Employers' Information Advantages over Employees*

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Abstract

Employers may have private information on impending separation shocks and may choose to withhold it if disclosing the information risks causing workers to leave prematurely. We examine whether employers have such information advantages by leveraging variations in the coverage of the Worker Adjustment and Retraining Notification (WARN) Act across states. The WARN Act requires employers to give advance notice of mass layoffs or plant closings to employees, reducing information asymmetry. We test whether there is excessive voluntary quits before WARN-covered mass layoffs or plant closings, as these quits indicate workers' knowledge about impending layoffs. Using confidential establishment-level labor turnover data, we observe an increase in voluntary quits leading up to WARN-covered plant closings, relative to trends in the control group, but results for mass layoffs are noisy due to a lack of statistical power. We also find evidence that WARN-covered establishments manipulate layoff scales to avoid triggering the advance notice requirement. Both findings suggest that employers hold information advantages over workers. We build an extended search-and-matching model to study the implications of such information advantages for equilibrium labor market outcomes.

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1 Introduction

As firms operate in markets, they frequently gain first-hand private information about upcoming economic shocks, such as demand shifts, supply chain disruptions, or economic downturns. Firms may choose to withhold such information from employees if disclosure incurs any costs. For example, if an employer expects a negative shock leading to layoffs in the near future, revealing this could prompt employees to search for new jobs and leave prematurely, reducing the firm's payoffs.

To empirically examine whether employers have such information advantages over employees, we leverage the variations in Worker Adjustment and Retraining Notification (WARN) Act. The federal WARN Act mandates that employers with 100 or more employees provide a 60-day advance notice of plant closings or mass layoffs that will result in a significant number or percentage of employees losing their jobs. Several states also have similar state laws but with different thresholds for employer coverage and different triggering events. Using these variations, we conduct two empirical exercises. First, we test for discontinuities in layoff sizes around the WARN act thresholds to examine whether establishments are manipulating layoff sizes to circumvent the advance notice requirement. Such manipulation would indicate that employers have information advantages and tend to withhold information from employees whenever possible. Second, we leverage the threshold variations in state-level WARN acts to compare two types of events: covered events occurring in states with their own state-level WARN acts, which are only covered by the state WARN and not by the federal WARN; and placebo events occurring in states without state-level WARN acts, which are not covered by the federal WARN Act either, but would have been covered by a state's WARN Act if they had occurred in that state. The assumption is that the covered events are otherwise similar to the placebo events, with the key difference being that the advance notice requirements of WARN acts reduce employers' information advantages in covered events. We then examine if there is an increase in voluntary quits prior to covered mass layoffs or plant closings events, relative to the trend in the placebo events. Voluntary quits indicate workers' awareness of impending layoffs, because workers are more likely to search on the job and quit for new employment opportunities when they anticipate job loss. Significant increase in voluntary quits would suggest that employers indeed hold information advantages, and the WARN Act effectively mitigates this advantage. We discuss the details of the empirical strategies in section 3.

We implement our exercise using two restricted-access establishment-level datasets from US Bureau of Labor Statistics. Specifically, the Job Openings and Labor Turnover Survey (JOTLS) collects establishment-level self-reported data on separations by reason (quits, layoffs and discharges, other separations) on a monthly basis. We then link JOLTS with Quarterly Census of Employment and Wages (QCEW) program, which includes quarterly payroll and employment data for all employers covered by state and federal unemployment insurance programs. The linkage is necessary for determining whether an establishment is owned by an employer that is covered by WARN, as some WARN acts define "employer" as the firm that may own or control one or more sites of employment, rather than the establishment itself. We describe the two datasets in detail in section 3.

Using the method proposed by McCrary (2008), we find evidence that WARN-covered establishments manipulate layoff scales to avoid triggering the advance notice requirement. Specifically, we plot the distribution of the deviation of layoffs from WARN thresholds (normalized by baseline establishment size), and conduct local linear smoothing separately for data points to the right and left of zero. We observe a discontinuity around zero. As a placebo test, we repeat the analysis for establishments that are not covered by any WARN acts but would be covered under certain state-level WARN acts if the establishment were located in those states. We calculate the hypothetical WARN thresholds for these establishments and find that the deviation of layoff rates from the hypothetical thresholds does not exhibit any discontinuity around zero.

Next, using an event study design, we analyze the pattern of worker flows around mass layoffs and plant closings separately. For plant closings, we find that the quits rate—defined as the number of voluntary quits relative to baseline employment—is 5 percentage points higher in covered events at the quarter of closure, relative to the trend in placebo events. The cumulative effect from two quarters before closure to the closure quarter amounts to a 12 percentage point difference. In addition, the layoffs rate is 14 percentage points lower at the quarter of closure in covered events, relative to the trend in placebo events. The results indicate that employers have private information about impending plant closures. For mass layoffs, the results are noisy, partly due to the relatively small average size of employment contraction in our sample, which is approximately 20%. We find no significant difference in quits rate, although layoff rates appear slightly lower in covered events during the three quarters leading up to the mass layoff. The details of the results are in section 4.

To understand the implications of employers' information advantages on labor market efficiency, we build an extended search-and-matching model in section 5. In the model, at an exogenous Poisson rate, an idiosyncratic separation shock is triggered and the firm immediately receive signals about the impending separation shock while workers do not. Following this, the shock materializes for the firm at another exogenous Poisson rate. Wages are negotiated through a bargaining game where firms and workers bargain over the surplus from their match. We consider two scenarios: one where wages are flexible and continually renegotiated, and another where wages are rigid and only bargained at the start of new matches. Firms decide whether to disclose the information to workers by weighing the costs and benefits of disclosure. Workers, on the other hand, decide whether to search on the job, based on their beliefs about the firm's health. This decision hinges on whether they trust employers to provide timely notifications or rely on their own inference. Without trust in employers, workers are likely to engage in precautionary on-the-job search, driven by the fear of sudden layoffs, even when employers are in good condition.

When wages are flexible, in equilibrium, firms prefer to disclose information promptly even in the absence of the WARN act. Revealing information has two opposing effects on firms. On the one hand, it eliminates precautionary on-the-job search among workers and increases the match surplus. On the other hand, in some cases, in order to credibly demonstrate their commitment to promptly disclose information, firms may need to increase the wage gap between the no-impending-shock state and the impending-shock state by offering a higher wage in the no-impending-shock state. Ultimately, the elimination of precautionary search proves to be more important, incentivizing firms to disclose information. In those cases where trust needs to be "earned," the advance notice law increases the value of a job for firms, because with the law in place, firms no longer need to "buy" trust from workers, as the government's mandate grants them credibility for free. By increasing the value of a job, the law encourages job creation and thereby increases the equilibrium labor market tightness. In terms of the effects of the law on workers, it is clear that the law reduces the net value of employment, as workers receive lower wages and the match duration is shorter with a higher job finding rate. However, the impact on worker welfare is less straightforward. While workers may earn lower wages when employed, the law also reduces the unemployment rate. We show that the law could decrease worker welfare, especially when workers' bargaining power is low, because the wage reduction induced by the law is significant.

When wages are rigid, firms have no credible way to assure workers that they will promptly disclose information, leaving withholding information their only option. As a result, workers rely on their own beliefs and engage in precautionary on-the-job search, even when firms are in healthy conditions with no impending shock. The advance notice law restores information transparency and eliminates the need for precautionary on-the-job search, thereby increasing the match surplus. Firms always get a fixed fraction of the match surplus as a result of the bargaining game, so the value of a job for firms is also higher, which in turn leads to a higher equilibrium labor market tightness. Therefore, it is clear that the law improves worker welfare, as they not only receive higher wages but are also less likely to be in unemployment.

In our empirical exercise, we observe an increase in voluntary quits prior to plant closings covered by the WARN acts compared to the trend in the placebo events not covered by the acts. This suggests that we are likely in an economy where wages are somewhat rigid, because when wages are flexible and subject to continual renegotiation, firms would be revealing information even in the absence of the WARN acts, meaning that the WARN acts would not impact workers' search behavior. When wages are rigid, voluntary quits should remain consistently high in the absence of the acts due to workers' precautionary on-the-job search. With the acts in place, voluntary quits during normal periods with no impending shock should be low, only rising when a separation shock is triggered. Wage rigidity might seem at odds with another piece of our empirical evidence: firms manipulating layoff sizes to avoid mandated disclosures. Under rigid wages, the WARN acts would increase the value of a job for firms, and they should welcome such regulation, but our findings show firms are actively avoiding the notification requirements. These two points can, in fact, be consistent. Firms support the introduction of WARN Act, but once the Act is in place, with weak enforcement, they would still seek to avoid triggering notifications to prevent premature worker departures—especially if workers still believe the Act is fully enforced. Weak enforcement could undermine the WARN Act's effectiveness if workers lose trust in it, but this issue lies outside the scope of our discussion. Therefore, in our context, the WARN Act is likely to be welfare-improving for workers. However, it is important to note that the advance notice law may not always improve worker welfare, particularly in situations where wages are flexible and can already serve as a credible signal of the firm's health.

Related Literature

This work speaks to the literature that studies information asymmetry in labor markets. For example, Shimer and Wright (2004) and Brügemann and Moscarini (2010) build search models with bilateral asymmetric information where only the firm observes the match-specific productivity shock and workers have private information about their effort level or amenity. While these works have focused on studying bilateral asymmetric information between workers and their employers, others have focused on employers' information advantages. For example, in order to build models that can generate the observed labor market volatility, Menzio (2005), Kennan (2010), and Morales-Jiménez (2022) assume that while firms have perfect information, workers may not have full information about aggregate conditions or firms' idiosyncratic productivity. In these papers, assumptions about information asymmetry were key to their results; however, there was no empirical evidence to support these assumptions. This paper contributes to the literature by providing causal evidence that employers have information advantages over employees.[1]

Our empirical findings add to previous research examining the effects of advance notice on workers' employment outcomes. In particular, Cederlöf et al. (2021) exploits a discontinuity in mandatory advance notice period length around a worker age cutoff (55) in Sweden, finding that a longer notice period reduces the unemployment duration between jobs, increases the likelihood of

[1] Interestingly, some previous literature have documented that individuals have knowledge about their future job loss (e.g., Stephens 2004; Hendren 2017). However, this may be partly due to advance notice laws providing workers with some foresight, and it does not preclude firms from having more precise information.

direct job-to-job transitions, and mitigates some of the wage loss associated with displacement. Their findings and ours complement each other in two key ways: (i) while their estimated effects apply to workers near the age cutoff, our results are more general and apply to all workers as we leverage cross-state variations. (ii) we only have establishment-level outcomes, whereas they are able to analyze worker-level outcomes. Additionally, there are works from the 1990s that estimated the effects of advance notice on the jobless durations post displacement and subsequent earnings of affected workers, spurred by the introduction of the WARN Act at that time (e.g., Swaim and Podgursky 1990; Ruhm 1992, 1994; Addison and Portugal 1992; Addison and Blackburn 1994; Jones and Kuhn 1995; Friesen 1997). With the caveat that the empirical methods are primarily correlational and constrained by data availability, these studies also find that advance notice reduces jobless durations and increases post-displacement earnings. Our work is also related to the literature that empirically examine the advance notices from other perspectives. For example, Krolikowski and Lunsford (2024) and Lunsford, Krolikowski and Yang (2019) found that WARN Act notices lead unemployment rate changes and can be used as real-time indicators for forecasting unemployment trends. Guernsey, Kim and Lin (2023) found that the WARN Act decreases corporate innovation and slows employment growth, highlighting the broader implications of advance notice requirements on firm dynamics.

On the theory side, our work is related to the literature that incorporates advance notice into search and matching models. Existing works have focused on the role of advance notice as an insurance device (Pissarides 2001, 2010; Ifergane 2022), its impact on shock transmission (Zeev and Ifergane 2022), and its impact on worker flow dynamics and unemployment (Garibaldi 1998, 2004; Bentolila et al. 2012). Cederlöf et al. (2021) studies how advance notice serves as a policy tool to mitigate market failures caused by information frictions in a two-period model, where fixed wages set at the beginning of new matches may lead to layoffs if productivity declines. Since firms incur the full cost of notification without internalizing the benefits to workers, mandating advance notice enables workers to search for new jobs while employed, potentially enhancing efficiency if the gains from job transitions exceed current production losses. Our model highlights two novel channels: (i) unlike the canonical search model, where the frequency of wage negotiation does not impact key equilibrium objects like labor market tightness or job creation, here, the frequency of wage renegotiation is crucial to equilibrium outcomes, as flexible renegotiation allows firms to credibly signal information when desired.[2] (ii) under information asymmetry, workers rely on their own beliefs and may engage in precautionary on-the-job search even when employers are in healthy conditions with no impending shock.

[2] A similar insight is presented in Kuhn (1992), who studies a two-period signaling game and finds that, if wages are flexible and can be set after firms learn their types, wages will perfectly signal firm types. The advance notice law reduces worker utility by removing the need for high-type firms to signal through higher wages.

Additionally, this work is also related to the literature that studies the mass layoffs and worker displacement. The literature has established that displaced workers suffer persistent earnings losses (e.g., Jacobson, LaLonde and Sullivan 1993; Couch and Placzek 2010; Davis and Von Wachter 2011; Flaaen, Shapiro and Sorkin 2019). There are also works that document worker composition change before mass layoffs (e.g., Hamermesh and Pfann 2001; Lengermann and Vilhuber 2002; Schwerdt 2011). Our work contributes to the literature by documenting the patterns of voluntary quits and layoffs during mass layoff events.

The rest of this paper is organized as follows. We discuss the institutional background of WARN Acts in section 2. Section 3 describes the establishment-level datasets we use and the empirical strategies. We discuss the empirical results in section 4 and present the model in section 5. Finally, we conclude in section 6.

2 Institutional Background

2.1 WARN Acts

The federal Worker Adjustment and Retraining Notification (WARN) Act, enacted in 1988, mandates that employers with 100 or more employees must give a 60-day advance notice before implementing plant closings or mass layoffs that affect a certain number or percentage of employees. This requirement aims to provide workers with advance notice of significant job losses, allowing them time to adjust and seek alternative employment or training.

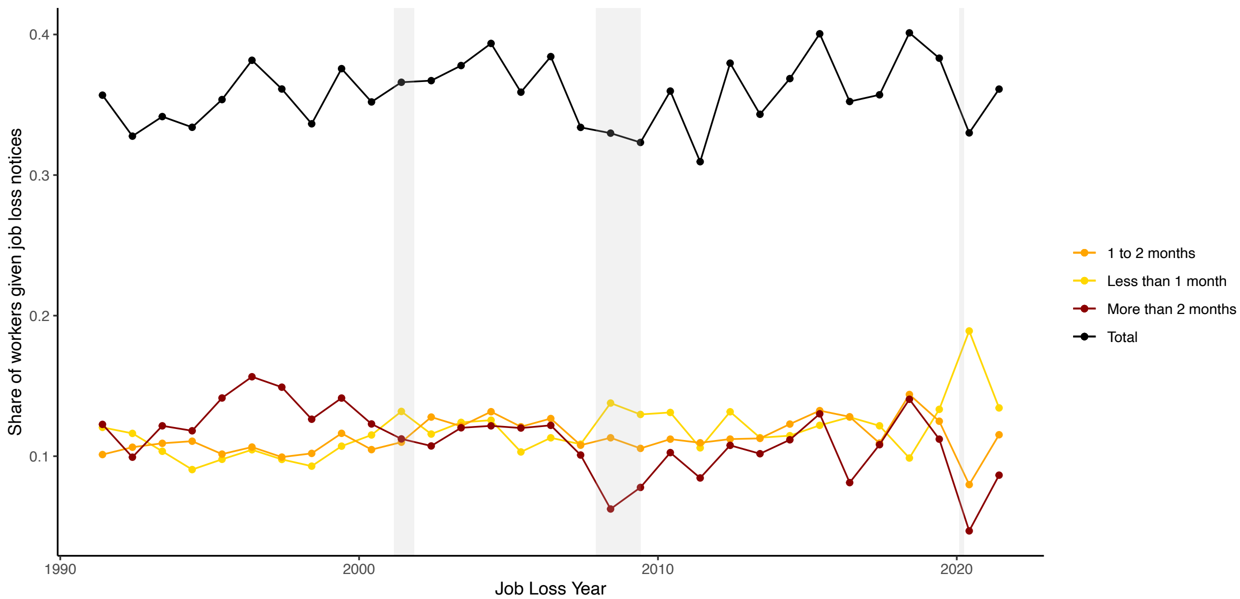
In addition to the federal WARN Act, twelve states plus Philadelphia have also enacted their own versions of the WARN Act, known as mini-WARN acts. These state laws often complement federal requirements but have significant variations in coverage thresholds and triggering events. For instance, in California, the employer size threshold is 75 employees, whereas in Iowa, it is 25 employees. Moreover, California mandates notifications for layoffs involving 50 or more workers, while Maryland requires notifications for layoffs of 15 workers or 25% of their workforce, whichever is greater. The specifics of these mini-WARN acts are detailed in tables A.1 and A.2.

2.2 Advance Notice Trends

To gain insight into the overall landscape of advance notification for job losses, we plot trends in the share of workers receiving advance notice, examining both the overall trend and variations across different notice periods. The data is from the Displaced Worker Supplement of the Current Population Survey, which collects information from displaced workers who have lost their jobs in the past three years. Specifically, it asks whether they received a written notice before their job loss and the length of time provided before termination.

As shown in Figure 1, the share of displaced workers who were given advance notices ranges from 30% to 40%. This share is fairly evenly distributed across three notice period categories: less than one month, one to two months, and more than two months. Notably, the data reveals an interesting pattern where the share of workers receiving advance notice declines during recessions, and the duration of advance notice also shortens in such periods.

Figure 1: Share of Displaced Workers Receiving Advance Job Loss Notices Over Time



Notes: This figure plots changes over time in the share of workers receiving job loss notices with different advance notice periods. The shaded areas indicate recessions. The data source is the Displaced Worker Supplement of the Current Population Survey (IPUMS-CPS, Flood et al. (2023)). The sample period starts from 1994, and the job loss year starts from 1991 because displaced workers are defined as those who have lost their jobs in the past three years. Although IPUMS-CPS data is available from 1984, the questions and conditions related to displaced workers became consistent starting in 1994.

3 Data and Empirical Strategies

3.1 Data

Our primary data sources are two restricted-access establishment-level datasets from US Bureau of Labor Statistics (BLS). Specifically, the Job Openings and Labor Turnover Survey (JOTLS) collects data of establishment-level labor turnover on a monthly basis. Importantly, JOTLS asks employers to identify the amount of separations by reason: quits, layoffs and discharges, other separations. Most sampled establishments remain in the survey for 36 months. JOLTS collects data at the establishment level and covers only a subset of establishments, but some WARN acts define "employer" as a firm that may own or control one or more sites of employment, rather than the establishment itself. Therefore, to determine whether an establishment is owned by an employer that is covered by the WARN act, we need to link JOLTS with Quarterly Census of Employment and Wages (QCEW) Program using BLS identifiers.[3] QCEW collects payroll and employment information from employers covered by state and federal unemployment insurance programs. And our QCEW microdata runs from 1990 Q1 to 2022 Q4. QCEW is a Fed-State cooperative program, with the States being the ultimate owners of the data. While most states provide blanket access to this data for research purposes, some states require case-by-case approval. Our project was granted access to data from 40 states and DC and Puerto Rico and US Virgin Islands.[4] Every establishment in QCEW is associated with both a federal enterprise identification number (EIN) and a state UI account number. These identifiers allow us to compute employer-level employment by aggregating employment in establishments that share the same EIN or UI account number, depending on the definition of employer. We also use state-level unemployment rates from Local Area Unemployment Statistics (LAUS) as controls in regressions. Next, we discuss our empirical strategies.

