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Sources of Displaced Workers' Long-Term Earnings Losses

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Abstract

We estimate the magnitudes of lost earnings, reduced work hours, and lower wage rates of workers displaced during the Great Recession using linked employer-employee panel data. We find that displaced workers' substantial earnings losses occur mainly because hourly wage rates drop at the time of displacement and recover sluggishly at best. Further, lost employer-specific premiums play a minor role in explaining displaced workers' losses, accounting for 11 percent of average earnings losses and 25 percent of lower hourly wages. The estimates point to lost specific skills or lost favorable employer-employee matches as principal sources of displaced workers' earnings losses.

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1 Introduction

Permanent loss of a long-term job—worker displacement—leads to earnings losses that are enduring, even permanent.[5] But long-standing unanswered questions surround the reasons for these losses. Are they the result of lost firm-specific rents, lost specific human capital, loss of a specific employer-employee match, or something else? Longitudinal data on workers' earnings have established the magnitude of displaced workers' earnings losses, but questions remain about the reasons for these losses, which are important both theoretically and from the standpoint of mitigating the losses.

We use linked employer-employee panel data based on administrative records from the unemployment insurance (UI) system of Washington State during 2002–2014 to examine the role of employers in generating displaced workers' earnings losses. To do this, we estimate employer-specific fixed effects as suggested by Abowd, Kramarz, and Margolis (1999; hereafter AKM), then use these estimated employer effects to quantify whether displaced workers' losses result from displacement by employers who pay earnings premiums followed by reemployment with employers who do not.

The Washington administrative records are unusual because, in addition to reporting employer-specific quarterly earnings of all UI-covered workers in the state, they report quarterly paid work hours. The availability of both earnings and work hours allows us to calculate hourly wage rates on a quarterly basis, and to decompose displaced workers' long-term earnings losses

[5] See, for example, Topel (1990), Jacobson, LaLonde, and Sullivan (1993a, 1993b), Farber (1993, 1997, 2015, 2017), Stevens (1997), von Wachter, Song, and Manchester (2009), Couch and Placzek (2010), Davis and von Wachter (2012), Jarosch (2015), Jung and Kuhn (2018), Krolikowski (2017), Fackler, Mueller, and Stegmaier (2017), Schmieder, von Wachter, and Heining (2018), and the reviews by Hamermesh (1996), Fallick (1996), Kletzer (1998), von Wachter (2010), and Carrington and Fallick (2017). Worker displacement has also been shown to reduce household expenditure (Stephens 2001), lead to poorer health (Schaller and Stevens 2015), reduce happiness (Kalil and DeLeire 2013), increase mortality (Sullivan and von Wachter 2009), and harm children affected by parental job loss (Oreopoulos, Page, and Stevens 2008; Stevens and Schaller 2011).

into components due to reduced hours and lower hourly wages. The decomposition is important because we want to know whether the earnings losses of displaced workers who remain attached to the labor force result from an inability to find full-time work or from a drop in the return to their human capital.

Workers displaced in Washington during the Great Recession suffered earnings losses similar to those in Pennsylvania during the 1980s (Jacobson, LaLonde, and Sullivan 1993a, 1993b; hereafter JLS), in Connecticut during 2000–2001 (Couch and Placzek 2010; hereafter CP), and in the U.S. (nationally) over the 1980–2005 period (Davis and von Wachter 2012): five years after job loss, displaced workers' earnings were 16 percent less than those of a stably employed comparison group.[6] The decomposition of these losses into hours and wage rates shows that virtually all earnings losses in the year following displacement resulted from lost work hours. But five years after displacement, only 45 percent of lost earnings were due to reduced work hours, whereas 55 percent were due to lower hourly wage rates.[7] An unexpected finding is that the pattern of displaced workers' wage rate losses differs strikingly from that of earnings losses: whereas earnings follow a well-known pattern of "dip, drop, and partial recovery," wage rates drop suddenly at the time of displacement and recover far more sluggishly.

Overall, employer fixed effects play only a limited role in explaining these losses. Employer effects account for about 11 percent of the average earnings losses of displaced workers, and for about 25 percent of average hourly wage rate reductions. Hence, employer premium losses, as measured by lost employer effects, are small. Mean reversion is the mechanism behind the relative unimportance of employer fixed effects—workers displaced from

[6] JLS and CP also use administrative records, so we will draw frequent comparisons between our estimates of displaced workers' earnings losses and theirs.

[7] This differs from Stevens's (1997) findings using the Panel Study of Income Dynamics, which suggest that reduced work hours play a relatively minor role in explaining the long-term earnings losses of displaced workers.

high fixed-effects employers tend to move to lower fixed-effects employers, and vice versa. This pattern differs from that observed for the full losses due to displacement, which are large and negative regardless of the type of employer (high or low fixed effect) from which a worker is displaced.

These main results—that displaced workers suffer substantial long-term wage rate losses regardless of the type of employer from which they separate, and that employer fixed effects are mean reverting and of minor importance overall—imply that lost firm-specific human capital, or loss of a favorable employer-employee match, is significantly more important than lost firm-specific premiums in explaining displaced workers' lost earnings.

The paper is organized as follows. Section 2 describes the data, and section 3 describes the empirical strategy. We extend JLS's seminal approach to a decomposition of earnings losses into components attributable to lost work hours and reduced wage rates. We then combine the JLS approach with the AKM model to examine the importance of employer fixed effects in explaining the losses of displaced workers. Section 4 presents the main results on earnings losses and their decomposition into lost work hours and lower hourly wage rates. Section 5 examines the role of employer fixed effects in explaining displaced workers' losses. The final section reviews the estimates and discusses their implications. Appendix A describes additional analyses, and Appendix B describes the AKM analysis underlying the estimates in section 5.

2 Data

The data we use come from the records maintained by the Employment Security Department of Washington State to administer the state's UI system: quarterly earnings records from all UI-covered employers in Washington from 2002:I through 2014:IV; and the UI claims records of all individuals who claimed UI in Washington at any time during the same period.

The administrative earnings records of most states include a worker's quarterly earnings by employer; in addition, UI-covered employers in Washington are required to report each worker's quarterly work hours.[8] Hence, a record appears for each quarter-worker-employer combination that includes the worker's earnings and work hours during the quarter with a given employer. This allows to us construct an hourly wage rate in quarter *t* for most workers in Washington's formal labor market. We focus on the wage rate with the primary employer in each quarter (that is, the employer from whom the worker had the largest share of earnings in the quarter), dividing earnings from that employer by hours worked with that employer.[9]

Each worker's quarterly earnings record includes an employer identifier and the employer's four-digit North American Industry Classification System (NAICS) code, making it possible to construct employment at both the employer and industry level by summing over the

[8] Washington is the only state that uses hours worked in the year before claiming UI to determine UI eligibility, so employers are required to report hours, including overtime and hours of paid leave. Actual hours of salaried, commissioned, and piecework employees are reported unless those hours are not tracked, in which case employers are instructed to report 40 hours per week—see *Unemployment Insurance Tax Information*, Employment Security Department, Washington State, October 2014 (Revised). Our examination of the hours data starting in 2001 suggests they are reliable and of high quality—see Lachowska, Mas, and Woodbury (2018). For further discussion of Washington's UI system, see Lachowska, Meral, and Woodbury (2016).

[9] All earnings are converted to constant 2010 dollars using the Consumer Price Index for All Urban Consumers (CPI-U). We handle outliers by winsorizing positive earnings at the 99th percentile (about $69,000 per quarter). Work hours coded "9999" are set to missing. Most observations with positive earnings and zero reported hours in a quarter are accurate: the Washington Employment Security Department instructs employers to report back pay, bonuses, commissions, cafeteria and 401k plan payments, royalties and residuals, severance and separation pay, settlements, sick leave, and tips and gratuities as quarter *t* earnings if they were paid in quarter *t*, even if the worker no longer worked for the employer in quarter *t* < https://esd.wa.gov/employer-taxes/zero-hour-reports>. Finally, we winsorize positive hours at the 99th percentile (783 hours per quarter) and winsorize positive wage rates at the 99 percentile (about $139 per hour).

records associated with a given employer or industry in each quarter. At the worker level, the linked employer identifiers and NAICS codes, along with the panel nature of the administrative records, allow us to observe worker transitions between employers. The panel nature of the wage records also allows us to observe each worker's tenure with a given employer.

We use the Washington administrative records just described for two distinct analyses: an AKM analysis, which estimates individual employer and worker fixed effects for earnings, work hours, and wage rates using data on all UI-covered workers and employers in Washington; and an analysis of displaced workers' earnings losses, part of which makes use of the AKM analysis. In the rest of this section, we describe the sample used in the displaced worker analysis. Appendix B describes the dataset used in the AKM analysis, along with further discussion of the Washington administrative records and the AKM analysis itself.

2.1 Construction of the displaced worker analysis sample

We define a displaced worker by three criteria. First, a worker must have at least six years of job tenure (24 consecutive quarters of positive earnings) with the same primary employer during 2002–2007.[10] We refer to these as long-tenure workers. Second, we define such a long-tenure worker as displaced if, at any time during 2008–2010,[11] that worker separated from her primary employer within four quarters of a quarter in which the employer experienced a mass layoff.[12] An employer is counted as having a mass layoff in a quarter during 2008–2010 if (i) employment

[10] This criterion follows JLS and CP. In Appendix A.1, we describe estimates for displaced workers with shorter pre-displacement job tenures.

[11] We focus on separations during 2008–2010 because, although the Great Recession contraction officially lasted from December 2007 until June 2009, the recovery of the labor market lagged substantially: Washington's unemployment rate did not fall below 10 percent until June 2010, and had fallen only to 9.6 percent by December 2010 <https://www.bls.gov/lau/>.

[12] A worker's displacement is dated to the quarter of his or her separation (not the quarter of the separating employer's mass layoff). Workers who separated, but not in connection with a mass layoff, are dropped from the displaced worker treatment group because, for these workers, the decision to separate is more likely to have been the result either of worker choice or employer selection.

dropped by 30 percent or more compared with the quarter of 2007 in which employment was greatest and (ii) maximum employment in 2007 was less than 130 percent of maximum employment in 2006. The latter condition helps to avoid classifying employers in steady decline as experiencing a mass layoff (Davis and von Wachter 2012).[13]

Third, for all quarters starting with 2008:I, we require displaced workers to have at least one quarter per calendar year with positive earnings to remain in the sample. This follows JLS and implies that the estimates should be interpreted as effects of displacement on workers who remain attached to the Washington labor force.[14] (In Appendix A.2, we estimate the effects of displacement without imposing this requirement.)

The comparison group consists of long-tenure workers who were not displaced and who continued to have positive earnings with the same primary employer in every quarter from 2008:I through 2014:IV. The comparison, then, is between the outcomes of long-tenure displaced workers and long-tenure non-displaced workers who retain employment with the same primary employer for another seven years.[15,16]

For two reasons, we restrict the main analysis to workers who claimed UI at least once during 2002–2014. First, we observe demographic characteristics—age, gender, race,

[13] Because mass layoffs are defined by percentage changes in employment, small employers may be counted as having a mass layoff with only a small absolute change in employment. Accordingly, we drop any worker who at any time had a primary employer whose employment dropped below 50 workers in any quarter during 2002–2007.
[14] Workers who drop out of the labor force, become self-employed, work in the underground economy, or move out of state will not appear in the Washington wage records. (Self-employed workers are not covered by UI, underground earnings are not reported, and out-of-state earnings will be picked up in the wage records of another state.)
[15] For estimates based on an alternative comparison group that need not remain with the same primary employer from 2008:I through 2014:IV, see Appendix A.3.
[16] We have conducted a robustness check that excludes the non-displaced co-workers of displaced workers from the comparison group. This exclusion drops about 20 percent of the original comparison group, and produces slightly larger estimates of displaced workers' earnings, hours, and wage rate losses.

education—only for this subset of workers (about 33 percent of the displaced workers).[17] Observing workers' characteristics allows us to make our analysis similar to previous research by restricting attention to displaced workers aged 20–50 at the time of displacement. Second, restricting attention to workers who claimed UI implies that all workers in the non-displaced comparison group experienced at least one UI-covered temporary layoff (with recall to the same employer) during the 2002–2014 period. [It is common for workers to receive UI benefits during temporary layoffs lasting less than one quarter (Anderson and Meyer 1994). The median UI claim duration of non-displaced workers in the sample we use was 2 weeks.] Selecting non-displaced workers who have experienced one or more temporary layoffs should result in a comparison group at greater risk of displacement, and hence more comparable to the displaced treatment group.[18]

2.2 Summary statistics for displaced workers and the comparison group

Table 1 displays descriptive statistics of key variables for the full UI claimant sample (columns 1 and 2) and for two subsamples: the sample excluding workers in NAICS industries 51–56 (columns 3 and 4); and including only workers whose employers paid top-quintile earnings premiums (columns 5 and 6). The full sample includes 3,032 displaced workers and 13,290 non-displaced workers.

In the pre-displacement years 2002–2005,[19] the displaced workers had somewhat higher quarterly average earnings and work hours, and substantially higher hourly wage rates, than did

[17] State UI agencies typically record workers' characteristics only when they claim UI. For gender and race, we assign an indicator with a constant value over the 13-year period. We assign the age of a worker in each quarter based on the worker's age in the quarter he or she was observed. For education, we assign a constant level if we observe the worker only once; however, if we observe the worker more than once (that is, if he or she claimed UI more than once), we assign the first observed value of education for all quarters until the quarter in which we observe a change.

[18] Appendix A.4 describes estimates using a sample not restricted to UI claimants.

[19] We omit 2006–2007 to avoid including lower earnings and hours that may occur due to pre-displacement "Ashenfelter's dips."

the non-displaced comparison group (Table 1, top panel). These differences nearly disappear when workers in NAICS industries 51–56 are dropped from the sample (columns 3 and 4). The demographic characteristics of the sample fit the well-known profile of displaced workers: 70 percent male, 77 percent white, 45 percent with a high school education but no post-secondary education, 11 percent with less than high school or a GED, and averaging 40 years of age.

The bottom panel of Table 1 shows two substantial differences between the displaced worker treatment group and the non-displaced comparison group. First, the employers of displaced workers were smaller on average than those of non-displaced workers. This difference arises because, as noted earlier, small employers are more likely than large employers to satisfy the definition of a mass layoff. Second, the distribution of displaced and non-displaced workers differs by major industry of employment in 2007:IV. About 83 percent of displaced workers came from just three major industries: NAICS codes 31–33 (manufacturing; 27 percent), 42–49 (trade; 15 percent), and 51–56 (information, finance and insurance, real estate, professional services, management, and administrative support; 41 percent). In contrast, only two-thirds of the non-displaced comparison group worked in these industries. The imbalance results mainly from NAICS industries 51–56, which employed 41 percent of the displaced workers, but only 6 percent of the non-displaced comparison group.

The composition of displaced workers in the Washington samples differs sharply from the composition of the Pennsylvania workers examined by JLS, 75 percent of whom came from manufacturing; however, the Connecticut sample analyzed by CP is more like the Washington sample: 16 percent from manufacturing, 19 percent trade, and 23 percent from NAICS codes 51–56. (As a check on the estimates using all displaced workers, we estimate the losses of workers displaced from all industries except NAICS 51–56 in Appendix A.5.)

3 Estimation methods

We begin with a description of methods used to estimate earnings losses following displacement and to decompose those losses into components due to lost work hours and reduced hourly wage rates. We then describe the use of AKM methods to estimate the importance of employer effects in displaced workers' employment outcomes.

3.1 Estimated displacement effects on earnings, hours, and wage rates

To estimate displaced workers' earnings losses, we apply JLS's multi-period difference-in-differences estimator, which compares the employment outcomes of displaced workers before, during, and after displacement with observationally similar long-tenure workers who were not displaced. The effect of displacement can be obtained by estimating a worker fixed-effects model of the following form:

$$Y_{ijt} = c_i + \gamma_t + \mathbf{Z}_{it}\boldsymbol{\theta}_1 + \mathbf{W}_{it}\boldsymbol{\theta}_2 + \mathbf{X}_{j(i,t)}\boldsymbol{\beta} + \sum_{k=-20}^{20}(\delta_k \cdot D_{itk}) + e_{ijt} \quad (1)$$

where Y_{ijt} is an employment outcome (earnings, hours, or wage rate) of worker i (with primary employer j) in quarter t; c_i is a worker-specific fixed effect; γ_t is a vector of calendar quarter indicators; $\mathbf{Z}_{it}$ includes the worker's age and age squared, and a vector of gender, race, and education indicators, interacted with the worker's age; $\mathbf{W}_{it}$ includes averages of the worker's pre-displacement (2002–05) earnings and pre-displacement hours with the primary employer, both interacted with a vector of yearly indicators; and $\mathbf{X}_{j(i,t)}$ consists of the characteristics of worker i's pre-layoff employer j (log of employer size and one-digit NAICS code in 2007:IV interacted

with a vector of yearly indicators). Each D_{itk} is an indicator equal to one if the worker is observed in quarter k relative to displacement, zero otherwise ($k = 0$ is the quarter of displacement).[20]

Interest lies mainly in the estimates of δ_k, which are regression-adjusted differences in outcomes between displaced and non-displaced workers before ($k < 0$), at the time of ($k = 0$), and after ($k > 0$) the quarter of displacement. Interpreting the estimated δ_k as causal effects of displacement requires the assumption that, absent displacement, displaced workers' outcomes would have paralleled those of non-displaced workers. Given parallel trends, negative estimated δ_ks after displacement are taken as evidence of a displacement effect.[21]

Figure 1 illustrates the parallel-trends assumption using unconditional earnings and hours data for workers displaced in 2009:I and workers who remain stably employed by the same employer. During the first 5–6 years of the seven before displacement, the earnings and hours of workers who will be displaced parallel those of workers who will remain stably employed. Also, the earnings and hours profiles in Figure 1 give a first impression that, following displacement, hours worked come closer to recovering to their pre-displacement levels than do earnings.

3.2 Employer fixed effects

A growing body of research has examined the importance of employers in earnings determination (e.g., Abowd, Kramarz, and Margolis 1999; Card, Heining, and Kline 2013; Card, Cardoso, and Kline 2016; Barth, Bryson, Davis, and Freeman 2016; Sorkin 2018). In general, this line of research has shown that "where you work" is important to "what you earn." The Washington data allow us to construct a linked employer-employee panel and estimate AKM

[20] The omitted reference category consists of non-displaced workers and all observations recorded in quarters 21, 22, 23, and 24 before the displacement ($k < -20$); hence, we limit the analysis sample to observations recorded between –24 and 20 quarters relative to the quarter of displacement.

[21] As a robustness check of the parallel-trends assumption, we estimate a version of the model with worker-specific trends (a random trend model)—see Appendix A.6.

models of earnings, hours, and hourly wages using data for 2002–2014 (see Appendix B). The resulting estimated employer fixed effects allow us in turn to observe the extent to which the earnings, hours, and wage-rate losses of displaced workers result from working for post-displacement employers with policies regarding earnings, hours, and wage rates that differ systematically from the pre-displacement employer.

The AKM models we estimate can be written:

$$\log Y_{ijt} = \alpha_i + \psi_{j(i,t)} + \theta_t + u_{ijt} , \qquad (2)$$

where Y_{ijt} denotes earnings, hours, or the wage rate of worker i with employer j in year t; α_i is a worker-specific fixed effect (reflecting the productive characteristics of the worker that can be transferred between employers); $\psi_{j(i,t)}$ is an employer-specific fixed effect (reflecting employer characteristics that result in above- or below-average earnings, hours, or wage rates for all workers at employer j); θ_t is a vector of calendar year indicators; and u_{ijt} is the error component. The function $j(i,t)$ indexes the employer effect for worker i in year t.

Estimation of equation (2) for each of the three outcomes results in three vectors of estimated employer fixed effects ($\widehat{\psi}_j$), one each for the log of earnings, log of hours, and log of wage rates (all necessarily conditional on employment). Most generally, these fixed effects represent time-invariant policies of a given employer with respect to compensation—such as incentive pay, delayed compensation, and wage compression—or work hours (Baker, Gibbs, and Holmstrom 1994; Lazear and Shaw 2009). A more specific interpretation, applicable only to earnings and wage rates (not hours), is that $\widehat{\psi}_j$ is a measure of the advantages—premiums or rents—derived from being employed by a given employer (Card, Heining, and Kline 2013). Still

another interpretation is that $\widehat{\psi}_j$ is an estimate of employer *j*'s position on a job ladder (Engbom and Moser 2017).[22]

We treat the estimated employer fixed effects, $\widehat{\psi}_j$, as additional outcomes of the displacement process. The goal is to estimate the proportion of earnings, hours, and wage rate losses following displacement that can be attributed to a displaced worker's reemployment by an employer with a different $\widehat{\psi}_j$ than the employer from which she was displaced.[23] To do this, we assign the appropriate $\widehat{\psi}_j$s (for employer *j*) to each worker-quarter observation in the data, which is possible for all worker-quarter observations in the pre-displacement period (2002–2007) and to all but 622 worker-quarter observations in the post-displacement period.[24]

To estimate the importance of employer-specific fixed effects in explaining the adverse outcomes of displaced workers, we regress the estimated employer fixed effect $\widehat{\psi}$ (once each for earnings, hours, and wage rates) on pre- and post-displacement indicators, along the lines of equation (1):

$$\widehat{\psi}_{ijt} = c_i + \gamma_t + \mathbf{Z}_{it}\boldsymbol{\theta}_1 + \mathbf{W}_{it}\boldsymbol{\theta}_2 + \mathbf{X}_{j(i,t)}\boldsymbol{\beta} + \sum_{k=-20}^{20}(\delta_k \cdot D_{itk}) + e_{ijt} \qquad (3)$$

[22] Interpretation of the employer fixed effect as a measure of an employer's position on the job ladder is consistent with Moscarini and Postel-Vinay's (2016) view of the job ladder as a stable ranking of jobs agreed upon by all workers.

[23] Goldschmidt and Schmieder (2017) take a similar approach to estimating the loss of employer-specific effects due to outsourcing of jobs, and Fackler, Mueller, and Stegmaier (2017) and Schmieder, von Wachter, and Heining (2018) examine employer-specific effects for displaced workers. Fackler, Mueller, and Stegmaier (2017) focus on workers displaced in connection with employer bankruptcy. All make use of data on Germany.

[24] All 622 observations are for displaced workers in the post-displacement period, from a total of 71,819 worker-quarter observations of displaced workers in the post-displacement period. The unmatched cases occur when the employer of a displaced worker was not in the connected set used to estimate the AKM $\widehat{\psi}_j$s. There are 124 such employers, and they employed altogether 160 unique displaced workers for at least one quarter following displacement. If we estimate the AKM model using data only from the pre-displacement years (2002–2007), rather than from all available years (2002–2014), we are unable to match 22,806 worker-quarter observations for 1,762 unique displaced workers who were employed by 834 employers in the post-displacement period. For these 834 employers, $\widehat{\psi}_j$s could not be produced either because they were not in the connected set or because they did not exist before 2008. (As with the 2002–2014 data, 2002–2007 data produces $\widehat{\psi}_j$s for all pre-displacement employers.) The correlation coefficients between $\widehat{\psi}_j$s estimated using 2002–2014 data and $\widehat{\psi}_j$s estimated using 2002–2007 data are 0.98 for log earnings, 0.96 for log hours, and 0.96 for log wage rates.

The estimated δ_ks are regression-adjusted differences in employer fixed effects realized by displaced workers relative to non-displaced workers and relative to before displacement. Equation (3) includes individual worker fixed effects, so the estimated δ_ks represent within-worker changes in employer fixed effects (for earnings, hours, and wage rates) resulting from transitions from pre- to post-displacement employers. For earnings and wage rates, we interpret negative estimated δ_ks as evidence of lost employer-specific premiums (which could result from lost rents or compensating differentials; see Sorkin 2018). For hours worked, we interpret negative estimated δ_ks as evidence of reduced hours due to the differing working time policies of post-displacement employers.

