Job-to-Job Flows:
New Statistics on Worker Reallocation and Job Turnover

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1 Introduction

In late 2014, the U.S. Census Bureau begins release of new beta national statistics on worker reallocation in the United States. Job-to-Job Flows (J2J) provide data on worker flows resulting from job change as well as hires and separations from and to persistent nonemployment spells. Also included in the new statistics are origin-destination data on workers changing jobs. This is unique data allowing a comprehensive look at the reallocation of workers across different sectors and regions of the U.S. economy. For example, J2J data by industry allow the decomposition of employment declines in an industry by shares of workers moving to other industries vs. worker

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flows to persistent nonemployment. J2J origin-destination data by state allow examination of economic migration of workers within the United States. Earnings changes associated with job change, another new feature of J2J, can help analysts better understand the nature of job ladders and lifetime earnings growth.

In this paper, we describe the methodology used to generate statistics on the flows of workers across jobs. We begin by describing the source data and how we identify worker movements between employers. We then explain the types of job transitions tabulated and provide some basic statistics on the rate of job change in the United States. We then compare the J2J data to available statistics on quits, layoffs, and employer-to-employer flows tabulated from survey sources. In the last sections of the paper, we describe how the data is protected and our methodology for estimating national statistics when there is partially missing geography.

2 Identifying Flows of Workers Between Jobs

Job-to-Job Flows are derived from the Longitudinal Employer-Household Dynamics (LEHD) data at the U.S. Census Bureau. The LEHD data consist of quarterly worker-level earnings submitted by employers for the administration of state unemployment insurance (UI) benefit programs, linked to establishment-level data collected for the Quarterly Census of Employment and Wages (QCEW) program. As of this writing, all 50 states, DC, Puerto Rico, and the Virgin Islands share QCEW and UI wage data with the LEHD program as part of the Local Employment Dynamics federal-state partnership. LEHD data coverage is quite broad; state UI covers 95% of private sector employment, as well as state and local government. Demographic data come from survey, Census, and administrative record sources.[2] The LEHD program recently linked data on national firm age and size from the Business Dynamics Statistics to LEHD establishments (see Haltiwanger et al., 2014, for details).

Some notation is necessary to understand how we identify job-to-job transitions in the LEHD administrative data. First and foremost, we must clarify what we mean by a job, which in the LEHD data is identified from quarterly wage data provided by firms to state governments for the administration of unemployment insurance programs. We say that individual i is employed at firm j in time t if the worker receives positive wages w from that firm in quarter t. Formally:

[2] For detailed description of the LEHD data, see Abowd et al. (2009) and Abowd, Haltiwanger, and Lane (2004).

$$m_{ijt} = \begin{cases} 1, \text{ if } w_{ijt} > 0 \\ 0, \text{otherwise} \end{cases}$$

Instead of linking every job in a worker's employment history, J2J links only the main jobs held on the first day of the quarter. Thus, a worker whose main job was at firm A on January 1st and firm C on April 1st would be identified as having a job-to-job flow from A to C during the quarter, even if shorter transitory jobs were also held during that quarter. This restriction is necessary because the precise timing of job starts and separations are not available in the LEHD data. Short LEHD jobs that do not survive the quarter might be part of a job transition, or might instead be a secondary source of income that is concurrent with another job during the quarter. Because we cannot distinguish job transitions within the quarter from multiple job holding (nor can we determine which job is the origin or destination job in these cases) we focus instead on transitions between main jobs held at the start and end of the quarter. While necessary given the limitations of the data, this approach does have the obvious disadvantage of dropping legitimate job transitions between short duration jobs during the quarter and restricts each worker to only one job flow per quarter.[3]

An individual i is *beginning-of-quarter employed* at employer j in time t if the worker received positive wages from that employer in both t and $t-1$. Formally:

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

and the *dominant (or main) beginning-of-quarter* job $domb_{ijt}$ is the beginning-of-quarter job with the greatest combined wages across quarters t and $t-1$, or:

$$domb_{ijt} = \begin{cases} 1, \text{if } b_{ijt} = 1 \text{ and } w_{ijt} + w_{ijt-1} > w_{ilt} + w_{ilt-1} \; \forall \; b_{ilt} \text{ where } l \neq j \\ 0, \text{otherwise} \end{cases}$$

A separation from the main job at the start of the quarter occurs during that quarter if no earnings for the main job are observed in the subsequent quarter. Specifically:

[3] A potential advantage of linking only main job-to-job transitions is that movements between very short duration jobs (which may not necessarily be economically interesting) do not dominate the J2J statistics. Bjelland, et al. (2011) found that treating all very short duration jobs in the LEHD data as job-to-job flows results in an extremely high job-to-job flow rate – several times the typical CPS quarterly job-to-job flow rate. They speculate that a good many of these short duration jobs are likely held simultaneously.

$$all\_doms2_{ijt} = \begin{cases} 1, \text{if } domb_{ijt} = 1 \text{ and } m_{ijt+1} = 0 \\ 0, \text{otherwise} \end{cases}$$

Likewise, new main job hires are accessions in this quarter to jobs that are the main job at destination employer k held on the first day of the subsequent quarter:

$$all\_doma2_{ikt} = \begin{cases} 1, \text{if } domb_{ikt+1} = 1 \text{ and } m_{ikt-1} = 0 \\ 0, \text{otherwise} \end{cases}$$

If a main job held on the first day of the quarter ends and a new main job starts within the same quarter, we call this a within-quarter job-to-job (employer-to-employer) flow.

$$ee_{ijkt} = \begin{cases} 1, \text{if } all\_doms2_{ijt} = 1 \text{ and } all\_doma2_{ikt} = 1 \\ 0, \text{otherwise} \end{cases}$$

Of course, even when the job separation and accession occur in the same quarter, there could be a spell of nonemployment between jobs. Such a spell would not necessarily be inconsistent with a voluntary job move - workers may choose to take a break between jobs. We discuss this issue in depth in section 5.1.

Just as we use overlapping earnings across quarters to identify point-in-time employment, we use the absence of any job with overlapping earnings across quarters to identify point-in-time nonemployment. For example, if we observe a worker who has *no* job with positive earnings in both Q1 and Q2 (i.e. has no beginning-of-quarter job) we assume the worker was not employed on April 1st of that year. Because a worker employed on January 1st but not employed on April 1st may be in the middle of either a long or short nonemployment spell, we look forward an additional quarter to see if they are employed on July 1st. We call main job separations to a new job in the next quarter, adjacent-quarter (aq) flows, and they are identified as follows:

$$aq\_doms2_{ijt} = \begin{cases} 1, \text{if } all\_doms2_{ijt} = 1 \text{ and } all\_doma2_{ikt+1} = 1 \text{ and } b_{ilt+1} = 0 \; \forall \; l \\ 0, \text{otherwise} \end{cases}$$

Thus, adjacent quarter job-to-job flows describe a job transition where an individual was employed at the beginning of quarter t, not employed at the beginning of quarter $t+1$, but is employed at the beginning of quarter $t+2$.