3.2 Determining WARN Coverage

Before we delve into the empirical strategies that leverage the WARN Act, it is crucial to first determine whether an event is covered by the Act. In this section, we detail the criteria for determining WARN Act coverage. An event is considered covered by the WARN Act if both the employer size and the layoff size exceed the respective thresholds specified in the legislation.

3.2.1 Employer Size

The definition of employer size used to determine coverage varies across WARN acts. This definition is often vague, relying on general terms rather than specifying precise identifiers. Therefore, we need to decide on our own which specific employer identifiers to use for our analysis, aiming to align them as closely as possible with the descriptions in the WARN Acts. Specifically, when the WARN act is being very specific that the relevant size is the size of the establishment, we simply use the establishment sizes to determine coverage. Some WARN acts like the federal WARN act has a broader definition about the employer and an employer may own multiple establishments.[5] In this

[3]Specifically, the identifiers we use include state FIPS code, state UI account number, and UI reporting unit number that differentiates individual establishments within the same UI account.

[4]The 40 states are AK, AL, AR, AZ, CA, CO, CT, DE, GA, HI, IA, ID, IL, IN, KS, LA, MD, ME, MI, MN, MO, MT, ND, NE, NH, NJ, NM, NV, OH, OK, SC, SD, TN, TX, UT, VA, WA, WI, WV, WY. The ten states that did not grant us access are Florida, Kentucky, Massachusetts, Mississippi, New York, North Carolina, Oregon, Pennsylvania, Rhode Island, Vermont. Some of these states typically only approve projects from federal agencies.

[5]According to the federal WARN act, an example would be a major auto maker which has dozens of automobile plants throughout the country. Each plant would be considered a site of employment, but there is only one "employer",

case, we use the Federal Employer Identification Number (EIN) as the employer identifier and use the total number of employees under the same EIN to determine if the employer is covered. If so, all establishments with the same EIN are classified as being covered. An important caveat is that ten states, including populous states like New York and Pennsylvania, did not grant us access to their QCEW data. Consequently, we may underestimate the size of employers with establishments in these states and potentially misclassify their establishments as not being covered by WARN. In other words, if our data indicates that an establishment is covered by WARN, it is definitely covered. However, if our data indicates that an establishment is not covered by WARN, there remains a possibility that it actually is covered. Finally, some state-level WARN acts like Maryland WARN add a state boundary to employer size definition and an employer is covered if it employs more than a certain number of workers within the state. In this case, we use the state UI Account Number as the employer identifier and determine the coverage in a similar way to the EIN case.

In addition to the employer identifier, another crucial factor in determining coverage is the point in time at which the number of employees is to be measured for determining coverage. Certain WARN acts, such as California's, offer clear guidelines, specifying the use of the highest employment level within the preceding 12 months. However, many WARN acts lack explicit clarity. In such instances, we resort to using the employment from 3 months before the onset of the mass layoff or plant closing events to determine coverage.

3.2.2 Layoff Size

The layoff size is calculated at the establishment level, but it's also important to clarify the specific time span used in determining the layoff size. The Federal WARN act as well as most state-level WARN acts use 90-day aggregation rule to determine layoff size, that is, in the aggregate for any 90-day period, if the layoff size exceeds the threshold, then the event is covered. Hence, for mass layoffs, we follow the WARN act guidelines and compute the change in employment from month m to $m + 3$.[6] And we label month m as the onset of a mass layoff event if the establishment-level employment keeps declining from m to $m + 3$ and the change exceeds the corresponding WARN act threshold. We impose this additional criterion of sustained employment decline over the 90-day period to filter out fluctuations due to factors like seasonal business patterns, ensuring that only actual mass layoffs are identified. For plant closings, it's common for establishments to take time to fully reduce their workforce after a closure decision is made. Hence, we mark the month that is

the auto maker.

[6] Ideally, we would compute the number of layoffs during the 90-day periods using JOLTS data. However, since JOLTS is survey-based, it has measurement issues (Davis et al., 2008) and missing values, which would introduce additional noise into our calculations. In contrast, the employment data from the QCEW is much more reliable. Moreover, during mass layoffs, changes in employment should be a good proxy for the actual number of layoffs.

nine months before the closure as the onset of the closing event and use the employment level at that time as the layoff size to determine if the plant closing meets the coverage criteria.

3.3 Manipulation of Layoff Scale

Some establishments subject to WARN may intentionally adjust the size of their layoffs to avoid triggering the advance notice requirement. Such manipulation suggests that employers may withhold information from employees whenever possible. We examine if such manipulation exists by testing for a discontinuity in layoff scales around the WARN-specified threshold, using the method proposed by McCrary (2008).

Specifically, for establishment i in month m, we first determine whether i is covered by the WARN act in that month based on the criteria outlined in section 3.2.1. If covered, we find the WARN layoff size threshold for i in that month. Next, we calculate the total number of layoffs over the subsequent 90-day period, covering months m, $m+1$, and $m+2$. Layoff rates are then defined as the total layoffs divided by the establishment's employment level 12 months prior, $\frac{\sum_{k=0}^{2} Layoff_{i,m+k}}{Emp_{i,m-12}}$. The running variable for which we test discontinuity is the deviation of layoffs rates from the employer-size normalized WARN threshold, $RunningVar_{im} = \frac{\sum_{k=0}^{2} Layoff_{i,m+k}}{Emp_{i,m-12}} - \frac{Threshold_{im}}{Emp_{i,m-12}}$. We choose the deviation rate over the deviation level as the running variable for two key reasons: (1) rates are easier to interpret and align with the analysis conducted in the following section, and (2) the same level of deviation can imply different degrees of manipulability for establishments of varying sizes, making it necessary to normalize by establishment size. We restrict the sample to establishment-months with positive layoffs.

As a placebo test, we repeat the analysis for establishment-months that are not covered by any WARN Act but would be covered under certain state-level WARN acts if the establishment were located in those states. We calculate the hypothetical WARN thresholds for these establishments and examine whether their layoff rates show any discontinuity around the thresholds.[7]

Additionally, it is important to note that due to the structure of WARN Acts, layoff size thresholds tend to cluster around a few specific values. The most common thresholds are 25, 50, and 500. Since these thresholds are not only prominent in WARN Acts but may also serve as key benchmarks in other legal or managerial contexts, any observed discontinuities around them could be driven by factors unrelated to WARN. To address this concern, we run robustness checks by (1) excluding establishment-months with these three most common thresholds from the sample and redoing the analysis, and (2) examining whether similar discontinuities appear around these thresholds in the

[7] When a placebo establishment is coverable by WARN acts in multiple states, we take the median as the threshold. We also run additional robustness checks by testing for discontinuity around each of the possible state WARN thresholds.

placebo establishment-months.

3.4 Event Studies

Our second empirical exercise examines whether there are excessive voluntary quits before establishments shrink or close and whether the amount of voluntary quits depends on WARN act coverage. Voluntary quits before mass layoff events indicate employees' knowledge about the forthcoming shocks that could lead to layoffs. WARN acts affect the information transparency within a firm by forcing employers to promptly disclose information. If the amount of voluntary quits before establishments shrink or close is greater when the event is covered by WARN acts, it implies that employers have informational advantages over employees.

Specifically, we compare two types of events. The "covered" group of events is mass layoffs or plant closing events that happened in states with state-level WARN acts and are only covered by the state WARN and not by federal WARN. Recall that an event is covered by a WARN act if both the employer size and the layoff size exceed the corresponding thresholds in the act. Hence the covered group also includes establishments with sizes exceeding the federal WARN threshold but are conducting small-scale layoffs that only exceed the state WARN threshold. The "placebo" group of events is mass layoffs or plant closings that happened in states without state-level WARN acts and are not covered by federal WARN act either but would have been covered by a state's mini WARN Act had they occurred in that state. The thought experiment is that we compare two establishments both with 80 workers, one in California, and the other in Michigan. Federal WARN covers firms with 100 or more workers while California WARN covers firms with 75 or more workers, and Michigan does not have state-level WARN. Therefore, when these two establishments undergo mass layoffs/plant closings with a scale exceeding the threshold in California WARN, we can identify the effect of (California) WARN by comparing the trajectory of quits rates in these two establishments.

In addition to quits rates, we also include layoffs rate in our analysis because layoffs and quits are closely related; studying layoffs also helps us better understand patterns in quits.

3.4.1 Covered vs Placebo Events

We begin by analyzing whether the time paths of quits and layoffs during covered events differ from those observed in placebo events.

Mass Layoffs Events An establishment is defined to have initiated a mass layoff event, whether covered or placebo, in month y if its employment keeps declining from y to $y + 3$, with the total reduction exceeding the corresponding WARN Act threshold–actual for covered events or hypothetical for placebo events.

We pool across event months and keep 18 months of data prior to each event month y and 18 months of data after y. The establishment-level outcome variables of interest are the quits rate and layoffs rate. We construct the rate variables by dividing the corresponding level variable by the baseline employment level from month $y-18$. Specifically, $QuitsRate_{im}^{y} \equiv Quits_{im}^{y}/Employment_{i,y-18}$, where $Quits_{im}^{y}$ is the monthly quits of establishment i in month m from JOLTS, and $Employment_{i,y-18}$ is the employment of establishment i in month $y-18$ and is from QCEW. Similarly, $LayoffsRate_{im}^{y} = Layoffs_{im}^{y}/Employment_{i,y-18}$, where $Layoffs_{im}^{y}$ is the total amount of layoffs of establishment i in month m from JOLTS.

Because monthly rates are small and noisy, after constructing the monthly rates, I divide the event window into multiple three-month periods indexed by t. The division of the event window is such that months $y+1$ to $y+3$ constitute relative period $t = 0$ and is illustrated in figure 2. With a slight bend of wording, I call each three-month period a quarter. To derive quarterly rates, I aggregate the monthly quits rates and layoffs rates within each quarter.[8]

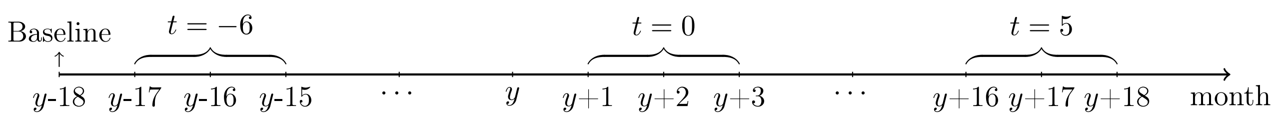


Figure 2: Event Window

To avoid labelling seasonal employment fluctuations as mass layoffs, I drop the following two types of establishments: (i) those that have undergone more than 3 mass layoffs in QCEW data and consistently lay off workers in particular months (ii) those that have undergone more than 3 mass layoffs in QCEW and have an average time gap between two mass layoffs below 12 months. In addition, at the event level, I also require that the establishment-level employment rate, defined as establishment-level employment over the baseline employment, is below 1.5 during the entire event window and the average quarterly new hires rate during the window is below 0.5. Finally, to get rid of outliers, I drop observations with quarterly quits rate or layoffs rate above 1.

We estimate the time paths of outcome variables based on the following event study framework:

$$VarRate_{it}^{y} = \alpha_i^{y} + \alpha_t + \sum_{k=-6}^{5} \gamma_k \times \mathbf{1}\{t=k\} + \sum_{k=-6}^{5} \beta_k \times \mathbf{1}\{t=k\} \times CVG_i^{y} + X_{it}^{y} + \epsilon_{it}^{y} \qquad (1)$$

where $VarRate_{it}^{y}$ is the quits rate or layoffs rate of establishment i in quarter t with the corresponding event month being y, α_i^{y} is the establishment-event month fixed effects, α_t are calendar-

[8] Due to the missing values in JOLTS, we compute the quarterly rate by first computing the average monthly rate using the non-missing values and then multiplying the average monthly rate by 3.

quarter fixed effects[9]. The model also includes leads and lags around event time, $\mathbf{1}\{t = k\}$. CVG_i^y indicates whether the event initiated by establishment i in event month y is a covered event. The coefficients of interest are β_k. β_{-6} is normalized to 0. X_{it}^y represents covariates and includes both the state-level unemployment rate at $t-1$ and establishment employment rate at t. The standard errors are clustered at the establishment level. As robustness checks, we also ran a version of the regression without the calendar quarter fixed effects. The results are similar.

Plant Closing Events The empirical strategy for studying the plant closing events is very similar to mass layoff events, with some small differences. Unlike with mass layoffs, we do not have data after establishment closure, leaving us with 9 months of data following the event month and before the closure.[10] We keep 24 months of data prior to each event month y. The division of the event window is also such that the months $y+1$ to $y+3$ constitute period 0. The rate variables are constructed by dividing the corresponding level variable by the baseline employment level from month $y-24$. In terms of sample restriction, we use all the establishments, including those that have periodic employment fluctuations. And at the event level, we still require that the employment rate is below 1.5 during the entire event window and the average quarterly new hires rate during the window is below 0.5. We also drop observations with quarterly quits rate or layoffs rate above 1.

The regression is identical to the one used for mass layoff events, except that k now ranges from -8 to 2 and β_{-8} is normalized to 0.

3.4.2 Distressed vs Stable Establishments

After comparing the time paths of quits and layoffs in covered versus placebo events, it's also useful to show how these establishment-level outcomes evolve around covered or placebo events in comparison to trends in stable establishments.

For each type of mass layoff or plant closing event, consider a control group of establishments that have similar sizes but are relatively stable in that month.[11] An establishment is defined to be stable in month y if the quarterly employment growth rates are between -5% and $+5\%$ from month $y-3$ to $y+3$.

We use a similar event study framework:

$$VarRate_{it}^y = \alpha_i^y + \alpha_t + \sum_{k=-6}^{5} \gamma_k \times \mathbf{1}\{t = k\} + \sum_{k=-6}^{5} \beta_k \times \mathbf{1}\{t = k\} \times ML_i^y + X_{it}^y + \epsilon_{it}^y \tag{2}$$

[9] I assign the calendar quarter of the second month within the three-month period as the calendar quarter of this period.

[10] Remember that we mark the month that is nine months before the closure as the onset of the closing event, because it's common for establishments to take time to fully reduce their workforce after a closure decision is made.

[11] By similar sizes, we mean that the condition for selecting the treated group of establishments (i.e., establishment size > some WARN threshold) is also applied when selecting the control group.

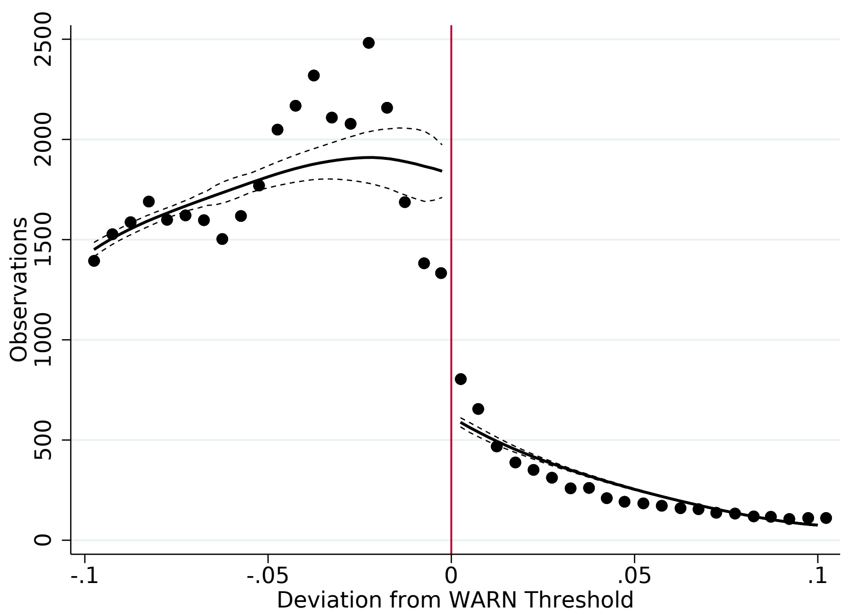
where ML_i^y indicates whether establishment i initiated a mass layoff in event month y. For plant closing events, we use CL_i^y instead, which indicates whether establishment i initiated a plant closure in event month y. And k ranges from -8 to 2. The standard errors are clustered at the establishment level.

4 Empirical Results

4.1 Manipulation of Layoff Scale

Figure 3 shows the McCrary plot for all establishment-months that are covered by WARN acts. We can see that there is discontinuity around zero, which indicates that there is manipulation of layoff sizes.

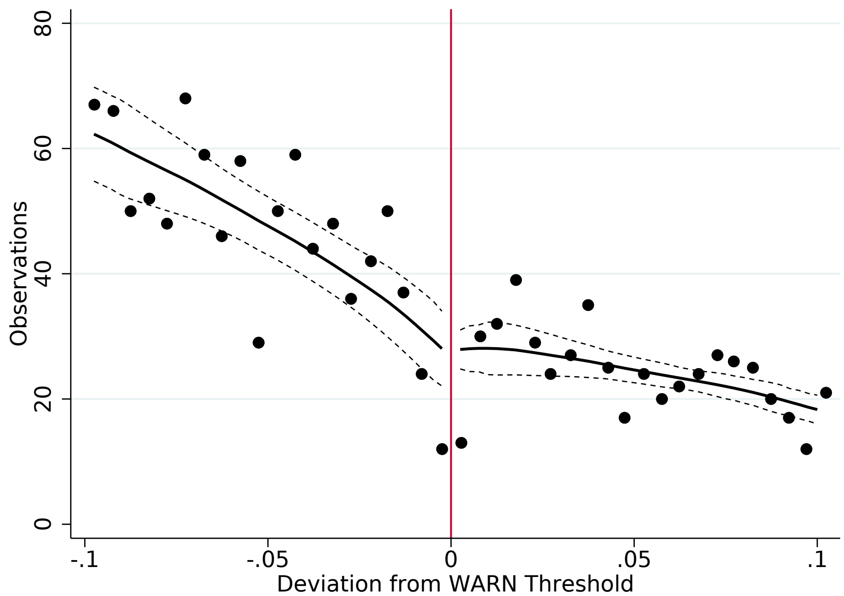
Figure 3: The Distribution of Layoff Rate Deviations from WARN Thresholds



Notes: This figure plots the distribution of the deviation of layoff rates from WARN thresholds (which are also normalized by establishment size 12 months prior). An observation is an establishment-month. Local linear smoothing is conducted separately for the bins to the right and left of zero.

