

Furloughs, Employment, and Worker Reallocation in Normal Times

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Abstract

Are furlough schemes useful under normal business cycle conditions? We address this question using Finnish administrative data and two complementary models. We first develop a stylized model that yields analytical results and clarifies a central trade-off. By keeping workers attached to firms after temporary adverse shocks, furloughs can raise output because firms do not internalize that laid-off workers take time to find new jobs. At the same time, furloughs can reduce output by allowing firms to keep some workers attached while temporarily removing them from production and from the firm's wage bill. In equilibrium, this lowers the expected effective productivity of the attached workforce and induces firms of a given productivity to choose larger workforces, lowering aggregate productivity. We then use the data on furlough use and labor adjustment to calibrate a richer firm-dynamics model with frictional unemployment. In the calibrated model, the adverse effects dominate, and it is optimal to eliminate the furlough option altogether.

Keywords: furloughs, firm dynamics, layoffs, labor market

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1 Introduction

European labor markets typically give employers less flexibility to lay off workers than the US, reflecting more stringent employment protection legislation. In environments where firms frequently need to adjust their scale due to idiosyncratic productivity shocks or changing market conditions, such labor market regulations may impose significant costs. On the other hand, many European countries have furlough or short-time work (STW) schemes in place. These schemes are designed to help companies reduce labor costs during temporary challenges, while maintaining the employer-employee relationship and supporting workers' income.

During the COVID-19 crisis, several countries introduced or expanded furlough schemes. These policies were widely viewed as effective in preventing a wave of business failures and limiting what might otherwise have been a large and persistent increase in unemployment. By keeping workers attached to their firms, they also enabled firms to quickly resume operations without the need for costly recruitment and retraining.

However, while these schemes may help firms navigate temporary disruptions, they can also have negative consequences. Rather than preserving valuable employer-employee relationships, furloughs may hinder productivity-enhancing worker reallocation. They may also reduce employment or hours worked by incentivizing firms to furlough workers instead of keeping them employed. These adverse effects may dominate in normal times, when aggregate employment is not limited by weak labor demand and fewer firms face binding liquidity constraints.

In this paper, we examine how a furlough option affects labor productivity and employment under normal business cycle conditions. We focus on the Finnish furlough scheme, which has been in place since well before the COVID-19 pandemic and for which we have rich data on how firms make use of it.

In Finland, firms can lay off or furlough workers only when there is a legally acceptable reason for doing so. The conditions for furloughs are less stringent than those for layoffs: a temporary reduction in the employer's ability to provide work, defined as a period of up to 90 days, is sufficient to justify a furlough, whereas layoffs require a more permanent reduction. Both adjustment margins also require firms to follow specific, administrative procedures, including communication and negotiations with workers. These procedures are often shorter for furloughs than for layoffs. Under the current Finnish institutional setting, the associated adjustment costs do not take the form of government-mandated severance payments or explicit layoff or furlough taxes, but instead reflect the time-consuming procedural requirements associated with workforce reductions and the need to reorganize production.

At the same time, the Finnish unemployment insurance system also provides benefits to furloughed workers. However, furloughed workers are not required to seek new employment during the first three months of their furlough spell. In practice, the monitoring of job search is likely to be less strict for furloughed workers also after the first three months. About 90 percent of furlough spells end with the furloughed worker returning to the firm that furloughed them.

The furlough scheme used in Finland is similar to various short-time work arrangements applied in some European countries. The key difference between furloughs and STW schemes is that, while furloughs typically reduce workers' hours to zero, STW schemes aim for more moderate work time reductions; though in many countries, zero hours are also allowed (see

Cahuc (2024) for a discussion on STW schemes).

To clarify the main economic mechanisms, we first consider a stylized model a la Melitz (2003) with heterogeneous firms, free entry, frictional unemployment, and temporary firm-level productivity shocks. Firms choose employment before the temporary shock is realized, and wages cannot be renegotiated after the shock. We compare two labor adjustment regimes: one in which firms respond to adverse shocks through layoffs, and one in which they instead furlough workers.

The model highlights opposing channels. When firms lay off workers after an adverse shock, these workers do not immediately find new jobs, but instead pass through unemployment. Since firms do not internalize this delay, furloughs can raise output by preventing workers from entering unemployment. However, furloughs can also reduce output through a labor-underutilization channel. This channel arises because furloughs allow firms to keep some workers attached while temporarily removing them from production and from the firm's wage bill, even though their marginal product remains positive. In equilibrium, this lowers the effective productivity of a given attached workforce and induces firms of a given productivity to choose larger pre-shock workforces. This also concentrates workers in fewer firms, which lowers aggregate output under decreasing returns to labor.

Next, we document key patterns in furlough use and its relationship to job creation and destruction using administrative data from 2013 to 2019—a period of relative stability in the Finnish economy. During this time, the share of furloughed workers hovered around 1% of employment, while annual job destruction and job creation rates ranged from 5% to 8%. Furloughs are typically used for relatively small workforce adjustments compared to job destruction and the probability to use furloughs increases with firm size. Furloughing is also fairly common: about 11% of all firms furlough at least one worker in a given year, with the share rising to 30% among firms with more than 500 employees. In these larger firms, on the other hand, furloughed workers typically make up an even smaller share of the workforce than in smaller firms.

Our main quantitative analysis incorporates a furlough option into a model of firm dynamics with workforce adjustment costs and frictional unemployment. Firms face both persistent and temporary productivity shocks, and they can reduce their workforce through layoffs or furloughs, both of which involve costs. Frictional unemployment is modeled following Alvarez and Veracierto (2001): laid-off workers must exert costly search effort before entering a competitive hiring market, whereas furloughed workers remain attached to their employer and can be recalled without search. Wages are not renegotiated at the firm level after productivity shocks. Thus, after a negative shock is realized, the firm and its workers cannot reduce wages to preserve otherwise valuable employment relationships. This assumption is consistent with the Finnish context, where wages are collectively determined for most workers.

Firms choose endogenously whether to adjust through layoffs, furloughs, or both. We interpret the associated adjustment costs as capturing the procedural and organizational costs, as well as the legal risks, associated with the regulation of layoffs and furloughs in Finland. Furloughing allows firms to temporarily reduce labor input without incurring hiring and training costs when workers are recalled. However, if a firm does not recall furloughed workers in the next period, it must either lay them off or furlough them again, both of which are costly.

We allow for a flexible adjustment-cost structure to be able to replicate empirical patterns in hiring, layoffs, and furlough use, including the extent to which firms use layoffs and furloughs separately or jointly. We calibrate the model to match these patterns in the data, along with broader labor market reallocation dynamics. To vary the extent to which firms use layoffs and furloughs, we also introduce layoff and furlough taxes, which can be negative and therefore act as subsidies. The resulting revenues are redistributed to workers as lump-sum transfers, while any subsidy costs are financed by lump-sum taxes.

We first show that, in the calibrated model economy, layoffs are too limited: both output and welfare are maximized by a small layoff subsidy rather than by a tax. This result can be understood through the trade-off emphasized by Alvarez and Veracierto (2001). Layoffs facilitate productivity-enhancing worker reallocation across firms, while discouraging layoffs reduces transitions through unemployment and the associated search costs. In our baseline calibration, which features sizable resource costs of labor adjustment, the productivity gains from encouraging additional reallocation outweigh the losses from lower employment and higher search costs. This contrasts with the policy conclusion in Alvarez and Veracierto (2001), where a moderate layoff tax is welfare-improving. However, in counterfactual economies with sufficiently smaller resource costs, the welfare-maximizing policy switches to a positive layoff tax in our model as well.

The welfare results for furloughs are different. Even though the calibrated economy would benefit from somewhat more layoffs, furloughs do not provide a useful additional margin of flexibility. Instead, it is optimal to tax furloughs at a rate that eliminates their use entirely. The intuition partly echoes the stylized model. The furlough option may reduce frictional unemployment by keeping workers attached to firms after temporary adverse shocks, but it can also reduce labor input and increase the average firm size by making it possible to temporarily remove workers from production and from the firm's wage bill. In this richer model, the furlough option also affects productivity-enhancing reallocation across firms and the job-finding probability. Overall, we find that the adverse effects dominate, and the furlough option reduces both output and welfare.