4 Estimated effects of displacement on earnings, work hours, and wage rates

This section describes estimates of the magnitude of displaced workers' earnings losses and decomposes those losses into their work-hour and hourly wage rate components.

4.1 Estimates of lost earnings

Figure 2 displays estimated effects of displacement on unconditional earnings (top) and log earnings (bottom) over a period of 5 years, and Table 2 summarizes the estimates for the quarter following displacement (quarter 1) and the average of quarters 17–20 following displacement.[25] The graphs are obtained by estimating equation (1) and plotting the estimated δ_ks, along with 95-percent confidence intervals (which are very small and at times hard to see). The vertical line in each graph marks the quarter of displacement; that is, the last quarter in which a displaced worker is observed with earnings or hours with the employer of the previous six years.

[25] Columns 1 and 3 of Appendix Table A2 display the estimates on which Figure 2 is based.

Soon-to-be-displaced workers' earnings drift downward in roughly the year before displacement (Ashenfelter's dip), drop sharply in the quarter of displacement and the quarter immediately after (quarters 0 and 1), then recover, but never to their pre-displacement level, as gauged relative to earnings of the comparison group. The top graph in Figure 2 shows that, in the quarter following displacement, workers lost on average about $5,960 compared with non-displaced workers. Dividing this by pre-displacement (2002–05) average earnings with the former primary employer ($12,482, from Table 1) implies a loss of about 48 percent in the quarter following displacement. The estimate in logs conditions on positive earnings and is somewhat smaller, suggesting a loss of about 39 percent [exp(–0.488) – 1] in the quarter after displacement.[26]

Figure 2 and Table 2 also show that, five years after displacement, workers earned on average $1,940 less per quarter from their primary employer than did comparable non-displaced workers, which translates to lost earnings of about 16 percent (dividing by $12,482). The log earnings estimates suggest long-term losses of about 15 log points.[27]

Table 3 compares the estimates in Figure 2 and Table 2 with those obtained by JLS and CP, the studies most similar to ours. In their sample of Pennsylvania UI claimants, JLS (1993b, Figure 5.5) estimate lost earnings of about 66 percent at the time of displacement, and about 24 percent five years later. Using their sample of Connecticut UI claimants, CP (Figure 4) estimate lost earnings of about 49 percent at the time of displacement, and about 32 percent five years later. The earnings losses we estimate for Washington workers displaced in 2008–2010 (48

[26] Inclusion of worker-specific trends in the model produces similar profiles of earnings, hours, and wage rates—see Appendix A.6.

[27] The estimates in Figure 2 and Table 2 are based on earnings from the primary employer only. If we instead use earnings from all employers, estimated earnings losses are similar, although somewhat smaller (see Appendix Table A2, columns 2 and 4). That is, accounting for the presence of multiple employers does not substantially change the conclusions drawn from focusing solely on outcomes from primary employers.

percent at the time of displacement; 16 percent five years later) are somewhat smaller than those reported by either JLS or CP, but in view of the differences in time and place, the similarities are perhaps more striking than the differences.[28]

4.2 Estimates of lost work hours and reduced hourly wage rates

Figure 3 displays estimated effects of displacement on unconditional work hours (top) and log hours (bottom), again based on equation (1).[29] As was true for earnings, the work hours of soon-to-be-displaced workers dip somewhat in roughly the year before displacement, drop greatly in the quarter of displacement and the quarter following displacement, then partially recover. Although the recovery of work hours is more robust than the recovery of earnings, work hours of the displaced workers remain below those of the non-displaced comparison group five years after displacement.

Specifically, lost hours in the quarter after displacement amount to 200 hours on a base of 500 hours (40 percent, estimated in levels, or 38 log points). The corresponding earnings losses are about 48 percent (in levels, or 49 log points), so lost work hours are responsible for roughly 80 percent of lost earnings at the time of displacement. Five years after displacement (in quarters 17–20), the average displaced worker still works 29 fewer hours per quarter than otherwise (about 6 percent, estimated in levels, or 7 log points). The corresponding earnings losses are about 16 percent (in levels, or 15 log points), so reduced work hours account for about 45 percent (7 out of 15 log points) of the long-term earnings losses of displaced workers. As we

[28] The JLS sample consists largely of workers displaced from manufacturing in Pennsylvania during the time of the decline of the U.S. steel industry, and the CP sample, although more diverse, consists disproportionately of workers displaced from shipbuilding during the 2001 recession. No single industry in Washington imploded during the Great Recession, although Washington clearly experienced a severe contraction.

[29] The estimates underlying Figure 3 are shown in columns 1 and 3 of Appendix Table A3.

confirm below, the remaining 55 percent of long-term earnings losses are attributable to lower hourly wage rates.[30]

To further investigate displacement's effects on work hours, we estimate a set of linear probability models based on equation (1), using indicators of whether a worker's weekly work hours (averaged over a quarter) exceeded a given threshold. Specifically, we estimate models for weekly hours exceeding 0, 10, 20, 30, 35, 40, 45, 50, and 60. The estimates are displayed in Table 4 and suggest two main points about how displacement changes the distribution of hours in the long-term (quarters 17–20). First, the overall long-term loss of work hours appears not to be driven by non-employment (i.e., more workers with 0 hours): although displacement reduces the probability of any work (hours > 0) by about 2 percentage points in quarters 17–20, this is a small reduction in proportional terms (0.02 on a base of 0.996). Second, the main effect of displacement is to reduce the probability of working at least 20, 30, 35, and 40 hours per week. This is surprising because displacement implies lost seniority, which would imply loss of overtime hours, but this appears not to be the case.[31]

Figure 4 shows estimated hourly wage rate losses based on equation (1). Five years after displacement, hourly wage rates are about 8 log points lower than otherwise (top panel of Table 2). Comparing these wage rate estimates with those for log earnings and log hours implies that about 45 percent of the long-term earnings deficit of 15 percent is due to fewer work hours, and about 55 percent to lower hourly wage rates.[32]

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[30] The estimates are consistent with Farber's (2017) finding that movement from full-time to part-time employment explains a significant part of the cost of displacement during and after the Great Recession. Farber's (1993, 2015, 2017) studies are based on the Displaced Worker Supplement to the Current Population Survey, so they pertain to a broader group of workers than those we are considering.

[31] The estimates for hours in excess of 50 and 60 suggest displacement may very slightly *increase* the probability of work hours at the high end of the hours distribution.

[32] Figure 4 also shows a clear 6 log-point spike in hourly wage rates in the quarter of displacement (quarter 0). This spike results from a greater drop in work hours than in earnings in the quarter of displacement: for example, Figure 2

The estimated hourly wage profile in Figure 4 differs strikingly from both the earnings and work hour profiles (Figures 2 and 3). Following displacement, wage rates drop by about 10 percent and remain permanently lower by about 7 percent. (The sluggish recovery of wage rates is even more apparent in a broadened sample that includes workers who did not claim UI—see Appendix A.4.) In contrast, earnings and hours show notably more recovery after just two years. Workers' post-displacement search effort leads to jobs with gradually improving work hours, but that search effort is far less successful in yielding higher-wage jobs.

5 Employer fixed effects

Section 3.2 described an approach to estimating whether some portion of displaced workers' losses are due to employer fixed effects. For earnings or wage rates, this would imply loss of a job with an employer offering premium earnings or wage rates, and reemployment with an employer that did not. For hours worked, it would imply loss of a job with systematically longer hours than the job obtained after displacement. This section describes the results of that approach. We first examine the overall importance of employer effects in generating displaced worker's reduced earnings, work hours, and wage rates. Second, we examine differences in the role of employer effects for workers displaced from employers paying high and low earnings premiums. Third, we examine the losses of displaced workers who move to employers offering lower, similar, and higher premiums compared with their pre-displacement employers.

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shows a drop in earnings of about 36 log points in quarter 0, whereas Figure 3 shows a drop in work-hours of about 40 log points. Severance payments paid in the quarter of separation are the most likely cause of this pay bump. Severance payments are included with earnings in administrative wage records and would inflate reported earnings relative to work hours in the quarter of separation, leading to an apparent increase in the hourly wage around the time of displacement.

5.1 Estimated average losses due to employer fixed effects

The solid-dot time paths in the three panels of Figure 5 display estimated effects of displacement on the employer fixed effects ($\hat{\psi}_j$) for log earnings, log hours, and log of the hourly wage rate for the sample average displaced worker. [These are the $\hat{\delta}_k$s from equation (3).] For comparison with the main results in Figures 2–4, the open-circle time paths in Figure 5 repeat the estimated full effects of displacement on log earnings, log hours, and log of the hourly wage rate with the primary employer.[33]

For each of the three outcomes, lost employer fixed effects explain a minimal (although statistically significant) fraction of the losses due to displacement—see the summary in row 2 of Table 2. In the quarter following displacement (quarter 1), about 3 log points of the overall earnings loss of 49 log points (6.6 percent) are due to working for an employer that pays less to all its workers, controlling for worker fixed effects. For work hours, differing employer hours policies account for about 1.5 of the overall 38 log-point loss (4 percent), and lost wage rate premiums account for 1.7 of the overall 11 log-point reduction (about 16 percent).

Five years after displacement, the role of employer fixed effects in explaining the role in the lost earnings and wage rates of the average displaced worker is still minor, and employer fixed effects play no role with respect to lost work hours. Specifically, employer fixed effects account for 1.7 of the overall 15 log-point earnings loss (11 percent), and 2 of the overall 8 log-point reduction in hourly wages rates (25 percent). Overall, employer fixed effects are of minor importance in explaining the average long-term losses from displacement.

[33] The estimates underlying Figure 5 are reported in Appendix Table A4.

The estimates in Figure 5 suggest a substantial role for the AKM residual u_{ijt} in equation (2) in explaining displaced worker's losses on average. The large gap between overall losses and losses due to employer fixed effects implies that employer-employee match effects or time-varying factors (such as lost specific human capital) are important in explaining displaced workers' long-term losses.[34]

5.2 Estimated losses by quintile of pre-displacement employer earnings premium

Figure 6 displays estimated displacement effects for workers who separated from an employer whose earnings fixed effect ($\widehat{\psi}$) was in the top quintile of employers before 2008, and Figure 7 shows estimated effects for workers who separated from an employer with an earnings fixed effect in a lower quintile (1 through 4).[35] The open-circle time paths in Figures 6 and 7 show the estimated effects of displacement on log earnings, log hours, and log hourly wage rates [from equation (1)]; the solid-dot time paths show estimated effects of displacement on employer fixed effects for each outcome [from equation (3)].

For workers displaced from top-quintile employers, long-term earnings losses are significantly less than for workers displaced from lower-quintile employers (12.5 log points, compared with 20 log points for workers displaced from a quintile 1–4 employer—see Table 2, rows 3 and 5). However, for workers displaced from top-quintile employers, a greater share of long-term losses are due to foregone employer effects: lost employer premiums explain about 54 percent (–0.067/–0.125) of the earnings loss, 38 percent (–0.021/–0.056) of reduced work hours,

[34] By broadening the concept of specific human capital, Lazear (2009) shows the similarities between specific human capital and a favorable match.

[35] The thresholds for the employer fixed-effect quintiles are obtained using the 2002–2014 AKM dataset described in Appendix B, sorting on worker-year records. In the AKM data, worker-year observations fall into five equal groups, but the displaced worker dataset contains a disproportionate number of workers employed by high effect employers. Fixed effects for log earnings are used consistently to classify the separating employer by quintile for all three outcomes—earnings, hours, and wage rates. Descriptive statistics for the sample of workers who separated from top-quintile employers are displayed in columns 5 and 6 of Table 1.

and 83 percent (–0.046/–0.063) of the reduced wage rate. In contrast, for workers displaced from lower-quintile employers, none of the overall losses can be attributed to lost employer effects—in fact, for these workers, employer effects slightly increase earnings, hours, and wage rates, suggesting a process of reversion to the mean in employer fixed effects.

Mean reversion is even clearer when we fully disaggregate the estimated changes in outcomes by the quintile of the pre-displacement employer's fixed effect—see Appendix Figures A13–A15 (Appendix A.7). For workers displaced from third- and fourth-quintile employers, fixed effects are immaterial, and for workers displaced from first- and second-quintile employers, fixed effects tend to *increase* earnings, hours, and wage rates after displacement.

This pattern of mean reversion is again consistent with the losses of workers displaced from employers below the top quintile resulting wholly from factors specific to a given employer-employee match or factors that vary over time with a given employer (such as specific human capital). Even for workers displaced from top-quintile employers, employer effects provide only a partial explanation of lost earnings and wages.

5.3 Losses of workers moving to employers offering lower, similar, and higher premiums

We examine next the losses of displaced workers who, two years after displacement, worked for an employer whose earnings fixed effect ($\widehat{\psi}$) was in the same quintile as the pre-displacement employer, or alternatively worked for an employer in a higher or lower quintile. The analysis provides another test of the AKM model for displaced workers: If the model provides a good description of post-displacement outcomes, we would expect workers who move to higher fixed-effect employers to experience the smallest losses, and workers who move to lower fixed effects employers to experience the largest losses.

This analysis is in the same spirit as Card, Heining, and Kline's (2013) event-study analysis, which plots the earnings profiles of workers who move among employers paying similar or different premiums.[36] We describe such an event study analysis for the Washington linked employer-employee data in Appendix B.3, and find evidence similar to that in Card, Heining, and Kline (2013): The average gain in earnings for those who move to a higher fixed effect employer is symmetric to the average loss in earnings for those who move to a lower fixed effect employer, suggesting that the AKM framework is a good fit for the Washington labor market overall.

The analogous event study for displaced workers is shown in Figure 8, which displays estimated displacement effects for three groups of workers: those reemployed by an employer whose earnings fixed effect was in the same quintile as the pre-displacement employer's (solid dots), by an employer with a lower-quintile earnings fixed effect (open circles), and by an employer with a higher-quintile earnings fixed effect (hollow squares).[37] Regardless of destination, displaced workers experience earnings losses and lower wage rates, but the losses are smallest for workers reemployed by an employer with an earnings fixed effect in the same quintile as the pre-displacement employer. Workers reemployed by an employer with a lower fixed effect experience the largest losses, and those reemployed by an employer with a higher fixed effect suffer losses in between those of the other two groups. Also, although work hours recover to nearly their pre-displacement level for all three groups of workers, they recover most quickly for workers reemployed by a same-quintile employer.

[36] The analyses here and in Appendix B.3 are both strictly descriptive because they condition on an outcome (type of employment two years after displacement), but they offer useful information about the fit of the AKM model for different groups of workers.

[37] We again use *earnings* fixed effects to classify employers by quintile for all three outcomes.

The pattern in Figure 8 runs counter to what we would expect if the AKM model, with its additive worker and employer effects, were a good model of the determinants of displaced workers' earnings, work hours, and hourly wage rates. Whereas the AKM model does a good job with labor market as a whole (Appendix B.3), it falls short for displaced workers—that is, relatively skilled workers with long tenure who lose their jobs. The inability of worker and employer fixed effects to explain displaced workers' losses is again consistent with the importance of lost specific human capital or match effects in explaining those losses.

6 Conclusions and Discussion

The failure of displaced workers' earnings to recover to their pre-displacement trajectory is a consequence mainly of the sluggish recovery of hourly wage rates. At the time of displacement, wage rates drop by about 11 percent on average, and they remain 8 percent below their pre-displacement level five years later (Figure 4). In contrast, paid hours drop by 38 percent at the time of displacement and rebound substantially (Figure 3). As Figure 5 shows, loss of jobs with employers paying premium earnings can account for only 11 percent of average long-term earnings losses and 25 percent of average long-term reduced hourly wage rates. It follows that the failure of wage rates to recover is attributable mainly to the dissolution of good employer-employee matches and to lost specific human capital.

Overall, employer fixed effects play a minor role in displaced workers' losses because those effects are evidently mean reverting. For workers displaced from first- and second-quintile employers, employer effects tend to improve post-displacement outcomes; for workers displaced from third- and fourth-quintile employers, they are negligible; only for workers displaced from top-quintile employers do employer effects tend to reduce post-displacement outcomes. Workers

displaced from high fixed-effects employers tend to move to lower fixed-effects employers, and vice versa (see Appendix A.7).

Although the importance of employer effects varies greatly with the type of employer (high or low fixed effect) from which a worker is displaced, the *full* losses from displacement are large regardless of the type of employer from which a worker is displaced. In fact, the full losses of workers displaced from employers below the top quintile are about two-thirds greater than those of workers displaced from top-quintile employers (compare rows 3 and 5 of Table 2). If a job ladder is understood as a hierarchy of employers ordered by the wage premiums they pay, then many displaced workers are not falling from a high rung on the job ladder, but they suffer large losses nevertheless.

The evidence in section 5 points to the loss of valuable job matches and lost specific human capital as the main sources of displaced workers' losses. A central question, which that evidence does not directly address, is why the earnings and wage rates of workers who have shown themselves to be capable—as demonstrated by at least six years of steady work with the same employer—recovery so sluggishly. These reasons may differ from the reasons for displaced workers' losses.

Three points about displaced workers in their post-displacement years seem clear: (i) they do not quickly re-accumulate specific capital, or if they do, it is not yielding a return within the time we observe; (ii) they are not finding jobs that offer a good specific match for their skills and abilities and in which the wage rate is likely to grow; and (iii) their job search is not yielding better draws from the wage-offer distribution (that is, from better-paying employers) with time.

The importance of specific human capital to displaced workers' losses suggests that once displaced, a worker is seen as a poor candidate for specific capital investment. This could be

because a displaced worker is no longer at the start of his or her career, so the horizon over which any investment can yield a return is shorter; less investment in specific capital and lower wage growth are predictable consequences.

The estimates we have described are also consistent with a particular type of search-based explanation for the slow recover to displaced workers' earnings and wage rates—the failure of job search to reestablish favorable employer-employee matches. Haltiwanger, Hyatt, Kahn, and McEntarfer (2018) have shown that such a failure could stem from a tight recessionary labor market that stymies workers' upward wage mobility.[38] The reasons for earnings and wage rate growth—or their absence—should continue to be an active area of research.

[38] This mechanism is emphasized by two recent contributions to the macro-labor literature—Krolikowski (2017) and Jung and Kuhn (2018)—who also conclude that lost match effects are important to displaced workers' losses.

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Table 1
Sample descriptive statistics

	(1)	(2)	(3)	(4)	(5)	(6)
	All workers		Workers outside NAICS 51–56[1]		Workers employed by top-quintile employers	
	Displaced	Non-displaced	Displaced	Non-displaced	Displaced	Non-displaced
Quarterly average earnings, hours, and wage rates, 2002–2005						
Earnings (2010 dollars)	13,739	12,482	12,417	12,135	15,759	16,243
	(6,668)	(5,996)	(6,215)	(5,490)	(6,457)	(6,042)
Paid work hours	518	500	508	500	537	514
	(80)	(95)	(85)	(97)	(64)	(84)
Hourly wage rate (2010 dollars/hour)	64.41	51.22	52.68	49.49	75.15	65.23
	(44.45)	(38.96)	(38.66)	(37.69)	(44.94)	(39.54)
Worker characteristics, 2007:IV						
Female (proportion)	0.300	0.359	0.274	0.353	0.240	0.230
Race (proportions)						
White, not Hispanic	0.774	0.677	0.736	0.671	0.813	0.739
Black, not Hispanic	0.031	0.033	0.030	0.032	0.022	0.034
Hispanic	0.074	0.133	0.105	0.139	0.043	0.058
Asian/Pacific Islander	0.071	0.100	0.078	0.100	0.068	0.109
American Indian or Alaskan Native	0.014	0.014	0.015	0.015	0.012	0.011
Missing, unknown, or not available	0.037	0.044	0.035	0.044	0.042	0.050
Schooling (proportions)						
less than high school	0.079	0.129	0.111	0.135	0.053	0.062
GED	0.031	0.032	0.038	0.033	0.022	0.035
high school graduate	0.446	0.462	0.469	0.472	0.461	0.496
some college	0.153	0.161	0.151	0.158	0.134	0.183
associate's degree	0.125	0.101	0.121	0.102	0.125	0.108
bachelor's degree	0.135	0.093	0.095	0.081	0.161	0.093
master's/PhD	0.030	0.023	0.016	0.019	0.043	0.022
Age (years)	39.68	41.47	39.01	41.53	40.53	41.87
	(6.39)	(6.44)	(6.53)	(6.44)	(5.90)	(6.20)
Employer characteristics in 2007:IV						
Employer size (number of workers)	2,097	8,478	824	8,400	2,881	16,622
	(2,562)	(20,065)	(1,550)	(20,317)	(2,694)	(28,378)
NAICS Industry (proportions)						
11 agriculture, forestry, fishing	0.014	0.045	0.024	0.048	0.001	0.002
21–23 mining, utilities, construction	0.078	0.082	0.132	0.087	0.097	0.153
31–33 manufacturing	0.268	0.460	0.455	0.491	0.274	0.631
42–49 trade, transportation	0.152	0.145	0.258	0.155	0.035	0.058
51–56 information, finance, prof. services	0.411	0.063	n/a	n/a	0.589	0.103
61–62 educational and health care services	0.013	0.093	0.021	0.099	0.003	0.024
71–72 arts, recreation, hospitality services	0.051	0.032	0.087	0.034	n/a	0.000
81 other services	0.007	0.006	0.011	0.006	0.001	0.002
92–99 public administration and unclassified	0.007	0.075	0.012	0.080	0.001	0.028
Number of employers (pre- and post-displacement)	3,621	1,570	513	1,383	195	447
Number of workers	3,032	13,290	1,786	12,447	1,802	5,621

Notes: Standard deviations in parentheses.
1. NAICS industries 51–56 include information, finance and insurance, real estate, professional, scientific, and technical services, management of companies; administrative, support, and waste management and remediation services.
Source: Authors' tabulations of Washington administrative wage and claims records. See section 2.1 for details of the sample construction.

Table 2
Summary of estimated quarterly losses due to displacement

	Earnings		Hours		Hourly wage rate	
	Qtr 1	Qtrs 17–20	Qtr 1	Qtrs 17–20	Qtr 1	Qtrs 17–20
1. All displaced workers, full losses (sections 4.1 and 4.2)						
levels	–$5,964	–$1,941	–200	–29.3	–1.89	–1.46
	(–47.8%)	(–15.6%)	(–40.0%)	(–5.9%)	(–3.7%)	(–2.9%)
logs	–0.488	–0.152	–0.384	–0.070	–0.109	–0.080
2. All displaced workers, changes due to employer fixed effects (section 5.1)						
logs	–0.032	–0.017	–0.015	0.003	–0.017	–0.020
3. Workers displaced from top-quintile employers, full losses (section 5.2)						
logs	–0.368	–0.125	–0.303	–0.056	–0.074	–0.063
4. Workers displaced from top-quintile employers, changes due to employer fixed effects (section 5.2)						
logs	–0.074	–0.067	–0.038	–0.021	–0.036	–0.046
5. Workers displaced from quintile 1–4 employers, full losses (section 5.2)						
logs	–0.675	–0.203	–0.500	–0.095	–0.177	–0.108
6. Workers displaced from quintile 1–4 employers, changes due to employer fixed effects (section 5.2)						
logs	–0.002	–0.021	–0.013	–0.033	0.005	0.015

Note: Each entry gives the estimated displacement effect on the indicated outcome in either quarter 1 (Qtr 1) or the average of quarters 17, 18, 19, and 20 (Qtrs 17–20) following displacement. For levels, implied percentage changes relative to the non-displaced comparison group are shown in parentheses. (For example, the estimated effect of displacement on average earnings in quarters 17–20 after displacement is –$1,941, which is 15.6% less than the earnings of the non-displaced comparison group.)

