^{***}	-0.017^{***}
	(0.000)	(0.000)	(0.000)
Age^2/1000	0.098^{***}	0.218^{***}	0.148^{***}
	(0.000)	(0.000)	(0.000)
CPS Avg. Hours	-0.001^{**}	0.006^{**}	0.003
	(0.000)	(0.003)	(0.002)
Unemployment Rate	-0.001^{***}	0.000	0.002^{***}
	(0.000)	(0.001)	(0.001)
Quarter	-0.002^{***}	-0.005^{***}	-0.006^{***}
	(0.000)	(0.000)	(0.000)
Quarter^2/1000	0.012^{***}	0.032^{***}	0.038^{***}
	(0.000)	(0.000)	(0.000)
Spring	-0.005^{***}	0.013^{***}	0.016^{***}
	(0.001)	(0.004)	(0.003)
Summer	-0.010^{***}	0.012^{***}	0.030^{***}
	(0.001)	(0.004)	(0.003)
Fall	-0.007^{***}	0.001	0.015^{***}
	(0.001)	(0.004)	(0.003)
No. of Fridays	0.008^{***}	0.014^{**}	0.005
	(0.001)	(0.006)	(0.005)
R^2	0.642	0.660	0.747

Notes: Variables included in the diagnostic regression but not included in the table above are dummy variables for worker demographics (sex, race, level of completed education) and destination firm chracteristics (industry group, firm age group, firm size category). Stayers indicates job stayers. Emp. to Emp. indicates employer-to-employer transitions. Entrants indicates workers entering employment from nonemployment. * denotes statistical significance at the 10% confidence level, ** at the 5% confidence level, and *** at 1% confidence level.

C Comparability of LEHD Earnings, Hours, and Wages to Other U.S. Data Sources

Figure C1 shows the trend in earnings for our eleven state data set and compares it with other earnings series available from sources like the Current Employment Statistics (CES), Current Population Survey (CPS), Employer Cost of Employee Compensation Survey (ECEC), and the Quarterly Census of Employment and Wages (QCEW). While there are notable differences between the various earnings series [24], all of them trend upward and have sharp increases during the late 1990s. Our series shows higher levels of wage and salary compensation from employers than others, with the exception of ECEC's total compensation line, which includes employee benefits like health insurance and is therefore greater on a per-worker basis, and the LEHD QWI line. However, it also tracks both the Average Weekly Wage (QCEW) and LEHD QWI series fairly closely.[25] This suggests the differences we see in the figure can generally be attributed to differences in data sources and tabulation strategies. We additionally ran correlations between all of the series and two cyclical indicators, the real GDP and the unemployment rate, and find our earnings series is moderately procyclical. In contrast, the Average Weekly Wages and LEHD QWI series are much more procyclical while the other series are nearly acyclical or even slightly countercyclical. See Table C1.

Table C1: Correlations - Earnings

Source	**Series**	**Real GDP**	**Unemployment Rate**
LEHD 11 State	Avg Quarterly Earnings	0.458	-0.351
LEHD 4 State	Avg Quarterly Earnings	0.481	-0.381
LEHD QWI	Avg Quarterly Earnings	0.732	-0.556
QCEW	Avg Weekly Wages	0.610	-0.382
CES	Avg Weekly Earnings	0.013	0.053
CPS	Median Weekly Earnings	-0.175	0.327
ECEC	Wages and Salary	-0.142	0.200
ECEC	Total Compensation	-0.125	0.177

Notes: Real GDP is the first difference of the log of the seasonally-adjusted and Henderson-filtered real GDP and is in log 2014 constant dollars. Unemployment Rate is the first difference of the log of the seasonally-adjusted national unemployment rate. Correlations with these cyclical indicators were calculated using the first difference of the log of the seasonally-adjusted and Henderson-filtered earnings series from 1996Q1 to 2015Q4. All earnings series are in log 2014 constant dollars.

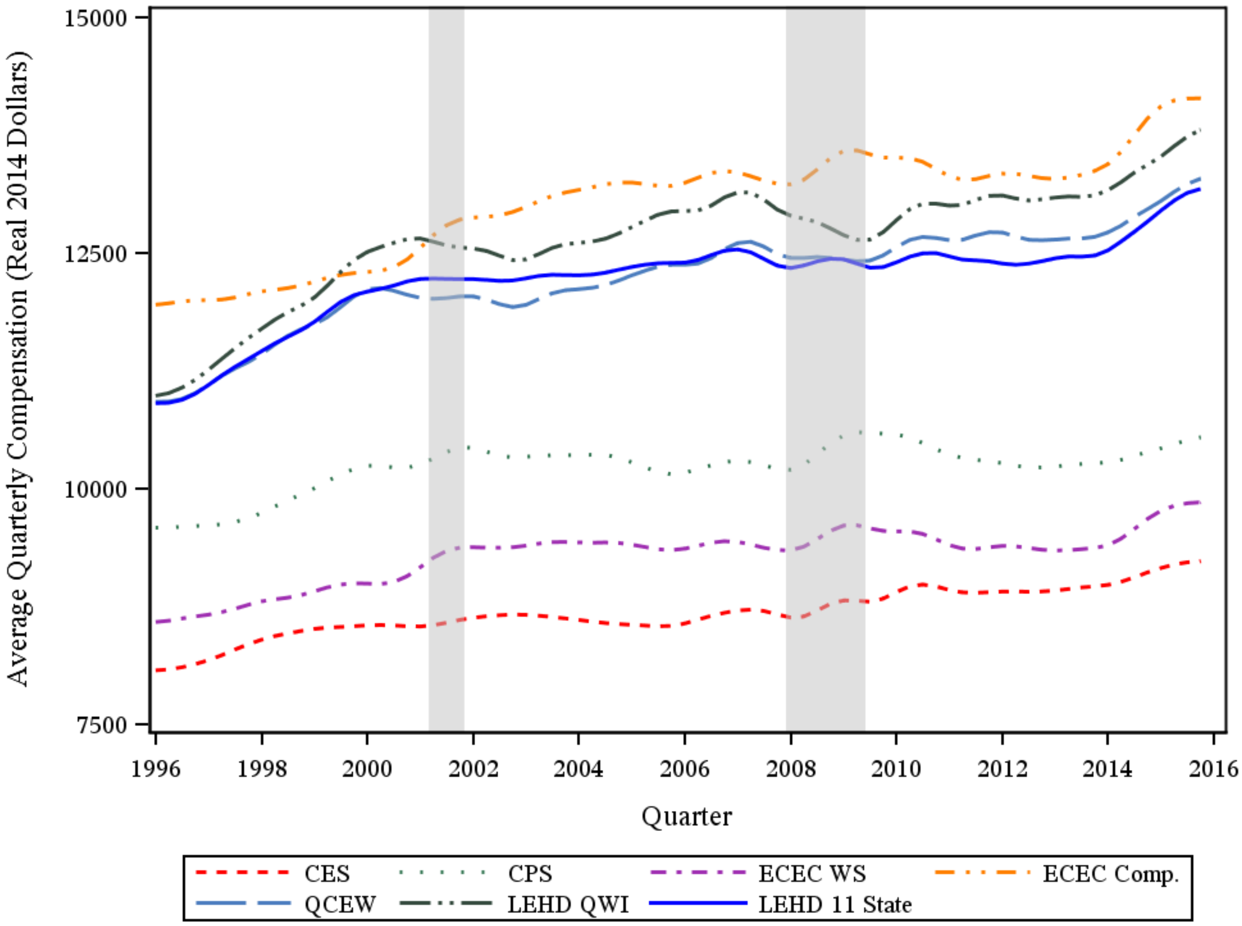
In Figure C2, we present our imputed hours series from our eleven state data set alongside hours series available from the CES and CPS[26]. We also include our non-imputed hours series from our