The unemployment channel turns out to be quantitatively weak. One reason is that furloughs are not close substitutes for layoffs from the firms' perspective. Firms often use furloughs as an additional adjustment margin rather than as a way to avoid layoffs. Given the structure of labor adjustment costs, firms use furloughs mainly to manage temporary reductions in labor input, while layoffs are reserved for more permanent downsizing. This is in line with the descriptive evidence that furloughs typically involve much smaller workforce reductions than job destruction. Even when furloughs do replace layoffs, the resulting decrease in unemployment is limited by the fact that the calibrated labor market friction does not generate very long unemployment spells on average.

The quantitative model also contains an additional force that weakens the unemployment channel: the furlough option decreases the search effort of unemployed workers, since the possibility of being furloughed reduces the value of employment. By lowering the job-finding probability and thereby lengthening unemployment spells, this effect works against the unemployment-reducing role of furloughs. As a result, the furlough option mainly lowers employment, measured

net of furloughed workers, rather than preventing unemployment.

The furlough option does raise output per worker in production, but this effect is too small to offset its adverse effects on employment and firm size. One reason is that furloughs contribute little to productivity-enhancing labor reallocation across firms. In the quantitative model, firms with low productivity tend to shrink or exit, while more productive firms expand by hiring workers from unemployment. Layoffs support this mechanism by releasing workers who may then be hired by expanding firms. Furloughs, by contrast, typically keep workers attached to the same firms and therefore do not facilitate reallocation toward more productive firms. In addition, as in the stylized model, the furlough option increases average firm size measured in terms of attached workers. This reflects firms' incentive to carry larger workforces when they can temporarily remove some attached workers from production and from the wage bill after adverse shocks. Thus, the furlough option both weakens worker reallocation and shifts the equilibrium toward larger firms with more attached workers.

Taken together, the limited reduction in unemployment, the lower use of attached workers in production, the associated increase in average firm size, and the weak contribution to productivity-enhancing reallocation explain why eliminating the furlough option is welfare-improving in the calibrated economy.

Finally, we provide complementary empirical evidence on the model's prediction that firms rarely use furloughs as substitutes for layoffs. We exploit the fact that layoff regulations vary with worker tenure: the notice period for layoffs increases substantially with tenure, whereas the notice period for furloughs does not. If furloughs were an important substitute for layoffs, firms with longer-tenured workforces should respond to higher effective layoff costs by relying more heavily on furloughs. Instead, we find that firms with longer-tenured marginal workers are less likely to destroy jobs, but not more likely to furlough workers. This pattern remains after controlling for firm size, value added, and industry and year fixed effects, and is robust to alternative thresholds for measuring job destruction and furlough events.

Literature. We build on a body of firm dynamics research that has explored the consequences of high layoff costs when firms face idiosyncratic productivity or demand shocks, and therefore need to adjust employment. A partial equilibrium analysis by Bentolila and Bertola (1990) concludes that severance payments can increase employment. The seminal paper by Hopenhayn and Rogerson (1993) finds that layoff taxes could have severe consequences on total factor productivity. In their framework, this also leads to a reduction in employment as households decrease their labor supply in response to declining productivity. Alvarez and Veracierto (2001) extend the Hopenhayn-Rogerson framework to include frictional labor markets. In line with Hopenhayn and Rogerson (1993), they conclude that severance payments increase misallocation and thus decrease aggregate productivity. Employment, however, increases with the tax and a moderate layoff tax increases welfare compared to no tax. Our contribution to this literature is to examine whether, in the presence of high labor adjustment costs and frictional unemployment, the additional flexibility offered by the option to furlough can increase welfare.

Other papers have explored the effects of adjustment costs in the search and matching framework: in Saint-Paul (1995), firing costs increase unemployment, while in Mortensen and Pissarides (1999), firing costs have the opposite effect. As highlighted by Ljungqvist (2002),

specific assumptions about the bargaining process are the key to these varying results.

Some recent papers have studied the effects of furloughs or STW policies in recessions using structural models. Cooper et al. (2017) examine the German short-time work (STW) scheme in a model with matching frictions, multi-worker firms, and firm-level wage bargaining. They analyze how STW policies help firms adjust the intensive margin of labor during downturns, reducing layoffs and preserving firm-worker relationships. Diaz et al. (2025) study the Spanish furlough scheme in a search and matching model that incorporates sector-specific human capital and sector-specific productivity shocks, focusing on how furloughs affect unemployment and worker flows. In their model, wages are fully flexible.

In contrast to these models, we assume that firms take wages as given, meaning they cannot lower wages in response to firm-level shocks. This reflects institutional wage-setting constraints in the Finnish labor market and implies that furloughs may help preserve valuable firm-worker relationships that might otherwise be lost due to wage rigidity. Our model also features richer firm dynamics, including endogenous entry and exit. These elements make our framework well-suited for analyzing how the furlough option affects aggregate productivity through worker reallocation across firms.

Other papers that analyze the effects of STW during downturns using quantitative search models with single-worker firms include Tilly and Niedermayer (2017) and Albertini et al. (2022), both of whom develop models with rich worker-level heterogeneity, as well as Balleer et al. (2016), who differentiate between rule-based and discretionary STW policies. Cahuc et al. (2021) illustrate the heterogeneous effects of STW policies using a theoretical partial equilibrium model that incorporates both within-firm and between-firm heterogeneity. Generally, these papers find that STW policies help stabilize employment over the business cycle. However, this often comes at a cost: hours worked are reduced for some workers who would not have been laid off in the absence of the STW policy.

There is also a small but growing body of empirical research analyzing the effects of STW schemes during recessions using firm-level data and quasi-experimental variation in STW rules (see Giupponi and Landais (2022), Cahuc et al. (2021) and Kopp and Siegenthaler (2021)). Typically, this literature finds that, at least in the short term, these job retention programs are effective in preserving jobs. A notable exception is Brinkmann et al. (2024), who study the effects of STW in Germany. They compare the employment outcomes of cohorts above retirement age, who are ineligible for STW, to slightly younger cohorts who are still eligible, and find no difference in job retention between the two groups during the COVID period.

In Finland, furloughed workers are eligible for unemployment benefits but are not required to actively search for new work. As a result, the concept of ‘furlough unemployment’ resembles the mismatch unemployment described in Shimer (2007) or the rest unemployment in Alvarez and Shimer (2011).

Another type of unemployment, common in the US and similar to furlough unemployment, is recall unemployment, which arises from temporary layoffs. This type of unemployment has recently been analyzed by Fujita and Moscarini (2017), Gertler et al. (2022) and Albertini et al. (2023). The main difference between furloughs and recall unemployment is that recall is much more likely for furloughed workers because the employment contract has not been terminated.

A related framework that incorporates this type of unemployment while also modeling heterogeneous firms is Buera et al. (2021), which examines the ripple effects of temporary lockdowns induced by the COVID-19 shock on the aggregate economy. Their model features both financial and labor market frictions and, like ours, assumes that firm-level wages are fixed after shocks are realized. They find that the effects of lockdowns on output, employment, and firm dynamics are not persistent, provided that workers on temporary layoff can be recalled by their previous employers and that the government provides employment subsidies during the lockdown. This result highlights the potential role of furlough schemes, or similar arrangements, in preventing temporary disruptions from turning into persistent job losses. Like Buera et al. (2015), Buera et al. (2021) assume that a constant fraction of unemployed workers can access the competitive hiring market in each period. We instead allow unemployed workers to choose their search intensity, as in Alvarez and Veracierto (2001). This margin is potentially important because endogenous changes in the job-finding probability may influence the unemployment-reducing role of furloughs. Costly search effort is also directly relevant for welfare, whereas furloughed workers can be recalled without search.

An important distinction between Buera et al. (2021) and our analysis concerns firms' workforce adjustment incentives. In their model, firms are indifferent between temporarily laying off workers with recall and separating from workers and hiring new ones once the shock dissipates. Because furloughs are used only after the aggregate shock has hit, the furlough option does not affect the initial distribution of firms and employment. In contrast, our model endogenizes the choice between layoffs and furloughs. This allows the furlough option to affect firms' ex ante choices and thereby the stationary distribution of firms. This difference is potentially important for welfare. Our model also reproduces empirically realistic patterns in the incidence and size of layoffs and furloughs observed in Finnish data, including the joint use of both adjustment margins.

2 Stylized model

To build intuition for the quantitative results, we consider a stylized model, similar to Melitz (2003), that isolates two forces through which furloughs affect aggregate output. On the one hand, furloughs can raise output by preventing workers from entering unemployment after temporary adverse shocks. On the other hand, furloughs can reduce output through a labor-underutilization channel: they make it less costly for firms to keep attached workers out of production after adverse shocks. In equilibrium, this lowers the expected effective productivity of a given attached workforce, induces firms of a given productivity to choose larger workforces, and reduces the mass of entrants and operating firms for a given aggregate workforce.

