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Abstract

We investigate a prevalent, but understudied, employment protection policy: mandatory advance notice (MN), requiring employers to notify employees of forthcoming layoffs. MN increases future production, as notified workers search on the job, but reduces current production as they supply less effort. Our theoretical model captures this trade-off and predicts that MN improves production efficiency by increasing information sharing, whereas large production losses can be avoided by worker-firm agreements on side-payments – severance pay – in lieu of MN. We provide evidence of such severance increases in response to an extension of MN using novel Swedish administrative data. We then estimate the production gain of MN: extending the MN period leads to shorter non-employment duration and higher reemployment wages, plausibly driven by on-the-job search. Using variation in notice duration across firms, we estimate the productivity loss of notice. The estimates of benefits and costs suggest that MN has a positive net impact on production, offering an empirically-grounded efficiency argument for mandating notice.

JEL-Codes: J310, J330, J630, J680.

Keywords: unemployment, advance notice, job mobility, job quality.

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A fundamental challenge for economists and policymakers alike is to design programs that facilitate the transition of laid-off workers to a new job. The policy that has received most attention in this context has certainly been unemployment insurance (UI), where the government takes on the onus of supporting unemployed during their job search period.

Mandatory advance notice of layoff (MN) is an alternative policy to achieve a smoother transition across jobs for laid-off workers. MN requires that employers notify workers in advance before layoff. During the notice period, workers continue to work and stay on the payroll. In this way, MN acts like a fully experience-rated UI system with complete insurance during the notice period. All OECD countries have MN programs. In the U.S., for example, the Worker Adjustment and Retraining Notification (WARN) act of 1988 requires large employers a 2-month advance notice.[1] Despite the prevalence of MN policies, few papers have examined their normative implications, and there is a void of credible evidence on the effects of such programs.

This paper puts MN in the spotlight by investigating its potential from a theoretical and an empirical perspective. Our theory shows how MN can improve efficiency as it provides workers with more time to search on the job. But MN also reduces production as notified workers supply less effort. A key insight of the theory is that the production loss is attenuated if severance pay is used when information sharing is detrimental to efficiency. Empirically, we estimate the impact of MN on the behavior of employees and employers using novel data on notifications from Sweden and four research designs: a Regression Discontinuity (RD) design, an instrumental variables approach, as well as difference-in-differences and bunching analysis. We find that severance pay increases when the MN period is extended, which is consistent with firms undoing the law.[2] We also find that MN raises wages at the next job and shortens the exposure to non-employment, but the productivity of notified employees drops.

Our theoretical model incorporates a trade-off in providing notice: Notified workers intensify their on-the-job search and supply less effort on the job. Both of these behaviors reduce current production, but intensified job search increases future employment and production. The current employer has no direct incentive to share information about planned layoffs as it does not internalize these benefits. MN prescribes information sharing and changes the property rights over information. But if the market equilibrium is efficient, MN has no impact on outcomes because when the production loss from information sharing is high, severance pay is used in lieu of notice. However, the same mechanism helps to increase efficiency in the presence of frictions, e.g., due to workers under-estimating the risk of layoff. When advance notice is under-provided in equilibrium – because workers do not value information sharing sufficiently – MN corrects this distortion. In fact, additional notice will only be provided when frictions prevent efficient information-sharing, while inefficient information-sharing is avoided using severance.

We bring these theoretical insights to the data. Our goal is to investigate whether severance pay is used instead of notice, and to estimate the production gains and losses of notice. To achieve these objectives, we must overcome three hurdles. First, to observe individual-level notification, we use

[1] The state of New York extended the mandatory notice period to 90 days in 2009, and New Jersey is currently considering a similar extension (Krolikowski and Lunsford, 2020).

[2] Both in Sweden and in the U.S., it is legal to sidestep the MN requirement with bilaterally-agreed payments.

unique and novel administrative data from Sweden. Second, to estimate the causal effects of MN, we exploit an age-based discontinuity from Swedish collective agreements. Third, to measure severance payments, we develop a simple method using annual earnings and employment spell data that is generalizable to other countries and contexts.

Our RD estimates reveal that employers do provide longer notice periods to workers entitled to extended MN. Longer MN also increases severance pay. In light of our theory, the increase in the notice period indicate the presence of frictions, and the usage of side-payments suggests that information sharing is not always efficient. On net, MN leads to a smoother transition across jobs (shorter non-employment duration) and better subsequent job matches (higher wages). The wage gain occurs mainly for workers who transition to a new job without a spell of unemployment. Higher severance, lower non-employment, and higher wages yield an increase in post-notification earnings corresponding to 13% of annual earnings. Shorter non-employment, higher severance and wages contribute to 50%, 35%, and 11% of this earnings increase, respectively.[3]

To distinguish the effects of MN that arise due to extended notice periods or higher severance pay, we exploit an additional source of exogenous variation stemming from spill-overs across workers within the same layoff. Using our age-based RD-design, we first show that longer (de jure) MN of a worker causes longer actual (de facto) notice of her co-workers. Our additional instrument — the share of laid-off co-workers above age 55 — leverages this fact. We find that the earlier the worker is aware of future layoff, the shorter is her exposure to non-employment, and the higher is the wage of her future job. Severance pay has no impact on future wages but lengthens non-employment duration.

Importantly, workers notified a month earlier find a job paying 1.8% higher wages. This is substantially larger than the UI wage effects documented in the prior literature.[4] This points to the effectiveness of on-the-job search compared to search while unemployed; slower skill deterioration and no stigma of prolonged on-the-job search, imply that workers can be more selective in their job search without suffering from declining opportunities (negative duration dependence).

In the second part of our empirical analysis, we provide evidence regarding the costs of the policy. We first exploit legislation that requires employers to report to the Public Employment Service any layoff of at least 26 workers a minimum of four months in advance. We show that this requirement is mainly relevant for firms that would like to give workers advance notice – i.e., when the productivity loss of notice is low – and lay off workers with less than four months of mandatory notice. Such firms have an incentive to lay off only 25 workers (i.e., bunch) and retain other workers temporarily. Our empirical analysis documents substantial bunching at and below 25 workers. As predicted, excess mass is larger, the higher is the share of workers eligible for less than four-months of MN. Although indicating that that the productivity loss due to notice is moderate – at least in some firms – this exercise does not provide a quantitative estimate of the productivity loss of notice.

To estimate the productivity loss of having workers on notice, we use variation in notice duration across firms in a difference-in-differences framework. Holding layoff size constant, we show that the revenue per effective worker falls for firms where notified workers remain longer on the payroll. A

[3]The remaining 4% has to do with the transition from the old to the new job.

[4]See Nekoei and Weber (2017) for a review of the evidence on the UI wage effect.

causal interpretation of this analysis requires the assumption that productivity would evolve similarly in the absence of layoff for similar firms with different average notice duration. The fact that the pre-notification evolution of the marginal revenue product is unrelated to subsequent average notice duration across firms support this assumption. The temporary nature of the effects suggests that differences in the composition of laid-off workers, which are correlated with average notice duration, are not likely to be the driver of the productivity loss. Our estimates suggest a 35% productivity loss of notified worker relative to other workers.

Third, we show that severance is not paid in displacements involving cash-constrained firms. This is problematic, as the normative case for MN relies on firms being able to use severance payments to avoid cases where the productive loss of notice is larger then the gains for workers. In the light of our theory, this evidence suggests that MN can impose an efficiency loss for cash-constrained firms.

Finally, we pull the pieces together by comparing the size of the production gains and losses of the MN policy. The production gains consist of the positive wage effect plus the shorter duration of non-employment, which should be compared with the productivity loss of notice. Our estimates suggest that the net impact of the policy on average production is positive. In fact, the gains are so large that the productivity loss of notice would have to be in the excess of 80 percent — our estimate corresponds to 35 percent — for the policy to negatively impact production efficiency. The main caveat to these results is that the policy may affect the hiring margin. Hiring will be impacted if firms cannot shift the average cost of the policy onto workers in the form of a reduction in wages. Moreover, the positive impact on production contributes to a positive fiscal externality, which is further enhanced by a reduction in UI expenditure. To give a sense of the magnitudes involved, the increase in production corresponds to 88% of a monthly wage, and the fiscal externality to 71% of a monthly wage.

Our paper is related to several strands of the literature. The empirical evidence on MN mainly comes from the research during the decade after the introduction of the WARN act of 1988; see, e.g. Ruhm (1992, 1994), Burgess and Low (1992) and Jones and Kuhn (1995). Papers in this literature mainly compare workers in firms subject to the WARN act to workers in firms which are not, controlling for a rich set of covariates. Our finding that MN helps workers to find a better job emphasizes the effectiveness of on-the-job search, echoing the similar pattern in survey data (Blau and Robins (1990) and Faberman et al. (2021)).

With respect to the theoretical literature, Pissarides (2001) focuses on the insurance properties of advance notice. He shows that advance notice can be a part of an optimal contract, as it effectively provides an alternative insurance mechanism for workers. There are only a few examining the efficiency properties of MN. In the settings of Kuhn (1992) and Deere and Wiggins (1988), MN plays the role of a commitment device for employers. We discuss such cases, but also consider cases where notice is contractable but under-appreciated by workers. Our main theoretical point is valid no matter the source of friction: MN is efficiency-enhancing, as severance can be used to undo the inefficient part of the program.

More generally, our theoretical findings relate to Lazear (1990), who show that public policies (in his case severance pay) will be undone by private contracts in the absence of transaction costs. One general lesson from our paper is the importance of studying why and how labor laws are sidestepped using private contracts. In contrast to Lazear (1990), there are potential benefits of the public policy in our setting. We thus show that bypassing the law with a bilateral agreement can be efficiency-enhancing since it allows the agents to avoid the policy when it is inefficient.

The paper unfolds as follows. Section 1 provides a framework that guides our empirical analysis. Section 2 describes the institutional setting for our empirical work as well as the data used. Sections 3 and 4 provide our empirical analysis of the benefits and costs of MN, respectively. Section 5 connects the empirical results to the theory and calculates the efficiency effect of MN. Section 6 concludes.

1 Conceptual Framework

This section provides a simple framework that guides our empirical analysis. We first examine the role of MN in the case of exogenous private contracts, and then consider the polar case of endogenous efficient contracts that can adjust fully in response to MN. Finally, we discuss the more realistic case of endogenous contracts with frictions. The full treatment of these cases is provided in Appendix A.

1.1 The Theoretical Setting

We consider a two-period model. Production is the result of a match between a worker and an employer. Workers are homogeneous and risk-neutral. The risk neutrality assumption, a deviation from the literature, allows us to focus on the first-order impact on productive efficiency (rather than insurance). For now, there is free entry and perfect competition among employers.[5]

In the first period, production is "high", and equal to Y. In the second period, production remains high with probability θ or drops to zY with probability $1-\theta$. At the beginning of the two periods, the worker is hired with a contract specifying a wage, a severance payment and an advance notice requirement, $(wY, sY, \delta \in \{0,1\})$. Without loss of generality, we normalize $Y = 1$. The contracted wage is fixed for both periods, with no possibility of renegotiation. This assumption leads to separation in case of a productivity drop in the second period.

Just after signing the contract, the employer receives private information about the productivity of the match in the second period. The information is verifiable: the employer may share this information with the employee, i.e., giving her advance notice, at the start of the first period.

When an employee receives advance notice, her productivity falls for two reasons: first she starts to look for alternative employment (on-the-job search); second, work effort decreases (i.e., she "shirks") since work incentives have fallen. Together, these two forces lower production by a factor $\alpha \in [0,1)$, to which we refer as "productivity loss of notice".

Safe jobs are available in the second period; they have productivity $\rho < 1$, which captures the displacement effect (e.g., Jacobson et al., 1993). Laid-off workers will find such a job with probability e.[6]

[5] This assumption and many other aspects of the setting are borrowed from Blanchard and Tirole (2008). We also follow them in focusing on the optimal contract and to characterize the equilibrium.

[6] To make the setting interesting to study, we assume that the the outside option is better than remaining in a low-productive job, $e\rho > z$ (see Appendix A).

On the job search is productive. It increases both the likelihood of finding a job in the second period by Δe and the wage in the new job by $\Delta\rho$ (Acemoglu and Shimer (1999), Faberman et al. (2021)). We denote the total expected production increase due to notice by σ, $\sigma \equiv (e + \Delta e)(\rho + \Delta\rho) - e\rho$.[7]

The trade-off in providing notice is between the production loss of notice, α, and the production gain due to on-the-job search for the worker, σ. First-best information sharing (advance notice) occurs when the productivity loss in the first period is smaller than the gain from notice, i.e., if and only if $\alpha < \sigma$. By contrast, providing severance pay does not involve the same trade-off since it lacks the information sharing aspect.

1.2 The Role of Mandatory Notice of Layoff (MN)

Exogenous contracts In this section, we first study the role of MN in the case of an exogenous contract without advance notice, $(w, s, 0)$. This is a partial equilibrium analysis – in fact, it is the counterpart of Baily-Chetty setting for the analysis of optimal UI, applied to the case of advance notice (Baily, 1978; Chetty, 2006).

In the absence of MN, employers do not provide advance notice. The reason is simply that employers do not internalize the gain accruing to the employee but they bear the entire cost. The expected profit equals[8]

$$\pi_0 = \underbrace{(1-w)}_{\text{1st period}} + \underbrace{\theta \times (1-w) + (1-\theta) \times (-s)}_{\text{2nd period}} \tag{1}$$

Now, if labor law mandates advance notice, the employer has three options. The first option is to provide advance notice, which reduces expected profit by the (expected) production loss of notice; the expected profit associated with this option is thus $\pi_0 - (1-\theta)\,\alpha$. The second option is to not provide advance notice, but compensate the worker ex post with an additional severance payment of σ; an additional severance payment of σ exactly compensates for what the worker lost by not getting advance notice. The expected profit associates with this second option is $\pi_0 - (1-\theta)\,\sigma$. The third option is to notify the worker in the second period, such that the productivity loss of notice occurs during the low productivity period. This "labor-hoarding" strategy leads to the profit of $\pi_0 - (1-\theta)\,\Xi$, where $\Xi \equiv w - (1-\alpha)\,z$.

[7] To focus on productive efficiency, we ignore the disutility cost of working and searching. To incorporate such costs, we would have to adjust $e\rho$ and σ.

[8] For the sake of simplicity, we ignore discounting.

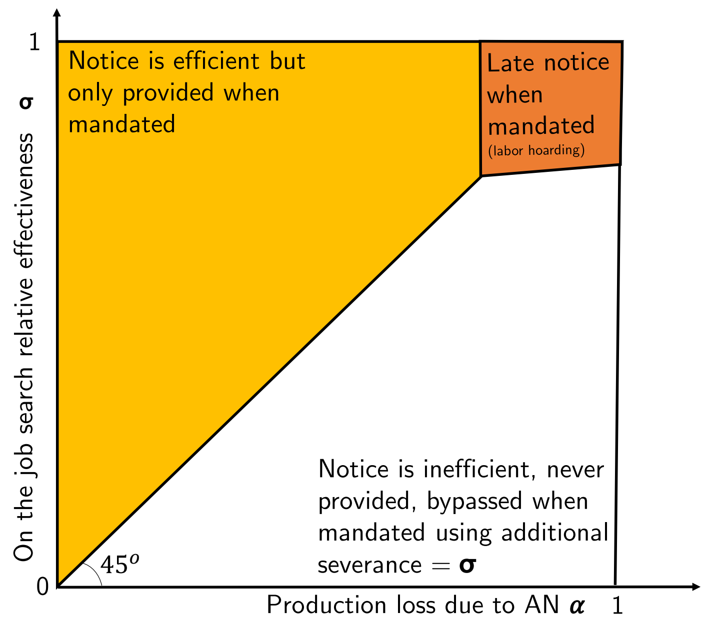

Figure 1: Provision of advance notice and the role of mandated notice (MN)
Note: This figure illustrates how MN affect the allocation of notice and severance pay in the setting with an exogenous contract. Appendix A provide similar illustrations for the case of an endogenous contract, with or without frictions.

Figure 1 illustrates the optimal actions that the employer would take:

1. Notifying the worker in advance when $\min(\sigma, \alpha, \Xi) = \alpha$. MN increases production by $\Delta W = (1-\theta)\,\sigma$ from the base of $W_0 = 1 + \theta + (1-\theta)\,e\rho$.

2. Side-stepping notice using severance when $\min(\sigma, \alpha, \Xi) = \sigma$. Severance is thus used in place of notice, so that production is unaffected by MN.

3. Notifying the worker at the start of the 2nd period when $\min(\sigma, \alpha, \Xi) = \Xi$.[9] This is an inefficient outcome, and the production loss in this case would be $\Delta W = (1-\theta)\left((1-\alpha)\,z - e\rho\right) < 0$.

Endogenous contracts The other extreme setting is when the contracts are endogenous, with no frictions at all. Appendix A investigates this case and shows that MN does not change allocations – it only changes the terms of the contract. The market achieves the first-best allocation, and private contracts provide notice when it is efficient. When notice is not efficient – when the benefit is smaller than the cost $\sigma < \alpha$ – MN is sidestepped using severance pay. This is due to the rich contractual environment. In fact, it is an application of Lazear (1990)'s insight to the case of mandatory notice (see also Pissarides, 2001).

A more realistic setting, perhaps, lies in between the above two extremes. Appendix A investigates a setting with endogenous contracts, when some frictions prevent the efficient provision of notice. We consider two types of frictions. The first type of friction has workers being too optimist regarding the

[9] Using the expression for Ξ , these two conditions can be written as $\alpha > \frac{w-z}{1-z}$ and $\sigma - \alpha z > w - z$.

stability of their jobs, i.e., $\widehat{\theta} > \theta$; the second type of friction comes from cash-constrained workers and firms. When workers overestimate the stability of their jobs, MN has the potential to increase efficiency, because there is a range of parameters where efficient notice was not part of the private contract. When firms are cash-constrained, there is a range where inefficient notice will be provided, when mandated, since firms are not able to compensate workers for not having received notice. Appendix A also considers the interaction between UI and MN. Given the risk-neutrality assumption, a budget-balanced UI does not affect the equilibrium. However, a UI system that is not budget neutral acts as friction since it creates a wedge between employment and unemployment. In this case, MN also create a non-zero fiscal externality. We will return to this in Section 5, where we use our empirical results to calculate this fiscal externality.

Extensions Appendix A also covers a number of extensions to the basic framework. One important side-effect of employment protection is that it affects the hiring margin because of an increase in separation costs. To capture such side-effects , we assume an elastic supply of employers, so that the employment rate in the first period l_0 is a function of net profit π_0. MN lowers employment as it reduces the profit by $(1 - \theta) \times \min(\alpha, \sigma, \Xi)$. However, with endogenous contracts, the hiring effect is dampened, to the extent that the layoff cost can be passed onto workers through lower wages.

Another concern with MN is that mandated notification periods may be too long. In other words, MN may require information sharing even before the employer has information about a future productivity shock. So far we have ignored this issue by considering the case where the duration of MN has been equal to the information horizon of the firm. Appendix A studies a case where the law mandates notice T periods in advance, where $T > 1$. Under this law, all three options discussed above are still possible, but in each case an additional severance payment of $(T - 1)\,\sigma$ must be paid to the worker to compensate for the additional length of MN. In this sense, too long MN is equivalent to well-timed MN plus a mandatory severance. But now the employer also has a forth option: provide two periods of notice. This fourth option leads to notice periods that are too long and thus inefficient. However, with endogenous contracts, the long MN scenario is equivalent to mandatory severance as contracted wage and severance adjust accordingly.