As a placebo test, we repeat the analysis for establishment-months that are not covered by any WARN Act but would be covered under certain state-level WARN acts if the establishment were located in those states. Figure 4 shows the McCrary plot for placebo establishments. The distribution is continuous around zero. When a placebo establishment is coverable by WARN acts in multiple states and has multiple hypothetical thresholds, we take the median as the threshold. As an additional robustness check, in Appendix Figure A.1, we show the results of placebo tests by state. That is, we run the McCrary test on the subset of establishments that are coverable by each state and use the hypothetical threshold in that particular state as the threshold. The results also indicate continuity in distribution around zero.

Figure 4: The Distribution of Layoff Rate Deviations from WARN Thresholds in Placebo Establishments

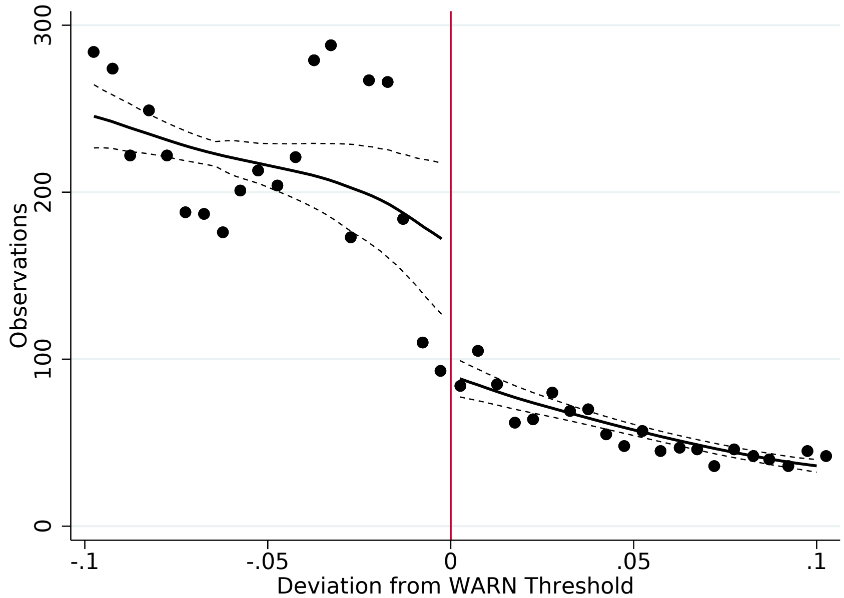


Notes: This figure plots the distribution of the deviation of layoff rates from hypothetical WARN thresholds (which are also normalized by establishment size 12 months prior) in placebo establishments. An observation is an establishment-month. Local linear smoothing is conducted separately for the bins to the right and left of zero.

Finally, to address the concern that layoff size thresholds tend to cluster around a few values, Figure 5 shows the McCrary plot for the subsample where we exclude observations with common and special threshold levels (25, 50, and 500). The discontinuity remains in this subsample, although it is less pronounced. In addition, we also compare the patterns of the running variables when the thresholds are those special values for the covered establishments vs placebo establishments, as shown in Figures 6a and 6b for the threshold of 25 and Appendix Figures A.2a and A.2b for the threshold of 50.[12] For these two special thresholds, we continue to observe a discontinuity around zero in the covered establishments, but not in the placebo establishments.

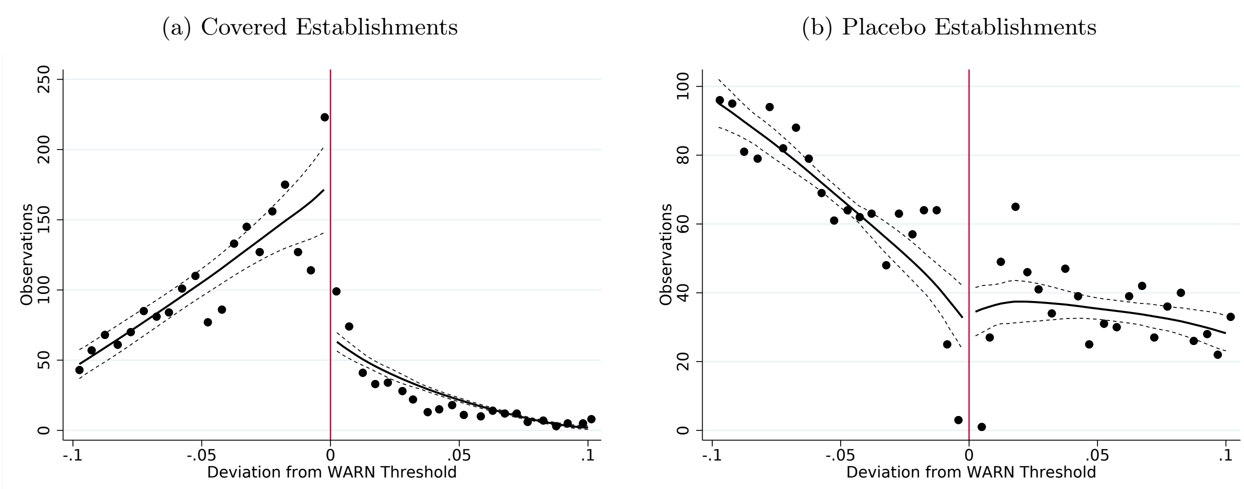
[12]We can not do the same exercise for the threshold of 500 because there is no placebo establishments with a hypothetical threshold of 500.

Figure 5: The Distribution of Layoff Rate Deviations from Less Common WARN Thresholds



Notes: This figure plots the distribution of the deviation of layoff rates from establishment-size normalized WARN thresholds, excluding observations with common and prominent thresholds of 25, 50, and 500. An observation is an establishment-month. Local linear smoothing is conducted separately for the bins to the right and left of zero.

Figure 6: The Distribution of Layoff Rate Deviations When the WARN Threshold Is 25



Notes: This figure plots the distribution of the deviation of layoff rates from establishment-size normalized WARN thresholds when the threshold is 25, separately for covered establishments and placebo establishments. An observation is an establishment-month. Local linear smoothing is conducted separately for the bins to the right and left of zero.

4.2 Event Studies

Before discussing the results of the event studies, it's important to note that the number of covered events in our sample is relatively small: approximately 70 covered closing events and about 360 covered mass layoff events. This small sample size is due to (1) mass layoffs and plant closings being uncommon in the first place (2) the much smaller coverage of the JOLTS dataset compared to QCEW, both in terms of the number of establishments and the number of periods each establishment remains in the sample, and (3) the fact that only 9 states have a state-level WARN in our data.[13]

4.2.1 Covered vs Placebo Events

Figure 7 plots coefficients β_k from regression (1). It shows the trajectory of quits and layoffs around WARN-covered plant closing events in comparison to placebo closing events. The relative quits rate remains stable until it begins to rise two quarters before the closure, while the relative layoffs rate remains stable until it drops in the quarter of the closure. This pattern indicates that workers, upon receiving advance notice, are more likely to quit—likely because they have secured other employment—before the plant closes, reducing the number of layoffs establishments need to conduct at the time of closure. The rise in voluntary quits indicates that the WARN Act is effective in reducing information asymmetry between workers and employers, further implying that, in the absence of legal constraints, employers may hold and potentially exploit private information to their advantage. As a robustness check, we also run a version of regression without calendar fixed effects. The results are similar and are shown in Appendix Figure A.3.

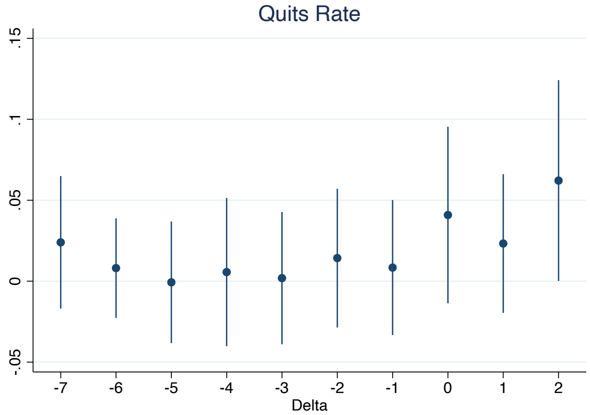
Similarly, figure 8 presents the time paths of the quits rate and the layoffs rate around WARN-covered mass layoff events, relative to placebo mass layoff events. There is no significant difference in the trajectory of quits rates. The relative layoffs rates are slightly lower two to three quarters before mass layoffs. The observed drop in layoffs rates provides indirect and suggestive evidence that quits rates may actually increase slightly during this period, as the reduction in layoffs could be a result of higher quits offsetting the need for layoffs. As a robustness check, we also run a version of regression without calendar fixed effects. The results are similar and are shown in Appendix Figure A.4.

One possible explanation for finding an effect of the WARN Act in plant closing events but not in mass layoff events could be the difference in the magnitude of employment change. In mass layoffs, the percentage change in employment (around 20 to 30 percentage points) is significantly smaller compared to plant closings (100 percentage points). This smaller employment change makes it more

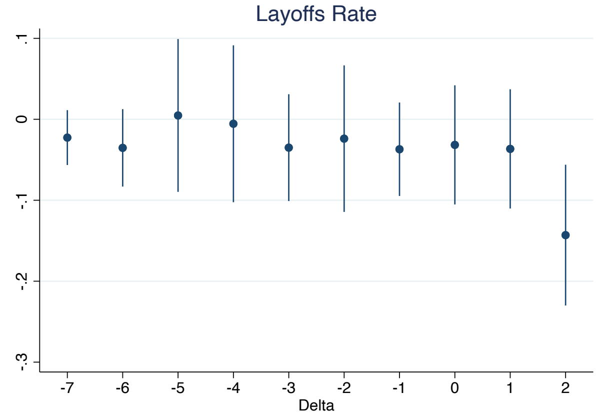
[13] To be precise, twelve states have state-level WARN acts, but New York and Vermont did not grant us access to their data, and Delaware WARN is identical to the federal WARN for our purposes.

Figure 7: Layoffs and Quits around Plant Closings

(a) Covered vs Placebo Events



(b) Covered vs Placebo Events

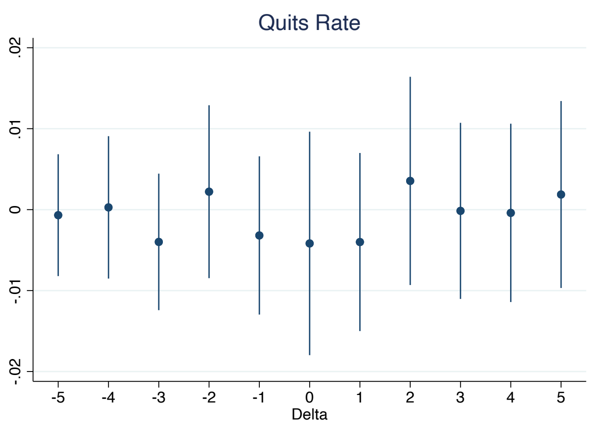


Notes: This figure plots how quits rate and layoffs rate evolve before plant closings from comparing covered events to placebo events. One relative time period (delta) is a quarter. We mark the month that is nine months before the closure as the onset of the closing event, because it's common for establishments to take time to fully reduce their workforce after a closure decision is made. Hence, Delta = 0 represents the quarter when the closure begins, and Delta = 2 represents the actual closure quarter. The baseline period is 8 quarters before the onset. The quits rate (layoffs rate) is calculated as the number of voluntary quits (layoffs) divided by the baseline employment.

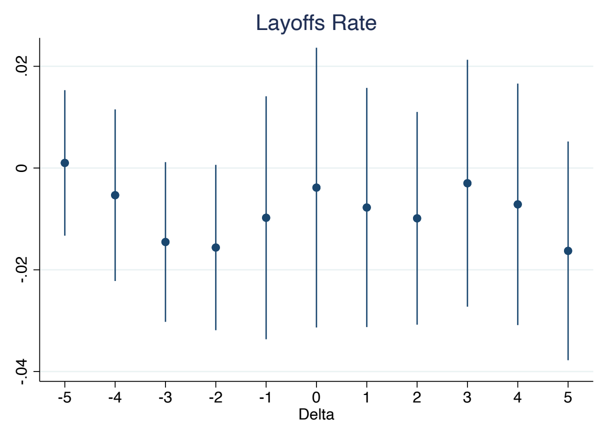
challenging to detect differences in quits and layoffs, particularly quits, which are not only smaller in magnitude than layoffs but also influenced by job market conditions.

Figure 8: Layoffs and Quits around Mass Layoffs

(a) Covered vs Placebo Events



(b) Covered vs Placebo Events



Notes: This figure plots how quits rate and layoffs rate evolve around mass layoffs from comparing covered events to placebo events. One relative time period (delta) is a quarter. Delta = 0 represents the quarter during which the mass layoff is occurring. The baseline period is 6 quarters before the event. The quits rate (layoffs rate) is calculated as the number of voluntary quits (layoffs) divided by the baseline employment.

4.2.2 Distressed vs Stable Establishments

After comparing the time paths of quits and layoffs in covered versus placebo events, we present the trajectory of quits and layoffs during covered and placebo events, respectively, relative to stable establishments.

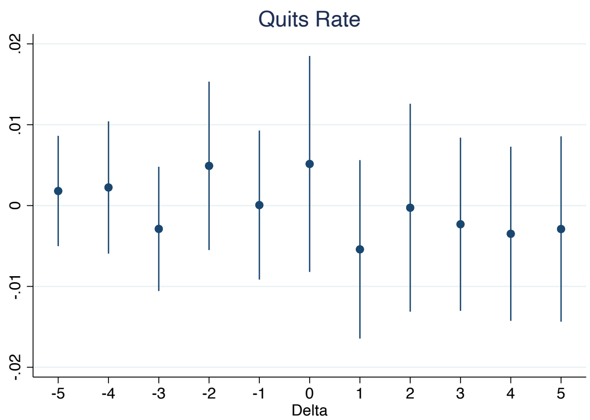
Figure 9 plots coefficients β_k from regression (2) and shows the evolution of quits rate and layoffs rate around mass layoffs, in comparison to stable establishments. For covered events, the time path of quits rate is noisy. If anything, there is only a small and insignificant increase at the mass layoff quarter. And layoffs are concentrated in the mass layoff period. For placebo events, the quits rate trends upward one to two quarters before the event, and is 0.5 percentage points higher at the mass layoff quarter but 1 percentage point lower in every period after the mass layoff. Layoffs begin to increase four quarters before the mass layoff, peaking during the mass layoff quarter. The slight rise in quits rate before mass layoffs not covered by WARN indicates that employees may still pick up on signals about potential layoffs and are not entirely in the dark. One possible source of these signals could be the increase in layoffs, as shown in figure 9d. It's also noteworthy that quits rates remain lower after mass layoffs, which could indicate that workers perceive the likelihood of further mass layoffs in the following year to be low, leading them to reduce precautionary job searches. As a robustness check, we also run a version of regression without calendar fixed effects. The results are similar and are shown in Appendix Figure A.5.

Similarly, figure 10 shows the time path of quits rate and layoffs rate before plant closings, relative to stable establishments. For covered events, although the results are noisy, quits rates start rising two quarters before the actual closure. Layoffs rates drop at the closure quarter—about 5 percentage points lower relative to the baseline and relative to the trends in stable establishments. For placebo events, quits rates are stable before dropping at the last quarter and layoffs rates are stable before jumping up at the last quarter. As a robustness check, we also run a version of regression without calendar fixed effects. The results are similar and are shown in Appendix Figure A.6.

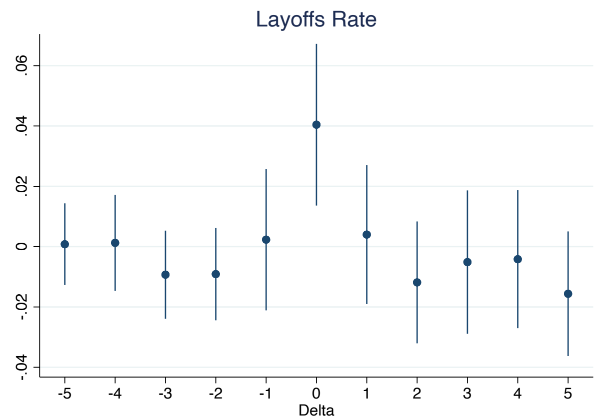
Therefore, the pattern of higher quits rates in covered events compared to trends in placebo events, as shown in figure 7, can be further broken down into covered events having more quits relative to the baseline and relative to trends in stable establishments, and placebo events having relatively fewer quits. Similarly, the pattern of fewer layoffs in covered events compared to trends in placebo events can be further broken down into covered events having fewer layoffs relative to the baseline and trends in stable establishments, and placebo events having relatively more layoffs.

Figure 9: Layoffs and Quits around Mass Layoffs

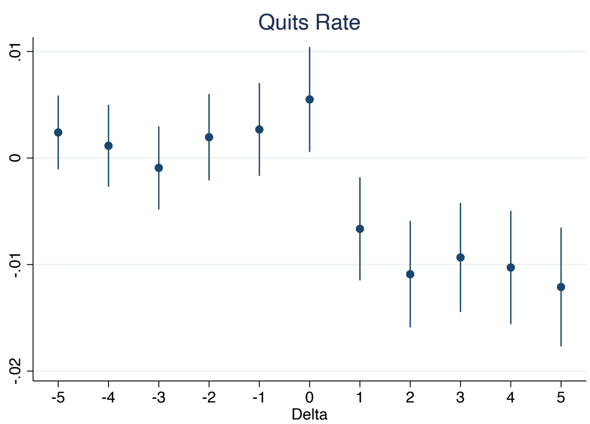
(a) Covered Events vs Stable Establishments



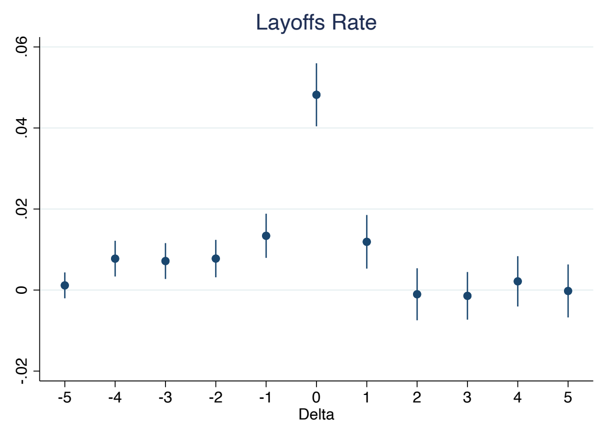
(b) Covered Events vs Stable Establishments



(c) Placebo Events vs Stable Establishments



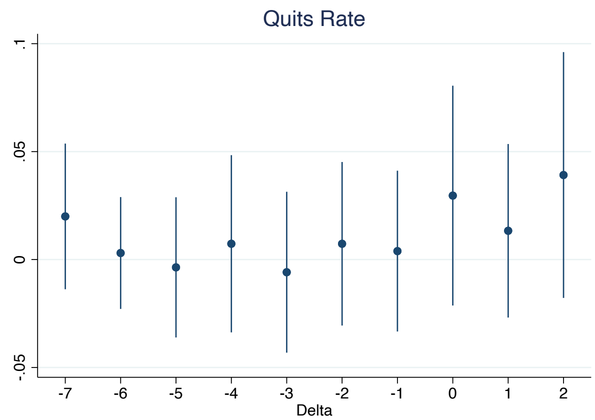
(d) Placebo Events vs Stable Establishments



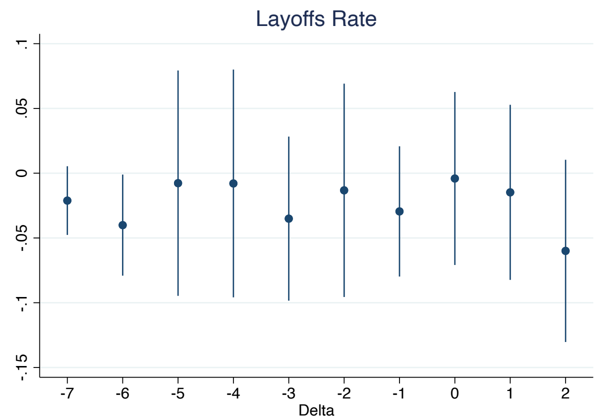
Notes: This figure plots how quits rate and layoffs rate evolve around mass layoffs from comparing distressed establishments to stable establishments. One relative time period (delta) is a quarter. Delta = 0 represents the quarter during which the mass layoff is occurring. The baseline period is 6 quarters before the event. The quits rate (layoffs rate) is calculated the number of voluntary quits (layoffs) divided by the baseline employment.