[24] These have been noted by Abraham, Spletzer, and Stewart (1998), as well as Champagne, Kurmann, and Stewart (2016).

[25] Of these, we expect our series to be most similar to the Average Weekly Wage series created as part of the Quarterly Census of Employment and Wages (QCEW) and the Average Monthly Earnings series from LEHD's Quarterly Workforce Indicators (LEHD QWI). All three rely on the QCEW and use universe-level, employer-reported total wage and salary payments calculated from administrative records. The difference between them primarily lies in the types of jobs included in the average. The Average Weekly Wage series counts jobs where workers are employed during the week of the 12th in the third month of the quarter while the Average Monthly Earnings series from the LEHD QWI includes all jobs that span at least three consecutive quarters. Our series is essentially a subset of the latter as it includes all *dominant* jobs that span at least three consecutive quarters.

[26] The CPS hours series is created from microdata available from IPUMS (Flood et al., 2017).

Figure C1: Trends in Average Compensation and Earnings in the U.S., 1996-2015



Notes: All values are in 2014 constant dollars and have been seasonally adjusted and Henderson-filtered using x12. Shaded areas indicate recessions. CES indicates the Current Employment Statistics' average weekly earnings series for production and nonsupervisory employees in the private sector, multiplied by 13. CPS indicates the Current Population Survey's median usual weekly earnings series for full-time wage and salary workers in all industries and occupations who are 16+ years old, multiplied by 13. ECEC WS indicates the Employer Costs of Employee Compensation Survey's cost per hour worked (wages and salaries) series of all private industry employees for all occupations, multiplied by 13 and 34.5. ECEC Comp. indicates the Employer Costs of Employee Compensation Survey's cost per hour worked (total compensation, including wages and salaries and benefit compensation) of all private industry employees for all occupations, multiplied by 13 and 34.5. QCEW indicates the Bureau of Labor Statistics' average weekly earnings series of all employees in the private sector, multiplied by 13. LEHD QWI indicates the LEHD Quarterly Workforce Indicators' average monthly earnings series of employees with stable jobs, (i.e. worked with the same firm throughout the quarter), multiplied by 3. LEHD 11 State indicates our average earnings series from our eleven state sample.

Table C2: Correlations - Hours

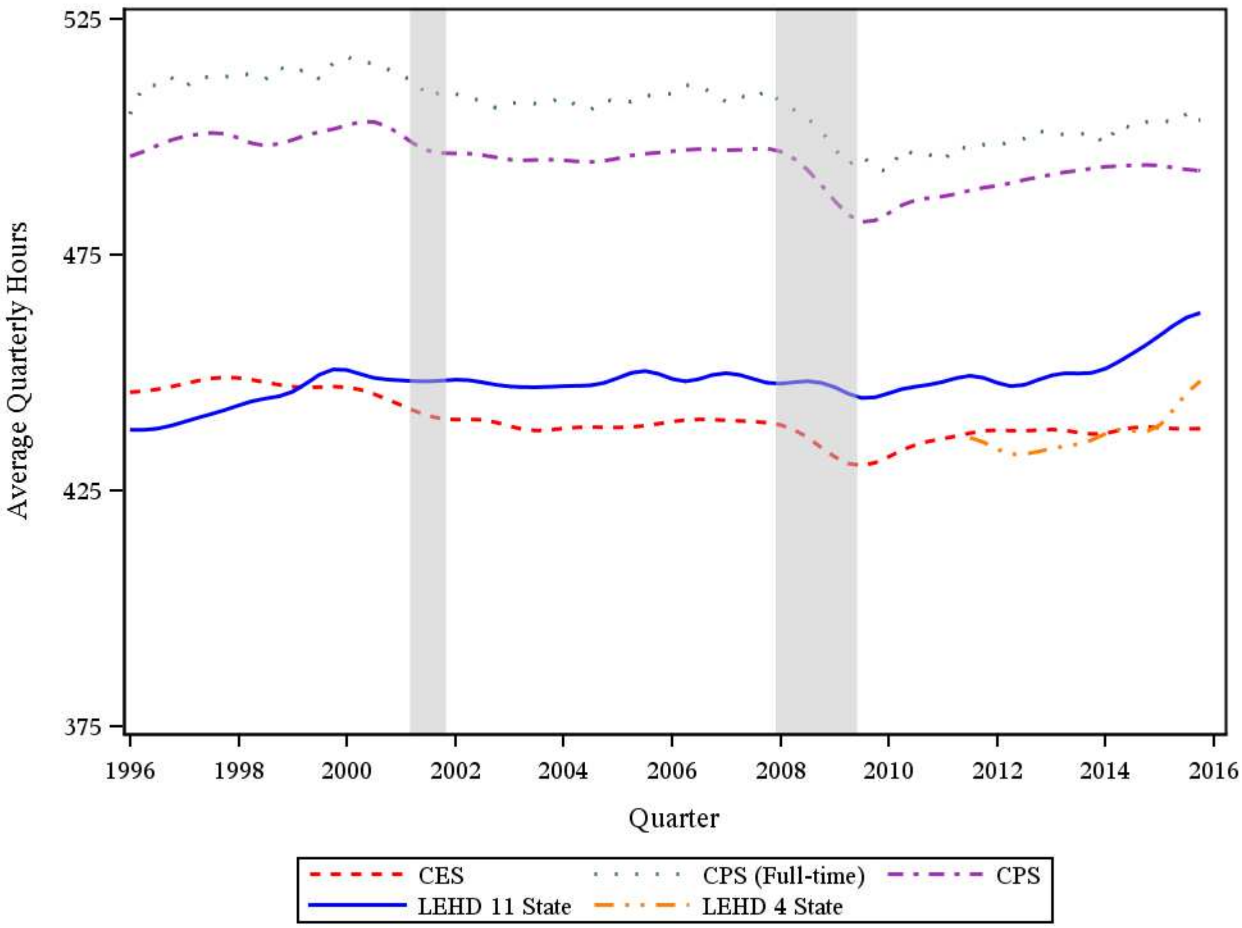
Source	Series	Real GDP	Unemployment Rate
LEHD 11 State	Avg Quarterly Hours	0.372	-0.430
LEHD 4 State	Avg Quarterly Hours	-0.303	-0.076
CES	Avg Weekly Hours	0.597	-0.685
CPS	Avg Weekly Hours (Full-Time)	0.351	-0.356
CPS	Avg Weekly Hours	0.701	-0.712

