Longitudinal Employer - Household Dynamics

Technical paper No. TP-2002-18

Displaced workers, early leavers, and re-employment wages

Date	:	November 2002
Prepared by	:	Audra Bowlus and Lars Vilhuber
Contact	:	Ronald Prevost (Ronald.C.Prevost@census.gov)
		U.S. Census Bureau, LEHD Program
		FB 2138-3
		4700 Silver Hill Rd.
		Suitland, MD 20233 USA

This document reports the results of research and analysis undertaken by the U.S. Census Bureau staff. It has undergone a Census Bureau review more limited in scope than that given to official Census Bureau publications, and is released to inform interested parties of ongoing research and to encourage discussion of work in progress.

This research is a part of the U.S. Census Bureau's Longitudinal Employer-Household Dynamics Program (LEHD), which is partially supported by the National Science Foundation Grant SES-9978093 to Cornell University (Cornell Institute for Social and Economic Research), the National Institute on Aging, and the Alfred P. Sloan Foundation. The views expressed herein are attributable only to the author(s) and do not represent the views of the U.S. Census Bureau, its program sponsors or data providers. Some or all of the data used in this paper are confidential data from the LEHD Program. The U.S. Census Bureau is preparing to support external researchers' use of these data; please contact Ronald Prevost (Ronald.C.Prevost@census.gov), U.S. Census Bureau, LEHD Program, FB 2138-3, 4700 Silver Hill Rd., Suitland, MD 20233, USA.

Displaced workers, early leavers, and re-employment wages

Preliminary

Do not cite without the authors' permission

Audra Bowlus and Lars Vilhuber*

This version: November 13, 2002

*Audra Bowlus: University of Western Ontario, London, Canada (abowlus@uwo.ca). Lars Vilhuber: CISER, Cornell University, Ithaca, NY, and U.S. Census Bureau, LEHD Program, Washington D.C, USA (lars.vilhuber@cornell.edu). The authors wish to acknowledge the substantial contributions of John Abowd, Fredrik Andersson, Karen Conneely, Paul Lengermann, Kevin McKinney, John Messier, Ron Prevost, Kristin Sandusky, Bryce Stephens, and Martha Stinson, and wish to thank John Haltiwanger and Julia Lane for their comments. This research is a part of the U.S. Census Bureau's Longitudinal Employer-Household Dynamics Program (LEHD), which is partially supported by the National Science Foundation Grant SES-9978093 to Cornell University (Cornell Institute for Social and Economic Research), the National Institute on Aging, and the Alfred P. Sloan Foundation. Bowlus wishes to thank the CIBC for support. Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of the employing or funding agencies. Confidential data from the LEHD Program were used in this paper. The U.S. Census Bureau is preparing to support external researchers' use of these data; please contact Ronald Prevost (Ronald.C.Prevost@census.gov), U.S. Census Bureau, LEHD Project, FB 2138-3, 4700 Silver Hill Rd., Suitland, MD 20233, USA.

Contents

List of Tables

List of Figures

Abstract

In this paper, we lay out a search model that takes explicitly into account the information flow prior to a mass layoff. Using universal wage data files that allow us to identify individuals working with healthy and displacing firms both at the time of displacement as well as any other time period, we test the predictions of the model on re-employment wage differentials. Workers leaving a "distressed" firm have higher re-employment wages than workers who stay with the distressed firm until displacement. This result is robust to the inclusion of controls for worker quality and unobservable firm characteristics.

JEL CLASSIFICATION: J31 - Wage Level and Structure; J65 - Unemployment Insurance; Severance Pay; Plant Closings, J63 - Turnover; Vacancies; Layoffs

KEYWORDS: Displaced workers, search theory, advance notice, linked firm-worker data sets.

1 Introduction

Displaced workers have been the subject of an extensive literature. The basic stylized facts were established by Jacobson, LaLonde & Sullivan (1993): when compared to continuously employed workers, displaced workers suffer an earnings dip prior to displacement, and recovery from displacement is long and persistent, both in terms of work experience and earnings.[1] Other work has studied the effects of advance knowledge of displacement on the outcomes of displaced workers.[2] These studies point to the unemployment-lowering effect of advance notice (mostly through a reduction in the incidence of unemployment as opposed to shorter unemployment spells), but also to the apparent endogeneity of the provision of advance notice (Fallick 1994, Jones & Kuhn 1995, Ruhm 1992). Firms provide advance notice to workers likely to suffer from prolonged periods of unemployment. However, there is also evidence that this may be due to a correlation of advance notice and unobserved characteristics of the firm (Ruhm (1994) for US data, Jones & Kuhn (1995) using Canadian data).

Most of these studies suffer from a distinct data problem. Generally, these studies use the Displaced Worker Supplement (DWS) to the Current Population Survey (CPS) or similar surveys. All but the 1984 and 1986 DWS have no information on whether workers left before the layoff date specified in the advance notice received, and thus one cannot identify and follow early leavers. Furthermore, since the CPS is a cross-sectional survey, it is not possible to follow workers or their firms for prolonged periods of time. For instance, it is not possible to compare displaced workers to continuously employed workers at the *same* firm in other time periods,and to the best of our knowledge, only Abowd & Finer (1997) have contrasted displaced workers and early leavers at the same firm. Even when it is possible to follow workers over longer periods of time (Storer & Van Audenrode 1998, using Canadian panel data) or to observe multiple workers within the same firm (Jones & Kuhn 1995, using Ontario data), the studies involved typically could not distinguish early leavers from workers present at displacement, or chose not to focus on these workers.

The work on advance notice to displaced workers relies implicitly on search models. In fact, the rationale behind mandatory notice laws in Canada and the US is to give workers a chance to search while on the job, rather than being surprised by displacement and searching from the disadvantaged position of unemployment. However, no formal structural model of search that incorporates features of displacement, including the possibility of leaving the displacing firm prior to a mass layoff, has been proposed and estimated in the literature, potentially missing many behavioral patterns and linkages that one should be looking for around displacement.

[1] See Fallick (1996) and Kletzer (1998) for overviews and Abe, Higuchi, Kuhn & Sweetman (forthcoming), Abbring, van den Berg, Gautier, Gijsbert, van Lomwel & Ruhm (forthcoming), and Farber (1999) for more recent analyses involving Canadian and US data

[2] Addison & Portugal (1987), Jones & Kuhn (1995), Ruhm (1992, 1994), Swaim & Podgursky (1990). See also Table 5 in Storer & Van Audenrode (1998).

In this paper, we set out to improve in both the theoretical and empirical dimension. The paper is organized as follows. In Section 2, we construct a partial equilibrium search-theoretic model that allows for the possibility of surprise announcements of future displacement. This announcement may be formal in the form of mandatory advance notice, or informal, through information diffusion (the *internal grapevine*) within the company, or even through announcement in the public media without any formal notification of workers. Several of the theoretical implications from this model are tested using a unique new American data set, described in Section 3. In particular, this data set allows us to compute in which period a mass layoff occurs, where the definition of a mass layoff is very flexible and does not require administrative reporting or survey-based sampling. Although lacking a worker report on the actual receipt of information, we do observe workers leaving (and entering) the firm prior to the displacement period. Lengermann & Vilhuber (2000), using the same data, report significant changes in the distribution of worker skills in the periods prior to displacement. Both based on that study and on the coverage of legislated advance notice, we infer that these movements are due to increased knowledge of impending layoffs. The data set also allows us to match workers to both pre- and post-displacement firms, and to follow their earnings path for prolonged periods of time. Section 4 outlines the estimation methods used and reports results. We find that the results correlated nicely with the implications from the search-theoretic model. Sensitivity analysis using variants on the basic model do not alter the primary result: Workers who separate shortly before a mass layoff do substantially better in the labor market than comparable displaced workers. Section 5 concludes with some notes and caveats.

2 A Search Model of Displacement

2.1 Model assumptions

A starting point for understanding the labor market transitions of workers in the firms in question is the following partial equilibrium model of search with notice or information of impending displacement. Workers search on the job as well as off the job, in line with most other search models (Mortensen 1986). When unemployed, they receive job offers at rate λ_0, when on the job at rate λ_1. Those that receive acceptable job offers leave current employment or unemployment for the new employer. When searching, workers take the wage offer distribution $F(w)$ as given. The value of non-market time while unemployed is b, and jobs are exogenously dissolved at rate δ_1. The interest rate is denoted by r.

In order to introduce some of the features of displacement into this model, the following assumptions are made. First, at rate η_1, employed workers receive information of an impending mass layoff. After receipt of this information, which might be

formal notice or informal information gathered by other means (the term "notice" is used without implying any formal notice), workers expect job destruction to occur at rate $\delta_2 > \delta_1$. Mass layoffs are modeled as being stochastic, so workers do not know the precise moment the mass layoff will occur. This is designed to resemble the large variation in actual notice received by workers across firms (Jones & Kuhn 1995). Layoffs (exits) can and do occur at firms that have not issued notice of a mass layoff.

Second, the fraction of firms in the notice state is given by γ, and it is assumed that these firms do not participate in the hiring process.[3] Although this is probably empirically true for plant closures, it is not quite true for mass layoffs in which the firm continues operations.[4] However, in this partial equilibrium model, this assumption only affects from where workers expect to receive wage offers. Since the proportion of firms in the notice state at any given point in time is small,[5] this assumption is a close approximation of the true distribution of wage offers, and facilitates the analysis.