Table 3
Estimated earnings losses due to displacement, selected studies using UI administrative records

Study	State and time period	Sample	Earnings losses in the first year	Earnings losses after five years
Jacobson, Lalonde, and Sullivan (1993b)	Pennsylvania, 1974–1986	All UI claimants	$7,800 (66%*)	$2,900 (24%*)
Couch and Placzek (2010)	Connecticut, 1993–2004	All UI claimants	$7,700 (49%)	$5,100 (32%)
Lachowska, Mas, and Woodbury (2018)	Washington, 2002–2014	All UI claimants	$5,960 (48%)	$1,940 (16%)

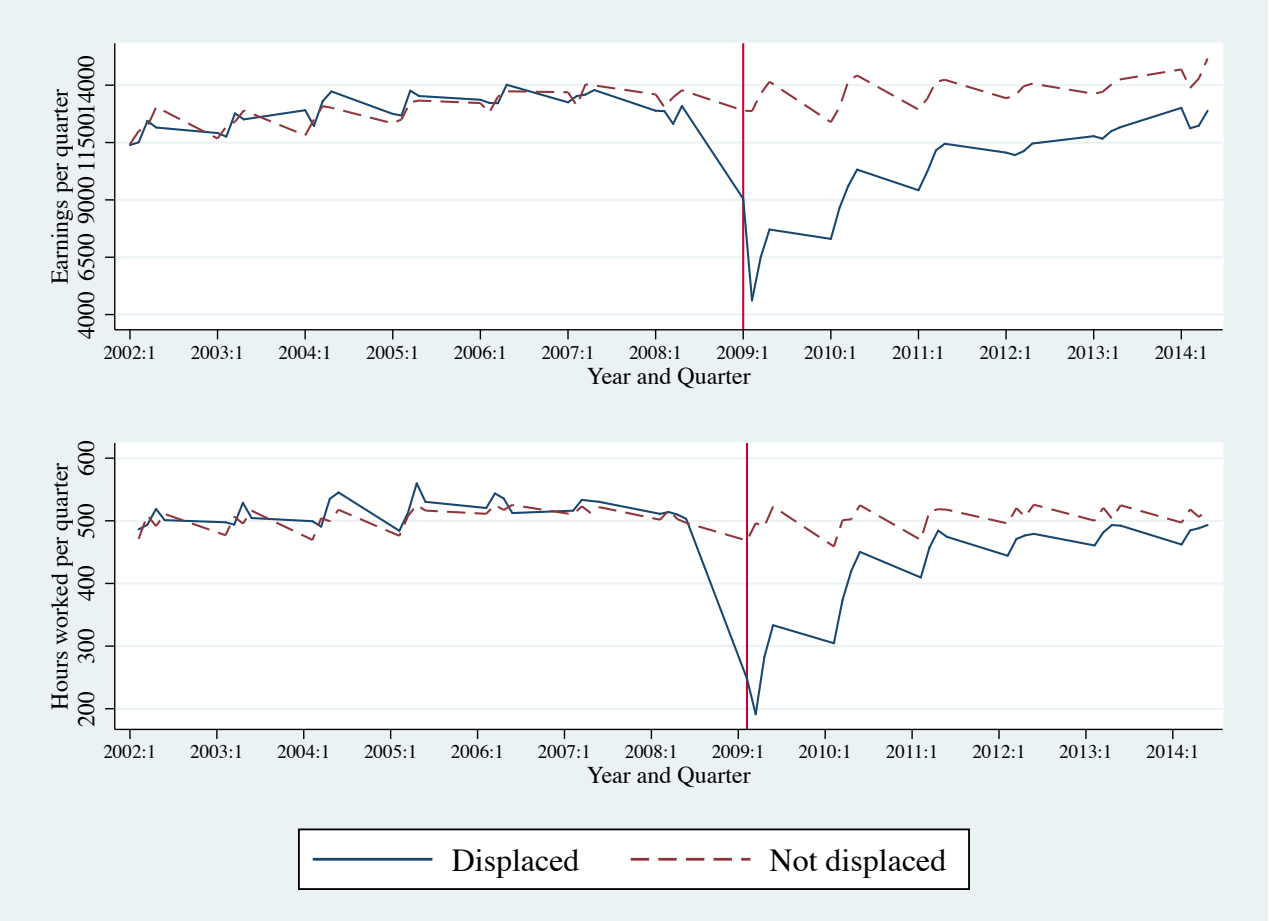
*Percentage estimates for Jacobson, LaLonde, and Sullivan (1993b) are reported in Couch and Placzek (2010), Table 1.
Sources: Estimates from the papers cited.

Table 4
Estimated displacement effects on the distribution on average weekly work hours

Quarter relative to displacement	Outcome								
	Hours > 0	Hours > 10	Hours > 20	Hours > 30	Hours > 35	Hours > 40	Hours > 45	Hours > 50	Hours > 60
0	-0.065	-0.154	-0.253	-0.360	-0.372	-0.276	-0.057	-0.001	0.005
	(0.005)	(0.007)	(0.009)	(0.010)	(0.010)	(0.009)	(0.007)	(0.005)	(0.002)
1	-0.228	-0.287	-0.346	-0.442	-0.513	-0.291	-0.086	-0.017	0.004
	(0.008)	(0.009)	(0.009)	(0.010)	(0.010)	(0.009)	(0.006)	(0.004)	(0.002)
2	-0.139	-0.195	-0.248	-0.277	-0.240	-0.210	-0.057	-0.005	0.007
	(0.007)	(0.008)	(0.009)	(0.010)	(0.010)	(0.010)	(0.007)	(0.005)	(0.002)
3	-0.108	-0.158	-0.198	-0.219	-0.166	-0.086	-0.061	-0.011	0.006
	(0.006)	(0.008)	(0.009)	(0.010)	(0.010)	(0.010)	(0.007)	(0.004)	(0.002)
4	-0.095	-0.148	-0.192	-0.196	-0.207	-0.161	-0.040	-0.001	0.009
	(0.006)	(0.007)	(0.008)	(0.009)	(0.010)	(0.010)	(0.007)	(0.005)	(0.002)
5	-0.081	-0.118	-0.155	-0.145	-0.110	-0.089	-0.014	0.013	0.011
	(0.006)	(0.007)	(0.008)	(0.009)	(0.010)	(0.010)	(0.007)	(0.005)	(0.002)
6	-0.052	-0.077	-0.111	-0.123	-0.107	-0.112	-0.031	0.002	0.010
	(0.005)	(0.006)	(0.007)	(0.009)	(0.010)	(0.010)	(0.007)	(0.005)	(0.002)
7	-0.037	-0.068	-0.100	-0.105	-0.101	-0.127	-0.042	0.001	0.009
	(0.005)	(0.006)	(0.007)	(0.009)	(0.010)	(0.010)	(0.007)	(0.005)	(0.002)
8	-0.038	-0.064	-0.098	-0.114	-0.094	-0.107	-0.034	0.002	0.010
	(0.005)	(0.006)	(0.007)	(0.009)	(0.010)	(0.010)	(0.007)	(0.005)	(0.002)
9	-0.032	-0.058	-0.085	-0.105	-0.111	-0.063	-0.007	0.013	0.012
	(0.004)	(0.006)	(0.007)	(0.008)	(0.010)	(0.010)	(0.008)	(0.006)	(0.003)
10	-0.033	-0.052	-0.076	-0.092	-0.102	-0.065	-0.026	-0.000	0.008
	(0.004)	(0.006)	(0.007)	(0.008)	(0.010)	(0.011)	(0.008)	(0.005)	(0.003)
11	-0.032	-0.044	-0.077	-0.112	-0.101	-0.072	-0.028	0.008	0.007
	(0.004)	(0.005)	(0.007)	(0.008)	(0.009)	(0.011)	(0.008)	(0.006)	(0.002)
12	-0.033	-0.061	-0.096	-0.110	-0.091	-0.019	0.024	0.029	0.012
	(0.004)	(0.006)	(0.007)	(0.008)	(0.009)	(0.011)	(0.008)	(0.006)	(0.003)
13	-0.028	-0.051	-0.080	-0.111	-0.121	-0.084	-0.015	0.020	0.018
	(0.004)	(0.005)	(0.007)	(0.008)	(0.009)	(0.011)	(0.008)	(0.006)	(0.003)
14	-0.034	-0.061	-0.086	-0.095	-0.072	-0.015	0.015	0.026	0.008
	(0.004)	(0.006)	(0.007)	(0.008)	-0.009	(0.011)	(0.008)	(0.006)	(0.003)
15	-0.026	-0.047	-0.074	-0.096	-0.096	-0.084	-0.013	0.012	0.011
	(0.004)	(0.005)	(0.007)	(0.008)	(0.009)	(0.011)	(0.008)	(0.006)	(0.003)
16	-0.027	-0.051	-0.086	-0.093	-0.077	-0.020	0.010	0.017	0.006
	(0.004)	(0.005)	(0.007)	(0.008)	(0.009)	(0.011)	(0.008)	(0.006)	(0.003)
17	-0.026	-0.047	-0.074	-0.080	-0.087	-0.057	0.002	0.022	0.020
	(0.004)	(0.005)	(0.006)	(0.008)	(0.009)	(0.011)	(0.008)	(0.006)	(0.003)
18	-0.026	-0.048	-0.062	-0.066	-0.065	-0.028	0.023	0.028	0.012
	(0.004)	(0.005)	(0.006)	(0.008)	(0.009)	(0.011)	(0.009)	(0.006)	(0.003)
19	-0.022	-0.037	-0.056	-0.073	-0.089	-0.085	-0.028	0.008	0.018
	(0.004)	(0.005)	(0.006)	(0.008)	(0.010)	(0.011)	(0.009)	(0.006)	(0.003)
20	-0.017	-0.040	-0.075	-0.085	-0.084	-0.054	-0.008	0.015	0.008
	(0.004)	(0.005)	(0.007)	(0.008)	(0.010)	(0.012)	(0.009)	(0.006)	(0.003)
Comparison group mean	0.996	0.980	0.952	0.867	0.758	0.457	0.207	0.095	0.022

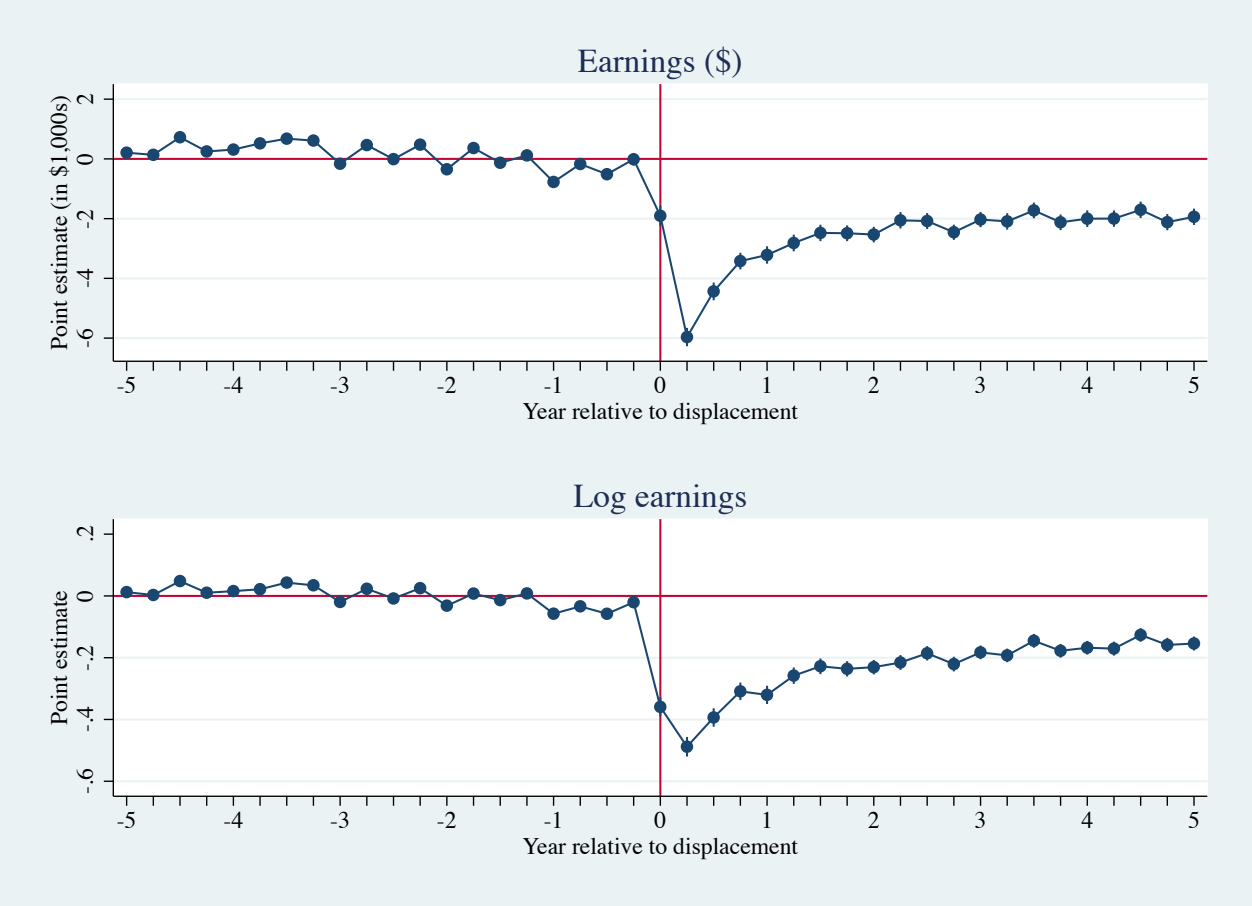
Note: Each column shows estimated changes in the probability of working at least a given number of weekly hours (on average over a quarter), based on estimates of equation (1). For example, the column headed "Hours > 35" is based on equation (1) with an indicator of whether the worker's weekly hours exceeded 35 as the dependent variable. Standard errors clustered by worker are shown in parentheses. The estimates are based on a sample of 16,322 workers and 826,219 worker-quarter observations.

Figure 1
Earnings (top) and hours (bottom) profiles of displaced and non-displaced workers



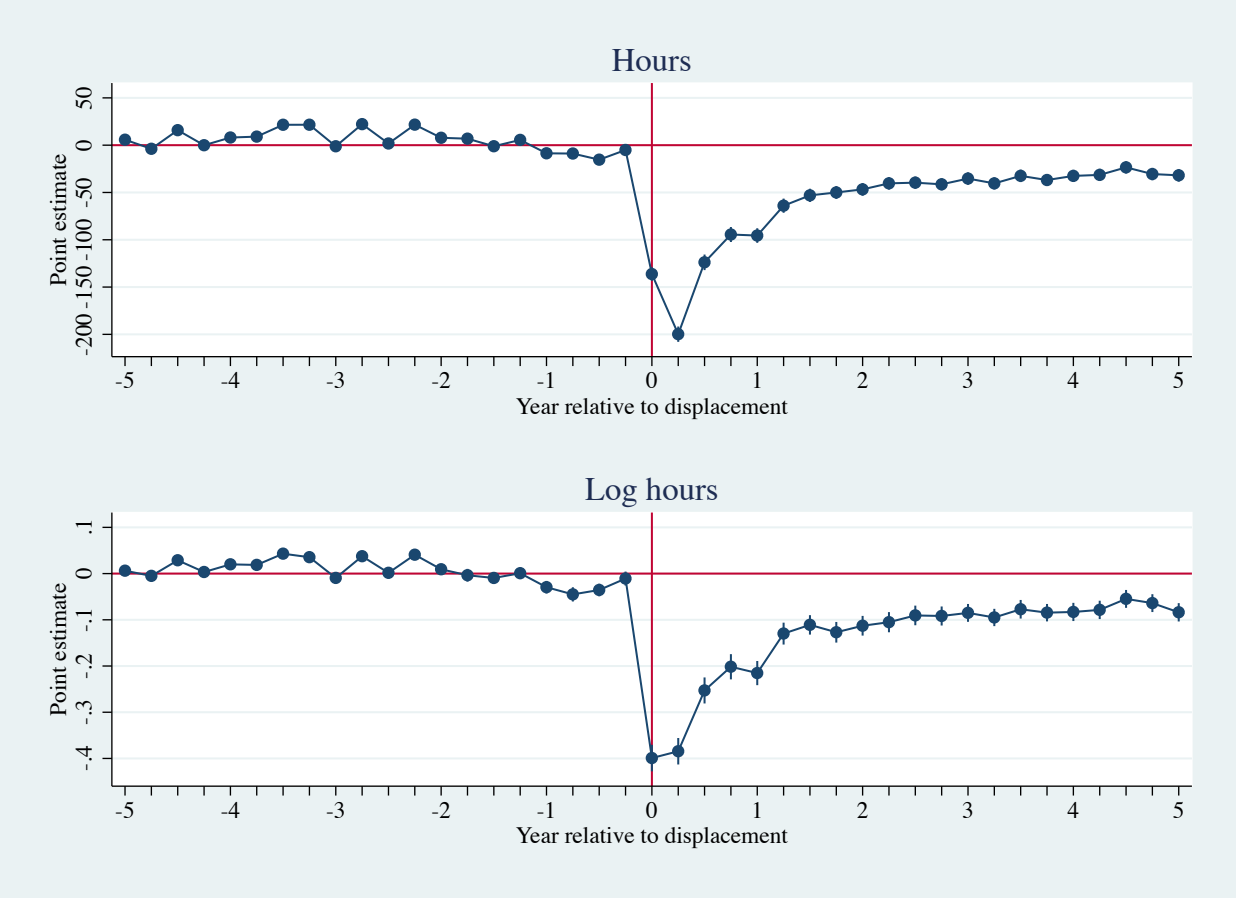
Notes: The top figure shows the quarterly earnings profiles (constant 2010 dollars) of workers displaced in Washington during the first quarter of 2009 (solid line) and the non-displaced comparison group (dashed line). The bottom figure shows the work hour profiles of the same two groups. Both earnings and hours are unconditional (that is, include observations of zero earnings and hours). The vertical lines denote the quarter of separation.
Source: Authors' calculations using Washington administrative wage and claims records. See sections 3.1, 4.1, and 4.2 of the text for details.

Figure 2
Estimated earnings losses due to displacement, Washington, 2008–2010



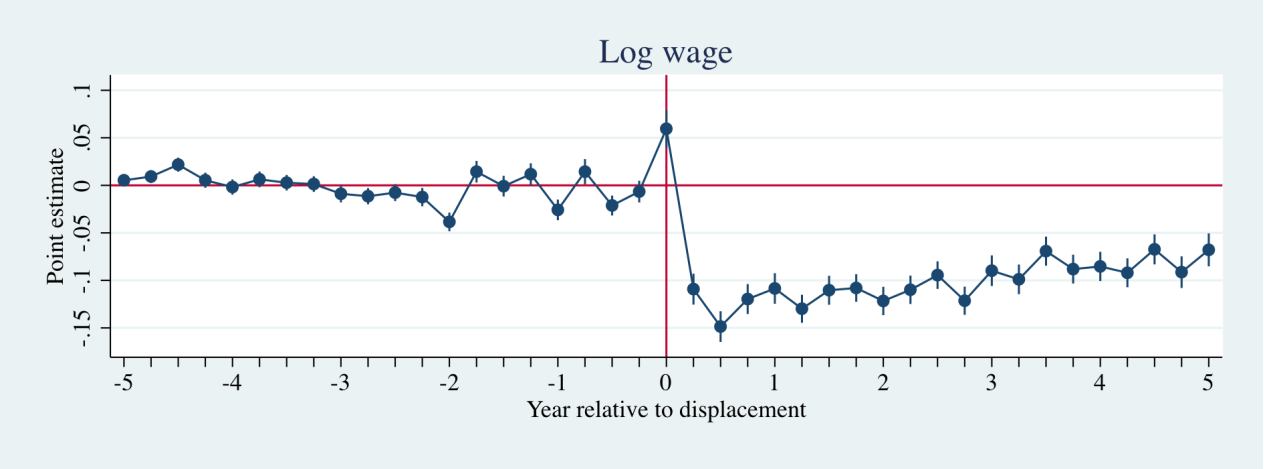
Notes: The top figure shows estimated δ_ks—quarterly unconditional earnings lost due to displacement (in constant 2010 $1,000s)—based on equation (1) with unconditional earnings from the primary employer as the dependent variable. The bottom figure shows estimated δ_ks—logarithm of quarterly earnings lost due to displacement—based on equation (1) with the log of earnings from the primary employer as the dependent variable. Whiskers (which are very small) denote 95-percent confidence intervals based on standard errors clustered by worker. The vertical lines denote the quarter of displacement.
Source: Authors' calculations using Washington administrative wage and claims records. See sections 3.1, 4.1, and 4.2 of the text for details.

Figure 3
Estimated work hour losses due to displacement, Washington, 2008–2010



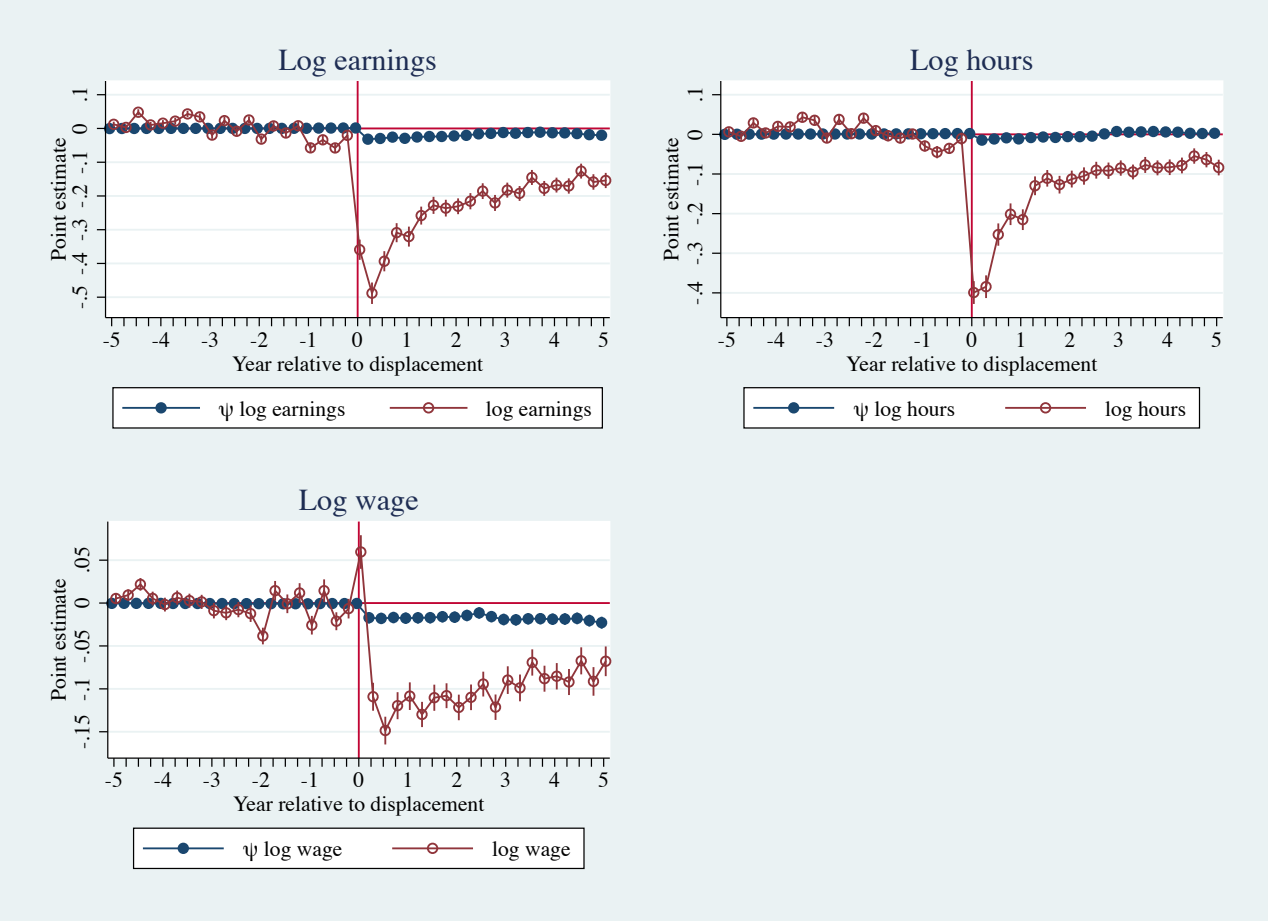
Notes: The top figure shows estimated δ_ks—quarterly unconditional hours lost due to displacement—based on equation (1) with unconditional hours at the primary employer as the dependent variable. The bottom figure shows estimated δ_ks—logarithm of quarterly hours lost due to displacement—based on equation (1) with the log of hours at the primary employer as the dependent variable. Whiskers denote 95-percent confidence intervals based on standard errors clustered by worker. The vertical lines denote the quarter of displacement.
Source: Authors' calculations using Washington administrative wage and claims records. See sections 3.1, 4.1, and 4.2 of the text for details.

