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

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1 Introduction

The U.S. Census Bureau is releasing new beta national statistics on worker reallocation in the United States. Job-to-Job Flows (J2J) provide data on worker transitions resulting from job change as well as hires and separations from and to persistent non-employment. Also included in the new statistics are origin-destination data for workers changing jobs. This unique data allows 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

[1] This technical working paper is an updated version of a shorter paper presented at the 2014 Joint Statistical Meetings, "Job-to-Job Flows: New Labor Market Statistics from Linked Employer-Employee Data" 2014 Joint Statistical Meetings Papers and Proceedings, forthcoming. This paper serves as preliminary documentation for the Job-to-Job Flows data and will be updated as we receive feedback during the beta release. The authors would like to thank John Abowd, Hubert Janicki, Alexandria Zhang, Tucker McElroy, and Ken Ueda for contributions to the national imputation, the confidentiality protection, and the seasonal adjustment of the statistics. We would also like to acknowledge John Haltiwanger and Bruce Fallick for contributions to the early research that led to the development of a job-to-job flows public use data product from LEHD data. Comments on this paper and the associated data product are welcome, for questions and comments please contact Erika McEntarfer at erika.mcentarfer@census.gov

declines by shares of workers moving across industries vs. worker flows to persistent non-employment. J2J origin-destination data by state allow for the examination of economic migration patterns 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 discussing the source data and how we identify worker movements between employers. We explain the types of job transitions tabulated and provide 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 states are missing. Finally, we provide guidance to users on using and interpreting the data.

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 job-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 have agreements in place to share QCEW and UI wage data with the LEHD program as part of the Local Employment Dynamics federal-state partnership.[2] The coverage of LEHD data is quite broad; state UI and QCEW data covers approximately 95% of private sector employment, as well as state and local government. Individual demographic and additional firm characteristics such as firm age and size are not part of the UI or QCEW data and instead come from survey, Census, and other administrative record sources.[3]

[2] Statistics for some states have not been released yet. See Section 6.2 on how missing data of this type is handled.
[3] For a detailed description of the LEHD data, see Abowd et al. (2009); Abowd, Haltiwanger, and Lane (2004); Haltiwanger et al. (2014).

2.1 Microdata Definitions

2.1.1 Count Measures

Some notation is necessary to understand how we identify job-to-job transitions in the LEHD administrative data. Abowd et al. (2009) provide definitions for fundamental concepts in the LEHD administrative data, and which are used here as a starting point to develop additional definitions related to job-to-job transitions. First and foremost, we must clarify what we mean by a job, which in the LEHD data is identified from quarterly earnings data provided by firms to state governments for the administration of UI programs. We say that individual i is *employed* (has a job) at firm j in time t if the worker receives positive earnings w from that firm in quarter t. Formally [A.1] [4]:

$$m_{ijt} = \begin{cases} 1, \text{ if } w_{ijt} > 0 \\ 0, \text{otherwise} \end{cases} \qquad \text{Eq 2-1}$$

An individual i is *beginning-of-quarter employed* at firm j in time t if the worker receives positive earnings from that employer in both t and $t-1$. Formally [A.2]:

$$b_{ijt} = \begin{cases} 1, \text{ if } w_{ijt} > 0 \text{ and } w_{ijt-1} > 0 \\ 0, \text{otherwise} \end{cases} \qquad \text{Eq 2-2}$$

An individual i is *end-of-quarter employed* at firm j in time t if the worker receives positive earnings from that employer in both t and $t+1$. [5] Formally [A.3]:

$$e_{ijt} = \begin{cases} 1, \text{ if } w_{ijt} > 0 \text{ and } w_{ijt+1} > 0 \\ 0, \text{otherwise} \end{cases} \qquad \text{Eq 2-3}$$

In a departure from the Quarterly Workforce Indicators (QWI), J2J is primarily concerned with beginning of period and end of period *dominant* jobs. This restriction is necessary because the precise timing of job starts and separations are not available in the LEHD data. Short LEHD

[4] Where appropriate, we reference equivalent definitions from Abowd et al. (2009), Appendix A.2 as "[A.1]", etc.
[5] Without additional information, we cannot identify specific period(s) of job activity during a quarter. If an individual *i* receives positive earnings from employer *j* in quarter *t* and quarter *t*-1, we assume worker *i* is employed by firm *j* a minimum of both the first day of quarter *t* and the last day of quarter *t*-1 (this implies $b_{ijt} = e_{ijt-1}$).

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 dominant (main) jobs held at the start and end of the quarter. Thus, a worker whose dominant (main) job is at firm 5 on January 1st and firm 10 on April 1st would be identified as having a job-to-job flow from employer 5 to 10, even if shorter transitory jobs were also held during that quarter. While necessary given the limitations of the data, this approach does have the obvious disadvantage of dropping legitimate transitions between short duration jobs and restricts each worker to only one job flow per quarter.[6]

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

$$domb_{ijt} = \begin{cases} 1, \text{if } b_{ijt} = 1 \text{ and } (w_{ijt} + w_{ijt-1}) > (w_{ilt} + w_{ilt-1}) \\ \quad \forall\ l \text{ where } b_{ilt} = 1 \text{ and } l \neq j \\ 0, \text{otherwise} \end{cases} \qquad \text{Eq 2-4}$$

The *dominant (or main) end-of-quarter* job $dome_{ijt}$ is the end-of-quarter job with the greatest combined earnings across quarters t and $t+1$, or:

$$dome_{ijt} = \begin{cases} 1, \text{if } e_{ijt} = 1 \text{ and } (w_{ijt} + w_{ijt+1}) > (w_{ilt} + w_{ilt+1}) \\ \quad \forall\ l \text{ where } e_{ilt} = 1 \text{ and } l \neq j \\ 0, \text{otherwise} \end{cases} \qquad \text{Eq 2-5}$$

We do not define a corresponding dominant job measure for m_{ijt}.

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

[6] 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.

$$all\_doms2_{ijt} = \begin{cases} 1, \text{if } domb_{ijt} = 1 \text{ and } m_{ijt+1} = 0 \\ 0, \text{otherwise} \end{cases} \quad \text{Eq 2-6}$$

Likewise, an accession to the main job active at the end of the quarter occurs during that quarter if no earnings for the main job are observed in the previous quarter:

$$all\_doma2_{ikt} = \begin{cases} 1, \text{if } domb_{ikt+1} = 1 \text{ and } m_{ikt-1} = 0 \\ 0, \text{otherwise} \end{cases} \quad \text{Eq 2-7}$$

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 flow from an origin dominant employer j to a destination dominant employer k $(k \neq j)$.

$$ee_{ijkt} = \begin{cases} 1, \text{if } all\_doms2_{ijt} = 1 \text{ and } all\_doma2_{ikt} = 1 \\ 0, \text{otherwise} \end{cases} \quad \text{Eq 2-8}$$

The flow from employer j to employer k represents two economic events: the separation from the origin firm j

$$ee\_doms2_{ijt} = \begin{cases} 1, \text{if } \exists\ k \text{ such that } ee_{ijkt} = 1 \\ 0, \text{otherwise} \end{cases}. \quad \text{Eq 2-9}$$

and the accession to the destination firm k.

$$ee\_doma2_{ikt} = \begin{cases} 1, \text{if } \exists\ j \text{ such that } ee_{ijkt} = 1 \\ 0, \text{otherwise} \end{cases}. \quad \text{Eq 2-10}$$

We call a main job transition to a new main job in the next quarter an *adjacent-quarter* (aq) flow and they are identified as follows:

$$ee\_aq_{ijkt} = \begin{cases} 1, \text{if } all\_doms2_{ijt-1} = 1 \text{ and } all\_doma2_{ikt} = 1 \\ \quad \text{and } b_{ilt} = 0\ \forall\ l \\ 0, \text{otherwise} \end{cases} \quad \text{Eq 2-11}$$