Third, when a worker receives notice, there is no downgrading of the wage. Again, this might seem to contradict the empirical evidence of a dip in *earnings* prior to displacement,[6] but this finding is not universally upheld in the data.[7] The actual mechanism behind the dip in earnings is not yet fully understood. It may reflect changes in hours of work at a constant wage rate or selection on early leavers. In future work, this can be relaxed.

Fourth, the distressed state is an absorbing state. A firm, once it has given notice, never reverts to a non-distressed state. This is an assumption that would be relaxed in a general equilibrium model, either by specifying the entry of new firms, or a process describing reversion to a non-distressed state, in order to achieve an equilibrium with positive steady-state employment.

No further constraints are imposed on the model. In particular, the worker's reservation wage strategies for all four possible transitions (employment - unemployment, notice - unemployment, notice - employment, unemployment - employment) are in no way constrained.

---

[3] In this, our model differs from Burdett & Mortensen (1980). In their model, jobs are characterized by their permanent or temporary layoff probabilities *ex ante*. Here, all jobs have the same *ex ante* probability of becoming notice jobs, and only differ *ex post*.

[4] Lengermann & Vilhuber (2000) provide empirical evidence of increased hiring activities at firms prior to displacement events.

[5] In our data, in any given quarter, approximately 1.3 percent of firms have a displacement event, see Section 3.

[6] This was first established by Jacobson et al. (1993).

[7] See f.i. Schoeni & Dardia (1996) for an example using data similar to ours.

2.2 Value Functions for Employment and Unemployment

The value of employment in a non-notice firm with wage w is given by

$$\begin{aligned} rV_E(w) &= w + \lambda_1 (1-\gamma) \left[\max\{V_E(w'), V_E(w)\} - V_E(w)\right] \\ &\quad + \delta_1 \left(V_U - V_E(w)\right) + \eta_1 \left[\max\{V_U, V_E^n(w)\} - V_E(w)\right]. \end{aligned} \tag{1}$$

While employed the worker receives wage w. With probability $\lambda_1 (1-\gamma)$ the worker receives an outside wage offer w' from a non-notice firm which she can either accept or reject. With probability δ_1 she is laid off and with probability η_1 she receives notice of an impending mass layoff. Upon receipt of notice she has to decide whether to stay employed at the notice firm or go into unemployment.

The value of employment at a notice firm with wage w is given by

$$\begin{aligned} rV_E^n(w) &= w + \lambda_1 (1-\gamma) \left[\max\{V_E(w'), V_E^n(w)\} - V_E^n(w)\right] \\ &\quad + \delta_2 \left(V_U - V_E^n(w)\right). \end{aligned} \tag{2}$$

Here the worker receives outside offers from non-notice firms and must decide to accept or reject them. He now has a higher chance of ending up in unemployment ($\delta_2 > \delta_1$).

The value of unemployment, V_u, is given by

$$rV_U = b + \lambda_0 (1-\gamma) \left[\max\{V_E(w), V_U\} - V_U\right]. \tag{3}$$

While unemployed, workers have non-market time value b and receive wage offers with probability $\lambda_0 (1-\gamma)$, which they can either accept or reject.

2.3 Reservation Wage Strategies

Under the above setup workers have four state dependent reservation wage strategies.[8] While employed at a non-notice firm and receiving offers from other non-notice firms, it is well known that the current wage w is the reservation wage, *i.e.*, any wage offer above w is accepted. This is still the case in this model. However, the current wage is likely not the reservation wage for those employed at notice firms contemplating non-notice firm offers. Hence, label $r(w)$ the reservation wage function for those employed at notice firms at wage w such that $V_E(r(w)) = V_E^n(w)$. Label w^* the reservation wage of unemployed workers such that $V_E(w^*) = V_U$. Finally, label r^* the

[8] Transitions from the non-notice to the notice state of employment and transitions from unemployment into the notice state have been excluded. If notice firms were to hire, both of these transitions would have an associated reservation wage strategy.

reservation wage associated with the transition to unemployment when faced with notice such that $V_E^n(r^*) = V_U$.

Given these reservation wage strategies the above value functions can be rewritten as follows. From (1),

$$\begin{aligned} rV_E(w) &= w + \lambda_1(1-\gamma)\int_w^{\overline{w}} (V_E(w') - V_E(w))\, dF(w') + \delta_1 (V_U - V_E(w)) \\ &\quad +\eta_1 (V_U - V_E(w)) \end{aligned} \tag{4}$$

if $w \leq r^*$,

$$\begin{aligned} rV_E(w) &= w + \lambda_1(1-\gamma)\int_w^{\overline{w}} (V_E(w') - V_E(w))\, dF(w') + \delta_1 (V_U - V_E(w)) \\ &\quad +\eta_1 (V_E^n(w) - V_E(w)) \end{aligned} \tag{5}$$

if $w > r^*$. From (2),

$$\begin{aligned} rV_E^n(w) &= w + \lambda_1(1-\gamma)\int_{r(w)}^{\overline{w}} (V_E(w') - V_E^n(w))\, dF(w') \\ &\quad +\delta_2 (V_U - V_E^n(w)), \end{aligned} \tag{6}$$

(7)

and from (3),

$$rV_U = b + \lambda_0(1-\gamma)\int_{w^*}^{\overline{w}} (V_E(w) - V_U)\, dF(w). \tag{8}$$

where $\overline{w}$ is the highest wage offered.

To solve for w^* and r^* set $V_E(w^*) = V_U$ and $V_E^n(r^*) = V_U$, respectively, under the conjecture that $w^* \leq r^*$. This is the most reasonable conjecture since the expectation is that the non-notice jobs are more attractive than the notice jobs and therefore one is more picky about keeping a notice job, *i.e.*, $V_E(w) \geq V_E^n(w)$. Note that by the definition of $r(w)$, $r(r^*) = w^*$. Solving for w^* and r^* yields.

$$w^* = b + (\lambda_0 - \lambda_1)(1-\gamma)\int_{w^*}^{\overline{w}} (V_E(w') - V_E(w^*))\, dF(w') \tag{9}$$

$$r^* = b + (\lambda_0 - \lambda_1)(1-\gamma)\int_{w^*}^{\overline{w}} (V_E(w') - V_E^n(r^*))\, dF(w') \tag{10}$$

Since $V_E(w^*) = V_E^n(r^*) = V_U$ by definition, the formulas for w^* and r^* are the same and therefore $w^* = r^*$. Thus we have the first result. At the time of notice workers always opt to stay employed; there is no voluntary exit to unemployment to search for another non-notice job.

We now turn to solving for $r(w)$, the reservation wage while employed at a notice firm. The conjecture here is that $r(w)$ is less than w. That is, workers accept a lower wage at a non-notice firm in order to escape the higher likelihood of unemployment. To solve for $r(w)$ we set $V_E(r(w)) = V_E^n(w)$. This yields

$$\begin{aligned} r(w) &= w + (\delta_1 - \delta_2)\left(V_E^n(w) - V_U\right) + \eta_1\left(V_E(r(w)) - V_E^n(r(w))\right) \\ r(w) &= w + (\delta_1 - \delta_2)\left(V_E^n(w) - V_U\right) + \eta_1\left(V_E^n(w) - V_E^n(r(w))\right) \end{aligned}$$

$$\begin{aligned} r(w) = w &+ \frac{\delta_1 - \delta_2}{r + \delta_2 + \lambda_1(1-\gamma)(1 - F(r(w)))} \times \\ &\left[w - w^* - \lambda_1(1-\gamma)\int_{w^*}^{r(w)} \left(V_E(w') - V_U\right) dF(w')\right] \\ &+ \frac{\eta_1}{r + \delta_2 + \lambda_1(1-\gamma)(1 - F(r(w)))} \times \\ &\left[w - r(w) - \lambda_1(1-\gamma)\int_{r(r(w))}^{r(w)} \left(V_E(w') - V_E^n(r(w))\right) dF(w')\right]. \end{aligned} \tag{11}$$

To show that $r(w) < w$ we rearrange the above expression for $r(w)$.

$$\begin{aligned} &\left(r + \delta_2 + \lambda_1(1-\gamma)(1 - F(r(w))) + \eta_1\right)(r(w) - w) \\ = \;& (\delta_1 - \delta_2)\left[w - w^* - \lambda_1(1-\gamma)\int_{w^*}^{r(w)} \left(V_E(w') - V_U\right) dF(w')\right] \\ &-\eta_1\lambda_1(1-\gamma)\int_{r(r(w))}^{r(w)} \left(V_E(w') - V_E^n(r(w))\right) dF(w') \end{aligned}$$

The term on the left hand side that is multiplied by $(r(w) - w)$ is positive because γ and $F(r(w))$ are less than or equal to 1. The first term on the right hand side is negative because $\delta_1 < \delta_2$ and $V_E^n(w) > V_U$ for all $w > w^*$ (see first line of $r(w)$ expression). The second term on the right hand side is positive because the expression in the integral is positive over the integrated wage range, *i.e.*, $V_E(w') \geq V_E^n(r(w))$ for $r(r(w)) \leq w \leq r(w)$. Therefore $r(w) - w$ must be negative or $r(w) < w$.