Adjacent-quarter job-to-job transitions are tricky to categorize as either flows to nonemployment or as a job change with little-to-no nonemployment. As we state above, a short nonemployment spell is not inconsistent with a voluntary job change. But clearly the potential for the job transition to involve a longer spell of nonemployment between jobs is greater for adjacent-quarter job-to-job transitions than within-quarter job-to-job transitions. As we discuss in section 5.1, our preference is to group within-quarter and adjacent-quarter job-to-job transitions together for many analyses, and we provide a variable in the public use file which aggregates these two measures.

If, however, we observe the worker in the previous example not holding a job on either April 1st or July 1st, this worker is much more likely to have entered a spell of fairly persistent nonemployment. Job separations and accessions from and to longer and more persistent spells of nonemployment (employment-to-nonemployment $en2$) are defined as follows, respectively:

$$en2\_doms2_{\text{ijt}} = \begin{cases} 1, \text{if } all\_doms2_{ijt} = 1 \text{ and } b_{ilt+1} = 0 \text{ and } b_{ilt+2} = 0 \; \forall \; l \\ 0, \text{otherwise} \end{cases}$$

and

$$ne2\_doma2_{\text{ikt}} = \begin{cases} 1, \text{if } all\_doma2_{ikt} = 1 \text{ and } b_{ilt} = 0 \text{ and } b_{ilt-1} = 0 \; \forall \; l \\ 0, \text{otherwise} \end{cases}$$

While our definition of 'persistent nonemployment' does allow workers to hold short transitory jobs during the quarter (the worker must be observed as not employed at both the start and the end of the quarter) the overwhelming majority do not work at all during the quarter. Approximately 90% of transitions to/from persistent nonemployment have zero earnings the quarter after separating or before starting their new job. For those interested in these workers particularly, transitions to/from full-quarter nonemployment are provided as separate tabulation variables.

To calculate earnings changes associated with job change, we restrict attention to job transitions where both the origin and destination job have a full-quarter of earnings observed.[4] An

[4] This restriction is necessary because there is no hours worked available for most states in the LEHD data, so we calculate earnings changes using quarterly earnings. For workers who do not work the entire quarter before and after the job transition, we cannot compare the earnings between the two jobs.

individual i is full-quarter employed at employer j in time t if the worker received positive wages from that employer in periods $t-1$, t, and $t+1$. Formally:

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

Full-quarter to full-quarter job transitions can be written as

$$fee_{ijkt} = \begin{cases} 1, \text{if } all\_doms2_{ijt} = 1 \text{ and } all\_doma2_{ikt} = 1 \\ \quad \text{and } f_{ijt-1} = 1 \text{ and } f_{ikt+1} = 1 \\ 0, \text{otherwise} \end{cases}$$

Origin and destination job earnings are as follows:

$$fee\_origearn_{ijt} = w_{ijt-1}, \text{where } fee_{ijkt}=1$$

$$fee\_destearn_{ikt} = w_{ikt+1}, \text{where } fee_{ijkt}=1$$

For a complete set of measures and definitions, please see Tables 1 and 2.

3 Job-to-Job Flows - National Rates of Job Change

The first file to be released in the beta J2J release is the national job-to-job flows rates file. This tabulation file contains national main job start and separation rates, by whether or not the worker is moving to/from a recent employment spell. Figure 1 shows the J2J national main job separation and start rates for the United States for the period 2000-2013. What we call the 'job-to-job hire' and 'job-to-job separation' rates are the aggregated within-quarter (*ee*) and adjacent-quarter (*aq*) job transition rates, and are hires and separations resulting from job changes with little-to-no nonemployment. Hires to and separations from persistent nonemployment are also shown. This decomposition shows several interesting trends in labor market flows during the last decade. First, as noted by Hyatt and McEntarfer (2012a, 2012b) and Lazear and Spletzer (2012), there is a marked decline in the rate of job change over this period, particularly pronounced in the last two recessions. While there is also a slight downward trend in hires to and separations

from nonemployment, the recent decline in job separations and hires is largely driven by this decline in worker reallocation.[5]

In the national aggregate flows shown in Figure 1, job separations and hires from employment cancel each other out, and net employment flows are entirely due to flows to and from nonemployment. However, this will not be the case when decomposing net employment growth at the industry or state-level. At the sub-national level, employment growth can occur because a state is 'poaching' employed workers from other states; industry growth can occur when an expanding industry poaches workers away from other industries.

The initial release of the J2J flows data will include job transition and flows to and from nonemployment at the national and state level, by industry sector, firm age and size, worker age, sex, education, and race/ethnicity. A powerful advantage of the LEHD data is that the size of the data allows even more detailed tabulations than these listed; later releases will likely include more detailed geography (metro area) and more detailed industry (industry sub-sector).

3.1 Job-to-Job Flows – State-Level Rates

In addition to the rates series shown in Figure 1, Census will also release state-level files with the same set of job-to-job statistics. Not all LEHD states are available for all years, so states that do not have a complete LEHD time-series from 2000 forward will have missing data, typically in the early years of the time series. Sometimes, however, a particular state will fall behind other LEHD states with respect to their available time series, often due to a lapse of the data-sharing agreement with Census. In these cases, state-level data for a particular state may fall behind the latest available data nationally (the missing data will be imputed in the national data).

Because workers cross state lines, the lack of data for one state may impact state-level data for other states. Some states will have suppressed J2J series because there are a large number of labor flows between that state and a state with missing data. For example, LEHD only has complete data for Massachusetts starting in 2010. All other New England states – Connecticut, Rhode Island, Vermont, New Hampshire, and Maine – have large cross-state job-to-job flows with Massachusetts, enough to generate significant bias in the rates of flows to and from

[5]Hyatt and Spletzer (2013) investigate several possible causes of the decline in employment dynamics during this period and find that relatively little of the decline can be explained by changes in worker demographics or industry composition over this period. Most of the decline in job change remains unexplained.

employment. So state-level data for all of New England is suppressed until Massachusetts data becomes available in 2010. A similar problem affects the Washington, DC region, as District of Columbia data is not available before 2006.[6]

3.2 Job-to-Job Flows – Origin and Destination Data on Flows of Workers between Jobs

A separate tabulation file provides origin and destination statistics for flows from one job to another. Specifically, for job transitions that take place either within the quarter or within adjacent quarters, we tabulate characteristics of the origin and destination jobs – industry, geography, ownership, firm age, and firm size. This allows a further decomposition of the data and a new set of statistics on labor market adjustment. For example, when decomposing the net employment decline of an industry into separations to employment and nonemployment, the separations to employment can further be stratified by destination industries and geographies. The data can therefore be used to measure the extent to which workers exiting a declining regional industry migrate somewhere else in the U.S. (which is beyond the scope of the CPS, which does not track movers) – and, in addition, the J2J data permits the measurement of earnings losses or gains associated with such transitions.