Thus, adjacent quarter job-to-job flows describe a job transition where individual i is beginning-of-quarter employed at the dominant firm j in quarter $t-1$, has no beginning-of-quarter employment in quarter t, and is end-of-quarter employed in t at the dominant firm k.[7]

Similarly to ee_{ijkt}, the adjacent-quarter flow ee_aq_{ijkt} represents two economic events: the separation from the origin firm j, which is recorded in period $t-1$

$$aq\_doms2_{ijt-1} = \begin{cases} 1, \text{if } \exists\ k \text{ such that } ee\_aq_{ijkt} = 1 \\ 0, \text{otherwise} \end{cases}, \qquad \text{Eq 2-12}$$

and the accession to the destination firm k, which is recorded in period t.

$$aq\_doma2_{ikt} = \begin{cases} 1, \text{if } \exists\ j \text{ such that } ee\_aq_{ijkt} = 1 \\ 0, \text{otherwise} \end{cases}. \qquad \text{Eq 2-13}$$

When a job-to-job flow occurs for individual i there may be a spell of reduced labor market activity between the end of one dominant job and the start of another. This spell of reduced activity may be a complete exit from the labor market for a period of up to three months for a within quarter transition and up to six months for an adjacent quarter transition or a period characterized by one or perhaps several active short duration jobs. A period of reduced labor market activity during the transition from one main job to another main job is not inconsistent with a voluntary move; workers may choose to take a break from their main job, an issue we discuss further in section 8.1.

Job separations to and accessions from spells of non-employment are defined as follows, respectively:

$$en\_doms2_{ijt} = \begin{cases} 1, if\ all\_doms2_{ijt} = 1 \text{ and } e_{ilt} = 0 \quad \forall\ l \\ 0, \text{otherwise} \end{cases} \qquad \text{Eq 2-14}$$

and

[7] Unlike within quarter flows (ee), the quarter of an adjacent-quarter flow can be assigned to either the separation or the accession. We choose to assign ee_aq to the quarter of the accession.

$$ne\_doma2_{ikt} = \begin{cases} 1, if\ all\_doma2_{ikt} = 1 \text{ and } b_{ilt} = 0\ \ \forall\ l \\ 0, \text{otherwise} \end{cases} \quad \text{Eq 2-15}$$

Job separations to and accessions from *persistent* spells of non-employment are defined as follows, respectively:

$$en2\_doms2_{ijt} = \begin{cases} 1, \text{if } all\_doms2_{ijt} = 1 \text{ and } e_{ilt} = 0 \text{ and } e_{ilt+1} = 0\ \forall\ l \\ 0, \text{otherwise} \end{cases} \quad \text{Eq 2-16}$$

and

$$ne2\_doma2_{ikt} = \begin{cases} 1, \text{if } all_{doma2_{ikt}} = 1 \text{ and } b_{ilt} = 0 \text{ and } b_{ilt-1} = 0\ \forall\ l \\ 0, \text{otherwise} \end{cases} \quad \text{Eq 2-17}$$

Our definition of 'non-employment' allows an individual to hold short transitory jobs - the worker holds a job in t (m_{ijt} = 1) but is not observed as being employed at both the start and the end of the quarter - , but the overwhelming majority do not work at all during the quarter. Approximately 90% of transitions to/from persistent non-employment have zero earnings the quarter after separating or before starting their new job.

We use the concept of full-quarter employment as a basis for earnings calculations in section 2.1.3. An individual i is full-quarter employed at firm j in time t if the worker receives positive earnings from that employer in periods t, $t-1$, and $t+1$. Formally [A.6]:

$$f_{ijt} = \begin{cases} 1, \text{ if } w_{ijt-1} > 0 \text{ and } w_{ijt} > 0 \text{ and } w_{ijt+1} > 0 \\ 0, \text{otherwise} \end{cases} \quad \text{Eq 2-18}$$

A full-quarter to full-quarter employer to employer job transition can be written as

$$fee_{ijkt} = \begin{cases} 1, \text{if } all\_doms2_{ijt} = 1 \text{ and } all\_doma2_{ikt} = 1 \\ \quad \text{and } f_{ijt-1} = 1 \text{ and } f_{ikt+1} = 1 \\ 0, \text{otherwise} \end{cases} \quad \text{Eq 2-19}$$

2.1.2 Identities

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

First, we define a measure of job-to-job flows that includes both within-quarter and adjacent-quarter separations and accessions. As discussed in section 8.1, both within and adjacent-quarter flows appear to be consistent with the notion of a direct job flow. We define job-to-job separations and accessions as the sum of within-quarter and adjacent-quarter flows:

$$eeall\_doms2_{ijt} = ee\_doms2_{ijt} + aq\_doms2_{ijt} \quad \text{Eq 2-20}$$

$$eeall\_doma2_{ikt} = ee\_doma2_{ikt} + aq\_doma2_{ikt} \quad \text{Eq 2-21}$$

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

$$en\_doms2_{ijt} = en2\_doms2_{ijt} + aq\_doms2_{ijt} \quad \text{Eq 2-22}$$

Flows from non-employment consist of adjacent-quarter flows and flows from persistent non-employment:

$$ne\_doma2_{ikt} = ne2\_doma2_{ikt} + aq\_doma2_{ikt} \quad \text{Eq 2-23}$$

The above identities hold at both the individual and at higher levels of aggregation. At the individual level, the identities are arguably less interesting as a worker can contribute to at most one of the variables on the right hand side. For example, if $ee_{ijkt} = 1$ then $ee\_doms2_{ijt} = 1$ and $ee\_doma2_{ikt} = 1$, and by construction aq_doms2_{ijt}=0 and $aq\_doma2_{ikt} = 0$. A single worker either has a within quarter flow, an adjacent quarter flow, or no flow at all, but never both a within and adjacent flow in the same quarter. Similarly for transitions to non-employment, a worker either transitions to persistent non-employment, has an adjacent quarter flow, or no transition at all, but never a transition to both non-employment and an adjacent quarter flow.

However, at higher levels of aggregation these identities become more interesting as multiple workers transition to multiple firms and into/out of non-employment.

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

$$dome_{it} - domb_{it} = ne\_doma2_{it} - en\_doms2_{it} \qquad \text{Eq 2-24}$$

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, nor for any particular firm, nor for worker age, which is time-variant. This is because some job changes do not involve flows to or from non-employment, such as workers moving directly between employers in the same quarter. These types of worker transitions do not affect employment at the national level, but they may, for example, affect state-level or industry-level employment totals if the origin and destination firm are not in the same state and/or industry.

Another interesting issue is the presence of multiple jobholders. As described in more detail in section 8.2, the dominant employer may change even without a separation or an 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 transitions from the old dominant job to the new dominant job.

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

$$mbs\_domb_{ijt} = \begin{cases} 1, if\ domb_{ijt} = 1 \text{ and } dome_{ijt} = 0\ and\ e_{ijt} = 1 \\ 0, \text{otherwise} \end{cases} \qquad \text{Eq 2-25}$$

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:

$$sbm\_dome_{ikt} = \begin{cases} 1, if\ domb_{ikt} = 0 \text{ and } dome_{ikt} = 1\ and\ b_{ikt} = 1 \\ 0, \text{otherwise} \end{cases} \quad \text{Eq 2-26}$$

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 Ends" and "Main Job Starts." Formally:

$$mjobend_{ijt} = all\_doms2_{ijt} + mbs\_domb_{ijt} \quad \text{Eq 2-27}$$

$$mjobstart_{ikt} = all\_doma2_{ikt} + sbm\_dome_{ikt} \quad \text{Eq 2-28}$$

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

$$dome_{ikt} - domb_{ijt} = mjobstart_{ikt} - mjobend_{ijt} \quad \text{Eq 2-29}$$

Once again, at the individual level this identity isn't particularly interesting, but at higher levels of aggregation it shows 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.