2.1 Environment

Time is discrete and there is a unit mass of workers. Firms are heterogeneous and enter freely. A firm with workforce n produces according to

$$y = azl^\alpha, \tag{1}$$

where $\alpha \in (0, 1)$, z is a permanent firm-specific productivity draw, l is labor input, and a is a temporary productivity shock realized after hiring. We assume that z follows a Pareto distribution with parameters (z_{\min}, k) , where $k > \frac{1}{1-\alpha}$, and denote its density by $g(z)$. The temporary shock is given by

$$a = \begin{cases} 1 & \text{with probability } p, \\ \underline{a} & \text{with probability } 1 - p, \end{cases} \quad (2)$$

where $\underline{a} \in (0, 1)$.

Firms pay an entry cost c_e and a fixed operating cost c_o , both in units of the final good. Entrants pay the entry cost before drawing their permanent productivity and then decide whether to operate or exit. Continuing firms exit exogenously with probability δ and discount future profits at rate β . Hiring takes place at the start of each period and is costless. Workers in exiting firms are reallocated directly to new firms and do not pass through unemployment. Thus, in this stylized model, unemployment arises only from layoffs following bad productivity shocks.

We compare two stationary economies. In both economies, the extent of labor adjustment after a bad shock is governed by exogenous regime-specific parameters. We assume that bad-state productivity \underline{a} is sufficiently low that, after a bad shock, firms always reduce labor input as much as the adjustment regime allows. In the *layoff economy* (L), firms that experience a bad shock ($a = \underline{a}$) retain a fraction σ of their workforce in production and lay off the remaining fraction $1 - \sigma$. Laid-off workers enter unemployment after the temporary shock. Before the next period's hiring stage, each unemployed worker, including those newly laid off, is re-employed with probability q . In the *furlough economy* (F), firms that experience a bad shock retain a fraction θ of their workforce in production and furlough the remaining fraction $1 - \theta$, where $0 < \theta \leq \sigma \leq 1$. Furloughed workers remain attached to the firm and do not enter unemployment. The case $\theta < \sigma$ captures the idea that furloughs allow firms to reduce labor input following temporary shocks more easily than layoffs.

2.2 Firm problem

It is useful to define

$$A_L \equiv p + (1 - p)\underline{a}\sigma^\alpha, \quad B_L \equiv p + (1 - p)\sigma, \quad (3)$$

and

$$A_F \equiv p + (1 - p)\underline{a}\theta^\alpha, \quad B_F \equiv p + (1 - p)\theta. \quad (4)$$

Here $A_j z$ summarizes expected effective productivity and B_j summarizes the expected wage bill per worker in economy $j \in \{L, F\}$.

The firm problem in economy j can then be written as

$$\pi^j(z) = \max_n \{A_j z n^\alpha - B_j w^j n - c_o\}. \quad (5)$$

The optimal workforce is

$$n^j(z) = \left(\frac{\alpha A_j z}{B_j w^j} \right)^{\frac{1}{1-\alpha}}. \quad (6)$$

Substituting back yields maximized expected profits

$$\pi^j(z) = \frac{1-\alpha}{\alpha} B_j w^j n^j(z) - c_o. \quad (7)$$

Only firms with positive profits operate. Let z_j^* denote the cutoff productivity satisfying $\pi^j(z_j^*) = 0$. The cutoff condition implies the following convenient representation of maximized profits:

$$\pi^j(z) = c_o \left[\left(\frac{z}{z_j^*} \right)^{\frac{1}{1-\alpha}} - 1 \right], \quad z \geq z_j^*. \quad (8)$$

2.3 Free entry and equilibrium wages

Potential entrants pay the entry cost c_e before drawing z . Free entry implies that the expected discounted value of entry equals the entry cost:

$$\frac{c_o}{1-\beta(1-\delta)} \int_{z_j^*}^{\infty} \left[\left(\frac{z}{z_j^*} \right)^{\frac{1}{1-\alpha}} - 1 \right] g(z) dz = c_e. \quad (9)$$

Since this condition does not depend on the wage or on the adjustment regime directly, the cutoff productivity is the same in the two economies:

$$z_L^* = z_F^* \equiv z^*. \quad (10)$$

The cutoff condition, after solving the equilibrium wage from the zero-profit condition at the profitability margin, implies

$$\frac{B_F w^F}{B_L w^L} = \left(\frac{A_F}{A_L} \right)^{\frac{1}{\alpha}}. \quad (11)$$

Substituting this relation into the firm labor demand functions gives

$$\frac{n^F(z)}{n^L(z)} = \left(\frac{A_L}{A_F} \right)^{\frac{1}{\alpha}}. \quad (12)$$

Since $\theta < \sigma$ implies $A_F < A_L$, firms of a given productivity are larger in the furlough economy.

2.4 Labor market clearing

Let M_j^e denote the mass of potential entrants in economy j . Since firms exit exogenously at rate δ , the stationary mass of firms with productivity in an interval dz is $(M_j^e/\delta)g(z)dz$ for $z \geq z^*$. Define aggregate pre-shock workforce as

$$N_j \equiv \frac{M_j^e}{\delta} \int_{z^*}^{\infty} n^j(z)g(z) dz. \quad (13)$$

This is the workforce chosen before the temporary productivity shock is realized.

In the layoff economy, a mass $(1-p)(1-\sigma)N_{L,t}$ of workers is laid off after bad shocks in period t . These workers join the unemployment pool. Before the next period's hiring stage,

a fraction q of unemployed workers is re-employed. Let u_t denote the unemployment stock at the hiring stage of period t , after re-employment opportunities from the previous period's unemployment pool have been realized. Unemployment then evolves according to

$$u_{t+1} = (1 - q) [u_t + (1 - p)(1 - \sigma)N_{L,t}]. \quad (14)$$

In a stationary equilibrium, this implies

$$u = \frac{(1 - q)(1 - p)(1 - \sigma)}{q} N_L. \quad (15)$$

At the hiring stage, workers who remain unemployed are not part of firms' pre-shock workforce. Hence labor market clearing implies

$$1 = N_L + u = \psi N_L, \quad \psi \equiv \frac{q + (1 - q)(1 - p)(1 - \sigma)}{q}. \quad (16)$$

In the furlough economy, there is no unemployment, so

$$1 = N_F. \quad (17)$$

Therefore,

$$\frac{N_F}{N_L} = \psi. \quad (18)$$

2.5 Aggregate output and the two channels

Gross aggregate output in economy $j \in \{L, F\}$ is

$$Y_j = \frac{M_j^e}{\delta} \int_{z^*}^{\infty} A_j z (n^j(z))^\alpha g(z) dz. \quad (19)$$

Using the firm's first-order condition, this can be written as

$$Y_j = \frac{B_j w^j}{\alpha} N_j. \quad (20)$$

Taking the ratio of the output expressions for the furlough and layoff economies, and using $N_F/N_L = \psi$ together with the cutoff ((11)) condition gives

$$\frac{Y_F}{Y_L} = \psi \left(\frac{A_F}{A_L} \right)^{\frac{1}{\alpha}} = \frac{q + (1 - q)(1 - p)(1 - \sigma)}{q} \left(\frac{p + (1 - p)\underline{a}\theta^\alpha}{p + (1 - p)\underline{a}\sigma^\alpha} \right)^{\frac{1}{\alpha}}. \quad (21)$$

The same expression also gives the relative mass of entrants. To see this, take the ratio of the aggregate pre-shock workforce condition (13) across the two economies. Since the cutoff productivity is common and the firm-size ratio (12) is the same for all z , we have

$$\frac{N_F}{N_L} = \frac{M_F^e}{M_L^e} \left(\frac{A_L}{A_F} \right)^{1/\alpha}.$$

Using (18) then gives

$$\frac{M_F^e}{M_L^e} = \psi \left(\frac{A_F}{A_L} \right)^{1/\alpha} = \frac{Y_F}{Y_L}.$$

Thus, the ratio of outputs in the two economies is also the ratio of entry masses. Furloughs raise output if and only if they raise the equilibrium firm mass.