Notes: Real GDP is the first difference of the log of the seasonally-adjusted and Henderson-filtered real GDP and is in log 2014 constant dollars. Unemployment Rate is the first difference of the log of the seasonally-adjusted national unemployment rate. Correlations with these cyclical indicators were calculated using the first difference of the log of the seasonally-adjusted and Henderson-filtered hours series from 1996Q1 to 2015Q4.

four state data set, which is shown here from 2011Q3 on as hours data for the four states are only complete beginning in that quarter. Overall, our imputed hours series appears to be comparable to the three outside hours series between 2000 and 2014. It lies consistently above the CES line and below the two CPS lines and exhibits similar behaviors with all series indicating hours remained constant until the 2007-2009 recession when they declined. While the CES, CPS (Full-Time), and CPS lines exhibit larger drops in hours than our imputed hours series, all show a slight recovery in hours after 2010. Outside 2000-2014, our imputed series shows sharp increases in hours when the other lines are mostly flat. However, we believe this difference in trend is not due to the quality of our hours impute as our non-imputed series also increases at a similar rate after 2014. Correlations between these hours series and the cyclical indicators show the CES and CPS series are highly procyclical while the CPS (Full-Time) and our imputed hours series are much less so. These are shown in Table C2.

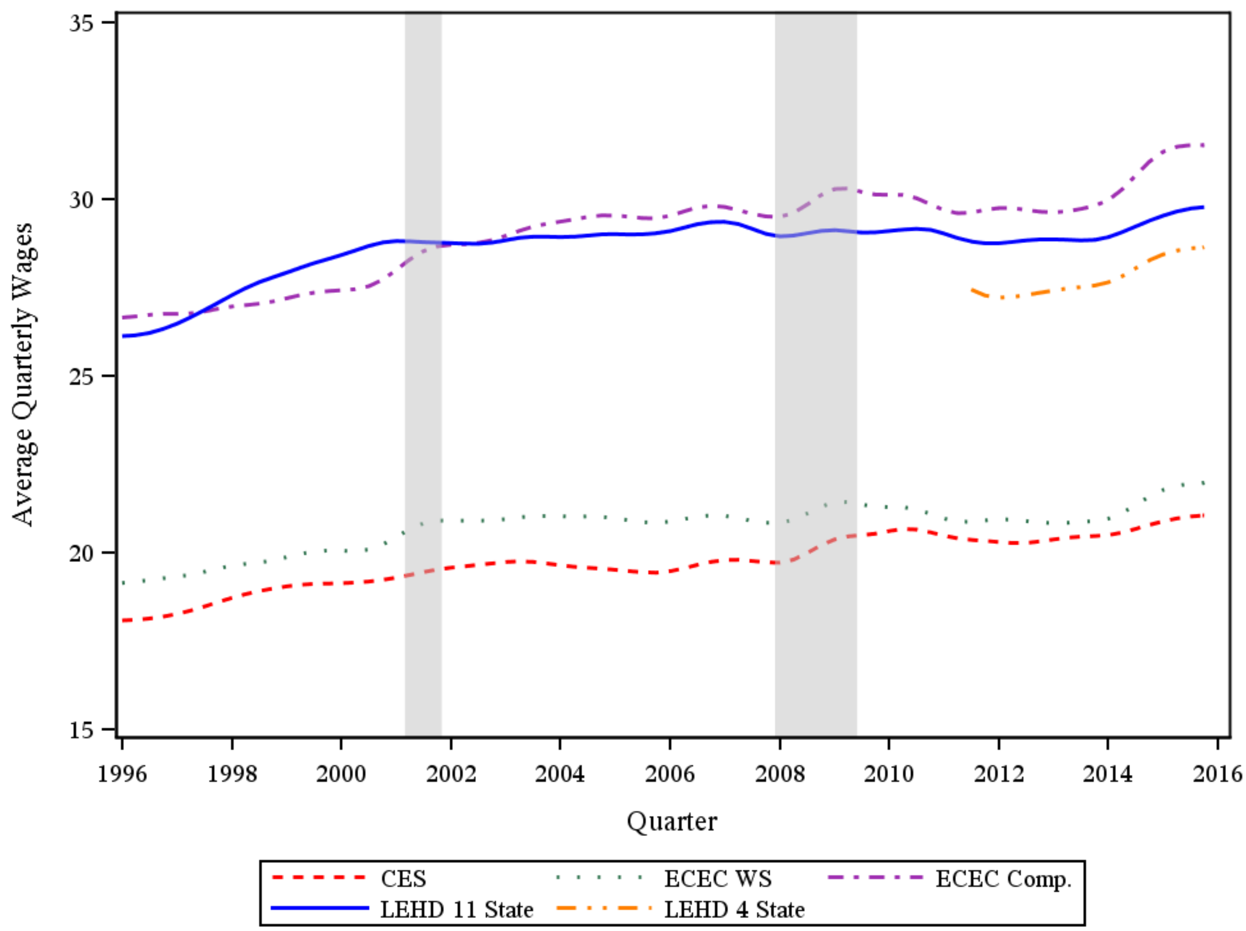
Figure C3 shows our imputed wage series from our eleven state data set as well as other wage series available from the CES and ECEC. Also included is our non-imputed wage series from our four state data set, again only shown from 2011Q3 on when hours data are complete. Our imputed wage series is similar in trend to the others in the figure. All lines suggests wages rose on average during the late 1990s and were mostly flat afterwards. While the other series show a slight increase in wages during the 2007-2009 recession, our imputed series suggests wages remained roughly the same. However, all lines do display a slight increase in wages at the end of the time series. Our imputed series is substantially higher than the others, with the exception of the ECEC's total compensation line, but it is similar in level to our non-imputed series suggesting our hours impute is functioning well. Correlations in Table C3 between these wage series and the cyclical indicators reveal our imputed and non-imputed series are procyclical while those from the CES and ECEC are countercyclical.