2.1.3 Earnings Measures

To calculate earnings changes, we restrict our attention to job transitions where both the origin and destination job have at least a full-quarter of observed earnings.[8] For a full-quarter employer to employer transition, the earnings at the origin employer is

$$fee\_jfqearn_{ijkt} = w_{ijt-1}, \text{ where } fee_{ijkt} = 1, \quad \text{Eq 2-30}$$

[8] This restriction is useful because weeks worked during a quarter and hours worked per week are not available for most states. For workers not employed the entire quarter before and after a job transition, the weeks worked will likely differ between the old and the new job, distorting earnings comparisons. Using only transitions between full quarter jobs implies that the at risk weeks are the same in the old and the new job, however even if the weeks worked is the same the hours worked per week may differ if, for example, a worker transitions from a full-time to a part-time job.

and the earnings at the destination employer is

$$fee\_kfqearn_{ijkt} = w_{ikt+1},\ \text{where}\ fee_{ijkt} = 1. \qquad \text{Eq 2-31}$$

From this we can calculate the change in earnings as follows:

$$fee\_dearn_{ijkt} = fee\_kfqearn_{ijkt} - fee\_jfqearn_{ijkt}\ . \qquad \text{Eq 2-32}$$

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

2.2 Aggregation

2.2.1 Counts

For each microdata element we can produce an analogous count measure that is the sum of the instances of the event for sets of workers and firms with particular characteristics. Generically,

$$Measure_{IJKt} = \sum_{i \in I, j \in J, k \in K} measure_{ijkt} \qquad \text{Eq 2-33}$$

The variable *I* represents a set of workers, *J* represents a set of origin firms, and *K* represents a set of destination firms. For some measures, the origin or destination firm may be unobserved or beyond the scope of the measure, and the subscript may be omitted. One additional notational concept is introduced here: some measures can be tabulated on only the origin or destination (e.g., accession to or separations from dominant jobs), and others can be tabulated on an origin-destination pair (e.g., an employer to employer flow). The latter measures can also be calculated across all origins or across all destinations. When aggregating over these margins, a period (.) is used in the appropriate subscript. Several examples follow - the complete list of released measures is available in Table 1, at the end of this document.

2.2.1.1 Selected Aggregate Measures

Main Beginning of Quarter Jobs

$$MainB_{IJt} = \sum_{i \in I, j \in J} \text{domb}_{\text{ijt}} \qquad \text{Eq 2-34}$$

Main End of Quarter Jobs

$$MainE_{IKt} = \sum_{i \in I, k \in K} \text{dome}_{\text{ikt}} \quad \text{Eq 2-35}$$

Employer to Employer Flows – Origin *J*, Destination *K*

$$EE_{IJKt} = \sum_{i \in I, j \in J, k \in K} \text{ee}_{\text{ijkt}} \quad \text{Eq 2-36}$$

Employer to Employer Separations – Origin *J*, Any Destination

$$EESep_{IJt} = \sum_{i \in I, j \in J} \text{ee\_doms2}_{\text{ijt}} \quad \text{Eq 2-37}$$

Employer to Employer Accessions – Any Origin, Destination *K*

$$EEHire_{IKt} = \sum_{i \in I, k \in K} \text{ee\_doma2}_{\text{ikt}} \quad \text{Eq 2-38}$$

Employer to Employer Separations, Adjacent Quarter – Origin *J*, Any Destination

$$AQSep_{IJt} = \sum_{i \in I, j \in J} \text{aq\_doms2}_{\text{ijt}} \quad \text{Eq 2-39}$$

Employer to Employer Accessions, Adjacent Quarter – Any Origin, Destination *K*

$$AQHire_{IKt} = \sum_{i \in I, k \in K} \text{aq\_doma2}_{\text{ikt}} \quad \text{Eq 2-40}$$

Job-to-Job Separations, Origin *J*, Any Destination

$$J2JSep_{IJt} = EESep_{IJt} + AQSep_{IJt} \quad \text{Eq 2-41}$$

Job-to-Job Accessions, Any Origin, Destination *K*

$$J2JHire_{IKt} = EEHire_{IKt} + AQHire_{IKt} \quad \text{Eq 2-42}$$

Separation to Non-employment – Origin *J*

$$ENSep_{IJt} = \sum_{i \in I, j \in J} \text{en\_doms2}_{\text{ijt}} \quad \text{Eq 2-43}$$

Accession from Persistent Non-employment – Destination *K*

$$NEHire_{IKt} = \sum_{i \in I, k \in K} \text{ne\_doma2}_{\text{ikt}} \quad \text{Eq 2-44}$$

Separation to Persistent Non-employment – Origin *J*

$$ENPersist_{IJt} = \sum_{i \in I, j \in J} \text{en2\_doms2}_{\text{ijt}} \quad \text{Eq 2-45}$$

Accession from Persistent Non-employment – Destination *K*

$$NEPersist_{IKt} = \sum_{i \in I, k \in K} \text{ne2\_doma2}_{\text{ikt}} \quad \text{Eq 2-46}$$

2.2.1.2 Disclosure Protection

All released count measures aggregate from noise-infused components. For more information, see section 4.

2.2.2 Rates

Rates are calculated for all flow variables, using average dominant beginning and ending quarter employment in the cell as the denominator. Average dominant employment, $\overline{MainE_{IJt}}$, is calculated as

$$\overline{MainE_{IJt}} = \frac{\left(MainB_{IJt} + MainE_{IJt}\right)}{2} \quad \text{Eq 2-47}$$

The naming convention for rate variables appends an "R" to the end of the count variable name. For example, the *Employer to Employer Separation Rate* is computed as

$$EESepR_{IJt} = \frac{EESep_{IJt}}{\overline{MainE_{IJt}}}, \quad \text{Eq 2-48}$$

and the *Employer to Employer Accession Rate* is computed as

$$EEHireR_{IKt} = \frac{EEHire_{IKt}}{\overline{MainE_{IKt}}}. \quad \text{Eq 2-49}$$

Other selected rates follow:

Separation to Non-employment Rate

$$ENSepR_{IJt} = \frac{ENSep_{IJt}}{\overline{MainE_{IJt}}}. \quad \text{Eq 2-50}$$

Accession from Non-employment Rate

$$NEHireR_{IKt} = \frac{NEHire_{IKt}}{MainE_{IKt}}. \quad \text{Eq 2-51}$$

Separation to Persistent Non-employment Rate

$$ENPersistR_{IJt} = \frac{ENPersist_{IJt}}{MainE_{IJt}}. \quad \text{Eq 2-52}$$

Accession from Persistent Non-employment Rate

$$NEPersistR_{IKt} = \frac{NEPersist_{IKt}}{MainE_{IKt}}. \quad \text{Eq 2-53}$$

Job-to-Job Separation Rate

$$J2JSepR_{IJt} = \frac{J2JSep_{IJt}}{MainE_{IJt}}. \quad \text{Eq 2-54}$$

Job-to-Job Hire Rate

$$J2JHireR_{IKt} = \frac{J2JHire_{IKt}}{MainE_{IKt}}. \quad \text{Eq 2-55}$$

2.2.2.1 Disclosure Protection

All released rate measures are calculated from post-publication counts in both the numerator and the denominator, and no additional disclosure protection measures beyond those already applied to the counts (see section 4) are applied.

2.2.2.2 Deviations Between Released Count and Rate Series

The not seasonally adjusted national rate series are directly calculable from the corresponding released count series. However, the seasonal adjustment process for counts and rates at both the state and national level is done separately for each series. This will likely result in seasonally adjusted rate series that differ from a direct calculation of the rates using the corresponding seasonally adjusted count series.

2.2.3 Earnings

Average earnings and the average change in earnings are calculated in the origin-destination table for several types of earnings transitions. Average earnings is defined as the sum of earnings in the appropriate reference quarter for all transitions of a particular type, divided by the

count of those transitions. The average change in earnings is computed as the total change in earnings for a transition type divided by the count of those transitions. Examples of these calculations follow. As in the count data, summations are performed over $i \in I$, $j \in J$, and $k \in K$.