Figure 10: Layoffs and Quits around Plant Closings

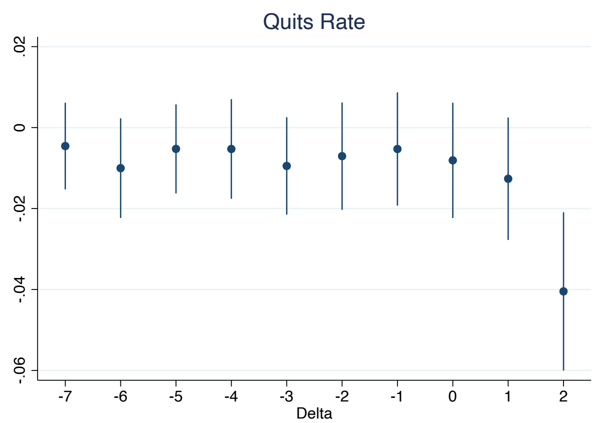
(a) Covered Events vs Stable Establishments



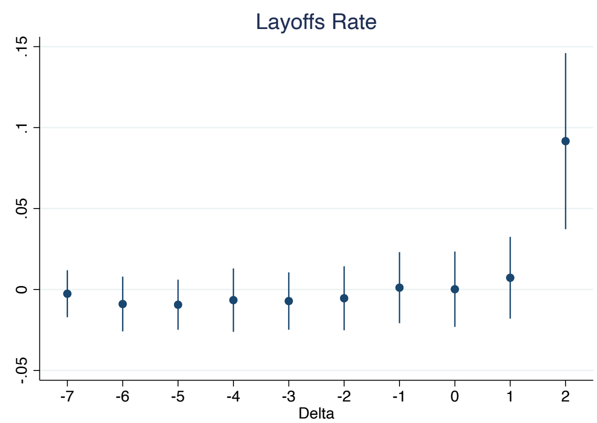
(b) Covered Events vs Stable Establishments



(c) Placebo Events vs Stable Establishments



(d) Placebo Events vs Stable Establishments



Notes: This figure plots how quits rate and layoffs rate evolve before plant closings from comparing distressed establishments to stable establishments. One relative time period (delta) is a quarter. We mark the month that is nine months before the closure as the onset of the closing event, because it's common for establishments to take time to fully reduce their workforce after a closure decision is made. Hence, Delta = 0 represents the quarter when the closure begins, and Delta = 2 represents the actual closure quarter. The baseline period is 8 quarters before the onset. The quits rate (layoffs rate) is calculated as the number of voluntary quits (layoffs) divided by the baseline employment.

5 Model

We extend the standard Mortensen-Pissarides search and matching model to understand the effect of advance notice laws on the labor market. Specifically, we examine how the advance notice law affects equilibrium outcomes and worker welfare. In the model, there is a time lag between when firms receive news of an impending shock and when the shock actually takes effect, breaking the match. Workers, however, remain unaware of the upcoming shock. Firms can choose whether to disclose this information based on whether it is in their best interest. Additionally, workers have the option to search on the job. We explore two scenarios: one where wages are flexible and continually negotiated, and another where wages are bargained in new matches but remain fixed afterward without renegotiation.

5.1 Setup

The setup is similar to a canonical undirected search model (Mortensen and Pissarides, 1994; Pissarides, 2000). Time is continuous. The economy is populated by a set of infinitely-lived and risk-neutral workers with measure one who supply one unit of labor inelastically, alongside a continuum of risk-neutral firms. All agents discount future payoffs at a rate r. Workers can be either unemployed or employed. Unemployed workers derive flow payoff z from non-market activities (like leisure or unemployment insurance) while actively searching for jobs. Employed workers earn a wage and may search on the job. A firm, when matched with a worker, generates output $A > z$. To hire a worker, the firm must maintain a vacancy at a flow cost of k. Free entry conditions drive the value of an open vacancy to zero.

At an exogenous Poisson rate λ, an *idiosyncratic* separation shock is triggered and the firm immediately receives the news. Following this, the shock materializes for the firm at another exogenous Poisson rate δ. Once the shock hits, the firm exits the market, and the worker loses the job and becomes unemployed unless they have already left. Workers are unaware of the impending shock unless their employer discloses it. Workers have the option to search on the job.

Matching between job seekers and vacancies arrives at a Poisson rate $m = m(s+u, v)$ that depends on the on-the-job search rate s, the unemployment rate u and the vacancy rate v. This implies that the flow probability for a job seeker to find a job is $f = \frac{m}{s+u} = m(1, \frac{v}{s+u}) = f(\theta)$, where $\theta \equiv \frac{v}{s+u}$ represents the labor market tightness. Similarly, the flow probability for a firm to find a worker is $q = \frac{m}{v} = q(\theta)$.

5.2 Value Functions

As a benchmark, we begin by characterizing the value functions of firms and workers in a scenario where all agents in the economy have complete information. We then introduce information frictions, assuming that workers are unaware of impending shocks.

5.2.1 Benchmark: Complete Information

Workers We start by writing down the value functions when workers have complete information. We assume that the cost of job search is minimal, such that workers are better off searching on the job when there is a separation shock on the horizon. Hence, the value of an employed worker with a shock impending is

$$rW_3 = w_3 - \sigma + \delta(U - W_3) + f(\theta)(W_1 - W_3)$$

where w_3 is an endogenous wage and σ is the cost of job search and $\sigma \to +0$.

And U is the present value of unemployment and is given by

$$rU = z + f(\theta)(W_1 - U)$$

And W_1 is the value of the employed worker when there is no impending separation shock and is given by

$$rW_1 = w_1 + \lambda(W_3 - W_1)$$

where w_1 is also an endogenous wage, which may or may not differ from w_3.

Firms Firms have complete information about the state of the firm. When there is no shock on the horizon, the net present value of a firm is J_1^n if workers do not search on the job and is J_1^n if workers search on the job. Specifically,

$$rJ_1^n = A - w_1 + \lambda(J_3 - J_1^n)$$

$$rJ_1^s = A - w_1 + \lambda(J_3 - J_1^s) - f(\theta)J_1^s$$

where J_3 is the net present value of a firm when there is a shock on the horizon and $J_3 = J_3^n$ if workers do not search on the job and $J_3 = J_3^s$ if workers search on the job. Specifically,

$$rJ_3^n = A - w_3 - \delta J_3^n$$

$$rJ_3^s = A - w_3 - (\delta + f(\theta))J_3^s \tag{3}$$

Finally, the free entry condition means that the flow cost of a vacancy k must equal the flow probability that the vacancy gets filled times the value of a firm

$$k = q(\theta)J_1 \tag{4}$$

5.2.2 Information Frictions

Workers In scenarios where workers do not have information about the state of their employer, they rely on their own expectations. Let time 0 denote the moment when the firm and worker first pair. At time t, the worker infers the probability that no impending shock has been triggered by time t is π_t and $\mathrm{d}\pi_t/\mathrm{d}t < 0$. The expression of π_t is provided in Appendix B.1.

When workers have to rely on their own beliefs, they start searching on the job immediately after being matched with an employer. This is because the cost of search is assumed to be minimal, and π_t is less than one in their current match, but equal to one in a new match. Hence, the (perceived) value of an employed worker is[14]

$$rW_2(t) = w_{2t} + \pi_t\lambda[W_4 - W_2(t)] + (1-\pi_t)\delta[U_2 - W_2(t)] + f(\theta)[W_2(0) - W_2(t)] + \frac{\partial W_2(t)}{\partial t}$$

where w_{2t} is an endogenous wage.

And U_2 is the expected returns of unemployment in this scenario and is given by

$$rU_2 = z + f(\theta)[W_2(0) - U_2]$$

And W_4 is the value of the worker when there is an impending shock

$$rW_4(t) = w_{2t} + \delta(U_2 - W_4(t)) + f(\theta)[W_2(0) - W_4(t)] + \frac{\partial W_4(t)}{\partial t}$$

Firms: Perceived Values From workers' perspective, the value of a firm is

$$r\tilde{J}_2(t) = A - w_{2t} + \pi_t\lambda[J_4(t) - \tilde{J}_2(t)] - (1-\pi_t)\delta\tilde{J}_2(t) - f(\theta)\tilde{J}_2(t) + \frac{\partial \tilde{J}_2(t)}{\partial t}$$

And $J_4(t)$ is the value of the firm when there is an impending shock

$$rJ_4(t) = A - w_{2t} - [\delta + f(\theta)]J_4(t) + \frac{\partial J_4(t)}{\partial t} \tag{5}$$

Firms: Actual Values Since workers are always searching on the job, the net present value of a firm

[14] We are omitting the cost of search term σ under our assumption that $\sigma \to +0$.

when there is no impending shock is

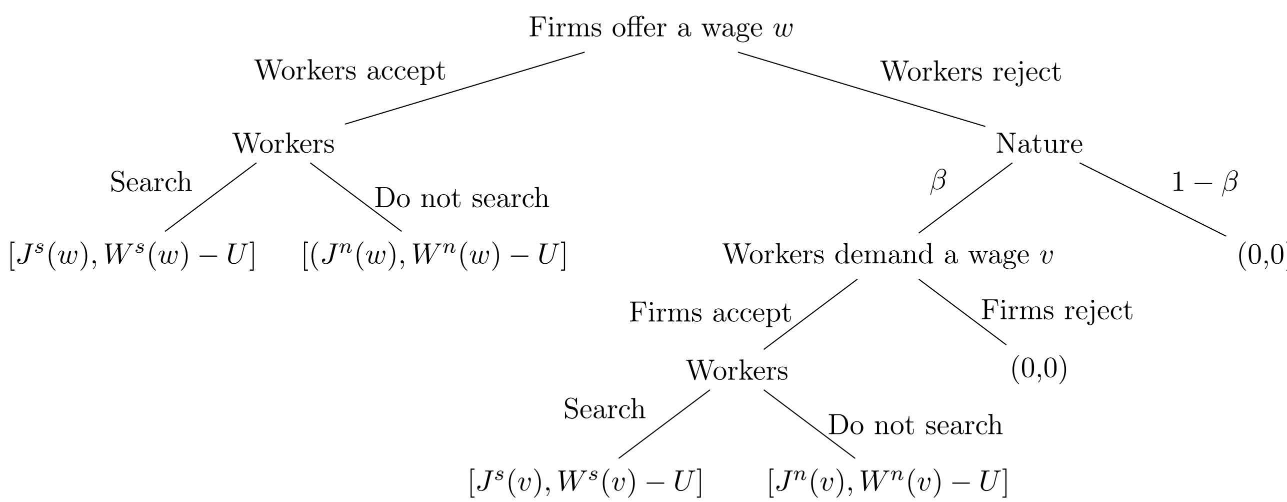
$$rJ_2(t) = A - w_{2t} + \lambda[J_4(t) - J_2(t)] - f(\theta)J_2(t) + \frac{\partial J_2(t)}{\partial t}$$

And the value when there is an impending shock is given by equation (5).

5.3 Wage Negotiation

With the value functions established, we now turn to wage determination and characterize the corresponding equilibrium outcomes. Following Morales-Jiménez (2022), we assume that wages are continually negotiated through a simple game where firms and workers bargain over the match surplus.[15] The extensive form of the game is illustrated in Figure 11. First, firms offer a wage of w to the worker. If workers decide to accept the wage offer, they then decide whether they want to search on the job or not. And the game ends with payoffs of $W^n(w) - U$ (or $W^s(w) - U$ if searching) to the worker and $J^n(w)$ (or $J^s(w)$ if searching) to the firm.[16] If workers reject the wage offer, the match breaks with an exogenous probability of $1-\beta$, and both parties receive zero payoffs. Otherwise, workers demand a wage of v. If firms accepts the wage offer, workers then choose whether they search on the job or not. And the game ends with payoffs of $W^n(v) - U$ (or $W^s(v) - U$ if searching) to the worker and $J^n(v)$ (or $J^s(v)$ if searching) to the firm. Otherwise, the match is destroyed and both parties receive zero payoffs.

Figure 11: Wage Negotiation Game



Although our model assumes that workers lack complete information, the equilibrium with com-

[15] We begin with the assumption of flexible wages, but we will later consider the case of rigid wages, where negotiation occurs only in new matches.

[16] For simplicity, we use W^n, W^s and J^n, J^s to represent the value of workers and firms without explicitly specifying the subscripts to encompass all possible scenarios.

plete information serves as an important benchmark. Hence, we first characterize the equilibrium of the wage bargaining game under complete information in the following lemma. We will then explore the conditions under which the complete information equilibrium can be achieved despite workers having incomplete information, as well as other possible equilibria under information frictions.

Lemma 1. *If both workers and firms have complete information about any impending shock, the following strategy profiles constitute the unique sub-game perfect Nash equilibrium of this game:*

- *Workers: (i) When there is no impending shock, do not search on the job and accept wage offers at or above w_1^* in the first stage, and demand a wage equal to v_1^* in the second stage. (ii) When there is an impending shock, search on the job and accept wage offers at or above w_3^* in the first stage, and demand a wage equal to v_3^* in the second stage.*

- *Firms: (i) When there is no impending shock, offer w_1^* in the first stage and accept wage demands that are at or below v_1^* in the second stage. (ii) When there is an impending shock, offer w_3^* in the first stage and accept wage demands that are at or below v_3^* in the second stage.*

w_1^* and v_1^* satisfy $J_1^n(w_1^*) = (1-\beta)S_1$ and $J_1^n(v_1^*) = 0$, where $S_1 = W_1 - U + J_1^n$ is the match surplus when there is no impending shock.

w_3^* and v_3^* satisfy $J_3^s(w_3^*) = (1-\beta)S_3$ and $J_3^s(v_3^*) = 0$, where $S_3 = W_3 - U + J_3^s$ is the match surplus when there is an impending shock.

Proof. See Appendix B.2 □

Hence, under complete information, the solution to this wage bargaining game coincides with the Nash bargaining solution in a canonical search model, with the worker's bargaining power set to β.

With the complete information equilibrium as a benchmark, we next explore whether this equilibrium can be achieved when workers have incomplete information.

The complete information equilibrium can still be achieved if firms disclose information promptly. Firms may have incentives to do so because disclosing news about an impending shock can lead workers to believe that the match surplus is lower, thereby allowing firms to offer lower wages. The following lemma outlines the conditions under which the complete information equilibrium can be achieved despite information asymmetry.

Lemma 2. *Suppose that workers do not have information about the state of the employer.*

When $\beta > \frac{r+\lambda}{r+\lambda+\delta}$, there exists a Perfect Bayesian equilibrium equilibrium that replicates the complete information equilibrium, in which firms disclose the information promptly and strategy profiles of both parties coincide with those outlined in Lemma 1

When $\beta < \frac{r+\lambda}{r+\lambda+\delta}$, there does not exist an equilibrium that replicates the complete information equilibrium.

Proof. See Appendix B.3 ☐

Whether there exists an equilibrium that replicates the complete information equilibrium depends on firms' disclosure decision. Firms face a tradeoff in their disclosure decision. On one hand, disclosing the information makes workers believe that the match surplus is lower, allowing firms to offer a lower wage w_3^*. On the other hand, if firms choose to conceal the information, they must continue paying the high wage w_1^*, but workers, believing there is no impending shock, will not search on the job, which increases the match surplus and firms' value.

When $\beta < \frac{r+\lambda}{r+\lambda+\delta}$, firms find it optimal to conceal information and consistently pay workers the high wage w_1^*. Intuitively, when β is small, workers have low bargaining power and firms capture a large share of the match surplus. In this case, the wage savings from being transparent, $w_1^* - w_3^*$, are small relative to the increase in firms' value from workers believing there is no impending shock and not searching. And firms are incentivized to consistently pay workers the slightly higher wage w_1^* to discourage on-the-job search, thereby increasing the match surplus, from which they capture a significant share. Additionally, this condition is less likely to hold when δ is larger, meaning that the time lag between the onset and materialization of the shock is shorter and the shock is more imminent. This is also intuitive because it would not make sense for firms to continue offering higher wages when the shock is so imminent that workers' job search efforts have minimal impact on the timing of the separation.

After gaining insight into the conditions under which the complete information equilibrium can be replicated even in the presence of information frictions, we proceed to characterize possible equilibria under information frictions more generally. Two scenarios arise: (1) firms withhold information, leaving workers to rely on their own noisy beliefs about the state, or (2) firms promptly reveal the information to workers but must offer different wages than in the complete information equilibrium to convince workers of their commitment to information transparency.

We characterize the truth-concealing equilibrium corresponding to scenario (1) in Lemma 3 and the truth-telling equilibrium corresponding to scenario (2) in Lemma 4.

Lemma 3 shows that when firms withhold information and workers have to rely on their noisy beliefs, despite the fact that workers' beliefs and perceived match surplus change over time, the equilibrium wage path remains constant.

Lemma 3. *Suppose that workers do not have information about the state of the employer. If there is a truth-concealing equilibrium where the firm's strategy is to withhold information, then the best* *strategy profiles of firms and workers are as follows*

- *Workers: search on the job and accept wage offers at or above* w_{2t}^* *in the first stage, and demand a wage equal to* v_{2t}^* *in the second stage.*

- *Firms: offer* w_{2t}^* *in the first stage and accept wage demands that are at or below* v_{2t}^* *in the second stage.*

w_{2t}^* *and* v_{2t}^* *satisfy* $\tilde{J}_2(t, w_{2t}^*) = (1-\beta)\tilde{S}_2(t)$ *and* $\tilde{J}_2(t, v_{2t}^*) = 0$*, where* $\tilde{S}_2(t) = W_2(t) - U_2 + \tilde{J}_2(t)$ *is the match surplus perceived by workers. Further,* w_{2t}^* *is constant over time and* $w_{2t}^* = w_3^*$*.*

Proof. See Appendix B.4 □

Intuitively, by backward induction, in the second stage of the game, firms will accept the wage proposal as long as that leaves firms' value non-negative. Hence, workers will demand a wage v_{2t}^* that, according to their beliefs, sets firms' value to zero, which leaves workers with a payoff of $\tilde{S}_2(t)$ in the second stage. Therefore, in the first stage, the firm knows that workers will not accept a wage offer that makes their value lower than $\beta\tilde{S}_2(t)$, the expected value they can get if they turn down the offer, and that if it cannot get workers to accept the wage it will get zero payoff in the next stage. Hence, the firm will offer a wage that gives workers exactly that level of payoff, leaving the firm with a positive payoff of $(1-\beta)\tilde{S}_2(t)$.