Lessons for our empirical work In our empirical work, we estimate the effect of MN (de jure notice) on de facto notice and severance pay. An effect of MN (de jure notice) on de facto notice means that we do not live in the endogenous efficient contract world. Any evidence suggesting that employers use severance pay in response to an increase in the length of the mandate speaks directly to the efficiency aspects of MN, since employers being able to undo inefficient mandates with severance pay is a key component of the normative case for MN. We also estimate the gains of MN (i.e., Δe and $\Delta \rho$ in the notation of the model) as well as the productivity loss of notice (α in terms of the model). Connecting these components with the theory allow us to measure the total efficiency gain of the program.

Our empirical setting, described in the next section 2, is closest to the exogenous contract case, since it is arguably impossible for employers to adjust the terms of the contract to the quasi-random variation that we use for identification. Nevertheless, the study of the endogenous contracts allows us to discuss the general welfare implications of our findings in Section 5.

2 Setting and Data

2.1 Institutional Setting

Swedish labor law stipulates that a firm intending to lay off a worker must give written notice to the worker in advance.[10] The length of the notification period varies discontinuously with tenure, from a minimum of 1 month, for employees with less than 2 years of tenure, to a maximum 6 months, which applies to workers with at least 10 years of tenure. Alternative rules can be agreed upon in collective bargaining agreements. For instance, the white-collar agreement within manufacturing stipulates that workers above age 55 with 10 years of tenure get an additional 6 months of notice. After being notified, individuals may also agree to severance pay packages that are different from the default rules and perceived as more generous from the worker's point of view.

We have collected information from all major collective agreements on the Swedish labor market for the relevant time period (2005-2014). In all these cases, age 55 rules exist for white-collar workers in the private sector (26% of total employment). The most common formulation, by far, is the one described above. Workers who are older than 55 should receive an additional six months of notification.[11] Ideally, we would match the information from the collective agreements to the individual-level microdata. However, these microdata do not include information on the collective agreement a worker belongs to at a given point in time. In our empirical analyses, we focus on the age-55 threshold for all white-collar workers in the private sector. We do not use tenure discontinuities due to measurement error in tenure.[12] For age per se, there is no measurement error involved.

2.2 Data and Estimation Sample

Swedish labor law stipulates that a firm intending to lay off at least five workers simultaneously must report to the Public Employment Service (PES).[13] This procedure occurs in two steps. First, the firm reports the number of workers that it intends to displace along with the reason for downsizing. Upon this initial report, the firm enters negotiations with the labor unions regarding who to lay off, respecting the last-in-first-out principle that requires workers with shorter tenure to be laid off first, conditional on occupation type. In the second step, the firm submits a list of the names of displaced workers and their individual-specific displacement dates. This list must be submitted to the PES within one month before the first displacement date.

[10] Verbal announcements are legally binding as well, but come with pecuniary penalties.

[11] Other age rules do exist but they are much less prevalent. The white-collar agreement in retail trade during 2004-2007, for instance, determines MN duration as a combination of age and tenure. For given tenure, notification periods are prolonged discretely at age 25, 30, 35, 40, and 45. This age proviso was later changed to the one described in the main text.

[12] Measurement error in tenure at notification has three sources. One issue is that January is reported too often as the starting month of an employment spell. This potential problem comes from the fact that employers should report the duration of the employment spell within the year in the annual income statements for the employees. The risk is that employers routinely report months 1-12 as the employment spell rather than the true employment spell (say 4-12), since the spell length does not affect taxes due. A second issue is the precise definition of tenure. The formal rule allows for breaks in tenure due to, e.g., parental leave and sick-leave. The challenge is to determine whether a break in two consecutive spells at a firm is due to the worker being on leave or whether the break should reset the tenure clock. A third issue is that there may be measurement error in notification dates, meaning that tenure at notification would be measured with error even if tenure itself is measured perfectly. The third issue also implies that there will be some measurement error in age at notification. See Davezies and la Barbanchon (2017) for an analysis of the consequences of measurement error in the forcing variable.

[13] Two layoff events occurring at the same plant within three months are treated as the same event.

Our main dataset is the notification register containing both steps of all displacement events occurring during 2005-2014. For each worker, we use these data to define the length of the notification period as the duration between her displacement date and the notification date, where the latter is the date when the list arrives at the PES. We assume that the notification date also corresponds to the date when the worker learns about her future displacement. The typical configuration in the data is that all workers involved in a given displacement event are notified at the same date, but that future displacement dates vary depending on individual variation in age or tenure.

We match the notification register with five other administrative datasets: (i) RAMS contains the universe of matches between employers and employees; it includes information on earnings, months worked and the characteristics of their workplaces (plants and firms), such as industry codes; (ii) LISA contains individual-level characteristics, including demographic variables for all individuals, aged 16 and older, residing in Sweden at the end of the calendar year; (iii) Wage and Hours Survey provides information for all workers in the public sector and around 50% of all private-sector workers. For each employee, employers report the full-time equivalent monthly wage (during September-November). The wage includes all fixed-wage components, as well as piece rates, performance pay, and fringe benefits; (iv) Unemployment spell register provides us with exact duration of unemployment spells; (v) Income Statement and Balance Sheet register contains information on revenue and value added for all non-financial firms. All these five registers are available for the period of 2005-2014 covered by the notification register.

Population and Descriptive Statistics To be included in our analysis, individuals must have experienced a displacement event and be residents in Sweden at the end of the notification year. Table 1 presents descriptive statistics of our analysis sample as well as three relevant comparison groups. Panel (a) shows individual-level characteristics, while Panel (b) presents firm-level statistics. The first column focuses on all notified individuals in our data. The set of notified individuals compares relatively well with the average employed worker in the same industries (column 2). The main difference is that educational attainment is lower among the notified, which in turn is driven by the fact that blue-collar workers are over-represented among notified individuals. Educational attainment among the notified is also lower compared to the average employed workers (column 3). The fact that private sector manufacturing firms are over-represented among notifying firms, implies that males are over-represented among notified individuals.

Column (4) of Table 1 shows characteristics of our worker-level estimation sample. It consists of private-sector white-collar workers aged 52 to 58 who are notified of displacement. Since individuals in this sample are older white-collar workers, they have higher wages, earnings, and educational attainment, than the average individual notified of displacement.

Panel (b) describes the firms involved in a displacement event in our data. Given that the firms in the data must have notified at least five workers simultaneously in order to be included in the data, it is no surprise that average firm size is large. It also conforms to intuition that they tend to belong to cyclically sensitive sectors (e.g., manufacturing) to a greater extent than the average firm.

3 Benefits of Mandatory Notice: Smoother job-to-job Transitions

3.1 Effects of Mandatory Notice using a Regression Discontinuity Design

Our identification strategy exploits the discontinuity in the duration of mandatory notice at age 55, which is induced by collective bargaining agreements. This age rule is a feature of most collective agreements for white-collar workers in the private sector (Section 2.1). Our data allow us to identify private-sector white-collar workers, but we cannot identify which collective agreement they belong to (Section 2.2).

Our main specification is

$$y_i = \beta \mathbf{1}(A_i \geqslant 55) + g^0(A_i - 55) + \mathbf{1}(A_i \geqslant 55) \times g^1(A_i - 55) + \varepsilon_i \quad (2)$$

where y_i denotes an outcome and A_i age at notification for individual i. $g^k(.)$, $k = 0, 1$, are age control functions. Our main analysis uses data for individuals who are aged ± 3 years relative to the age-55 threshold. This corresponds relatively well with the optimal bandwidth according to Calonico et al. (2014) (Appendix B.2). Given that we have only month of birth, age is discrete and measured in months; we therefore rely on a parametric control function.[14] Our default empirical specification has a linear control function in age at notification, which is interacted with the threshold; we motivate this choice in the sequel. In addition, we control for a number of pre-determined covariates and month-by-year fixed effects for precision.

Subject to an exclusion restriction, estimates of β from equation (2) gives the effect of mandating longer notice on outcomes. The validity of the exclusion restriction hinges on whether other parts of the public support system feature a discontinuity at age 55.[15] We are not aware of such a rule. In particular, there are no rules specifically tied to the *age at notification*.

In the remainder of this section, we investigate the effects of the age-55 threshold empirically. Appendix Section B.1 provides supportive evidence for the validity of our RD design. In particular, we show that the distribution of notified individuals is smooth around the threshold and pre-determined covariates balance.

3.1.1 Actual Notice Duration and Severance Payments

We first investigate the effect of the mandated notification period on actual notification duration. According to the theory, this effect is zero in a frictionless world with endogenous contracts. Figure 2a implements our RDD. It shows that notification times are long. Just below the age-55 threshold, individuals have around 6.5 months of notice (196 days).[16] Notice times then jump by slightly more than 2.5 months (81 days) at the age-55 threshold.

Table A3 in the Online Appendix probes the robustness of the MN effect on notice duration.

[14] Since age is measured in months we cannot determine whether someone turning 55 during the same month as the notification takes place is just above 55 or just below 55. We therefore exclude observations exactly at the cut-off.

[15] For instance, there used to be a rule prolonging UI duration for workers who were at least 55 years old at the time of unemployment entry. This rule was abolished in 1998.

[16] In Section 3.2, we show that there are spillovers from long-notification to short-notification workers which partly rationalizes long notice periods in the control group.

Among other things, it shows that controlling for baseline covariates does not matter and that we can include displacement event fixed effects without changing the results. What does matter, however, is whether we include a more flexible polynomial control function in age at notification. With a second-order polynomial the discontinuity estimate is reduced by a month. This reduction is most likely an artifact of the measurement error in notification dates, which translates into measurement error in age at notification. This measurement error, in turn, causes the discontinuity to look a like a non-linearity (see Figure 2a). Since the reduction in the discontinuity estimate is mainly driven by measurement error, our preferred specification is the linear interacted one.

We then estimate the effect of longer MN on severance pay. A major obstacle pertains to the measurement of severance pay, since the tax registers record severance as part of annual labor earnings, making severance difficult to distinguish from general wage payments in the data. We overcome this obstacle by first predicting the component of annual earnings which comes from regular wage payments. Severance is then measured as annual earnings minus the predicted wage payments. More concretely, if a given worker separates from an employer in, say, April, we construct severance by subtracting four months worth of monthly earnings, calculated from the previous year, from earnings received from the displacing employer (adjusted for average growth in the industry). This is a biased measure of severance pay in levels, but any non-severance pay components get differenced out when we compare workers across the threshold.[17]

Figure 2b shows that severance increases by 16.9 kSEK at the age-55 threshold.[18] This estimate, which captures the extensive as well as the intensive margin, corresponds to 56% of a monthly wage. Monetary side-payments are thus used to reduce the duration of inefficient mandatory notice. This evidence thus shows that private agents use bilateral private agreements to undo public regulation, at least to some extent, as pointed out by Lazear (1990). In fact, to our knowledge, this is the first paper that documents the existence of such transactions.

3.1.2 Employment Status

Now, we examine how MN affects the transition process for workers, in general, and whether a longer MN period shields them from non-employment, in particular.

Panels (a) and (b) of Figure 3 show the probability of remaining in the notifying firm and the probability of working at a new firm at different points in time relative to the month of notification, respectively.[19] The black-circled line in each panel pertains to those just above the age-55 threshold, and the hollow-circled line to those just below the threshold. The difference between the two lines at any given time point is an RD-estimate, and we indicate statistically significant estimates at the 5-percent level by dashed vertical lines.[20]

[17] Appendix Figure A9 illustrates our method by focusing on workers laid off in January. It shows that they receive total average transfers of around 180 kSEK (SEK 180,000) in January, which is well above monthly earnings in the preceding year (around 30 kSEK).

[18] All amounts have been deflated to 2010 values. In November 2019, the SEK/US Dollar conversion rate is 9.65 SEK/Dollar and the SEK/Euro conversion rate is 10.75 SEK/Euro.

[19] Appendix Figure A10 contains RD-graphs for employment status 12 months after notification.

[20] In principle, all workers notified of displacement in a particular month should be observed at the notifying firm in the month before. Because of measurement error (mainly in the notification dates), this is not the case in our data. According to panel (a), the fraction remaining in the notifying firm in $t = -1$ is 0.99, and according to panel (b), the fraction observed

Panel (a) conveys several messages. First, prior to notification, and up to 2 months after notification, the probability of remaining at the notifying firm is the same across the two groups, but after 3 months a small gap starts to open up. Second, between months 6 and 11 a rather substantial gap opens up between workers with long and short notification periods. At 12 months after notification, the probability of remaining at the notifying firm increases from 29 percentage points to 40 percentage points as a result of longer MN. Third, when the mandated notification period expires for the treatment group (which seems to happen around month 12), the gap between the two groups closes. The differential survival rates persist to around 20 months after notification, after which there are no treatment effects of being eligible for longer notification. Fourth, in the longer run, 7 percent of workers remain at the firm despite being notified of layoff.[21]

Panel (b) of Figure 3 shows that MN lowers the probability of working at another firm during months 6-12 after notification. The difference between the two groups falls one year after notification and becomes non-existent after two years. In the longer run, 80 percent of notified workers move to another firm, and this mobility rate does not differ across the treatment and control groups. Figure 3 suggests that all of the employment adjustment occurs during the first two years after notification.[22]

Table 2 summarizes the employment impacts over the first two years. As a result of a longer MN period, individuals stay in the notifying firm an additional 1.8 months. This is almost a month less than the additional 2.7 months of actual notice duration (c.f. Figure 2a or Table A3, column 2), suggesting that they separate one month prior to their layoff date. The duration worked in the new firm is reduced by one month (see column 2). Taken together, columns (1) and (2) imply that mandating longer notice reduces exposure to non-employment by three quarters of a month (column 3). Two thirds of the non-employment reduction comes from shorter unemployment duration and one third from spending less time out of labor force (columns 4 and 5).

3.1.3 Wage

Since longer notification means more insurance without exposure to unemployment, one would expect individuals eligible for longer notification to find higher-quality jobs.

Figure 4a examines the effect of longer MN on the monthly wage in the first new job. Following the literature on the impact of UI on re-employment wages, we consider the first wage reported in a new job within the first two years (Card et al., 2007). We use this time window since MN has no impact on employment rates after two years (see Figure 3). Figure 4a documents a positive and statistically significant wage effect as result of a longer MN.[23]

Figure 4b shows the evolution of wages by month since notification for those just above and below the age-55 threshold.[24] As before, the differences between the solid and dashed lines represent the

in another firm in $t = -1$ is 0.003.

[21]The potential explanations for this pattern include: notified workers replacing an unexpected departure of another worker, and market conditions improving for the notifying firm. Importantly, this pattern is not driven by recalls. The vast majority of workers are observed at the notifying firms because they never left.

[22]Appendix Figure A7 shows that these results are robust to using the optimal bandwidth proposed by Calonico et al. (2014).

[23]The wage estimates are significant at the 10%-level and thus less precise than those for employment status. This reduction in precision is partly due to wage information being available for 50% of the population (see Section 2.2).

[24]Since we observe wages at a single point in time each year (see Section 2.2), the monthly variation comes from the

RD-estimates. We show wages for all employed individuals, independently of whether they are at the notifying firm or the new firm. Given that employment rates differ across treatment and control group during the first 20 months, the wage differences do not have a causal interpretation during this period. After 20 months, however, the difference in wages between the two groups reflects differential wage losses associated with the move to another firm caused by the treatment. On average, the wage difference between the two groups amounts to around 3 percent during months 20-36 after notification.

An interesting pattern in Figure 4b is that wages seem to catch up for the control group after 36 months. This probably reflects that individuals with short notification have stronger incentives to accept any job, and later climb the wage ladder faster. If so, we should expect greater onward mobility in the control group than in the treatment group. Appendix Figure A11 provides supportive evidence by showing that those with short notification move on to other jobs at a greater rate than those with long notification, consistent with greater onward job mobility.

Table 3 reports the magnitude of the wage effect. It shows that longer MN allows workers to avoid 2.7% of the wage loss associated with moving to a new job after notification. Column (2) focuses on the difference in log wages. Since prior wages are balanced, this should improve precision without affecting the estimates much. Whereas workers in the control group experience a wage loss of 8.6% as a result of displacement, longer notification limits the wage loss to 5.5%. The effect of being eligible for longer notification is therefore 3.1 percentage points. The additional insurance provided by MN, as well as extended possibilities for search on-the-job, thus allow workers to obtain a better job after displacement.[25]

A critical question is whether the wage effect of MN is due to workers being more selective in their job search – either on the job or while unemployed – or whether it is driven by a higher likelihood of finding a job while employed. To shed light on this question, we decompose the wage impact for those who make an employment-to-employment (EE) transition and a non-EE transition, as well as the change in the probability of doing an EE transition. Descriptively, the lion's share of the wage effect occurs conditional on an EE-transition; seecolumn (5) in Table 3. Using these estimates, we get

$$\Pr(\mathrm{EE})\,\mathrm{E}(\Delta \ln w|\mathrm{EE}) = 0.7 \times 0.037 = 2.6\% \tag{3}$$

which should be compared with $\mathrm{E}(\Delta \ln w) = 3.1\%$. Appendix B.3 provides the details regarding this decomposition.

Table 3 also examines whether the wage effects extend beyond the initial wage. It seems that individuals with long notification are able to find better jobs, both in terms of wage levels (panel a) and initial wage growth (see the first column of panel b). But the effects on longer-run wage growth are negative (although statistically insignificantly so). The evidence on wage growth thus lines up with the pattern we observed in Figure 4b.

In Appendix Table A2, we examine whether longer MN also affects the characteristics of the new

variation in notification dates relative to the wage observation.

[25] Appendix Figure A8 shows the distributional impact of being eligible for long notification. It illustrates that individuals who are eligible for longer notice are exposed to wage losses to a lesser extent and increases the probability of observing large wage increases. See Nekoei and Weber (2017) for similar distributional wage impact of prolonging UI duration.

firm. We consider the average wage, earnings, age of workers, size of firms, profits, profit margins, and value added. Most results are statistically and economically insignificant. Overall, an increase in the quality firms does not seem to be the main driver of the wage effect.

3.1.4 Total Earnings and a Decomposition of the Earnings Effect

Figure 5a shows RD estimates for earnings in the calendar year after notification. Individuals just to the left of the threshold earn 314 kSEK, while individuals just to the right earn 356 kSEK. Being eligible for longer notification thus increases annual earnings by 42 kSEK. This corresponds to about 14% increase in earnings.

Figure 5b illustrates the evolution of annual earnings in different calendar years relative to the notification event for those just above the age-55 threshold (black-circled line) and those just below the threshold (hollow-circled dashed line). It conveys several insights. First, it shows that the treatment and control groups are strongly balanced during the four years prior to notification. Second, after two years there are no discernible effects of being eligible for longer notification. A comparison of earnings at event year $t = 2$ and $t = -1$ suggests that the earnings losses associated with displacement amount to roughly 25% of pre-displacement earnings. These losses are similar in magnitude to those typically documented in the literature (see, e.g., Jacobson et al., 1993). Third, because of the longer notice period, earnings losses are much lower for the treatment group (0%) than for the control group (11%) one year after notification ($t = 1$) when compared to the year before notification ($t = -1$). Fourth, there is a striking increase in annual earnings during the year of notification, which is surprising given that in most contexts we would expect earnings growth to fall for notified individuals. This is prima facie evidence of the existence of severance pay packages, as predicted by the theory.