2.2.3.1 Selected Earnings Calculations

Average Earnings in the Destination Job Following a Full-Quarter Employer to Employer Transition

$$EEFullQEarn\_dest_{IJKt} = \frac{\sum_{ijk} fee\_kfqearn_{ijkt}}{\sum_{ijk} fee_{ijkt}} \quad \text{Eq 2-56}$$

Average Change in Earnings Following a Full-Quarter Employer to Employer Transition

$$EEFullQEarn\_change_{IJKt} = \frac{\sum_{ijk} fee\_dearn_{ijkt}}{\sum_{ijk} fee_{ijkt}} \quad \text{Eq 2-57}$$

2.2.3.2 Disclosure Protection

For average earnings and average change in earnings measures, only the numerator aggregates from noise-infused data.

3 Accounting for Incomplete Reporting - Imputation of National Series

States provide data to the LEHD program with different start quarters. We release the national time-series beginning in the second quarter of the year 2000. In the initial quarter, data is available for 41 states, which make up up about 87% of QCEW 2012Q2 Month 1 private sector employment. As shown in Figure 5, additional states become available in subsequent quarters. The largest missing data state, Michigan, enters first, followed shortly 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. By 2010Q2 the data is complete, with all 50 states and the District of Columbia regularly reporting to LEHD.

Similar to Abowd and Vilhuber (2011), we develop two missing data models, the first covers the period prior to 2005Q2 (10 states missing) and the second model covers the later missing data period (1 state missing). We also use the same alternative reference series (the QCEW), to calculate rates (J2J measure/QCEW employment) for the complete data states. For the missing

data states, we impute each rate value by sampling from the adjusted complete data states' rates. An estimate of the counts is constructed by taking a weighted average of the sampled rates for each missing data state multiplied by the corresponding missing data state's QCEW employment value. Although this method is similar to Abowd and Vilhuber (2011), we implement several adjustments to both reduce the small sample variance of the estimates and address a fundamental difference between the calculation of the J2J and the QWI statistics.

For the QWI, statistics are unbiased at the state level when other states are missing; however, this is not the case for J2J. The J2J uses the concept of national dominant beginning and ending quarter jobs for each worker; if data for a state is missing, a non-dominant job in a reporting state may be incorrectly classified as a dominant job. In addition, workers that transition to a job in a missing data state will be incorrectly classified as transitioning to non-employment. To address the resulting bias in the observed or reporting data states' rates during the incomplete data period, we adjust the rates using information from the complete data period (2010Q2 forward).

The average rate for the missing data states differs noticeably from the average rate for the reporting data states. Although this finding may seem like a violation of the missing at random assumption, it is more likely a feature of the Bayesian bootstrap methodology when the set of states is small and the number of missing data states differs substantially from the number of complete data states. For example, assume the missing and complete data states' rates are drawn from the same population distribution. As long as this distribution is not degenerate, the sampled rates will differ across states. For any two samples of states drawn at random, the average rate in the two samples will differ by some amount, but this difference is likely to be smallest when the number of missing and complete data states is about the same. In the two missing data periods or "regimes," there are 10 missing and 41 reported data states in the first regime and 1 missing data state and 50 reported data states in the second regime. Due to both the small number of missing data states and the large difference in the number of missing and reporting data states in both regimes, the average of the reporting data states is likely to be much closer to the overall average than the average of the missing data states.

To adjust for both the difference in the average rates between the missing and the reporting states and reduce the variance in our estimates we implement a modification to the Abowd and Vilhuber (2011) methodology. Using the complete data period where the rates are observed for

each missing-reporting state pair, we estimate a correction model at the NAICS sector level. We then sample from the correction model PPD(s), generating adjusted rates for each sampled state pair. Assuming the differences in state labor market dynamics are relatively stable over time, this methodology accounts for unobserved differences between the missing data states and the sampled reporting data states.

With the data completed, the national rate estimates 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.[9]

4 Disclosure Protection

To ensure the confidentiality of the released data, a variety of confidentiality protection measures are applied to the J2J data. In an extension of the existing noise infusion procedure used for the QWI, each item in the J2J data receives a multiplicative fuzz factor (Abowd et al., 2009). However, unlike the QWI, where an item is uniquely related to a single establishment with a unique fuzz factor, 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. The methodology used here (Abowd and McKinney, 2014) is based on the notion of an "edge" in graph theory and is designed to draw a single fuzz factor from the two available establishment fuzz factors, 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. Note that no new fuzz factors are created.

In addition to noise infusion, additional protection is provided by synthesizing values for small cells. First, cells that do not have any positive weight ("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

[9] Standard errors computed according to the Rubin (1987) methodology are also obtained. These may be released in the future.

multinomial Posterior Predictive Distribution (PPD). Every quarter for each release table, we count the number of fuzzed counts (the confidential value multiplied by the fuzz factor) that are 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.

To maintain consistency across releases, the synthetic values drawn from the PPD are carried forward into all subsequent releases. In particular, each suppressed cell receives a single synthetic value. That same synthetic value is used in all future releases in which the cell is suppressed.

5 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 series. The initial release of national rates and counts 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 poses additional challenges beyond the basic methodology. Our research has found that quarterly earnings in administrative data exhibit significant irregular variation that does not follow seasonal patterns. Some of this is due to so-called "trading day" effects, as quarterly earnings vary by the number of pay periods in each quarter. However, a significant amount of variation is unexplained by trading day or other seasonal patterns. We continue to explore alternative methods to smooth quarterly earnings series.

5.1 Pretreatment of Seasonally-Adjusted State-Level Data

When examining the state-by-industry level beta J2J, unusual spikes in the separations and hires from persistent non-employment series can be observed in several time series. Further examination of the data led us to the conclusion that these spikes were principally the result of reporting errors in the administrative data. A typical scenario would be an employer failing to report UI earnings for one quarter, causing the administrative data to reflect an unusually large number of workers in the industry moving from employment to non-employment and then back to employment again. To address this issue, prior to seasonal adjustment, we pretreat the state-level tabulations by detecting additive outliers and replacing them with forecasted values from the time series, using the X-11-ARIMA method. We then seasonally adjust the pretreated data with outliers removed. Outliers are not removed from the not seasonally adjusted data. In the longer term, we plan to impute wage records for these cases in the microdata.

6 Job-to-Job Flows – Released Data

6.1 National Measures of Job Change

The national job-to-job flows rates file contains national main job hire and separation rates, by whether or not the worker is moving to/from a recent employment spell. Figure 1 shows the job-to-job separation rate $J2JSepR_{IJt}$ (Eq 2-54) and job-to-job hire rate $J2JHireR_{IKt}$ (Eq 2-55) for the United States for the period 2000-2013. Job separation rates to persistent non-employment $ENPersistR_{IJt}$ (Eq 2-52) and accession rates from persistent non-employment $NEPersistR_{IKt}$ (Eq 2-53) 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 non-employment, the recent decline in job separations and hires is largely driven by this decline in worker reallocation.[10]

[10]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.

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 non-employment. 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.

Additional release tables describe job transitions and flows to and from non-employment at the national, state-level, and sub-state geography, by industry sector and sub-sector, firm age and size, worker age, sex, education, and race/ethnicity.[11]

6.2 State Measures of Job Change and Criteria for Release

In addition to the rates series shown in Figure 1, state-level files with the same set of job-to-job statistics are also available. The length of the time series will vary by state, depending on availability of data. However, in contrast to the QWI, 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 (or states) with missing data. For example, LEHD 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. The absence of Massachusetts creates significant bias in the rates of flows to and from employment for these other states. Therefore, 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.[12]

State interrelatedness is established by analyzing patterns of within-quarter employer-to-employer flows. These transitions are summarized by origin and destination states for an eight-quarter window during which all states are available, 2011-2012. From this, we calculate the

[11] The J2J beta releases will only contain a subset of these tables. The final specifications for official J2J data releases have not yet been fixed.