Further, to understand intuitively why w_{2t}^* is time-invariant and equal to w_3^*, let's first consider the dynamics of the match surplus over time. As time progresses, the surplus from the match declines, which implies that w_2^* should be non-increasing over time. Now, consider the long-term behavior of w_{2t}^*. Over time, w_{2t}^* should converge to w_3^*, the wage offer that prevails when there is an imminent shock and both the worker and employer are aware of that. Next, consider the possible values $w_{2,0}^*$ can take. At the start of each match, workers may not know exactly when the separation shock will be triggered, but they understand the arrival process of the shock. This means that their perceived match surplus at time 0, $\tilde{S}_2(0)$, should be equal to the actual expected match surplus at the beginning of each match. If w_{2t}^* is constant over time and is equal to $w_{2,0}^*$, then $w_{2,0}^*$ has to equal to w_3^*. This is because workers always search on the job, regardless of whether there is an imminent shock, meaning the only difference between the two states is the effective discount rate, which does not impact the negotiated wage. This also automatically rules out the possibility that w_{2t}^* is time-variant. If w_{2t}^* were time-variant, the workers' surplus would exceed $\beta\tilde{S}_2(0)$, as the average wage would be higher than w_3^*, given that w_{2t}^* is non-increasing and asymptotes to w_3^*.

Next, in Lemma 4, we characterize the truth-telling equilibrium where firms promptly reveal the information to workers and have to convince workers of their commitment to information transparency.

Lemma 4. *Suppose that workers do not have information about the state of the employer. If there exists a truth-telling equilibrium where firms promptly disclose information, such equilibrium is unique. Specifically,*

When $\beta > \frac{r+\lambda}{r+\lambda+\delta}$*, such equilibrium replicates the complete information equilibrium.*

When $\beta < \frac{r+\lambda}{r+\lambda+\delta}$*, firms' best strategies would be slightly different from those in the complete information equilibrium in that they offer a higher wage* $w_1^{**} > w_1^*$ *when there is no impending shock. And* $w_1^{**} = w_3^* + f(\theta)J_3^s$*.*

Proof. See Appendix B.5 □

Note that under any truth-telling equilibrium, firms' wage offer when there is an impending shock has to be equal to the wage offer in the complete information case, w_3^*. They cannot offer a lower wage, because they know that workers will reject the offer in this stage and demand a wage that leave no surplus for firms in the second stage. They will not offer a higher wage, as that only lowers their profits. For firms' wage offer when there is no impending shock, it must satisfy two conditions. First, the wage offer w_1 has to high enough be acceptable to workers in the bargaining game, meaning it must exceed w_1^*. Second, in order to sustain a truth-telling equilibrium, firms have to credibly demonstrate to workers that they will promptly disclose the news, by making sure that the wage offer when there is no impending shock, w_1, is sufficiently higher than the wage offer when there is an impending shock, w_3^*. Taken together, when there is no impending shock, firms will offer a wage that is high enough to satisfy both criteria, but not higher as firms' profits decrease with their wage offers. When $\beta > \frac{r+\lambda}{r+\lambda+\delta}$, w_1^* also satisfies the second condition, so the complete information equilibrium is replicated. However, when $\beta < \frac{r+\lambda}{r+\lambda+\delta}$, firms have to increase the wage offer above w_1^* to convince workers of their commitment to information transparency.

Having characterized the possible equilibria under information frictions, we move on to equilibrium refinement, as both truth-concealing and truth-telling equilibria can exist within a given parameter space, and some of these equilibria appear to be fragile. Specifically, we apply the intuitive criterion (Cho and Kreps, 1987) to narrow down the potential equilibrium outcomes.

Lemma 5. *Suppose that workers do not have information about the state of the employer. The Perfect Bayesian equilibrium characterized in Lemma 4 (the truth-telling equilibrium) satisfies the Intuitive Criterion, whereas the Perfect Bayesian equilibrium characterized in Lemma 3 (the truth-concealing equilibrium) does not satisfy the Intuitive Criterion.*

Proof. See Appendix B.6 □

The truth-telling equilibrium is the only one that satisfies the Intuitive Criterion. In the parameter space where the complete information equilibrium can be replicated ($\beta > \frac{r+\lambda}{r+\lambda+\delta}$), this is intuitive, as revealing information maximizes the match surplus and, in turn, the firm's value. In the parameter space where the complete information equilibrium cannot be replicated ($\beta < \frac{r+\lambda}{r+\lambda+\delta}$), firms face a trade-off between offering workers higher wages when there is no impending shock to prevent them from doing precautionary job search and leaving prematurely, and offering consistently low wages, which leads workers to always search on the job. And it turns out that the benefit to firms from preventing precautionary job search and extending the match duration always outweighs the cost of paying a higher wage when there is no impending shock.

Clearly, the results we have obtained so far hinge critically on the assumption that wages are flexible and subject to renegotiation. If wages are rigid—bargained only at the start of new matches but not renegotiated over time—firms lose the ability to use wage differences to credibly signal their commitment to information transparency, leading workers to always search on the job. Lemma 6 characterizes the equilibrium under rigid wages.

Lemma 6. *Suppose that workers do not have information about the state of the employer. If wages are bargained in new matches but then not continually renegotiated, the following strategy profiles form the unique sub-game perfect equilibrium.*

- *Workers: At $t = 0$, accept wage offers at or above w_2^* in the first stage, and demand a wage equal to v_2^* in the second stage. At $t > 0$, search on the job.*
- *Firms: offer w_2^* in the first stage and accept wage demands that are at or below v_2^* in the second stage.*

w_2^* and v_2^* satisfy $J_1^s(w_2^*) = (1-\beta)S_1^s$ and $J_1^s(v_2^*) = 0$, where $S_1^s = W_1 - U + J_1^s$ is the match surplus when workers always search on the job. Further, we can show that $w_2^* = w_3^*$.

Proof. See Appendix B.7 □

Given the importance of the wage flexibility assumption for the equilibrium outcomes, we will discuss results under both flexible and rigid wages in the following sections.

5.4 The Effects of Advance Notice Law

After characterizing the equilibrium outcomes under information frictions, we now turn to discussing the effects of advance notice law under both flexible and rigid wages.

We assume that, under the advance notice law, firms will disclose any information they have promptly, so that the complete information equilibrium is fully restored. To examine the effects of advance notice law, we begin by characterizing the labor market equilibrium under complete information in Lemma 7.

Lemma 7. *The following equations determine the equilibrium labor market tightness and worker distribution under complete information, whether wages are rigid or flexible*

$$u = \frac{1}{1 + (\frac{1}{\lambda} + \frac{1}{\delta})f(\theta) + \frac{1}{\lambda\delta}f(\theta)^2}, \quad x = \frac{f(\theta)}{\lambda + f(\theta)}, \quad y = u\frac{f(\theta)}{\delta}, \quad v = (u+y)\theta$$
$$(1-\beta)(A-z)(1 + \frac{\lambda}{r+\delta+f(\theta)})(\frac{1}{r+\lambda+\beta f(\theta)}) = \frac{k}{q(\theta)}$$

where x denotes the mass of workers whose employers do not have an impending shock and y denotes the mass of workers whose employers have an impending shock.

The welfare of workers is the present discounted value of total wages and is given by

$$r\mathcal{W} = uz + xw_1^* + yw_3^* \text{ if flexible wage;} \quad r\mathcal{W} = uz + (1-u)\bar{w} \text{ if rigid wage}$$

where $\bar{w}$ is the wage bargained in new matches under complete information and $w_3^* < \bar{w} < w_1^*$.

Proof. See Appendix B.8 □

Workers are distributed across three possible states: unemployment, employed without an impending shock, and employed with an impending shock. In the steady state, the inflow to each state must equal the outflow, which determines the mass of workers in each and provides the expressions for u and y. Since both unemployed workers and those employed with an impending shock are searching, we have $\theta = \frac{v}{u+y}$ and $v = (u+y)\theta$. The last equation arises from the free entry condition of firms and determines the equilibrium labor market tightness.

After characterizing the labor market equilibrium in the complete information case, we can now compare equilibrium outcomes under information frictions with it to examine the effects of the advance notice law that eliminates these frictions. Specifically, we look at how the law affects various outcomes such as labor market tightness, the unemployment rate, and the welfare of workers.

We start with the scenario where wages are continually renegotiated.

Lemma 8. *Suppose wages are continually renegotiated. Suppose that workers do not have information about the state of the employer.*

When $\beta > \frac{r+\lambda}{r+\lambda+\delta}$, the equilibrium replicates the complete information equilibrium, so the advance notice law does not have an effect on the equilibrium outcomes.

When $\beta < \frac{r+\lambda}{r+\lambda+\delta}$, the following equations determine the equilibrium labor market tightness and *worker distribution*

$$u = \frac{1}{1+(\frac{1}{\lambda}+\frac{1}{\delta})f(\theta)+\frac{1}{\lambda\delta}f(\theta)^2}, \quad x = \frac{f(\theta)}{\lambda+f(\theta)}, \quad y = u\frac{f(\theta)}{\delta}, \quad v = (u+y)\theta$$
$$(1-\beta)(A-z)(1+\frac{\delta}{r+\lambda})\frac{1}{r+\delta+f(\theta)} = \frac{k}{q(\theta)}$$

The welfare of workers is given by

$$r\mathcal{W} = uz + xw_1^{**} + yw_3^*$$

Introducing the advance notice law to this environment increases the equilibrium labor market tightness and decreases the unemployment rate. The law increases the value of a job for firms but reduces the net value of employment for workers. The law could decrease the welfare of workers, especially when β is small.

Proof. See Appendix B.9 □

When $\beta < \frac{r+\lambda}{r+\lambda+\delta}$, the advance notice law increases the value of a job for firms, because with the law in place, firms no longer need to "buy" trust, which is valuable to them, from workers, as the government's mandate grants them credibility. By increasing the value of a job, the law encourages job creation and thereby increases the equilibrium labor market tightness. In terms of the effects of the law on workers, it is clear that the law reduces the net value of employment, as workers receive lower wages and the match duration is shorter with a higher job finding rate. However, the impact on worker welfare is less straightforward. While workers may earn lower wages when employed, the law also reduces their time spent in unemployment. This decrease in unemployment probability could offset some of the negative effects of lower wages, leading to a more nuanced overall effect on worker welfare. When β is relatively small, the wage reduction induced by the law is significant, resulting in lower worker welfare.

Next, we discuss the effects of the law in a scenario where wages are rigid, meaning they are bargained in new matches but then not continually renegotiated.

Lemma 9. *If wages are bargained in new matches but then not continually renegotiated, the following equations determine the equilibrium labor market tightness and worker distribution.*

$$u = \frac{1}{1+(\frac{1}{\lambda}+\frac{1}{\delta})f(\theta)+\frac{1}{\lambda\delta}f(\theta)^2}, \quad x = \frac{f(\theta)}{\lambda+f(\theta)}, \quad y = u\frac{f(\theta)}{\delta}, \quad v = \theta$$
$$(1-\beta)(A-z)(1+\frac{\lambda}{r+\delta+f(\theta)})(\frac{1}{r+\lambda+f(\theta)}) = \frac{k}{q(\theta)}$$

The welfare of workers is given by

$$r\mathcal{W} = uz + (1-u)w_3^*$$

Introducing the advance notice law to this environment increases the equilibrium labor market tightness and decreases the unemployment rate. The law increases the value of a job for firms and increases the net value of employment for workers. The law increases the welfare of workers.

Proof. See Appendix B.10 □

The advance notice law eliminates the unnecessary precautionary on-the-job search among workers and increases the match surplus. Workers always get a fixed fraction, β, of the match surplus, while firms retain the remainder, whether or not the law is in place. Therefore, both the value of a job for firms and the net value of employment for workers increase. By increasing the value of a job, the law encourages job creation and thereby increases the equilibrium labor market tightness. Also, it is obvious that the law increases the worker welfare as workers receive higher wages and are at the same time less likely to be in unemployment.

Empirically, we observe an increase in voluntary quits prior to mass layoffs–especially those induced by plant closings–in firms covered by the WARN Act compared to the trend in the control group not covered by the Act. This suggests that we are likely in an economy where wages are somewhat rigid, because when wages are flexible and subject to continual renegotiation, firms would be revealing information even in the absence of the Act, meaning that the WARN Act would not impact workers' search behavior. On the other hand, when wages are rigid, voluntary quits should remain consistently elevated in the absence of the Act due to workers' precautionary on-the-job search. With the Act in place, voluntary quits during normal periods without an impending shock should be low, only rising when a separation shock is triggered. Wage rigidity might seem at odds with another piece of our empirical evidence: firms manipulating layoff sizes to avoid mandated disclosures. Under rigid wages, the WARN Act would increase the value of a job for firms, and they should welcome such regulation. However, our findings show firms are actively avoiding the notification requirements. These two points can, in fact, be consistent. Firms support the introduction of WARN Act, but once the Act is in place, with weak enforcement, they would still seek to avoid triggering notifications to prevent premature worker departures. Weak enforcement could undermine the WARN Act's effectiveness if workers lose trust in it, but this issue lies outside the scope of our discussion. Therefore, in our context, the WARN Act is likely to be welfare-improving for workers. However, it is important to note that the advance notice law may not always improve worker welfare, particularly in situations where wages are flexible and can already serve as a means to credibly convey information about the firm's health.

6 Conclusion

This study provides important insights into the information asymmetry between employers and employees surrounding impending mass layoffs and plant closings. By leveraging variations in the coverage of the WARN Act across states, we examine whether employers have information advantages by testing whether there is excessive voluntary quits in WARN-covered mass layoffs or plant closings events. Our analysis shows that the quits rate is 12 percentage points higher and the layoffs rate is 14 percentage points lower in WARN-covered plant closing events, relative to the baseline and relative to the trends in placebo events. However, the results for mass layoff events are mixed due to the lack of statistical power. Additionally, we observe a discontinuity in layoff rates around the WARN thresholds. Our findings demonstrate that employers have information advantages over employees and tend to withhold information on future employment disruptions, potentially manipulating layoff sizes to avoid mandated disclosures.

Using an extended search-and-matching model with information asymmetry and on-the-job search, I characterize labor market equilibrium under both flexible and rigid wages and show how advance notice laws like the WARN Act affects equilibrium labor market outcomes. When wages are flexible, firms disclose information to reduce precautionary on-the-job search, despite sometimes needing to offer higher wages in the no-impending-shock state to credibly demonstrate their commitment to transparency. The advance notice law weakly increases the value of a job for firms by providing them government-backed credibility, which boosts job creation, increases labor market tightness, and reduces unemployment. For workers, the law reduces the net value of employment by lowering wages and shortening match duration, but its impact on welfare is mixed since it also reduces unemployment. We show that the law could decrease worker welfare, especially when workers' bargaining power is low. When wages are rigid, firms cannot credibly assure workers of prompt information disclosure, making withholding information their only option. The advance notice law eliminates the precautionary on-the-job search among workers and increases the match surplus. Our empirical evidence is consistent with the predictions under wage rigidity: without the WARN Act, voluntary quits remain consistently high due to precautionary job search, but with the Act, quits are low during normal periods and rise only when a separation shock is triggered. Therefore, in our context, the WARN Act is likely to be welfare-improving for workers.

Overall, while advance notice laws like the WARN Act may reduce information asymmetry and support workers during employment disruptions, their benefits can vary depending on labor market factors like wage renegotiation frequency. Further research into the nature of information asymmetry between employers and employees could help refine these laws and provide insights for developing more effective, welfare-improving policy tools.

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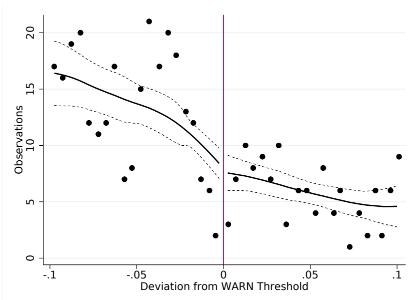
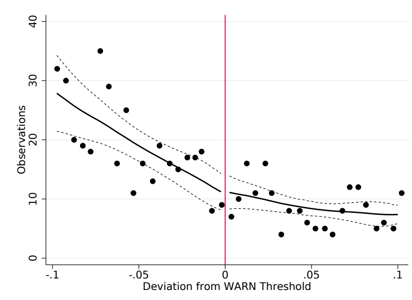
Appendix A Supplementary Figures and Tables

Figure A.1: The Distribution of Layoff Rate Deviations from WARN Thresholds in Placebo Establishments

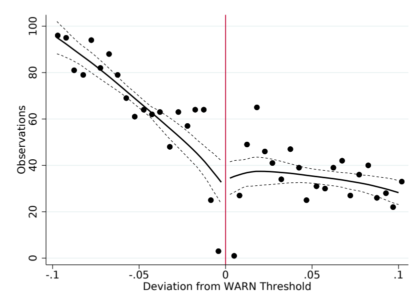
(a) California



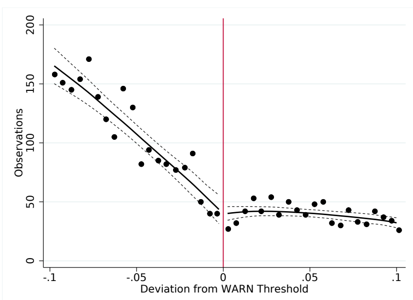
(b) Illinois



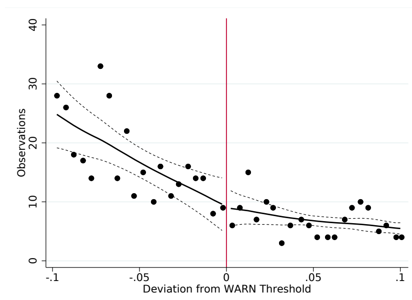
(c) Iowa



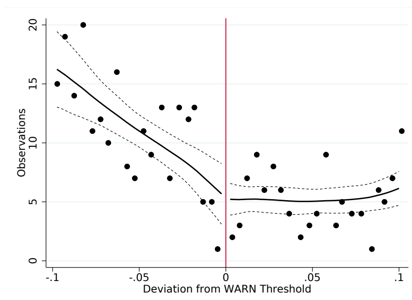
(d) Maryland



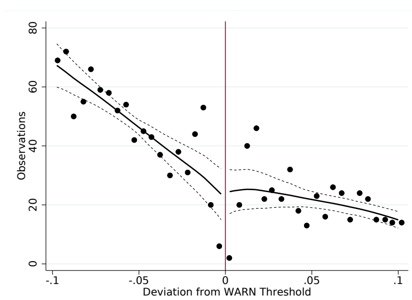
(e) New Hampshire



(f) Tennessee



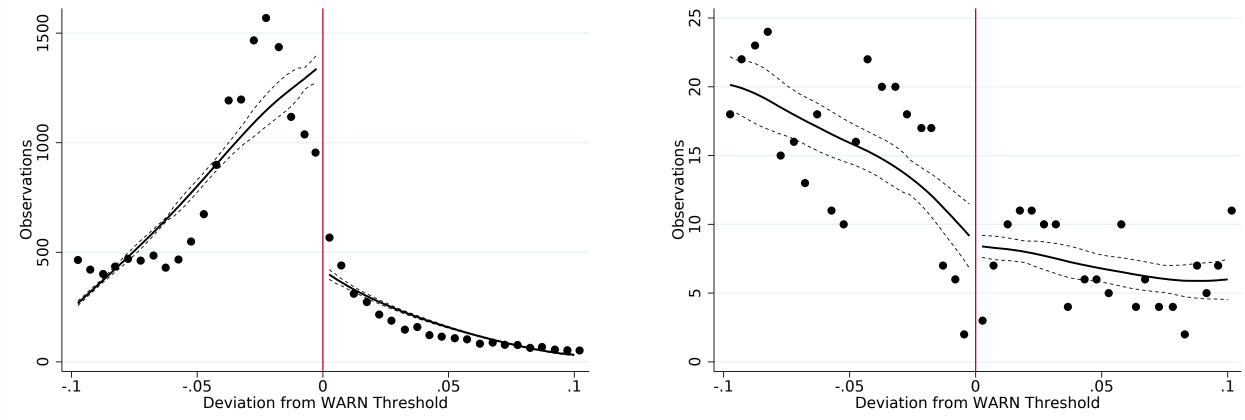
(g) Wisconsin



Notes: This figure plots, for each state with a WARN act, the distribution of the deviation of layoff rates from hypothetical WARN thresholds (which are also normalized by establishment size 12 months prior) in placebo establishments that are not covered by any WARN acts but would be covered by the state's WARN if they were located in that state. An observation is an establishment-month. Local linear smoothing is conducted separately for the bins to the right and left of zero.