What are the drivers of this overall earnings effect? The total earnings effect (Δy) of being eligible for longer notification can be decomposed into earnings from the old and the new job, plus additional severance pay.

$$\underbrace{\Delta y}_{\text{Earnings effect of MN}} = \underbrace{\Delta(w_0 l_0)}_{\text{MN effect on earnings from old job}} + \underbrace{\Delta(w_1 l_1)}_{\text{MN effect on earn. from new job}} + \underbrace{\Delta SP}_{\text{MN effect on severance pay}} \tag{4}$$

where Δ denotes a treatment and control difference, w_0 (w_1) the wage of old (new) job, and l_0 (l_1) job duration. We can rewrite this equation using $\Delta w_0 = 0$ (the treatment and control group have the same wages prior to treatment) and $T = l_0 + l_1 + NE$, where NE denotes non-employment duration, and get

$$\underbrace{\frac{\Delta y}{w_0}}_{\text{Earnings effect of MN}} = -\underbrace{\Delta NE}_{\text{non-employment dur. effect}} - \left(\frac{w_0 - w_1}{w_0}\right)\underbrace{\Delta l_1}_{\text{new job dur. effect}} + \underbrace{\frac{\Delta w_1}{w_0}}_{\text{wage effect}} l_1 + \underbrace{\frac{\Delta SP}{w_0}}_{\text{Severance pay effect}} \tag{5}$$

The first component is the effect of longer mandated notice on earnings through exposure to non-employment. The second component captures the effect of longer mandated notice on tenure at the notifying firm relative to the new firm. If the displacement involves wage losses, $w_1 < w_0$, the second component also contributes to increasing earnings. The third component reflects the wage effect. The fourth component, finally, is the severance pay effect.[26]

We decompose Equation (6) over a 2-year horizon.[27] The earnings effect of longer MN corresponds to 1.56 months of additional pay (LHS). Most of this overall earnings effect can be attributed to the non-employment effect (50 percent of the overall effect). Severance pay contributes to 35 percent of the earnings difference, while higher wages in the new job contribute to 11 percent.[28]

$$\underbrace{1.56\,\text{month}}_{\text{Earnings effect of MN}} \simeq \underbrace{50\%}_{\downarrow\text{non-emp. dur.}} + \underbrace{4\%}_{\uparrow\text{empl. at noti. firm}} + \underbrace{11\%}_{\uparrow\text{wage}} + \underbrace{35\%}_{\uparrow\text{severance pay}} \tag{6}$$

3.2 Separating the effects of advance notice and severance payment

We have shown that longer MN helps workers in avoiding non-employment and allows them to find new jobs that pay higher wages. These results should be interpreted as the net effect of longer notice *and* higher severance. It is important to disentangle the effects of these two channels as they shed light on relative importance of on-the-job vs. unemployed search.

To separate the effect of advance notice and severance pay requires two instruments. In addition to the discontinuity used in section 3.1, we leverage an additional source of exogenous variation coming from spillovers across individuals within layoff events. Given that layoff events are preceded by bargaining between the firm and the local union, one might expect individuals with a short notice period to receive longer notice if they are laid off with many long MN workers. Consistent with this reasoning, Figure A12 uses our RD design and illustrates that an increase in the de jure (mandatory) notice period of a worker, due to her age, extends the de facto notice period of her coworkers.

Building on this observation, we use the share of co-workers older than 55 as an additional instrument. Table A5 shows that pre-notification earnings do not vary with the share of co-workers who are 55+ (and thus eligible for longer notice). This is consistent with this instrument being quasi-randomly assigned. In addition, we require that the share of co-workers older than 55 only affects a notified worker through spillover of MN. To increase the power of our analysis, we add all white-collar workers who are notified of layoff together with the white-collar workers aged 52-58 that we have used in the previous analyses.

The IV-estimates presented in Table 4 imply that an increase in advance notice time by $81/30 = 2.7$ months reduces non-employment by 1.5 months and increases wages by 4.9%. Moreover, an increase in severance pay by 30 kSEK – around one month salary – increases non-employment by one month, but it has no significant impact on wages – neither economically, nor statistically.

The fact that severance has no significant impact on re-employment wages is similar to the finding of Card et al. (2007). It also lines up well with our finding that the estimated wage effect is mainly

[26]The Appendix provides the counterpart of this general decompsition in terms of our model in Section 1, which reveals the connection between each element of the decomposition and the trade off between α and σ.

[27]Our decomposition focuses on the first two years after notification since all employment adjustments have subsided by then (see Figure 3).

[28]Table A4 presents additional detail regarding our decomposition results. This table also presents an imputed severance pay effect: the residual after deducting the components relating to the wage effects and the employment effects from the estimated earnings effect. The severance pay effect that we estimate directly and the imputed severance pay effect line up remarkably well.

associated with EE transitions (Section 3.1).

How does the wage effect compare with prior evidence in the literature? The closest comparison comes from the literature on unemployment insurance (UI). Our wage estimates are much larger than the estimate of the wage effect of UI. The major difference between the wage effect of advance notice and the wage effect of UI is that workers on notice search on the job. Workers on notice thus avoid any negative duration dependence associated with searching for a job as an unemployed worker. UI induces workers to seek higher-wage jobs, but reduces wages by lengthening unemployment.[29] These two countervailing forces lead to ambiguous net effect of UI on wages that is in line with the varying results in the empirical literature (Card et al., 2007, Lalive, 2007, Schmieder et al., 2016, Nekoei and Weber, 2017). The absence of the latter force can justify a larger wage effect of MN, relative to UI.

Our estimate of the effect of severance on non-employment is substantially larger than the estimates in Card et al. (2007), who find a 10-day-increase in non-employment following a 2-month-increase in severance pay. It is difficult to pinpoint the exact reasons for the difference in results. Apart from the obvious explanation that the study populations vary across the two studies, an interesting difference is that Card et al. (2007) examine the effect of a mandatory severance pay program. By contrast, our estimates reflect the causal impact of severance pay for the sub-population who accept such an offer. According to our theory, this population consists of individuals with low value of conducting on-the-job search relative to search as non-employed.

When we net out the big impact of severance on non-employment duration, we find that an increase in advance notice time by 2.7 months reduces non-employment by 1.5 months. This is an important result, which we have seen no counterpart of in the literature. It also corresponds well with the result that higher wages are due to longer notice periods, not severance pay. Again, our theory sheds additional light on the magnitude of these effects. The causal impact of notice is identified in the sub-population whose value of conducting on-the-job search is particularly large. That the law allows for bilateral agreements that undo the mandate, effectively identifies the population that has most to gain from advance notice.

4 Costs of Mandatory Notice: Lower Productivity and Cash Constraints

While the focus of Section 3 has been the benefits of MN, this section focuses on the costs of the program. Section 4.1 first presents evidence suggesting that the productivity loss of notice – α in the framework of Section 1 – is relevant empirically and affects the timing of layoff. Section 4.2 uses difference-in-differences analysis to provide an estimate of average α, by examining how revenue changes upon notification are related to the average duration of the notice period. Section 4.3, finally, provides evidence that the inefficient MN might not be sidestepped with severance payments when firms are cash-constrained; this suggests that there are efficiency losses associated with mandating notice.

[29] See Nekoei and Weber (2017). For empirical evidence on the latter, see Kroft et al. (2013), Eriksson and Rooth (2014), Marinescu and Skandalis (2021)

4.1 Manipulating the Timing of Layoff to Avoid Productivity Losses

This section provides empirical evidence on employers optimizing the timing of notifications and layoffs in order to avoid the production loss due to notification.

To do so, we use a law pertaining to the size of the notification: a firm intending to lay off more than 25 workers must report to the PES more than four months in advance.[30] This law thus does not bind for any layoff which is planned more than four months in advance or when workers have more than 4 months of MN. However, when the law does bind, it creates a trade-off. By postponing the layoffs of workers with short MN, the requirement increases the wage bill. However, some firms may opt to delay the notification its individual workers because that reduces the productivity loss of notice. The requirement thus leads to an incentive for firms to lay off only 25 workers (i.e., bunch) and retain other workers temporarily if the productivity loss of notice, α, is low and the share of workers with short MN is high.

An illustrative example is helpful. Consider an employer who realizes that productivity of 26 of its workers will drop to zero in 2 months. B of the 26 workers have 2 months of MN; remaining workers are eligible for more than 4 months of notice. If the employer's optimal decision is to wait and notify workers when productivity drops in the absence of PES requirement, then the law creates no distortions since all layoffs are effectively planned more than four month in advance.[31] The same is true if $B = 0$. If instead, $B > 0$ and the employer prefers to notify workers right away – which is optimal if productivity loss of notice is lower than the wage $\alpha < w$ – then the employer may bunch in response to the requirement.

To see this, consider the employer's two options: either report 26 workers to PES, which implies that workers can only be laid-off in four months; or report 25 workers now, lay off $B-1$ workers in 2 months and the Bth worker later (in 5 months).[32] The cost of adhering to the law, 2 months of extra salary to B workers, should be compared with the cost of bunching. The costs of bunching entail the productivity loss of notice for $B-1$ notified workers during 2 periods, and the extra three months of salary for the Bth worker. So, the employer will bunch if and only if $\frac{2\times B-3}{2\times B-2}w > \alpha$. It is more likely that this condition is true, when the productivity loss of notice (α) is small and the share of workers with short notice is large.[33]

Figure 6 provides evidence of bunching at the 25 threshold. Panel (a) shows the distribution of the size of layoffs for events that are due to closings (blue dashed line) and to non-closings (red solid line) around the 25-threshold for the years 2005-2015. We use closings to measure the counterfactual density, since if a firm goes bankrupt there is no reason to strategically time layoffs. We thus estimate excess bunching as the distance between the non-closing density and the closing density for layoff events where s $22 \leqslant \text{size} \leqslant 25$. This difference is then normalized by the share of layoffs in closing

[30] Similarly, if the intended size of the layoff exceeds 100, six-month period is required. But displacements involving around 100 workers are few thus we focus on the 25 threshold.

[31] Concretely, as productivity drops in 2 months, the employer tells the PES straight away, but notifies the individual workers only in two months. In that way, the firm respects the 4 months requirement, while not having to notify each individual worker until productivity falls.

[32] Remember that two notification events are treated as the same if they occur within 3 months of one another; see section 2.

[33] This argument is unchanged if the employer prefers to pay SP to undo MN.

establishments at the 25-threshold. We estimate standard errors by bootstrapping layoff events with replacement 100 times, following Chetty et al. (2011).

We then divide layoff events into four equally-sized groups by the share of laid-off workers with a mandated notification period of less than four months. For each quartile, Panel (b) plots the estimate of excess mass (using the same procedure as in Panel (a)) against the average share of laid-off workers with short notice; we use the same counterfactual density for all four groups. Panel (b) shows that a greater share of layoffs are postponed when the share of workers with short notice increases. The distortion caused by the PES requirement thus grows in magnitude along with the share of workers eligible for short notice.

4.2 Effects of Mandatory Notice on Productivity

We assess the costs of mandatory notice by estimating the production loss due to notification in a difference-in-differences framework. Across firms that notify of layoffs in a given year, there is variation in how long the notified workers stay at the firm. By relating the change in revenue per months worked to the share of effective labor provided by workers on notice (holding the size of the layoff constant), we estimate the productivity loss of notice (i.e., the α of section 1).

At this stage of the analysis, we consider firms, since we observe revenues at the firm level. We pool data from several notification years, since we are interested in the average productivity loss of notice, and since pooling improves precision. We thus focus on event year, i.e., the year relative to the notification year.

To fix ideas, consider a simple setting where a firm's revenue is $R_t = A_t K_t^{1-\lambda} (1 - \alpha\chi_t) L_t^{\lambda}$, where χ_t denotes the share of working time provided by notified workers. Following section 1, workers on notice potentially have lower productivity as given by the factor α.[34] By log-linearizing revenue, we obtain the following empirical version of the revenue equation:

$$\log(R_{it}) = \gamma_i + \delta_t + \lambda_t \log(L_{it}) + \alpha_t \chi_i + \omega_t s_i + \rho a_{it} + \varepsilon_{it} \quad (7)$$

where i indexes a notification event and t event year. γ_i thus denotes a fixed effect for a notification event, while δ_t are event-year fixed effects.[35]The α_t's are the objects of interest. They measure how an increase in the share of effective labor supplied by notified workers affects revenue. We compute χ_i as the share of total months worked by notified employees at a firm during the notification year and the year after, using the exact date of notification provided in the Notification register. We allow α_t to vary across event years, in part to provide a test of the parallel-trend assumption. The λ_t's comprise the effect of total months worked on revenue, and they are allowed to vary dynamically over time. We further control for the share of workers who are laid off, s_i, and the average age of workers, a_{it}. By holding the size of the effective labor force (total months worked) as well as the size of the layoff constant, the estimates on α_t capture the effect on the marginal revenue product of having workers

[34]Moving χ from 0 to 1, translates the one-worker-firm model of section 1 to the many worker firms considered here. Revenue drops from $AK^{1-\lambda}L^{\lambda}$ to $(1-\alpha)AK^{1-\lambda}L^{\lambda}$ when χ increases from 0 to 1, which is consistent with how we have defined α in section 1.

[35]The data include 11,381 notification events, involving 7,147 firms. We cluster standard errors by notification event; allowing standard errors to be correlated within firms does not matter for precision.

on notice for a longer period of time.[36]

The identification assumption is that the marginal revenue product would evolve in a similar way for similar firms with different average notification periods for their laid-off workers. This assumption could potentially be violated if the average notice period is correlated with the underlying productivity change that triggers the notification (z, following our notation in Section 1).[37] We also require that the average notice period does not affect the revenue per worker through other channels than notification itself. This assumption is violated if the composition of laid-off workers, which drives the differences in notification time, also directly impacts revenue.

Empirically, we identify the objects in Equation (7) as follows. Revenue is retrieved from firms' income statements while information on months worked is obtained from the matched employer-employee data as the sum of all months worked in a particular year. As noted above, the key variable, χ_i, is computed as the total number of months worked for workers on notice in the year of notification as well as the year after, divided by the total months worked during those two years.

Figure 7 presents the estimates of α_t. We find that the share of months worked by workers on notice is unrelated to revenue in the years prior to the notification event. This suggests that, at baseline, firms with longer average notification time do not have different patterns of revenue than firms with shorter average notification time, which is consistent with our identifying assumption. By contrast, longer average notice periods decrease revenue in the year of the notification and, in particular, in the year after.[38] Pooling event-years zero and one, we obtain a baseline estimate of the "production loss due to notification": $\hat{\alpha} \simeq 0.35$. The marginal revenue product thus falls by 35 percent for notified workers during their notification period. Beyond the first year after notification, the estimates are negative but not statistically significant. In addition to controlling directly for the average age of workers, the temporary nature of the effect suggests that the change in worker composition is less likely to be the driver of the productivity loss.

4.3 Severance Pay and Cash-Constrained Firms

A key message of our theory in section 1 is that the efficiency case for MN relies on firms being able to pay severance in the instances where giving advance notice would be inefficient. If some firms that lay off workers are credit constrained, it is possible that inefficient MN cannot be undone by such monetary side-payments.

To shed light on this issue, we examine whether the usage of severance payments is lower among cash-constrained firms. Empirically, we define a firm as cash-constrained if the share of liquid assets

[36] We assume homogeneous workers, namely that notified and non-notified workers are equally productive in the absence of notification. It is straightforward to allow productivity to vary across workers using prior earnings as a proxy. We abstain from modeling such heterogeneity here, as we are mainly interested in the average productivity loss for notified workers. Estimates of the average productivity loss do not depend on whether we allow productivities to differ across notified and non-notified workers.

[37] Our theory of section 1 shows that the higher is the productivity loss of notifice, α, the more likely it is that severance pay will be used instead of notice. This means that the average α among notified workers is lower than the average among all laid-off workers, implying that the regression 7 provides a lower bound for the average α in the population.

[38] There are two reasons for this lagged effect. First, it is reasonable to expect α to fall over the notice period, since workers are approaching the time where they are actually laid off. Second, some firms in our data have broken fiscal years. Third, production cycle.

over total assets is below the mean. The information on the asset position of firms comes from balance sheets.

Figure 8a shows severance pay (right-hand side) for unconstrained firms. Unconstrained firms pay around one month of severance to workers eligible for long notification. Figure 8b shows analogous results for constrained firms. The right-hand-side shows that constrained firms do not use severance payments at all. We interpret this evidence as saying that MN is associated with some efficiency loss for cash-constrained firms.

5 Efficiency Considerations

From the perspective of efficiency, MN involves a trade-off between the loss of productivity due to notice and the potential gains in future production due to less exposure to non-employment and better matches.

Our estimates from sections 3 and 4 enable us to calculate the net effect of MN on total production. Assuming that workers are paid their marginal product, the production gain can be based on the estimated earnings effect. We need to deduct the severance effect of MN (35% of the total earnings effect), since severance is a transfer from the firm to the worker, and adjust the estimate using the labor share; for the purposes of the calculation we assume a labor share of 2/3.[39]

Using our estimates from the equation (5), we get a total production gain of about 1.52 of the average monthly wage in the sample. To estimate the production loss due to notice, we use our estimated production loss factor, α, from Figure 7, and the additional number of months of a notified workers from Table 2. This leads to an estimate of the total production loss corresponding to 0.64 of a monthly wage.

Pulling the pieces together, we find that, on net, the effect of MN on total production is positive: it amounts to about 0.88 of the average monthly wage. One can also use the estimates in equation (8) to work out the production loss due to notice, α, which would cause us to reverse this conclusion: $\alpha > 1.52/1.82 = 0.84$. We thus conclude that the production loss due to notice has to the exceed 84 % for MN to a negative effect on overall production.[40]

$$\underbrace{\frac{3}{2} \times \underbrace{1.56 \times 0.65}_{\text{Labor earnings gain}}}_{\uparrow \text{Production gain } 1.52} - \underbrace{\underbrace{0.35}_{\text{Production loss rate}} \times \underbrace{1.82}}_{\downarrow \text{Production loss } 0.64} \simeq \underbrace{0.88 \,\text{Monthly wage}}_{\text{Net Production Effect}} \tag{8}$$

So far, we have ignored the fiscal implications of the MN policy. The fiscal externality of MN can be estimated by making assumptions about the average tax rates on labor and capital income. We assume that the average tax rates on both labor and capital incomes equals 50%, $\tau \simeq .5$.[41] This implies

[39] As a first approximation, we assume that MN only affects eligible workers. This approximation is not necessarily literally true for two reasons. First, there may be direct spillover; as shown in Section 3.2 the MN of one worker affects other workers involved in the same layoff.() Second, MN policies may affect labor market equilibrium; see Hagedorn et al. (2013), Lalive et al. (2015), Marinescu (2017), and Landais et al. (2018) for evidence in the case of UI.

[40] In this respect, it may be useful to note that the upper end of the confidence interval for α is 0.55; see Figure 7.