[12] In the case of both Massachusetts and the District of Columbia, data is available before these dates but did not meet standards for publication in 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.

mean share of accessions in a reference state coming from each linked state (including itself), as well as the mean share of separations from the reference state going to each linked state. For every reference state-linked state pair, the two rates are averaged together across quarters, resulting in an index L_{ab} representing the overall impact of the linked state *b* on the reference state *a*. Formally, the index *L* is calculated between reference state *a* and linked state *b*, using *N* quarters in *T*. We reference the measures for the margins across all person characteristics, so a period (.) replaces the usual *I* subscript. The denominators in the calculation sum over the set of all destination or origin states *S*, which includes the reference state *a*.

$$L_{ab} = \sum_{t \in T} \left(\frac{EE_{.abt}}{\sum_{s \in S} EE_{.ast}} + \frac{EE_{.bat}}{\sum_{s \in S} EE_{.sat}} \right) / 2N \qquad \text{Eq 6-1}$$

Using the L_{ab} index created above, the aggregate release index RL_{at} is calculated between reference state *a* and the set M_t of all missing linked states *b* in time period *t*.

$$RL_{at} = \sum_{b \in M_t} L_{ab} \qquad \text{Eq 6-2}$$

This aggregate index RL_{at} is used to determine if statistics for state *a* can be released in quarter *t*. If RL_{at} is 2.5% or greater, the absence of the linked state will by itself result in suppression of the reference state. If multiple linked states are missing, RL_{at} measures the aggregate impact of missing states on the reference state, with the same 2.5% benchmark as the upper limit for release of the reference state. During quality assurance review, some additional suppressions may be applied to marginal cases. For example, RL_{at} for Ohio drops from 3.3% to a marginal 2.4% when Michigan enters in the fourth quarter of 2000, but drops strongly to 0.5% when Kentucky enters in the second quarter of 2001, suggesting that the latter quarter is a more appropriate start date for the Ohio series.

6.3 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 non-employment, 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. and, in addition, measure the earnings losses or gains associated with such transitions.

7 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 Current Population Survey (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 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.

In Figure 2, we show a quarterly version of the CPS monthly rate of job-to-job flows along with three LEHD J2J series for job-to-job flows rates: job-to-job separation rate (*J2JSepR*, Eq 2-54), job-to-job hire rate (*J2JHireR*, Eq 2-55), and within-quarter job-to-job hire rate (*EEHireR*, Eq 2-49). 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 *J2JHireR* (which combines within- and adjacent-quarter flows), and a correlation of 0.87 with *EEHireR*.[13] 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

[13]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.

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) non-employment inflows and outflows series to J2J flows to non-employment (*ENSepR*, *ENPersistR*) and from non-employment (*NEHireR, NEPersistR*). 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 (*J2JSepR,* Eq 2-54) and persistent non-employment (*ENPersistR,* Eq 2-52) 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 non-employment is 0.62. There is, however, a substantial level difference, with separations to persistent non-employment 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 non-employment rate, suggesting that the gap between the two series is largely due to establishments with larger employment declines being underrepresented in JOLTS.

8 Some Considerations When Using the J2J Data

8.1 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 non-employment, 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 non-employment 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 non-employment.

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.[14] 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 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.[15] 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.

[14] 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. Earings 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.

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

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.

8.2 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. Workers also hold 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.

8.3 Main Jobs vs. Employment

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

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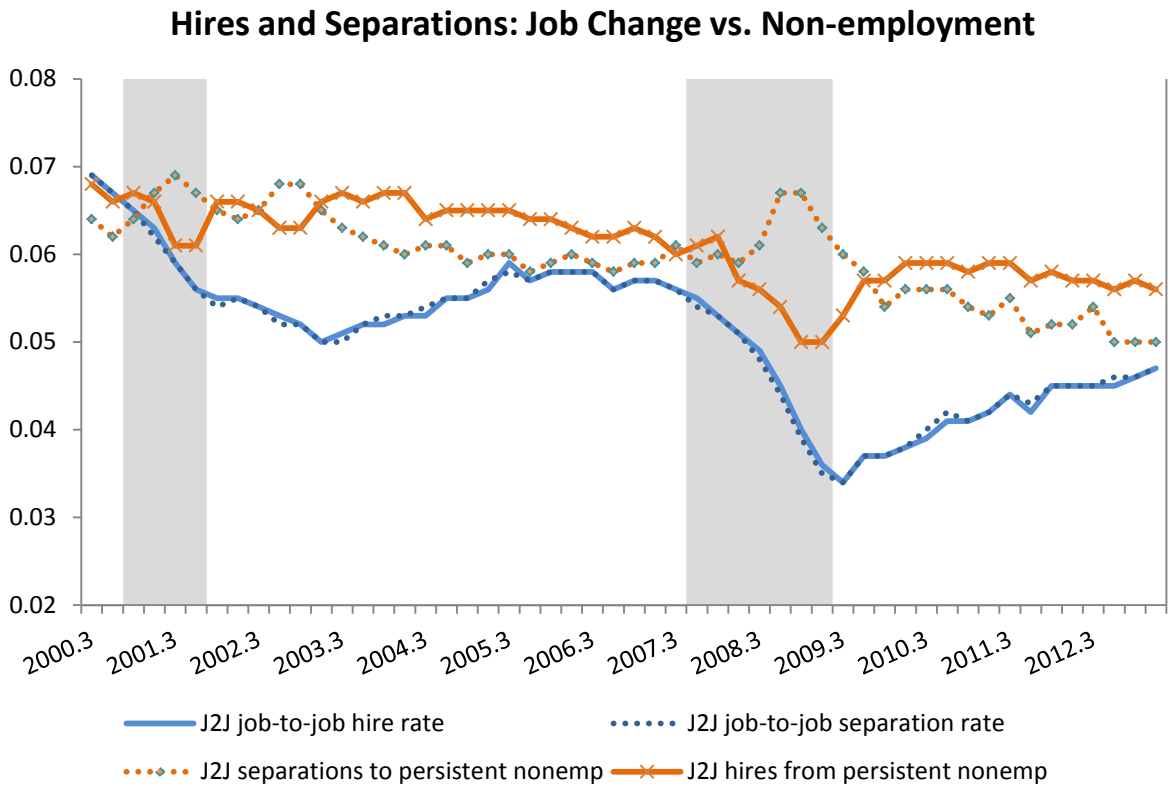
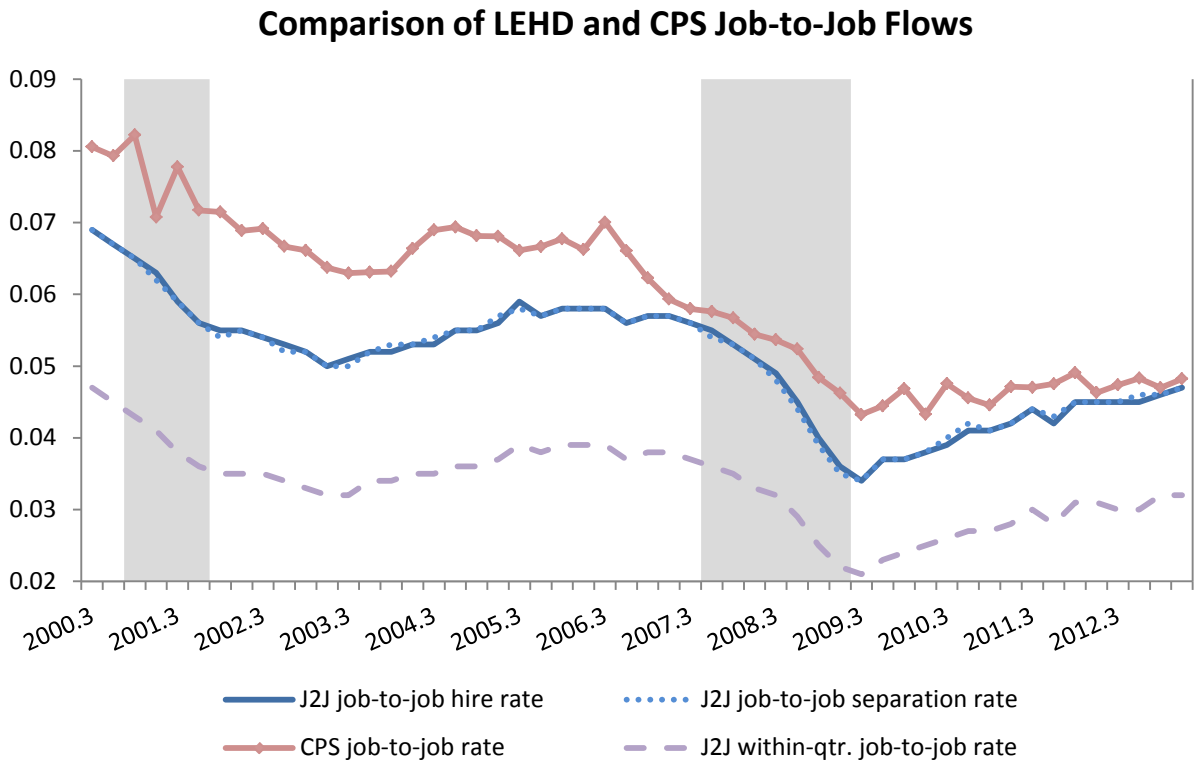
Figures