Figure 4
Estimated hourly wage rate losses due to displacement, Washington, 2008–2010



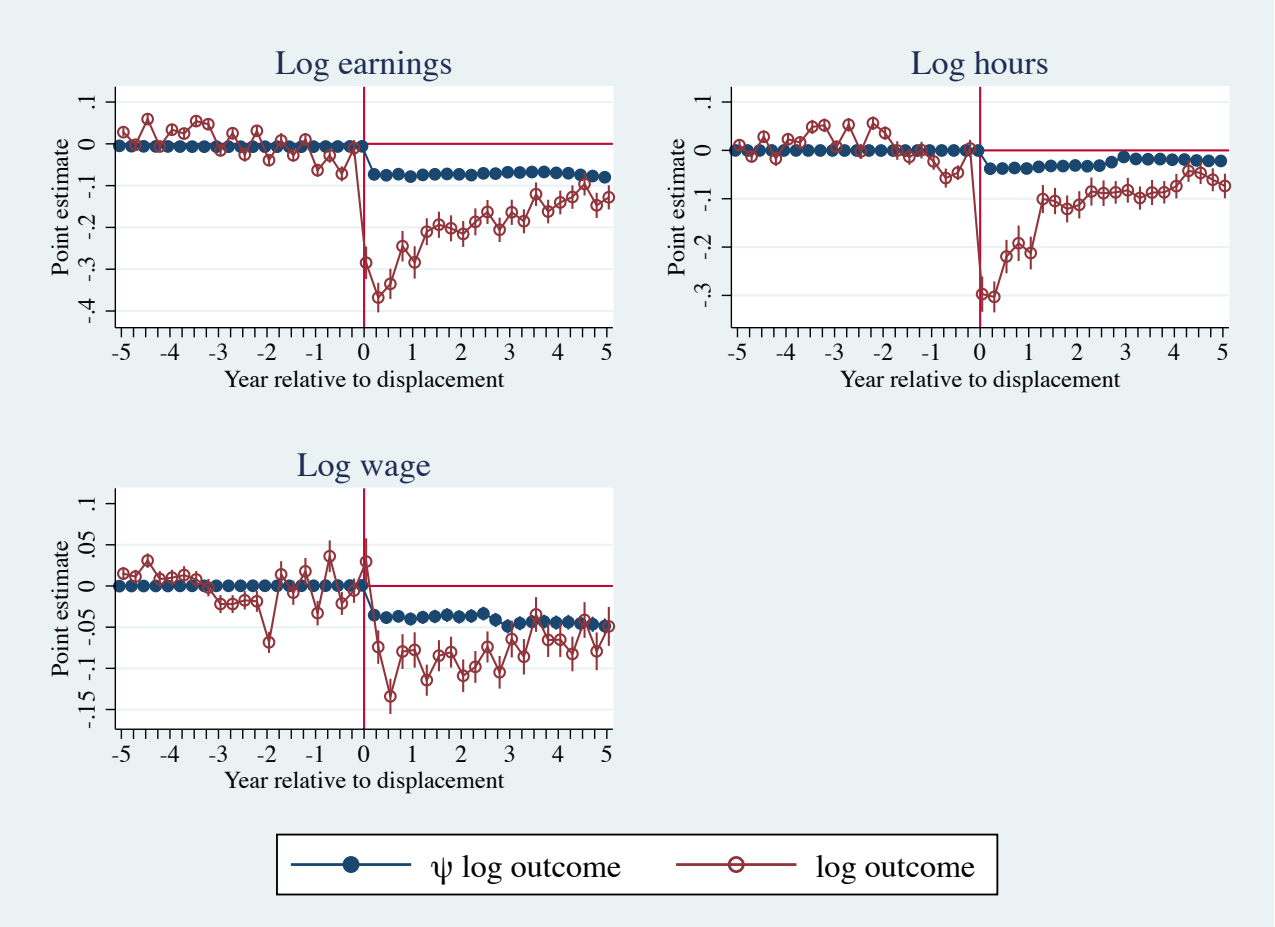
Notes: The figure shows estimated δ_ks—the reduction in the log hourly wage rate due to displacement—based on equation (1) with the log of hourly wage rate at the primary employer (constant 2010 dollars per hour) as the dependent variable. Whiskers denote 95-percent confidence intervals based on standard errors clustered by worker. The vertical lines denote the quarter of displacement.
Source: Authors' calculations using Washington administrative wage and claims records. See sections 3.1, 4.1, and 4.2 of the text for details.

Figure 5
Estimated displacement losses due to foregone employer fixed effects



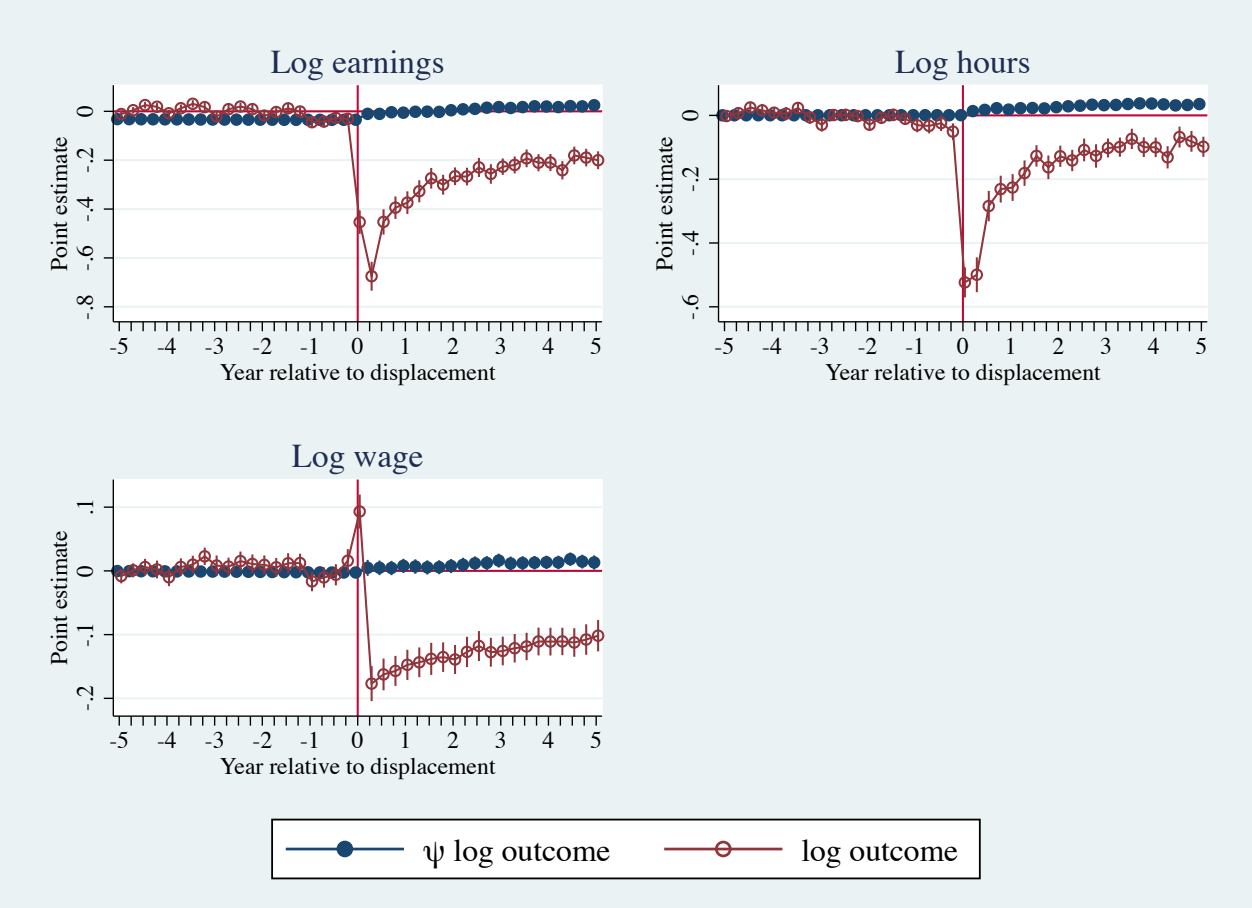
Notes: The figures show estimated displacement losses attributable to foregone employer fixed effects (solid dots) compared with the full losses due to displacement (open circles, repeated from Figures 2, 3, and 4). Losses attributable to foregone employer fixed effects are estimates of δ_k from equation (4). For example, to obtain the estimates of earnings lost due to foregone employer premiums, equation (4) was estimated with the AKM employer fixed effect ($\widehat{\psi}$) for log earnings as the dependent variable. Whiskers denote 95-percent confidence intervals based on standard errors clustered by worker. The vertical lines denote the quarter of displacement.
Source: Authors' calculations using Washington administrative wage and claims records. See sections 3.2 and 5.1 of the text for details.

Figure 6
Estimated displacement losses due to foregone employer fixed effects for workers displaced from employers paying top-quintile earnings premiums



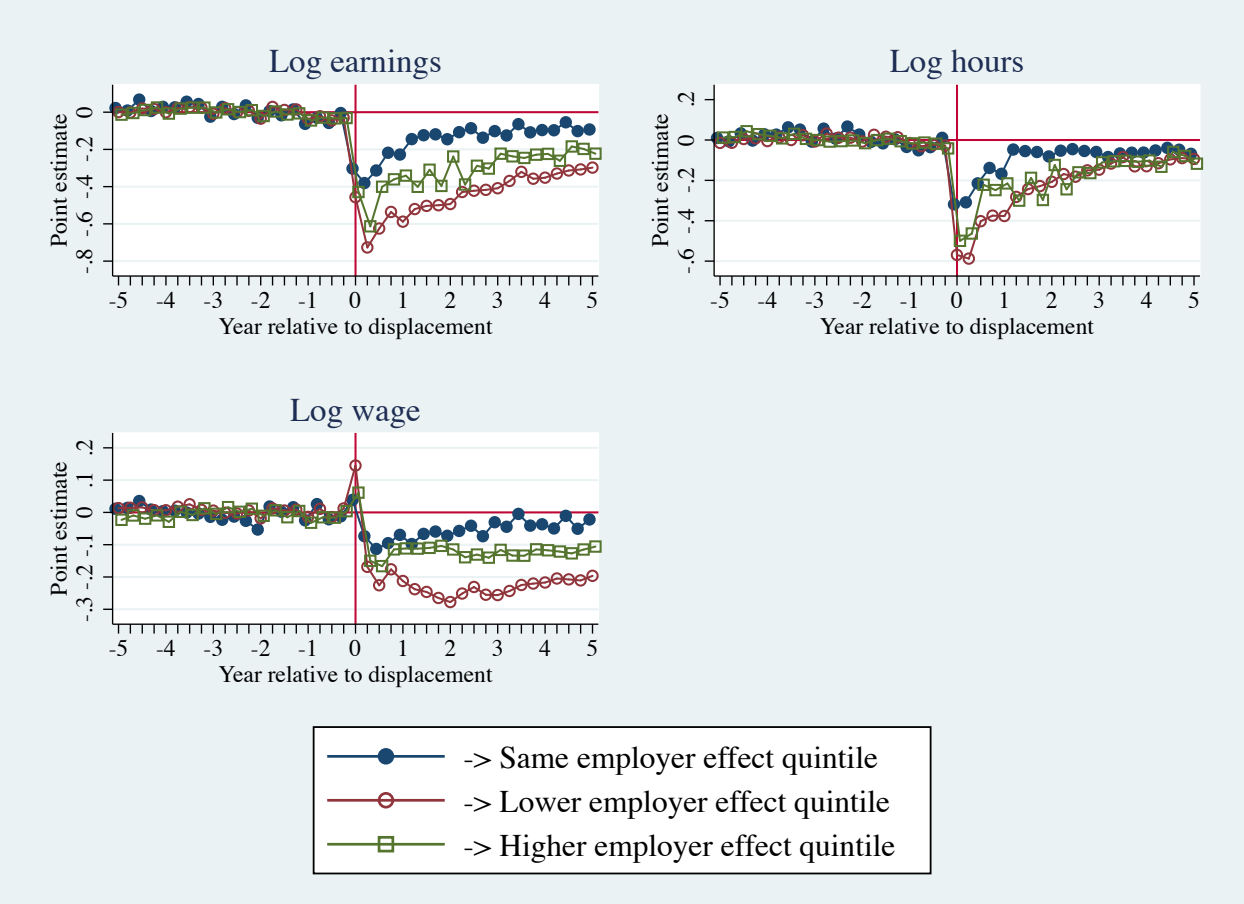
Notes: The figures show estimated displacement losses attributable to foregone employer fixed effects (solid dots, estimated from equation (4)), and full losses due to displacement (open circles, estimated from equation (1)), for workers displaced from employers paying top-quintile earnings premiums (60 percent of displaced workers in the sample—see columns 5 and 6 of Table 1). Whiskers denote 95-percent confidence intervals based on standard errors clustered by worker. The vertical lines denote the quarter of displacement.
Source: Authors' calculations using Washington administrative wage and claims records. See sections 3.2 and 5.2 of the text for details.

Figure 7
Estimated displacement losses due to foregone employer fixed effects for workers displaced from employers paying earnings premiums below the top quintile



Notes: The figures show estimated displacement losses attributable to foregone employer premiums (solid dots, estimated from equation (4)), and full losses due to displacement (open circles, estimated from equation (1)) and for workers displaced from employers paying an earnings premium below the top quintile (40 percent of displaced workers in the sample). Whiskers denote 95-percent confidence intervals based on standard errors clustered by worker. The vertical lines denote the quarter of displacement.
Source: Authors' calculations using Washington administrative wage and claims records. See sections 3.2 and 5.2 of the text for details.

Figure 8
Losses of displaced workers who moved to employers paying the same, lower, and higher earnings premiums compared with the separating employer



Notes: The figures show the losses of displaced workers who, eight quarters after separation, were reemployed by an employer paying an earnings premium in the same quintile as the separating employer (solid dots, 65.1 percent of the sample), by an employer paying a lower-quintile earnings premium than the separating employer (open circles, 18.4 percent of the sample), and by an employer paying a higher-quintile earnings premium than the separating employer (open squares, 16.5 percent of the sample). Whiskers denote 95-percent confidence intervals based on standard errors clustered by worker. The vertical lines denote the quarter of displacement.
Source: Authors' calculations using Washington administrative wage and claims records. See sections 3.2 and 5.3 of the text for details.

Sources of Displaced Workers' Long-Term Earnings Losses: Appendices

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April 2018

Appendix A: Alternative Estimates and Additional Analyses

Appendix B: Estimation of Employer Fixed Effects for Earnings, Hours, and Wage Rates

Appendix A: Alternative Estimates and Additional Analyses

Appendixes A.1–A.6 describe sensitivity tests of the estimates reported in the main text. Appendix Table A1 gives a tabular summary of these results.

Appendix A.7 is made up of three figures that disaggregate the influence of employer fixed effects on post-displacement outcomes, by quintile of the pre-displacement employer's fixed effect for log earnings.

Appendix A.8 is made up of three tables supporting Figures 2, 3, and 8 in the main text.

Appendix Table A1
Summary of estimated quarterly losses due to displacement

	Earnings		Hours		Hourly wage rate	
	Qtr 1	Qtrs 17–20	Qtr 1	Qtrs 17–20	Qtr 1	Qtrs 17–20
1. All displaced workers, full losses (sections 4.1 and 4.2)						
levels	–$5,964	–$1,941	–200	–29.3	–1.89	–1.46
	(–47.8%)	(–15.6%)	(–40.0%)	(–5.9%)	(–3.7%)	(–2.9%)
logs	–0.488	–0.152	–0.384	–0.070	–0.109	–0.080
2. All displaced workers, changes due to employer fixed effects (section 5.1)						
logs	–0.032	–0.017	–0.015	0.003	–0.017	–0.020
3. Workers displaced from top-quintile employers, full losses (section 5.2)						
logs	–0.368	–0.125	–0.303	–0.056	–0.074	–0.063
4. Workers displaced from top-quintile employers, changes due to employer fixed effects (section 5.2)						
logs	–0.074	–0.067	–0.038	–0.021	–0.036	–0.046
5. Workers displaced from quintile 1–4 employers, full losses (section 5.2)						
logs	–0.675	–0.203	–0.500	–0.095	–0.177	–0.108
6. Workers displaced from quintile 1–4 employers, changes due to employer fixed effects (section 5.2)						
logs	–0.002	–0.021	–0.013	–0.033	0.005	0.015
7. Displaced workers with shorter job tenure (3–5 years), full losses (Appendix A.1)						
logs	–0.574	–0.149	–0.510	–0.152	–0.067	0.005
8. Displaced workers less strongly attached, full losses (Appendix A.2)						
logs	–0.526	–0.242	–0.418	–0.109	–0.116	–0.134
9. All displaced workers, alternative comparison group, full losses (Appendix A.3)						
logs	–0.410	–0.065	–0.323	–0.026	–0.098	–0.036
10. All displaced workers, broadened sample, full losses (Appendix A.4)						
logs	–0.363	–0.195	–0.323	–0.091	–0.056	–0.105
11. Workers displaced from industries except NAICS 51–56, full losses (Appendix A.5)						
logs	–0.595	–0.206	–0.425	–0.098	–0.172	–0.110
12. All displaced workers, full losses from random trends model (Appendix A.6)						
logs	–0.483	–0.170	–0.401	–0.121	–0.092	–0.045

Note: Each entry gives the estimated displacement effect on the indicated outcome in either quarter 1 (Qtr 1) or the average of quarters 17, 18, 19, and 20 (Qtrs 17–20) following displacement. For levels, implied percentage changes relative to the non-displaced comparison group are shown in parentheses. (For example, the estimated effect of displacement on average earnings in quarters 17–20 after displacement is –$1,941, which is 15.6% less than the earnings of the non-displaced comparison group.)

A.1 Estimated losses of workers with relatively short job tenure

An implication of the specific human capital hypothesis is that longer pre-displacement job tenure will be associated with larger earnings losses (e.g., Topel 1990; Neal 1995; Carrington and Fallick 2017). Farber (1993) found that, on average, each additional year of pre-displacement job tenure was associated with an additional one percent drop in post-displacement earnings. In contrast, in a study using administrative data, von Wachter, Song, and Manchester (2009) found insubstantial differences between the earnings losses of workers with three years of tenure and workers with six or more years of tenure.

This appendix examines and compares the earnings, hours, and wage rate losses of workers with 6 or more years of pre-displacement job tenure (the main sample) to the losses of workers with only 3–4 years of pre-displacement job tenure. To do this, we first select displaced workers with 3–4 years of tenure according to the criteria described in section 2.1 (other than the six-year tenure requirement). We then estimate equation (1) using as the comparison group non-displaced workers with 6 or more years of tenure, so that comparisons between short- and long-tenure displaced workers are made with respect to the same comparison group. This is a descriptive exercise, not an attempt to estimate the effect of job tenure on the outcomes of displaced workers.

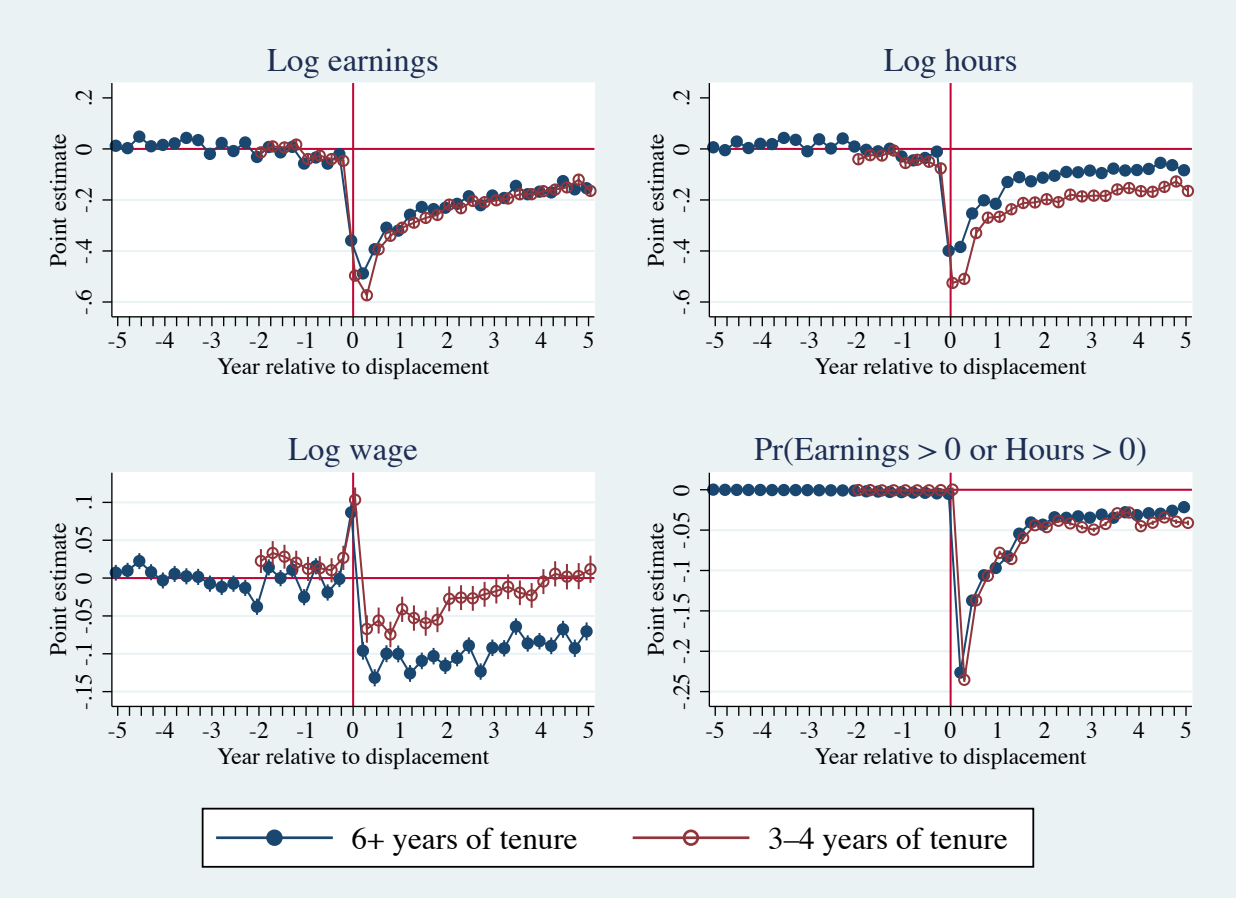
Appendix Figure A1 shows the estimated profiles of earnings, work hours, and wage rates (in logs), and the estimated time path of the quarterly employment probability—see also row 7 of Appendix Table A1. The earnings losses and employment probabilities of displaced workers with 3–4 years of tenure are similar to those with 6 or more years of tenure, consistent with the findings in von Wachter, Song, and Manchester (2009). However, the patterns of hours losses and wage rate reductions differ sharply between the two groups. The hours losses of short-

tenure displaced workers are consistently greater than the hours losses of long-tenure displaced workers. In contrast, the wage rates of short-tenure displaced workers return to their pre-displacement level within about four years, whereas the wage rates of long-tenure displaced workers never fully recover.