The equalization of values at the reservation wage ($V_E(w^*) = V_E^n(w^*)$) is a surprising finding given the intuition about the value of non-notice jobs being higher than the value of notice jobs. However, we will see that this holds only at the reservation wage and otherwise the intuition follows through. To show that $V_E(w) > V_E^n(w)$ for $w > w^*$ we subtract $V_E^n(w)$ from $V_E(w)$. After rearranging we have

$$\begin{aligned} &\left(r + \eta_1 + \lambda_1(1-\gamma)(1 - F(r(w))) + \delta_1\right)\left(V_E(w) - V_E^n(w)\right) \\ = \;& \lambda_1(1-\gamma)\int_{r(w)}^{w} \left(V_E(w) - V_E(w')\right) dF(w') + (\delta_2 - \delta_1)\left(V_E^n(w) - V_U\right). \end{aligned}$$

The first term on the left hand side is positive because γ and $F(r(w))$ are less than or equal to 1. The first term on the right hand side is positive because $V_E(w) - V_E(w') > 0$

since $r(w) < w$ and therefore $w > w'$. The second term on the right hand side is positive because by assumption $\delta_2 > \delta_1$ and $V_E^n(w) > V_U$ since $w > w^*$. Therefore $V_E(w) > V_E^n(w)$.

2.4 Predictions

The model as outlined generates a number of predictions. First, there are differences in observed re-employment wages among the three groups of workers - workers leaving non-notice firms, workers leaving notice firms, and workers laid off by notice firms. The reservation strategies at notice and non-notice firms immediately imply that accepted wage offers are lower for workers in the second group, conditional on wages at the old firm. Furthermore, once displaced, displaced workers are indistinguishable from other unemployed workers, who follow a reservation wage strategy defined by w^*. Since $w^* < r(w) < w$ for all $w > w^*$, it then follows that workers at notice firms who separate prior to displacement will on average have higher accepted wages than displaced workers. Thus, conditional on pre-separation wages, the average wage gains observed in the data should decline monotonically across the three groups. This is the primary prediction that is tested in this paper.

Second, there are no voluntary exits at time of notice, but the quitting likelihood increases at notice firms. Since the layoff decision by the firm is assumed to be exogenous, this implies that the overall separation likelihood also increases at notice firms. Some support for this prediction was found by Lengermann & Vilhuber (2000), who reported that for some skill groups separations increased above the firm-specific mean separation rate up to four quarters before a mass layoff.

3 Data

The data used here were extracted from the Longitudinal Employer and Household Dynamics (LEHD) Program database. The database contains, among other data sources, unemployment insurance (UI) records for several U.S. states covering the 1990s. UI records contain quarterly earnings on all workers covered by the unemployment insurance system[9] in a given state, matched to their respective employers. The UI records are augmented with basic demographic information (education, age, race, and sex). A "firm" in our empirical work refers to the UI reporting unit, *i.e.*, the account attributed to an employer by the state agencies responsible for UI taxes. Such

[9] Only a small fraction of workers in jobs not subject to state employment taxes are missed. This includes Federal employees, self-employed individuals, and employees of small agricultural enterprises, and philanthropic or religious organizations. Individuals who receive no salary, who are completely dependent on commissions, and who work with no fixed location or home base are also excluded.

an account number may cover multiple establishments, however, more than 90% of accounts are known to be single-establishment entities.

One can thus build a precise picture of the sequencing of employment in conjunction with earnings at each job. The data set shares a number of other advantages, as well as a few disadvantages, with previous work on displaced workers using unemployment insurance records. It provides a very large sample of displaced workers whose earnings can be tracked over long periods of time both before and after displacement. Furthermore, information on firm employment changes as well as individual earnings should be relatively free of measurement error.[10] The displacement event for any given worker is identified not from a survey report, but from observed movements out of employment at that worker's firm. Issues of recall bias or multiple displacement that have plagued the Displaced Worker Supplements (DWS) to the Current Population Survey (Farber 1998) are not of relevance here. On the minus side, but not unique to this paper, our analysis is limited to only two states out of the eight available,[11] demographic information is not as extensive as in the typical survey, and layoffs cannot be distinguished from quits. Finally, UI records, because they (typically) contain no information on hours worked, do not allow for the distinction between full- and part-time work.

Crucial to the analysis is the identification of a displacement "event". The data set contains information on all movements in and out of firms, but no administrative or survey reports of displacement. Displacement events are thus computed directly from observed worker flows.[12] A "displacement" is deemed to occur when observed job separations surpass 30% of maximum firm employment (Jacobson et al. 1993). Average employment is required to be larger than 50 workers. In order to properly capture the element of surprise notice postulated by the theoretical model, we restrict our analysis to firms that are observed to have only one displacement event.

Figures 1 on page 32 and 2 on page 33 give a graphical assessment of the restriction on firm size for the two states. Firms below the threshold are the vast majority of firms ever present in these states (*i.e.*, who have at least one quarter of positive employment). Firms above the threshold account for less than 4 percent of all firms in these two states. However, these firms account for over 60 percent of all employees, as shown by Figure 2. Thus, the sample selected here clearly covers a very large fraction of the workforce, and is designed to include layoffs that are large in both relative and absolute terms.

[10]The LEHD database, where feasible, has been edited to correct for coding errors in personal identifiers (Abowd & Vilhuber 2002). Such coding errors falsely increase separation rates by between 1 and 4 percent, and recall rates by up to 10 percent. This in turn biases the construction of indicators of displacement.

[11]At the time of writing, the LEHD database contained records from California, Florida, Illinois, Maryland, Minnesota, North Carolina, Pennsylvania, and Texas.

[12]One of the strengths of the data is that the sensitivity of the result to the definition of displacement can be explored.

Table 1 on page 21 compares statistics based on the displacement measure in our data with the DWS. Farber (2001) tabulates multiple years of data drawn from the DWS, corrected to be consistent as survey questions changed over time. Since the DWS is retrospective survey querying (in this tabulation) about job displacements in the three years before the survey date, we adjusted our data to give a similar picture. Thus, we computed for every worker in our sample whether he or she experienced at least one displacement within a three-year rolling window. This is approximately equivalent to a DWS-like question asked of these respondents at the end of the third calendar year. The higher frequency of sampling possible in the LEHD data allows for a more detailed analysis than the DWS data.[13] When comparing the equivalent three-year reference periods, only three data points are common to both data sets. Excluding the UI-based estimate for 1993, which are biased by a data problem in early years, the displacement rates in 1995, 1997, and 1999 are comparable, and fairly similar in levels. The LEHD data do not show the downward trend apparent in the DWS since 1995, although the 1999 estimate is also lower than the previous years. Despite differences in definitions and possible recall bias in the DWS data, the definition of displacement used here seems to be is close to what workers in the DWS understand by displacement.

In all, 14,821 firms had displacement events as defined above during the 1990-1999 period spanned by the data, out of a total of 54,672 firms satisfying the size requirement and having at most one displacement event.[14] Although the ratio of firms ever experiencing displacement seems high, note that this corresponds to a probability of approximately 1 percent of any given company having their sole displacement event in any given period. Within a twelve quarter window leading up to displacement, slightly more than 10 million workers worked for these firms for at least one quarter.

We construct a sample designed to address some of the sample selection and data quality issues. First, only earnings from "full-quarter employment" quarters are used. Under the full quarter assumption, a worker is counted as working for a firm for the entire period t if and only if he appears at the same firm in periods $t-1$ and $t+1$.[15] This is designed to correct for the problem of unobservable hours. Second, we select individuals who were in "full-quarter employment" four quarters before the displacement event, continually employed until separation, and who were in "full-quarter employment" four quarters after the displacement event, *i.e.*, they found new employment, were recalled to their old job by the third post-separation quarter, or were possibly continuously employed at the displacing firm.

[13] A data quality issue seems to be at the root of the very high displacement rates in 1991 and 1992. Observations from years before 1993 are excluded from the analysis. Future updates to the database will hopefully resolve this problem.

[14] 86% of firms having at least one event over the sample period have exactly one event. The remaining fraction of firms have on average 2.6 events.

[15] See Appendix A.2 for a precise description.

Figure 3 on page 34 charts the calendar time and relative time events surrounding both the definition of a displacement event, and the workers involved therein. Panel (a) shows layoff patterns for four firm types F through I. E and e denote high and low levels of employment, respectively, and D denotes a displacement event, *i.e.*, a layoff large enough to warrant classification as a displacement event. A firm of type F experiences two displacements events, probably seasonal (4 quarters apart), and is thus excluded. Firm G dies a slow firm death, but never has a layoff large enough to be classified as a displacing firm. Both firm types H and I have single displacement events, but firm H survives with a lower employment level, whereas firm I no longer exists after the displacement event. Our sample is made up of H and I firm types.