Figure 1



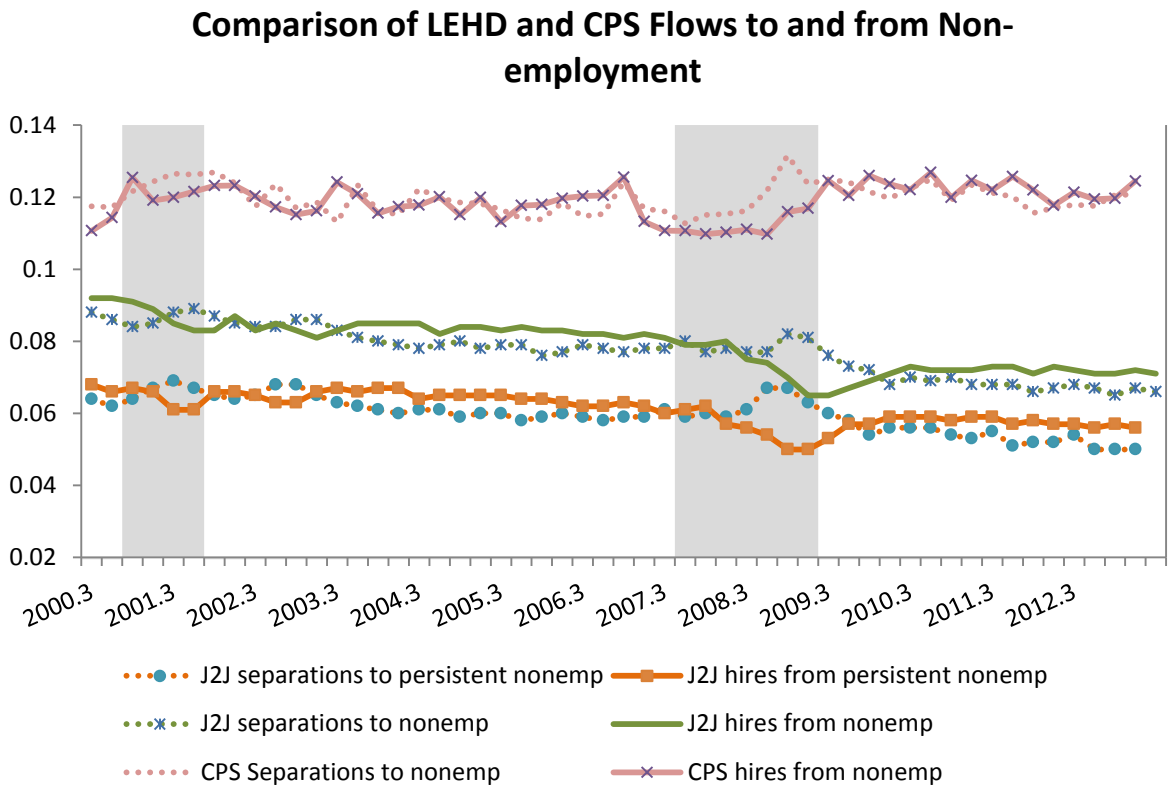
Note: Shaded regions indicate NBER recession quarters. All data are seasonally adjusted. J2J job-to-job hires are new main job starts this quarter where the separation from the previous main job occurred either in this quarter or the previous quarter. Job-to-job separations are separations from main jobs associated with a new job start this quarter or the subsequent quarter. Separations to persistent non-employment are nonemployed both at the end of the quarter and the end of the subsequent quarter. Accessions from persistent non-employment 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



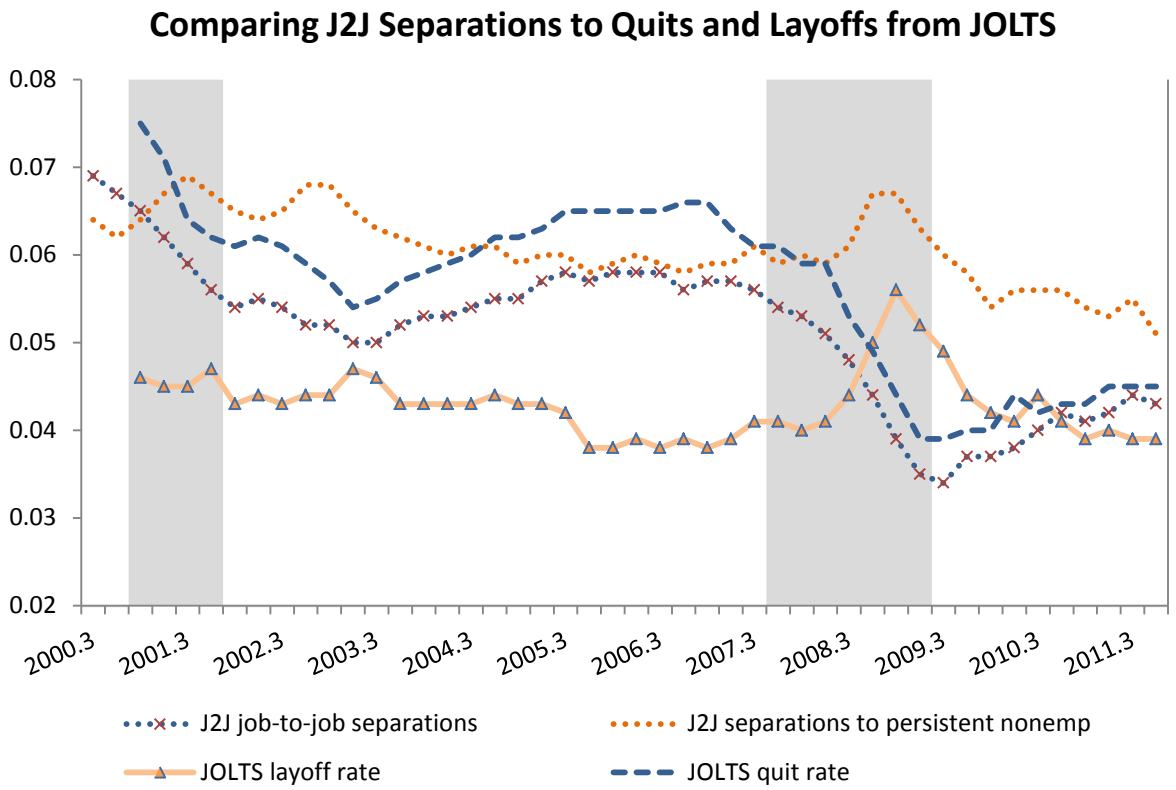
Note: Shaded regions indicate NBER recession quarters. All data are seasonally adjusted. CPS job-to-job flows series is calculated from the CPS by Fallick and Fleischman (2004). J2J hire rate here refers to new main job starts this quarter where the separation from the previous main job occurred either 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