A possible interpretation of these estimates is that the reduced work hours of long-tenure displaced workers represent a labor supply response to their reduced wage rates, whereas the substantially reduced hours of short-tenure displaced workers, along with wage rates similar to those faced before displacement, suggests demand constraints faced by these workers. The implication is that short- and long-tenure displaced workers differ in ways that should not be attributed to previous job tenure alone.[1]

[1] We have also examined losses due to displacement separately for workers younger than age 40 in the quarter of displacement, and for workers age 40 and older in the quarter of displacement. (To construct the non-displaced comparison groups, we use age in 2007:IV.) The estimated long-term earnings, hours, and wage-rate losses of the younger and older workers are quite similar, which is surprising because older workers have on average longer job tenure. However, the reemployment rates of older workers in the first two years after displacement are lower than those of younger workers, consistent with Farber's (2017) findings.

Appendix Figure A1
Estimated displacement effects for workers with relatively short job tenure



Notes: The figures show estimated displacement effects for workers with 3–4 years of job tenure at the time of displacement (open circles), and 6 or more years of job tenure at the time of displacement (solid dots, repeated from Figures 2, 3, 4 in the main text for the first three panels). The reference time period for workers displaced with 3–4 years of tenure (and their comparison group) is 3 years before displacement. Each figure shows the profile of displacement effects for an outcome—quarterly log earnings, log hours, log wage rate (all from the primary employer), or the probability of employment (positive earnings or hours)—based on estimates of δ_k in equation (1). Whiskers denote 95-percent confidence intervals based on standard errors clustered by worker. The vertical lines denote the quarter of displacement.
Source: Authors' calculations using Washington administrative wage and claims records. See sections 3.1, 4.1, and 4.2 of the text for details.

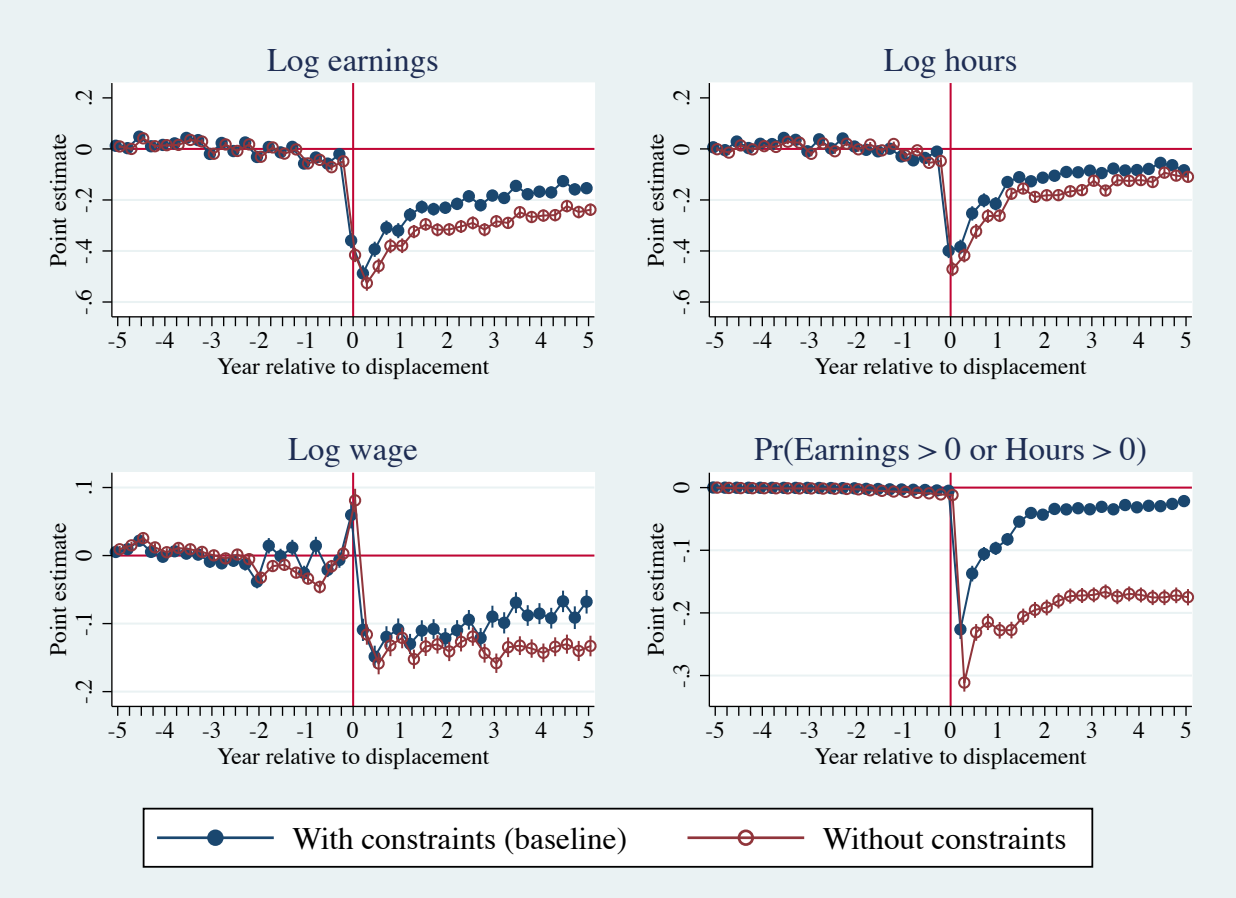
A.2 Estimated losses of workers less strongly attached to the labor force

The estimates in Figures 2–4 of the main text are based on a sample of displaced workers who were employed in at least one quarter per calendar year in each year following displacement. Relaxing this restriction, so that a displaced worker need never reappear with positive earnings or hours after being displaced, increases the sample of displaced workers from 3,032 to 4,199. Appendix Figure A2 plots the estimated time paths of lost log earnings, log hours, and log wage rates for this expanded sample (open circles), along with the time paths of earnings, work hours, and wage rates for the original sample (solid dots, repeated from Figures 2–4 in the main text)—see also row 8 of Appendix Table A1.

Estimates based on the expanded sample differ in two main ways from these based on the original sample. First, log wages following displacement fall and never recover even partially. At the time of displacement, hourly wage rates are 12 log points lower than the comparison group's; and five years after displacement, they are 13 log points lower. These larger wage losses translate into larger earnings losses: 24 log points lower in the unrestricted sample, compared with 15 log points lower in the restricted sample.[2] Second, in the expanded sample, the probability of employment (defined as having positive earnings or hours in a quarter) five years after displacement is 18 percent less than for the comparison group. This compares with a 4 percent gap in the original sample.

[2] When Couch and Placzek (2010, p. 579) relax the labor force attachment restriction, they find earnings losses that are greater by 15–18 percentage points, substantially larger than the 8 log-point increase we estimate.

Appendix Figure A2
Estimated displacement effects for workers less strongly attached to the labor force



Notes: The figures show estimated displacement effects for a sample of displaced workers not required to be observed with positive earnings or hours after being displaced (open circles), and for the sample observed with positive earnings or hours in at least one quarter of each year following displacement (solid dots, repeated from Figures 2, 3, and 4 of the main text). The whiskers denote 95–percent confidence intervals clustered by worker. The vertical lines denote the quarter of displacement.
Source: Authors' calculations using Washington administrative wage and claims records. See sections 3.1, 4.1, and 4.2 of the text for details.

A.3 Estimates using an alternative comparison group

The comparison group used by JLS included only workers continuously employed with their primary employer throughout the observation period (in our case, 2002–2014). As Krolikowski (2018) has pointed out, this could lead to an overstatement of displaced workers' losses. Accordingly, we estimate equation (1) using a comparison group of long-tenure workers (employed by the same primary employer during 2002–2007) who continued with the same employer (were not displaced) during 2008–2010, but who may have changed employers or separated from their primary employer sometime after 2010. We interpret the estimates obtained using this alternative comparison group as a lower bound of the effects of displacement.

Appendix Figures A3–A5 show the results of estimating equation (1) for earnings, hours, and hourly wage rates, using this alternative comparison group—see also row 9 of Appendix Table A1. The short-term losses are similar to those in Figures 2–4: In the quarter after displacement, earnings drop by 41 log points (compared with 49 log point using the baseline comparison group), hours drop by 32 log points (compared with 38 log points using the baseline comparison group), and wage rates are lower by 10 log points (compared with 11 log points using the baseline comparison group).

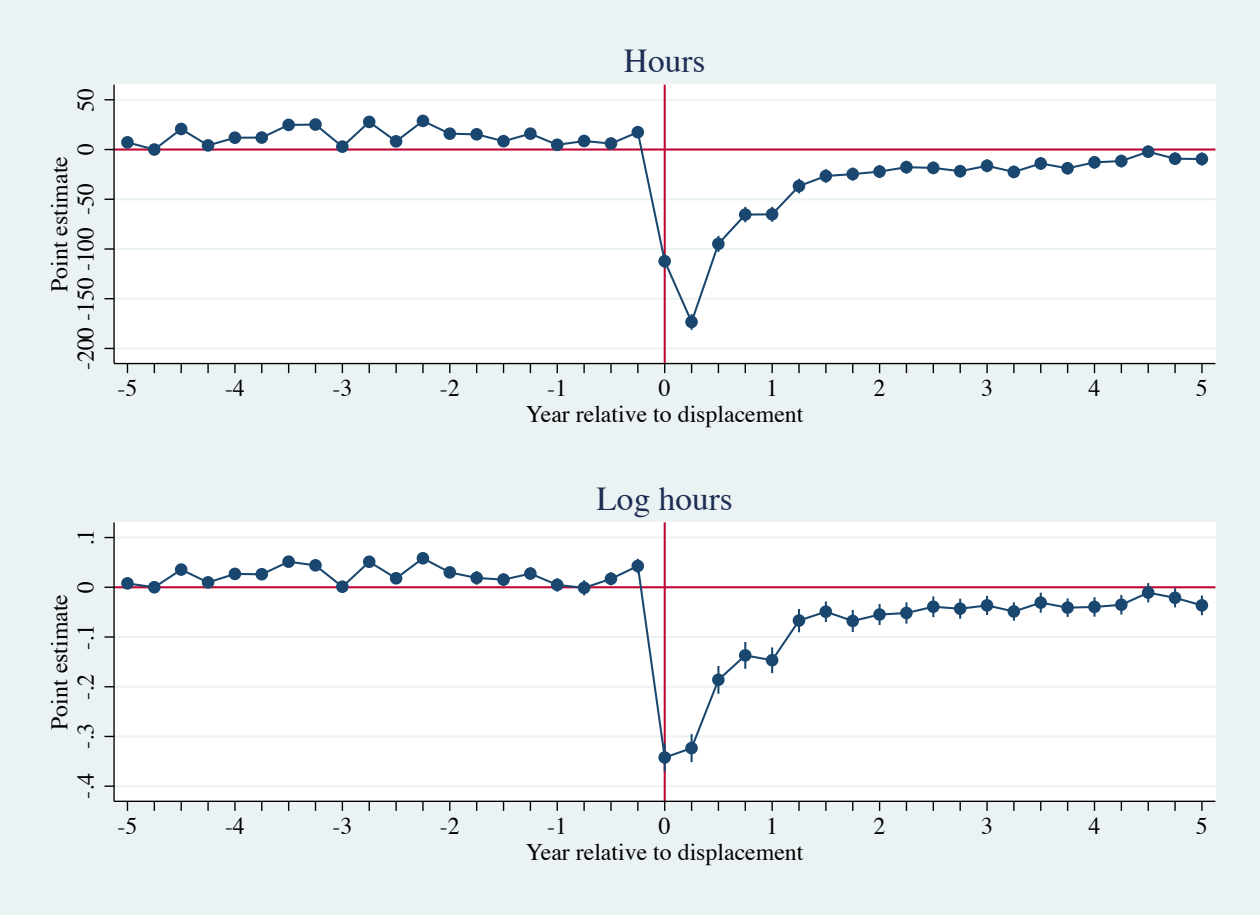
In contrast, the long-term losses estimated using the alternative comparison group are less than half those estimated using the baseline comparison group: After five years, earnings are lower than the alternative comparison group's by 6.5 log points (compared with 15 log points using the baseline comparison group), hours are lower by 2.6 log points (compared with 7 log points), and hourly wage rates are lower by 3.6 log points (compared with 8 log points). Using the alternative comparison group, it remains the case that hours come closer to a full recovery than do hourly wage rates; however, whereas wage-rate recovery stagnates when we rely on the

baseline comparison group, wage-rates appear to continue a very slow recovery with respect to the alternative comparison group.

Appendix Figure A3
Earnings losses due to displacement estimated using the alternative comparison group

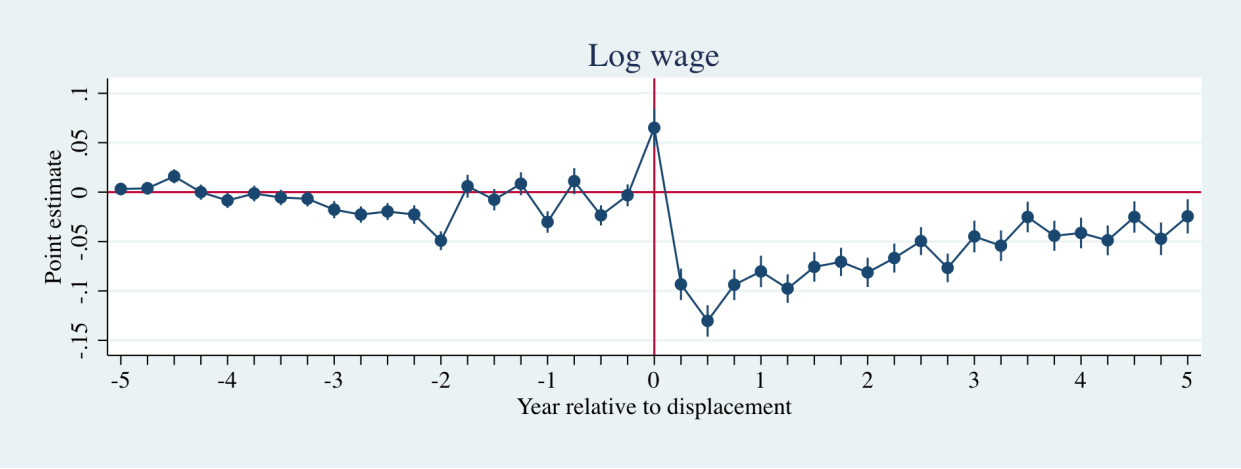
Notes: The figures show earnings losses estimated using a comparison group of long-tenure workers who were not displaced during 2008–2010, but who may have subsequently changed employers or separated from their primary employer (Krolikowski 2018). The top figure shows estimated δ_ks—quarterly unconditional earnings lost due to displacement (in constant 2010 $1,000s)—based on equation (1) with unconditional earnings from the primary employer as the dependent variable. The bottom figure shows estimated δ_ks—log of quarterly earnings lost due to displacement—based on equation (1) with the log of earnings from the primary employer as the dependent variable. Whiskers (which are very small) denote 95-percent confidence intervals based on standard errors clustered by worker. The vertical lines denote the quarter of displacement.
Source: Authors' calculations using Washington administrative wage and claims records. See section 2.1 for details of the baseline comparison group, and see Figure 2 in the main text for estimates using the baseline comparison group.

Appendix Figure A4
Work hour losses due to displacement estimated using the alternative comparison group



Notes: The figures show quarterly work hour losses estimated using a comparison group of long-tenure workers who were not displaced during 2008–2010, but who may have subsequently changed employers or separated from their primary employer (Krolikowski 2018). The top figure shows estimated δ_ks—quarterly unconditional hours lost due to displacement—based on equation (1) with unconditional hours from the primary employer as the dependent variable. The bottom figure shows estimated δ_ks—log of quarterly hours lost due to displacement—based on equation (1) with the log of hours from the primary employer as the dependent variable. Whiskers denote 95-percent confidence intervals based on standard errors clustered by worker. The vertical lines denote the quarter of displacement.
Source: Authors' calculations using Washington administrative wage and claims records. See section 2.1 for details of the baseline comparison group, and see Figure 3 in the main text for estimates using the baseline comparison group.

Appendix Figure A5
Hourly wage rate losses due to displacement estimated using the alternative comparison group



Notes: The figure shows hourly wage rate losses estimated using a comparison group of long-tenure workers who were not displaced during 2008–2010, but who may have subsequently changed employers or separated from their primary employer (Krolikowski 2018). The figure plots estimated δ_ks—the reduction in the log hourly wage rate due to displacement—based on equation (1) with the log of the hourly wage rate at the primary employer (constant 2010 dollars per hour) as the dependent variable. Whiskers denote 95-percent confidence intervals based on standard errors clustered by worker. The vertical lines denote the quarter of displacement.
Source: Authors' calculations using Washington administrative wage and claims records. See section 2.1 for details of the baseline comparison group, and see Figure 4 in the main text for estimates using the baseline comparison group.

A.4 Estimates from a broadened sample of displaced and non-displaced workers

The estimates in the text are based on a sample of workers who claimed UI at least once during 2002–2014.[3] In this appendix, we present an analysis based on a broadened sample not restricted to UI claimants.

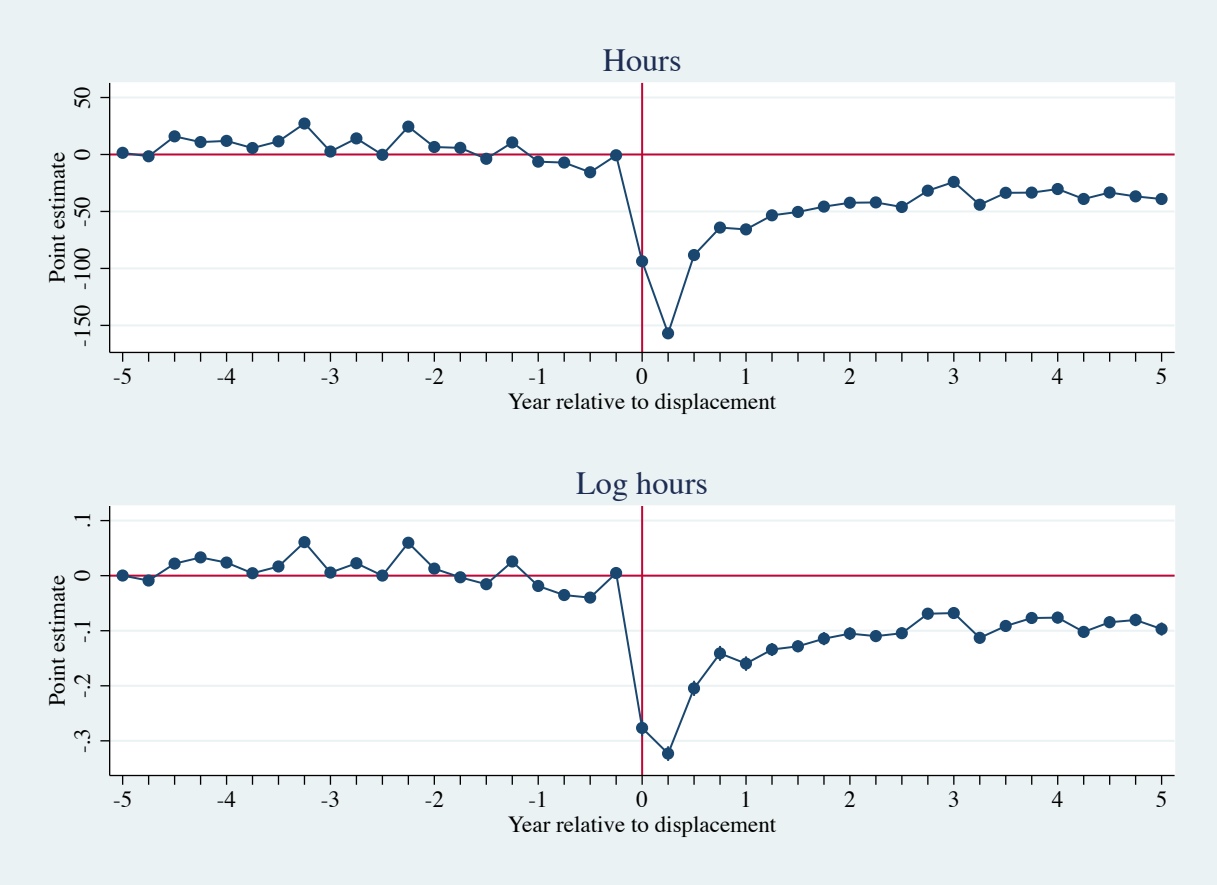
Appendix Figures A6, A7, and A8 repeat the analysis in the main text using all workers who satisfy the criteria for inclusion in the analysis sample described in section 2.1, *except* for the criterion that they claimed UI at least once—see also row 10 of Appendix Table A1. This results in a substantially larger sample (9,286 displaced workers, and 257,651 workers in the comparison group), although it does not materially change the conclusions. The pre-displacement Ashenfelter dip is more noticeable in the broadened sample, and the initial drops in earnings, hours, and wage rates are somewhat less than in the original sample (comparing Appendix Figures A6–A8 with Figures 2–4). But long-term losses appear to be somewhat greater in the broadened sample (19.5 log points in the broadened sample versus 15 log points in the sample restricted to UI claimants). The larger long-term earnings losses in the broadened sample occur mainly because wage rates in the broadened sample show little if any recovery from their drop at the time of displacement.

[3] As described in the text, this restriction is imposed on both the displaced workers and the comparison group for two reasons. First, we observe the individual characteristics of UI claimants, so we can restrict attention to displaced workers aged 20–50 at the time of displacement. Second, we can infer that non-displaced workers in the comparison group who claimed UI experienced at least one temporary layoffs (an unemployment spell lasting less than one quarter and ending in recall to the same employer), creating a comparison group at greater risk of displacement and more comparable to the displaced treatment group.

Appendix Figure A6
Estimated earnings losses due to displacement, based on the broadened sample of displaced and non-displaced workers, Washington, 2008–2010

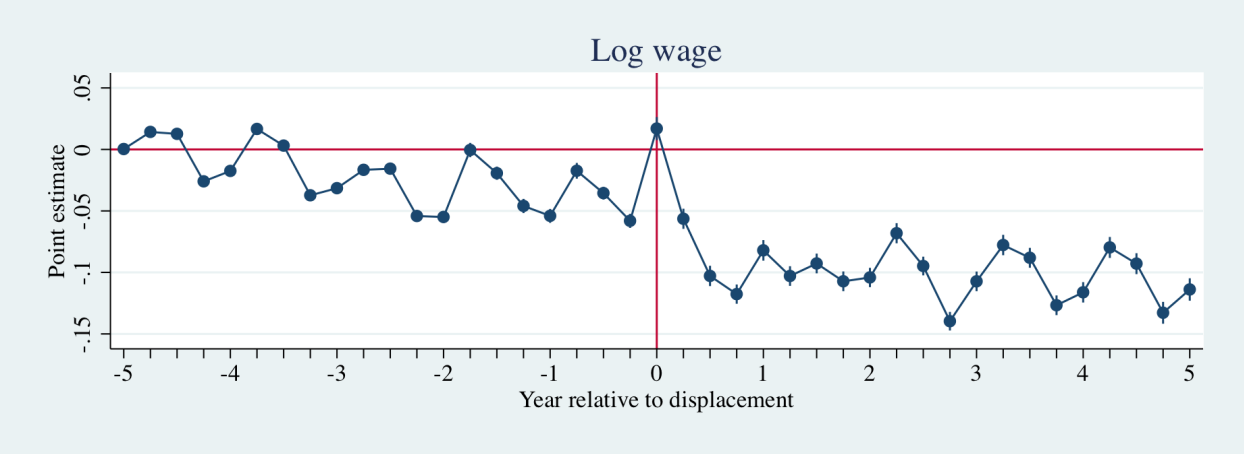
Notes: The figures show quarterly earnings losses estimated using the broadened sample of displaced and non-displaced workers—that is, without restricting the sample to workers who claimed UI at some time during 2002–2014. The top figure shows estimated δ_ks—quarterly unconditional earnings lost due to displacement (in constant 2010 $1,000s)—based on equation (1) with unconditional earnings from the primary employer as the dependent variable. The bottom figure shows estimated δ_ks—log of quarterly earnings lost due to displacement—based on equation (1) with the log of earnings from the primary employer as the dependent variable. Whiskers (which are very small) denote 95-percent confidence intervals based on standard errors clustered by worker. The vertical lines denote the quarter of displacement.
Source: Authors' calculations using Washington administrative wage and claims records.