[41] This corresponds well with reality. On average, workers in our sample face a marginal personal income tax rate of 52%. The corporate income tax rate is 22% and then dividends are taxed at the capital income tax rate of 30%.

that half of the production gain is transferred to the public fund. Moreover, MN reduces the duration of unemployment, creating another positive fiscal externality. Taking an average replacement rate of 50%, $\rho \simeq .5$, and using our estimate of the unemployment duration effect of MN from Table 2 (-0.54), leads to a fiscal externality corresponding to 0.27 of the average monthly wage. Putting the two fiscal externalities together, we find that the total fiscal externality, resulting from the extension of MN at age 55, corresponds to 71% of a monthly wage.

$$\underbrace{\tau \times \underbrace{0.88}_{\text{Production gain}}}_{\uparrow \text{Taxes } 0.44} \underbrace{- \rho \times \underbrace{-0.54}_{\text{Unemp. dur.}}}_{\uparrow \text{UI benefit } 0.27} \simeq \underbrace{0.71 \text{ Monthly wage}}_{\text{fisc. externality}} \tag{9}$$

The main caveat to these calculations is that we have ignored the potential effect that MN might have on hiring. Hiring will be adversely impacted if firms cannot shift the average cost of the policy onto workers in the form of a reduction in wages.

6 Conclusion

Mandatory advance notice (MN) requires employers to inform employees of forthcoming layoffs. We have analyzed the normative and positive aspects of such a requirement.

Our theoretical framework incorporates a trade-off as MN provides workers with more time to search on the job, but reduces production as notified workers are less productive. In the model, MN has no impact on the efficient equilibrium as it can be undone by severance pay. By contrast, MN can improve the efficiency of a second-best equilibrium by increasing information sharing. A key component of this result is that severance is used to avoid the inefficient outcomes.

We use Swedish administrative data and an age-based RD design to show that extending the MN period increases both the actual notice period and severance pay. Moreover, longer MN reduces non-employment duration and increases reemployment wages. The non–employment and wage effects reflect the combined influence of actual notice and severance pay. To distinguish these two channels, we construct an additional instrument, leveraging MN spillover. Combining the instrument based on the age threshold and the instrument based on MN spillover, we show that (i) the extended notice period reduces non-employment while severance increases it; (ii) the extended notice period alone drives the wage effect, pointing to the value of on-the-job search.

Turning to the costs of MN, we document bunching in the timing of layoff as a response to a law that employers must report to the Public Employment Service any layoff of at least 26 workers a minimum of four months in advance. Since such bunching behavior should mainly be visible among firms that plan to provide early advance notice, this provides a first indication that the productivity loss due to notice is moderate, at least in some firms. Using a difference-in-difference analysis that exploits variation in notice duration across firms, we estimate a rather moderate productivity loss of notice. Cash-constrained firms do not use severance, creating an efficiency loss. Pulling the pieces together, our estimates of the benefits and costs suggest that MN has a positive net impact on overall productiion. Overall, our paper thus provides an empirically-grounded efficiency argument for mandating notice.

Mandatory advance notice of layoff is an understudied program, given that such programs exist in all OECD countries. The main lesson from our analysis is that some mandated notice is generally optimal. It is, however, more of an open question how long that mandate should be. We should also think about how to improve the design of the program. Relative to the usual UI system, that is not fully expreeince rated, MN has the advantage of shifting part of layoff cost to the employer. But MN puts this financial pressure on firms in instances when they may not be doing well. One question then is whether we can provide an incentive for firms to share information about future layoffs without imposing excessive costs. One policy option could be to subsidize the wage bill of notified workers.

The most crucial piece of evidence we have offered is that severance seems to be used to sidestep the law. Lazear (1990) pointed out that private contracts undo policies, limiting their impact on the real economy. But private contracts would only undo policies when they are inefficient. Thus studying why and how labor laws are sidestepped using private contracts teaches us about the efficiency of the public mandate in question. When the law is not undone using private contracts, this may indeed signal that it improves allocations and efficiency.

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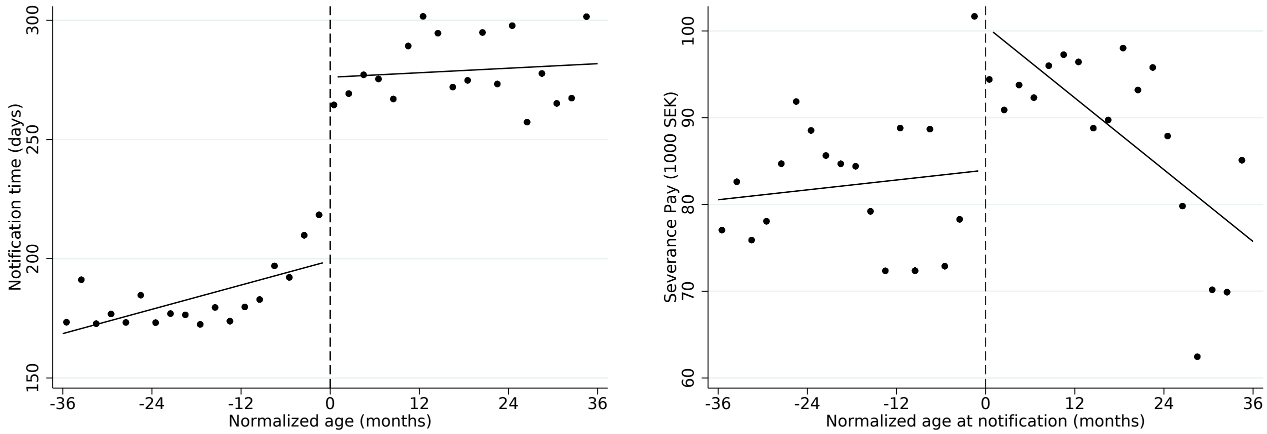
Table 1: Descriptive Statistics

	Notified ind.	Empl. workers Same industries	Empl. workers	Notified ind. Age-55 sample
	(1)	(2)	(3)	(4)
Panel (a): Individual-level characteristics				
Female	0.35	0.37	0.48	0.44
Immigrant	0.17	0.14	0.14	0.10
Age	40.93	41.54	42.00	55.02
Tenure	5.36	5.94	5.79	7.28
Earnings_{t-1} (1000 SEK)	256.9	249.9	224.8	356.4
Wage_{t-1} (1000 SEK)	24.6	25.8	24.8	31.1
Educational attainment				
Compulsory ed.	0.16	0.17	0.16	0.12
Upper-secondary ed.	0.60	0.50	0.47	0.50
College ed.	0.24	0.31	0.36	0.37
Panel (b): Firm-level characteristics				
Firm size (# employees)	599.04	53.11	62.47	1061.96
Agricultural	0.00	0.00	0.04	0.00
Mining	0.00	0.00	0.00	0.00
Manufacturing	0.36	0.39	0.11	0.32
Electricity	0.00	0.00	0.01	0.01
Construction	0.08	0.05	0.06	0.03
Wholesale and retail	0.12	0.14	0.11	0.16
Transport	0.11	0.09	0.08	0.20
Financial Services	0.01	0.00	0.02	0.01
Non-Financial services	0.15	0.21	0.14	0.15
Public administration	0.02	0.01	0.05	0.01
Education	0.02	0.02	0.10	0.03
Human health	0.03	0.04	0.15	0.04
Entertainment	0.02	0.01	0.07	0.03
Other	0.08	0.03	0.07	0.01
Observations	418,111	5,827,312	5,827,888	8,955

Notes: Column (1) contains all notified individuals. In column (2), we re-weight the industry distribution of employed workers to match that of notified workers. Column (3) focuses on the population of employed workers without reweighting. Column (4) includes white-collar workers in the private sector who were aged 52-58 at the time of notification. Firm-level characteristics are computed at the individual level, except firm size where the unit of observation is a firm.

Figure 2: Mandated Notice (MN) Increases Notice but also Severance Pay

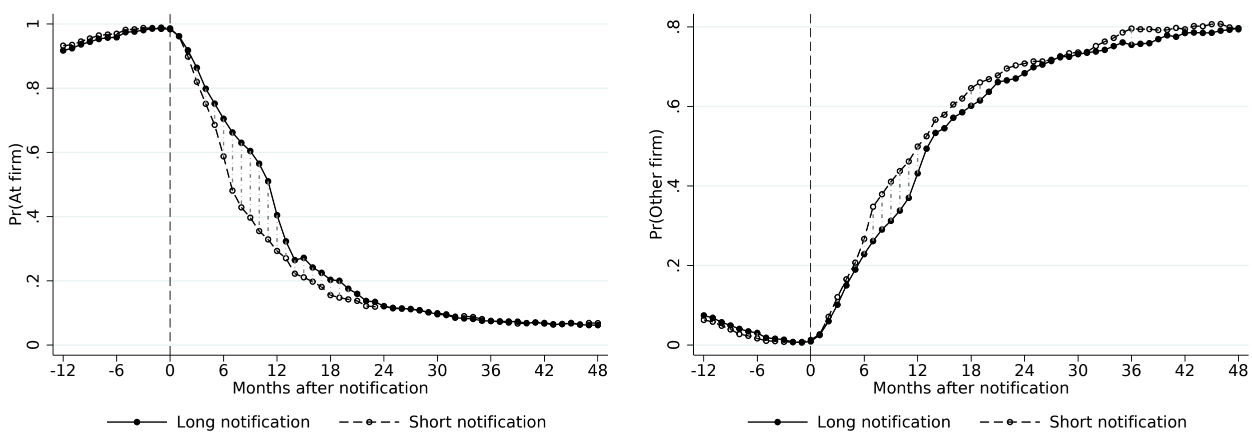
(a) MN effect on Notification Times (b) MN Effect on Severance Pay



Panel (a) shows notification times by age at notification in 2-month-bins. The estimated jump at the threshold is 80.8 days, with a standard error of 8.1. **Panel (b**) shows severance pay by age at notification in 2-month-bins. The estimated jump at the threshold is 16.9 kSEK, with a standard error of 6.4. **Both Panels:** The regression lines come from estimating equation (2) with a linear age polynomial interacted with the threshold indicator for individuals aged 52-58 at the time of notification. The regression also includes baseline covariates (earnings in the year prior to notification, gender, immigrant status, tenure, educational attainment FEs) and month-by-year FE:s.

Figure 3: Effect of Mandated Notice (MN) on Employment

(a) Probability of Remaining at the Notifying Firm (b) Probability of Working at a New Firm



Notes: The figures show employment outcomes by month relative to notification. At any given point in time, we plot estimates of the constant (hollow circles) and the constant+β (black circles) from a regression corresponding to equation (2). Dashed lines indicate that the estimate of β is significant at the 5% level. These regressions include a linear age polynomial interacted with threshold, baseline covariates (earnings in the year prior to notification, gender, immigrant status, tenure, educational attainment FEs), and month-by-year FE:s. The analysis only includes individuals aged 52-58 at the time of notification.

Table 2: Effect of Mandated Notice (MN) on Employment

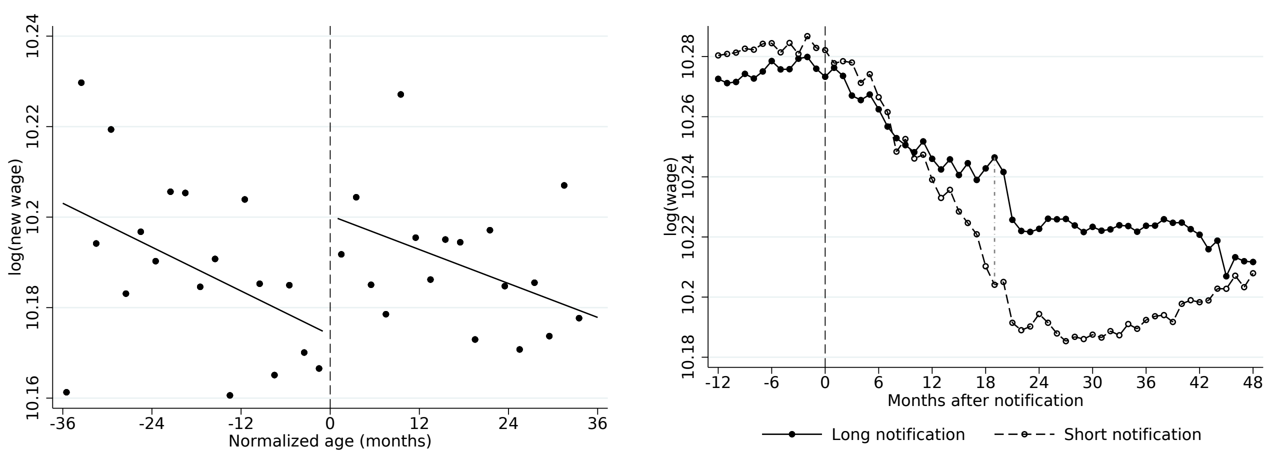
Cumulated duration in months over a 2-year-horizon					
	(1)	(2)	(3)	(4)	(5)
	At notifying firm	At other firm	Non-employed	Unemployed	Out of labor force
Above age-55	1.815***	-1.047***	-0.769***	-0.540***	-0.228**
	(0.262)	(0.303)	(0.203)	(0.155)	(0.113)
Control mean	8.999***	11.036***	3.965***	3.259***	0.706***
	(0.230)	(0.274)	(0.166)	(0.125)	(0.077)
R^2	0.065	0.058	0.018	0.020	0.006
# observations	8,856	8,856	8,856	8,856	8,856

Notes: Time out of the labor force is calculated as time in non-employment minus time in unemployment. Standard errors are clustered on notification event(3803 clusters). Regressions include individuals aged 52-58 at the time of notification. The regressions include a linear age polynomial interacted with threshold, baseline covariates (earnings in the year prior to notification, gender, immigrant status, tenure, educational attainment FEs), and month-by-year FE:s. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Figure 4: Effect of Mandated Notice (MN) on Initial Re-employment Wage and Wage Evolution

(a) Effect of MN on Re-employment Wage

(b) Wages Evolution Since Notification



Panel (a) shows the log of the full-time equivalent monthly wage by age at notification in 2-month-bins around 55. The esitmated jump at the threshold is 0.027 with a standard error of 0.015. **Panel (b)** shows the log monthly wage by month relative to notification. At any given point in time, we plot estimates of the constant (hollow circles) and the constant plus the discontinuity at 55 (black circles). Dashed lines indicate when the discontinuity is significant at the 5% level. **Both Panels:** The regressions come from estimating equation (2) with a linear age polynomial interacted with the threshold indicator for individuals aged 52-58 at the time of notification. The regressions also includes baseline covariates and month-by-year FE:s.

Table 3: Effect of MN on Re-employment Wage and Subsequent Wage Growth

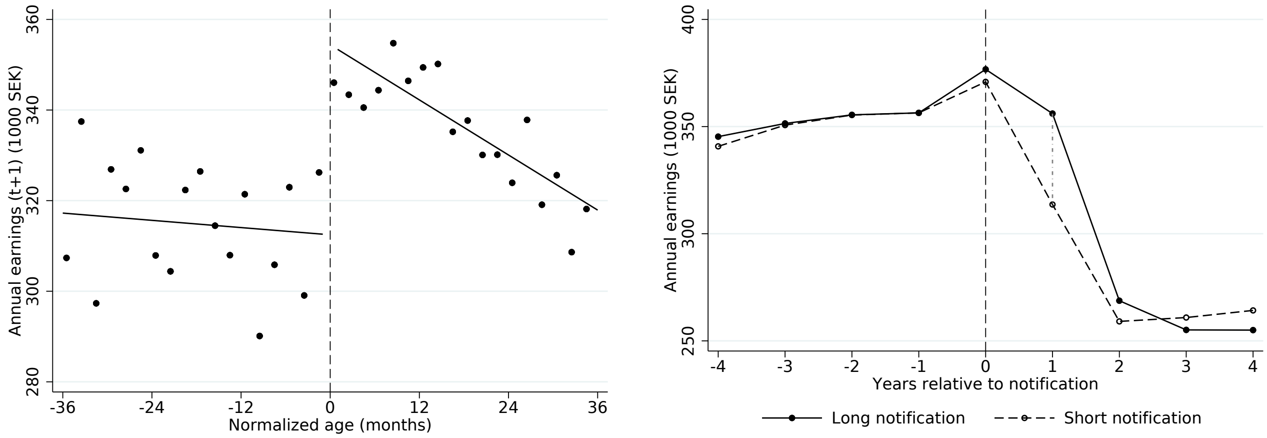
	(1)	(2)	(3)	(4)
Panel a	Re-employment wage			EE indicator
	$\ln(w)$	$\Delta\ln(w)$	$\Delta\ln(w)$	
Above age-55	0.027*	0.031*	0.002	0.038
	(0.015)	(0.017)	(0.034)	(0.036)
Above age-55× EE			0.036	
			(0.038)	
EE indicator			0.038	
			(0.026)	
Control mean	10.173***	-0.086***	-0.112***	0.702***
	(0.011)	(0.012)	(0.022)	(0.027)
# clusters	1,787	1,287	1,287	1,287
# observations	3,056	2,363	2,363	2,363
Panel b	Wage growth since start of new job			
	1 year	2 years	3 years	4 year
Above age-55	0.019*	0.019*	-0.009	-0.018
	(0.010)	(0.011)	(0.014)	(0.017)
Control mean	0.008	0.020**	0.073***	0.106***
	(0.007)	(0.008)	(0.010)	(0.012)
# clusters	1,363	1,168	931	751
# observations	2,187	1,834	1,453	1,112

Panel (a): The difference in wages is taken relative to the wage in the year prior to notification. The EE-indicator equals unity when a worker is observed making an Employment-to-Employment transition. **Panel (b):** Annual wage growth is defined relative to the initial wage for all individuals (movers as well as stayers) for whom we observe subsequent wages. **Both Panels:** The estimated regressions correspond to equation (2) and include a linear age polynomial interacted with the threshold indicator for individuals aged 52-58 at the time of notification. The regressions also include baseline covariates (earnings in the year prior to notification, gender, immigrant status, tenure, educational attainment FEs) and month-by-year FE:s. Standard errors are clustered by notification event. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Figure 5: Effect of MN on Earnings

(a) Earnings in the year after notification by age at notification

(b) Annual earnings by years relative to notification



Panel (a): The estimated jump at the threshold is 42.4 kSEK, with a standard error of 6.0. Age at notification is in 2-month-bins. **Panel (b)** shows annual earnings by year relative to notification. At any given point in time, we plot estimates of the constant (hollow circles) and the constant plus the discontinuity at 55 (black circles). Dashed lines indicate when the discontinuity is significant at the 5% level. **Both Panels:** The regressions come from estimating equation (2) with a linear age polynomial interacted with the threshold indicator for individuals aged 52-58 at the time of notification. The regressions also include baseline covariates (gender, immigrant status, tenure, educational attainment FEs) and month-by-year FE:s.