4 Comparability to Other Data

With any new data series, it is often instructive to compare it where we can with similar data. With regard to J2J flows to and from employment, the most comparable statistic is the employer-to-employer flows series constructed from the CPS by Fallick and Fleischman (2004). Fallick and Fleishman exploit the dependent interviewing technique adopted in the 1994 CPS redesign to identify workers who changed employers from one month to another. Since the Fallick and Fleischman CPS data is monthly, we simply sum the monthly data to obtain the quarterly rates, following Hyatt and Spletzer (2013). Note that individuals can have multiple employment transitions per quarter in the monthly Fallick and Fleishman series, while the LEHD J2J series limits workers to one job transition per quarter.

[6] In the case of both Massachusetts and the District of Columbia, data is available before these dates but did not meet standards for publication for the Quarterly Workforce Indicators. Future research will examine whether this data meets a standard that would allow neighboring state-level J2J statistics to be released in earlier years.

In Figure 2, we show a quarterly version of the CPS monthly rate of job-to-job flows along with the LEHD J2J series for job-to-job flows rates, one version that combines within and adjacent quarter transitions and another that restricts to flows where the separation and accession occurred within the same quarter. While there is a level difference in the rates, the trends between the two series track each other well: the CPS series has a correlation of 0.92 with the series that combines within- and adjacent-quarter flows, and a correlation of 0.87 with the within-quarter series.[7] That the quarterly J2J job-to-job flow rate is lower than the CPS rate is expected - J2J links only main jobs held at the start and end of the quarter hence workers that had several job changes during the quarter are counted only once.

Figure 3 compares the Fallick and Fleischman (2004) nonemployment inflows and outflows series to J2J flows to and from nonemployment. Again, the CPS rates are higher than those derived from the LEHD data. The CPS and LEHD data sources show small trends which diverge somewhat, especially during the expansion period between the two recessions. Although the levels are different and the overall trends diverge slightly, the series still move together on a quarterly basis: a correlation of 0.73 for separations and 0.78 for hires.

Figure 4 compares J2J separations to employment and persistent nonemployment to the quits and layoffs series in the Job Openings and Labor Turnover Survey (JOLTS). The correlation between JOLTS quits and job-to-job flows in J2J is quite high, at 0.99, and the correlation between JOLTS layoffs and J2J separations to persistent nonemployment is 0.62. There is, however, a substantial level difference, with separations to persistent nonemployment being much higher in the J2J series. Davis, Faberman, Haltiwanger, and Rucker (2010) create a synthetic JOLTS layoff series adjusting for higher non-response rates in JOLTS from declining establishments; this adjusted layoffs series is higher than the J2J separations to persistent nonemployment rate, suggesting that the gap between the two series is largely due to establishments with larger employment declines being underrepresented in JOLTS.

[7]The chief exception is a pre-recession collapse in the CPS job-to-job flows series around early 2007 with no corresponding decrease in the J2J rates. This decline in the CPS rate coincides with a sudden substantial increase in the missingness rate in the CPS on questions related to whether the respondent is still with the same employer as of the last interview.

5 Some Considerations When Using the J2J Data

5.1 Identifying voluntary job change in the J2J data

An obvious question for analysts using these new statistics is discerning which job-to-job movements are voluntary vs. involuntary moves. Unfortunately, the administrative data do not allow us to observe the reason for a particular job change. However, much of the research leading to the development of the J2J data examined whether certain types of job-to-job movements had other characteristics associated with voluntary job changes. Much of this evidence suggests that within-quarter job-to-job flows (and many adjacent-quarter job-to-job flows) are predominantly voluntary job changes. First, separations to a new job in the same quarter job are procyclical, unlike separations to persistent nonemployment, which are counter-cyclical. Also, earnings changes associated with job separations to a new job in the same quarter are positive, with the median within-quarter job changer experiencing about 8% earnings increase (Hyatt and McEntarfer, 2012b). Job tenure, on average, is also longer at the destination job than the origin job (Bjelland et al., 2011).

There is greater ambiguity as to whether the smaller category of adjacent-quarter job transitions are more correctly classed as voluntary or involuntary job-to-job flows. Clearly, the potential for a longer nonemployment spell between jobs is greater within this group. However, like within-quarter flows they are also associated with positive earnings changes at the median – albeit, smaller earnings increases (Hyatt and McEntarfer, 2012b). They are also pro-cyclical, like within-quarter job-to-job flows, and unlike flows to persistent nonemployment.

Here we use a simple earnings test to gauge what share of job flows might be voluntary job movements. Aggregating total earnings across all jobs in the quarters surrounding the job transition, we compare earnings in the transition quarters to earnings in the quarters surrounding the transition. We then choose one month as the maximum time a worker might voluntarily choose to remain nonemployed between jobs.[8] For within-quarter flows, we flag job transitions where total earnings in the transition quarter are less than two-thirds of the average earnings in

[8] In addition to allowing time off between jobs as part of a voluntary job transition, we also want to allow for earnings gaps caused by workers not yet paid in their new job. Wages reported to states for unemployment insurance program administration are paid earnings, not earned earnings. Differences between payroll processing at the two jobs could create a gap in earnings even when there is no gap in employment.

surrounding quarters. For adjacent quarter flows, the job transition takes place over two quarters, so the transition is flagged if the sum of total earnings in those quarters is less than 5/6 of the sum of earnings in the two quarters before and after the job transition.[9] Applying this simple test, 85% of workers changing jobs within the quarter met the earnings threshold consistent with a voluntary job transition, while only half of adjacent-quarter job transitions met this threshold.

While we tabulate within and adjacent quarter job-to-job flows separately and leave this decision to the individual analyst, our preference is to classify adjacent-quarter flows with within-quarter job-to-job flows as predominantly voluntary job transitions. Census is currently researching whether we can use earnings histories to better identify voluntary and involuntary job-to-job flows in future releases of the data.

5.2 Dual Jobholders Switching Main Source of Employment

Not every change in a worker's main job involves leaving an old job and starting a new job. Some workers hold two or more jobs, switching back and forth over time which job is the primary source of earnings. We also see workers holding jobs that are primarily a secondary source of earnings but become a primary job when the worker separates from the former main job.

To account for primary employment changes at the industry or state level, these main job changes must also be included. Thus we separately tabulate 'main job accessions' and 'main job starts'. Main job accessions include only new main jobs where the worker was hired by the firm during that quarter. Main job starts denote all jobs that are newly the main source of earnings, a measure that includes both new hires and jobs that were formerly secondary sources of earnings in the last quarter.

5.3 Main Jobs vs. Employment

When comparing employment counts in the J2J data to other sources such as the QCEW and Quarterly Workforce Indicators (QWI), keep in mind that employment in J2J is *main* job

[9] This is identical to the approach used to earnings adjust job-to-job flows in Haltiwanger, Hyatt, and McEntarfer (2014).

employment, not total employment, and thus you should expect that employment counts in J2J should be lower than in QCEW or QWI, which count all jobs.