Appendix Figure A7
Estimated work hour losses due to displacement, based on the broadened sample of displaced and non-displaced workers, Washington, 2008–2010



Notes: The figures show quarterly work hour losses estimated using the broadened sample of displaced and non-displaced workers—that is, without restricting the sample to workers who claimed UI at some time during 2002–2014. The top figure shows estimated δ_ks—quarterly unconditional hours lost due to displacement—based on equation (1) with unconditional hours at the primary employer as the dependent variable. The bottom figure shows estimated δ_ks—log of quarterly hours lost due to displacement—based on equation (1) with the log of hours at the primary employer as the dependent variable. Whiskers denote 95-percent confidence intervals based on standard errors clustered by worker. The vertical lines denote the quarter of displacement.
Source: Authors' calculations using Washington administrative wage and claims records.

Appendix Figure A8
Estimated hourly wage rate losses due to displacement, based on the broadened sample of displaced and non-displaced workers, Washington, 2008–2010



Notes: The figure shows hourly wage rate losses estimated using the broadened sample of displaced and non-displaced workers—that is, without restricting the sample to workers who claimed UI at some time during 2002–2014. The figure plots estimated δ_ks—reductions in the log hourly wage rate due to displacement—based on equation (1) with the log of the hourly wage rate at the primary employer (constant 2010 dollars per hour) as the dependent variable. Whiskers denote 95-percent confidence intervals based on standard errors clustered by worker. The vertical lines denote the quarter of displacement.
Source: Authors' calculations using Washington administrative wage and claims records.

A.5 Estimates excluding workers displaced from NAICS industries 51–56

In this appendix, we repeat the analysis *excluding* workers displaced from jobs in NAICS industries 51–56 (information, finance and insurance, real estate, professional, scientific, and technical services, management of companies; administrative, support, and waste management and remediation services). We do this for three reasons: first, as seen in Table 1 of the main text, workers in NAICS industries 51–56 have higher earnings and wage rates than other workers; second, the comparison sample for workers displaced from NAICS industries 51–56 is relatively thin, making inferences about the influence of displacement on these workers less convincing than for others; third, dropping NAICS industries 51–56 brings the industry composition of our analysis sample closer to the industry composition of the samples examined by JLS and CP.

Appendix Figure A9 plots the losses of workers displaced from industries other than NAICS 51–56—see also row 11 of Appendix Table A1. Immediate earnings losses are nearly 60 log points, and long-term earnings losses (quarters 17–20) are more than 20 log points. For workers displaced from industries other than NAICS 51–56, then, both short- and long-term losses appear larger than for the overall sample. However, these long-term losses remain somewhat smaller than those estimated by JLS and CP for Pennsylvania and Connecticut.

Appendix Figure A9 shows that the long-term lost work hours and reduced wage rates of workers displaced from industries other than NAICS 51–56 also exceed those for workers overall. The long-term hours loss is about 10 log points (compared with 7 log points for all workers), and the long-term wage reduction is about 11 log points (compared with 8 log points for all workers).

Appendix Figure A9
Estimated displacement effects for workers displaced from industries other than NAICS industries 51–56

Notes: The figures show estimated displacement effects for workers displaced from any industry *except* NAICS industries 51–56 (information, finance and insurance, real estate, professional, scientific, and technical services, management of companies; administrative, support, and waste management and remediation services). Each figure shows the profile of displacement effects for an outcome—log quarterly earnings, log quarterly hours, and log wage rate (all from the primary employer), or the probability of employment (positive earnings or hours)—based on estimates of δ_k in equation (1). Whiskers denote 95-percent confidence intervals based on standard errors clustered by worker. The vertical lines denote the quarter of displacement.
Source: Authors' calculations using Washington administrative wage and claims records.

A.6 Estimates from a model with worker-specific trends (random trend model)

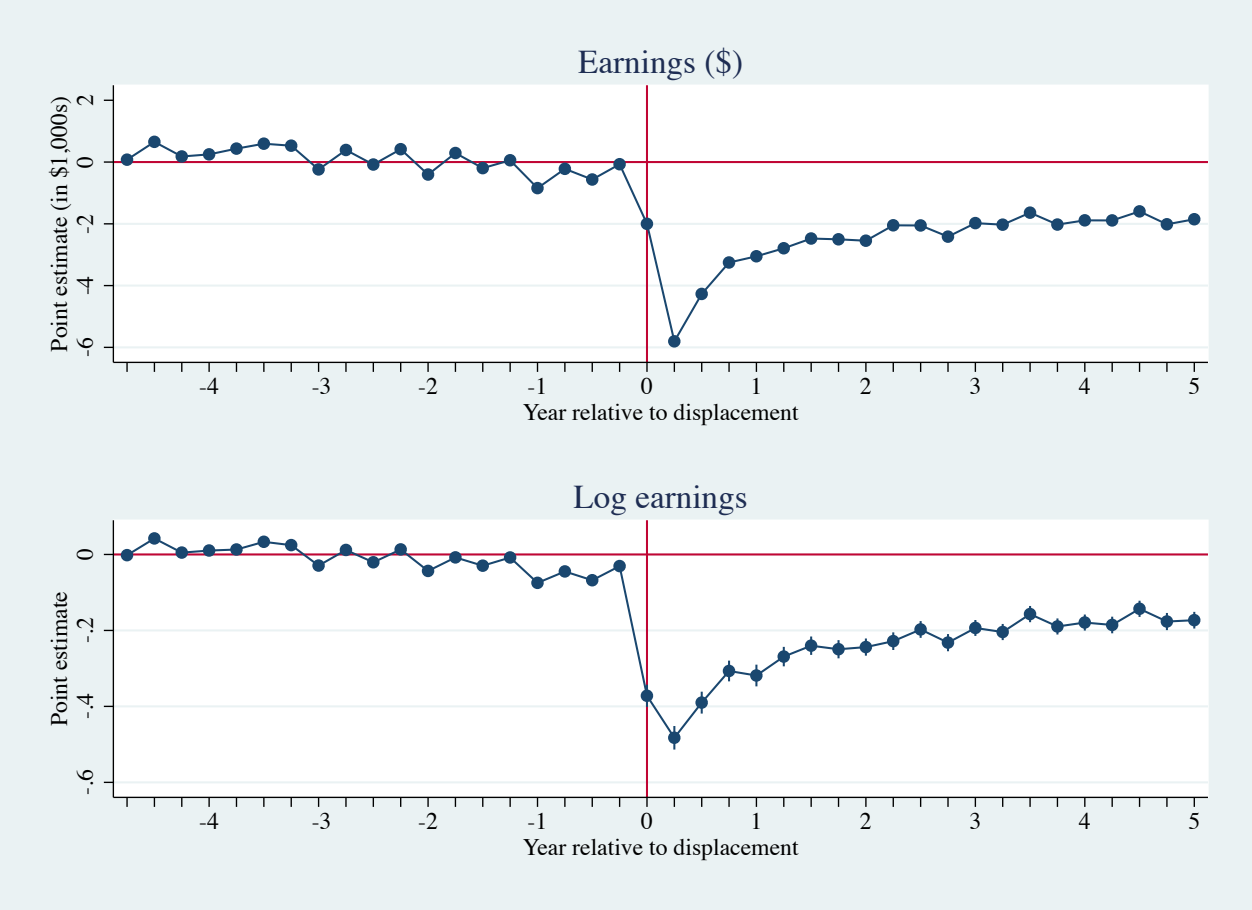
As a robustness check of the parallel-trends assumption, we estimate a version of the worker fixed-effects difference-in-differences model with worker-specific trends (a random trend model):

$$Y_{it} = c_i + \omega_i t + \gamma_t + \sum_{k=-20}^{20}(\delta_k \cdot D_{itk}) + e_{it}\ , \qquad \text{(A.1)}$$

where t is a quarterly time trend, ω_i is a worker-specific quarterly growth rate over the period, and γ_t is a vector of calendar quarter indicators. [Other notation is the same as for equation (1) in the main text.] In practice, we de-mean all variables in equation (A.1), then apply a fixed-effects estimator to the de-meaned data—see JLS (1993a, p. 694), Wooldridge (2002, pp. 315–317).

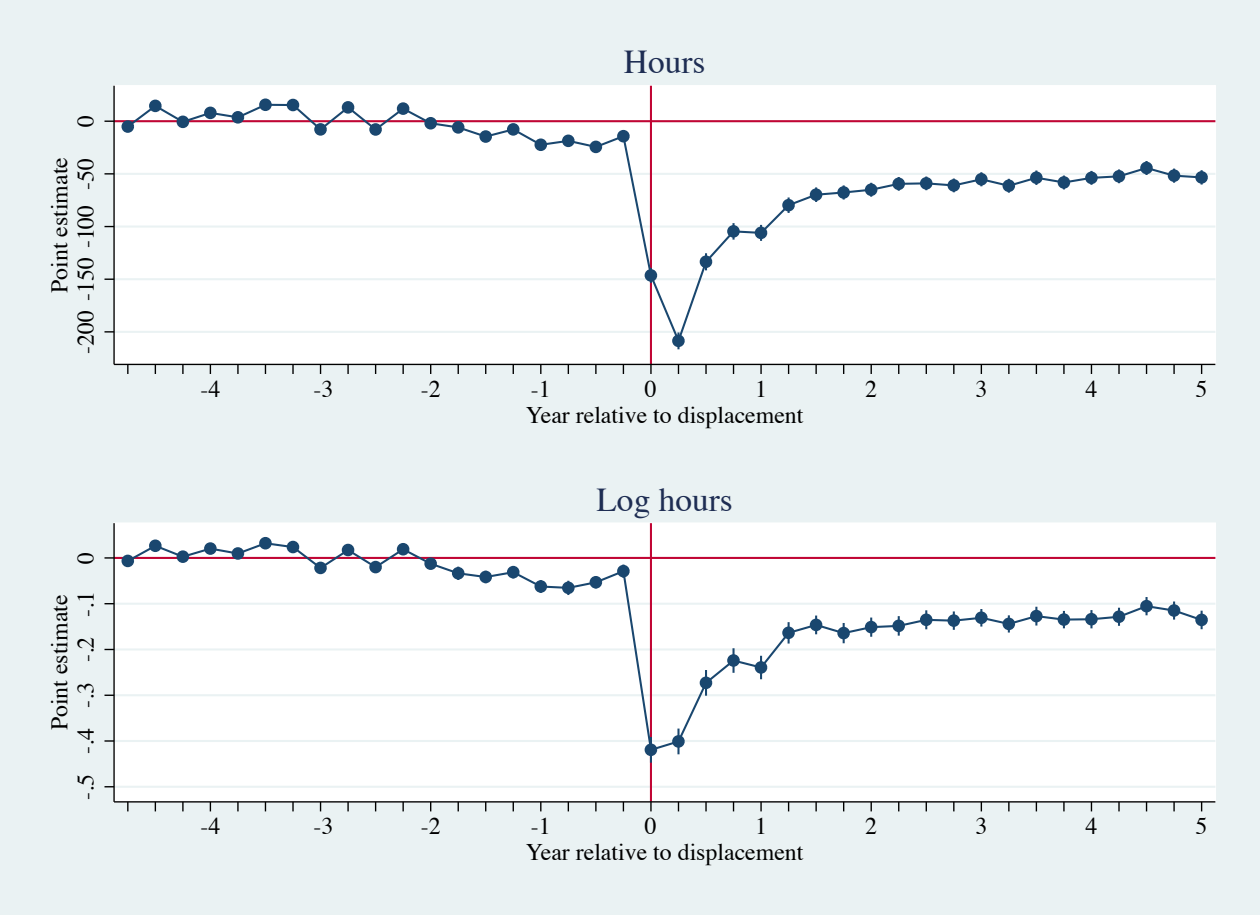
The results are shown in Appendix Figures A10, A11, and A12—see also row 12 of Appendix Table A1. The estimated profiles of earnings, hours, and wage rates are quite similar to those estimated using equation (1) and shown in Figures 2, 3, and 4. Estimated long-term earnings losses are nearly identical, long-term lost work hours are somewhat greater, and long-term reductions in wage rates are somewhat smaller. The overall similarity of the estimates suggests that pre-displacement earnings and work hours of displaced and non-displaced workers evolve approximately in parallel. This is consistent with interpreting the estimated δ_ks in equation (1) as displacement effects.

Appendix Figure A10
Estimated earnings losses due to displacement, Washington, 2008–2010, based on the random-trend model



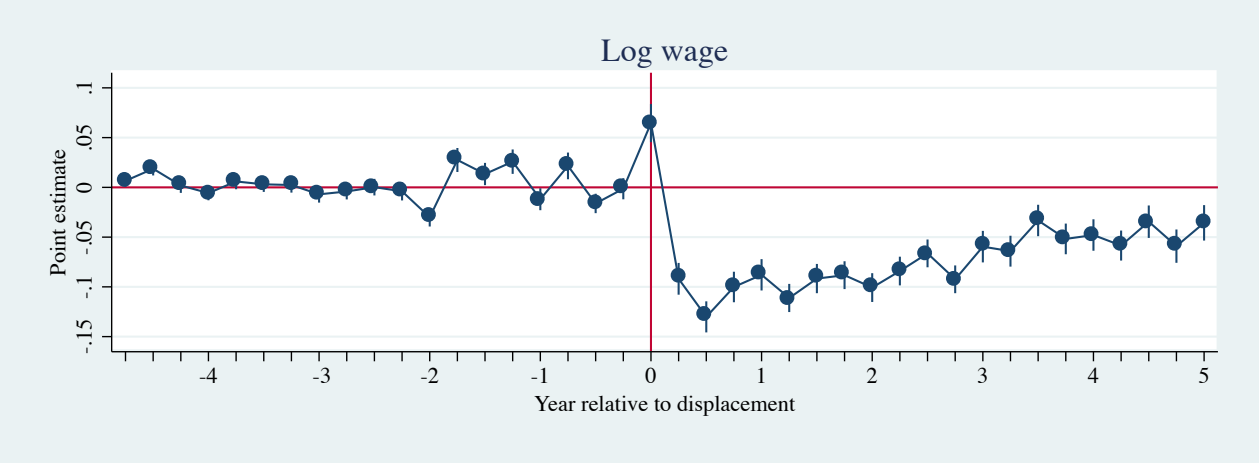
Notes: The top figure shows estimated δ_ks—quarterly unconditional earnings lost due to displacement (in constant 2010 $1,000s)—based on the random trend model [equation (A.1)] with unconditional earnings from the primary employer as the dependent variable. The bottom figure shows estimated δ_ks—log of quarterly earnings lost due to displacement—based on equation (A.1) with the log of earnings from the primary employer as the dependent variable. Whiskers (which are very small) denote 95-percent confidence intervals based on standard errors clustered by worker. The vertical lines denote the quarter of displacement.
Source: Authors' calculations using Washington administrative wage and claims records. See also sections 3.1 and 4.1 of the main text.

Appendix Figure A11
Estimated work hour losses due to displacement, Washington, 2008–2010, based on the random-trend model



Notes: The top figure shows estimated δ_ks—quarterly unconditional hours lost due to displacement—based on the random trend model [equation (A.1)] with unconditional hours at the primary employer as the dependent variable. The bottom figure shows estimated δ_ks—log of quarterly hours lost due to displacement—based on equation (A.1) with the log of hours at the primary employer as the dependent variable. Whiskers denote 95-percent confidence intervals based on standard errors clustered by worker. The vertical lines denote the quarter of displacement.
Source: Authors' calculations using Washington administrative wage and claims records. See also sections 3.1 and 4.2 of the main text.

Appendix Figure A12
Estimated hourly wage rate losses due to displacement, Washington, 2008–2010, based on the random-trend model



Notes: The figure shows estimated δ_ks—the reduction in the log hourly wage rate due to displacement—based on the random trend model [equation (A.1)] with the log of the hourly wage rate at the primary employer (constant 2010 dollars per hour) as the dependent variable. Whiskers denote 95-percent confidence intervals based on standard errors clustered by worker. The vertical lines denote the quarter of displacement.
Source: Authors' calculations using Washington administrative wage and claims records. See also sections 3.1 and 4.2 of the main text.

A.7 Estimated displacement losses due to employer fixed effects, by pre-displacement employer fixed effect

This appendix provides additional details on the importance of employer fixed effects to post-displacement outcomes. Appendix Figure A13 shows the influence of employer fixed effects on post-displacement log earnings, disaggregated by quintile of the pre-displacement employer's fixed effect (for log earnings).[4] Appendix Figures A14 and A15 do the same for post-displacement log hours and log wage rates.

The bottom figure in Appendix Figure A13 ("Quintile 5 employer effect") is repeated from Figure 6) and shows that 54 percent (–0.067/–0.125) of the earnings losses of workers displaced from top-quintile employers are due to employer fixed effects. But for workers displaced from third- and fourth-quintile employers, employer fixed effects are of little importance, and for workers displaced from first- and second-quintile employers, employer fixed effects have a *positive* influence on post-displacement earnings.

This pattern is consistent with a process of displaced workers reverting to the mean fixed-effect employer. Mean reversion is in turn consistent with OLS estimation of the AKM model—that workers do not move strategically to take advantage of favorable employer-employee matches. Taking employer fixed effects as estimates of an employer's position on a job ladder, the findings imply that displaced workers do not systematically fall to the bottom of the ladder.[5]

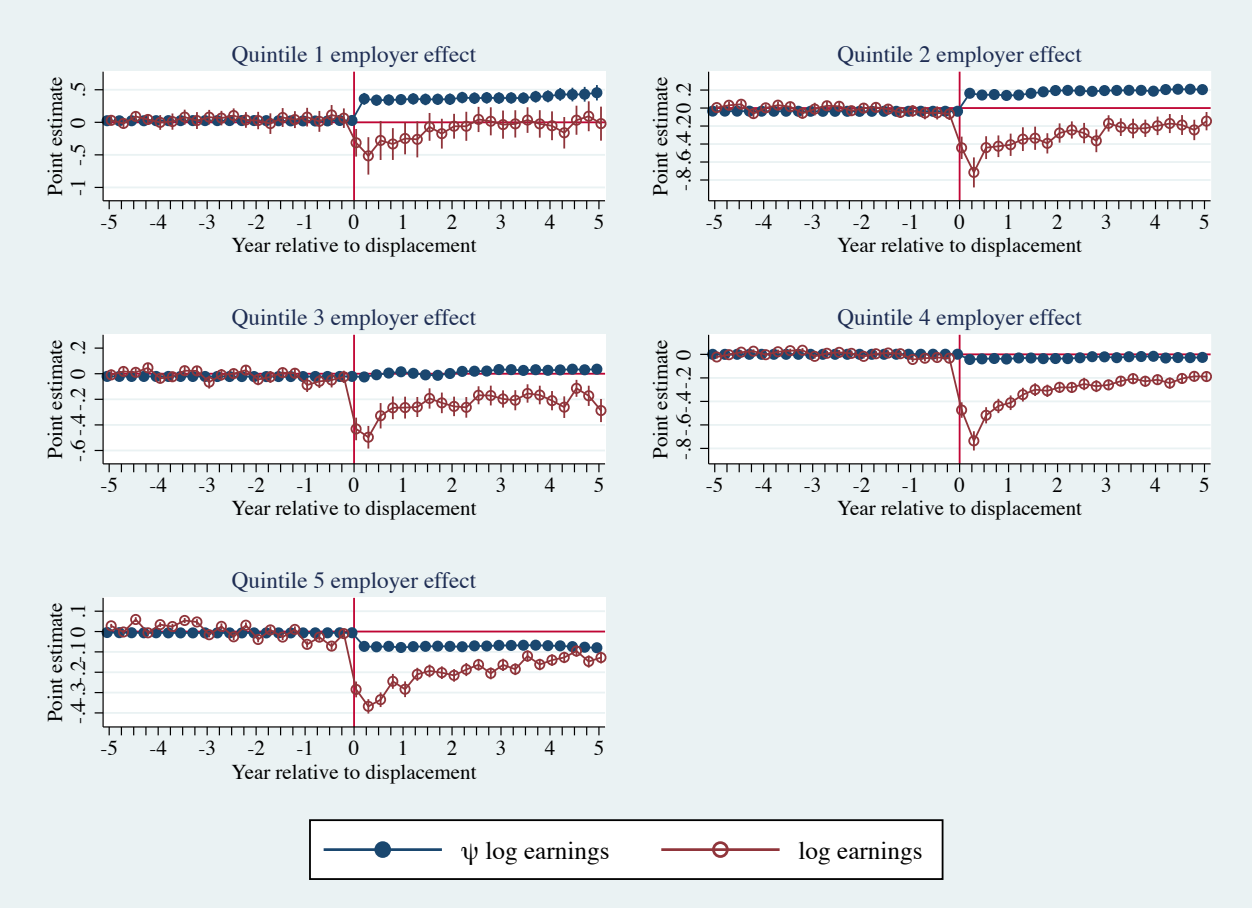
Appendix Figures A14 and A15 show generally similar patterns regarding the importance of employer effects for changes in hours and wage rates following displacement. For workers displaced from top-quintile employers, employer fixed effects contribute substantially to reduced

[4] Fixed effects for log earnings are used to classify the separating employer by quintile for all three outcomes—earnings, hours, and wage rates.

[5] Moscarini and Postel-Vinay (2016, p. 56) characterize a job ladder as "a stationary… uniform ranking of jobs by all workers," which is consistent with the idea of employer fixed effects. Their findings suggest that the job ladder ceased to operate during the Great Recession.

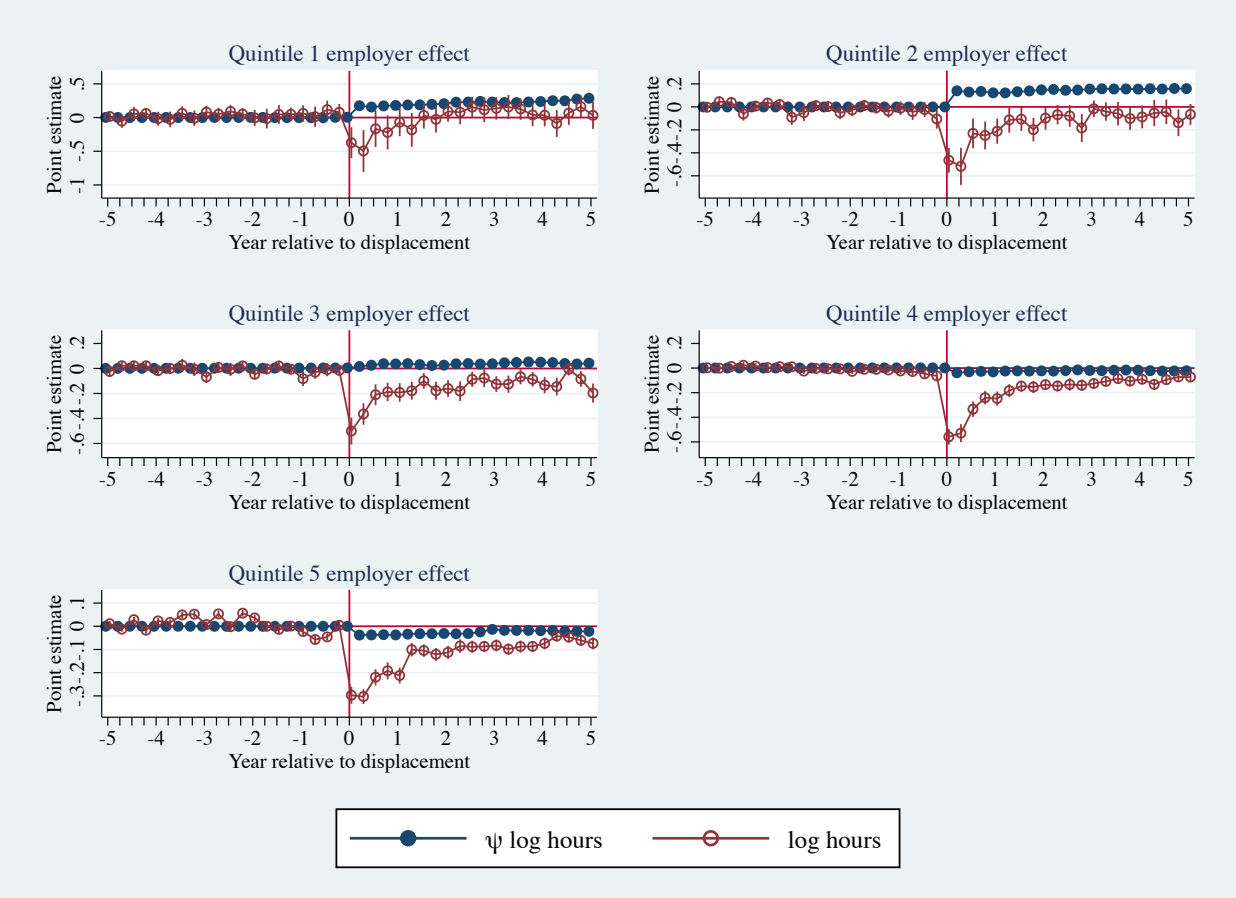
hours and wage rates. But for workers displaced from third- and fourth-quintile employers, fixed effects are immaterial, and for workers displaced from first- and second-quintile employers, fixed effects tend to increase both hours and wage rates after displacement. Again, the pattern is consistent with mean reversion and runs counter to the idea that displaced workers fall back to the bottom of a job ladder. The losses of workers displaced from employers below the top quintile are entirely the result of lost employer-employee matches or factors that vary over time with the employer, such as specific human capital. Even for workers displaced from top-quintile employers, employer effects provide only a partial explanation of lost earnings and wage rates.