Once a displacement event is defined, workers are classified here into four mutually exclusive groups: "displaced workers," "temporary layoffs" (or "recalls"), "continuously employed workers" (all in Panel (b)), and "early leavers" (Panel (c)). For clarity, we will assume these workers were displaced from a firm of type H, since firms of type I do not have any recalls or continuously employed workers. A worker of type a worked for the displacing firm H in the displacing quarter 6, but did not experience any (observable) unemployment.[16] Workers of this type are, therefore, included in the sample, appropriately flagged. Worker types b through e are all displaced in quarter 6. Worker b finds a job at firm J by quarter 9, and worker c gets recalled to displacing firm H in quarter 8. Both are also included in the sample. Worker types d and e have some trouble in the labor market after being displaced by H in 6. Both find a job quick enough, being hired by J in quarter 8, but d separates again and finds employment at K in quarter 10, whereas e's employment at J is intermittent. Both these employment patterns, indicative of either unstable employment relationships or at least a late stabilization of employment patterns, exclude them from the sample. Finally, Panel (c) shows employment patterns for some early leavers. Workers f through j all leave in quarters prior to the displacement quarter (in relative time, they leave in $t \leq -1$). Relative post-separation time for these workers starts earlier in calendar time than for workers in Panel (b). Worker f leaves in quarter 5, and finds a job in quarter 8, which is three quarters after his separation, though only two quarters after the displacement event. Worker g finds a new job even quicker, making an immediate transition, to firm Q, and finding stable employment by quarter 7, three quarters after separation, at firm M. These two worker types are included in the sample. Worker h has a post-separation employment profile identical to worker e, only earlier in calendar time. As was e, worker h is excluded from the sample. Finally, workers such as i are also excluded, having separated too early to be included.

This sample does not include the typical displaced worker. Mean unemployment for displaced workers is around 27 weeks in the CPS (Ruhm 1992), whereas the selection criteria here limit unemployment to a maximum of two full quarters (24 weeks). Rather, it includes those displaced workers who, like the early leavers, found a job fairly quickly. We further restrict the sample to men with at least 5 years of experi-

[16] See AppendixA for details concerning the measurement of unemployment in this data.

ence, and take a 10 percent stock sample.

Approximately 120,000 men, who are present in all periods 3 to 5 quarters before a firm's displacement event, constitute the at-risk group. Of those, the 70,000 (58%) who are also working in periods 3 to 5 after having left the displacing firm are the final analysis sample.[17]

4 Estimation and Results

The base wage equation is an expanded version of the generic displaced worker regression (Jacobson et al. 1993). Let $T_{displ,j}$ denote the displacement date of employer j. Let $T_{depart,i,j}$ denote worker i's separation date from employer j. Finally, let $J(i,t)$ be the function identifying worker i's employer at time t. The effect of displacement on the wages of workers prior to displacement is captured by

$$DJ'_{J(i,t)}\mu_1 = \sum_{-m \leq \tau \leq 0} DJ^{\tau}_{J(i,t)}\mu_\tau, \tag{12}$$

where $DJ^{\tau}_{J(i,t)}$ is unity if displacement will occur in $-\tau$ periods at the worker i's current employing firm $J(i,t)$ (*i.e.*, $t - T_{displ,J(i,t)} = \tau$). m denotes how many periods in advance this vector of dummies is started. For instance, μ_{-1} measures the effect of next period's displacement on the present period's earnings.

The pre-displacement dummies are specific to a firm and likely apply to that firm's entire workforce, whether or not any particular member of that workforce is actually displaced at $T_{displ,j}$. In particular, workers leaving at some time $T_{depart,i,j} < T_{displ,j}$, whom we call "early leavers", are likely to experience similar wage changes as "displaced workers" in the stricter sense ($T_{depart,i,j} = T_{displ,j}$), up to the time of departure from the firm. In contrast, the post-displacement effects on wages are worker specific, independent of the firm that they work at after separation or displacement. The effect of person-specific post-displacement dummies DI_{it} can be constructed in a similar fashion as the pre-displacement dummies:

$$DI'_{it}\mu_2 = \sum_{0 < \tau \leq m} DI^{\tau}_{it}\mu_\tau, \tag{13}$$

where DI^{τ}_{it} is unity if a worker left a displacing firm τ periods ago (*i.e.*, for some j, $t - T_{depart,i,j} = \tau$ and $m > T_{displ,j} - T_{depart,i,j}$). For instance, μ_4 measures the effect of having worked at a displacing firm one year ago on this period's earnings. The notation here corresponds to that in Jacobson et al. (1993) for workers with $T_{displ,j} = T_{depart,i,j}$. However, the post-displacement dummies are person-specific, and are a function of the worker's employment history.

[17] More details on the construction of the data set are available in Appendix A on page 26.

Both Equations (12) and (13) assume that the earnings patterns related to displacement are the same for early leavers and displaced workers. This assumption can be relaxed. Let $e_{i,t,J(i,t)} = 1\left(-m \leq T_{depart,i,j} - T_{displ,j} < 0\right)$ flag early leavers from firm j in period t. A more general specification allowing for variation in the earnings patterns is

$$DJ'_{J(i,t)}\mu_1 = DJ'_{J(i,t)}\mu_{11} * (1 - e_{i,t,J(i,t)}) + DJ'_{J(i,t)}\mu_{12} * e_{i,t,J(i,t)} \tag{14}$$

$$DI_i{}'\mu_2 = DI_i{}'\mu_{21} * (1 - e_{i,t,J(i,t)}) + DI_i{}'\mu_{22} * e_{i,t,J(i,t)} \tag{15}$$

Assembling all the elements defined above yields the basic wage specification:

$$w_{it} = X_{it}\beta + DJ'_{J(i,t)}\mu_1 + DI'_{i,t}\mu_2 + \theta_i + \psi_{J(i,t)} + \varepsilon_{it} \tag{16}$$

where w_{it} measures log earnings for individual i at time t, X_{it} are individual characteristics, both time-varying and time-invariant, θ_i measures the effect of time-invariant individual characteristics ("worker quality"), $\psi_{J(i,t)}$ is a firm-specific (productivity) effect on wages, and ε_{it} is a statistical residual, uncorrelated with all the right hand side variables.[18] In our data, X_{it} includes a quadratic in experience and year dummies, whereas as the effects of education and race are subsumed into θ_i.

In this paper, we concentrate on persons who worked for the same firm during the same time period prior to a displacement event, and who either left early (within two quarters of the displacement quarter) or who were present at displacement (whom we call "displaced workers", despite the fact that some portion was not actually displaced, but simply employed by the displacing firm at the time of displacement). Their pre-displacement earnings a year before the displacement event are then compared to earnings a full year after separation from the displacing firm. In the case of early leavers, this is computed not from the date the firm displaced its remaining workers, but from the date they left the firm (see Section 3 and Figure 3 on page 34). All these individuals satisfy $DJ^{-4}_{J(i,t)} = 1$ for some quarter t, and the earnings from that quarter are contrasted with post-separation earnings from the quarter t' in which $DI^{4}_{i,t'} = 1$. As Figure 3 shows, the time difference $t' - t$ will be different for early leavers and displaced workers. In this analysis, it is the re-employment path that is held constant, and not the absolute time difference between earnings measurements.

Define $DJ_{pre} := DJ^{-4}_{J(i,t)}$, $DI_{post} := DI^{4}_{i,t'}$, and $w_{i,pre}$ and $w_{i,post}$ the log earnings associated with the respective quarters. Differencing (16) obtains

$$\begin{aligned} w_{i,post} - w_{i,pre} &= (X_{i,post} - X_{i,pre})\,\beta \\ &+ (DI_{post}\mu_{21} - DJ_{pre}\mu_1) \\ &+ DI_{post}e_{i,t,J(i,t)}\,(\mu_{22} - \mu_{21}) \\ &+ \psi_{J(i,post)} - \psi_{J(i,pre)} + \Delta\varepsilon_i \end{aligned} \tag{17}$$

[18] See Abowd & Kramarz (1999) for a more detailed description of this model.

where we have assumed that pre-displacement wage paths are identical within the displacing firm for both early leavers and displaced workers ($\mu_{12} = \mu_{11} = \mu_1$ in (14)). Rewriting,

$$\begin{aligned} w_{i,post} - w_{i,pre} &= \alpha + \Delta X_i \beta \\ &+ e_{i,t,J(i,t)} \Delta\mu + \psi_{J(i,post)} - \psi_{J(i,pre)} + \tilde{\varepsilon}_i \end{aligned} \tag{18}$$

where $\alpha = \mu_{21} - \mu_1$ is the component for all workers finding employment post-displacement, $\Delta X_i = X_{i,post} - X_{i,pre}$ captures any changes in time-varying observables,and $\Delta\mu = \mu_{22} - \mu_{21}$ is the difference in post-displacement earnings due solely to the fact that some workers left earlier than others, and all the displacement dummies are set to unity due to sample selection. Note in particular that θ no longer plays a role in (18) because of first-differencing, but that ψ still enters for two different firms.

Table 2 on page 22 reports both the (log) difference in earnings as well as the levels of the variables entering (16) or (18). The starting point of this analysis are the first two rows of Table 2. The first row shows the raw earnings differential between the fourth pre-displacement quarter and the fourth post-displacement quarter. The second row shows the differential when computed using "full-quarter" earnings, as defined earlier. The difference between the two columns is a first estimate of the parameter of interest $\Delta\mu$, and both difference-in-differences tell the same story: Earnings for early leavers are significantly higher than for workers from the same firms who stay until displaced, by approximately 17 percent if using full-quarter earnings, and by nearly 22 percent when using raw quarterly earnings, consistent with the search model outlined earlier.

The table also reveals marked differences between the groups. Levels of earnings are lower for early leavers, as are their experience and education. The racial composition is also more diverse among early leavers. There are small differences in the estimated fixed person effect, a measure of long-term earnings potential, and both groups are below, but quite close to the population average of zero. Early leavers leave smaller firms, but also move to smaller firms. Measured by the firm fixed effect, a measure of pay policy differences, the more seasoned displaced workers separate from higher-paying firms than the early leavers, find new jobs in such firms, and experience a larger improvement. Finally, few early leavers return to their displacing firms, contrary to displaced workers, and a substantial fraction leave their industry. A small fraction of workers present at the time of displacement are continously employed, *i.e.*, they never actually separate from the displacing firm during the mass layoff, whereas by definition, no early leavers can stay continuously employed at the displacing employer.