6 Identities

There are several identities that serve to relate the J2J measures with each other. Some of the identities are definitional in nature, and show how certain measures can be calculated directly from other released measures. Other identities illustrate that employment flows can be used to calculate the overall employment change during a quarter.

First, we define a measure of job-to-job flows that includes both within-quarter and adjacent-quarter flows. As discussed previously, adjacent-quarter flows may be consistent with the notion of a direct job flow. We define job-to-job separations and accessions as the sum of both within-quarter and adjacent-quarter flows:

$$\text{j2j\_doms2}_{ijt} = \text{ee\_doms2}_{ijt} + \text{aq\_doms2}_{ijt}$$

$$\text{j2j\_doma2}_{ikt} = \text{ee\_doma2}_{ikt} + \text{aq\_doma2}_{ikt}$$

Next, we define flows from employment to nonemployment as follows:

$$\text{en\_doms2}_{ijt} = \begin{cases} 1, \text{if all\_doms2}_{ijt} = 1 \text{ and } b_{ilt+1} = 0 \quad \forall\, l \\ 0, \text{otherwise} \end{cases}$$

Flows to nonemployment are the sum of adjacent-quarter flows and flows to persistent nonemployment:

$$\text{en\_doms2}_{ijt} = \text{en2\_doms2}_{ijt} + \text{aq\_doms2}_{ijt}$$

Similarly, we define flows from nonemployment to employment as:

$$\text{ne\_doma2}_{ikt} = \begin{cases} 1, \text{if all\_doma2}_{ikt} = 1 \text{ and } b_{ilt} = 0 \quad \forall\, l \\ 0, \text{otherwise} \end{cases}$$

These flows from nonemployment consist of adjacent-quarter flows and flows from persistent nonemployment:

$$\text{ne\_doma2}_{ikt} = \text{ne2\_doma2}_{ikt} + \text{aq\_doma2}_{ikt}$$

With these definitions, we can establish the aggregate employment change identity. This identity states that the change in employment between the beginning and the end of the quarter is equal to the difference between flows to and from nonemployment. Formally:

$$\text{dome}_t - \text{domb}_t = \text{ne\_doma2}_t - \text{en\_doms2}_t$$

It is important to note that the above employment change identity holds only at the national employment level; it does not necessarily hold at lower levels of aggregation, such as the state or industry sector level. This is because some job changes do not involve flows to or from nonemployment, such as workers moving directly between employers in the same quarter, which will affect state-level or industry-level employment totals.

Another interesting issue is the presence of multiple jobholders. As described in section 5.2, the dominant employer may change even without a separation or accession, as a job that was not the highest earning job in one quarter becomes the highest earning job in the subsequent quarter. We define two measures for multiple jobholders that capture the transition from the old dominant job and to the new dominant job.

The transition from the old dominant job is defined as a "main becomes secondary" transition:

$$\text{mbs\_domb}_{ijt} = \begin{cases} 1, \text{if domb}_{ijt} = 1 \text{ and dome}_{ijt} = 0 \text{ and e}_{ijt} = 1 \\ 0, \text{otherwise} \end{cases}$$

In this transition, the main job at the beginning of the quarter is no longer the main job at the end of the quarter, but the individual is still employed in this job at the end of the quarter.

Similarly, the transition to the new dominant job is defined as a "secondary becomes main" transition:

$$\text{sbm\_dome}_{ikt} = \begin{cases} 1, \text{if domb}_{ikt} = 0 \text{ and dome}_{ikt} = 1 \text{ and b}_{ikt} = 1 \\ 0, \text{otherwise} \end{cases}$$

In this transition, the secondary job in which the individual was employed at the beginning of the quarter is now the main job at the end of the quarter.

To capture all changes in main job employment, we define two final measures: "Main Job Starts" and "Main Job Ends." Formally:

$$\text{mainjobstarts}_{ikt} = \text{all\_doma2}_{ikt} + \text{sbm\_dome}_{ikt}$$

$$\text{mainjobends}_{ijt} = \text{all\_doms2}_{ijt} + \text{mbs\_domb}_{ijt}$$

Equipped with these measures, we can now define the employment change identity that holds at all levels of aggregation:

$$\text{dome}_t - \text{domb}_t = \text{mainjobstarts}_t - \text{mainjobends}_t$$

This identity illustrates that the change in employment during the quarter is equal to the difference between the number of main jobs that start during the quarter and the number of main jobs that end during the quarter. We do not separately release the sbm and mbs transitions, but they can be derived from the public use statistics using the identity above.

7 Disclosure Protection

To ensure the confidentiality of the released data, the J2J flows utilize a variety of confidentiality protection measures. In an extension of the existing noise infusion procedure used for the Quarterly Workforce Indicators (QWI), each item in the J2J data receives a multiplicative fuzz factor, see Abowd et al. (2009). However, unlike the QWI, a particular feature of the J2J data is that many indicators involve flows between jobs. For transitions between employers, the noise infusion mechanism must consider whether to assign the fuzz factor associated with the origin establishment or the destination establishment. Our methodology (Abowd and McKinney, 2014) is based on the notion of an "edge" in graph theory and is designed to draw one fuzz factor from the two available, designating the chosen establishment fuzz factor as the fuzz factor for that edge. The new edge fuzz factor is used in all subsequent statistics and tabulations to multiplicatively modify any employment transition between the same two establishments.

In addition to noise infusion, the data product provides additional protection by synthesizing values for small cells. First, cells that do not have any positive weight, what we call "true zeros," are removed and do not pass through the synthesizer. These cells are released as is, with no distortion. To synthesize the values in the remaining small cells, we take a Bayesian approach by sampling from a multinomial Posterior Predictive Distribution (PPD). Every quarter for each release table, we count the number of fuzzed zeros (n0), ones (n1), twos (n2), and threes (n3). We use a uniform prior of size U, and add the fuzzed counts to this prior, resulting in parameters

for the Dirichlet posterior of (n0+U/4, n1+U/4, n2+U/4, n3+U/4). To complete the table, we sample from the multinomial PPD once for each candidate suppressed cell, replacing what would have been a suppression with a synthesized value. The share of "true zeros" and small cells is quite large in some tables and this approach preserves the general pattern of job-to-job flows, while at the same time enabling the public release of complete tables.

8 Seasonally Adjusted J2J series

Many of the J2J series exhibit significant seasonal variation; quarter-to-quarter changes in hires and separations are large and can make analysis of longer trends in the data difficult. Because of the strong seasonality, we will release seasonally adjusted data whenever possible, as well as the non-seasonally adjusted data. The initial release of national rates will include both the seasonally adjusted and the non-seasonally adjusted series. For count and rate measures, the data are adjusted using the X-12-ARIMA methodology developed by the U.S. Census Bureau, with a separate adjustment for each series.

Seasonal adjustment of average earnings presents additional challenges beyond the basic methodology. In particular, our measures of earnings are derived from Unemployment Insurance wage records, which are reported based on when wages are paid to workers. As a result, quarterly earnings vary by the number of pay periods in each quarter. These "trading day" effects present additional complications for seasonal adjustment. We are currently exploring methods to account for these factors.