Appendix Figure A13
Estimated changes in log earnings due to employer fixed effects, by quintile of pre-displacement employer fixed effect for log earnings



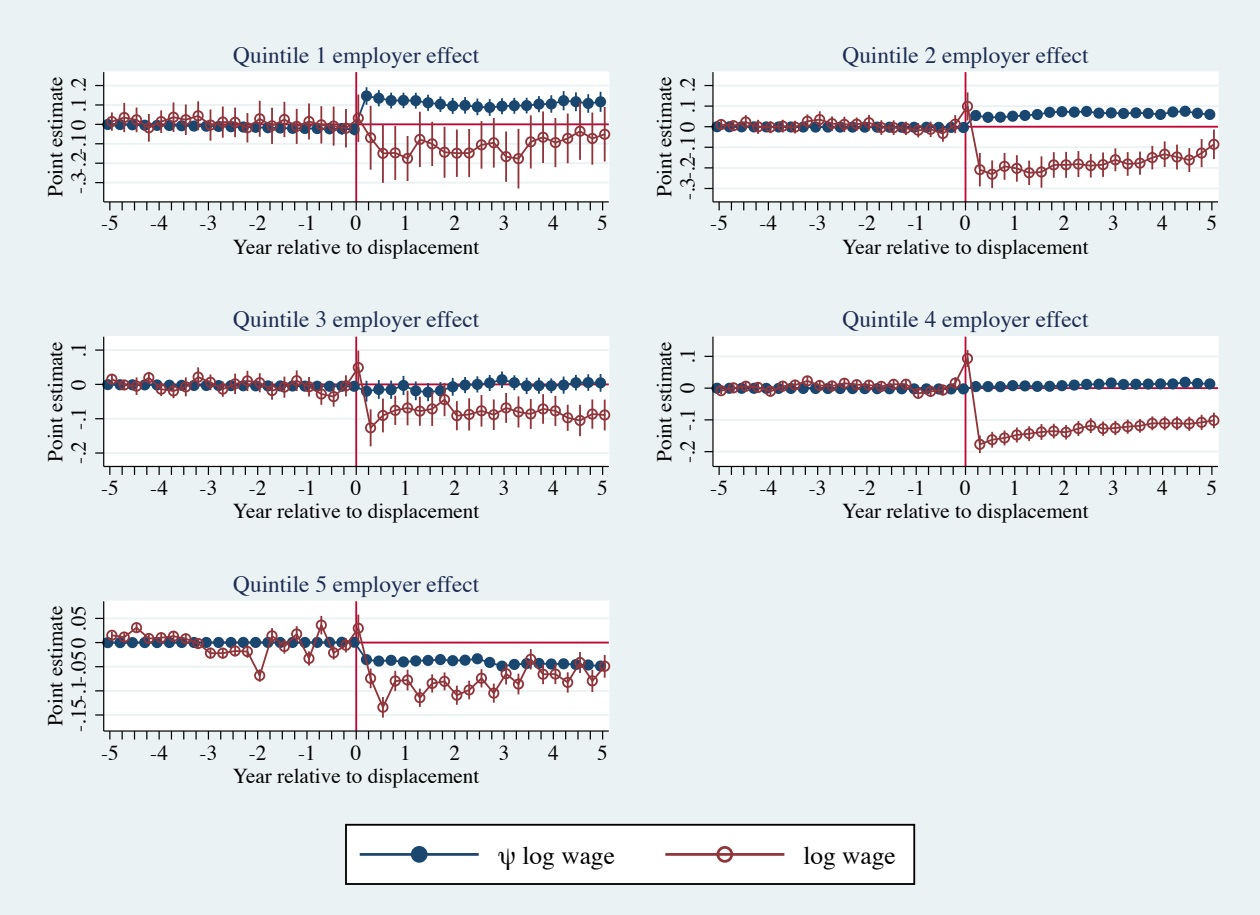
Notes: The figures show estimated full earnings changes due to displacement (open circles, estimated from equation (1)) and the changes attributable to employer fixed effects (solid dots, estimated from equation (3)), for workers displaced from employers grouped by quintile of their employer fixed effect for earnings. (The figure for "Quintile 5 employer effect" is repeated from Figure 6 in the main text.) Whiskers denote 95-percent confidence intervals based on standard errors clustered by worker. The vertical lines denote the quarter of displacement.
Source: Authors' calculations using Washington administrative wage and claims records. See sections 3.2 and 5.2 of the text for details.

Appendix Figure A14
Estimated changes in log work hours due to employer fixed effects, by quintile of pre-displacement employer fixed effect for log earnings



Notes: The figures show estimated full work hour changes due to displacement (open circles, estimated from equation (1)) and the changes attributable to employer fixed effects (solid dots, estimated from equation (3)), for workers displaced from employers grouped by quintile of their employer fixed effect for earnings. (The figure for "Quintile 5 employer effect" is repeated from Figure 6 in the main text.) Whiskers denote 95-percent confidence intervals based on standard errors clustered by worker. The vertical lines denote the quarter of displacement.
Source: Authors' calculations using Washington administrative wage and claims records. See sections 3.2 and 5.2 of the text for details.

Appendix Figure A15
Estimated changes in log hourly wage rates due to employer fixed effects, by quintile of pre-displacement employer fixed effect for log earnings



Notes: The figures show estimated full hourly wage rate changes due to displacement (open circles, estimated from equation (1)) and the changes attributable to employer fixed effects (solid dots, estimated from equation (3)), for workers displaced from employers grouped by quintile of their employer fixed effect for earnings. (The figure for "Quintile 5 employer effect" is repeated from Figure 6 in the main text.) Whiskers denote 95-percent confidence intervals based on standard errors clustered by worker. The vertical lines denote the quarter of displacement.
Source: Authors' calculations using Washington administrative wage and claims records. See sections 3.2 and 5.2 of the text for details.

A.8 Tables supporting Figures 2, 3, and 8

Appendix Table A2 displays the estimates underlying Figure 2 in the main text. Column 1 corresponds to the upper panel of Figure 2 (earnings from the primary employer), and column 3 corresponds to the lower panel (log earnings from the primary employer). Columns 2 and 4 show estimates based on earnings from all employers, which are similar.

Appendix Table A3 displays the estimates underlying Figure 3 in the main text. Column 1 corresponds to the upper panel of Figure 3 (hours with the primary employer), and column 3 corresponds to the lower panel (log hours with the primary employer). Columns 2 and 4 show estimates based on hours from all employers, which are again similar to those based only on earnings from the primary employer.

Appendix Table A4 displays the estimates underlying Figure 5 in the main text. For each post-displacement quarter, the estimates in the odd-numbered columns give the total log-point losses of earnings (column 1), hours (column 3), and hourly wages (column 5) attributable to displacement, and the even-numbered columns give the log-point changes in earnings (column 2), hours (column 4), and hourly wages (column 6) attributable to the effect of displacement on moving to an employer with a different fixed effect for earnings, hours, or hourly wages.

Appendix Table A2
Estimated effects of displacement on unconditional earnings and log earnings (from primary employer and all employers)

	(1)	(2)	(3)	(4)
	Earnings (in $1,000s)		Log earnings	
Quarter relative to displacement	From primary employer only	From all employers	From primary employer only	From all employers
–20	0.21***	0.21***	0.01***	0.01***
	(0.06)	(0.06)	(0.00)	(0.00)
–19	0.14**	0.14**	0.00	0.00
	(0.06)	(0.06)	(0.00)	(0.00)
–18	0.72***	0.73***	0.05***	0.05***
	(0.07)	(0.07)	(0.00)	(0.00)
–17	0.25***	0.25***	0.01**	0.01**
	(0.07)	(0.07)	(0.00)	(0.00)
–16	0.31***	0.31***	0.02***	0.02***
	(0.07)	(0.07)	(0.00)	(0.00)
–15	0.52***	0.53***	0.02***	0.02***
	(0.08)	(0.09)	(0.01)	(0.01)
–14	0.68***	0.68***	0.04***	0.04***
	(0.08)	(0.08)	(0.00)	(0.00)
–13	0.61***	0.61***	0.03***	0.03***
	(0.08)	(0.08)	(0.01)	(0.01)
–12	–0.16**	–0.16**	–0.02***	–0.02***
	(0.08)	(0.08)	(0.01)	(0.01)
–11	0.46***	0.47***	0.02***	0.02***
	(0.09)	(0.09)	(0.01)	(0.01)
–10	–0.01	0.01	–0.01	–0.01
	(0.08)	(0.08)	(0.01)	(0.01)
–9	0.48***	0.49***	0.03***	0.03***
	(0.08)	(0.09)	(0.01)	(0.01)
–8	–0.35***	–0.34***	–0.03***	–0.03***
	(0.08)	(0.08)	(0.01)	(0.01)
–7	0.36***	0.38***	0.01	0.01
	(0.09)	(0.09)	(0.01)	(0.01)
–6	–0.13	–0.11	–0.01**	–0.01**
	(0.09)	(0.09)	(0.01)	(0.01)
–5	0.12	0.14	0.01	0.01*
	(0.09)	(0.09)	(0.01)	(0.01)
–4	–0.77***	–0.75***	–0.06***	–0.05***
	(0.09)	(0.09)	(0.01)	(0.01)
–3	–0.17*	–0.14	–0.03***	–0.03***
	(0.10)	(0.10)	(0.01)	(0.01)
–2	–0.51***	–0.49***	–0.06***	–0.05***
	(0.10)	(0.10)	(0.01)	(0.01)
–1	–0.01	0.03	–0.02***	–0.01*
	(0.11)	(0.11)	(0.01)	(0.01)
0	–1.91***	–0.94***	–0.36***	–0.27***
	(0.17)	(0.18)	(0.02)	(0.02)

1	–5.96***	–5.16***	–0.49***	–0.39***
	(0.16)	(0.17)	(0.02)	(0.02)
2	–4.44***	–4.22***	–0.39***	–0.36***
	(0.15)	(0.15)	(0.02)	(0.02)
3	–3.42***	–3.23***	–0.31***	–0.28***
	(0.14)	(0.14)	(0.01)	(0.01)
4	–3.22***	–3.04***	–0.32***	–0.30***
	(0.15)	(0.15)	(0.02)	(0.01)
5	–2.82***	–2.65***	–0.26***	–0.23***
	(0.14)	(0.14)	(0.01)	(0.01)
6	–2.48***	–2.34***	–0.23***	–0.21***
	(0.14)	(0.14)	(0.01)	(0.01)
7	–2.49***	–2.37***	–0.24***	–0.22***
	(0.13)	(0.13)	(0.01)	(0.01)
8	–2.53***	–2.40***	–0.23***	–0.21***
	(0.13)	(0.13)	(0.01)	(0.01)
9	–2.06***	–1.90***	–0.22***	–0.20***
	(0.14)	(0.14)	(0.01)	(0.01)
10	–2.08***	–1.94***	–0.19***	–0.16***
	(0.14)	(0.14)	(0.01)	(0.01)
11	–2.46***	–2.07***	–0.22***	–0.18***
	(0.13)	(0.13)	(0.01)	(0.01)
12	–2.03***	–1.92***	–0.18***	–0.17***
	(0.13)	(0.13)	(0.01)	(0.01)
13	–2.09***	–1.89***	–0.19***	–0.17***
	(0.14)	(0.14)	(0.01)	(0.01)
14	–1.73***	–1.54***	–0.15***	–0.13***
	(0.13)	(0.14)	(0.01)	(0.01)
15	–2.12***	–1.93***	–0.18***	–0.16***
	(0.13)	(0.14)	(0.01)	(0.01)
16	–2.00***	–1.86***	–0.17***	–0.15***
	(0.14)	(0.14)	(0.01)	(0.01)
17	–2.00***	–1.81***	–0.17***	–0.15***
	(0.14)	(0.14)	(0.01)	(0.01)
18	–1.71***	–1.56***	–0.13***	–0.11***
	(0.14)	(0.14)	(0.01)	(0.01)
19	–2.12***	–1.99***	–0.16***	–0.14***
	(0.14)	(0.14)	(0.01)	(0.01)
20	–1.94***	–1.81***	–0.15***	–0.14***
	(0.14)	(0.14)	(0.01)	(0.01)
Number of worker-quarter observations	826,219	826,219	822,933	822,933
Number of workers	16,322	16,322	16,322	16,322
R^2	0.091	0.087	0.083	0.078

Notes: Columns (1) and (3) show the coefficients (and standard errors clustered by worker) underlying Figure 2 in the main text. These are estimated δ_ks from equation (1) with the log of earnings from the primary employer as the dependent variable. Each regression controls for a worker-specific fixed effect; a vector of quarterly dummies; worker's age and age squared; a vector of gender, race, and education dummies interacted with the worker's age; logarithm of pre-displacement employer size and one-digit NAICS code in 2007:Q4 interacted with a vector of

yearly dummies; a simple average of pre-displacement earnings with the primary employer and an average of pre-displacement hours with the primary employer, each interacted with a vector of yearly dummies. Earnings are expressed in 2010-constant dollars.
Source: Authors' calculations using Washington administrative wage and claims records. See sections 3.1, 4.1, and 4.2 of the text for details.
*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Appendix Table A3
Estimated effects of displacement on unconditional hours and log hours (from primary employer and all employers)

	(1)	(2)	(3)	(4)
	Work hours		Log work hours	
Quarter relative to displacement	From primary employer only	From all employers	From primary employer only	From all employers
–20	5.77***	5.55***	0.01	0.01
	(1.59)	(1.68)	(0.00)	(0.00)
–19	–3.81**	–3.75**	–0.01	–0.01
	(1.60)	(1.67)	(0.00)	(0.00)
–18	15.86***	16.63***	0.03***	0.03***
	(1.83)	(1.91)	(0.01)	(0.01)
–17	–0.06	0.47	0.00	0.00
	(1.89)	(1.97)	(0.01)	(0.01)
–16	8.09***	8.65***	0.02***	0.02***
	(1.97)	(2.07)	(0.01)	(0.01)
–15	9.02***	10.13***	0.02***	0.02***
	(1.87)	(1.96)	(0.01)	(0.01)
–14	21.55***	23.08***	0.04***	0.05***
	(1.99)	(2.10)	(0.01)	(0.01)
–13	21.62***	22.39***	0.04***	0.04***
	(2.09)	(2.18)	(0.01)	(0.01)
–12	–1.19	–0.07	–0.01	–0.01
	(2.02)	(2.12)	(0.01)	(0.01)
–11	22.23***	23.74***	0.04***	0.04***
	(2.15)	(2.27)	(0.01)	(0.01)
–10	1.78	2.89	0.00	0.00
	(2.09)	(2.23)	(0.01)	(0.01)
–9	21.68***	23.94***	0.04***	0.04***
	(2.21)	(2.35)	(0.01)	(0.01)
–8	7.81***	10.65***	0.01	0.01**
	(2.19)	(2.35)	(0.01)	(0.01)
–7	6.85***	8.37***	–0.00	–0.00
	(2.28)	(2.41)	(0.01)	(0.01)
–6	–1.14	0.57	–0.01	–0.01
	(2.21)	(2.34)	(0.01)	(0.01)
–5	5.55**	6.39***	0.00	0.00
	(2.30)	(2.42)	(0.01)	(0.01)
–4	–8.60***	–7.18***	–0.03***	–0.03***
	(2.32)	(2.47)	(0.01)	(0.01)
–3	–8.83***	–6.65**	–0.04***	–0.04***
	(2.47)	(2.62)	(0.01)	(0.01)
–2	–15.34***	–13.96***	–0.04***	–0.03***
	(2.28)	(2.41)	(0.01)	(0.01)
–1	–5.09*	–4.11	–0.01	–0.01*
	(2.65)	(2.77)	(0.01)	(0.01)
0	–136.26***	–98.41***	–0.40***	–0.30***
	(3.66)	(3.80)	(0.01)	(0.01)

1	–199.82***	–176.32***	–0.38***	–0.31***
	(4.14)	(4.48)	(0.01)	(0.01)
2	–123.86***	–115.82***	–0.25***	–0.22***
	(4.20)	(4.31)	(0.01)	(0.01)
3	–94.46***	–86.91***	–0.20***	–0.18***
	(4.04)	(4.16)	(0.01)	(0.01)
4	–95.53***	–89.43***	–0.22***	–0.20***
	(3.93)	(4.04)	(0.01)	(0.01)
5	–63.99***	–57.80***	–0.13***	–0.11***
	(3.82)	(3.91)	(0.01)	(0.01)
6	–53.05***	–48.96***	–0.11***	–0.10***
	(3.57)	(3.65)	(0.01)	(0.01)
7	–50.01***	–45.27***	–0.13***	–0.11***
	(3.46)	(3.58)	(0.01)	(0.01)
8	–46.73***	–41.56***	–0.11***	–0.10***
	(3.43)	(3.53)	(0.01)	(0.01)
9	–40.38***	–35.17***	–0.11***	–0.09***
	(3.36)	(3.49)	(0.01)	(0.01)
10	–39.64***	–33.85***	–0.09***	–0.07***
	(3.29)	(3.39)	(0.01)	(0.01)
11	–41.38***	–27.34***	–0.09***	–0.06***
	(3.27)	(3.44)	(0.01)	(0.01)
12	–35.30***	–31.40***	–0.09***	–0.08***
	(3.34)	(3.46)	(0.01)	(0.01)
13	–40.42***	–32.50***	–0.09***	–0.07***
	(3.27)	(3.38)	(0.01)	(0.01)
14	–32.43***	–26.83***	–0.08***	–0.07***
	(3.35)	(3.43)	(0.01)	(0.01)
15	–36.85***	–30.65***	–0.08***	–0.07***
	(3.21)	(3.30)	(0.01)	(0.01)
16	–32.47***	–26.97***	–0.08***	–0.07***
	(3.27)	(3.35)	(0.01)	(0.01)
17	–31.41***	–23.75***	–0.08***	–0.06***
	(3.31)	(3.42)	(0.01)	(0.01)
18	–23.48***	–18.87***	–0.05***	–0.05***
	(3.30)	(3.40)	(0.01)	(0.01)
19	–30.53***	–25.04***	–0.06***	–0.05***
	(3.32)	(3.44)	(0.01)	(0.01)
20	–31.87***	–26.35***	–0.08***	–0.07***
	(3.41)	(3.48)	(0.01)	(0.01)
Number of worker-quarter observations	826,219	826,219	819,241	819,500
Number of workers	16,322	16,322	16,322	16,322
R^2	0.114	0.101	0.054	0.049

Notes: Columns (1) and (3) show the coefficients (and standard errors clustered by worker) underlying Figure 3 in the main text. These are estimated δ_ks from equation (1) with the log of hours from the primary employer as the dependent variable. Each regression controls for a worker-specific fixed effect; a vector of quarterly dummies; worker's age and age squared; a vector of gender, race, and education dummies interacted with the worker's age; logarithm of pre-displacement employer size and one-digit NAICS code in 2007:Q4 interacted with a vector of

yearly dummies; a simple average of pre-displacement earnings with the primary employer and an average of pre-displacement hours with the primary employer, each interacted with a vector of yearly dummies
Source: Authors' calculations using Washington administrative wage and claims records. See sections 3.1, 4.1, and 4.2 of the text for details.
*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Appendix Table A4
Estimated displacement effects on log earnings, log hours, log wage rates: full losses and losses due to employer fixed effects (ψ)

Quarter relative to displacement	(1) Log earnings	(2)	(3) Log hours	(4)	(5) Log hours wage rate	(6)
	full loss	ψ effect	full loss	ψ effect	full loss	ψ effect
0	–0.36***	0.00*	–0.40***	0.00***	0.06***	–0.00
	(0.02)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)
1	–0.49***	–0.03***	–0.38***	–0.01***	–0.11***	–0.02***
	(0.02)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)
2	–0.39***	–0.03***	–0.25***	–0.01***	–0.15***	–0.02***
	(0.02)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)
3	–0.31***	–0.03***	–0.20***	–0.01***	–0.12***	–0.02***
	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)
4	–0.32***	–0.03***	–0.22***	–0.01***	–0.11***	–0.02***
	(0.02)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)
5	–0.26***	–0.03***	–0.13***	–0.01***	–0.13***	–0.02***
	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)
6	–0.23***	–0.02***	–0.11***	–0.01**	–0.11***	–0.02***
	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)
7	–0.24***	–0.02***	–0.13***	–0.01***	–0.11***	–0.02***
	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)
8	–0.23***	–0.02***	–0.11***	–0.01**	–0.12***	–0.02***
	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)
9	–0.22***	–0.02***	–0.11***	–0.01**	–0.11***	–0.01***
	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)
10	–0.19***	–0.02***	–0.09***	–0.00	–0.09***	–0.01***
	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)
11	–0.22***	–0.01***	–0.09***	0.00	–0.12***	–0.02***
	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)
12	–0.18***	–0.01***	–0.09***	0.01**	–0.09***	–0.02***
	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)
13	–0.19***	–0.01***	–0.09***	0.01*	–0.10***	–0.02***
	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)
14	–0.15***	–0.01***	–0.08***	0.01**	–0.07***	–0.02***
	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)
15	–0.18***	–0.01**	–0.08***	0.01**	–0.09***	–0.02***
	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)
16	–0.17***	–0.01***	–0.08***	0.01**	–0.09***	–0.02***
	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)
17	–0.17***	–0.01***	–0.08***	0.01*	–0.09***	–0.02***
	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)
18	–0.13***	–0.02***	–0.05***	0.00	–0.07***	–0.02***
	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)
19	–0.16***	–0.02***	–0.06***	0.00	–0.09***	–0.02***
	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)
20	–0.15***	–0.02***	–0.08***	0.00	–0.07***	–0.02***
	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)

Number of worker-quarter observations	822,933	822,279	819,241	822,279	819,233	822,279
Number of workers	16,322	16,322	16,322	16,322	16,322	16,322
R^2	0.083	0.030	0.054	0.019	0.066	0.029

Notes: Columns (1), (3), and (5) show the coefficients (and standard errors clustered by worker) underlying in Figures 2, 3, and 4 in the main text. These are estimated δ_ks from equation (1) with the log of earnings, log of hours, and log of the wage rate from the primary employer as the dependent variables. Columns (2), (4), and (6) show the coefficients (and standard errors clustered by worker) underlying Figure 8. These are estimated δ_ks from equation (3) with employer fixed effects (ψ_{ijt}) for log of earnings, log of hours, and log of the wage rate from the primary employer [estimated by equation (2)] as the dependent variables.
Source: Authors' calculations using Washington administrative wage and claims records. See sections 3, 4, and 5.1 of the text for details.