Many of the differences noted in Tables 2 are correlated with wage levels, and in the further analysis, we will use regressions based on Equation (18) to disentangle the determinants of wage levels from the more basic implication of the search model, namely that the wage difference is due to the fact that the early leavers received a

better draw than the displaced workers. [19]

Table 3 on page 23 presents results from a series of OLS specifications using the full sample described by Table 2. Column (1) builds on the basic difference-in-difference (DID) comparison done in the first row of Table 2 by controlling for the other distinguishable groups in this sample: workers who only temporarily left the displacing firm (*i.e.*, their post-displacement employer was the same as their displacing employer), and workers who had no observed separation from the displacing firm. Interestingly, workers who only temporarily leave the firm have higher wage gains than those who stay with the displacing firm, although this difference is not statistically significant in Column (1). Compared to the naive DID estimator, $\Delta\mu$ remains essentially unchanged.

Column (2) estimates Equation (18) using independently estimated fixed firm effects.[20] In this specification, a firm will have the same fixed effect whether it is a displacing firm, a new firm, or both. Controlling for estimated fixed firm effects actually increases the estimate of $\Delta\mu$ substantially. The coefficients on $\hat{\Psi}_{pre}$ and $\hat{\Psi}_{post}$ are statistically not different from unity, as implied by the derivation of Equation (18) from Equation (16).

As a specification check, Column (4) adds the estimated fixed person effect $\hat{\theta}$ to the Column (2) specification. Remember that since (18) is expressed in within-person differences, θ drops out and, therefore, should be insignificant.[21] We also add controls for state-specific differences in earnings differences. Column (4) allows for state-specific variation across both the intercept and added year dummies, as well as allowing the coefficient on early leavers to vary across states.

Adding these supplementary controls changes some of the coefficients, and in particular shows significant correlation of earnings differences with $\hat{\theta}$ and significant deviation of the coefficients on $\hat{\Psi}$ from unity, when state controls are added. State differences in the intercept are significant, as are some of the state-specific time paths. Nevertheless, the coefficients of interest $\Delta\mu$ is very robust across all specifications, and when allowed for, there is no statistically significant state-specific variation in this parameter. In regressions not reported here, this also holds when all coefficients are allowed to vary across states.

Both the theoretic model and the econometric specification assume homogeneous workers, up to observed controls. The significant coefficient on $\hat{\theta}$ in the previous table seems to reject that hypothesis. In other words, if $\Delta\mu$ differs across homogenous

[19] The other major implication, the difference between workers of non-notice firms who change jobs and early leavers from notice firms, will be tested in a later revision of this paper.

[20] The estimation of these fixed firm effects is described in Appendix A on page 26.

[21] $\hat{\theta}$ is estimated, but we are interested only in the significance of the coefficient on $\hat{\theta}$, $\beta_{\hat{\theta}}$, since we have no priors as to what value it should have. For the hypothesis test $\beta_{\hat{\theta}} = 0$, the OLS standard errors are consistent and t-statistics valid (Pagan 1984).

labor markets, then dividing the sample along those same lines is necessary. Table 4 reports results from separating the analysis sample into four sub-groups, based on the population distribution of $\hat{\theta}$, in order to obtain sub-groups that are homogeneous in skill levels. Each column estimates (18), augmented with state controls as in Column (3) of Table 3,[22] independently for each sub-groups. Even though the groups are selected within quartiles of the distribution of $\hat{\theta}$, $\hat{\theta}$ is still included in the regression as a control.

Rows 1 through 3 report the mean and standard deviation for the classifying variable $\hat{\theta}$, the fraction of workers who are early leavers, and the size of the group. Note in particular that the groups are *not* equally sized, since the classification is *not* based on the (flow) sample distribution of $\hat{\theta}$, but on the stock population distribution. The groups are nevertheless fairly homogeneous within each group as evidenced by the very similar standard deviations for both $\hat{\theta}$ and fq_wdiff, with the middle quartiles slightly more homogeneous than the top and bottom quartiles. However, the unconditional (on early leaver status) percentage gains made around displacement increases with $\hat{\theta}$, as already evidenced by the (conditional) positive coefficient in Table 3.

The parameter of interest $\Delta\mu$ is significant in all quartiles. $\Delta\mu$ is of the same order of magnitude as for the sample as a whole, but increases monotonically across the distribution of $\hat{\theta}$. Also, the included $\hat{\theta}$ is significant only for the bottom and top quartile. Since these are precisely the quartiles within which $\hat{\theta}$ is more dispersed, it would seem that the econometric specification (18) fits the data better in more homogenous populations.

Table 3 and 4 present results based on the use of estimated fixed firm effects. It is, however feasible to explicitly estimate fixed firm effects. Table 5 on page 25 reports results from an OLS regression which explicitly estimated fixed effects for all 7,243 displacing firms, but controls for the previously estimated fixed firm effect for the 15,622 new firms as well as $\hat{\theta}$. The results from these within-displacing-firm regressions show a higher estimated $\Delta\mu$ for all sub-groups, and substantially changes the coefficients for the other groups. Continuously employed workers are now estimated to gain more than workers displaced *from the same firm*, but temporary layoffs earn substantially less than workers *from the same firm* who found jobs in other firms.[23]

The primary test in this paper is whether early leavers, *i.e.*, workers who leave firms before these proceed with a mass layoff, differ in their earnings gain or loss from displaced workers. The theoretical model presented in Section 2 suggests that such workers should have better earnings outcomes than comparable displaced workers. The implications of that model are tested using Equation (18), and the direct estimation of (18) in Column (2) of Table 3 fits the data remarkably well.

[22] Estimating the equivalent of Column (4) of Table 3 yielded almost identical results.

[23] Preliminary results when estimating fixed effects for both displacing and new firm yields similar results.

The robustness of this result is tested by the different specifications in the remaining columns of Table 3 and subsequent tables, using a variety of controls. Column (3) suggests that the homogeneity of the labor market within which (18) is estimated matters. Since the model postulates homogeneous labor markets, the specifications reported in Table 4 separate the workers into what are arguably more homogeneous labor markets by skill. Table 5 further controls for firm-specific factors by estimating within-displacing firm regressions, contrasting only workers leaving the same firm with each other. Throughout all these tests, the parameter of interest associated with the earnings differential between early leavers and displaced workers, $\Delta\mu$, is remarkably unaffected.

Although obviously displacing firms differ from "normal" firms in the economy, the difference in results between Tables 4 and 5 suggests substantial heterogeneity across displacing firms as well, in particular in the way workers from these firms experience the displacement. When contrasting displaced workers with continuously employed workers at all displacing firms, the latter have a negative earnings differential. However, when contrasting displaced workers to workers who kept their jobs at the same firm the former were laid off from, it turns out that continously employed workers earn substantially more. Since a large fraction of firms actually dies at the time of displacement, and thus does not have continuously employed workers, earnings differentials for displaced workers at firms that die must be substantially higher than at firms that do not.

5 Conclusion

One of the primary concerns of policy makers when faced with mass layoffs is how to quickly return these individuals to work. Mostly, the emphasis has relied on mandatory advance notice laws, but their efficacy has only circumstantially been proven. Firms, on the other hand, might worry about destructive attrition prior to displacement. In particular, if the mass layoff was the result of a plant closure which the firm had deemed avoidable, then attrition might have been detrimental to the rescue attempt.

In this paper, we provide some evidence that a solution to these competing incentives is non-trivial. We lay out a search model that incorporates aspects of displacement, in particular the receipt of information as to the viability of a worker's job, which here is interpreted to be related to a mass layoff. Workers endogenously adapt their reservation wages to the changed circumstances. The model predicts that workers who have received "notice" of a higher job failure risk, will adjust their reservation wages downwards. This implies that their departure from the firm is more likely than if they had not received this information, and furthermore that their re-employment wages will lie below normal re-employment wages, but above the wages obtained by

displaced and other unemployed job seekers.

The data, derived from US universal wage record data, support these conclusions. The data are used to determine when mass layoffs occur. The regressions then compare those workers who left up to 2 quarters prior to the mass layoff with workers displaced at the time of the mass layoff. The results indicate that within categories of homogeneous workers, and controlling for characteristics of workers and displacing firms, early leavers consistently obtain higher re-employment wages than displaced workers. The results also point to a rich and complex variety of ways in which firms handle and workers experience displacements, with significant differences across firms. Future research will tackle both the empirical and theoretical issues this raises.

Although the data do not report if these workers had received formal advance notice, the results are suggestive of the beneficial effect to workers of advance notice. However, accelerated attrition is clearly a feature of the model used here. Whether this accelerated attrition is beneficial in a general equilibrium framework, for instance through improved reallocation of workers, remains to be determined in future work.

The results presented are both empirically and theoretically intriguing, and point to directions for further research. Some of the controls included in the regressions were empirically motivated, without having a counterpart in the theoretical model. One of the challenges will be to construct a theoretical model that fully encompasses not just early leavers and displaced workers, but also workers continuously employed at displacing firms as well as temporary layoffs. Such features presumably require incorporating wage renegotiation, selective layoff of workers, and most importantly the reasons why some firms would use one or the other method in case of distress. In terms of the model structure, such a model requires allowing for non-atomistic firms, defining a non-absorbing distressed state for firms, and *ex ante* knowledge of firm-specific job destruction rates by workers (Burdett & Mortensen 1980).