Since fixed operating and entry costs are paid in output goods, welfare is not directly determined by gross output Y_j . Instead, the relevant measure is net output, defined as gross output less operating and entry costs:

$$C_j = Y_j - M_{o,j}c_o - M_j^e c_e, \quad (22)$$

where $M_{o,j}$ is the mass of operating firms. In this economy, however, the ratio of net outputs is the same as the ratio of gross outputs. The reason is that free entry implies a common cutoff productivity, so the productivity distribution of active firms is the same in the two economies. Although firms of a given productivity may be larger in one economy than in the other, aggregate operating and entry costs are constant shares of gross output in both economies.¹

Thus, the expression derived above for Y_F/Y_L also applies to net output, C_F/C_L , which is the measure that is relevant for welfare. The expression highlights two opposing channels. The first factor, ψ , captures the *unemployment channel*, which favors furloughs. In the layoff economy, workers laid off after a bad shock join the unemployment pool. Some are re-employed before the next hiring stage, but those who are not re-employed due to the labor market friction reduce the workforce available to firms. This effect is stronger when layoffs are extensive, that is, when σ is low, and when the labor market friction is severe, that is, when the re-employment probability q is low. Through this channel, furloughs raise the aggregate pre-shock workforce and thereby tend to increase entry and output.

The remaining factor captures the *labor-underutilization channel*, which works against furloughs when $\theta < \sigma$. The channel arises because furloughs allow firms to keep some workers attached while temporarily removing them from production and from the firm's wage bill. Since the marginal product of these workers remains positive ($\underline{a} > 0$), using fewer of them in the bad state lowers output for a given pre-shock workforce. This lowers A_F , the expected effective productivity of a given attached workforce in the furlough economy, relative to A_L . The same margin also changes firms' ex ante workforce choices. Since $A_F < A_L$ when $\theta < \sigma$, the earlier firm-size expression implies that firms of a given productivity choose larger pre-shock workforces in the furlough economy. Hence, for a given aggregate pre-shock workforce, workers are spread across fewer, larger firms, and the mass of entrants and operating firms is lower. Under decreasing returns to labor at the firm level, this concentration of labor lowers aggregate output. This is reflected in the exponent $1/\alpha$: with $A_F/A_L < 1$, a smaller α , corresponding to stronger decreasing returns, makes the factor $(A_F/A_L)^{1/\alpha}$ smaller and therefore magnifies the output loss associated with this channel.

The net effect is ambiguous because the two channels have opposing signs. Furloughs reduce

¹Formally, because z^* is common across economies, the integrals over active firms are common up to the scale factor M_j^e . The first-order condition implies that gross output is proportional to $B_j w^j N_j$, while aggregate operating costs and entry costs are also proportional to M_j^e . Free entry pins down the same relationship between these terms in both economies. Hence C_j/Y_j is the same for $j = L, F$, implying $C_F/C_L = Y_F/Y_L$.

unemployment, which tends to raise output, but they also lower effective labor use and increase firm size, which tends to reduce output under decreasing returns.

Some limiting cases are instructive. If $\theta = \sigma < 1$, then $A_F = A_L$: firms in the two economies use the same amount of labor in the bad state and choose the same workforce size for a given productivity. The labor-underutilization channel then creates no difference between the two regimes, and furloughs raise output by reducing unemployment, provided that $q < 1$. Hence the labor-underutilization channel creates no difference between the two regimes. Furloughs then only reduce unemployment and therefore increase output relative to layoffs. If instead $\sigma = 1$ and $\theta < 1$, layoffs generate no unemployment, so the unemployment channel creates no difference between the two regimes. Furloughs then operate only through the labor-underutilization channel, reducing bad-state labor use and increasing firm size.

When $\theta < \sigma < 1$, both forces are present: furloughs reduce unemployment by preventing some layoffs from turning into unemployment spells, but they also reduce bad-state labor utilization. Furloughs are therefore more likely to increase output when the labor market friction is severe and when θ is close to σ , so that furloughs do not reduce bad-state labor utilization much relative to layoffs. This also highlights that strict restrictions on layoffs do not necessarily make a furlough option beneficial: when layoffs are already limited, the unemployment channel is weak, while the adverse effects on labor utilization and firm size may remain important.

Finally, suppose that bad-state productivity approaches zero, $\underline{a} \rightarrow 0$. Then A_F and A_L both converge to p , so the second factor in the output ratio converges to one. In this case, keeping workers out of production in the bad state does not reduce output because their marginal product is zero. Furloughs then operate only through the unemployment channel and raise output whenever layoffs would otherwise generate unemployment spells. This case captures the idea that furloughs are most likely to be useful when workers are temporarily totally unproductive or cannot participate in production, as during lockdowns or other exceptional disruptions.

3 Furloughs and job reallocation in Finland

In this section, we report some key empirical regularities regarding the firms' use of furloughs, as well as the labor reallocation patterns in Finland. Following Davis et al. (1998), we measure reallocation by gross job destruction (JD) and gross job creation (JC).

3.1 Data

We use register data provided by Statistics Finland (FOLK data and Financial Statement Statistics) and the Ministry of Economic Affairs and Employment (URA database). We identify the furlough periods from URA data, which contains all furlough spells for which the worker was receiving unemployment compensation payments. In order to link these workers to firms, we utilize FOLK period data on employment relationships. This gives us access to employment periods for the whole population. From this data, we take the employment period that is still ongoing at the end of a year and the three longest employment periods for all worker-year pairs. A furlough is linked to an employment spell when the starting day of the furlough coincides with the employment period. In the case of overlapping employment periods, we attach the

furlough to the employment period that is ongoing at the end of the year if possible. For other overlapping employment spells, we assign the furlough to the employment period with the longest duration. This process enables us to associate firms for nearly all furlough spells. Finally, we match the firm IDs to Financial Statement Statistics, which gives us annual balance sheet information, including employment, for nearly all Finnish firms.

We focus on the period 2013-2019 and restrict our attention to industries 10-63, 68-82 and 86-93 with NACE rev 2 codes.² That is, we do not consider the agricultural and mining sectors (0-9) nor industries that are mainly dominated by the public sector, such as education and public administration (84-85). We also omit finance and insurance activities (64-67), for which the data coverage on the Financial Statement Panel is somewhat weaker than for other industries. We restrict our sample to limited liability companies with more than one worker and a value added of over 10 000 in euros in 2014 currency.

We use full-time equivalent (FTE) employees to measure annual employment, job creation, job destruction and furloughs in firms. We only report JC, JD and furlough events that amount to at least 0.1% of the firm’s labor force. For reallocation measures, we consider relative changes in potential employment available to firms including furloughed workers. In practice, we calculate the change in (potential) employment between years t and $t-1$ (or the absolute value of employment change in the case of destruction) and divide it by the average (potential) employment in these years. To keep our furlough measure comparable with these job reallocation measures, we also divide the FTE measure of furloughed employees in year t by the average employment in years t and $t-1$. Thus, the values of our job creation/destruction and furlough measures vary between 0 and 2 for all firms. For the economy-wide aggregate measures, we use current average total employment between years t and $t-1$ as a scaling variable.

3.2 Descriptive patterns

Figure 1 depicts the aggregate annual job creation, job destruction and furlough rates measured for 2014-2019. There is a substantial difference in the level of furloughs compared to job creation and destruction: the fraction of furloughed workers hovers around 1% of employment, while job creation and destruction rates are always over 5%. The business cycle conditions are visible for all time series. GDP growth was slightly negative up to the first quarter of 2015 and positive thereafter. In 2016 and 2017, when GDP growth reached around 3%, job creation began to exceed destruction more markedly, and furlough use declined visibly.

Table 1 presents basic descriptive statistics for firms’ use of furloughs, job destruction, job creation, and the joint use of job destruction and furloughs. The reported moments are computed after controlling for industry and year effects, although the corresponding unconditional moments are very similar. The first three columns describe the marginal distributions of furloughs, job destruction, and job creation, while the last column focuses on firms that use job destruction and furloughs jointly in the same year. The first row shows the probability that a firm uses each adjustment margin in a given year. About 11% of firms use furloughs, while

²For a descriptive analysis of Finnish firms’ furlough use over a longer timespan, see Korpela (2024). Korpela documents, among other things, a very large increase in the use of furloughs during both the deep recession of 2009 and the recent Covid-19 crisis.