Figure C2: Trends in Average Hours in the U.S., 1996-2015



Notes: All values have been seasonally adjusted and Henderson-filtered using x12, unless indicated otherwise below. Shaded areas indicate recessions. CES indicates the Current Employment Statistics' average weekly hours series for production and nonsupervisory employees in the private sector, multiplied by 13. CPS (Full-Time) indicates the Current Population Survey's seasonally adjusted average total hours at work series for workers in all industries who are 16+ years, multiplied by 13. CPS indicates the Current Population Survey's hours worked last week series, multiplied by 13; the average was calculated directly from the microdata (see text). LEHD 11 State indicates our average imputed hours series from our eleven state sample. LEHD 4 State indicates our average non-imputed hours series from our four state sample. This series begins in 2011Q3 when the hours data for the four state data set is complete.

Figure C3: Trends in Average Wages in the U.S., 1996-2015



Notes: All values are in 2014 constant dollars and have been seasonally adjusted and Henderson-filtered using x12. Shaded areas indicate recessions. CES indicates the Current Employment Statistics' average hourly earnings series for production and nonsupervisory employees in the private sector, multiplied by 13. ECEC WS indicates the Employer Costs of Employee Compensation Survey's cost per hour worked (wages and salaries) series of all private industry employees for all occupations, multiplied by 13. ECEC Comp. indicates the Employer Costs of Employee Compensation Survey's cost per hour worked (total compensation, including wages and salaries and benefit compensation) of all private industry employees for all occupations, multiplied by 13. LEHD 11 State indicates our average imputed wage series from our eleven state sample. LEHD 4 State indicates our average non-imputed wage series from our four state sample. This series begins in 2011Q3 when the hours data for the four state data set is complete.

Table C3: Correlations - Wages

Source	Series	Real GDP	Unemployment Rate
LEHD 11 State	Avg Quarterly Wages	0.446	-0.267
LEHD 4 State	Avg Quarterly Wages	0.303	-0.146
CES	Avg Hourly Earnings	-0.279	0.363
ECEC	Hourly Cost of Wages and Salaries	-0.142	0.200
ECEC	Hourly Cost of Compensation	-0.125	0.177

Notes: Real GDP is the first difference of the log of the seasonally-adjusted and Henderson-filtered real GDP and is in log 2014 constant dollars. Unemployment Rate is the first difference of the log of the seasonally-adjusted national unemployment rate. Correlations with these cyclical indicators were calculated using the first difference of the log of the seasonally-adjusted and Henderson-filtered wage series from 1996Q1 to 2015Q4. All wage series are in log 2014 constant dollars.

D Earnings and Employment Shares Over Time by Transition Type

Summary statistics that document the basic features of our four state and eleven state data sets are shown in Table D1. Each dataset detailed below consists of a one percent sample from the employed population in each group of states. See Section 2.2 for a detailed listing of the states found in each group.

Table D1: Summary Statistics

Statistic	Overall	Stayers	Emp. to Emp.	Residual
Four States with Observed Hours Data, Unbalanced Panel of States				
Average Earnings	12097	12559	7981	7923
Average Hours	438	445	383	369
Average Wages	27	28	21	21
Average Employment Share	100	85	4	12
Eleven States with Earnings 1996-2015, Mostly Imputed Hours and Wages				
Average Earnings	12203	12905	8042	6812
Average Hours	438	461	393	337
Average Wages	29	30	21	20
Average Employment Share	100	81	4	15