Figure A.2: The Distribution of Layoff Rate Deviations When the WARN Threshold Is 50

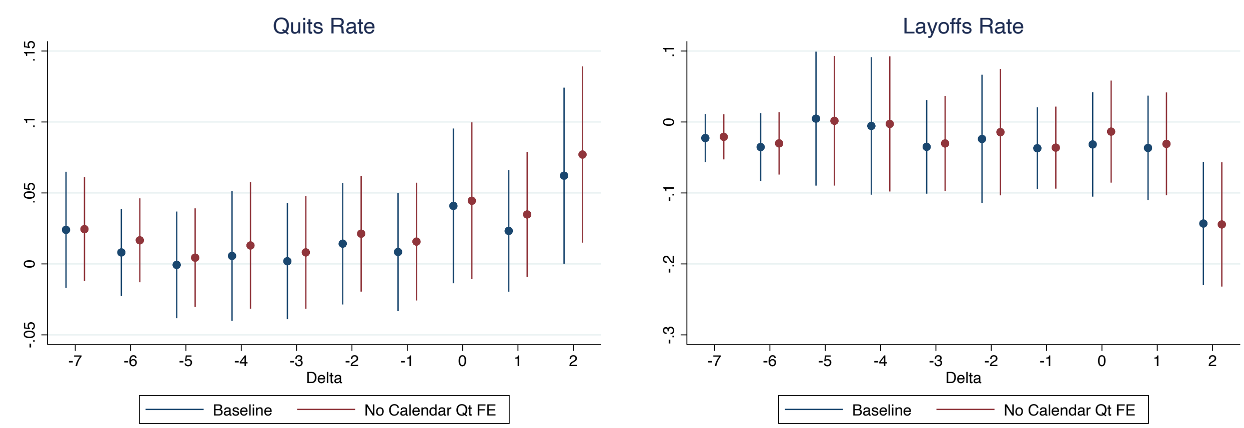
(a) Covered Establishments (b) Placebo Establishments



Notes: This figure plots the distribution of the deviation of layoff rates from establishment-size normalized WARN thresholds when the threshold is 50, separately for covered establishments and placebo establishments. An observation is an establishment-month. Local linear smoothing is conducted separately for the bins to the right and left of zero.

Figure A.3: Layoffs and Quits around Plant Closings

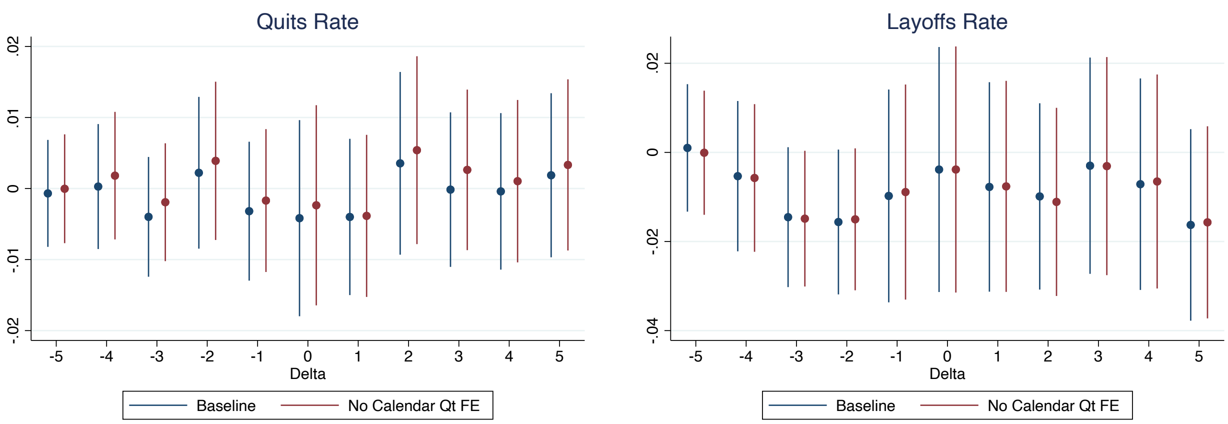
(a) Covered vs Placebo Events (b) Covered vs Placebo Events



Notes: This figure plots how quits rate and layoffs rate evolve before plant closings from comparing covered events to placebo events. The blue bars represent the baseline regression results with calendar quarter fixed effects, while the red bars show the regression results without calendar quarter fixed effects. One relative time period (delta) is a quarter. We mark the month that is nine months before the closure as the onset of the closing event, because it's common for establishments to take time to fully reduce their workforce after a closure decision is made. Hence, Delta = 0 represents the quarter when the closure begins, and Delta = 2 represents the actual closure quarter. The baseline period is 8 quarters before the onset. The quits rate (layoffs rate) is calculated as the number of voluntary quits (layoffs) divided by the baseline employment.

Figure A.4: Layoffs and Quits around Mass Layoffs

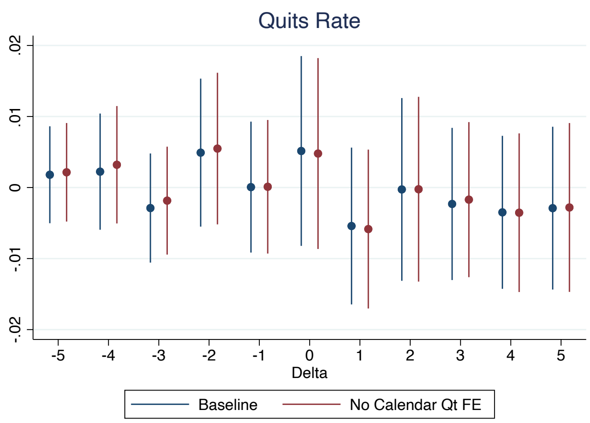
(a) Covered vs Placebo Events (b) Covered vs Placebo Events



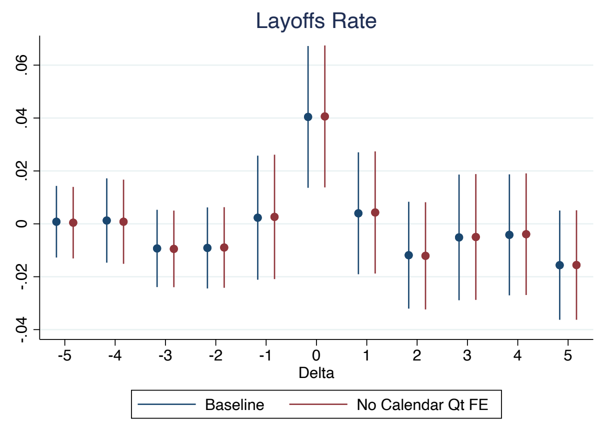
Notes: This figure plots how quits rate and layoffs rate evolve around mass layoffs from comparing covered events to placebo events. The blue bars represent the baseline regression results with calendar quarter fixed effects, while the red bars show the regression results without calendar quarter fixed effects. One relative time period (delta) is a quarter. Delta = 0 represents the quarter during which the mass layoff is occurring. The baseline period is 6 quarters before the event. The quits rate (layoffs rate) is calculated as the number of voluntary quits (layoffs) divided by the baseline employment.

Figure A.5: Layoffs and Quits around Mass Layoffs

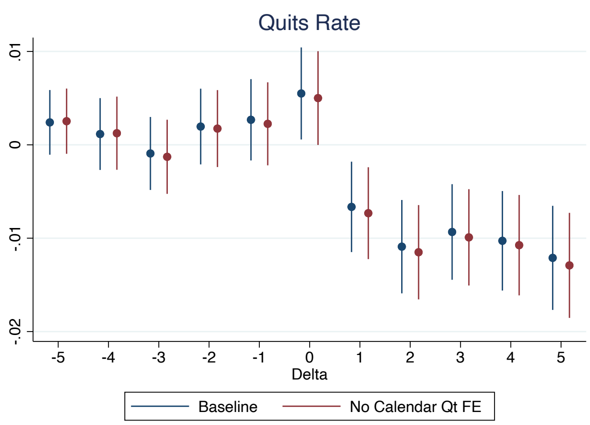
(a) Covered Events vs Stable Establishments



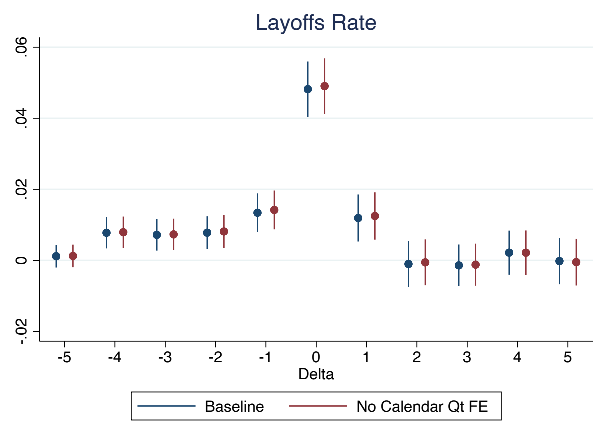
(b) Covered Events vs Stable Establishments



(c) Placebo Events vs Stable Establishments



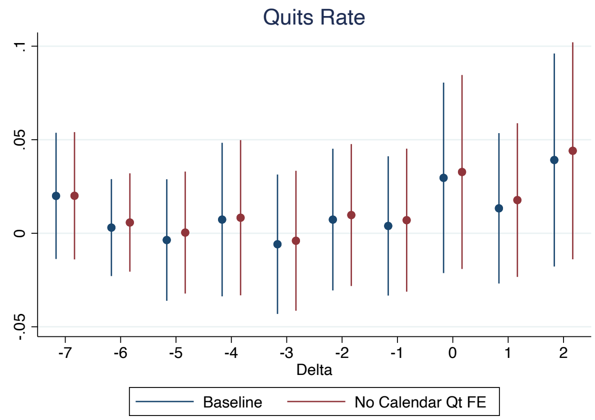
(d) Placebo Events vs Stable Establishments



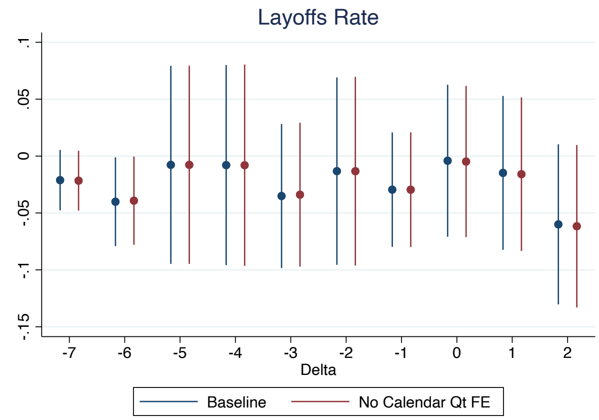
Notes: This figure plots how quits rate and layoffs rate evolve around mass layoffs from comparing distressed establishments to stable establishments. The blue bars represent the baseline regression results with calendar quarter fixed effects, while the red bars show the regression results without calendar quarter fixed effects. One relative time period (delta) is a quarter. Delta = 0 represents the quarter during which the mass layoff is occurring. The baseline period is 6 quarters before the event. The quits rate (layoffs rate) is calculated the number of voluntary quits (layoffs) divided by the baseline employment.

Figure A.6: Layoffs and Quits around Plant Closings

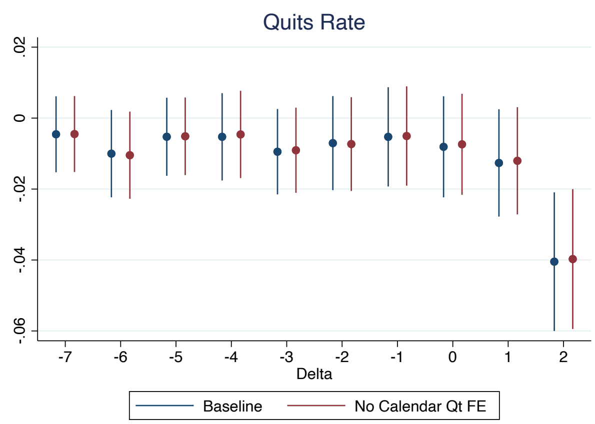
(a) Covered Events vs Stable Establishments



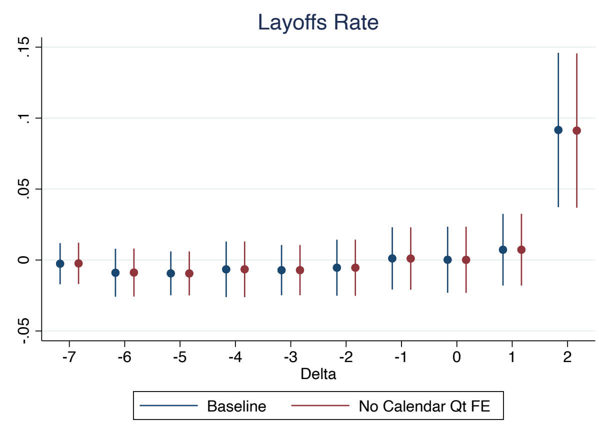
(b) Covered Events vs Stable Establishments



(c) Placebo Events vs Stable Establishments



(d) Placebo Events vs Stable Establishments



Notes: This figure plots how quits rate and layoffs rate evolve before plant closings from comparing distressed establishments to stable establishments. The blue bars represent the baseline regression results with calendar quarter fixed effects, while the red bars show the regression results without calendar quarter fixed effects. One relative time period (delta) is a quarter. We mark the month that is nine months before the closure as the onset of the closing event, because it's common for establishments to take time to fully reduce their workforce after a closure decision is made. Hence, Delta = 0 represents the quarter when the closure begins, and Delta = 2 represents the actual closure quarter. The baseline period is 8 quarters before the onset. The quits rate (layoffs rate) is calculated as the number of voluntary quits (layoffs) divided by the baseline employment.

Table A.1: Summary of Federal and State WARN Acts: Coverage

Region	Employer coverage	Mass layoff	Plant closing
Federal	$FirmEmp_{i,\tau-3} \geq 100$	Let τ denote the end month of a mass layoff. (i) $Emp_{i,\tau-3} - Emp_{i\tau} > 50$ and $Emp_{i,\tau-3} - Emp_{i\tau} > 0.33 * Emp_{i,\tau-3}$ or (ii)$Emp_{i,\tau-3} - Emp_{i\tau} > 500$; 90-day aggregation applies	Establishment i shuts down at month t, and $Emp_{it} - Emp_{i,t-3} < -50$
California	$\max_{1 \leq k \leq 12}\{Emp_{t-k}\} \geq 75$	$\Delta Emp_{it} > 50$	Establishment i shuts down at month t
Delaware	Identical as the federal WARN act for our purpose		
Hawaii	$\max_{1 \leq k \leq 12}\{Emp_{t-k}\} \geq 50$ (unclear if a parent company constitutes a "covered establishment" when its smaller subsidiary has shut down)	NA ("Partial closing" means the permanent shutting down of a portion of operations within a covered establishment... and results in or may result in the termination of a portion of the employees of a covered establishment by the employer.)	Establishment i shuts down at month t
Illinois	$FirmEmp_{i,\tau-3} \geq 75$	Let τ denote the end month of a mass layoff. (i) $Emp_{i,\tau-3} - Emp_{i\tau} > 25$ and $Emp_{i,\tau-3} - Emp_{i\tau} > 0.33 * Emp_{i,\tau-3}$ or (ii) $Emp_{i,\tau-3} - Emp_{i\tau} > 250$; 90-day aggregation applies	Establishment i shuts down at month t, and $Emp_{it} - Emp_{i,t-3} < -50$

Iowa	$FirmEmp_{i,\tau-3} \geq 25$ (unclear if Emp or $FirmEmp$)	Let τ denote the end month of a mass layoff. $Emp_{i,\tau-3} - Emp_{i\tau} > 25$; 90-day aggregation applies	Establishment i shuts down at month t, and $Emp_{it} - Emp_{i,t-3} < -25$
Maine (June 20, 2007 to Jun 27, 2016)	$\max_{1 \leq k \leq 12}\{Emp_{t-k}\} \geq 100$	NA	Establishment i shuts down at month t
Maine (After Jun 27, 2016)	$\max_{1 \leq k \leq 12}\{Emp_{t-k}\} \geq 100$	Mass layoffs only require severance pay; Only plant closing requires advance notice to employees	Establishment i shuts down at month t
Mary-land	$FirmEmpS_{i,\tau-3} \geq 50$ (unclear if $FirmEmp$ or Emp; employs at least 50 employees in the State; excludes any employer who has been doing business in the State less than 1 year.)	Let τ denote the end month of a "reduction in operations". $Emp_{i,\tau-3} - Emp_{i\tau} > 15$ and $Emp_{i,\tau-3} - Emp_{i\tau} > 0.25 * Emp_{i,\tau-3}$	Establishment i shuts down at month t, and $Emp_{i,t-3} - Emp_{it} > 15$ and $Emp_{i,t-3} - Emp_{it} > 0.25 * Emp_{i,t-3}$
New Hamp-shire	$FirmEmpS_{i,\tau-3} \geq X_t$ (employs at least X_t employees in the State, $X_t = 75$ if Jan 2010 $\leq t \leq$ Dec 2011 and $X_t = 100$ if $t \geq$ Jan 2012)	Let τ denote the end month of a mass layoff. (i) $Emp_{i,\tau-3} - Emp_{i\tau} > 25$ and $Emp_{i,\tau-3} - Emp_{i\tau} > 0.33 * Emp_{i,\tau-3}$ or (ii) $Emp_{i,\tau-3} - Emp_{i\tau} > 250$; 90-day aggregation applies	Establishment i shuts down at month t, and $Emp_{i,t-3} - Emp_{it} \geq 50$