Appendix B: Estimation of employer fixed effects for earnings, hours, and wage rates

This appendix describes estimation of the AKM employer fixed effects for earnings, hours, and hourly wages used in the main text. Raw data for the analysis come from quarterly administrative earnings records of Washington State. The records available to us provide information on the earnings and work hours of virtually all workers employed in Washington during 2002–2014,[6] as well as information on all UI-covered employers in the state.[7] A record appears for each employer-worker-quarter combination, so a worker has as many earnings records as he or she has employers in a given quarter. Each record includes a year-quarter indicator; the ID and NAICS industry code of the reporting employer; and the worker ID, earnings, and work hours of the worker with that employer in the specified quarter. The availability of both quarterly earnings and work hours allows us to calculate the hourly wage rate by quarter, and the availability of quarterly hours for each employer allows us to include both full-time and part-time jobs in the analysis.

B.1 Construction of the analysis sample

We use the raw administrative records to construct a linked employer-employee panel similar to a procedure developed by Sorkin (2018). First, for each quarter, we identify each worker's primary employer, defined as the employer from whom the worker earned the largest share of

[6] Exemptions from coverage are limited to the self-employed, including outside sales workers paid solely by commission and independent contractors meeting exemption tests specified in Washington's UI law (Revised Code of Washington, Title 50). Nonprofit religious organizations are also exempt.

[7] The employer is the entity from which the state collects UI payroll taxes and to which the state "charges" UI benefits (for the purpose of experience rating the UI payroll tax). Typically, the employer is the set of establishments operating in Washington under a single owner, so for a company operating entirely in Washington (with a single or multiple addresses) the employer is a firm, and for a company with one address in Washington, the employer is also an establishment.

his/her earnings in that quarter.[8] We then define an employment spell as a series of at least five consecutive quarters during which a worker has earnings from the same primary employer. For each of these spells, we drop the first quarter (to avoid making inferences about earnings and hours based on a partial quarter of employment) and the last two quarters (to avoid making inferences based on earnings and hours in the quarter before a job loss and the quarter of a job loss).

We next annualize the remaining quarterly data within each calendar year, conditional on the calendar year including at least two consecutive quarters of earnings from the same primary employer. Earnings are defined as annualized earnings in a given year with the primary employer, and similarly for hours and wage rates.

Appendix Figure B1 illustrates the process and gives some examples, described in the figure notes. Ultimately, the unit of observation is the worker-year, with a focus on the primary employer in a year.[9]

We impose several restrictions on the sample, dropping the following:

- workers with more than 9 employers in a year (this affects 1 percent of the sample)
- workers with annual earnings less than $2,850 (in 2005 dollars) and workers with calculated hourly wage rates ≤ $2.00/hour (in 2005 dollars) (Sorkin 2018; Card, Heining, and Kline 2013)
- workers who worked fewer than 400 hours in the year
- workers who worked more than 4,800 hours in the year

[8] In most cases, a worker has only one employer during the quarter, but multiple employers appear for about 27 percent of the worker-quarter observations.

[9] By removing the first quarter and the last two quarters of any worker-primary-employer spell and by including at least two consecutive quarters of earnings from the same primary employer in a calendar year, we lose about 27 percent of all worker-primary-employer spells. If we only remove the first quarter and the last two quarters of any worker-primary-employer spell (without requiring at least two consecutive quarters of earnings from the same primary employer in a calendar year), we lose about 23 percent of all worker-primary-employer spells.

- employers with fewer than 5 employees in the year (Song, Price, Guvenen, Bloom, and von Wachter 2015)
- all displaced workers and all non-displaced comparison workers (as defined in section 2.1 of the main text)

The last restriction is imposed because including displaced workers and the non-displaced comparison group in estimating the AKM model could create a mechanical relationship between the employer fixed effects and displaced workers' earnings, hours, and wage rate losses, potentially overstating the role of employer fixed effects.

The first column of Appendix Table B1 ("Full annualized panel") shows summary statistics for the annualized linked employer-employee panel—that is, after processing the quarterly records as illustrated in Appendix Figure B1 and imposing the sample restrictions described above.

The employer effects are identified only within the "connected set" of employers that are linked by worker transitions between those employers, so the AKM estimation is necessarily restricted to the largest connected set of employers. This consists of 64 percent of employers in the full annualized panel, 79 percent of workers in the panel, and 90 percent of worker-year observations in the panel.

The second column of Appendix Table B1 shows descriptive statistics for the largest connected set. Because identification of employer fixed effects comes from workers moving between primary employers, it is important to know how much mobility there is in the sample. The table shows that the largest connected set includes about 3.5 million unique workers, and about 42 percent of those workers changed primary employer at least once during 2002–2014.

B.2 Estimation and variance decompositions

We estimate the AKM model [equation (2) in the main text] using the linked employer-employee panel for each of the three outcomes: log earnings, log hours worked, and log wage rates. Appendix Table B2 displays the resulting variance decompositions. The variance of each outcome is decomposed into five components: one each for worker effects, employer effects, year effects, the covariance between worker and employer effects (sorting of workers and employers), and a residual. (To conserve space, we do not show the worker-year or employer-year covariances. Together, these two covariances explain about one percent of the variation in each outcome.) The numbers in italics below each variance-covariance term show the share of the total variance of each outcome attributable to that component.

Worker fixed effects explain a large share of the variation in all three outcomes: 52 percent of the variation in earnings, 45 percent of the variation in work hours, and 60 percent of the variation in hourly wage rates. This compares with worker fixed effects explaining 51 percent of the variation in earnings in Sorkin (2018) (see his Table 1, U.S., 2000–2008) and 51–61 percent of daily earnings in Card, Heining, and Kline (Table 3, Germany, 1985–2009).

Employer effects are also important: They explain about 20 percent of the variation in earnings, 35 percent of the variation in work hours, and 13 percent of the variation in hourly wage rates. This compares with employer fixed effects explaining about 14 percent of the variation in earnings in Sorkin (2018) and 18–21 percent in Card, Heining, and Kline (Table 3, Germany, 1985–2009).

The rightmost columns of Appendix Table B2 show adjusted-R^2s and RMSEs from a model in which each outcome variable is regressed on (i) an indicator for each employer-employee spell and (ii) year effects. Card, Heining, and Kline (2013, p. 990) suggest that the

explanatory power of this model, compared with the explanatory model of the AKM model, provides a test of the importance of idiosyncratic employer-employee matches. The adjusted-R^2 from the AKM model for earnings is 0.872, whereas the adjusted-R^2 from the employer-employee match effects model for earnings is about 0.925.[10] Although the fit is somewhat better for the match effects model, the roughly 5 percentage-point difference between the R^2s of the AKM and match-effects models suggests that the AKM model specification of earnings as the sum of worker and employer fixed effects is not greatly off the mark.

B.3 Event studies of inter-employer mobility

OLS estimation of the AKM model will be biased for the employer effects (ψ) if worker mobility among employers is endogenous, or correlated with time-varying components of the residual in equation (2). This problem would arise, for example, if workers moved to take advantage good specific employer-employee matches, or if workers developed specific human capital within a job over time.[11] To examine the importance of endogenous mobility, Card, Heining, and Kline (2013) developed an event study analysis of the movement of earnings when workers move among employers. If the AKM model is a correct description of earnings determination, then workers who move from low-ψ to high-ψ employers should on average see their pay rise, and conversely. Further, workers who move from low-ψ to high-ψ employers should receive (on average) pay increases equal and opposite those of workers who move from high-ψ to low-ψ employers. In contrast, the presence of specific employer-employee match effects would lead to

[10]These estimates are similar to those in Sorkin (2018), who obtains an adjusted-R^2 of 0.86 for the AKM model of earnings, and an adjusted-R^2 of 0.92 for the match effects model of earnings.

[11] Card, Heining, and Kline (2013) and Card, Cardoso, Heining, and Kline (2018) provide clear discussions of the assumptions needed for unbiased estimation of employer fixed effects in the AKM model, with several examples of situations that do and do not violate those assumptions.

average pay increases for workers moving in any direction, as they take advantage of opportunities for favorable specific matches.

Following Card, Heining, and Kline (2013), we conduct event study analyses of how earnings, work hours, and wage rates change when workers move between employers of different types in the Washington linked employer-employee panel. For example, we can follow a group of workers who start with an employer whose fixed effect (ψ) is in the fourth quartile, and who then move to other employers. Some of these "destination" employers will have a high ψ, others will have a low ψ, and observing how workers' earnings, hours, and wage rates change with these moves provides information about employers' influence on earnings, hours, and wage rates.

The procedure for constructing these event studies is as follows. For each outcome (earnings, hours, or wage rates) we classify employers into quartiles by their AKM-estimated employer effect (ψ). Next, for a given year t, we select workers in each ψ quartile who have been with the employer at least two years, change employers (i.e., are observed with a different primary employer in year t+1), and remain with the subsequent employer for at least two years. Finally, we calculate the average outcome before and after the move for each possible type of interquartile move (1→1, 1→2, ..., 4→3, and 4→4).

Appendix Figure B2 shows the results for eight of interquartile transitions (4→4, 4→3, 4→3, 4→1 1→4, 1→3, 1→2, and 1→1) for log earnings. Appendix Figures B3 and B4 show same transitions for log work hours and log wage rates. Appendix Table B3 displays the data underlying these figures.

We note two main points about Appendix Figure B2. First, workers who move from lower-ψ to higher-ψ employers tend to improve their earnings, and conversely. For example,

workers who start with a low-ψ (quartile 1) employer and move to a high-ψ (quartile 4) employer experience a 70 log point increase in their earnings. (This 1→4 change falls to 60 log points when adjusted by the 1→1 within-quartile change, which is 10 log points—see the "Adjusted change from year –2 to year 1" column in Appendix Table B3.) Conversely, workers who start with a high-ψ (quartile 4) employer and move to a low-ψ (quartile 1) employer experience a 54 log point decrease in their earnings (63 log points if adjusted by the 4→4 within-quartile change, which is 9 log points). Consistent with the AKM model, the pay of workers who move from low-ψ to high-ψ employers increases on average, and conversely. Appendix Figures B3 and B4 show similar patterns.

Second, the approximate symmetry of gains and losses suggests that idiosyncratic match effects are not of great importance (Card, Heining, and Kline 2013, p. 990). If employer-employee match effects were important, we would observe average pay increases for workers moving in any direction, but this is not the case. The symmetry of earnings changes for workers moving from low-ψ to high-ψ employers and those moving from high-ψ to low-ψ employers is consistent with the specification of the AKM model, with its additive worker and employer effects. For the Washington labor market overall, the AKM model appears to be a reasonable fit.

Appendix Table B1
Summary statistics for the overall sample and the largest connected set (AKM dataset)

	Full annualized panel	Largest connected set
Number of worker/year observations	25,578,007	22,941,274
Number of workers	4,450,785	3,508,811
Number of employers	341,553	218,593
Number of movers	1,546,094	1,463,030
Log earnings (mean)	10.321	10.432
Log hours (mean)	7.338	7.453
Log hourly wage rate (mean)	3.063	3.052

Source: Authors' tabulations of Washington administrative wage records, 2002–2014. See Appendix section B.1.

Appendix Table B2
Variance decompositions of log earnings, log hours, and log hourly wage rates, Washington, 2002–2014
(variance shares accounted for by each component in italics)

	Variance of outcome and decomposition into components						AKM model fit		Match effects model fit	
Outcome	Total variance	Worker FEs (α)	Employer FEs (ψ)	Year FEs (θ)	2cov(α,ψ)	Residual	Adj. R^2	RMSE	Adj. R^2	RMSE
Log earnings	0.596	0.309	0.123	0.004	0.101	0.064	0.872	0.253	0.925	0.211
		0.519	*0.207*	*0.006*	*0.169*	*0.107*				
Log hours	0.129	0.058	0.045	0.000	–0.013	0.039	0.638	0.197	0.754	0.178
		0.449	*0.352*	*0.001*	*–0.104*	*0.303*				
Log hourly wage rate	0.411	0.247	0.053	0.022	0.065	0.040	0.885	0.199	0.932	0.167
		0.601	*0.128*	*0.054*	*0.159*	*0.096*				

Source: Authors' tabulations of Washington administrative wage records, 2002–2014.
Notes: The decompositions include covariances between worker and employer fixed effects and year fixed effects. Because these covariances explain only about 1 percent of the variation, they are omitted from the table. The match effects model is estimated by regressing each outcome variable on worker-employer indicators and year indicators. See Appendix section B.2.

Appendix Table B3
Mean outcomes, classified by quartile of employer fixed effect

Panel A: Mean log earnings of movers, classified by quartile of employer earnings fixed effect at origin (year = –1) and destination (year = 0) employer

Origin/destination quartile	Year –2	Year –1	Year 0	Year 1	Change from year –2 to year 1	Adjusted change from year –2 to year 1[a]	Number of observations
1 to 1	9.79	9.79	9.88	9.89	0.10	0.00	247,950
1 to 2	9.83	9.83	10.12	10.14	0.31	0.21	120,636
1 to 3	9.80	9.81	10.27	10.30	0.50	0.40	74,936
1 to 4	9.88	9.89	10.54	10.58	0.70	0.60	38,488
2 to 1	10.16	10.13	10.03	10.03	–0.12	–0.18	80,566
2 to 2	10.29	10.28	10.35	10.35	0.06	0.00	173,078
2 to 3	10.36	10.35	10.54	10.55	0.19	0.13	116,916
2 to 4	10.39	10.39	10.75	10.78	0.38	0.33	57,176
3 to 1	10.36	10.32	10.02	10.02	–0.34	–0.40	29,168
3 to 2	10.52	10.50	10.46	10.46	–0.07	–0.12	84,368
3 to 3	10.65	10.64	10.70	10.71	0.06	0.00	234,702
3 to 4	10.73	10.73	10.92	10.94	0.21	0.15	122,092
4 to 1	10.72	10.70	10.18	10.18	–0.54	–0.63	13,102
4 to 2	10.77	10.74	10.51	10.51	–0.25	–0.34	27,982
4 to 3	10.87	10.86	10.81	10.81	–0.06	–0.15	84,974
4 to 4	11.15	11.15	11.21	11.24	0.09	0.00	313,108
							1,819,242

Panel B: Mean log hours of movers, classified by quartile of employer hours fixed effect at origin (year = –1) and destination (year = 0) employer

Origin/destination quartile	Year –2	Year –1	Year 0	Year 1	Change from year –2 to year 1	Adjusted change from year –2 to year 1[a]	Number of observations
1 to 1	7.24	7.22	7.27	7.26	0.02	0.00	221,266
1 to 2	7.27	7.24	7.49	7.47	0.20	0.18	124,596
1 to 3	7.22	7.18	7.56	7.55	0.33	0.32	69,170
1 to 4	7.21	7.17	7.65	7.64	0.43	0.42	55,296
2 to 1	7.45	7.41	7.29	7.28	–0.18	–0.17	78,030
2 to 2	7.51	7.48	7.52	7.50	–0.01	0.00	169,094
2 to 3	7.50	7.47	7.58	7.57	0.07	0.08	142,100
2 to 4	7.49	7.46	7.66	7.65	0.16	0.16	83,628
3 to 1	7.54	7.50	7.25	7.23	–0.31	–0.31	32,736
3 to 2	7.57	7.54	7.51	7.49	–0.09	–0.08	90,480
3 to 3	7.58	7.55	7.58	7.57	–0.01	0.00	189,088
3 to 4	7.59	7.57	7.66	7.65	0.05	0.06	144,280
4 to 1	7.65	7.61	7.21	7.20	–0.45	–0.44	21,302
4 to 2	7.66	7.63	7.50	7.48	–0.18	–0.17	47,296
4 to 3	7.65	7.63	7.60	7.58	-0.07	–0.07	115,634
4 to 4	7.67	7.66	7.68	7.67	0.00	0.00	235,246
							1,819,242

Note: a. The adjusted change is the change from year –2 to year 1, minus the within-quartile change from year –2 to year 1.

Panel C: Mean log hourly wage rate of movers, classified by quartile of AKM employer wage effects at origin (year = –1) and destination (year = 0) employer

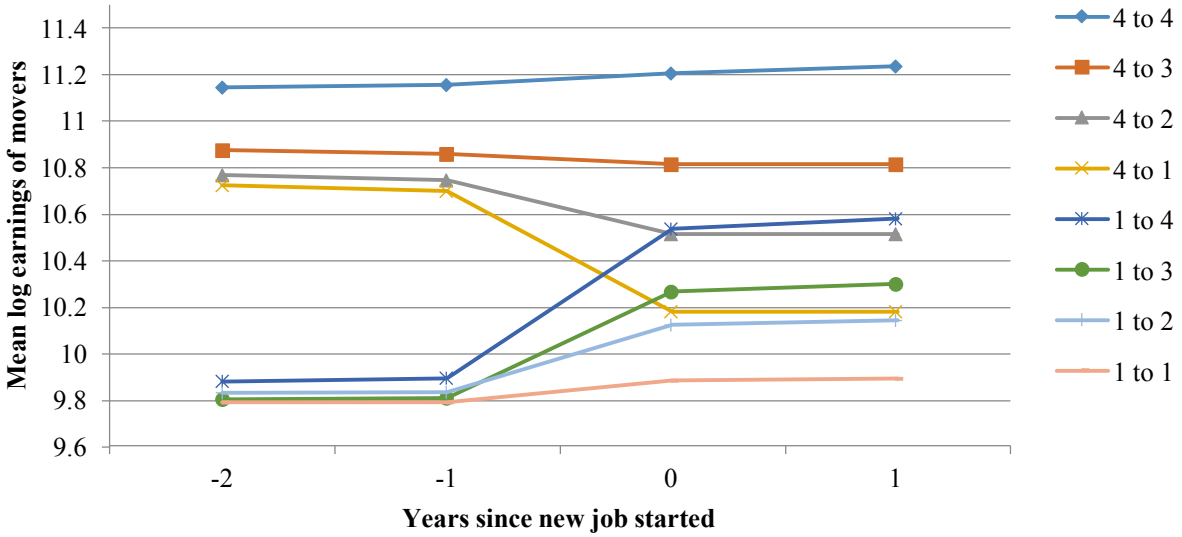
Origin/destination quartile	Year –2	Year –1	Year 0	Year 1	Change from year –2 to year 1	Adjusted change from year –2 to year 1[a]	Number of observations
1 to 1	2.46	2.49	2.53	2.57	0.12	0.00	225,660
1 to 2	2.54	2.59	2.75	2.80	0.26	0.15	121,060
1 to 3	2.57	2.64	2.90	2.96	0.39	0.27	82,656
1 to 4	2.65	2.71	3.17	3.23	0.59	0.47	45,184
2 to 1	2.72	2.76	2.69	2.73	0.01	–0.12	97,952
2 to 2	2.86	2.90	2.95	2.99	0.13	0.00	164,396
2 to 3	2.91	2.96	3.09	3.14	0.23	0.10	127,162
2 to 4	2.93	2.98	3.27	3.33	0.40	0.27	61,112
3 to 1	2.91	2.94	2.75	2.79	–0.13	–0.27	44,052
3 to 2	3.03	3.07	3.04	3.07	0.04	–0.10	100,114
3 to 3	3.12	3.17	3.22	3.27	0.14	0.00	195,376
3 to 4	3.22	3.27	3.45	3.50	0.29	0.14	121,480
4 to 1	3.17	3.21	2.78	2.82	–0.35	–0.51	17,238
4 to 2	3.29	3.33	3.12	3.16	–0.14	–0.30	40,524
4 to 3	3.37	3.41	3.33	3.37	0.00	–0.16	95,154
4 to 4	3.59	3.64	3.68	3.75	0.16	0.00	280,122
							1,819,242

Note: a. The adjusted change is the change from year –2 to year 1, minus the within-quartile change from year –2 to year 1.

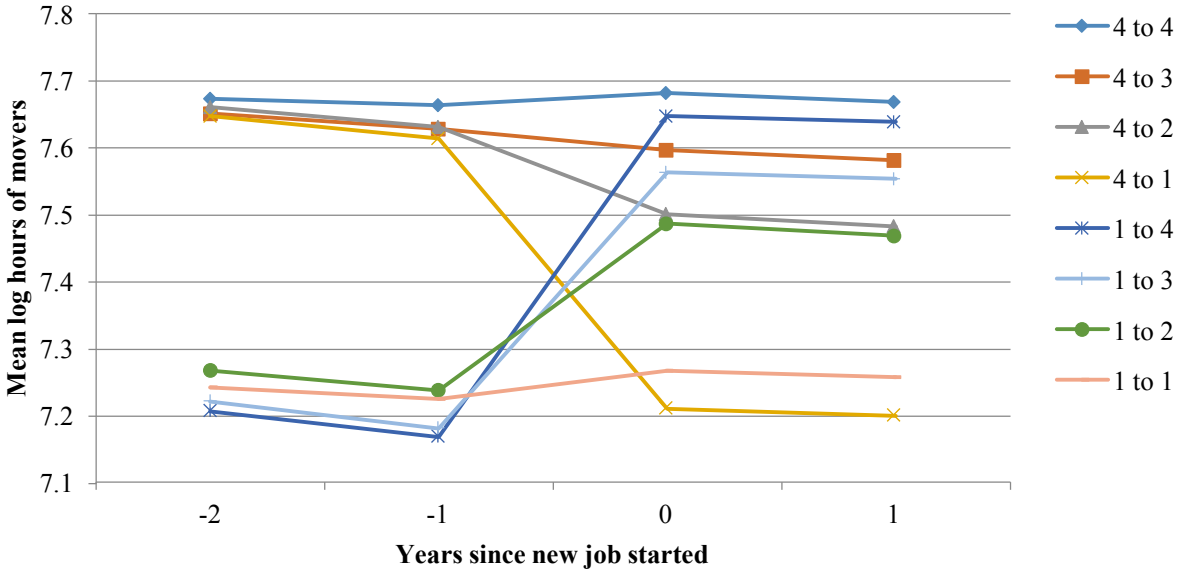
Appendix Figure B1
Construction of the analysis sample for the AKM dataset

Notes: The figure shows three hypothetical employment spells with three different employers (Er1, Er2, and Er3), each of which has the minimum five quarters required to be included in the analysis sample. The first quarter and last two quarters of each employment spell (denoted by ×) are dropped from the analysis, and outcomes from the remaining quarters are then annualized for each calendar year, conditional on the calendar year including at least two consecutive quarters of earnings from the same primary employer. For example, outcomes for 2005 (Employment spell 1) and 2008 (Employment spell 3) are obtained by averaging the outcomes for the first, second, and third quarters of 2005 (or 2008) and multiplying by four. (The quarters used in the calculations are denoted by ☑.) Outcomes for 2006 (Employment spell 2) are obtained by averaging the outcomes for the third and fourth quarters of 2006 and multiplying by four. Outcomes for 2007 (part of Employment spell 2) are excluded because 2007 does not include two consecutive quarters that can be used under the selection criteria (that is, after excluding the first quarter and last two quarters of each employment spell). As a result, the data from 2007:I (denoted by ☒) are not used.

Appendix Figure B2
Mean log earnings of movers, classified by quartile of AKM employer earnings effects (ψ) at origin (year = –1) and destination (year = 0) employer



Appendix Figure B3
Mean log hours of movers, classified by quartile of AKM employer hours effects (ψ) at origin (year = –1) and destination (year = 0) employer



Appendix Figure B4
Mean log hourly wage rates of movers, classified by quartile of AKM employer wage rate effects (ψ) at origin (year = –1) and destination (year = 0) employer