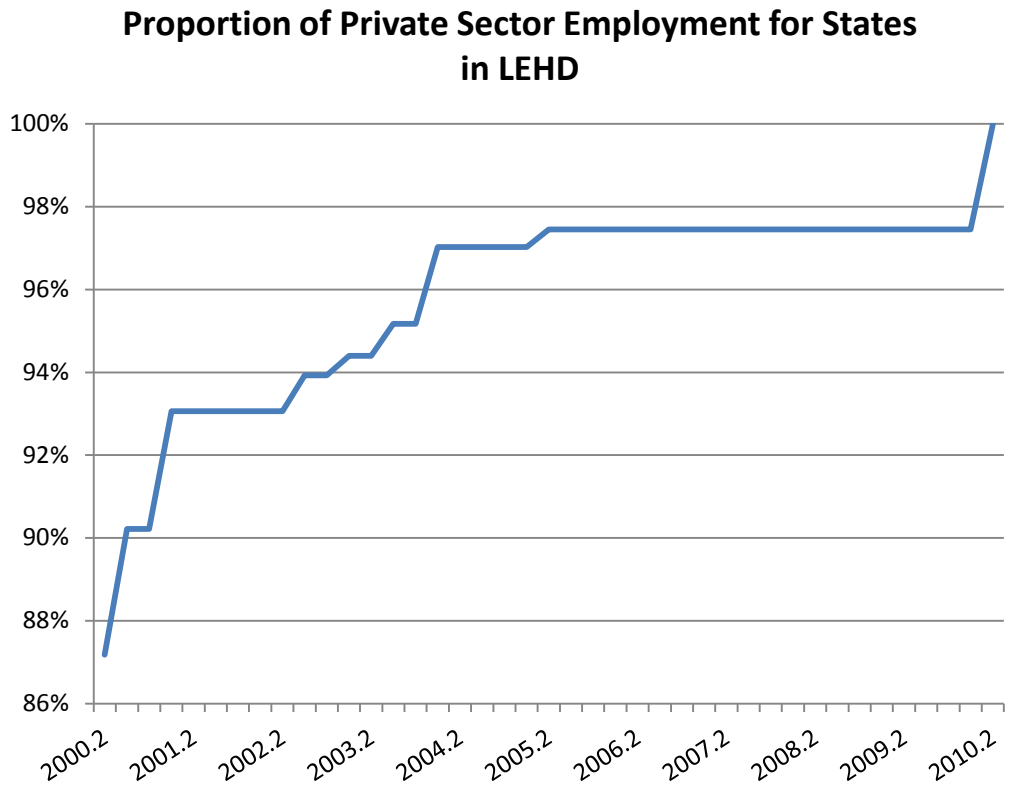
Note: Shaded regions indicate NBER recession quarters. All data are seasonally adjusted. CPS data was downloaded from the Fallick and Fleischman (2004) website. J2J hires/separations from non-employment includes adjacent-quarter job-to-job flows as well as flows from persistent non-employment.

Figure 4



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 non-employment are nonemployed both at the end of the quarter and the end of the subsequent quarter.

Figure 5



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.

Tables

List of Count Variable Definitions[16]

Table 1

Microdata Variable	Short Description	Definition	Aggregate Variable (sum)
Job Counts			
$\mathbf{b_{ijt}}$	Beginning of Quarter Job	$\begin{cases} 1, \text{if } w_{ijt} > 0 \text{ and } w_{ijt-1} > 0 \\ 0, \text{otherwise} \end{cases}$	
$\mathbf{e_{ijt}}$	End of Quarter Job	$\begin{cases} 1, \text{if } w_{ijt} > 0 \text{ and } w_{ijt+1} > 0 \\ 0, \text{otherwise} \end{cases}$	
$\mathbf{domb_{ijt}}$	Main Beginning of Quarter Job	$\begin{cases} 1, \text{if } b_{ijt} = 1 \text{ and } (w_{ijt} + w_{ijt-1}) > (w_{ilt} + w_{ilt-1}) \\ \quad \forall\, l \text{ where } b_{ilt} = 1 \text{ and } l \neq j \\ 0, \text{otherwise} \end{cases}$	MainB
$\mathbf{dome_{ijt}}$	Main End of Quarter Job	$\begin{cases} 1, \text{if } e_{ijt} = 1 \text{ and } (w_{ijt} + w_{ijt+1}) > (w_{ilt} + w_{ilt+1}) \\ \quad \forall\, l \text{ where } e_{ilt} = 1 \text{ and } l \neq j \\ 0, \text{otherwise} \end{cases}$	MainE
$\mathbf{dombe_{ijt}}$	Main Beginning and End of Quarter Job	$\begin{cases} 1, \text{if } domb_{ijt} = 1 \text{ and } dome_{ijt} = 1 \\ 0, \text{otherwise} \end{cases}$	
$\mathbf{f_{ijt}}$	Full-Quarter Job	$\begin{cases} 1, \text{if } w_{ijt-1} > 0 \text{ and } w_{ijt} > 0 \text{ and } w_{ijt+1} > 0 \\ 0, \text{otherwise} \end{cases}$	
$\mathbf{fdombe_{ijt}}$	Full-Quarter Dominant Beginning and End of Quarter Job	$\begin{cases} 1, \text{if } domb_{ijt} = 1 \text{ and } dome_{ijt} = 1 \\ \quad \text{and } f_{ijt-1} = 1 \text{ and } f_{ijt+1} = 1 \\ 0, \text{otherwise} \end{cases}$	
Transitions from and to Dominant Jobs			
$\mathbf{all\_doms2_{ijt}}$	Separation from Main Job	$\begin{cases} 1, \text{if } domb_{ijt} = 1 \text{ and } m_{ijt+1} = 0 \\ 0, \text{otherwise} \end{cases}$	MSep
$\mathbf{all\_doma2_{ikt}}$	Accession to Main Job	$\begin{cases} 1, \text{if } dome_{ikt} = 1 \text{ and } m_{ijt-1} = 0 \\ 0, \text{otherwise} \end{cases}$	MHire
$\mathbf{en2\_doms2_{ijt}}$	Separation to Persistent Non-employment	$\begin{cases} 1, \text{if } all\_doms2_{ijt} = 1 \text{ and } e_{ilt} = 0 \text{ and } e_{ilt+1} = 0 \ \forall\, l \\ 0, \text{otherwise} \end{cases}$	ENPersist
$\mathbf{ne2\_doma2_{ikt}}$	Accession from Persistent Non-employment	$\begin{cases} 1, \text{if } all\_doma2_{ikt} = 1 \text{ and } b_{ilt} = 0 \text{ and } b_{ilt-1} = 0 \ \forall\ l \\ 0, \text{otherwise} \end{cases}$	NEPersist

[16] Note on Rates: The denominator for rates is the average employment over the quarter, or the average of main jobs held at the start and end of the quarter (MainB and MainE). Rates corresponding to the variables listed above have the same name but end with an R (for example, the rate corresponding to job-to-job hires (J2JHire) is the job-to-job hiring rate J2JHireR).