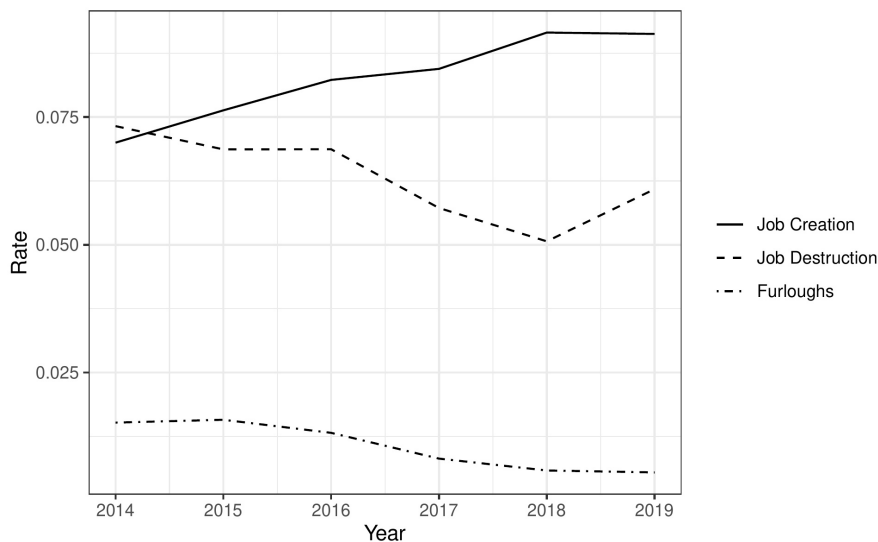


Figure 1: Aggregate reallocation and furloughs

Notes: job creation (destruction) is the total potential employment increase (decrease) in firms that increased (decreased) their employment, divided by the total average potential employment between years t and $t-1$. Furlough rate is the amount of furloughed workers in a year scaled with total average potential employment.

about 46% reduce employment and 47% increase employment. Thus, furloughs are much less common than job destruction or job creation. The last column shows that about 6% of firms use job destruction and furloughs jointly in a given year. Since about 11% of firms use furloughs, this means that a large share of furlough-using firms also reduce employment in the same year.

	Furlough	Job destruction	Job creation	Job destruction & furlough
Pr. to Use	0.114	0.465	0.469	0.061
Mean adj. (rel. to workforce)	0.072	0.193	0.191	0.267
Variance adj.	0.008	0.049	0.051	0.053

Table 1: Descriptive statistics on furloughs, job destruction, job creation, and joint job destruction–furlough adjustments after controlling for industry and year effects

The second row in Table 1 reports the mean relative size of an adjustment, conditional on the corresponding margin being used. Furloughs are substantially smaller than job destruction and job creation: the mean size of furloughs is about 7% of FTE employment, while job destruction and job creation are both about 19% of FTE employment. When job destruction and furloughs are used jointly, the average adjustment is larger, about 27% of FTE employment.

The variances of adjustment sizes are reported in the third row. The dispersion of furloughs is substantially smaller than the dispersion of job destruction and job creation, whose variances are quite similar. The variance of joint job destruction–furlough adjustments is also close to the variance of job destruction and job creation.

Figure 2 shows the histograms of relative labor adjustments. The furlough, job-destruction, and job-creation panels report the marginal distributions of each adjustment margin among

firms using that margin, regardless of whether they also adjust along other margins. The figure further corroborates that furloughs are typically small relative to job destruction and job creation. The additional panel focuses on the joint use of furloughs and job destruction, and shows that the largest adjustments often involve the use of both margins. Note also that the histograms of job creation and job destruction look quite similar.

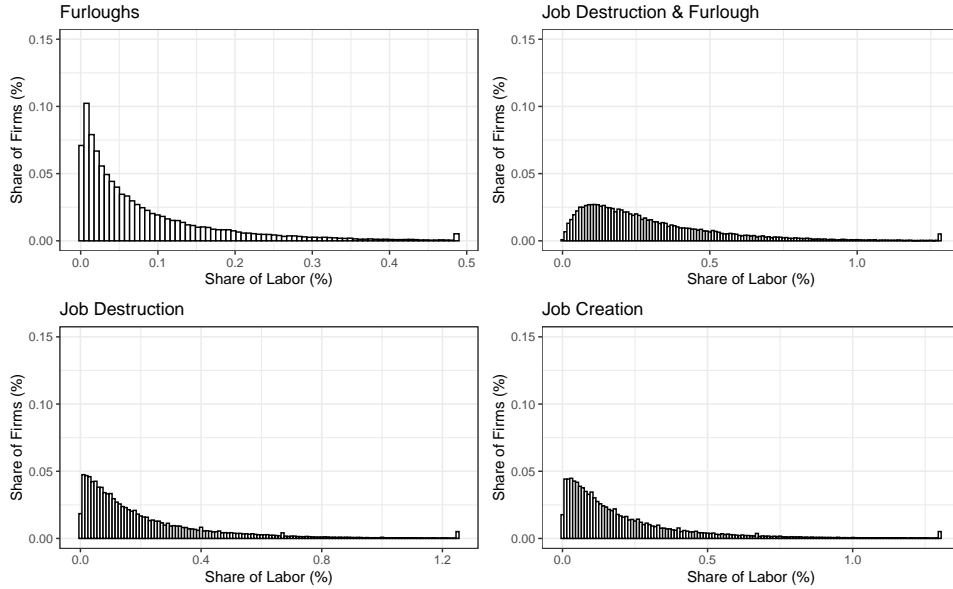


Figure 2: Distribution of relative adjustment sizes for furloughs, job destruction, job creation, and joint job destruction–furlough episodes

Figures 3 and 4 extend the exercise of Table 1 by showing how firm size affects the use and relative size of furloughs, job creation, and job destruction. In all cases, we control for industry and year fixed effects. Figure 3 shows that small firms are much less likely to use furloughs than larger firms: less than 10% of firms with fewer than 5 workers use furloughs, compared with over 30% of firms with more than 500 workers. The probability of using both furloughs and job destruction also increases with firm size, although it remains well below the overall probability of using furloughs. Job creation is likewise more common in larger firms, whereas the probability of job destruction varies much less with firm size.

Figure 4 shows the opposite pattern for the relative size of adjustments. Conditional on using a given margin, the relative size of furloughs, job destruction, and job creation all decline with firm size. The same pattern holds for the joint of the two margins. Thus, while larger firms are more likely to use furloughs, these furloughs typically account for a smaller share of their workforce.

4 Model

We explore the quantitative effects of furloughs with the help of a firm dynamic model in the spirit of Hopenhayn and Rogerson (1993), augmented with a labor market friction.

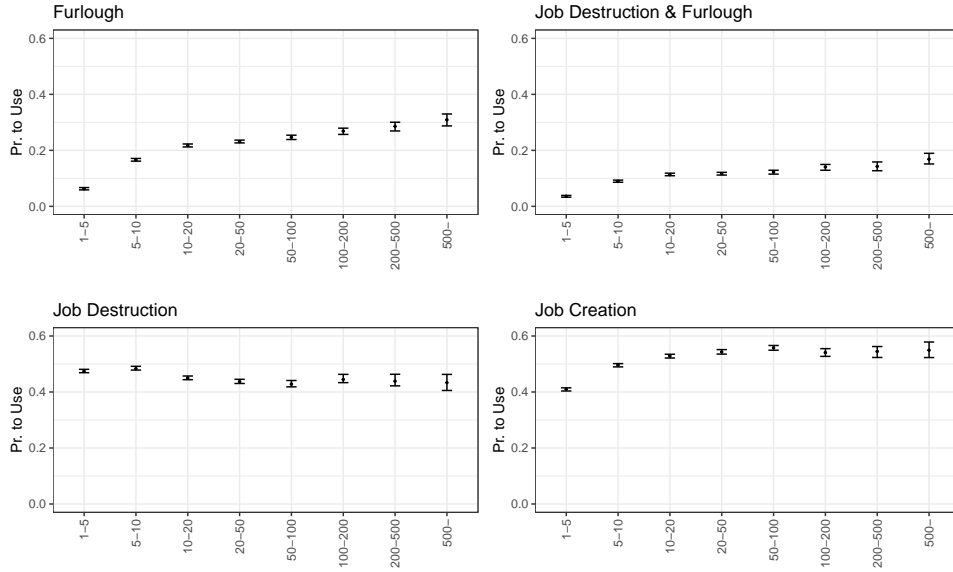


Figure 3: Fraction of firms using furloughs, job destruction, job creation, and joint job destruction–furlough adjustments by firm size