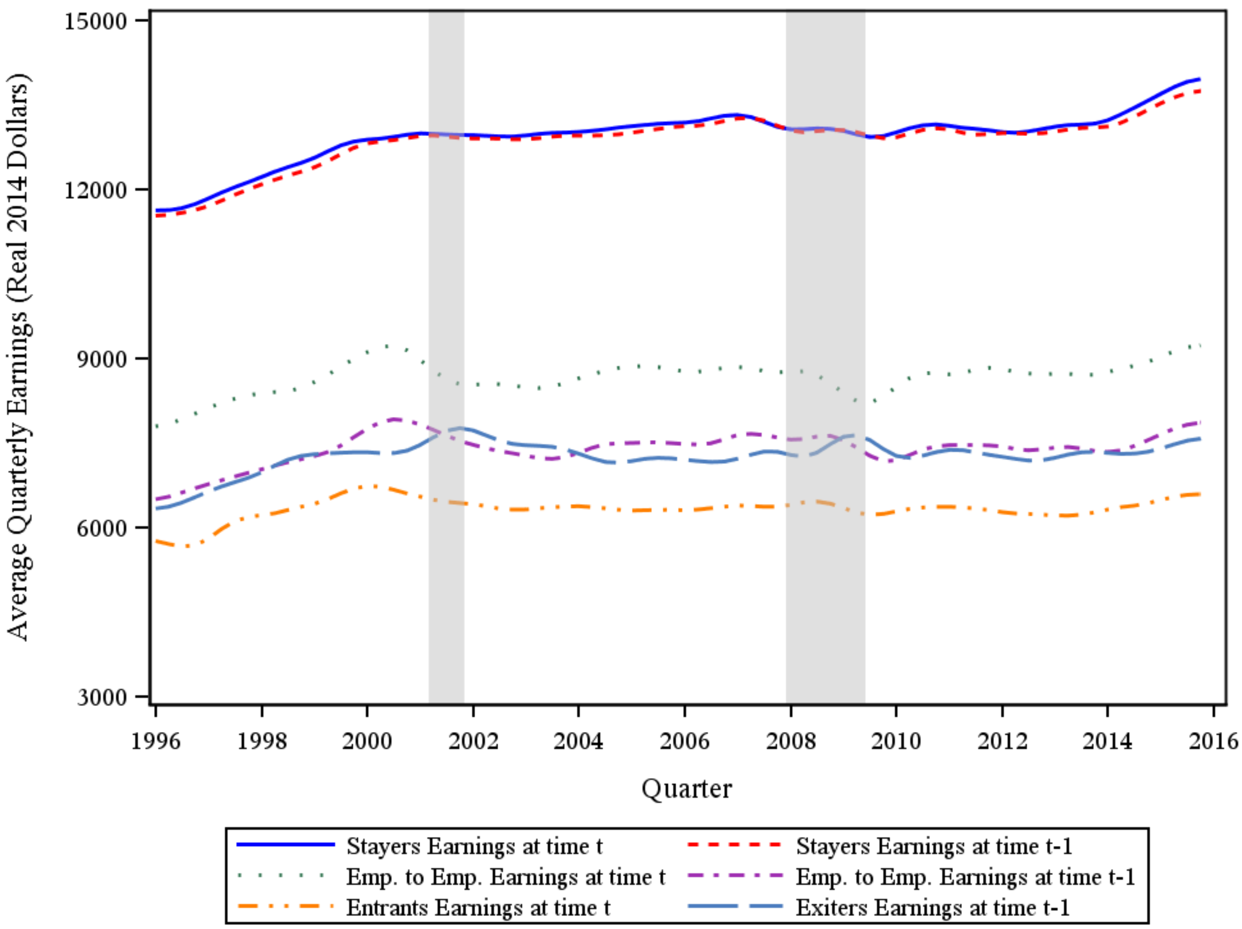
Notes: Summary statistics are presented for two analysis datasets. The top set are of the non-imputed earnings, hours, and wages data from four states. The bottom set are of the non-imputed earnings data and mostly imputed hours and wages data from eleven states. Sample size is the number of unique persons (PIKs) from 1996Q1 to 2015Q4. Average Earnings, Hours, and Wages are the averages of quarterly averages from 1996Q1 to 2015Q4. Quarterly averages are calculated as the average of the means in quarters t and t-1. Average Employment Share is the average employment share from 1996Q1 to 2015Q4. Overall indicates the overall average. Stayers the average for job stayers. Emp. to Emp. the average for those changing employers. Residual the average for those entering and exiting nonemployment.

While we focus on growth in earnings for the majority of our analysis, it is useful to document the earnings levels data that is the basis for our analysis. Figure D1 shows average earnings for job stayers, employer-to-employer transitions, and flows into and out of nonemployment. Job stayers in times $t-1$ and t have the highest average earnings and exhibit incremental increases from time $t-1$ to time t. These increases are smallest during economic downturns (indicated by shaded areas). The next to highest earnings levels are found in the earnings of job-to-job flows in time t. These earnings tend to be markedly higher, about $3,000 more, than earnings for the same workers in time $t-1$. The remaining lines show earnings of workers transitioning into and from nonemployment. Earnings of exiters in time $t-1$ tend to be about $500 greater than earnings of entrants in time t, which can be attributed to tenure and composition effects. Figure D2 shows the same figure in logs.

Since we decompose earnings growth into change in average earnings and change in shares by type of job transition, it is also important to look at how employment shares have changed over the past two decades. In Figure D, we see employment is generally dominated by job stayers. In the late 1990s, this group of workers made up roughly 86% of employment. This share subsequently increased by about 3%, largely due to a level shift after the 2001 recession, and has remained just under 90% since 2010. Meanwhile, the share of employer-to-employer transitions fell from 5% in the late 1990s to a low of 3% after the 2007-2009 recession. It has subsequently returned to levels seen before the 2001 recession and is approximately 5% again. The shares of entrants and exiters started at roughly 9% of employment in the beginning of the time series but have decreased, mostly during recessions, to 7%.