New Jersey	Identical as the federal WARN act for our purpose before April 10, 2023. After April 10, 2023: $FirmEmp_{i,\tau-3} \geq 100$	Let τ denote the end month of a mass layoff. $Emp_{i,\tau-3} - Emp_{i\tau} \geq 50$; 90-day aggregation applies	Establishment i shuts down at month t, and $Emp_{it} - Emp_{i,t-3} < -50$
New York	$FirmEmpS_{i,\tau-3} \geq 50$ (employs 50 or more employees within New York State)	Let τ denote the end month of a mass layoff. (i) $Emp_{i,\tau-3} - Emp_{i\tau} > 25$ and $Emp_{i,\tau-3} - Emp_{i\tau} > 0.33 * Emp_{i,\tau-3}$ or (ii) $Emp_{i,\tau-3} - Emp_{i\tau} > 250$; 90-day aggregation applies	Establishment i shuts down at month t, and $Emp_{i,t-3} - Emp_{it} \geq 25$
Philadelphia, PA	$\max_{1 \leq k \leq 12}\{FirmEmp_{t-k}\} \geq 50$ (unclear if $FirmEmp$ or $FirmEmpS$ or Emp; Any person, corporation or other entity which employs or has employed at any time in the proceeding 12 month period at least 50 individuals and has operated an industrial, commercial or business enterprise in the City of Philadelphia for more than 6 months prior to the proposed date of closing or relocation)	NA	Establishment i shuts down at month t

Tennessee	07/01/1988 - 05/29/1989: $Emp_i \geq 50$; After 05/29/1989: $50 \leq Emp_i \leq 99$ (employs at least 50 but not more than 99 full-time employees at a workplace located within this state)	Let τ denote the end month of a mass layoff. $Emp_{i,\tau-3} - Emp_{i\tau} \geq 50$	Establishment i shuts down at month t, and $Emp_{i,t-3} - Emp_{it} \geq 50$
Vermont	$FirmEmp_{i,\tau-3} \geq 50$	Let τ denote the end month of a mass layoff. $FirmEmpS_{i,\tau-3} - FirmEmpS_{i\tau} \geq 50$ and $Emp_{i,\tau-3} - Emp_{i\tau} > 0$ ("Mass layoff" means a permanent employment loss of at least 50 employees at one or more worksites in Vermont during any 90-day period.)	Establishment i shuts down at month t
Wisconsin (Mar 8, 1984 to Sep 1, 1989)	$FirmEmpS \geq 100$	affecting 10 or more employes	

Wisconsin (After Sep 1, 1989)	$FirmEmpS_{i,\tau-3} \geq 50$	Let τ denote the end month of a mass layoff. (i) $Emp_{i,\tau-3} - Emp_{i\tau} \geq 25$ and $Emp_{i,\tau-3} - Emp_{i\tau} > 0.25 * Emp_{i,\tau-3}$ or (ii) $Emp_{i,\tau-3} - Emp_{i\tau} \geq 500$ (WI WARN does not specify the timeframe, this 90-day timeframe is imposed by us)	Establishment i shuts down at month t, and $Emp_{i,t-3} - Emp_{it} \geq 25$ (WI WARN does not specify the timeframe, this 90-day timeframe is imposed by us)

Notes: The data source consists of materials collected and organized by the author from LexisNexis and Thomson Reuters Practical Law. t denotes month, Emp_{it} denotes the employment in establishment i at month t, and $\Delta Emp_{it} = Emp_{it} - Emp_{i,t-1}$ denotes the monthly employment change in establishment i. $FirmEmp_{it}$ denotes the employment at month t in the firm to which establishment i belongs, $FirmEmp_{it} = \sum_{j,Firm(j)=Firm(i)} Emp_{jt}$. $FirmEmpS_{it}$ denotes the employment at month t in all the establishments that are in the same firm and state as establishment i, $FirmEmpS_{it} = \sum_{j,Firm(j)=Firm(i),State(j)=State(i)} Emp_{jt}$.If the criteria specified in the table are satisfied, we mark the layoff event in establishment i month t as a covered event.

Table A.2: Summary of Federal and State WARN Acts: Effective Dates and Notice Periods

Region	Effective date	Approved date	Notice periods (days)	Codes
Federal	02/1989	08/1988	60	29 U.S.C. §§2101 - 2109
California	1/2003	9/2002	60	Cal. Lab. Code §§1400.5 to 1408.
Delaware	1/2019		60	Delaware Code Title 19 Chapter 19 (19 Del. C. Section 1901 to 1911); Identical as the federal WARN act for our purpose
Hawaii	7/1987		45 (7/1987 - 6/2001); 60 (after 6/2001)	HRS §394B-1 to 394B-13. Hawaii Session Laws 1987 Act 377 initiated the requirement for notifications. Session Laws 2011 Act 137 explicitly directs the department of labor and industrial relations to enforce the provisions of §394B-9

Illinois	1/2005		60	820 ILCS §§65/1 - 65/99
Iowa	3/2010		30	Iowa Code Ch. 84C
Maine	9/1981		60 (9/1981 - 6/2007 only relocation needs to be notified; 6/2007 - 8/2019 both termination and relocation need to be notified); 90 (after 8/2019)	26 M.R.S. §625-B
Maryland	10/2020	5/2020	60	Md. Labor and Employment Code Ann. §§11-301 to 11-306. While the Economic Stabilization Act was initially introduced in 1985, the requirement for mandatory advance notice was instituted through Amendment 2020, ch. 406, §1; ch. 407, §1.
New Hampshire	1/2010	8/2009	60	N.H. RSA §§275-F:1 to 275-F:12; 2009, 325:1; 2011, 224:53
New Jersey	12/2007		60 (before April 10, 2023); 90 (on/after April 10, 2023)	N.J. Stat. §34:21; L.2007, c. 212, §1, eff. Dec. 20, 2007. Amended by L.2019, c. 423, §1, eff. April 10, 2023; L.2020, c. 22, §1, eff. April 14, 2020, retroactive to March 9, 2020.
New York	2/2009	8/2008	90	N.Y. Lab. Law §§860 to 860-i; 12 NYCRR §921-1.0 to 921-9.1.
Philadelphia, PA	1982		60	Title 9, Chapter 9-1500 of the Philadelphia Code

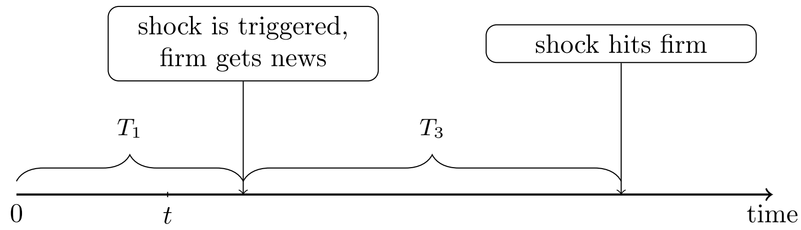
Tennessee	07/1988	60	T.C.A. §§50-1-601 to 50-1-604
Vermont	1/2015	30 (45 when all of the employees are not terminated on the same date)	21 V.S.A. §§411 to 418 and Vt. Admin. Code 13-1-104:1 to 13-1-104:13
Wisconsin	03/1984 (1983 Wisconsin Act 149); 09/1989 (1989 Wisconsin Act 44)	60	Wis. Stat. §109.07; Wis. Admin. Code DWD §§279.001 to 279.13

Notes: The data source consists of materials collected and organized by the author from LexisNexis and Thomson Reuters Practical Law.

Appendix B Proofs

B.1 Derivation of π_t

Figure A.7: Timeline of the Model



To derive π_t, note that

$$\pi_t = Pr(T_1 > t | T_1 + T_3 > t)$$

where $T_1 > 0$ is the time it takes for a separation shock to be triggered and follows an exponential distribution with $Pr(T_1 > s) = \exp(-\lambda s)$, and $T_3 > 0$ is the delay between when the shock is triggered and when it actually arrives and follows a conditional exponential distribution with $Pr(T_3 > s | T_1 = t_1) = \exp(-\delta s)$. Hence, we have

$$\pi_t = Pr(T_1 > t | T_1 + T_3 > t) = \frac{Pr(T_1 > t, T_1 + T_3 > t)}{Pr(T_1 + T_3 > t)} = \frac{Pr(T_1 > t)}{Pr(T_1 + T_3 > t)}$$

Applying the law of total expectation, we know that the denominator satisfies

$$\begin{aligned} Pr(T_1 + T_3 > t) = & \, Pr(T_1 + T_3 > t | T_1 > t) Pr(T_1 > t) \\ & + Pr(T_1 + T_3 > t | T_1 < t) Pr(T_1 < t) \end{aligned}$$

The first term is equal to $Pr(T_1 > t)$ and the second term can be re-written as

$$\begin{aligned} & Pr(T_1 + T_3 > t | T_1 < t) Pr(T_1 < t) \\ & = \int_{\tau=0}^{t} Pr(\tau < T_1 < \tau + d\tau) Pr(T_1 + T_3 > t | T_1 = \tau) \\ & = \int_{\tau=0}^{t} \lambda e^{-\lambda \tau} d\tau \cdot e^{-\delta(t-\tau)} \\ & = \lambda e^{-\delta t} \int_{\tau=0}^{t} e^{-(\lambda-\delta)\tau} d\tau \\ & = \lambda e^{-\delta t} \cdot \frac{1 - e^{-(\lambda-\delta)t}}{\lambda - \delta} \text{ (if } \lambda - \delta \neq 0) \\ & = \lambda e^{-\delta t} \cdot t \text{ (if } \lambda - \delta = 0) \end{aligned}$$

Hence, π_t is given by

$$\pi_t = \begin{cases} \frac{1}{1+\frac{\lambda}{\lambda-\delta}\left(\exp\left((\lambda-\delta)t\right)-1\right)} & \text{if } \lambda \neq \delta \\ \frac{1}{1+\lambda t} & \text{if } \lambda = \delta \end{cases}$$

And it can be shown that

$$\frac{d\pi_t}{dt} = -\frac{(\lambda-\delta)^2 \lambda e^{(\lambda-\delta)t}}{(\lambda e^{(\lambda-\delta)t} - \delta)^2} = -(\lambda-\delta)\pi_t - \delta\pi_t^2 < 0$$

B.2 Proof of Lemma 1

Proof. We begin with the proof for the scenario where there is no impending shock. The proof for the scenario with impending shocks follows a similar structure. In the second stage of the game, firms will accept the wage proposal as long as that leaves firms' value non-negative. Hence, workers will demand a wage v_1^* that sets firms' value to zero, which leaves workers with a payoff of S_1 in the second stage. In the first stage, the firm knows that workers will not accept a wage offer that makes their value lower than βS_1, the expected value they can get if they turn down the offer, and that if it cannot get workers to accept the wage it will get zero payoff in the next stage. Hence, the firm will offer a wage that gives workers exactly that level of payoff, leaving the firm with a positive payoff of $(1-\beta)S_1$. □

B.3 Proof of Lemma 2

Proof. Suppose that such an equilibrium exists. We show that firms have incentives to deviate from it when $\beta < \frac{r+\lambda}{r+\lambda+\delta}$.

To prepare for the proof, we first compute the match surplus in the complete information equilibrium.

$$\begin{aligned} rS_3 &= r(W_3 - U + J_3^s) \\ &= A - z - (\delta + f(\theta))(W_3 - U + J_3^s) \\ &= A - z - (\delta + f(\theta))S_3 \end{aligned}$$

and

$$\begin{aligned} rS_1 &= r(W_1 - U + J_1^n) \\ &= A - z + \lambda(W_3 - W_1 + J_3 - J_1^n) - f(\theta)(W_1 - U) \\ &= A - [z + \beta f(\theta)S_1] + \lambda(S_3 - S_1) \end{aligned}$$

Hence

$$S_3 = \frac{A - z}{r + \delta + f(\theta)}$$
$$S_1 = \frac{A - z + \lambda S_3}{r + \lambda + \beta f(\theta)} = \frac{r + \delta + f(\theta) + \lambda}{r + \lambda + \beta f(\theta)} S_3$$

Next, we write the wage difference $w_1^* - w_3^*$ in terms of the two match surpluses.

$$r(W_1 - W_3) = w_1^* - w_3^* + (\lambda + f(\theta))(W_3 - W_1) + \delta(W_3 - U)$$

With some algebra, we have

$$w_1^* - w_3^* = (r + \lambda + f(\theta))\beta(S_1 - S_3) - \delta\beta S_3 = f(\theta)\beta(1 - \beta)S_1$$

Firms may deviate from the equilibrium in two ways. First, firms may want to tell workers that there is no shock when there is one. Second, firms may want to tell workers that there is a shock when there isn't one. We derive below conditions under which each deviation is profitable for firms.

First, we derive the conditions under which firms have incentives to mislead workers to think that there is no shock when there is a shock on the horizon by making a wage offer of w_1^* instead of w_3^*. If firms make a wage offer of w_1^*, workers would believe that there is no shock on the horizon and would not search on the job. The value of the firm is

$$rJ_3' = A - w_1^* - \delta J_3'$$

If firms disclose the true state to workers and make a wage offer of w_3^*, the value is

$$rJ_3^s = A - w_3^* - (\delta + f(\theta))J_3^s$$

Firms deviate if $J_3' > J_3^s$. And we have

$$(r + \delta)(J_3' - J_3^s) = f(\theta)J_3^s - (w_1^* - w_3^*)$$

$f(\theta)J_3^s$ is expected benefit of withholding the information that comes from preventing workers from leaving prematurely, while $(w_1^* - w_3^*)$ is the cost as firms need to offer workers the same wage in order to convince them that there is no shock on the horizon. Hence, firms deviate if

$$
\begin{aligned}
f(\theta)J_3^s &> (w_1^* - w_3^*) \\
f(\theta)(1-\beta)S_3 &> (r+\lambda+f(\theta))\beta(S_1 - S_3) - \delta\beta S_3 \\
[f(\theta)(1-\beta)+\delta\beta]S_3 &> (r+\lambda+f(\theta))\beta[\frac{A-z}{r+\beta f(\theta)+\lambda} - \frac{r+\beta f(\theta)}{r+\beta f(\theta)+\lambda}S_3]
\end{aligned}
$$

Plugging in $S_3 = \frac{A-z}{r+\delta+f(\theta)}$, with some manipulation, we show that this inequality holds if and only if

$$
\beta < \frac{r+\lambda}{r+\lambda+\delta}
$$

Next, we check whether firms have incentives to mislead workers to think that there is a shock when there is no shock by making a wage offer of w_3^*.

If firms make a wage offer of w_3^*, workers would believe that there is a shock on the horizon and would search on the job. The value of the firm is

$$
rJ_1' = A - w_3^* + \lambda(J_3 - J_1') - f(\theta)J_1'
$$

If firms disclose the true state to workers and make a wage offer of w_1^*, the value is

$$
rJ_1^n = A - w_1^* + \lambda(J_3 - J_1^n)
$$

Firms deviate if $J_1' > J_1^n$. And we have

$$
(r+\lambda+f(\theta))(J_1' - J_1^n) = w_1^* - w_3^* - f(\theta)J_1^n
$$

Hence, firms deviate if

$$
\begin{aligned}
w_1^* - w_3^* &> f(\theta)J_1^n \\
(r+\lambda+f(\theta))\beta(S_1 - S_3) - \delta\beta S_3 &> f(\theta)(1-\beta)S_1
\end{aligned}
$$

With some manipulation, we show that this inequality holds if and only if

$$
\frac{\delta}{\delta+f(\theta)(1-\beta)} > \frac{r+f(\theta)+\lambda}{r+\beta f(\theta)+\lambda}
$$

However, the LHS is smaller than 1 while the RHS is greater than 1. Hence under no conditions will this inequality hold. This means that firms do not have incentives to tell workers that there is a shock when there isn't one on the horizon.

Taken together, when $\beta < \frac{r+\lambda}{r+\lambda+\delta}$, there does not exist an equilibrium that replicates the complete information equilibrium as firms have incentives to deviate by signaling to workers that there is no shock on the horizon when there is. □

B.4 Proof of Lemma 3

Proof. In the second stage of the game, firms will accept the wage proposal as long as that leaves firms' value non-negative. Hence, workers will demand a wage v_{2t}^* that, according to their beliefs, sets firms' value to zero, which leaves workers with a payoff of $\tilde{S}_2(t)$ in the second stage. In the first stage, the firm knows that workers will not accept a wage offer that makes their value lower than $\beta\tilde{S}_2(t)$, the expected value they can get if they turn down the offer, and that if it cannot get workers to accept the wage it will get zero payoff in the next stage. Hence, the firm will offer a wage that gives workers exactly that level of payoff, leaving the firm with a positive payoff of $(1-\beta)\tilde{S}_2(t)$.

Given that this is a truth-concealing equilibrium, firms have no incentives to deviate by offering a wage higher than w_{2t}^* because this does not change workers' job search behavior and only decreases firms' profits.

Next, we show that w_{2t}^* is constant over time and $w_{2t}^* = w_3^*$. To prepare for the proof, we first compute the match surplus in the truth-concealing equilibrium.

$$\begin{aligned} rS_4(t) &= r[W_4(t) - \bar{U} + J_4(t)] \\ &= A - z - [\delta + f(\theta)]S_4(t) + \frac{\partial S_4(t)}{\partial t} \end{aligned}$$

It's straightforward to see that $S_4(t) = S_3$. For $\tilde{S}_2(t)$, we have

$$\begin{aligned} r\tilde{S}_2(t) &= r[W_2(t) - \bar{U} + \tilde{J}_2(t)] \\ &= A - z + \pi_t\lambda[S_3 - \tilde{S}_2(t)] - (1-\pi_t)\delta\tilde{S}_2(t) - f(\theta)\tilde{S}_2(t) + \frac{\partial \tilde{S}_2(t)}{\partial t} \end{aligned} \tag{6}$$

Combining $\tilde{J}_2(t) = (1-\beta)\tilde{S}_2(t)$ with equation (6), we have $A - w_{2t}^* = (1-\beta)(A - z + \pi_t\lambda S_3) - \pi_t\lambda J_4(t)$. Hence, we have

$$\begin{aligned} rJ_4(t) &= A - w_{2t} - [\delta + f(\theta)]J_4(t) + \frac{\partial J_4(t)}{\partial t} \\ [r + \delta + f(\theta)]J_4(t) &= (1-\beta)(A - z + \pi_t\lambda S_3) - \pi_t\lambda J_4(t) + \frac{\partial J_4(t)}{\partial t} \end{aligned}$$

With this, we can solve for $J_4(t)$. Let $r(s,t) \equiv \int_t^s (r+\delta+f(\theta)+\lambda\pi_v)\mathrm{d}v$. And we have $\frac{\mathrm{d}r(s,t)}{\mathrm{d}s} = r+\delta+f(\theta)+\lambda\pi_s$ and $\frac{\mathrm{d}e^{-r(s,t)}}{\mathrm{d}s} = -e^{-r(s,t)}(r+\delta+f(\theta)+\lambda\pi_s)$.

$$
\begin{aligned}
J_4(t) &= (1-\beta)\int_t^\infty e^{-\int_t^s (r+\delta+f(\theta)+\lambda\pi_v)\mathrm{d}v}(A-z+\pi_s\lambda S_3)\mathrm{d}s \\
&= (1-\beta)\int_t^\infty e^{-r(s,t)}(A-z+\pi_s\lambda S_3)\mathrm{d}s \\
&= (1-\beta)\int_t^\infty \left[e^{-r(s,t)}(A-z) + S_3(-\frac{\mathrm{d}e^{-r(s,t)}}{\mathrm{d}s} - e^{-r(s,t)}(r+\delta+f(\theta))\right]\mathrm{d}s \\
&= (1-\beta)\int_t^\infty \left[e^{-r(s,t)}(A-z-(r+\delta+f(\theta))S_3) - S_3\frac{\mathrm{d}e^{-r(s,t)}}{\mathrm{d}s}\right]\mathrm{d}s \\
&= -(1-\beta)S_3\int_t^\infty \mathrm{d}e^{-r(s,t)} \\
&= -(1-\beta)S_3(e^{-r(\infty,t)} - e^{-r(t,t)}) \\
&= (1-\beta)S_3
\end{aligned}
$$

Therefore, $A - w_{2t}^* = (1-\beta)(A-z)$ and $w_{2t}^* = w_3^*$.