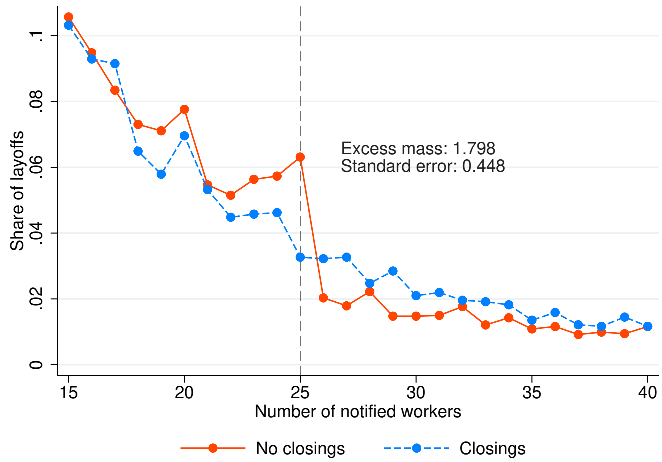
Table 4: Separating the Effects of Advance Notice and Severance Pay

	Reduced forms					
	Notification time (days)		Severance pay (1000 SEK)		Non-employ. (Months)	Δln(wage)
	(1)	(2)	(3)	(4)	(5)	(6)
Above 55	80.877***	80.181***	16.863**	16.346**	-0.702***	0.033*
(Indicator 0/1)	(6.508)	(6.354)	(6.664)	(6.490)	(0.259)	(0.018)
Share coworkers above 55		31.623*		54.518***	1.629***	-0.015
(0-1)		(18.643)		(14.886)	(0.408)	(0.017)
					Instrumental variables	
Notification time (months)					-0.542***	0.018*
					(0.196)	(0.009)
Severance pay (SEK 1,000)					0.035***	-0.000
					(0.012)	(0.001)
Controls						
Assignment variable (own age) (1st order, interacted w. threshold)	X	X	X	X	X	X
Month by year FEs	X	X	X	X	X	X
Individual covariates	X	X	X	X	X	X
Size of lay-off		X		X	X	X
Firm covariates (includes age)		X		X	X	X
Industry (1 digit) FEs		X		X	X	X
Estimation statistics						
1st stage F-statistic	154.42	80.82	6.40	9.03	--	--
# clusters (notification events)	3,803	3,780	3,760	3,770	3,770	2,309
# observations (RF)	48,797	48,655	46,474	45,083	48,568	13,273

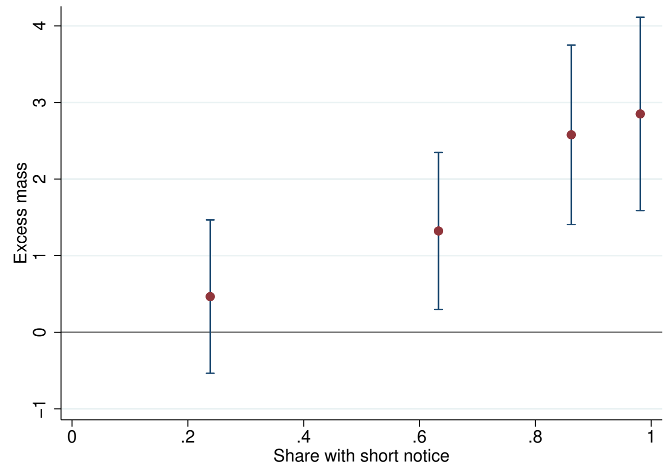
Panel (a) shows reduced-form estimates, while **Panel (b)** shows instrumental variables estimates. The sample includes all white-collar workers in notification events where a white-collar worker aged 52-58 was notified. Sample size varies marginally across columns 1-5 since we do not observe firm covariates and severance pay for all observations; the drop in sample size in column (6) is due to sampling in the wage survey. The regression specifications are such that the effect of the Above 55 indicator is identified within the sample of white-collar workers aged 52-58, while share co-workers above 55 is identified across all white-collar workers. "Individual covariates" are: earnings in the year prior to notification, gender, immigrant status, tenure, educational attainment FEs. Standard errors are clustered by notification events.

Figure 6: Distribution of Layoff Size by Incentives to Bunch

(a) Density of Layoff Size: closing vs. not

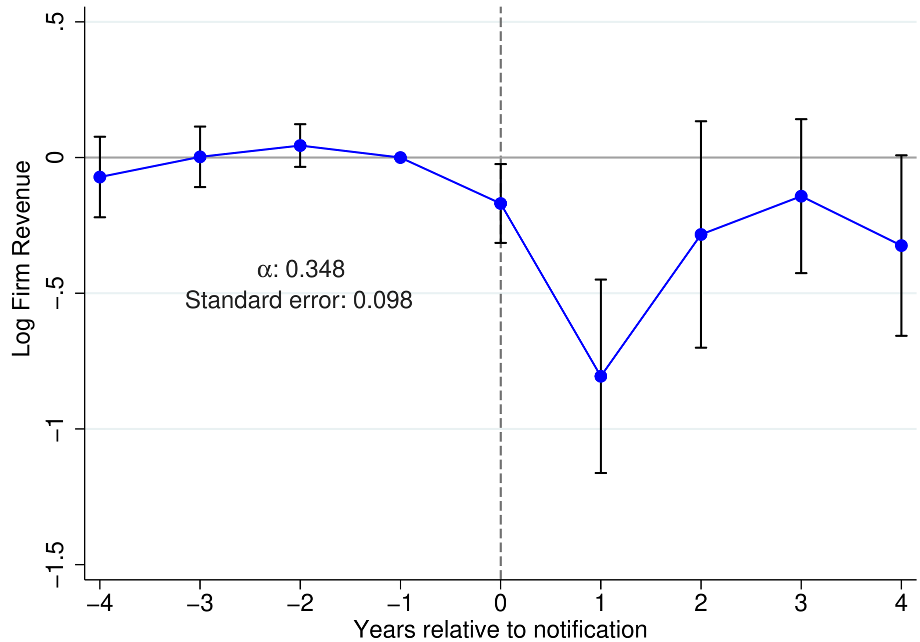


(b) Bunching Estimates by Share of Short Notice



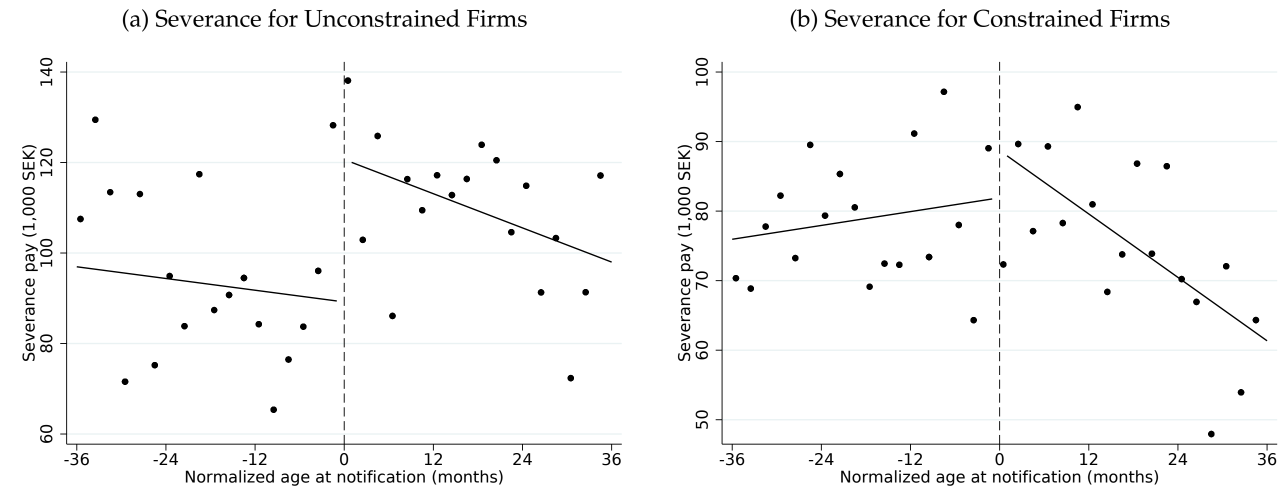
Employers are required to report to the Public Employment Service at least four months before any layoff of more than 25 workers. **Panel (a)** shows the distribution of layoff size for events that are due to closings (blue dashed line) and non-closings (red solid line) around the 25-threshold. We report estimated excess bunching, obtained as the difference between the non-closing density and the closing density for layoff events of sizes 22-25. We then normalize this difference by the share of layoffs in closing establishments that include 25 workers (the counterfactual density). We estimate standard errors by bootstrapping layoff events with replacement one hundred times. **Panel (b)** divides layoff events into four equally sized groups by the share of laid off workers with a mandated notification period which is shorter than four months. For each quartile, we plot the excess mass estimate as in Panel A against the average share of laid off workers with short notice. The counterfactual density consists of closing events, and we use the same counterfactual density for all four groups.

Figure 7: Productivity Loss of Notification



Notes: This figure shows estimates of event-time fixed effects α_t from Equation 7. In a panel of notifications, we regress the log of winsorized annual firm revenue (winsorization at the 1st and 99th percentile) on event-time dummies, notification fixed effects, log of number of months worked by all workers, average age of workers, as well as relative layoff size and the share of months worked during notice interacted with event-time dummies. The reported α-estimate in the figure pools event-times 0 and 1 to obtain the total production loss due to notification. The panel is balanced until time 0 and includes 74,591 notification-year observations. Standard errors are clustered on notification event and the figure displays 95% confidence intervals.

Figure 8: Effects of Mandated Notice (MN) on Severance Pay: Cash-Constrained vs -Unconstrained Firms



Panel (a) shows severance pay by age at notification in 2-month-bins for unconstrained firms, defined as firms with the share of liquid assets over total assets above the mean. **Panel (b)** is analogous but focuses on constrained firms. **Both Panels:** The regression lines come from estimating equation (2) with a linear age polynomial interacted with the threshold indicator for individuals aged 52-58 at the time of notification. The regressions also include baseline covariates earnings in the year prior to notification, gender, immigrant status, tenure, educational attainment FEs) and month-by-year FE:s.

A Online Appendix: Theoretical part

This section of the online appendix provides a more detailed description and omitted analysis of our theoretical work.

A.1 Setting

We consider a two-period model where production is the results of a match between a worker and an employer. Workers are homogeneous and risk-neutral. Risk neutrality assumption is a deviation from the literature. It allows us to focus on the first-order efficiency gain of advance notice instead of the second-order gain through provision of insurance. Employers are also homogeneous and risk neutral. For now, there is free entry and perfect competition among employers.

In the first period, production is "high", denoted by Y. In the second period, production remains high with probability θ or drops to zY with probability $1-\theta$, where $\theta \in [0,1)$ and $z \in [0,1)$.

At the beginning of the two periods, employers and employees match, with no search friction and write and sign a contract. The contract specifies a wage, a severance payment and an advance notice requirement, $(wY, sY, \delta \in \{0,1\})$. Without loss of generality, we normalize $Y = 1$. The contracted wage is fixed for both periods, with no possibility of renegotiation. This assumption leads to separation in case of a productivity drop in the second period. For sake of simplicity, we assume no time discounting or interest rate.

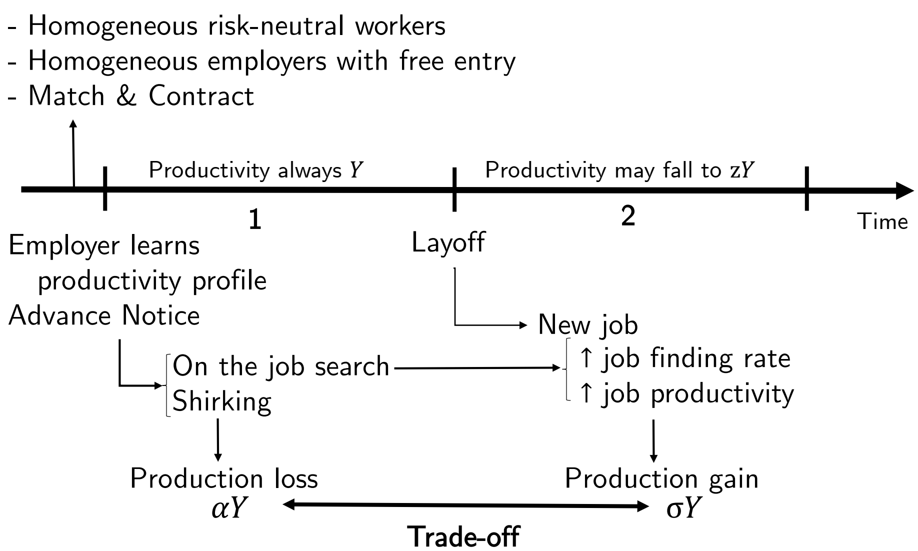


Figure A1: The Setting and The Timing of the Events

Just after signing the contract, the employer receives private information about the productivity of the match in the second period. The information is verifiable: the employer may share this information with the employee, i.e., giving her advance notice, at the start of the first period.

If an employee receive an advance notice, her productivity falls as she starts both to look for alternative employment (on-the-job search) and shirks given her lower incentives. These two forces together lead to a lower production at the first period equal to $(1-\alpha)Y$, where $\alpha \in [0,1)$ measures the total production loss. Without lose of generality, from here on, we use Y as the numeraire from here onward.

Safe jobs are available in the second period, with the productivity ρ, where $\rho \in [0,1)$ captures the displacement effect. Laid-off worker will find such a job with likelihood e. To make the setting interesting to study, we assume that it is efficient to separate in the second low-productivity period, i.e. the production loss is large relative to the outside option,

$$e\rho > z. \tag{A1}$$

On the job search is productive. It increases both the likelihood of finding a job in the second period by Δe and the wage in the new job by $\Delta\rho$ (Acemoglu and Shimer (1999), Faberman et al. (2021)). We denote the total expected production increase due to notice by σ,

$$\sigma \equiv (e+\Delta e)(\rho+\Delta\rho) - e\rho. \tag{A2}$$

To focus on productive efficiency, we ignore the disutility cost of working and searching. To incorporate such costs, we would have to adjust $e\rho$ and σ.

The most efficient on-the-job search would lead to finding a job with probability one with no displacement effect. This gives an upper bound for σ, that is

$$1 - e\rho \geqslant \sigma. \tag{A3}$$

The trade-off in providing notice is between the production loss of notice, α, and the production gain due to on-the-job search for the worker, σ. First-best information sharing (advance notice) occurs when the productivity loss in the first period is smaller than the gain from notice, i.e., if and only if $\alpha < \sigma$. By contrast, providing severance pay does not involve the same trade-off since it lacks the information sharing aspect.

A.2 Exogenous contract

In this section, we study the role of MN in the case of an exogenous contract without advance notice, $(w, s, 0)$. This is a partial equilibrium analysis – in fact, it is the counterpart of Baily-Chetty setting for the analysis of optimal UI, applied to the case of advance notice (Baily (1978); Chetty (2006)).

Layoff incentive compatibility (IC) condition assures layoff at low-productivity state: the cost of layoff to the employer is lower than cost of labor hoarding in the low-productivity second period:

$$w - z \geqslant s \tag{A4}$$

No layoff at high-productivity implies that $s \geqslant w - 1$.

Employers do not provide advance notice. This is independently of how much gains of providing notice are larger than its cost, since employers do not internalize the gain occurring to the employee but bear the cost. The expected profit would be

$$\pi_0 = \underbrace{(1-w)}_{\text{1st period}} + \underbrace{\theta \times (1-w) + (1-\theta) \times (-s)}_{\text{2nd period}} \tag{A5}$$

or

$$\pi_0 = (1+\theta)(1-w) - (1-\theta)s \tag{A6}$$

Total production or welfare is

$$W_0 = 1 + \theta + (1-\theta)e\rho$$

Now if the labor law mandate an advance notice, employer faces three options when receiving the bad news of productivity drop. First is to provide advance notice, reducing the expected profit by the production loss due to notice, $\pi_0 - (1-\theta)\alpha$.

The second option is to not provide advance notice but compensate the worker ex post with an additional severance payment of σ. This would leads to the expected profit $\pi_0 - (1-\theta)\sigma$.

The third option is to notify the worker but later so that the productivity loss happens during the low productivity period. This labor hoarding strategy leads to the profit of $\pi_0 - (1-\theta)\Xi$ where

$$\Xi \equiv w - (1-\alpha)z. \tag{A7}$$

Layoff IC implies that $\Xi > s + \alpha z$.

So the optimal choice of the employer is

1. To notify the worker in advance iff

$$\alpha = \min(\sigma, \alpha, \Xi) \tag{A8}$$

This condition is the advance notice IC condition and consists of two parts. First part assures that notice is ex post better than compensation using severance: the production loss of notice is smaller than the ex post additional severance payment needed to avoid the lawsuit, $\sigma > \alpha$. The second part is about timing of notice and assures that early notice is preferred by the employer relative to late notice,

$$w - (1-\alpha)z > \alpha \tag{A9}$$

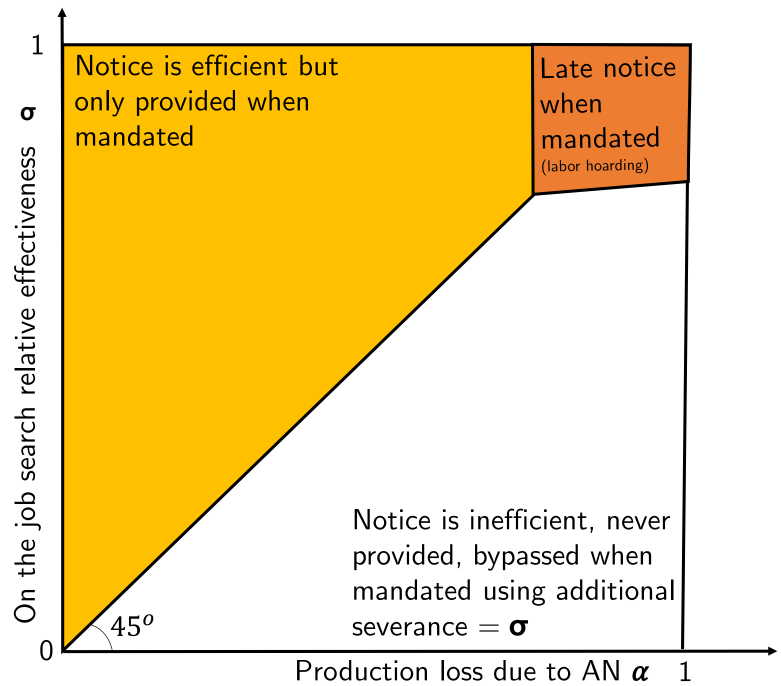


Figure A2: Exogenous contract and MN period = 1
Note: This figure shows the provision of notice decided by the employer in the absence and presence of MN, where the duration of the notice period is 1. Exogenous contract includes wage and severance, but not advance notice.

The welfare/production gain in this case would be $\Delta W = (1-\theta)\,\sigma$.

2. To keep the worker uninformed but pay her off at the time of layoff iff the profit loss due to notice is higher than the gain to the worker $\sigma = \min(\sigma, \alpha, \Xi)$. There is no welfare gain in this case.

3. To retain the worker in the second period when $\Xi = \min(\sigma, \alpha, \Xi)$: the cost of notice to employer and its benefit to the employee both are higher than the relative benefit of layoff to labor hoarding. Note that the condition $\Xi = \min(\sigma, \alpha, \Xi)$ can be written as $\alpha > \frac{w-z}{1-z}$ and $\sigma > w - z + \alpha z$, illustrated in Figure A3. The welfare/production loss in this case would be $\Delta W = (1-\theta)\left((1-\alpha)\,z - e\rho\right) < 0$.

The contracted severance does not matter, except satisfying in the layoff IC, condition A4. Moreover, the likelihood of the productivity fall, θ, does not matter either, since all decisions are taken conditional on productivity fall, and there is no substitution of resources between the two states.

Using these three equilibrium outcomes, the total labor earning increase for notified workers can be written as:

$$\underbrace{P_3}_{\text{MN effect on earnings from old job}} + \underbrace{P_1\sigma - P_3 e\rho}_{\text{MN effect on earn. from new job}} + \underbrace{P_2\sigma}_{\text{MN effect on severance pay}} \tag{A10}$$

where P_i represent the share of workers in each case. We can rewrite this equation as

$$\underbrace{P_1 \Delta e + P_3}_{\text{non-employment dur. effect}} - P_1 (1 - \rho) \underbrace{\Delta e}_{\text{new job dur. effect}} + P_1 e \underbrace{\Delta \rho}_{\text{wage effect}} + \underbrace{P_2 \sigma}_{\text{Severance pay effect}} \tag{A11}$$

that would be the base of the decomposition of earnings in Section 3.1. Except the severance pay term, the other components of the decomposition together constitute the production gain of MN.