9 Accounting for Partially Missing Geography - Imputation of National Series

States provide data to the LEHD program with different start quarters. To avoid releasing primarily imputed data, we begin our time series in the second quarter of the year 2000. In the initial quarter, data is available for 41 states, with additional states becoming available in subsequent quarters. The last state to report is Massachusetts, which is missing data for the first 41 quarters of the release. By 2010Q2 the data is complete, with all 50 states and the District of Columbia reporting regularly to LEHD.

In the first quarter of the planned release, the states with complete data make up about 87% of QCEW 2012Q2 Month 1 private sector employment. As shown in Figure 5, the proportion of total employment covered by the data grows as new states enter the LEHD production system. The largest state with missing data, Michigan, enters first, followed by an almost equal sized cluster of three geographically dispersed states. Another five states appear over the next four years and by 2005Q2 the data is virtually complete except for Massachusetts which does not appear in the data for another five years (2010Q2).

To deal with the missing data issue, we use the method proposed and implemented for the QWI by Abowd and Vilhuber (2011). This method uses an alternative reference series, the QCEW in this case, to calculate rates (J2J measure/QCEW employment) for the complete data states. For the missing data states, we impute each J2J measure by first sampling from the constructed complete data states' rates and then multiplying the sampled rates by the QCEW employment values for the missing data states. This procedure is valid, assuming the missing data process is ignorable, or equivalently that the rates are missing at random conditional on various characteristics of the worker and firm. Similar to Abowd and Vilhuber (2011), we develop two missing data models, the first covers the period prior to 2005Q2 and the second model covers the later missing data period, however, we also address a fundamental difference in the data required to calculate unbiased J2J statistics.

For the QWI, the statistics are unbiased at the state level when other states are missing; however, this is not the case for J2J flows. The J2J flows use the concept of a national dominant job for each worker each quarter; if data for a state is missing, a non-dominant job in a reporting state may be incorrectly classified as dominant job. In addition, workers that transition to a job in a missing data state will be incorrectly classified as transitioning to nonemployment. To address the resulting bias in the rates for the complete data states, we adjust them using information from 2010Q2 forward where all of the states are available. We then sample from the adjusted rates using the method proposed by Abowd and Vilhuber (2011). With the data completed, the national rate estimates and standard errors are formed using the customary Rubin (1987) combining formulas, properly accounting for the additional uncertainty due to both the missing state data as well as the rate adjustment process.

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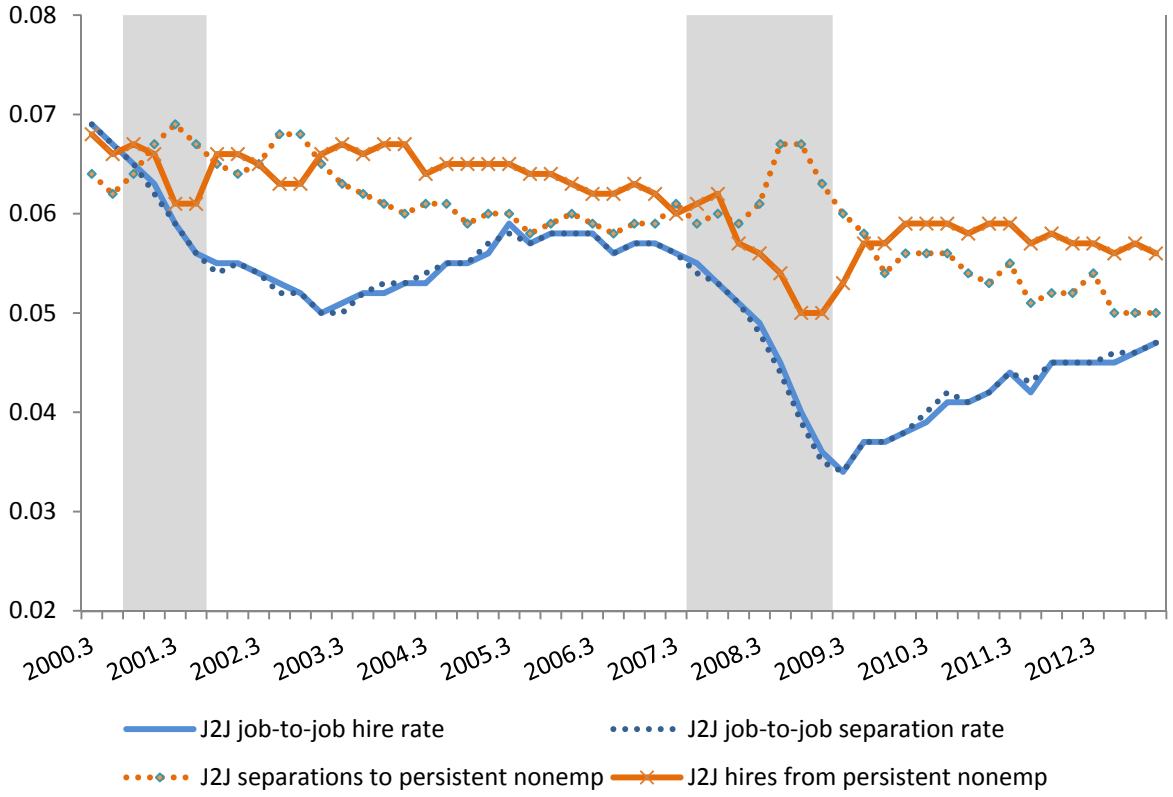
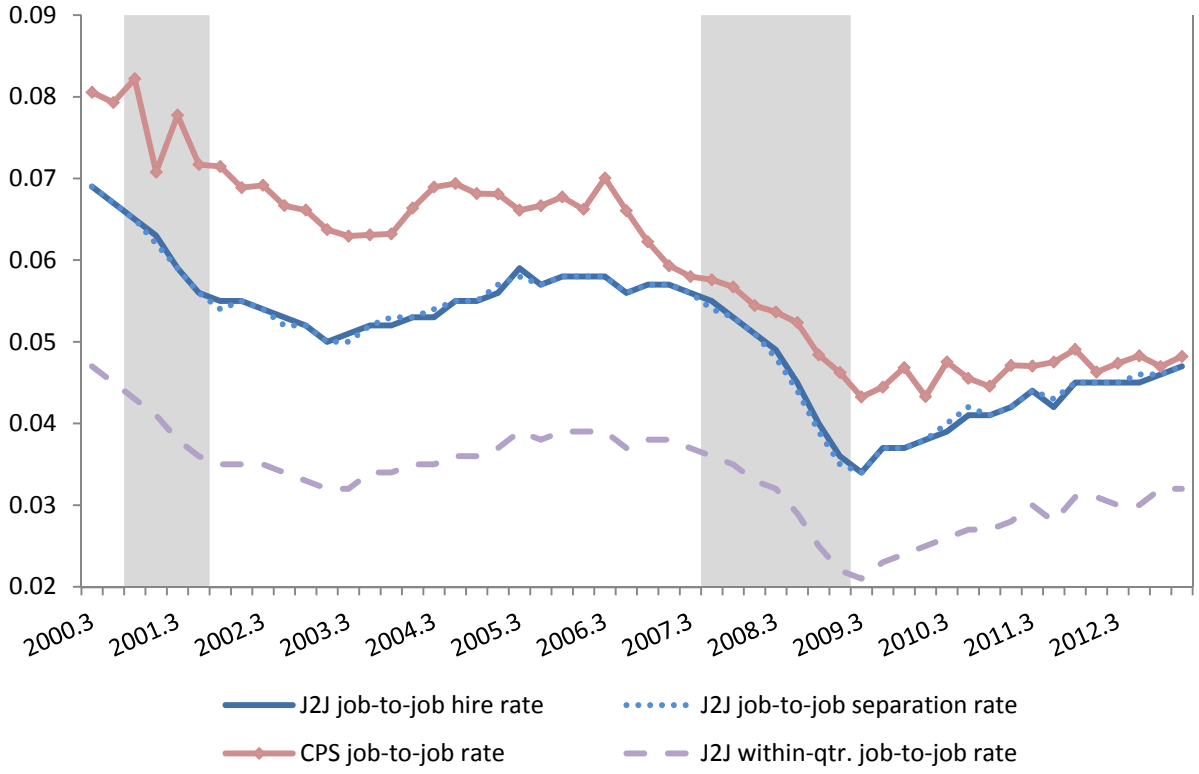
Figure 1: Hires and Separations: Job Change vs. Nonemployment