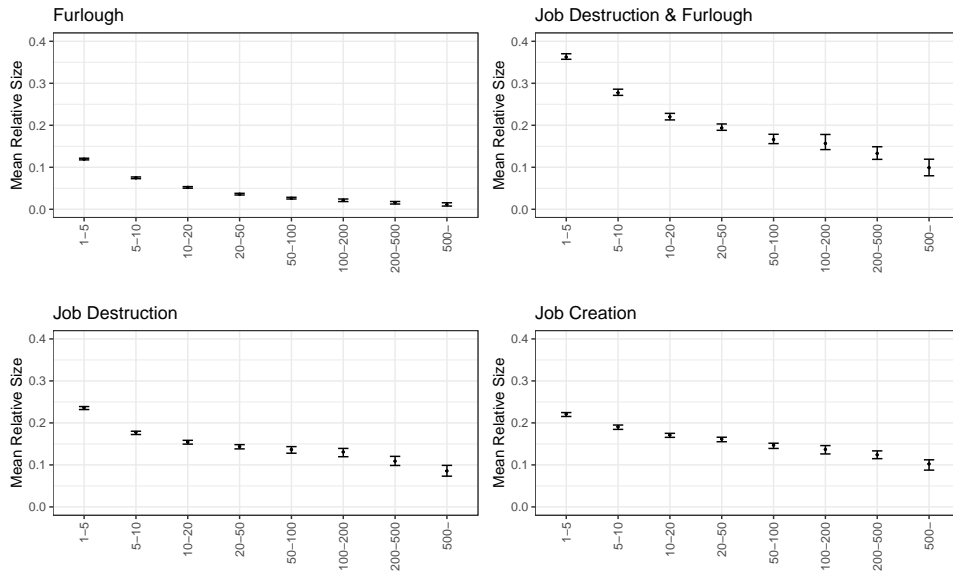


Figure 4: Relative adjustment size among firms using furloughs, job destruction, job creation, or joint job destruction–furlough adjustments by firm size

4.1 Environment

We consider a stationary equilibrium with heterogeneous firms and workers with varying labor market statuses.

Firms. There is an endogenous measure of heterogeneous firms, each producing a homogeneous good using a decreasing returns to scale production function in labor. Firm productivity is stochastic, which creates a need for labor reallocation between firms. However, firms face adjustment costs if they want to change their employment levels. We allow these costs to be

asymmetric, depending on whether a firm wants to increase or reduce its size. A firm seeking to reduce its workforce in the current period can either lay off or furlough some of its workers, both of which involve costs. The key difference is that furloughing allows firms to temporarily reduce labor input without incurring rehiring costs later. However, furloughed workers remain attached to the firm, so if the firm does not want them to work and receive wages in the next period, it must either furlough them again or lay them off, incurring the corresponding costs.

Workers. There is a unit mass of infinitely lived, risk-neutral workers who differ in their labor market status. At any point in time, each worker is either attached to a firm—meaning they have an ongoing job contract with it—or unemployed. For brevity, we refer to workers attached to a firm as *attached workers*. These workers may either be working in production or furloughed. The probabilities that an attached worker becomes unemployed, is furloughed, or works in production depend on the state of the firm they are attached to. In contrast, the probability that an unemployed worker finds a job and becomes attached to a firm depends only on their search effort.

Workers collectively own the firms and receive profit income Π . In addition to profits, workers in production earn the equilibrium wage w , while furloughed and unemployed workers receive unemployment benefits b , which are financed through a lump-sum tax, T , paid by all individuals. The flow utility is linear in consumption and disutility from search effort. Specifically, the flow utilities are $w + \Pi - T$ for workers in production, $b + \Pi - T$ for furloughed workers (who do not search), and $b + \Pi - T - \gamma s$ for unemployed workers who choose search intensity s , where $\gamma > 0$ governs the disutility from search.

Labor markets. In modeling labor markets and unemployment, we follow Alvarez and Veracierto (2001) and Buera et al. (2015). There is a centralized labor market from which firms can hire new workers with identical wage contracts. However, the entry of unemployed workers into this market is frictional. In line with Alvarez and Veracierto (2001), workers can affect their job-finding probability by choosing their search intensity. This probability is s^η , where $\eta > 0$.

Timing. At the beginning of a period, firms have a given number of attached workers determined by their decisions in the previous period, and they observe their new persistent and temporary productivity shocks. Workers, in turn, are either attached to a firm or unemployed. The period begins with the separation stage, where firms that want to reduce their number of attached workers lay off some of them. This is followed by the search stage, during which unemployed workers—both those unemployed at the beginning of the period and those just laid off—choose their search intensity. Search effort determines the probability of entering the competitive labor market.

In the hiring stage, unemployed workers who enter the labor market are randomly matched with firms that are hiring, i.e., firms that want to increase their number of attached workers. Unemployed workers who do not enter the labor market remain unemployed and start the next period in that state. In the production stage, firms decide whether to furlough some of their attached workers (if the option is available); the remaining attached workers participate in production. Wages and profits are then paid.

Finally, firms decide whether to continue operating with their chosen stock of attached

workers or exit before the next period. Workers who were either working for or furloughed by firms that remain in the market are attached to the same firm at the beginning of the next period. In contrast, workers attached to firms that exit are unemployed at the beginning of the next period.

4.2 Incumbent firm's problem

There is an endogenous mass of incumbent firms, denoted by Ω . Each firm produces a homogeneous good using the following production technology:

$$y = e^{z+\nu} l^\alpha, \quad (23)$$

where $0 < \alpha < 1$, l is the number of workers in production, z is the persistent component of firm-specific productivity, and ν is an i.i.d. transitory productivity shock. We assume that z follows an AR(1) process:

$$z' = \rho z + \varepsilon', \quad (24)$$

where $0 < \rho < 1$ and the innovation term ε is distributed according to $\varepsilon \sim N(0, \sigma_\varepsilon^2)$. The transitory shock is independently distributed over time and across firms, with $\nu \sim N(0, \sigma_\nu^2)$, and is independent of ε .

As described in the timing section, each firm begins the period by observing its persistent productivity component z , the current transitory shock ν , and the number (more precisely, the mass) of workers attached to it based on past decisions. We denote this number by n_- . If the firm wants to change the number of attached workers, it must pay both a fixed cost and a convex adjustment cost modeled with a quadratic function. These costs differ depending on the direction of adjustment: when increasing workforce size, the fixed and convex cost parameters are c_{ph} and c_{qh} , respectively; when decreasing workforce size, the corresponding parameters are c_{ps} and c_{qs} . This flexible formulation allows us to parsimoniously capture asymmetries between hiring and firing costs. We assume convex costs to reflect the notion that major expansions or reductions are likely to require costly reorganizations. Mass layoffs may also involve increased legal risks compared to smaller adjustments.

Furloughed workers do not participate in production and are not paid wages during the current period, but furloughing does not reduce the firm's stock of attached workers carried into the next period. Thus, if the firm wants to keep effective labor input below its inherited workforce in the following period as well, it must either furlough part of its attached workforce again or reduce the number of attached workers through layoffs, incurring the corresponding costs.

The furlough cost structure mirrors that of layoffs: a fixed cost c_{pf} and a convex component governed by parameter c_{qf} . In addition, firms that use furloughs and layoffs jointly pay an extra fixed cost c_{fj} . This cost captures the possibility that combining the two adjustment margins within the same period involves additional administrative, legal, or organizational costs. Firms also pay fixed operating costs c_o and decide at the end of the period whether to exit or continue.

All these adjustment costs, as well as the fixed operating cost, are resource costs: they do not generate revenue that could be redistributed or used to finance consumption. Since the

transitory productivity shock is i.i.d., it does not need to be included as a state variable. We therefore write the beginning-of-period (before the realization of the transitory shock) value function as $V(z, n_-)$. The firm observes also the realization of ν before choosing employment, furloughs, and exit; hence, the maximization is inside the expectation over ν . Denoting the decision variables, namely the number of current-period attached workers and furloughed workers, by n and f , respectively, the firm's problem can be summarized by the following Bellman equation:

$$\begin{aligned}
V(z, n_-) = E_\nu & \left[\max_{n \in [0, \infty), f \in [0, n]} e^{z+\nu} \underbrace{(n-f)^\alpha}_{\equiv l} - w(n-f) - c_o \right. \\
& - \mathbb{I}(f > 0) \left[c_{pf} + c_{qf} \left(\frac{f}{\bar{n}} \right)^2 \bar{n} \right] \\
& - \mathbb{I}(n > n_-) \left[c_{ph} + c_{qh} \left(\frac{n - n_-}{\bar{n}} \right)^2 \bar{n} \right] \\
& - \mathbb{I}(n < n_-) \left[c_{ps} + c_{qs} \left(\frac{n - n_-}{\bar{n}} \right)^2 \bar{n} \right] \\
& - \mathbb{I}(f > 0) \mathbb{I}(n < n_-) c_{fj} \\
& \left. + \frac{1}{1+r} \max \{ E_{\varepsilon'} V(z', n), -c_{ps} - 2c_{qs}n \} \right], \tag{25}
\end{aligned}$$

where $\bar{n} = \frac{n+n_-}{2}$. The expectation E_ν is taken over the current transitory productivity shock, while $E_{\varepsilon'}$ is taken over the innovation to the persistent productivity component. The last max-operator refers to the exit decision. If the firm continues, it enters the next period with n attached workers and continuation value $E_{\varepsilon'} V(z', n)$. If it exits, it instead sets its next-period attached workforce to zero and pays the corresponding downsizing cost, $c_{ps} + 2c_{qs}n$. The solution to this problem gives the optimal decision rules for attached workers $n(z, \nu, n_-)$, furloughs $f(z, \nu, n_-)$, and exit $x(z, \nu, n_-)$, equal to 1 if the firm exits and 0 otherwise.