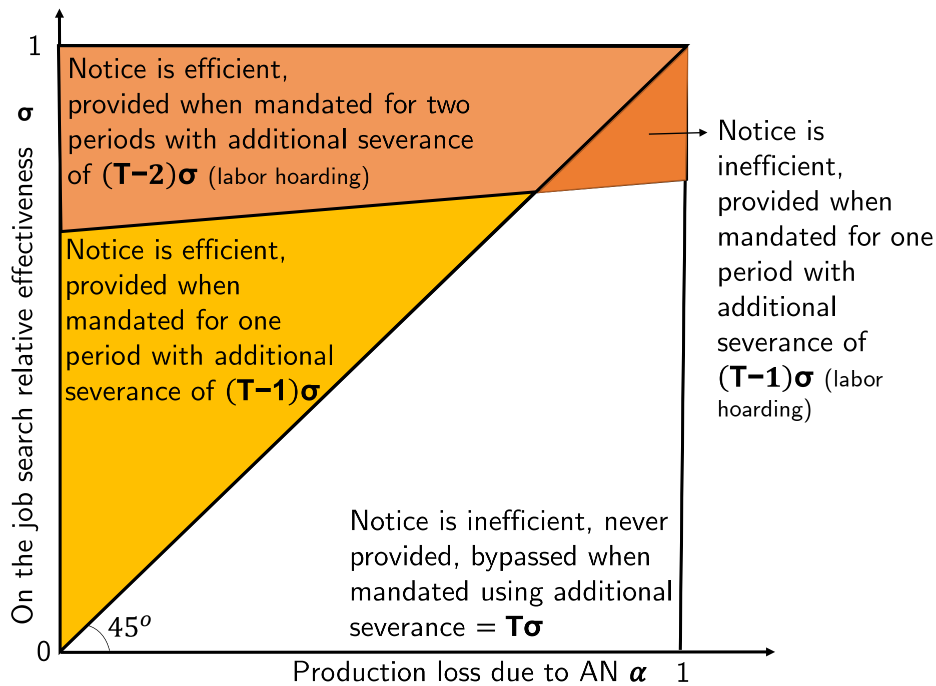


Figure A3: Exogenous contract, with MN duration of $T \geqslant 2$

Note: This figure shows the provision of notice decided by the employer in the absence and presence of MN, where the duration of the notice period is $T \geqslant 2$. Exogenous contract includes wage and severance, but not advance notice.

Extension 1 In the main framework, we consider the case where the duration of MN has been equal to the duration of the information horizon of the firm. One concern with MN is that it may require information sharing before even the employer has the information, i.e. the MN duration longer than the information horizon. We can model this in our setting by assuming that the law mandate notice T period in advance, $T \geqslant 2$.

Under this law, all the three options discusses above are possible but in each case an additional severance payment of $(T-1)\,\sigma$ must be paid to the worker to compensate for the additional length of MN. In this sense, too long MN is equivalent to well-timed MN plus a mandatory severance.

In addition, now employer has a forth option, providing two periods of notification. This will lead to profit of $\pi_0 - (1-\theta)(\Xi + (T-2)\,\sigma + \alpha)$.

Employer choice is then driven by minimizing the cost, so choosing the minimum of $(\sigma, \alpha, \Xi, \Xi + \alpha - \sigma)$. This leads to decisions illustrated in Figure A3 that are as follows:

1. To notify the worker in advance for one period iff $\alpha < \sigma < \Xi$.
2. To keep the worker uninformed but pay her off at the time of layoff iff $\sigma = \min(\sigma, \alpha, \Xi)$.
3. To retain the worker in the second period and provide her one period of notice iff $\Xi < \sigma < \alpha$.
4. To retain the worker in the second period and provide her two periods of notice iff $\sigma = \max(\sigma, \alpha, \Xi)$. In this case, the notice given is too long and inefficient.

We conclude that when MN period is longer than firm's information horizon, mandating notice is equivalent to mandating severance pay, unless when the benefit of on-the-job search σ is large. In that case, firm provide too long notice although it is inefficient since it is too costly to use severance instead.

Extension 2 To capture the hiring cost of MN, we assume production is the result of match between one worker and one unit of capital. The latter is elastically supplied, capital supply $\kappa(.)$ is an increasing function of the return. Then in the absence of mandating, the return and employment rate would be $\kappa(\pi_0) = l_0$.

Employment rate in the first period is l_0. In the second period from the e share of $(1-\theta)\, l_0$ newly laid-off workers will find a safe job, so that employment rate would be $\theta l_0 + e\,(1 - \theta l_0)$.

Mandating notice reduces the expected profit by $(1-\theta) \times \min(\alpha, \sigma, \Xi)$ that leads to lower hiring.

$$\kappa\left(\pi_0 - (1-\theta) \times \min(\alpha, \sigma, \Xi)\right) = l_M \tag{A12}$$

Lower hiring is at least partially offset with late layoff when labor hoarding. The second period the same as the first when $\min(\alpha, \sigma, \Xi) = \Xi$. The counter-veiling force in case of notice is the higher job finding rate, Δe. But when severance is used to bypass the MN, there is no counter-veiling force.

A.3 Endogenous contract

Free entry of firms and perfect competition among firms imply that equilibrium contract have zero expected profit and maximize the worker's utlity (similar to CITE). We thus solve the utility maximizing contract in each case.

A.3.1 Absence of mandated advance notice (MN)

Using the Revelation principle, we confine our attention to direct revelation contracts.

First option is to **layoff without notice**. In this case, agent utility is driven by the wages plus in case of layoff an additional severance and expected income from the new job.

$$u^L = \max_{w,s} \underbrace{w}_{\text{1st period}} + \underbrace{\theta \times w + (1-\theta) \times (s + e\rho)}_{\text{2nd period}} \tag{A13}$$

under two constraints of the layoff IC (A4) and profit zero:

$$1 + \theta = w + \theta w + (1-\theta)\, s \tag{A14}$$

There is no difference between wage and severance unless in the layoff IC (A4). The latter is satisfied with a high wage and low severance, e.g. $w^L = 1, s^L = 0$, where wage is equal to the marginal product with no layoff cost. This leads to utility level of

$$u^L = 1 + \theta + (1 - \theta)\, e\rho \tag{A15}$$

Note the irrelevance of production fall in period two, z.

This dominates retain contracts, $u^R = \overline{Y}$ where $\overline{Y} = 1 + \theta + (1 - \theta)\, z$ is the expected production of a match in the absence of separation. Retain contract itself dominates the strategy of late notification: notifying the worker at the end of the first period and lay him off at the end of the second period.

Second option is to **layoff with notice**

$$u^N = \max_{w,s} \underbrace{w}_{\text{1st period}} + \underbrace{\theta \times w + (1 - \theta) \times (s + e\rho + \sigma)}_{\text{2nd period}} \tag{A16}$$

under two constraints of advance notice IC (A8) and profit zero:

$$1 + \theta = w + \theta w + (1 - \theta)\,(s + \alpha) \tag{A17}$$

This leads to:

$$u^N = 1 + \theta + (1 - \theta)\,(e\rho + \sigma - \alpha)\,. \tag{A18}$$

This dominates a contract where on-the-job search is allowed at all time. The quit contract, $u^q = 1 + e\rho + \sigma - \alpha$, is dominated either by u^L or u^N.

Negative severance Severance must be negative when production loss due to notice is high relative to shock likelihood and magnitude, that is

$$\frac{\alpha}{1 - \alpha} > \frac{1 + \theta}{1 - \theta}\,(1 - z) \tag{A19}$$

Negative severance is the price of on-the-job search that worker pay when search is effective for employee and search/shirking is costly to employer. One problem is that worker quit with negative severance. A solution is that contract states that severance is paid when notice is given and independently of the type of separation. Severance becomes the price of advance notice (and on-the-job search). Note that the cutoff for α is a function of the magnitude of the productivity shock, the larger is the shock, the more likely the contract has negative severance.

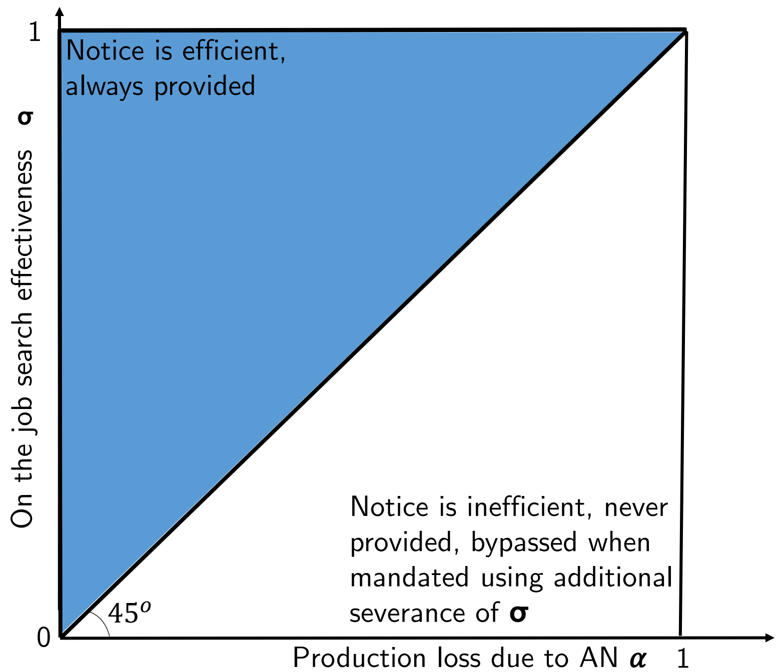


Figure A4: Endogenous Contract with no Friction

Note: This figure shows the provision of notice decided by the employer in the absence and presence of MN, where the duration of the notice period is 1. Endogenous contract may include wage, severance, and advance notice.

A.3.2 Mandating notice

When advance notice is mandated, then employer can follow the law leading to the same situation as a private contract with notice that we studied in the previous section, i.e. $u^N_M = u^N$.[42]

Sidestepping the law, employer can layoff the worker without advance notice and compensate her ex-post with an additional severance of σ. The equilibrium contract will be the result of following optimization:

$$u^L_M \equiv \max_{w,s} \underbrace{w}_{\text{1st period}} + \underbrace{\theta \times w + (1-\theta) \times (s + \sigma + e\rho)}_{\text{2nd period}} \tag{A20}$$

under three constraints of

$$w - z > s + \sigma \tag{A21}$$

$$\alpha > \sigma \tag{A22}$$

$$1 + \theta = w + \theta w + (1-\theta)(s+\sigma) \tag{A23}$$

This is similar problem than the optimization of (A13) with the difference that total severance is the contracted severance, s, plus the additional compensating severance, σ. This additional severance

[42] A retain contract is again dominated here as well.

compensates for lack of advance notice and undo the mandate. The second condition, (A22), is also new relative to (A13). It assures that employer does not provide notice ex post.

Worker obtains the same utility as the case of private contract with no notice, $u_M^L = u^L$. The difference is that wage adjusted to leave room for the compensating severance.[43] Thus there is no change in allocations by the mandate, but only different contracts. In particular, the amount of notice does not change, while total severance paid (not necessarily contracted severance) is increased in response to the mandate. This also means that the mandate has no employment effect. This is in spirit of Lazear (1990).

Total severance paid, sum of contracted and compensating severance, can be always set to be non-negative. That said, the contracted severance is negative when

$$\frac{1+\theta}{2}(1-z) < \sigma \tag{A24}$$

In contrast to the case of no MN, the negative contracted severance here is not the price of advance notice, but rather an initial payment for the additional severance that firm will later pay to undo the mandate.

A.4 Endogenous contract with Frictions

Worker misperceives the stability of the job, $\widehat{\theta} > \theta$. This is similar to the under-saving assumption in the Baily model. But the difference is that we allow for a rich set of contracts, as if augment the Baily setting would allow the firms to provide UI. In addition, we require that severance pay is limited from below and above, namely, $\bar{s} \geqslant s \geqslant 0$. These limits represent two additional source of frictions, namely firms and worker cash-constraints.

A.4.1 Absence of mandate

Layoff contracts are not affected by the misperception, but their perceived utility are different, for the contract without notice, the utility achieved is

$$\widehat{u}^L = 1 + \widehat{\theta} + \left(1 - \widehat{\theta}\right) e\rho \tag{A25}$$

and for the contract with notice

$$\widehat{u}^N = 1 + \widehat{\theta} + \left(1 - \widehat{\theta}\right)(e\rho + \sigma - \kappa\alpha) \tag{A26}$$

where $\kappa \equiv \frac{1-\theta}{1+\theta} / \frac{1-\widehat{\theta}}{1+\widehat{\theta}} > 1$ is a measure of misperception. Then

$$\widehat{u}^N > \widehat{u}^L \Leftrightarrow \sigma > \kappa\alpha \tag{A27}$$

So that misperception $\kappa > 1$ implies an under provision of notice in private contracts.[44]

[43] More precisely, $w_M^L = 1 - \frac{1-\theta}{1+\theta}\left(\sigma + s_M^L\right)$.

[44] The retain contract gives the same utility as before and it is dominated.

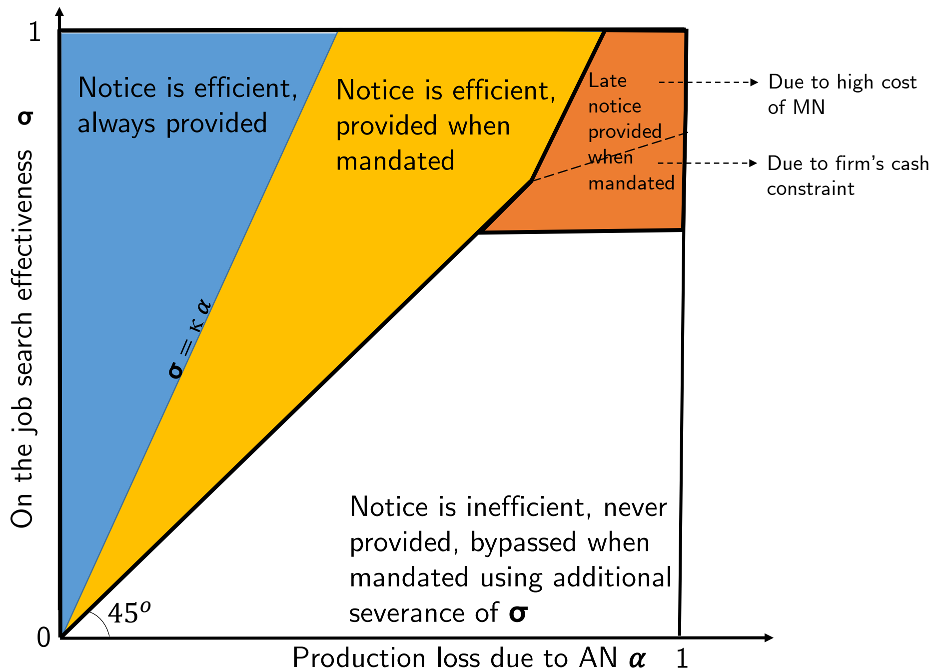


Figure A5: Endogenous contract with frictions

Note: This figure shows the provision of notice decided by the employer in the absence and presence of MN. There are three frictions: Worker misperceives the stability of the job, $\widehat{\theta} > \theta$, firms and worker cash-constraints so that neither can promise a large severance, $\bar{s} \geqslant s \geqslant 0$. The mandated duration of the notice period is 1. Endogenous contract may include wage, severance, and advance notice.

A.4.2 Mandating notice

If employer follows the law and provide notice, then the worker utility in equilibrium will be the same as in A26, $\widehat{u}_M^N = \widehat{u}^N$.

If employer ignores the law and do not provide notice but instead compensate the worker with an additional severance, then

$$\widehat{u}_M^L = 1 + \widehat{\theta} + \left(1 - \widehat{\theta}\right)(e\rho - (\kappa - 1)\,\sigma) \tag{A28}$$

relative to no mandate, equation A25, worker utility is shifted only through her misperception.Then

$$\widehat{u}_M^N > \widehat{u}_M^L \Leftrightarrow \sigma > \alpha \tag{A29}$$

So the equilibrium seems to be back to efficient allocation of notice. The intuition for this result is that once notice is mandated, firm becomes the decision maker and correct the misperception of the worker.

The caveat is that the retain contract, that leads to perceived utility $\widehat{u}_M^R = \overline{Y}$, is not always dominated when workers underestimate the likelihood of productivity loss. Safe a contract so the risk perception does not matter. In fact, the retain contract can be optimal when

$$\sigma > \alpha \;\&\; \alpha\left[\kappa - \frac{1-\theta}{1-\widehat{\theta}}z\right] - \sigma > \Gamma \tag{A30}$$

or when

$$\alpha > \sigma \;\&\; \sigma\left(\kappa - 1\right) - \frac{1-\theta}{1-\widehat{\theta}}z\alpha > \Gamma \tag{A31}$$

where

$$\Gamma \equiv \frac{\widehat{\theta}-\theta}{1-\widehat{\theta}}\left(1-z\right) + e\rho - z \tag{A32}$$

The former case corresponds to when $\widehat{u}_M^R > \widehat{u}_M^N > \widehat{u}_M^L$, that is when retain contract is better than notice and a contract with notice is better than a severance contract. And in the latter case, $\widehat{u}_M^R > \widehat{u}_M^L > \widehat{u}_M^N$. Note these conditions do not hold in the absence of misperception, that is to say that the retain contract is dominated. For example, conditions A30 is equivalent to $\sigma > \alpha > \frac{\sigma+e\rho-z}{1-z}$ in this case, that is impossible since $\frac{\sigma+e\rho-z}{1-z} > \sigma$.

If misperception is small relative to the firm cash-constraint, then the latter become binding and prevent the usage of severance instead of inefficient notice. To be precise, this is the case when

$$\bar{s}\left(\kappa - 1 - \frac{1-\theta}{1-\widehat{\theta}}z\right) < \Gamma$$

A.5 Endogenous contract with Friction: Unemployment Insurance (UI)

In this section, we study a setting where the friction stems from an unbalanced-budget UI system. Such system subsidizes unemployment and thus creates inefficiency in provision of advance notice in private contracts.

A.5.1 Absence of mandated advance notice

First option is to **layoff without notice**. In this case, agent optimization is similar to (A13) with the difference that it incorporates UI benefit and taxes:

$$u^L = \max_{w,s} \underbrace{w-\tau}_{\text{1st period}} + \underbrace{\theta \times (w-\tau) + (1-\theta) \times (s + (1-e)\,b + e\,(\rho-\tau))}_{\text{2nd period}} \tag{A33}$$

under two constraints of the layoff IC (A4) and profit zero of (A14). Given the similarity in the setting, the solution is also similar to the case without UI (optimization (X)). This leads to final utility level of:

$$u^L = 1 + \theta + (1-\theta)\,e\rho - T^L \tag{A34}$$

where T^L denotes the fiscal externality of the worker on the UI system:

$$T^L \equiv \tau - b + E^L\left(\tau + b\right)$$

E denotes the total employment rate, that is

$$E^L \equiv \theta + (1-\theta)\, e. \tag{A35}$$

The utlity of contract without notice are changed by the amount of fiscal externality they create, compare (A15) and (A34).