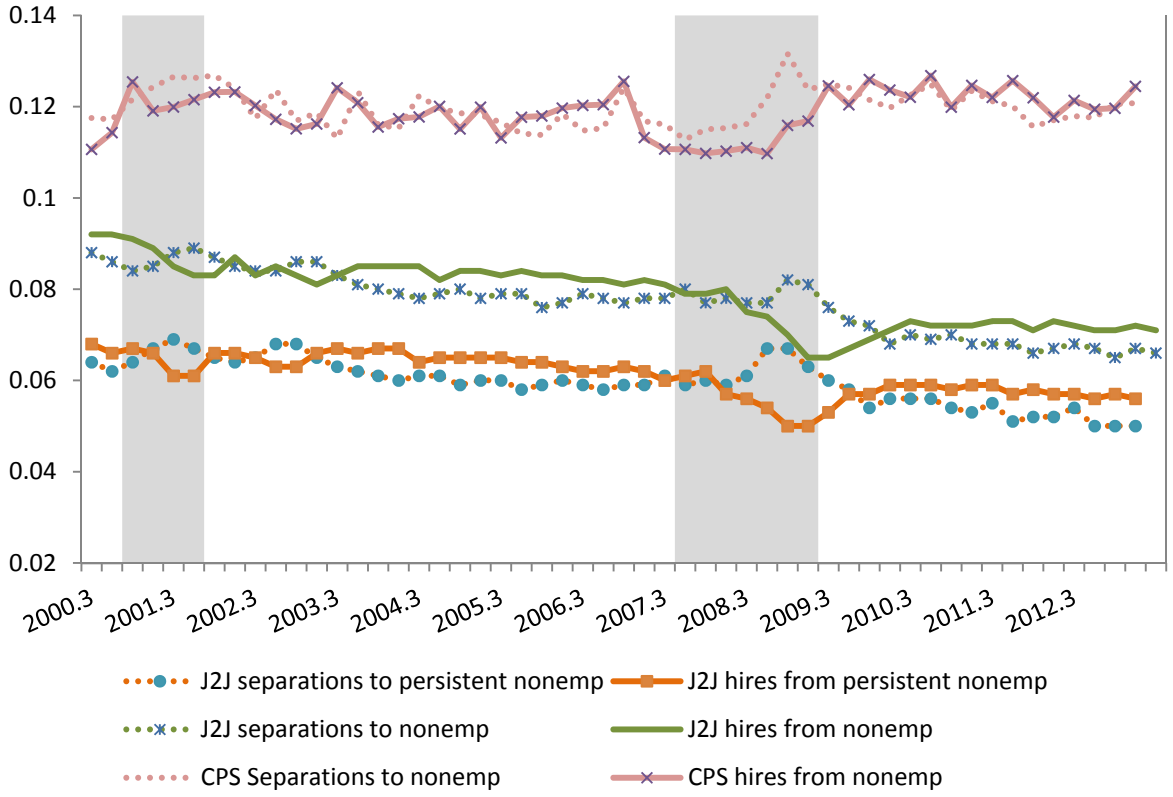
Note: Shaded regions indicate NBER recession quarters. All data are seasonally adjusted. J2J job-to-job hires are new main job starts this quarter where the separation from the previous main job occurred either in this quarter or the previous quarter. Job-to-job separations are separations from main jobs associated with a new job start this quarter or the subsequent quarter. Separations to persistent nonemployment are nonemployed both at the end of the quarter and the end of the subsequent quarter. Accessions from persistent nonemployment are not employed at this start of this quarter as well as the start of the previous quarter. Approximately 90% of the persistently not employed had zero earnings in the quarter prior/subsequent to the job start/separation.