4.3 Entrants

There is a continuum of ex ante identical potential entrants. If they want to start producing in the next period, they have to pay an entry cost, c_e . They start the next period as an incumbent firm with one attached worker $n_- = 1$ and productivity z that is drawn from the unconditional stationary distribution of the AR(1) process with associated density function given by $G(\cdot)$.

We focus on a stationary equilibrium with positive entry, in which the expected value of entry equals the entry cost:

$$\int V(z, 1) G(dz) = c_e. \tag{26}$$

4.4 Worker's problem

The only active decision on the worker side is the search effort of unemployed workers. However, to formulate this problem, we first need to characterize the value of entering employment. This value depends on the state of the firm with which the worker is matched, since the firm's state

determines the worker's subsequent layoff and furlough risks. We therefore begin by defining the values of workers attached to different firms and in different within-period situations.

At the beginning of each period, workers are either attached to a firm with persistent state z and inherited workforce n_- , or unemployed. We define the beginning-of-period value of an attached worker at the point at which z and n_- are known but before the current transitory productivity shock ν is realized. The shock is realized immediately thereafter and observed by the firm before it makes its employment, furlough, and exit decisions. Because ν is i.i.d. over time, past realizations of this shock contain no useful information about future payoffs and need not be included as state variables. We therefore denote the beginning-of-period value of an attached worker by $W(z, n_-)$.

For attached workers, both the risk of unemployment and the risk of being furloughed depend on the firm's persistent productivity z , inherited workforce n_- , and current transitory shock ν . We assume that if a firm reduces its workforce, workers to be laid off are chosen randomly from all attached workers. As a result, all workers attached to a firm with state (z, n_-) have the same beginning-of-period value $W(z, n_-)$, before the transitory shock and the firm's current decisions are realized.

After the firm has made its current-period decisions, however, workers who remain attached may be in different situations: they may either work in production or be furloughed. We therefore define conditional value functions for these two within-period outcomes, together with the layoff and furlough probabilities implied by the firm's decisions.

We denote these conditional value functions by $\tilde{W}_E(z, \nu, n_-)$ for a worker who works in production and $\tilde{W}_F(z, \nu, n_-)$ for a worker who is furloughed. They represent the value of an attached worker once the current separation and furlough outcomes have been resolved. Formally, the conditional value functions \tilde{W}_E and \tilde{W}_F , defined in the production stage after the firm's decisions, are given by:

$$\begin{aligned} \tilde{W}_E(z, \nu, n_-) = & w + \Pi - T + \beta \left[x(z, \nu, n_-) W_U \right. \\ & \left. + (1 - x(z, \nu, n_-)) E_{z'} W(z', n(z, \nu, n_-)) \right], \end{aligned} \quad (27)$$

$$\begin{aligned} \tilde{W}_F(z, \nu, n_-) = & b + \Pi - T + \beta \left[x(z, \nu, n_-) W_U \right. \\ & \left. + (1 - x(z, \nu, n_-)) E_{z'} W(z', n(z, \nu, n_-)) \right]. \end{aligned} \quad (28)$$

Here W_U denotes the value of being unemployed in the search stage. The first terms on the right-hand sides give the flow utility from wage or unemployment benefit and profit income, net of tax. The continuation values depend on the firm's decisions today, including whether it exits, and on its future persistent productivity level. Conditional on continuation, the number of attached workers carried into the next period is deterministic given (z, ν, n_-) , because it is directly determined by the firm's current workforce decision $n(z, \nu, n_-)$. The only remaining uncertainty in the continuation value is the future persistent productivity level z' .

Given (z, ν, n_-) and the firm's employment decision, the layoff probability is

$$p_U(z, \nu, n_-) = \mathbb{I}(n(z, \nu, n_-) < n_-) \frac{n_- - n(z, \nu, n_-)}{n_-}.$$

For states with $n(z, \nu, n_-) > 0$, the probability of being furloughed, conditional on remaining attached, is

$$p_F(z, \nu, n_-) = \frac{f(z, \nu, n_-)}{n(z, \nu, n_-)}.$$

When $n(z, \nu, n_-) = 0$, there are no remaining attached workers to furlough, and so $p_F(z, \nu, n_-) = 0$ for those states.

The beginning-of-period value for an attached worker is then obtained by integrating over the transitory shock³:

$$W(z, n_-) = E_\nu \left[(1 - p_U(z, \nu, n_-))(1 - p_F(z, \nu, n_-))\tilde{W}_E(z, \nu, n_-) + (1 - p_U(z, \nu, n_-))p_F(z, \nu, n_-)\tilde{W}_F(z, \nu, n_-) + p_U(z, \nu, n_-)W_U \right]. \quad (29)$$

Unemployed workers choose search effort s to maximize expected utility. With probability s^η , an unemployed worker enters the competitive labor market and is matched with a hiring firm, with matching probabilities proportional to firms' job creation. Because hiring takes place after the separation stage, newly hired workers are not subject to current-period layoff risk. They may, however, be furloughed in the production stage. Since firms' hiring and furlough decisions depend on the transitory shock ν , the expected value of entering the labor market is obtained by averaging over all job-creating firms, including entrants. The relevant distribution for incumbent firms is the beginning-of-period stationary distribution over persistent productivity and inherited workforce, denoted by $\Psi(dz, dn_-)$. We define this distribution formally in the next subsection. Letting JC denote aggregate job creation, also defined in the next subsection, and M_e the mass of entrants, this value is given by:

$$EW_E^{\text{entry}} = \frac{1}{JC} \left[\int E_\nu \left\{ \left[(1 - p_F(z, \nu, n_-))\tilde{W}_E(z, \nu, n_-) + p_F(z, \nu, n_-)\tilde{W}_F(z, \nu, n_-) \right] \times \mathbb{I}(n(z, \nu, n_-) > n_-) (n(z, \nu, n_-) - n_-) \right\} \Psi(dz, dn_-) + M_e \int E_\nu \left\{ \left[(1 - p_F(z, \nu, 1))\tilde{W}_E(z, \nu, 1) + p_F(z, \nu, 1)\tilde{W}_F(z, \nu, 1) \right] \times \min\{n(z, \nu, 1), 1\} \right\} G(dz) \right]. \quad (30)$$

The object EW_E^{entry} is the expected value of being matched with a hiring firm and includes both the current-period payoff and the continuation value associated with that firm. The first term averages this value over job creation by firms in the beginning-of-period distribution Ψ .

³We could define \tilde{W}_E and \tilde{W}_F without referring to W by replacing the continuation value $W(z', n(z, \nu, n_-))$ in (27) and (28) with the right-hand side of (29), evaluated at $(z', n(z, \nu, n_-))$. This substitution would introduce an additional expectation over next period's transitory shock ν' .

The second term adds the corresponding value for job creation by entrants. Because entrants are represented as firms with inherited workforce $n_- = 1$, the first term already counts any entrant job creation above one worker; the term $\min\{n(z, \nu, 1), 1\}$ adds entrant job creation up to the first worker.

Finally, we can write the Bellman equation for an unemployed worker, which characterizes the only optimization problem on the worker side:

$$W_U = \max_{s \in [0,1]} \left\{ -\gamma s + s^\eta E W_E^{\text{entry}} + (1 - s^\eta)(b + \Pi - T + \beta W_U) \right\}. \quad (31)$$

The first term on the right-hand side is the flow utility cost of search. With probability s^η the unemployed worker enters the competitive market and receives the expected value $E W_E^{\text{entry}}$. If the worker does not enter, their flow utility is determined by the unemployment benefit and profits, net of tax, and they remain unemployed next period.