Second option is to **layoff with notice**, again the agent problem and its solution are similar to the case with no UI, namely

$$u^N = \max_{w,s} \underbrace{w-\tau}_{\text{1st period}} + \underbrace{\theta \times (w-\tau) + (1-\theta) \times (s + (1-e-\Delta e)\, b + (e+\Delta e)\,(\rho + \Delta\rho - \tau))}_{\text{2nd period}} \tag{A36}$$

under two constraints of advance notice IC (A8) and profit zero of (A14). This leads to:

$$u^N = 1 + \theta + (1-\theta)\,(e\rho + \sigma - \alpha) - T^N. \tag{A37}$$

where the fiscal externality is now

$$T^N \equiv \tau - b + E^N\,(\tau + b)$$

The employment rate is now higher due to notice,

$$E^N \equiv E^L + (1-\theta)\,\Delta e \tag{A38}$$

where Δe is Mn effect on employment in the second period, that constitutes one of the two elements of the productivity gain of MN, σ (see the equation (A2)).

The equilibrium contract is then determined by the comparison of the benefit and cost of MN, σ and α, but also the MN effect on the size of subsidy received by the worker:

$$u^N \geqslant u^L \Leftrightarrow \sigma \geqslant \alpha + (\tau + b)\,\Delta e \tag{A39}$$

So the fiscal bias in treament of the two contract creates an extra wedge and thus inefficiency by inducing the choice of contract with higher unemployment risk.

Note that we assumed an additive pay-roll tax. The condition (A39) would be very similar if we have used a proportional tax. The only difference would be the wedge on the right hand side would be $\frac{b}{1-\tau}\Delta e$, instead.

A.5.2 Mandating notice

When advance notice is mandated, then employer can follow the law leading to the same situation as a private contract with notice that we studied in the previous section, i.e. $u^N_M = u^N$. A retain contract is always dominated now.

Sideste'pping the law, employer can layoff the worker without advance notice and compensate her ex-post with an additional severance of σ. The equilibrium contract will be the result of following optimization:

$$u_M^L \equiv \max_{w,s} \underbrace{w-\tau}_{\text{1st period}} + \underbrace{\theta \times (w-\tau) + (1-\theta) \times (s + \tilde{\sigma} + (1-e)\, b + e\, (\rho - \tau))}_{\text{2nd period}} \tag{A40}$$

under three constraints of

$$w - z > s + \tilde{\sigma} \tag{A41}$$

$$\alpha > \tilde{\sigma} \tag{A42}$$

$$1 + \theta = w + \theta w + (1-\theta)\,(s + \tilde{\sigma}) \tag{A43}$$

where

$$\tilde{\sigma} = \sigma - (\tau + b)\,\Delta e$$

This is similar problem than the optimization of (A20) with the difference that the compensating severance is lowered by the fiscal wedge between employment and unemployment. This leads to the utility, $u_M^L = u^L$.The fiscal externality of MN is

$$T^N - T^L = (\tau + b)\,(1-\theta)\,\Delta e \tag{A44}$$

B Online Appendix: Empirical Part

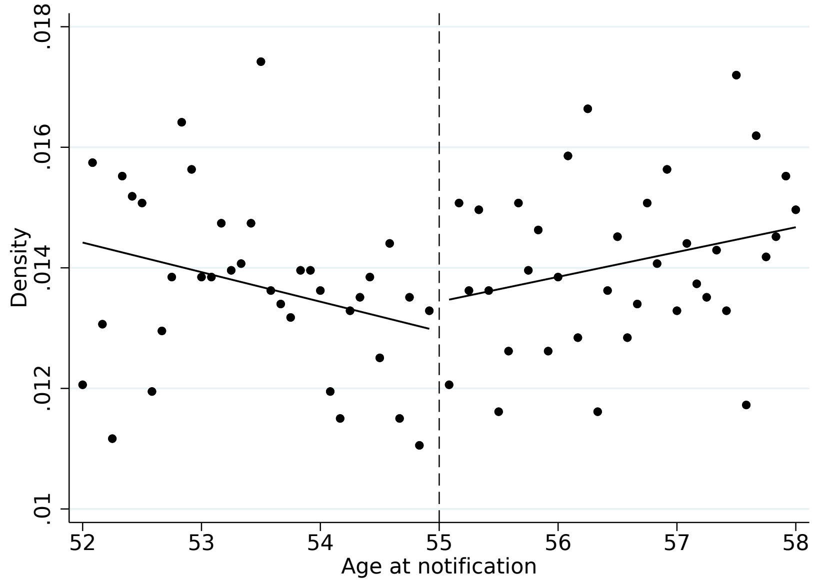
B.1 RDD Validity Tests

A possible concern is that firms try to selectively displace low-cost workers, along the lines of the insider-outsider theory (see Lindbeck and Snower, 1989). In our setting, this would manifest itself through more laid-off workers just to the left of the age-55 threshold. Figure A6 examines whether there is manipulation around the age-55 threshold by comparing the number of observations in the vicinity of the threshold. There is no evidence of suspect bunching on either side of the threshold.

Table A1 investigates whether baseline covariates are evenly distributed across the age-55 threshold. Columns (1)-(4) examine overall balancing. We regress an indicator for being above the age-55 threshold on all baseline characteristics and polynomial control functions in age. We are mainly interested in the F-statistics, reported at the bottom end of the table, which test the null hypotheses that all coefficients on individual (and firm) characteristics are jointly zero. As indicated by the p-values of the F-tests we cannot reject these hypotheses. Also, the individual coefficients are typically small.

Column (5) reports bivariate tests of equality of baseline covariates above and below the threshold. These tests reinforce the view that the coefficients are generally small: those just above the threshold earned 0.26% less than those just below the threshold, for instance.

Figure A6: Number of observations by age at notification



Notes: The figure shows the distribution of displaced individuals by age at notification (measured in months). The regression lines come from estimating a regression corresponding to equation (2) with the fraction of observations at each age bin as the outcome variable. The regression includes a linear age polynomial interacted with the threshold dummy. The estimated jump at the threshold is 0.0005 (standard error = 0.0006, p-value = 0.435).

Table A1: Balancing of pre-determined covariates

	(1)	(2)	(3)	(4)	(5)
$Earnings_{t-1}$	-0.0029	-0.0028	-0.0040	-0.0001	-0.0026
	(0.0062)	(0.0066)	(0.0066)	(0.0040)	(0.0174)
Female	0.0035	0.0037	0.0037	0.0002	0.0128
	(0.0049)	(0.0052)	(0.0055)	(0.0033)	(0.0215)
Immigrant	-0.0033	-0.0028	-0.0027	-0.0009	0.0012
	(0.0093)	(0.0091)	(0.0092)	(0.0062)	(0.0146)
Tenure (years)	-0.0035	-0.0035	-0.0045	-0.0015	-0.0496
	(0.0030)	(0.0030)	(0.0032)	(0.0020)	(0.0334)
Highest attained education					
Primary	-0.0252	-0.0224	-0.0211	0.0016	0.0052
	(0.0230)	(0.0232)	(0.0226)	(0.0151)	(0.0129)
High school	-0.0301	-0.0277	-0.0281	-0.0040	-0.0399*
	(0.0196)	(0.0197)	(0.0193)	(0.0119)	(0.0233)
College	-0.0189	-0.0175	-0.0182	0.0015	0.0295
	(0.0219)	(0.0216)	(0.0212)	(0.0137)	(0.0232)
Firm characteristics		✓	✓	✓	
Polynomial order					
1st degree	✓	✓	✓		✓
2nd degree				✓	
Interacted w. threshold	✓	✓	✓	✓	✓
Month/Year FE			✓	✓	✓
F-statistic	1.20	1.38	1.55	1.18	·
p-value	0.312	0.196	0.126	0.311	·
R^2	0.768	0.768	0.768	0.905	·
# observations	8,860	8,860	8,860	8,860	8,954–8,893

Notes: Earnings are measured relative to the control group. Standard errors are clustered on notitication event. Regressions include individuals aged 52-58 at the time of notification. Columns (1)-(4) show the results of regressing an indicator for being above the age–55 threshold on baseline covariates and polynomial control functions in age. The bottom part of the table reports the F-statistic and the associated p-value from testing the null hypothesis that all coefficients on (individual and firm) baseline covariates are jointly zero. Firm characteristics included in columns (2)-(4) are workforce characteristics – average earnings, share of females, share of immigrants, average age, share of college-educated, and number of employed. All firm characteristics are balanced, except average age in columns (2) and (3) (for instance, in column (2) average age is 0.0008 years higher for individuals above the age-55 threshold). Column (5) reports the results of bivariate balancing tests where each covariate listed in the left-hand column is regressed on the treatment indicator and an interacted first order polynomial control function in age at notification. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

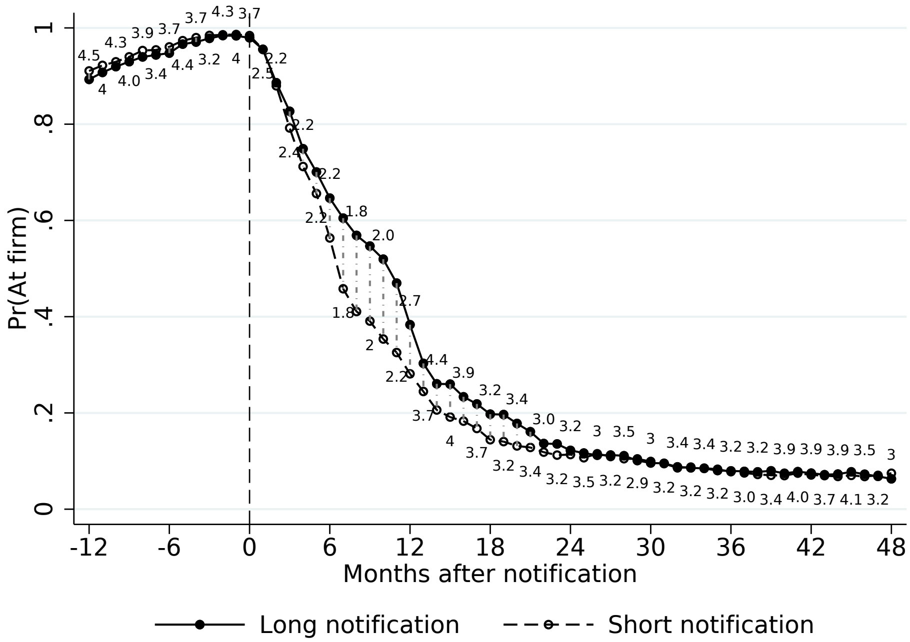
B.2 Optimal bandwidth

Figure A7 reproduces Figure 3 but with the optimal bandwidth selector of Calonico et al. (2014). The figure is built from 48 separate RD-regressions, and, consequently, there are 48 optimal bandwidths. In general, optimal bandwidths are in between 2.0 and 4.0 years, and our default bandwidth of 3 is thus well in-line with the optimal ones. There are instances when bandwith-selector picks 1.8 or 4.5 years as the optimal ones, but these are rare occasions.

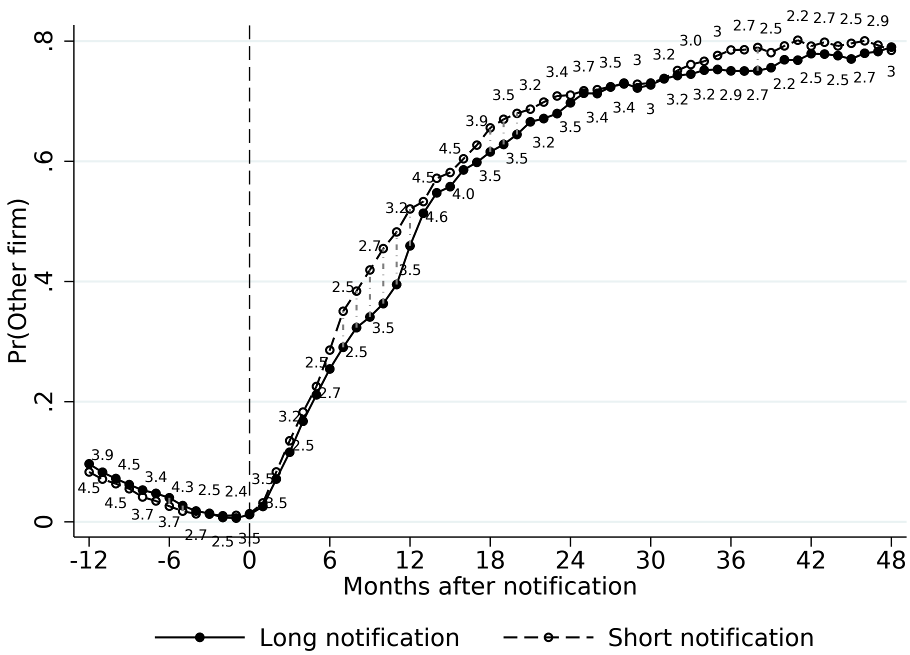
The most important message from A7, however, is that none of our results change when we use this approach rather than the one we opt for in the main text. Conceptually, since age is discrete in our data, we prefer the parametric approach of the main text. Our default approach also avoids the slightly cumbersome exercise of using potentially different data sets for each single point estimate.

Figure A7: Employment by month relative to notification (optimal bandwidth)

(a) Probability of remaining at notifying firm



(b) Probability of working at a new firm



Notes: The figures show each outcome by month relative to notification. At any given time point, we plot estimates of the constant (hollow circles) and the constant+β (black circles) from a local linear regression corresponding to (2) with a bandwidth which is indicated by the number above each point in the graph. Dashed lines indicate that the estimate of β is significant at the 5%-level. The regressions also include baseline covariates (earnings in the year prior to notification, gender, immigrant status, tenure, educational attainment FEs) and month-by-year FE:s.

B.3 MN Wage Effect

Decomposition of the MN Wage Effect

Starting from the decomposition of the expected wage to its average conditional on an employment-to-employment (EE) transition or not, that is:

$$w = \Pr(\mathrm{EE}=1)w_{\mathrm{EE}=1} + \Pr(\mathrm{EE}=0)w_{\mathrm{EE}=0}$$

This implies that the MN wage effect is

$$\Delta w = \Delta\left(\Pr(\mathrm{EE}=1)w_{\mathrm{EE}=1}\right) + \Delta\left(\Pr(\mathrm{EE}=0)w_{\mathrm{EE}=0}\right)$$

We can rewrite the MN wage effect and use the point estimate of each term from Table 3 as:

$$\begin{array}{ccccccc}
\underbrace{\Delta w}_{\text{Wage effect}} & = & \underbrace{\Delta \Pr(\mathrm{EE}=1)\left(w_{\mathrm{EE}=1} - w_{\mathrm{EE}=0}\right)}_{\text{EE effect}} & + & \underbrace{\Pr(\mathrm{EE}=1)\,\Delta w_{\mathrm{EE}=1}}_{\text{wage effect} \mid \text{EE}} & + & \underbrace{\Pr(\mathrm{EE}=0)\,\Delta w_{\mathrm{EE}=0}}_{\text{wage effect} \mid \sim\text{EE}} \\
0.031 & & 0.038 \times 0.038 & & 0.71 \times 0.037 & & 0.29 \times 0.001 \\
 & & .001 & + & .026 & + & 0.0003
\end{array}$$

Alternatively, if we use estimates from wage level instead of changes, we obtain similar results, namely:

$$\Pr(\mathrm{EE})\,\mathrm{E}\left(\ln w \mid \mathrm{EE}\right) = 0.7 \times 0.04 = 2.8\%$$

Role of Sorting in the MN Wage Effect

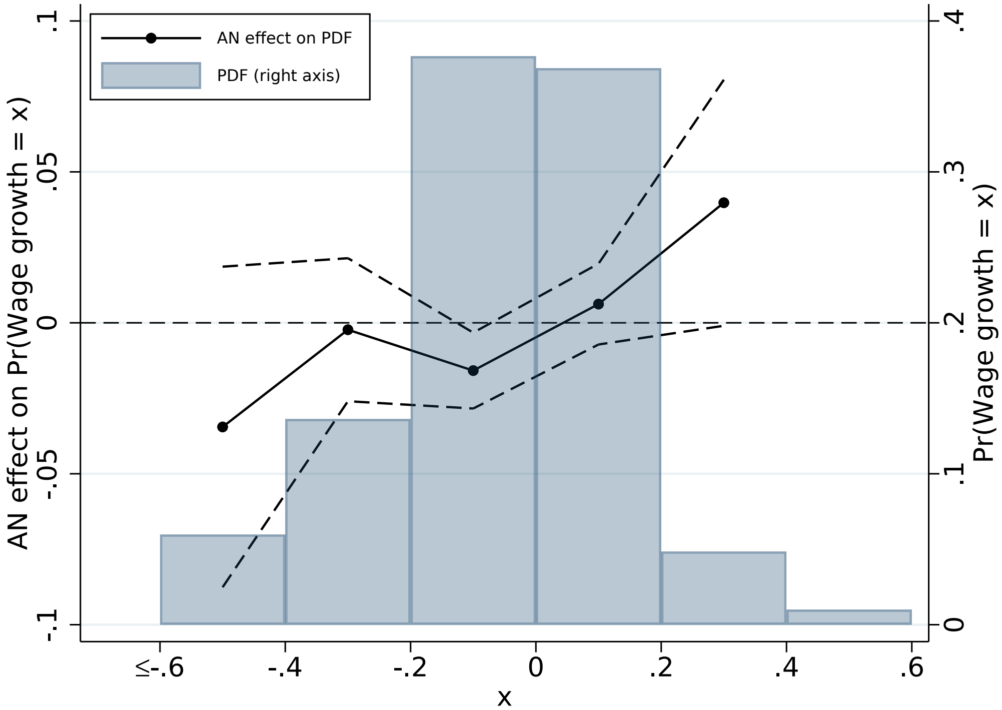
Higher firm quality partly explain our positive wage effects. The next Table estimates the effect of longer MN on characteristics of the new firm. We measure all outcomes in the year prior to notification, and thus before the worker joins the firm, so that the firm outcomes are not affected by the worker himself. With varying statistical significance, longer notification is associated with higher wages, higher earnings, older workers, smaller firms, higher profits, profit margins, and value added.

Table A2: Mandatory Notice (MN) Effect on Firm Sorting

	(1)	(2)	(3)	(4)	(5)	(6)
Panel a: Firm Characteristics using individual-level data						
	Log(New firm wage)	Log(New firm earnings)	Share males	Mean age	Log(firm size)	New firm size> old firm size
Above age-55	0.010	0.116**	0.007	0.817**	-0.099	-0.021
	(0.018)	(0.050)	(0.012)	(0.358)	(0.154)	(0.030)
Control mean	10.260***	11.878***	0.554***	40.965***	5.826***	0.431***
	(0.011)	(0.038)	(0.009)	(0.261)	(0.114)	(0.020)
N	2566	4967	4965	4966	4967	4967
Panel b: Firm Characteristics using firm-level data						
	Sales new firm > Sales old firm	Profit new firm > Profit old firm	Profit/VA new firm > Profit/VA old firm	VA new firm > VA old firm	Log(Value Added)	Labor share
Above age-55	-0.006	0.024	0.011	-0.032	0.016	-0.032
	(0.024)	(0.029)	(0.028)	(0.021)	(0.210)	(0.036)
Control mean	0.251***	0.529***	0.598***	0.278***	10.571***	0.461***
	(0.015)	(0.019)	(0.018)	(0.014)	(0.165)	(0.027)
N	4142	4142	4003	4142	3894	3874

Notes: All outcomes are measured in the year before the individual is notified and thus before joining the new firm. **Panel (a)** outcomes are workers characteristics. *New firm wage* and *New firm earnings* refer to the average monthly wage and annual earnings of the new firm, respectively. **Panel (b)** focuses on outcomes based on the balance sheets and income statements of firms. Labor share is defined as total labor costs including payroll taxes divided by value added. Standard errors, reported in parentheses, are clustered on notification event. Regressions include individuals aged 52-58 at the time of notification. The regressions include a linear age polynomial interacted with the threshold indicator, baseline covariates (earnings in the year prior to notification, gender, immigrant status, tenure, educational attainment FEs), and month-by-year FE:s. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Figure A8: Effects of eligibility for long Advance Notice (AN) on the distribution of wage changes



Notes: The figures plots the MN effect on the PDF of wage growth distribution on the left y-acix (marked solid line) and corresponding confidence intervals (dashed line), the PDF itself is on the right y-axis. The regression lines come from estimating equation (2) with a linear age polynomial interacted with the threshold indicator. The regressions also include baseline covariates (earnings in the year prior to notification, gender, immigrant status, tenure, educational attainment FEs) and month-by-year FE:s. The analysis only includes individuals aged 52-58 at the time of notification.