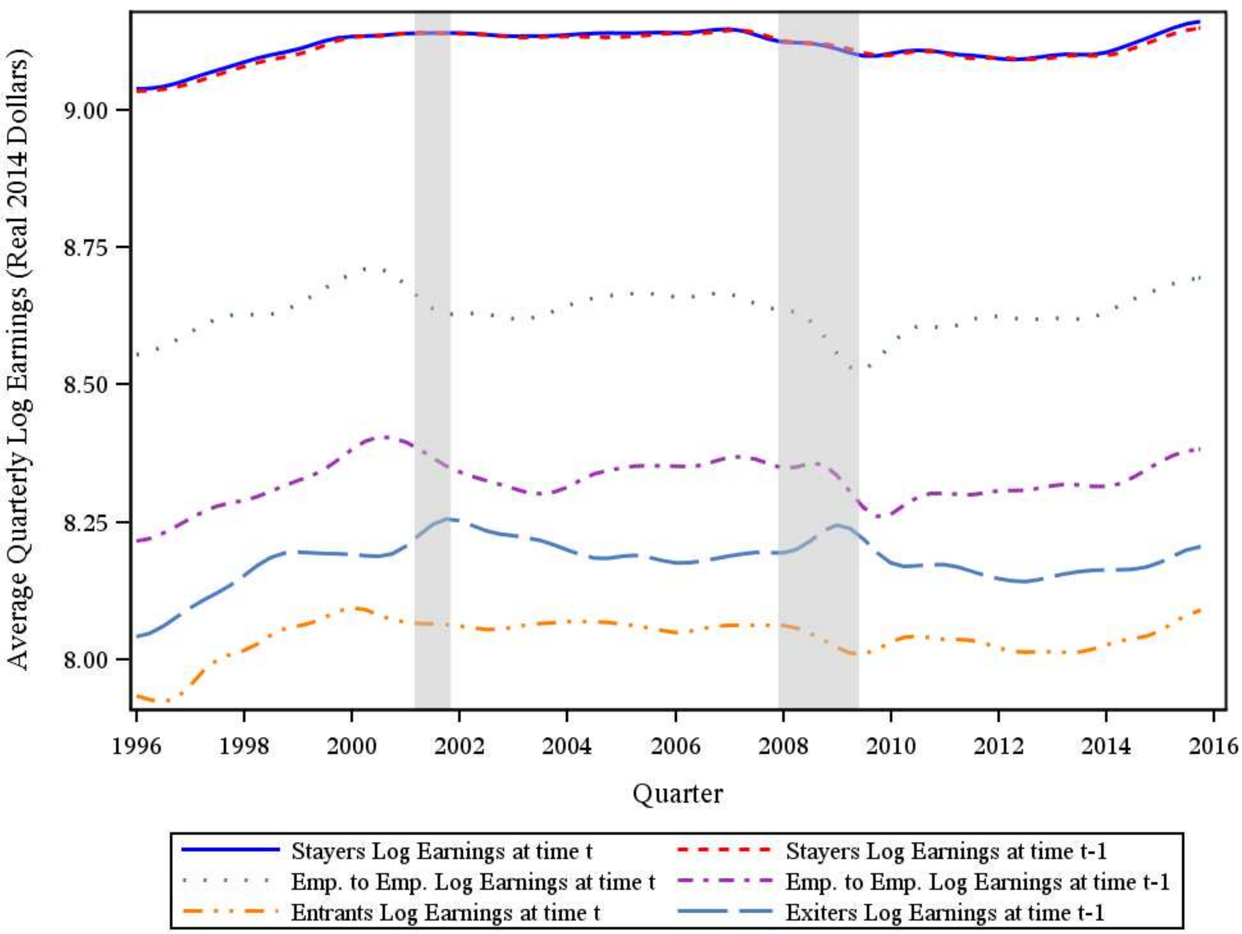
For workers who have full quarter earnings in times $t-1$ and t, i.e. job stayers and employer-to-employer transitioners, it is also important to note their shares vary depending on whether employment at time $t-1$ or t is used as the denominator. In the U.S., employment typically grows from time $t-1$ to time t, so employment shares by type of job transitions, and consequently contributions to the average, change even though the numerator remains the same. To better understand this, consider job stayers. When employment grows, the number of job stayers in time t remains the same but their share is lower when the denominator is employment in time t compared to employment in time $t-1$. In Figure D, we see the solid blue line is generally lower than the red line. This is similarly the case, although to a far smaller degree, for employer-to-employer transitioners.

Figure D1: Average Quarterly Earnings for Stayers and Transitioners in the U.S., 1996-2015



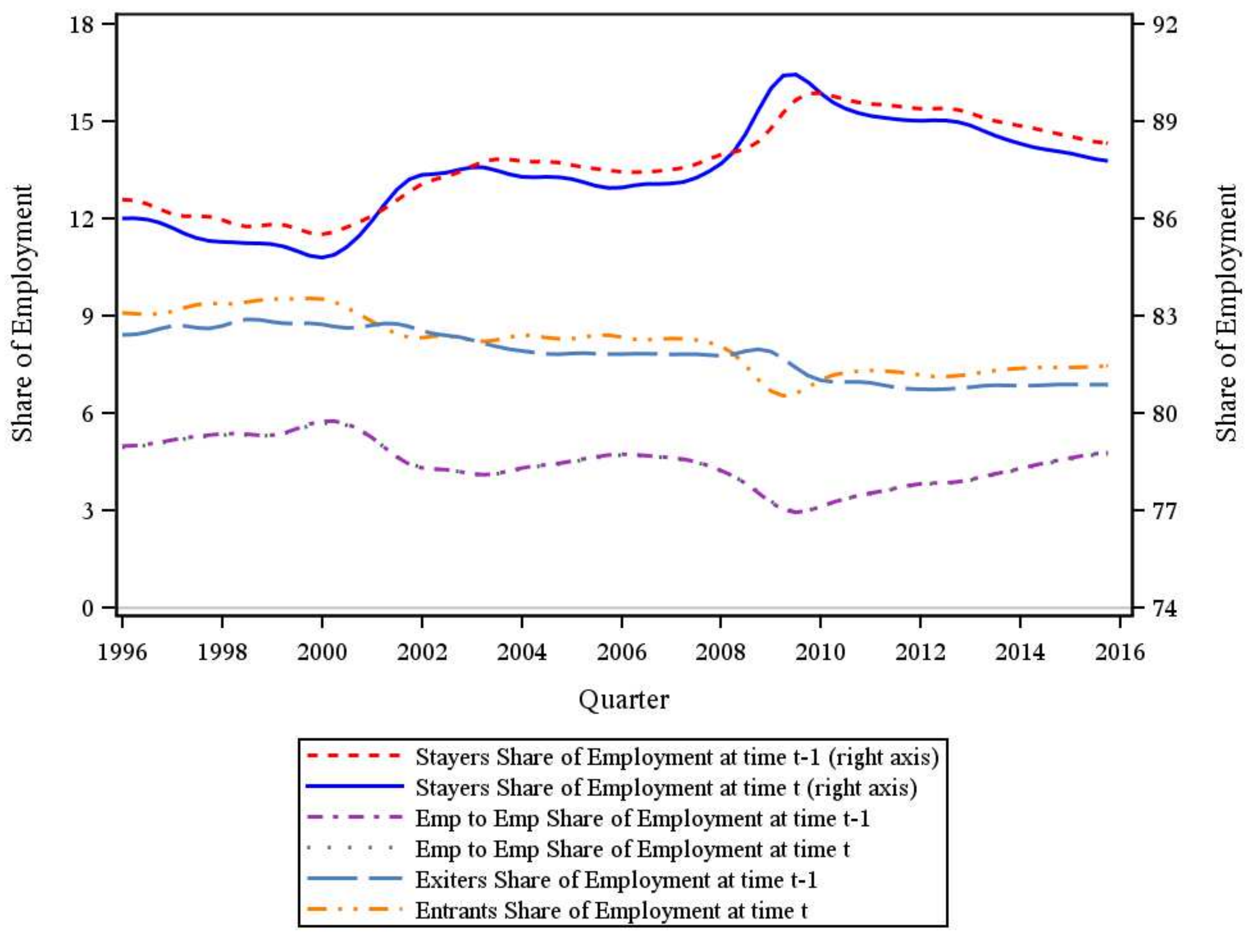
Notes: All data are presented in 2014 constant dollars, and are seasonally-adjusted and Henderson-filtered using x12. Shaded areas indicate recessions. Stayers Earnings at time t indicates the earnings of job stayers in time t. Stayers Earnings at time $t-1$ indicates the earnings of job stayers in time $t-1$. Emp. to Emp. Earnings at time t indicates the earnings of employer-to-employer transitions in time t. Emp. to Emp. Earnings at time $t-1$ indicates the earnings of employer-to-employer transitions in time $t-1$. Entrants Earnings at time t indicates the earnings of workers entering employment from nonemployment in time t. Exiters Earnings at time $t-1$ indicates the earnings of workers exiting employment into nonemployment in time $t-1$.