Empirically, contrasting the groups of workers highlighted in this paper, all of which work in distressed firms, with equivalent groups at healthy firms, will lead to a better understanding of the way firms layoff and hire workers in general. Among displacing firms, the difference in earnings differentials between displaced workers at firms that close versus those at firms that survive, highlighted at the end of the previous section, requires further investigation. Krashinsky (2001) reports a similar result for a sample of NLSY workers, which he relates to firm-size pay differentials, since smaller firms are more likely to suffer from complete plant closures than large firms. The data used here can be substantially enriched with firm-side data, and used to investigate this issue in more depth.

6 References

Abbring, J., van den Berg, G., Gautier, P. A., Gijsbert, A., van Lomwel, C. & Ruhm, C. (forthcoming). Worker displacement in the US and the Netherlands, *in* Kuhn & Eberts (forthcoming).

Abe, M., Higuchi, Y., Kuhn, M. N. P. & Sweetman, A. (forthcoming). Worker displacement in Canada and Japan, *in* Kuhn & Eberts (forthcoming).

Abowd, J. & Finer, H. S. C. (1997). Plant closings, personal wage heterogeneity and the mobility of employees, *mimeo*, Cornell University.

Abowd, J. & Kramarz, F. (1999). Econometric analysis of linked employer-employee data, *Labour Economics* pp. 53–74.

Abowd, J. M., Creecy, R. H. & Kramarz, F. (2002). Computing person and firm effects using linked longitudinal employer-employee data, *Technical paper TP-2002-06*, LEHD, U.S. Census Bureau.

Abowd, J. M. & Vilhuber, L. (2002). The sensitivity of economic statistics to coding errors in personal identifiers, *Technical paper TP-2002-17*, LEHD, U.S. Census Bureau.

Addison, J. T. & Portugal, P. (1987). The effect of advance notification of plant closings on unemployment, *Industrial and Labor Relations Review* **41**(1).

Burdett, K. & Mortensen, D. T. (1980). Search, layoffs, and labor market equilibrium, *Journal of Political Economy* **88**(4): 652–72.

Fallick, B. C. (1994). The endogeneity of advance notice and fear of destructive attrition, *Review of Economics and Statistics* **76**(2): 378–385.

Fallick, B. C. (1996). A review of the recent empirical literature on displaced workers, *Industrial and Labor Relations Review* **50**(1): 5–16.

Farber, H. S. (1998). Has the rate of job loss increased in the Nineties?, *working paper 394*, Princeton University IR Section.

Farber, H. S. (1999). Alternative and part-time employment arrangements as a response to job loss, *working paper 7002*, NBER.

Farber, H. S. (2001). Job loss in the united states, 1981-1999, *working paper 453*, Princeton University IR Section.

Jacobson, L. S., LaLonde, R. J. & Sullivan, D. G. (1993). Earnings losses of displaced workers, *American Economic Review* **83**(4): 685–709.

Jones, S. R. G. & Kuhn, P. (1995). Mandatory notice and unemployment, *Journal of Labor Economics* **13**(4): 599–622.

Kletzer, L. G. (1998). Job displacement, *Journal of Economic Perspectives* **12**(1): 115–36.

Krashinsky, H. (2001). Evidence on adverse selection and establishment size in the labor market, *mimeo*, University of Toronto, Centre for Industrial Relations.

Kuhn, P. & Eberts, R. (eds) (forthcoming). *Losing Work, Moving On: International Comparisons of Worker Displacement*, The Upjohn Institute, Kalamazoo, MI.

Lengermann, P. A. & Vilhuber, L. (2000). Abandoning the sinking ship: The composition of worker flows prior to displacement, *mimeo*, U.S. Census Bureau.

Mortensen, D. T. (1986). *Job Search and Labor Market Analysis*, Vol. 2, North-Holland, Amsterdam, New York, chapter 15.

Pagan, A. (1984). Econometric issues in the analysis of regressions with generated regressors, *International Economic Review* **25**(1): 221–47.

Ruhm, C. J. (1992). Advance notice and postdisplacement joblessness, *Journal of Labor Economics* **10**(1): 1–32.

Ruhm, C. J. (1994). Advance notice, job search, and postdisplacement earnings, *Journal of Labor Economics* **12**(1): 1–28.

Schoeni, R. F. & Dardia, M. (1996). Wage losses of displaced workers in the 1990s, *Labor and Population Program Working paper 96-14*, RAND.

Staff of the LEHD Program (2002). The Longitudinal Employer-Household Dynamics Program: Employment Dynamics Estimates Project versions 2.2 and 2.3, *Technical paper TP-2002-05 (rev.1)*, LEHD, U.S. Census Bureau.

Storer, P. & Van Audenrode, M. (1998). Long-term employment outcomes, *Final Report SP-AH048E-05-98*, Human Resources Development Canada.

Swaim, P. & Podgursky, M. (1990). Advance notice and job search: The value of an early start, *Journal of Human Resources* **25**(2): 147–178.

7 Tables

Table 1: Comparison of displacement measures

Year	Farber (2001) 3-year [1]	LEHD UI records 1-year [2]	LEHD UI records 3-year [3]
1983	0.128		
1985	0.103		
1987	0.095		
1988			
1989	0.085		
1990		0.039	
1991	0.118	0.122	
1992		0.044	
1993	0.109	0.035	0.107
1994		0.033	0.096
1995	0.115	0.041	0.094
1996		0.047	0.106
1997	0.091	0.040	0.111
1998		0.055	0.123
1999	0.086	0.030	0.105

Notes:

1: Source: Farber (2001), Appendix Table 2b, *Total Three-Year Rate of Job Loss*, defined as "At least one displacement in the past three years, Discounted Other Job loss."

2: Source: LEHD data sources. At least one displacement in the past 4 quarters, as of 31 December. For other data restrictions, consult the text.

3: Source: LEHD data sources. At least one displacement in the past 12 quarters, as of 31 December.

Table 2: Person summary statistics

Variable	Present at displacement Mean	*(Std Dev)*	Early leavers Mean	*(Std Dev)*
Raw Earnings difference	0.100	*(0.521)*	0.319	*(0.900)*
FQ Earnings difference	0.104	*(0.607)*	0.277	*(1.010)*
Person characteristics:				
Education	13.889	*(2.852)*	13.280	*(3.150)*
Race: Black	0.085	*(0.279)*	0.092	*(0.288)*
Race: Hispanic	0.135	*(0.342)*	0.167	*(0.373)*
Race: Other	0.146	*(0.353)*	0.151	*(0.358)*
Total experience (Q)	81.269	*(38.311)*	67.890	*(36.168)*
θ person fixed effect	-0.280	*(1.015)*	-0.273	*(0.992)*
Pre-displacement job:				
Log FQ earnings	9.007	*(0.852)*	8.494	*(1.119)*
FQ earnings	11155.100	*(15665.310)*	8020.500	*(15422.580)*
Average employment	8512.270	*(19231.570)*	2626.400	*(7661.210)*
ψ firm fixed effect	0.513	*(0.737)*	0.386	*(0.754)*
Post-displacement job:				
Log FQ earnings	9.110	*(0.793)*	8.771	*(0.911)*
FQ earnings	12725.080	*(67932.900)*	9519.180	*(20037.700)*
Average employment	9264.950	*(19070.030)*	2856.300	*(7949.970)*
ψ firm fixed effect	0.528	*(0.750)*	0.445	*(0.764)*
Temporary layoffs	0.283	*(0.451)*	0.027	*(0.161)*
Continuously employed	0.020	*(0.141)*	0.000	*(n.a.)*
Unemployment duration	1.220	*(0.834)*	1.023	*(1.168)*
Industry stayers	0.866	*(0.341)*	0.513	*(0.500)*
Observations	60222		8811	

Source: LEHD data sources, 10 percent random sample, authors' computations. For computation of θ and ψ, see Appendix A.

Table 3: OLS results: Log wage differential

Variable	(1)		(2)		(3)		(4)	
Intercept	**0.123**	*(0.008)*	**-0.495**	*(0.041)*	**-0.490**	*(0.041)*	**-0.511**	*(0.044)*
Flag: early leaver ($\Delta\mu$)	**0.155**	*(0.014)*	**0.284**	*(0.017)*	**0.275**	*(0.017)*	**0.259**	*(0.018)*
Flag: continuously employed	0.062	*(0.032)*	-0.030	*(0.032)*	-0.051	*(0.035)*	-0.036	*(0.028)*
Flag: temp layoff	**0.072**	*(0.022)*	**0.046**	*(0.021)*	0.044	*(0.023)*	**0.031**	*(0.015)*
Δ(Experience)			**0.099**	*(0.006)*	**0.094**	*(0.006)*	**0.094**	*(0.006)*
Δ(Experience^2)/1000			**-0.068**	*(0.007)*	**-0.035**	*(0.012)*	**-0.040**	*(0.012)*
$\hat{\Psi}_{pre}$			**-1.043**	*(0.042)*	**-1.107**	*(0.045)*	**-1.116**	*(0.042)*
$\hat{\Psi}_{post}$			**0.997**	*(0.041)*	**0.932**	*(0.040)*	**0.931**	*(0.038)*
$\hat{\theta}$					**0.042**	*(0.010)*	**0.040**	*(0.010)*
State controls					Yes		Yes	
State-specific early leaver							Yes	
State-year controls							Yes	
Adjusted R^2	0.009		0.1231		0.1274		0.1305	

NOTE: Dependent variable is the log difference in full-quarter earnings. When estimating state-specific $\Delta\mu_s$, one default state is omitted. No state-specific $\Delta\mu_s$ are significant at conventional signfiance levels. Bold face coefficients denote significance at the 5% level. Standard errors in parentheses, adjusted for clustering in displacing firms. 69033 observations.