Microdata Variable	Short Description	Definition	Aggregate Variable (sum)
$\mathbf{en2p\_doms2_{ijt}}$	Separation to Full-Quarter Non-employment	$\begin{cases}1, \text{if all\_doms2}_{ijt}=1 \text{ and } m_{ilt+1}=0 \ \forall \ l \\ 0, \text{otherwise}\end{cases}$	ENFullQ
$\mathbf{ne2p\_doma2_{ikt}}$	Accession from Full-Quarter Non-employment	$\begin{cases}1, \text{if all\_doma2}_{ikt}=1 \text{ and } m_{ilt-1}=0 \ \forall \ l \\ 0, \text{otherwise}\end{cases}$	NEFullQ
$\mathbf{en\_doms2_{ijt}}$	Separation to Non-employment	$\begin{cases}1, \text{if all\_doms2}_{ijt}=1 \text{ and } e_{ilt}=0 \ \forall \ l \\ 0, \text{otherwise}\end{cases}$	ENSep
$\mathbf{ne\_doma2_{ikt}}$	Accession from Non-employment	$\begin{cases}1, \text{if all\_doma2}_{ikt}=1 \text{ and } b_{ilt}=0 \ \forall \ l \\ 0, \text{otherwise}\end{cases}$	NEHire
$\mathbf{mbs\_domb_{ijt}}$	Main Job Becomes Secondary	$\begin{cases}1, \text{if domb}_{ijt}=1 \text{ and dome}_{ijt}=0 \text{ and } e_{ijt}=1 \\ 0, \text{otherwise}\end{cases}$	
$\mathbf{sbm\_dome_{ikt}}$	Secondary Job Becomes Main	$\begin{cases}1, \text{if dome}_{ikt}=1 \text{ and } b_{ikt}=1 \text{ and domb}_{ikt}=0 \\ 0, \text{otherwise}\end{cases}$	
$\mathbf{mjobend_{ijt}}$	Main Job End	$\begin{cases}1, \text{if mbs\_domb}_{ijt}=1 \text{ or all\_doms2}_{ijt}=1 \\ 0, \text{otherwise}\end{cases}$	MJobEnd
$\mathbf{mjobstart_{ikt}}$	Main Job Start	$\begin{cases}1, \text{if sbm\_dome}_{ikt}=1 \text{ or all\_doma2}_{ikt}=1 \\ 0, \text{otherwise}\end{cases}$	MJobStart
Employer to Employer Transitions			
$\mathbf{ee_{ijkt}}$	Employer-to-Employer Flow	$\begin{cases}1, \text{if all\_doms2}_{ijt}=1 \text{ and all\_doma2}_{ikt}=1 \\ 0, \text{otherwise}\end{cases}$	EE
$\mathbf{fee_{ijkt}}$	Full-Quarter Employer-to-Employer Flow	$\begin{cases}1, \text{if all\_doms2}_{ijt}=1 \text{ and all\_doma2}_{ikt}=1 \\ \quad \text{and } f_{ijt-1}=1 \text{ and } f_{ikt+1}=1 \\ 0, \text{otherwise}\end{cases}$	EEFullQ
$\mathbf{ee\_doms2_{ijt}}$	Separation in Employer-to-Employer Flow	$\begin{cases}1, \text{if } \exists \text{ k such that } ee_{ijkt}=1 \\ 0, \text{otherwise}\end{cases}$	EESep
$\mathbf{ee\_doma2_{ikt}}$	Accession in Employer-to-Employer Flow	$\begin{cases}1, \text{if } \exists \text{ j such that } ee_{ijkt}=1 \\ 0, \text{otherwise}\end{cases}$	EEHire
$\mathbf{ee\_aq_{ijkt}}$	Employer-to-Employer Flow, Adjacent Quarter	$\begin{cases}1, \text{if all\_doms2}_{ijt-1}=1 \text{ and all\_doma2}_{ikt}=1 \text{ and } b_{ilt}=0 \ \forall \ l \\ 0, \text{otherwise}\end{cases}$	AQHire
$\mathbf{fee\_aq_{ijkt}}$	Full-Quarter Employer-to-Employer Flow, Adjacent Quarter	$\begin{cases}1, \text{if all\_doms2}_{ijt-1}=1 \text{ and all\_doma2}_{ikt}=1 \\ \quad \text{and } b_{ilt}=0 \ \forall \ l \text{ and } f_{ijt-2}=1 \text{ and } f_{ikt+1}=1 \\ 0, \text{otherwise}\end{cases}$	AQFullQHire
$\mathbf{aq\_doms2_{ijt}}$	Separation in Employer-to-Employer Flow, Adjacent Quarter	$\begin{cases}1, \text{if } \exists \text{ k such that ee\_aq}_{ijkt}=1 \\ 0, \text{otherwise}\end{cases}$	AQSep
$\mathbf{aq\_doma2_{ikt}}$	Accession in Employer-to-Employer Flow, Adjacent Quarter	$\begin{cases}1, \text{if } \exists \text{ j such that ee\_aq}_{ijkt}=1 \\ 0, \text{otherwise}\end{cases}$	AQHire
$\mathbf{eeall\_doms2_{ijt}}$	Job-to-Job Separation	$\begin{cases}1, \text{if ee\_doms2}_{ijt}=1 \text{ or aq\_doms2}_{ijt}=1 \\ 0, \text{otherwise}\end{cases}$	J2JSep
$\mathbf{eeall\_doma2_{ikt}}$	Job-to-Job Accession	$\begin{cases}1, \text{if ee\_doma2}_{ikt}=1 \text{ or aq\_doma2}_{ikt}=1 \\ 0, \text{otherwise}\end{cases}$	J2JHire

Earnings Variable Definitions

Table 2

Microdata Variable	Short Description	Definition	Aggegation Calculation $i \in I, j \in J, k \in K$	Aggregate Variable (mean)
$\mathbf{fee\_jfqearn_{ijkt}}$	Earnings in Origin Job, Full-Quarter Employer-to-Employer Flow	w_{ijt-1}, where fee_{ijkt}=1		
$\mathbf{fee\_kfqearn_{ijkt}}$	Earnings in Destination Job, Full-Quarter Employer-to-Employer Flow	w_{ikt+1}, where fee_{ijkt}=1	$\frac{\sum_{ijk} fee\_kfqearn_{ijkt}}{\sum_{ijk} fee_{ijkt}}$	EEFullQEarn_dest
$\mathbf{fee\_dearn_{ijkt}}$	Earnings Change, Full-Quarter Employer-to-Employer Flow	$\frac{(fee\_kfqearn_{ijkt} - fee\_jfqearn_{ijkt})}{\frac{1}{2}(fee\_kfqearn_{ijkt} + fee\_jfqearn_{ijkt})}$, where $fee_{ijkt} = 1$	$\frac{\sum_{ijk} fee\_dearn_{ijkt}}{\sum_{ijk} fee_{ijkt}}$	EEFullQEarn_change
$\mathbf{faq\_jfqearn_{ijkt}}$	Earnings in Origin Job, Full-Quarter Adjacent-Quarter Flow	w_{ijt-2}, where faq_doma2_{ijkt}=1		
$\mathbf{faq\_kfqearn_{ijkt}}$	Earnings in Destination Job, Full-Quarter Adjacent-Quarter Flow	w_{ikt+1}, where faq_doma2_{ijkt}=1	$\frac{\sum_{ijk} faq\_kfqearn_{ijkt}}{\sum_{ijk} faq\_doma2_{ijkt}}$	AQFullQEarn_dest
$\mathbf{faq\_dearn_{ijkt}}$	Earnings Change, Full-Quarter Adjacent-Quarter Flow	$\frac{(faq\_kfqearn_{ijkt} - faq\_jfqearn_{ijkt})}{\frac{1}{2}(faq\_kfqearn_{ijkt} + faq\_jfqearn_{ijkt})}$, where $faq\_doma2_{ijkt} = 1$	$\frac{\sum_{ijk} faq\_dearn_{ijkt}}{\sum_{ijk} faq\_doma2_{ijkt}}$	AQFullQEarn_change