Figure D2: Average Quarterly Log Earnings for Stayers and Transitioners in the U.S., 1996-2015



Notes: All data are presented in log 2014 constant dollars, and are seasonally-adjusted and Henderson-filtered using x12. Shaded areas indicate recessions. Stayers Log Earnings at time t indicates the log earnings of job stayers in time t. Stayers Log Earnings at time $t-1$ indicates the log earnings of job stayers in time $t-1$. Emp. to Emp. Log Earnings at time t indicates the log earnings of employer-to-employer transitions in time t. Emp. to Emp. Log Earnings at time $t-1$ indicates the log earnings of employer-to-employer transitions in time $t-1$. Entrants Log Earnings at time t indicates the log earnings of workers entering employment from nonemployment in time t. Exiters Log Earnings at time $t-1$ indicates the log earnings of workers exiting employment into nonemployment in time $t-1$.

Figure D3: Share of Employment Transitions, 1996-2015



Notes: All data are seasonally-adjusted and Henderson-filtered using x12. Shaded areas indicate recessions. Stayers Share of Employment at time $t-1$ indicates the number of job stayers divided by employment in time $t-1$. Stayers Share of Employment at time t indicates the number of job stayers divided by employment in time t. Emp. to Emp. Share of Employment at time $t-1$ indicates the number of employer-to-employer transitions divided by employment in time $t-1$. Emp. to Emp. Share of Employment at time t indicates the number of employer-to-employer transitions divided by employment in time t. Exiters Share of Employment at time $t-1$ indicates the number of workers exiting employment into nonemployment divided by employment in time $t-1$. Entrants Share of Employment at time t indicates the number of workers entering employment from nonemployment divided by employment in time t.

E Additional Results

In Table E1, we apply a common sample selection technique that dates at least back to Bils (1985) and drops nonemployment transitions that have a relatively long duration. We also drop recalls. Regressions run on this restricted sample have some small differences relative to our main results in Table 1. New hires from nonemployment appear to respond differently to changes in the unemployment rate from new hires from other employers. This is especially apparent in the first difference specification, where earnings of new hires from nonemployment respond much more strongly to changes in the unemployment rate.

The average change in earnings, hours, and wages in levels and by component is shown in Figure E1. The main differences relative to Figure 1 are the contributions of nonemployment and employer-to-employer transitions to earnings and wages. In levels, nonemployment transitions detract and employer-to-employer transitions contribute comparatively less to earnings and wage growth. In contrast, the relative contributions to hours are qualitatively similar to the results in logs. This is a natural consequence of the log transformation, which gives proportionately more weight to changes in earnings and wages for workers who earn relatively little. For example, a roughly 10% proportionate earnings change from an employer-to-employer transition for a low-earnings worker will contribute more to the average after a log transformation than before. These earnings gains are still driven by gains in hours.

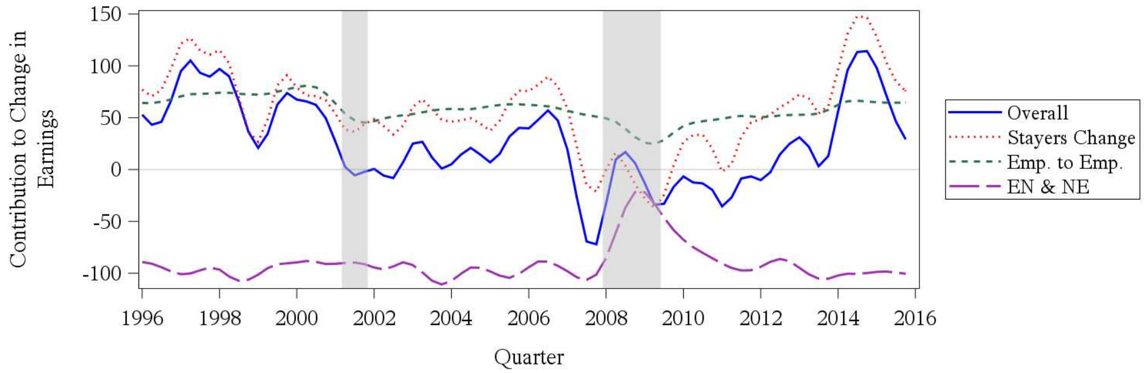
Table E1: Unemployment Rate Regressions: Dropping Recalls and Long Nonemployment Spells