Table 4: OLS results: by theta quartiles

Variable	(1)		(2)		(3)		(4)	
Mean of								
Theta θ	-1.468	*(0.770)*	-0.723	*(0.717)*	-0.070	*(0.693)*	0.670	*(0.790)*
flag early leaver	0.128	*(0.334)*	0.120	*(0.325)*	0.132	*(0.339)*	0.129	*(0.336)*
fq_wdiff	0.068	*(0.773)*	0.091	*(0.623)*	0.142	*(0.629)*	0.183	*(0.726)*
Intercept	**-0.242**	*(0.097)*	**-0.456**	*(0.055)*	**-0.447**	*(0.054)*	**-0.648**	*(0.105)*
Flag: early leaver ($\Delta\mu$)	**0.204**	*(0.040)*	**0.238**	*(0.024)*	**0.280**	*(0.024)*	**0.324**	*(0.031)*
Flag: continuously employed	-0.053	*(0.057)*	**-0.062**	*(0.031)*	**-0.063**	*(0.037)*	-0.032	*(0.064)*
Flag: temp layoff	0.037	*(0.025)*	**0.045**	*(0.020)*	0.043	*(0.028)*	0.038	*(0.033)*
Δ(Experience)	**0.062**	*(0.013)*	**0.086**	*(0.007)*	**0.093**	*(0.007)*	**0.113**	*(0.012)*
Δ(Experience^2)/1000	-0.020	*(0.018)*	**-0.025**	*(0.011)*	**-0.045**	*(0.014)*	**-0.058**	*(0.026)*
$\hat{\Psi}_{pre}$	**-1.277**	*(0.060)*	**-1.202**	*(0.058)*	**-1.120**	*(0.059)*	**-0.883**	*(0.084)*
$\hat{\Psi}_{post}$	**1.150**	*(0.065)*	**1.042**	*(0.053)*	**0.915**	*(0.054)*	**0.705**	*(0.071)*
$\hat{\theta}$	**0.090**	*(0.032)*	0.024	*(0.021)*	-0.037	*(0.025)*	**0.087**	*(0.032)*
Observations	9243		21344		21629		16817	
Adjusted R^2	0.1465		0.1593		0.1351		0.0779	

NOTE: Dependent variable is the log difference in full-quarter earnings. State dummies included and significantly different from zero in all regressions. Bold face coefficients denote significance at the 5% level. Standard errors in parentheses, adjusted for clustering in displacing firms. 69033 observations.

Table 5: OLS results: Log wage differential, partial fixed effects

Variable	(1)		(2)		(3)		(4)	
Mean of								
Theta θ	-1.468	*(0.770)*	-0.723	*(0.717)*	-0.070	*(0.693)*	0.670	*(0.790)*
flag early leaver	0.128	*(0.334)*	0.120	*(0.325)*	0.132	*(0.339)*	0.129	*(0.336)*
fq_wdiff	0.068	*(0.773)*	0.091	*(0.623)*	0.142	*(0.629)*	0.183	*(0.726)*
Flag: early leaver ($\Delta\mu$)	**0.197**	*(0.042)*	**0.276**	*(0.020)*	**0.2793**	*(0.019)*	**0.343**	*(0.025)*
Flag: continuously employed	0.194	*(0.114)*	**0.116**	*(0.046)*	**0.2050**	*(0.045)*	**0.106**	*(0.053)*
Flag: temp layoff	**-0.171**	*(0.052)*	**-0.193**	*(0.026)*	**-0.3148**	*(0.024)*	**-0.171**	*(0.031)*
Δ(Experience)	**0.061**	*(0.014)*	**0.102**	*(0.006)*	**0.1106**	*(0.006)*	**0.143**	*(0.009)*
Δ(Experience^2)/1000	0.003	*(0.020)*	-0.012	*(0.010)*	**-0.0640**	*(0.011)*	**-0.048**	*(0.016)*
$\hat{\Psi}_{post}$	**1.420**	*(0.054)*	**1.152**	*(0.028)*	**0.9019**	*(0.029)*	**0.732**	*(0.035)*
$\hat{\theta}$	**0.148**	*(0.022)*	0.027	*(0.023)*	-0.0265	*(0.026)*	**0.072**	*(0.015)*
Observations	9243		21344		21629		16817	
Number of displacing firms	3166		4705		4802		3969	
R^2	0.501		0.456		0.438		0.393	

NOTE: Dependent variable is the log difference in full-quarter earnings. Estimation using data demeaned by displacing firm-specific means. Bold face coefficients denote significance at the 5% level. Standard errors in parentheses.

A Data construction

The data extracted for two states from the LEHD data base as used for this research has a total of records 770,801,748 covering the time period of 1990-2000 45,812,494 workers appear at some point in time in the database, as do 1,937,434 state-specific firm identifiers.

A wage record w_{ijt} only reveals that worker i worked for firm j in quarter t, and that he or she earned w dollars. To compute point-in-time estimates of employment, the following definitions are used:[24]

Time A quarter t is the time elapsed between $[T, T+1)$, where continuous time $T \in \mathbf{R}$. T is the beginning of the quarter, and $T+1$ is the "end" of the quarter.

Flow employment Individual i employed (matched to a job) at some time during quarter t at employer j

$$m_{ijt} = \begin{cases} 1, \text{ if } i \text{ has positive earnings at employer } j \text{ during quarter } t \\ 0, \text{ otherwise.} \end{cases} \tag{19}$$

Beginning of quarter employment Individual i employed at the end of $t-1$, beginning of t

$$b_{ijt} = \begin{cases} 1, \text{ if } m_{ijt-1} = m_{ijt} = 1 \\ 0, \text{ otherwise.} \end{cases} \tag{20}$$

End of quarter employment Individual i employed at j at the end of t, beginning of $t+1$

$$e_{ijt} = \begin{cases} 1, \text{ if } m_{ijt} = m_{ijt+1} = 1 \\ 0, \text{ otherwise.} \end{cases} \tag{21}$$

Separations Individual i separated from j during quarter t

$$s_{ijt} = \begin{cases} 1, \text{ if } m_{ijt} = 1 \ \& \ m_{ijt+1} = 0 \\ 0, \text{ otherwise.} \end{cases} \tag{22}$$

[24] We abstract here from some of the finer technical details, as are defined in Staff of the LEHD Program (2002).

Full quarter employment Individual i was employed at j at the beginning and end of quarter t (full-quarter job)

$$f_{ijt} = \begin{cases} 1, \text{ if } m_{ijt-1} = 1 \ \& \ m_{ijt} = 1 \ \& \ m_{ijt+1} = 1 \\ 0, \text{ otherwise.} \end{cases} \tag{23}$$

Employer concepts For statistic x_{cijt} denote the sum over i during quarter t as $x_{c\cdot jt} = X_{jt}$. Then all individual statistics generate employer totals according to

$$X_{jt} = x_{\cdot jt} = \sum_i x_{ijt} \tag{24}$$

Some further statistics are then computed as follows.

Net job flows (change in employment) for employer j during quarter t

$$JF_{jt} = E_{jt} - B_{jt} \tag{25}$$

Average employment in quarter t for employer j in quarter t

$$\overline{EM}_{jt} = \frac{(B_{jt} + E_{jt})}{2} \tag{26}$$

Average firm size for employer j

$$AFS_j = \sum_{t:M_{jt}>0} \overline{EM}_{jt} \tag{27}$$

Maximum firm size for employer j

$$MFS_j = \max_{t:M_{jt}>0} \overline{EM}_{jt} \tag{28}$$

Firm death A firm death occurs when

$$M_{jt} = S_{jt} \tag{29}$$

Displacement event A displacement event occurs when

$$\frac{JD_{jt}}{MFS_j} > 30\% \tag{30}$$

A.1 Sample selection

To construct the sample of firms, we selected firms present for at least four quarters with $M_{jt} > 0$, and $AFS_j \geq 50$. Around 15 percent of firms are present for less than four periods. A large fraction of firms are present throughout the sample period (between 11 and 15 percent). Figure 1 on page 32 shows that the vast majority of firms that ever exist are very small. "Self-employed" is used to denote firms with a single employee, and they account for between 43 and 56 percent of all firms. Small firms employing less than 50 employees on average account for another 42 to 53 percent of firms. Only between 2.5 and 3.9 percent of all firms satisfy the average employment condition. However, as Figure 2 on page 33 shows, they account for about 60 percent of all employment.