B.4 Additional Results

Table A3: Effects of MN on advance notice duration, specification analysis

	(1)	(2)	(3)	(4)	(5)	(6)
Above age-55	78.370***	80.821***	81.889***	50.148***	51.008***	55.499***
	(8.409)	(8.119)	(6.698)	(11.498)	(10.158)	(9.330)
Control mean	198.043***	196.489***	200.176***	217.832***	216.710***	216.506***
	(6.200)	(5.766)	(4.702)	(8.790)	(6.875)	(6.265)
Polynomial order						
1st degree	✓	✓	✓			
2nd degree				✓	✓	✓
Baseline covariates	✓	✓	✓	✓	✓	✓
Interacted w. threshold		✓	✓		✓	✓
Month/Year FEs		✓			✓	
Displacement event FEs			✓			✓
F-stat	86.87	99.10	149.47	19.02	25.22	35.38
R^2	0.091	0.186	0.245	0.092	0.187	0.247
# observations	8,955	8,860	8,860	8,955	8,860	8,860

Notes: Standard errors are clustered on notification event (3803 clusters). Regressions include individuals aged 52-58 at the time of notification. Baseline covariates are earnings in the year prior to notification, gender, immigrant status, tenure, educational attainment FEs. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Two sources of approximation are (i) earnings and wage effects are estimated on two *calendar* year horizon; (ii) the wage effects are estimated on a subsample of the baseline population. Despite the approximations involved in the decomposition, the estimated and imputed severance pay effect line up remarkably well, leading to the following decomposition:

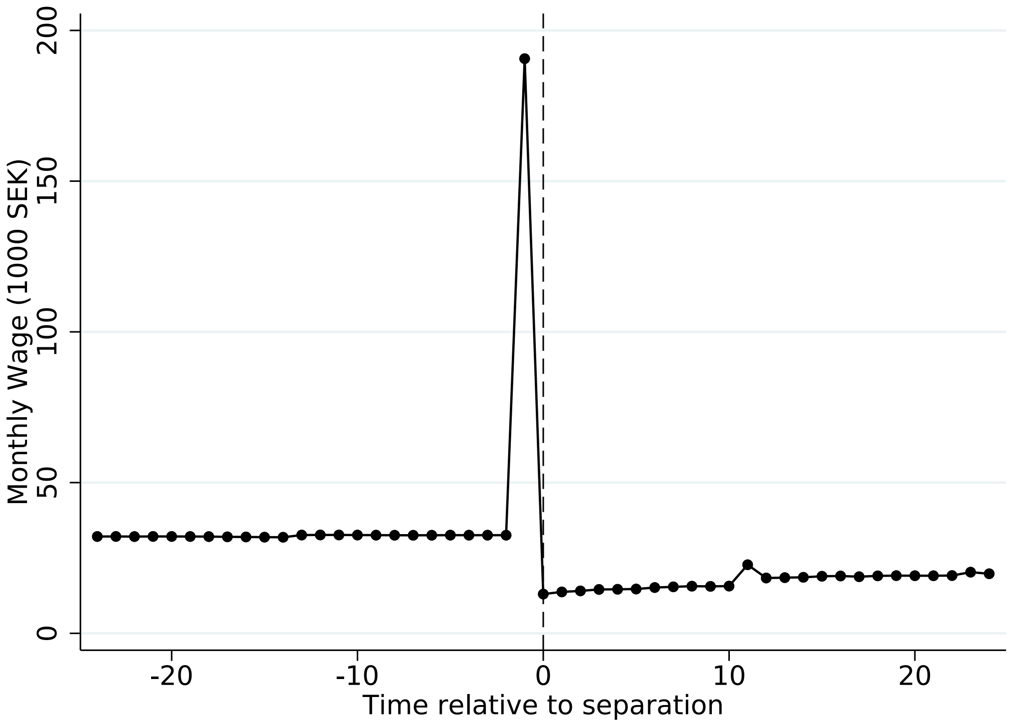
$$\underbrace{\frac{\Delta y}{w_0}}_{\text{Earnings effect of MN}} = -\underbrace{\Delta NE}_{\text{non-employment dur. effect}} - \left(\frac{w_0 - w_1}{w_0}\right) \underbrace{\Delta l_1}_{\text{new job dur. effect}} + \underbrace{\frac{\Delta w_1}{w_0}}_{\text{wage effect}} l_1 + \underbrace{\frac{\Delta SP}{w_0}}_{\text{Severance pay effect}} \tag{A45}$$

Table A4: Decomposition of 2-year cumulative earnings effect

	Component/monthly wage	Percent of earnings effect
Component		
Employment effects		
non-employment	0.796	50
new job	0.056	4
Wage effects		
wage at new job	0.314	20
imbalance in initial wage	-0.148	-9
Estimated severance pay effect	0.559	35
Imputed severance pay effect	0.544	
Sum of estimated components	1.578	100
Estimated earnings effect	1.563	

Notes: Estimated earnings effect $= \Delta y / w_0^L$. Employment effects: non-employment $= -\Delta NE$; new job $= -\left[(w_0^L - w_1^L)\Delta l_1\right]/w_0^L$. Wage effects: wage at new job $= \left[l_1^S w_1^S \Delta \ln w_1\right]/w_0^L$; imbalance in initial wage $= +\left[l_0^S w_0^S \Delta \ln w_0\right]/w_0^L$ (notice that the difference in pre-treatment wages is insignificant; it equals -0.014 (SE = 0.015)). Estimated severance pay effect $= \Delta SP/w_0^L$. The index L (S) denotes eligibility for long (short) notification. The employment effects come from Table 2, the wage estimate from column (2) of Table 3, the severance pay from Figure 2b.

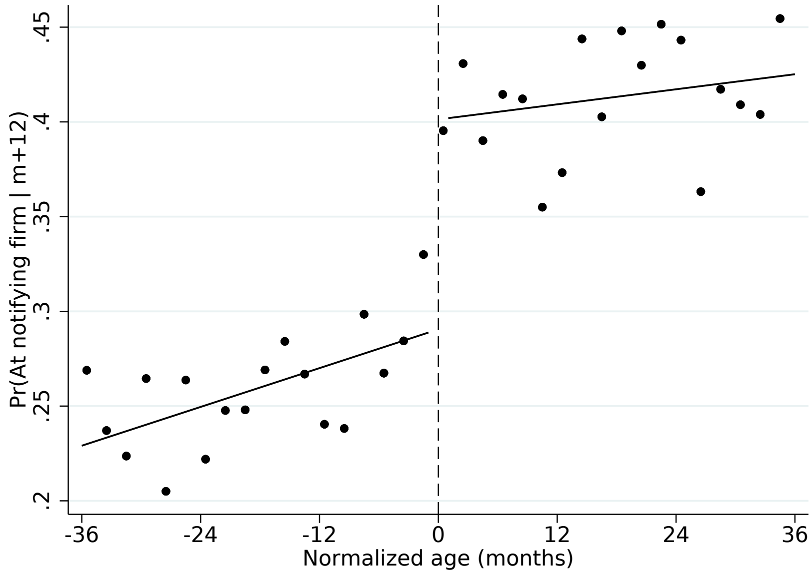
Figure A9: Earnings for workers for whom January is the last month with the notifying firm



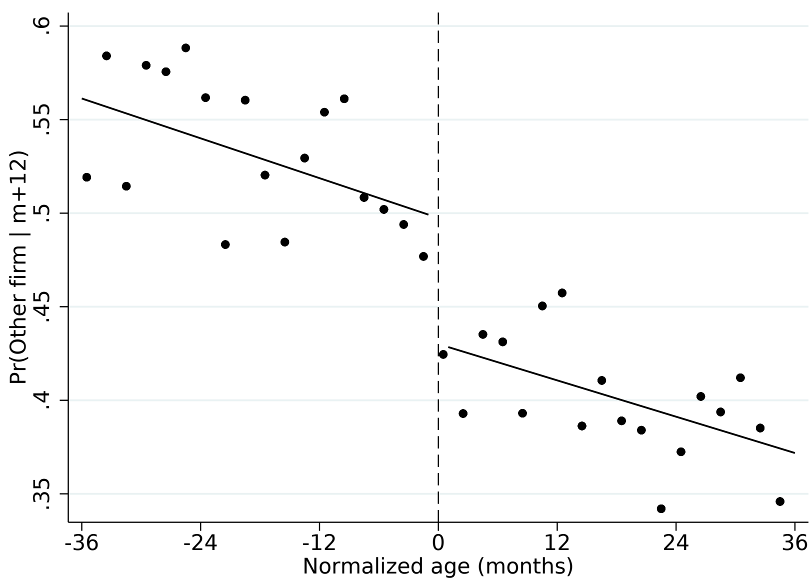
Notes: Monthly earnings for workers whose last recorded month with the notifying firm is January in the year of displacement.

Figure A10: Employment outcomes by age at notification

(a) Probability of remaining at the notifying firm 12 months after notification

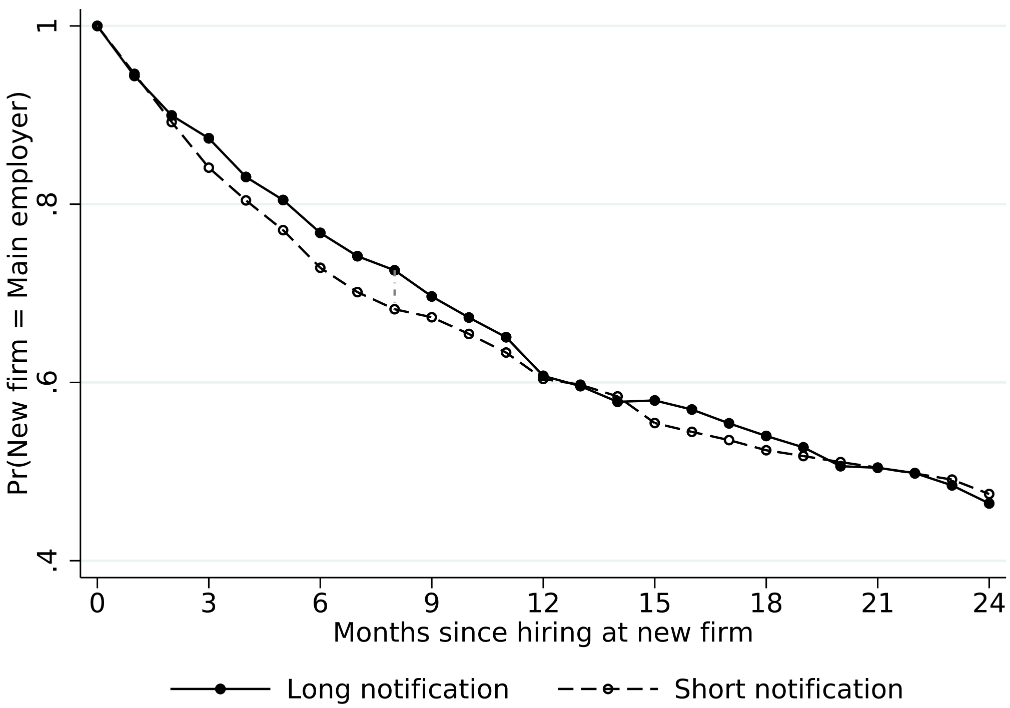


(b) Probability of working at a new firm 12 months after notification



Notes: The figures show employment outcomes by age at notification (2-month-bins). The regression lines come from estimating equation (2) with a linear age polynomial interacted with the threshold indicator. The estimated jump at the threshold in **panel (a)** is 11.2 percentage points, with a standard error of 2.3 ppt, while the estimated jump at the threshold in **panel (b)** is -6.8 percentage points, with a standard error of 2.4 ppt. The regressions also include baseline covariates (earnings in the year prior to notification, gender, immigrant status, tenure, educational attainment FEs) and month-by-year FE:s. The analysis only includes individuals aged 52-58 at the time of notification.

Figure A11: Probability of working at the first firm by months since employment start



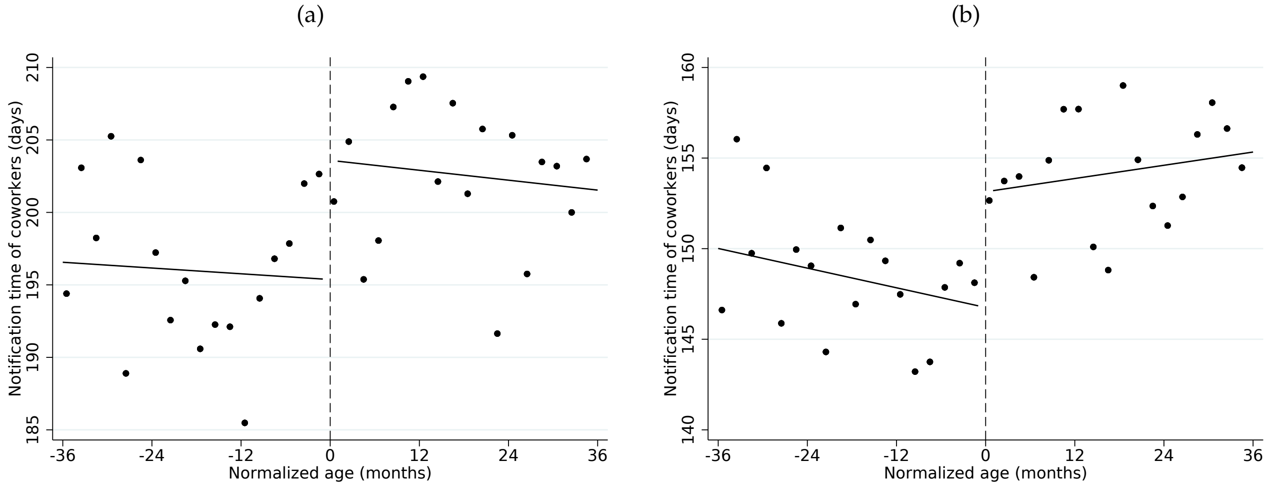
Notes: The figure shows the probability of working in the first new firm after notification over time. We define the first new job after notification as the first month of a new employment spell after the worker has left the notifying firm. The worker stays with that firm as long as imputed monthly earnings from that firm exceed those from some other firm (in months when the worker has no earnings from a different firm the threshold is zero). At any given point in time, we plot estimates of the constant (hollow circles) and the constant+β (black circles) from a regression corresponding to equation (2). Dashed lines indicates that the estimate of β is significant at the 5% level. These regressions include a linear age polynomial interacted with the threshold indicator, baseline covariates (earnings in the year prior to notification, gender, immigrant status, tenure, educational attainment FEs), and month-by-year FE:s. The analysis only includes individuals aged 52-58 at the time of notification.

Table A5: Balancing tests with respect to share coworkers above age-55

	Dep var: Annual earnings in $t-1$		
	(1)	(2)	(3)
Above 55	-3.003	-3.218	-3.120
(Indicator 0/1)	(5.507)	(5.518)	(5.432)
Share coworkers above 55	9.778	12.225	12.276
(0-1)	(8.203)	(8.631)	(8.450)
Controls			
Assignment variable (own age) (1st order, interacted w. threshold)	X	X	X
Month by year FEs	X	X	X
Individual covariates	X	X	X
Size of lay-off	X	X	X
Firm covariates (includes age)	X	X	X
Industry (1 digit) FEs		X	
Industry (2-digit) FEs			X
Estimation statistics			
# clusters (notification events)	3,803	3,780	3,803
# observations (RF)	48,797	48,655	48,797

The table examine whether the earnings a year prior to notification are balanced with respect to the (individual) age-55 indicator and the share coworkers who are above age-55. The sample includes all white-collar workers in notification events where a white-collar worker aged 52-58 was notified. Sample size varies marginally across columns since we do not observe firm covariates for all observations. The regression specifications are such that the effect of the Above 55 indicator is identified within the sample of white-collar workers aged 52-58, while share co-workers above 55 is identified across all white-collar workers. "Individual covariates" are: earnings in the year prior to notification, gender, immigrant status, tenure, educational attainment FEs. Standard errors are clustered by notification events.

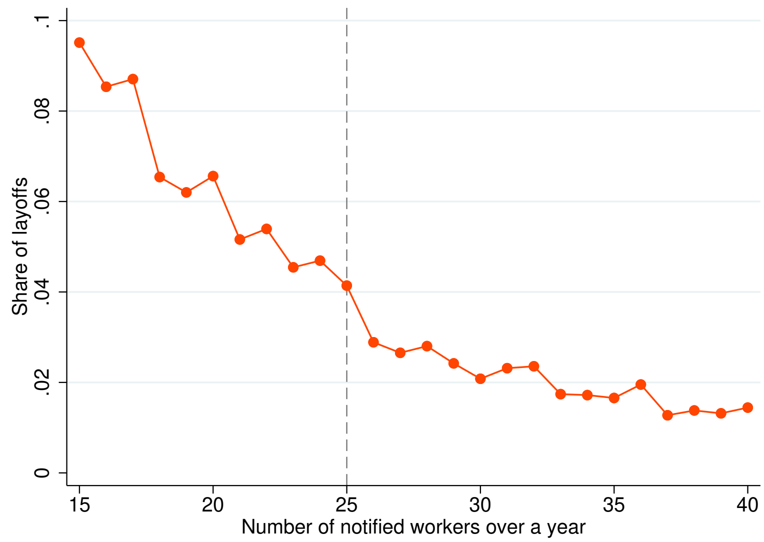
Figure A12: Spill-over of MN on Co-workers' Notice



Notes: This graph shows the average actual notice time of the co-workers of a worker around age 55. Panel (a) inludes only white-collar workers whereas panel (b) also include blue-collar workers. The estimated jump at the threshold is 7.9 days, with a standard error of 3.0 in panel (a). The regression lines come from estimating equation (2) with a linear age polynomial interacted with the threshold indicator. The regression also includes baseline covariates (earnings in the year prior to notification, gender, immigrant status, tenure, educational attainment FEs) and month-by-year FE:s.

Figure A13 shows the distribution of the size of layoffs when aggregating layoff events over a one-year period around the 25-threshold for the years 2005-2015.

Figure A13: Distribution of layoff size aggregated over a one-year period



Notes: This figure shows the distribution of the layoff size around the 25-threshold when aggregating layoff events over a one-year period for the years 2005-2015.