□

B.5 Proof of Lemma 4

Proof. If there exists a truth-telling equilibrium where firms promptly disclose information, to prove that such truth-telling equilibrium is unique, first note that under any truth-telling equilibrium, firms' wage offer when there is an impending shock has to be equal to the wage offer in the complete information case, w_3^*. They cannot offer a lower wage, because they know that workers will reject the offer in this stage and demand a wage that leave no surplus for firms in the second stage. They will not offer a higher wage, as that only lowers their profits. In addition, to sustain a truth-telling equilibrium, firms have to credibly prove to workers that they will promptly disclose the news, by making sure that the difference between wage offers when there is an impending shock vs when there is no impending shock is large enough. Specifically, as shown in the proof of Lemma 2, the wage difference has to satisfy

$$
w_1 - w_3^* > f(\theta)J_3^s(w_3^*) = f(\theta)\frac{A - w_3^*}{r+\delta+f(\theta)}
$$

In addition, the wage offer w_1 also has to high enough be acceptable to workers in the bargaining game. Taken together, when there is no impending shock, firms will offer a wage w^{**} that is high enough to satisfy both criteria, but not higher as firms' profits decrease with their wage offers, so we have

$$w_1^{**} = \max\{w_1^*, w_3^* + f(\theta)J_3^s\}$$

Therefore, if there exists a truth-telling equilibrium, such equilibrium is unique.

When $\beta > \frac{r+\lambda}{r+\lambda+\delta}$, $w_1^{**} = w_1^*$. Firms have no incentives to deviate from the truth-telling equilibrium that replicates the complete information equilibrium, because the minimum wage offer that is acceptable to workers also satisfies the inequality above, as shown in the proof of Lemma 2.

On the other hand, when $\beta < \frac{r+\lambda}{r+\lambda+\delta}$, firms will have incentives to deviate if they offer a wage of w_1^* when there is no impending shock. To tie their hands and credibly demonstrate their commitment to promptly disclose, firms have to raise the wage offer to $w_1^{**} = w_3^* + f(\theta)J_3^s$. □

B.6 Proof of Lemma 5

Proof. First, we show that the truth-telling equilibrium satisfies the Intuitive Criterion. We start with the proof for the case where $\beta > \frac{r+\lambda}{r+\lambda+\delta}$. Consider an off-equilibrium wage offer $w > w_1^*$. It is always equilibrium dominated, no matter whether there is an impending shock. Since a worker is willing to accept a wage offer of w_1^* regardless of any impending shock, offering a higher wage would only decrease the firm's profits. For an off-equilibrium wage offer $w < w_3^*$, it is also always equilibrium dominated because because workers will not accept a wage lower than w_3^* under any circumstances, leaving firms with a value of zero. Finally, consider an off-equilibrium wage offer $w_3^* < w < w_1^*$. If there is no impending shock and workers also believe so, their best response is to reject the offer and enter the second stage of the bargaining game with some probability, which gives them a higher expected value. This results in a firm value of zero, which is clearly lower than the equilibrium value. On the other hand, if there is an impending shock and workers also believe so, their best response is to accept the offer and search on the job. In this case, firms' value is also lower than the equilibrium value because they are paying workers more than w_3^*.

When $\beta < \frac{r+\lambda}{r+\lambda+\delta}$, recall that the equilibrium wage offer by the firm in the first stage is $w_1^{**} = w_3^* + f(\theta)J_3^s > w_1^*$. The proof follows the same reasoning as above for equilibrium wage offers $w < w_3^*$, $w_3^* < w < w_1^*$, and $w > w_1^{**}$. Consider an off-equilibrium wage offer $w_1^* < w < w_1^{**}$. This offer is not equilibrium dominated, regardless of whether there is an impending shock. This is because when there is no impending shock and workers believe the same, they will accept the offer and not search. In this case, the firm's value exceeds the equilibrium value, as they are paying workers less than w_1^{**}. When there is an impending shock but workers believe there is none and accept the offer without searching, the firm's value will also be above the equilibrium value. According to the proof of Lemma

2, the firm's value when offering w_1^{**} and having workers not search is equal to the equilibrium value in the case of an impending shock (J_3^s). Offering $w < w_1^{**}$ clearly increases the firm's value beyond the equilibrium level. To sum up, regardless of whether there is an impending shock, firms *could* achieve a higher utility level by offering the off-the-equilibrium wage $w \in (w_1^*, w_1^{**})$. We then examine if there is one scenario (shock or no-shock) in which firms prefer to deviate to the off-equilibrium wage offer w because it provides them with a higher value than the equilibrium wage offer, *regardless* of the response of workers. If there is an impending shock and workers also believe so and they accept the offer and search, then the firms' value is below the equilibrium value because they're paying workers more than w_3^*. If there is no impending shock but workers believe one is coming and accept the offer and search, the firms' value will also be below the equilibrium value. To see this, note that the equilibrium value is given by $rJ_1 = A - w_1^{**} + \lambda(J_3^s - J_1)$, and the firms' value when workers search despite no impending shock is given by $rJ_1' = A - w + \lambda(J_3^s - J_1') - f(\theta)J_1'$. The difference between these values is $(r+\lambda+f(\theta))(J_1' - J_1) = w_1^{**} - w - f(\theta)J_1 < w_1^{**} - w_3^* - f(\theta)J_1 = f(\theta)(J_3^s - J_1) < 0$.

Next, we show that the truth-concealing equilibrium does not satisfy the Intuitive Criterion. For brevity, we present the proof for the case where $\beta > \frac{r+\lambda}{r+\lambda+\delta}$. The proof for $\beta < \frac{r+\lambda}{r+\lambda+\delta}$ follows the same steps, with w_1^{**} substituted for w_1^*. Consider an off-equilibrium wage offer $w = w_1^*$. Workers know that firms will never make this offer when there is an impending shock. To see this, the highest possible value of firms in this case occurs when workers accept the offer and do not search, and the highest value is given by $rJ_4' = A - w_1^* - \delta J_4'$. However, the equilibrium value is J_4 and is greater than or equal to J_4', according to the proof of Lemma 2. Therefore, upon receiving this offer, workers know that there is no impending shock, and their best response is to accept the offer and not search. In this case, firms' value is $J_1^n(w_1^*)$ and it can be shown that this is greater than the equilibrium value J_2. To see this, we first compute J_2

$$\begin{aligned}
rJ_2 &= A - w_2^* + \lambda[J_4 - J_2] - f(\theta)J_2 \\
[r+\lambda+f(\theta)]J_2 &= (1-\beta)(A-z) + \lambda(1-\beta)S_3 \\
J_2 &= (1-\beta)\frac{r+\delta+f(\theta)+\lambda}{r+\lambda+f(\theta)}S_3 = (1-\beta)(1+\frac{\delta}{r+\lambda+f(\theta)})S_3
\end{aligned}$$

Then we compare $J_1^n(w_1^*)$ with J_2: $J_1^n(w_1^*) = (1-\beta)S_1 = (1-\beta)\frac{r+\delta+f(\theta)+\lambda}{r+\lambda+\beta f(\theta)}S_3 > J_2$.

Similarly, for $J_1^n(w_1^{**})$, we first show that $J_1^n(w_1^{**}) = (1+\frac{\delta}{r+\lambda})(1-\beta)S_3$. To see this, we know that $w_1^{**} = w_3^* + f(\theta)J_3^s(w_3^*)$ from the proof of Lemma 4. Hence, $rJ_1^n(w_1^{**}) = A - w_1^{**} + \lambda(J_3^s - J_1^n) = A - w_3^* - f(\theta)J_3^s(w_3^*) + \lambda(J_3^s - J_1^n)$. Plugging the expression of $J_3^s(w_3^*)$ from equation (3), we have $rJ_1^n(w_1^{**}) = (1+\frac{\delta}{r+\lambda})J_3^s(w_3^*) = (1+\frac{\delta}{r+\lambda})(1-\beta)S_3$. Then we compare $J_1^n(w_1^{**})$ with J_2: $J_1^n(w_1^{**}) = (1-\beta)(1+\frac{\delta}{r+\lambda})S_3 > J_2$.

□

B.7 Proof of Lemma 6

Proof. If wages are bargained in new matches but not continually renegotiated, firms have no credible way to assure workers that they will promptly disclose any news about upcoming shocks. As a result, workers begin searching on the job immediately after joining the firm. While workers may not know the exact timing of the shocks, they are aware of the shock arrival processes and bargain with firms at $t = 0$ based on the expected patterns of these shocks. The workers' value functions are identical to those in the complete information case, except that wages remain constant regardless of whether there is an impending shock. And the firm's value functions are given by $rJ_1^s = A - w + \lambda(J_3^s - J_1^s) - f(\theta)J_1^s$ and $rJ_3^s = A - w - (\delta + f(\theta))J_3^s$. Hence, we know that the match surplus is

$$rS_1^s = r(W_1 - U + J_1^s) = A - z + \lambda(S_3 - S_1^s) - f(\theta)S_1^s$$

w_2^* solves $J_1^s = (1-\beta)S_1^s$ or $\frac{A-w_2^*+\lambda J_3^s}{r+\lambda+f(\theta)} = (1-\beta)\frac{A-z+\lambda S_3}{r+\lambda+f(\theta)}$. It is clear to see that $A - w_2^* = (1-\beta)(A-z)$, since by coincidence $J_3^s(w_2^*) = (1-\beta)S_3$. Note that $J_3^s(w_2^*) = (1-\beta)S_3$ is not guaranteed, because wages are only bargained in new matches. Based on the proof above, it is obvious that $w_2^* = w_3^*$. □

B.8 Proof of Lemma 7

Proof. To pin down the worker distribution in equilibrium, note that the inflow into each state must equal the outflow from that state. The inflow into unemployment is $y\delta$ while the outflow from unemployment is $uf(\theta)$. The inflow into the state where workers are employed in a firm without an impending shock is $uf(\theta) + yf(\theta)$, while the outflow is $x\lambda$. Finally, the inflow into the state where workers are employed in a firm with an impending shock is $x\lambda$, while the outflow is $y(\delta + f(\theta))$. Given that $u + x + y = 1$, the worker distribution in equilibrium is $u = \frac{1}{1+(\frac{1}{\lambda}+\frac{1}{\delta})f(\theta)+\frac{1}{\lambda\delta}f(\theta)^2}$, $x = 1 - u - y = \frac{f(\theta)}{\lambda+f(\theta)}$, and $y = u\frac{f(\theta)}{\delta}$. Since both workers in u and y search, $\theta = \frac{v}{u+y}$, and $v = (u+y)\theta$. Further, the free entry condition is $J_1 = \frac{k}{q(\theta)}$, and $J_1 = (1-\beta)S_1 = (1-\beta)(A-z)(1+\frac{\lambda}{r+\delta+f(\theta)})(\frac{1}{r+\lambda+\beta f(\theta)})$. □

B.9 Proof of Lemma 8

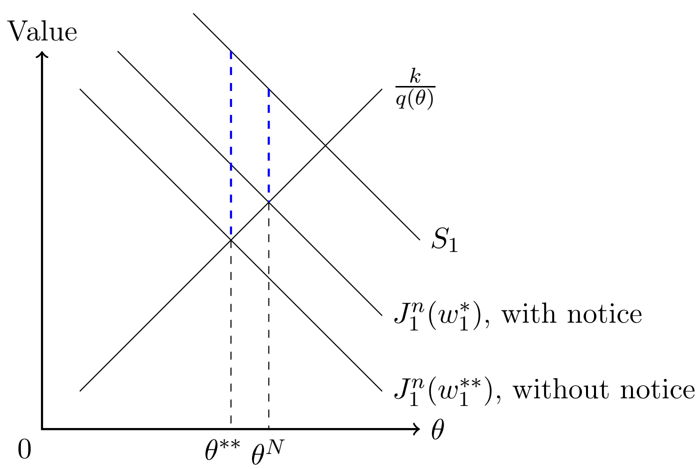
Proof. Firms would be revealing information even in the absence of the WARN acts, meaning that the WARN acts would not impact workers' search behavior and therefore would not change the equilibrium worker distribution across states.

When $\beta > \frac{r+\lambda}{r+\lambda+\delta}$, firms disclose information promptly and the equilibrium replicates the complete information equilibrium, so the advance notice law has no impact.

When $\beta < \frac{r+\lambda}{r+\lambda+\delta}$, with advance notice law, firms do not have to pay workers higher wages when there is no impending shock to credibly prove to workers that they will promptly disclose the news. The match surplus S_1 is the same with or without the law, because firms also disclose the information even without the law. For any given θ, it's obvious that $J_1^n(w_1^*) > J_1^n(w_1^{**})$. However, the advance notice law may change the equilibrium labor market tightness. To solve for the equilibrium θ under the two scenarios, according to equation (4) we have

$$J_1^n(w_1^*) = (1-\beta)S_1 = \frac{k}{q(\theta)} \quad \text{and} \quad J_1^n(w_1^{**}) = (1+\frac{\delta}{r+\lambda})(1-\beta)S_3 = \frac{k}{q(\theta)}$$

Since $q'(\theta) < 0$ and $f'(\theta) > 0$ and we can show $\partial J_1^n(w_1^*)/\partial f < 0$ and $\partial J_1^n(w_1^{**})/\partial f < 0$. The diagram below shows that the law increases the value of a job for firms, although the rise in labor market tightness partially offsets such increase. This occurs because the rise in job value attracts more entrants, leading to an increase in vacancies. The net value of employment for workers is given by $S_1 - J_1^n$ and is represented by the blue dashed lines in the diagram. It's clear to see that the law reduces the net value of employment for workers.



Using the "N" superscript to denote variables under advance notice law. The welfare of workers can be written as

$$\begin{aligned} r\mathcal{W}^N &= u^N z + x^N(w_3^* + f(\theta^N)\beta(1-\beta)S_1(\theta^N)) + y^N w_3^* \\ &= w_3^* - u(\theta^N)(w_3^* - z) + x(\theta^N)f(\theta^N)\beta\frac{k}{q(\theta^N)} \\ &= w_3^* - u(\theta^N)\beta(A - z) + x(\theta^N)f(\theta^N)\beta\frac{k}{q(\theta^N)} \\ r\mathcal{W} &= uz + x(w_3^* + f(\theta)J_3(\theta)) + yw_3^* \\ &= w_3^* - u(\theta)(w_3^* - z) + x(\theta)f(\theta)\frac{r+\lambda}{r+\lambda+\delta}\frac{k}{q(\theta)} \\ &= w_3^* - u(\theta)\beta(A - z) + x(\theta)f(\theta)\frac{r+\lambda}{r+\lambda+\delta}\frac{k}{q(\theta)} \end{aligned}$$

As $\beta \to 0$, $\mathcal{W}^N \to w_3^*$ and $\mathcal{W} \to w_3^* + x(\theta)f(\theta)\frac{r+\lambda}{r+\lambda+\delta}\frac{k}{q(\theta)}$, so $\mathcal{W}^N < \mathcal{W}$. Hence, it is possible for the advance notice law to decrease worker welfare.

□

B.10 Proof of Lemma 9

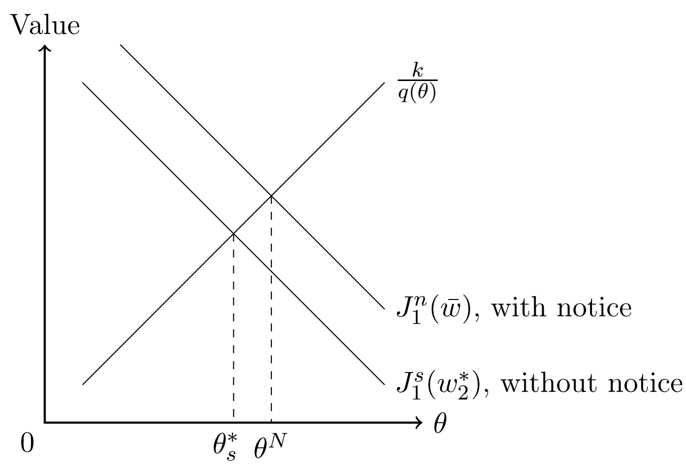
Proof. To pin down the worker distribution in equilibrium, note that the inflow and outflow associated with u and y remain the same as described in B.8. For x, the inflow is now $uf(\theta)+yf(\theta)+xf(\theta)$ and the outflow is now $x\lambda + xf(\theta)$, as workers in x also search on the job Since $xf(\theta)$ cancels out on both sides, we have the same equilibrium worker distribution described in B.8. And since all workers search, $\theta = \frac{v}{u+y+x}$, and $v = (u + y + x)\theta = \theta$.

With the advance notice law, firms will disclose any news about upcoming shocks promptly, so the equilibrium outcomes in complete information game are restored. The wage is determined by setting $J_1^n(\bar{w}) = (1-\beta)S_1$. And the wage remains constant throughout the entire duration of the match. From the proofs of Lemma 5 and Lemma 6, we know that for any given θ, $J_1^n(\bar{w}) = (1-\beta)S_1 > J_2 = J_1^s(w_2^*) = (1-\beta)S_1^s$. And we can also show that $\partial S_1^s/\partial f < 0$. Similar to the proof of Lemma 8, the following diagram shows that the law increases the value of a job for firms and increases the labor market tightness. Workers' net employment value is βS_1 with advance notice law and βS_1^s without advance notice law, so the law increases the net value of employment.

Using the "N" superscript to denote variables under advance notice law. The difference in the welfare of workers is given by

$$r(\mathcal{W}^N - \mathcal{W}) = u^N z + (1-u^N)\bar{w} - uz - (1-u)w_3^* = (w_3^* - z)(u - u^N) + (\bar{w} - w_3^*)(1 - u^N) > 0$$

□


Value
$\frac{k}{q(\theta)}$
$J_1^n(\bar{w})$, with notice
$J_1^s(w_2^*)$, without notice
0
θ
θ_s^*
θ^N