We identify displacement events, as described in the text and defined in Equation (30). Only firms having a single displacement were retained. 34.9 percent of all firms having at least one displacement event have multiple displacement events. Inspection of the data reveals that a large fraction look like temporary layoffs of more than one quarter in length; however, very cyclical firms will appear to have multiple "displacements" in the data as well. The restriction used here is designed to eliminate these cyclical layoff patterns. Nevertheless, temporary layoffs of less than three months length are difficult to observe in the data, because of low frequency of the data. A worker being laid off sometime in Quarter 1, and recalled sometime in Quarter 2, potentially up to one day less than 6 months later, will nevertheless appear to be continually employed in the UI wage records, albeit with lower earnings, since positive earnings appear in every quarter. The extreme case of a firm laying off its entire workforce on January 2 and rehiring every single one of its former employees on June 29 will be invisible to the algorithm.

All workers having worked within a three year window around the displacement were extracted from the database. Only workers having experienced no more than 4 displacements were retained, eliminating about 0.19 percent of all workers (slightly more than 6 thousand individuals). To facilitate analysis, a random 10 percent sample of people was taken, and we restrict the sample to the men with more than 5 years of labor market experience, leaving 3 562 101 observations for 133 998 workers. This constitutes our basic analysis sample.

Inspection of the data revealed data quality issues in 1991-1992, generating an seemingly artificially high displacement rate in these years. In the analysis, only workers displaced in later years contributed.

A.2 Construction of selected data elements

Fixed person and firm effects For some of the analysis, we use person- and firm-specific productivity factors, $\hat{\theta}$ and $\hat{\psi}$. These are computed from the full LEHD data base using OLS based on Equation (16) on page 13 with all displacement dummies set to zero. Dependent variable is full-time-equivalent FQ earnings, where an adjustment has been made based on an individual's imputed full-time or part-time status. Mean $\hat{\theta}$ is normalized to zero in the population of workers, weighted by the number of wage observations for each workers. $\hat{\psi}$ is set to zero for one arbitrary firm. Its mean is restricted to be zero across all wage observations. See Abowd, Creecy & Kramarz (2002) for a more detailed explanation of the estimation procedures used in this step of the data preparation.

Full quarter earnings Employment at both the beginning and the end of the quarter (full quarter employment, (23)) is assumed to imply employment throughout the quarter. This then implies that quarterly earnings are a simply the wage rate times some constant number. This set of assumptions is used throughout much of the literature and the official statistics based on UI wage records.

Thus, full quarter earnings are for those people who were in full quarter employment, whereas raw earnings are earnings for all people having some earnings during a quarter, but not necessarily satisfying the full quarter restriction. Since these include workers who are separating or acceding, and who have worked only part of the quarter, raw earnings are typically lower.

Unemployment duration is computed as follows. Let t be the last quarter worker i was observed employed with displacing firm A, and t' the first quarter observed employed with firm B. As defined above, a quarter t spans the time $[T, T+1)$. Since the data do not contain the precise date of separation or accession, the best estimate of a separation time for i is $T + \frac{1}{2}$, and the best estimate for a hiring date is $T' + \frac{1}{2}$. It follows that unemployment is computed simply as $t' - t$. This has the feature that if $t' = t + 1$, worker i is estimated to have experienced one quarter of unemployment, even though no quarter is observed without some employment.

Experience is calculated as potential experience at observed entry into the data, and updated with actual observed experience at subsequent points in time.

Temporary layoffs are defined as workers whose first job after separation is with the same firm as the displacing firm. Industry status is defined at the SIC division

level, and industry stayers are those whose new employer's primary activity is in the same SIC division as the displacing firm.

Education is known for a subsample of the population, and multiply imputed for the rest. In this paper, only one imputation was used. Age, race, and sex are known for all individuals.

B Figures

Figure 1: Distribution of firm sizes

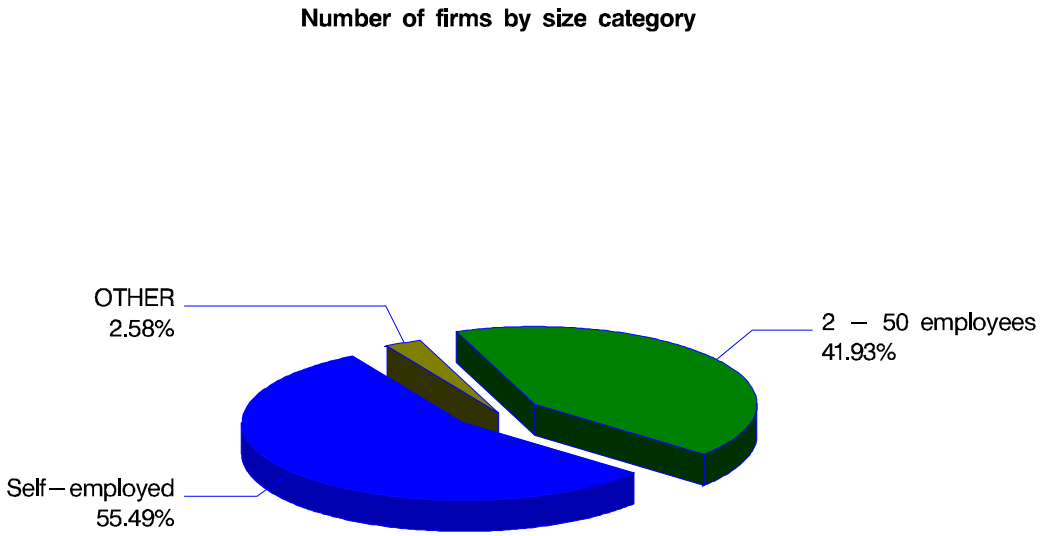
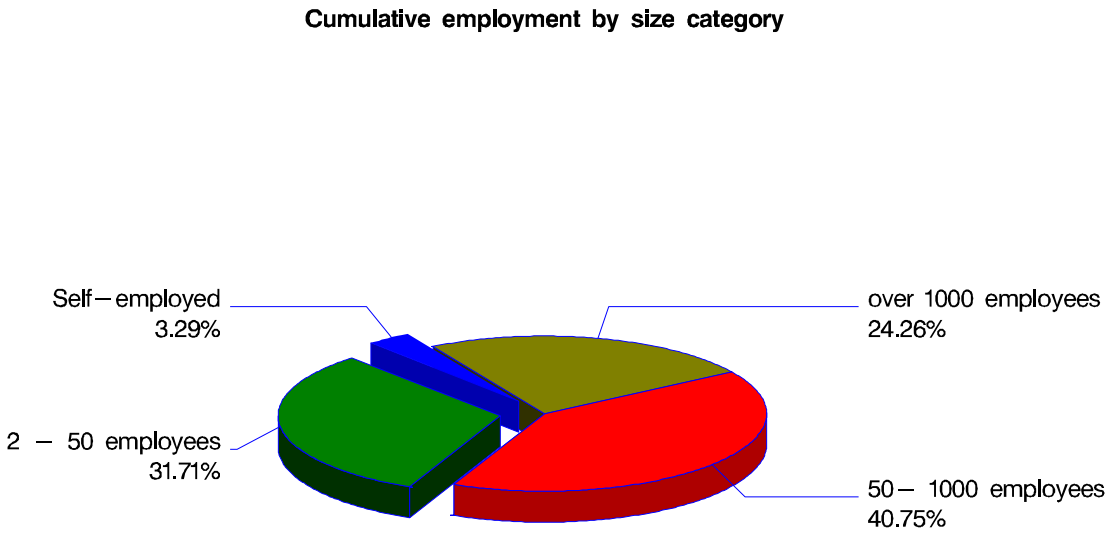


Figure 2: Total average employment, by firm size category



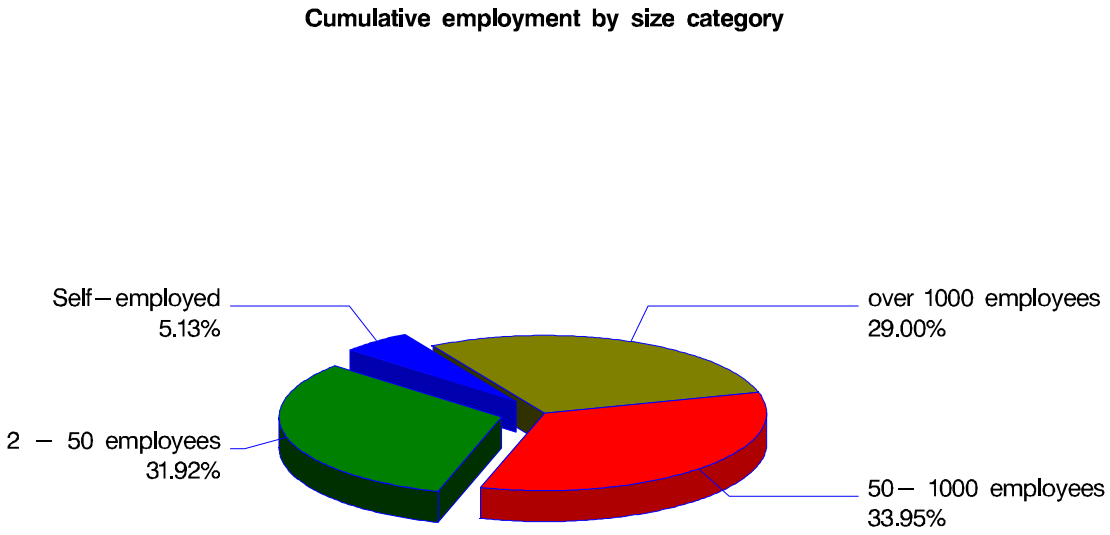


Figure 3: Diagram of employment paths