Figure 2: Comparison of LEHD and CPS Job-to-Job Flows



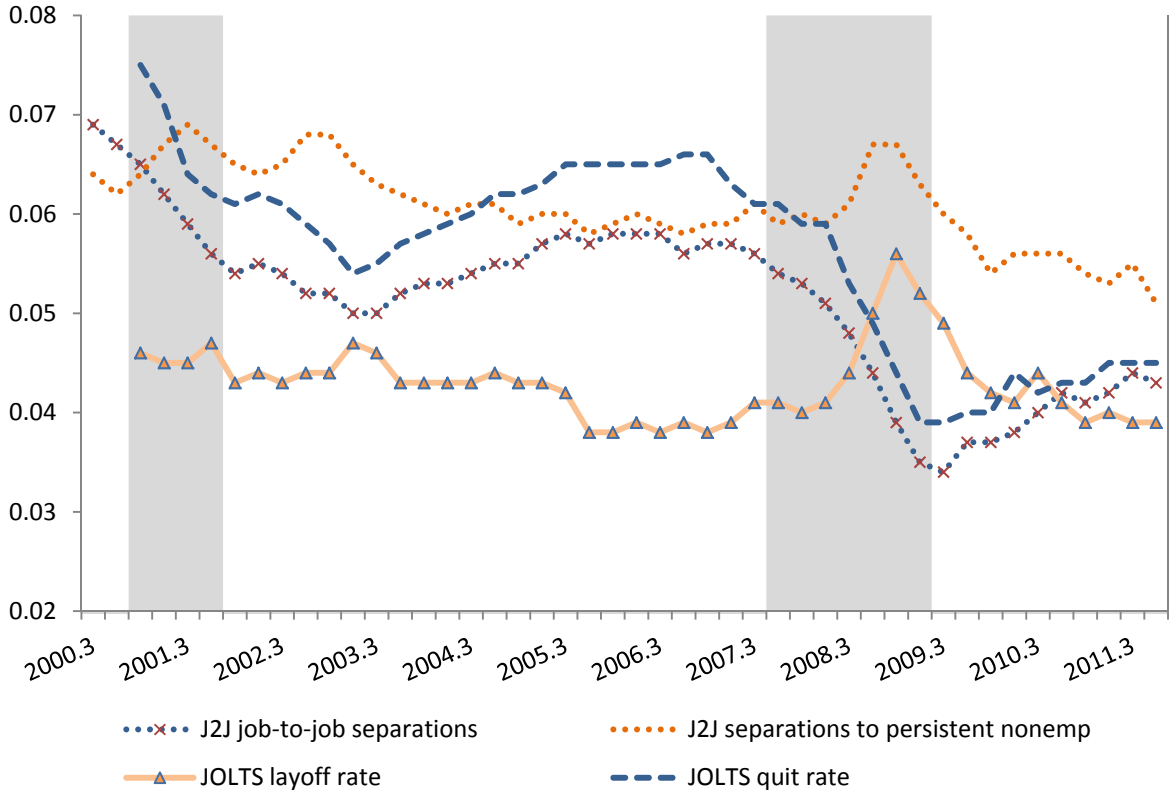
Note: Shaded regions indicate NBER recession quarters. All data are seasonally adjusted. CPS job-to-job flows series is calculated from the CPS by Fallick and Fleischman (2004). J2J hire rate here refers to new main job starts this quarter where the separation from the previous main job occurred either in this quarter or the previous quarter. J2J separations are separations from main jobs associated with a new job start this quarter or the subsequent quarter. The within-qtr. job-to-job flow rate restricts the J2J flows to starts and separations that occur within the same quarter only.

Figure 3: Comparison of LEHD and CPS Flows to and from Nonemployment



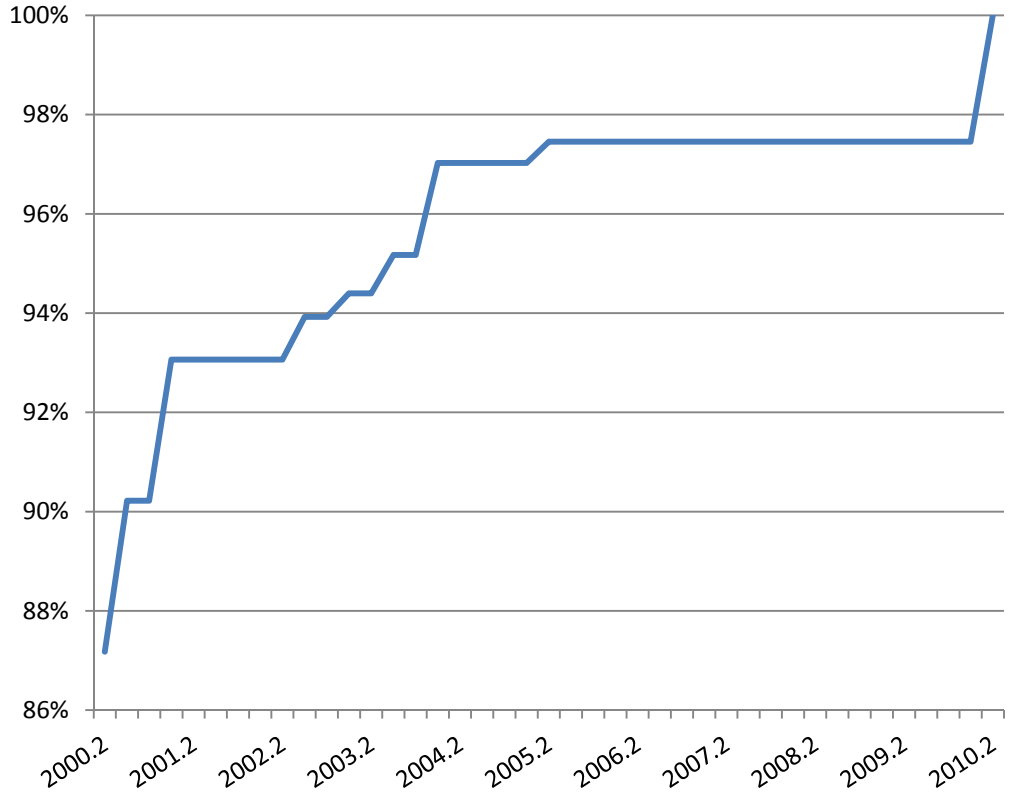
Note: Shaded regions indicate NBER recession quarters. All data are seasonally adjusted. CPS data was downloaded from the Fallick and Fleischman (2004) website. J2J hires/separations from nonemployment includes adjacent-quarter job-to-job flows as well as flows from persistent nonemployment.

Figure 4: Comparing J2J Separations to Quits and Layoffs from JOLTS



Note: Shaded regions indicate NBER recession quarters. All data are seasonally adjusted. JOLTS data are from the BLS website. J2J job-to-job separations are separations from main jobs associated with a new job start this quarter or the subsequent quarter. Separations to persistent nonemployment are nonemployed both at the end of the quarter and the end of the subsequent quarter.

Figure 5: Proportion of Private Sector Employment for States in LEHD



Note: Shares of QCEW private sector employment totals for April of 2012 as downloaded from the BLS website. Coverage reflects the number of states with data that has passed quality assurance thresholds for release in the QWI.