	First Difference			Person-specific Fixed Effects			Match-specific Fixed Effects		
	Earnings	Hours	Wages	Earnings	Hours	Wages	Earnings	Hours	Wages
				Four States with Observed Hours Data, Unbalanced Panel of States					
Baseline	-0.008^{***}	-0.007^{***}	-0.002^{***}	-0.018^{***}	-0.009^{***}	-0.009^{***}	-0.009^{***}	-0.005^{***}	-0.004^{***}
(γ_1)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
New hire:	-0.035^{***}	-0.014^{***}	-0.020^{***}	-0.019^{***}	-0.012^{***}	-0.006^{***}	-0.003^{***}	-0.005^{***}	0.002^{***}
Emp. (γ_2)	(0.004)	(0.004)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
New hire:	-0.097^{***}	-0.051^{***}	-0.038^{***}	-0.014^{***}	-0.008^{***}	-0.005^{***}	-0.004^{***}	-0.004^{***}	0.000
Nonemp. (γ_3)	(0.004)	(0.004)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
				Eleven States with Earnings 1996-2015, Mostly Imputed Hours and Wages					
Baseline	-0.008^{***}	-0.003^{***}	-0.006^{***}	-0.014^{***}	-0.006^{***}	-0.009^{***}	-0.009^{***}	-0.002^{***}	-0.007^{***}
(γ_1)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
New hire:	-0.062^{***}	-0.029^{***}	-0.033^{***}	-0.018^{***}	-0.012^{***}	-0.006^{***}	-0.003^{***}	-0.004^{***}	0.000
Emp. (γ_2)	(0.001)	(0.002)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
New hire:	-0.101^{***}	-0.028^{***}	-0.060^{***}	-0.014^{***}	-0.007^{***}	-0.007^{***}	-0.003^{***}	-0.002^{***}	-0.001^{***}
Nonemp. (γ_3)	(0.002)	(0.002)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

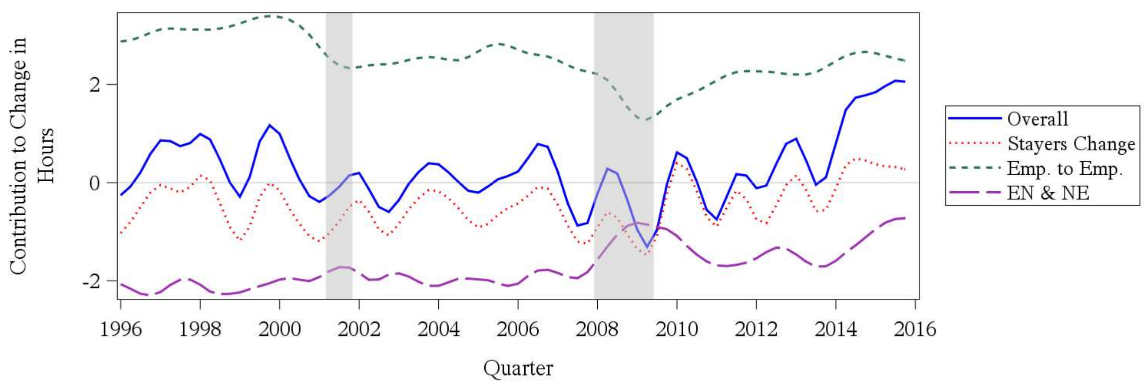
Regressions were run using two analysis datasets. The top set of results are from regressions using non-imputed, disaggregated earnings, hours, and wages data from four states. The bottom set of results are from regressions using non-imputed, disaggregated earnings data and mostly imputed, disaggregated hours and wages data from eleven states. Regressions were run using a first difference specification as well as with person-specific fixed effects and match-specific fixed effects. They were further restricted to exclude flows to and from nonemployment that were recalls to a previous job as well as those that involved nonemployment spells longer than five quarters. Additional control variables for all three specifications include age, job tenure, and various dummy variables that indicate whether a worker is newly hired from another employer or nonemployment, whether it is the last quarter of a specific employer-employee match by type of new hire, and specific time trends and seasonal effects that are specific to particular transition types. Earnings and wages series are presented in log 2014 constant dollars. γ_1 is the parameter estimate for the seasonally-adjusted national unemployment rate u_t, and provides the responsiveness of job stayers. γ_2 is the parameter estimate for the interaction term of the seasonally-adjusted national unemployment rate and a flag for a new hire from an employer-to-employer transition $u_t q_{it}$, i.e., the responsiveness of employer-to-employer transition hires relative to stayers. γ_3 is the parameter estimate for the interaction term of the seasonally-adjusted national unemployment rate and a flag for flows from nonemployment to employment $u_t n_{it}$, i.e., the responsiveness of new hire from nonemployment relative to stayers * denotes statistical significance at the 10% confidence level, ** at the 5% confidence level, and *** at 1%.

Figure E1: Average Change and Contribution by Component, in Levels

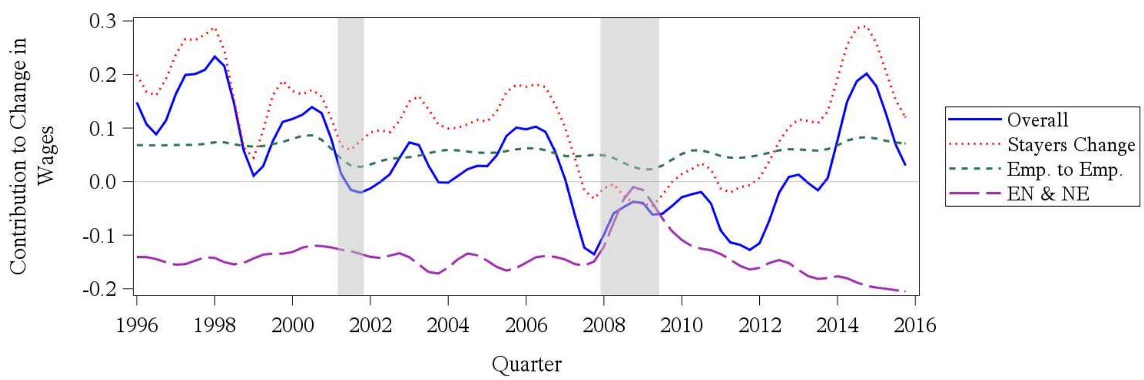
(a) Earnings



(b) Hours



(c) Wages



Notes: All series have been seasonally-adjusted and Henderson-filtered using x12. Earnings and wages series are presented in 2014 constant dollars. Shaded areas indicate recessions. Overall indicates the total change. Stayers indicates the component attributable to the change for job stayers multiplied by the average share of job stayers. Emp. to Emp. indicates the component attributable to the change for employer-to-employer transitions multiplied by the average share of employer-to-employer transitions. EN & NE indicates the sum of the component attributable to the difference between entrants and exiters multiplied by the average share of entrants and exiters and the change in share of employment where data are observable multiplied by the average for that quarter.