Table 1: List of Variable Definitions

Variable	Short Description	Public Use Name	Definition
b_{ijt}	Beginning of Quarter Job		$\begin{cases} 1, \text{if } w_{ijt} > 0 \text{ and } w_{ijt-1} > 0 \\ 0, \text{otherwise} \end{cases}$
e_{ijt}	End of Quarter Job		$\begin{cases} 1, \text{if } w_{ijt} > 0 \text{ and } w_{ijt+1} > 0 \\ 0, \text{otherwise} \end{cases}$
$domb_{ijt}$	Main Beginning of Quarter Job	MainB	$\begin{cases} 1, \text{if } b_{ijt} = 1 \text{ and } w_{ijt} + w_{ijt-1} > w_{ilt} + w_{ilt-1} \; \forall \; b_{ilt} \; l \neq j \\ 0, \text{otherwise} \end{cases}$
$dome_{ijt}$	Main End of Quarter Job	MainE	$\begin{cases} 1, \text{if } e_{ijt} = 1 \text{ and } w_{ijt} + w_{ijt+1} > w_{ilt} + w_{ilt+1} \; \forall \; b_{ilt} \; l \neq j \\ 0, \text{otherwise} \end{cases}$
$dombe_{ijt}$	Main Beginning and End of Quarter Job		$\begin{cases} 1, \text{if } domb_{ijt} = 1 \text{ and } dome_{ijt} = 1 \\ 0, \text{otherwise} \end{cases}$
all_doms2_{ijt}	Separation from Main Job	MSep	$\begin{cases} 1, \text{if } domb_{ijt} = 1 \text{ and } m_{ijt+1} = 0 \\ 0, \text{otherwise} \end{cases}$
ee_{ijkt}	Employer-to-Employer Flow	EE	$\begin{cases} 1, \text{if } all\_doms2_{ijt} = 1 \text{ and } all\_doma2_{ikt} = 1 \\ 0, \text{otherwise} \end{cases}$
aq_doms2_{ijt}	Adjacent Quarter Separation	AQSep	$\begin{cases} 1, \text{if } all\_doms2_{ijt} = 1 \text{ and } all\_doma2_{ikt+1} = 1 \text{ and } e_{ilt} = 0 \; \forall \; l \\ 0, \text{otherwise} \end{cases}$
$eeall\_doms2_{ijt}$	Job-to-Job Separation	J2JSep	$\begin{cases} 1, \text{if } ee_{ijkt} = 1 \text{ or } aq\_doms2_{ijt} = 1 \\ 0, \text{otherwise} \end{cases}$
$en2\_doms2_{ijt}$	Separation to Persistent Nonemployment	ENPersist	$\begin{cases} 1, \text{if } all\_doms2_{ijt} = 1 \text{ and } e_{ilt} = 0 \text{ and } e_{ilt+1} = 0 \; \forall \; l \\ 0, \text{otherwise} \end{cases}$
$en2p\_doms2_{ijt}$	Separation to Full-Qtr Nonemployment	ENFullQ	$\begin{cases} 1, \text{if } all\_doms2_{ijt} = 1 \text{ and } m_{ilt+1} = 0 \; \forall \; l \\ 0, \text{otherwise} \end{cases}$
en_doms2_{ijt}	Separation to Nonemployment	ENSep	$\begin{cases} 1, \text{if } all\_doms2_{ijt} = 1 \text{ and } e_{ilt} = 0 \; \forall \; l \\ 0, \text{otherwise} \end{cases}$
mbs_domb_{ijt}	Main Job Becomes Secondary		$\begin{cases} 1, \text{if } domb_{ijt} = 1 \text{ and } dome_{ijt} = 0 \text{ and } e_{ijt} = 1 \\ 0, \text{otherwise} \end{cases}$
$mjobend_{ijt}$	Main Job End	MJobEnd	$\begin{cases} 1, \text{if } mbs\_domb_{ijt} = 1 \text{ or } all\_doms2_{ijt} = 1 \\ 0, \text{otherwise} \end{cases}$
all_doma2_{ikt}	Accession to Main Job	MHire	$\begin{cases} 1, \text{if } dome_{ikt} = 1 \text{ and } m_{ijt-1} = 0 \\ 0, \text{otherwise} \end{cases}$
aq_doma2_{ikt}	Adjacent Quarter Accession	AQHire	$\begin{cases} 1, \text{if } all\_doms2_{ijt-1} = 1 \text{ and } all\_doma2_{ikt} = 1 \text{ and } b_{ilt} = 0 \; \forall \; l \\ 0, \text{otherwise} \end{cases}$
$eeall\_doma2_{ikt}$	Job-to-Job Accession	J2JHire	$\begin{cases} 1, \text{if } ee_{ijkt} = 1 \text{ or } aq\_doma2_{ikt} = 1 \\ 0, \text{otherwise} \end{cases}$
$ne2\_doma2_{ikt}$	Accession from Persistent Nonemployment	NEPersist	$\begin{cases} 1, \text{if } all\_doma2_{ikt} = 1 \text{ and } b_{ilt} = 0 \text{ and } b_{ilt-1} = 0 \; \forall \; l \\ 0, \text{otherwise} \end{cases}$
$ne2p\_doma2_{ikt}$	Accession from Full-Qtr Nonemployment	NEFullQ	$\begin{cases} 1, \text{if } all\_doma2_{ikt} = 1 \text{ and } m_{ilt-1} = 0 \; \forall \; l \\ 0, \text{otherwise} \end{cases}$
ne_doma2_{ikt}	Accession from Nonemployment	NEHire	$\begin{cases} 1, \text{if } all\_doma2_{ikt} = 1 \text{ and } b_{ilt} = 0 \; \forall \; l \\ 0, \text{otherwise} \end{cases}$
sbm_dome_{ikt}	Secondary Job Becomes Main		$\begin{cases} 1, \text{if } dome_{ikt} = 1 \text{ and } b_{ikt} = 1 \text{ and } domb_{ikt} = 0 \\ 0, \text{otherwise} \end{cases}$
$mjobstart_{ikt}$	Main Job Start	MJobStart	$\begin{cases} 1, \text{if } sbm\_dome_{ikt} = 1 \text{ or } all\_doma2_{ikt} = 1 \\ 0, \text{otherwise} \end{cases}$

Table 2: List of Variable Definitions – Full Quarter Flows and Earnings

Variable	Short Description	Public Use Name	Definition
f_{ijt}	Full-Quarter Job		$\begin{cases} 1, \text{if } w_{ijt-1} > 0 \text{ and } w_{ijt} > 0 \text{ and } w_{ijt+1} > 0 \\ 0, \text{otherwise} \end{cases}$
fee_{ijkt}	Full-Quarter Employer-to-Employer Flow	EEFullQ	$\begin{cases} 1, \text{if all\_doms2}_{ijt} = 1 \text{ and all\_doma2}_{ikt} = 1 \\ \quad \text{and } f_{ijt-1} = 1 \text{ and } f_{ikt+1} = 1 \\ 0, \text{otherwise} \end{cases}$
$fdombe_{ijt}$	Full-Quarter Dominant Beginning and End of Quarter Job		$\begin{cases} 1, \text{if domb}_{ijt} = 1 \text{ and dome}_{ijt} = 1 \\ \quad \text{and } f_{ijt-1} = 1 \text{ and } f_{ijt+1} = 1 \\ 0, \text{otherwise} \end{cases}$
faq_doma2_{ikt}	Full-Quarter Adjacent Quarter Accession	AQFullQHire	$\begin{cases} 1, \text{if all\_doms2}_{ijt-1} = 1 \text{ and all\_doma2}_{ikt} = 1 \\ \quad \text{and } b_{ilt} = 0 \; \forall \, l \text{ and } f_{ijt-2} = 1 \text{ and } f_{ikt+1} = 1 \\ 0, \text{otherwise} \end{cases}$
$fee\_kfqearn_{ijt}$	Avg. Earnings in Destination Job, Full-Quarter Employer-to-Employer Flow	EEFullQEarn_dest	$\bar{w}_{ikt+1}$, where fee_{ijkt}=1
$faq\_kfqearn_{ijt}$	Avg. Earnings in Origin Job, Full-Quarter Adjacent-Quarter Flow	AQFullQEarn_dest	$\bar{w}_{ikt+1}$, where faq_doma2_{ikt}=1