4.5 Labor markets

Firms and workers meet in a centralized labor market where all workers are paid the same equilibrium wage. However, as stated earlier, not all unemployed workers can access this market. Given search effort s , only a fraction s^η of those who were unemployed at the beginning of the period or became unemployed during the separation stage access the labor market in the current period.

Taken together, the amount of workers entering the labor market, M , is given by

$$M = s^\eta(U_- + J D^s + J D_-^e),$$

where U_- is the amount of unemployed workers in the previous period production stage, $J D^s$ is job destruction in the current separation stage and $J D_-^e$ is job destruction through firms' exits at the end of the previous period. Since we focus on a stationary equilibrium, we can write the previous equation in a more compact form with the help of aggregate job destruction:

$$M = s^\eta(U + J D). \quad (32)$$

Aggregate job destruction is the sum of job destructions in the separation and exit stages:

$$\begin{aligned} J D = & \int E_\nu \left[\mathbb{I}(n(z, \nu, n_-) < n_-) (n_- - n(z, \nu, n_-)) \right. \\ & \left. + \mathbb{I}(x(z, \nu, n_-) = 1) n(z, \nu, n_-) \right] \Psi(dz, dn_-) \\ & - M_e \int E_\nu \left[1 - \min\{n(z, \nu, 1), 1\} \right] G(dz). \end{aligned} \quad (33)$$

where the first indicator function takes the value of one if a firm reduces its size in the separation stage and the second indicator function does the same if a firm decides to exit at the end of the period. $\Psi(dz, dn_-)$ gives the measure of firms over different productivity and employment levels at the beginning of a period, while M_e gives the measure of new firms. New firms behave as if they had one worker in the previous period even though they did not produce anything.

The last component makes sure that we do not count the actions of these firms as part of job destruction.

Aggregate job creation was needed in defining the value of unemployment. It can be defined as

$$\begin{aligned}
JC = & \int E_\nu \left[\mathbb{I}(n(z, \nu, n_-) > n_-) (n(z, \nu, n_-) - n_-) \right] \Psi(dz, dn_-) \\
& + M_e \int E_\nu \left[\min\{n(z, \nu, 1), 1\} \right] G(dz).
\end{aligned} \tag{34}$$

The second line counts the job creation of new firms up to one worker (the rest of new firms' job creation is counted in the first term).

Finally, we can define the shares of furloughed and unemployed workers (recall that we have a unit mass of workers). The furlough rate in the economy is given by

$$F = \int E_\nu [f(z, \nu, n_-)] \Psi(dz, dn_-), \tag{35}$$

and the steady-state unemployment rate is

$$U = \frac{1 - s^\eta}{s^\eta} JD. \tag{36}$$

The remaining workers are in production. We refer to this share, $1 - U - F$, as the employment rate.

4.6 Equilibrium

A stationary equilibrium consists of employment, $n(z, \nu, n_-)$, furlough, $f(z, \nu, n_-)$, and exit, $x(z, \nu, n_-)$, policies; unemployed workers' search intensity s ; a wage rate w ; a mass of entrants M_e ; unemployment, furlough, job creation, and destruction rates; a lump-sum tax T ; and a stationary distribution of firms, $\Psi(dz, dn_-)$, such that:

1. given the wage rate, the policy rules $n(z, \nu, n_-)$, $f(z, \nu, n_-)$ and $x(z, \nu, n_-)$ solve the firm problem
2. given the wage rate, firms' behavior, job creation, and the stationary distribution of firms, s solves the problem of the unemployed worker
3. the stationary distribution of firms is given by:

$$\begin{aligned}
\Psi(Z', N) = & \int E_\nu \left[\mathbb{I}(n(z, \nu, n_-) \in N) Q(z, Z') (1 - x(z, \nu, n_-)) \right] \Psi(dz, dn_-) \\
& + M_e \mathbb{I}(1 \in N) \int_{z' \in Z'} G(dz'),
\end{aligned} \tag{37}$$

where $Q(z, Z')$ is the transition function giving the probability of moving from z to Z' , and the last term gives the measure of entrants with $z' \in Z'$ given that $1 \in N$

4. unemployment, U , is determined by (36), job destruction, JD , and creation, JC , are

pinned down by (33) and (34), respectively, and the aggregate measure of furloughed workers, F , is in line with (35)

5. the labor market clears:

$$1 = \int E_\nu [n(z, \nu, n_-)] \Psi(dz, dn_-) + U \quad (38)$$

6. The government's spending on unemployment benefits is financed by its tax revenue

$$T = b(U + F). \quad (39)$$

5 Calibration

We set the model period to one year. We also set the real interest rate r to 5% and the returns to scale parameter α to 0.66.

The remaining parameters are calibrated internally to match several empirical targets in the model's stationary equilibrium. These targets are shown in Table 2. They include the size distribution of firms, the autocorrelation of employment at the firm level, firm entry rate, and the frequencies and average sizes of hires, furloughs, and layoffs relative to firms' labor force, including the probabilities of using layoffs and furloughs separately or jointly and the average size of joint adjustments. These moments help ensure that the model captures not only the use of each margin in isolation but also their empirical interaction. In addition, we target an unemployment benefit replacement rate of 60% and an empirical estimate of the search elasticity of unemployed workers and the unemployment rate. Together, these targets discipline firm dynamics, the role of furloughs in overall labor adjustment, and the job-search friction that generates unemployment in the model.

All calibration targets, except for the search elasticity and the unemployment rate, are constructed from the same micro-data used in Section 3. The firm size distribution refers to the share of firms in different labor input bins, based on firms with at least one employee. In the model, we exclude entrants (i.e., firms in their first period) from this distribution.

The targeted frequencies and average sizes of hires, layoffs and furloughs, including the probability of using furloughs and layoffs jointly and the average relative size of adjustments, are taken directly from Table 1. The targeted search elasticity is based on Uusitalo and Verho (2010). Using a change in the Finnish unemployment benefit system, they estimate that a 15% increase in the replacement rate extended the average unemployment spell by about 12%. The targeted unemployment rate is the average unemployment rate for 2014–2019, as reported by Statistics Finland.

Table 3 lists the parameter values for our preferred calibration. The last column links each parameter value to an empirical target. For the internally calibrated parameters, a change in parameter value typically affects multiple target moments. The table highlights the target that is likely to be most sensitive to changes in that parameter.

The model is block recursive in the sense that workers' behavior does not affect the firms. This means that given the rest of the parametrization, we can adjust the disutility of search, γ ,

Target	Data	Model
Size distribution: 1-5	0.57	0.56
Size distribution: 5-10	0.19	0.18
Size distribution: 10-20	0.12	0.13
Size distribution: 20-50	0.08	0.09
Size distribution: 50-	0.05	0.04
Entry/exit rate	0.10	0.06
Aggregate unemployment	0.08	0.08
Average size of layoff	0.19	0.23
Probability to use layoff	0.47	0.49
Average size of furlough	0.07	0.07
Probability to use furlough	0.11	0.12
Autocorrelation of employment	0.97	0.99
Average size of hire	0.19	0.15
Probability to use hiring	0.47	0.42
Probability to use layoff and furlough jointly	0.06	0.07
Average size of joint layoff and furlough	0.27	0.29
Replacement rate of the unemployment benefit	0.60	0.60
Duration response to a 15% replacement rate increase	1.12	1.12

Table 2: Targeted moments and model fit

Parameter	Value	Explanation	Rationale
<i>External:</i>			
α	0.660	Returns to scale	convention
r	0.050	Interest rate	convention
<i>Internal:</i>			
σ_ε	0.159	Std of productivity shock	size distribution
ρ	0.975	Autocorrelation of productivity	autocorrelation of employment
c_o	1.504	Fixed operating costs	exit/entry rate
c_e	9.673	Entry costs	size distribution
c_{ph}	0.001	Fixed hiring cost	pr. of hiring
c_{qh}	3.439	Convex hiring cost	relative size of hiring
c_{ps}	0.001	Fixed layoff cost	pr. of layoff
c_{qs}	2.065	Convex layoff cost	relative size of layoff
c_{pf}	0.001	Fixed furlough cost	pr. of furlough
c_{qf}	1.586	Convex furlough cost	relative size of furlough
b	0.490	Replacement rate	replacement rate from OECD
η	0.309	Search elasticity	Uusitalo & Verho (2010)
γ	2.473	Search disutility	aggregate unemployment
σ_ν	0.126	Std of iid productivity shock	joint layoff-furlough targets
c_{fj}	0.074	Fixed cost of joint layoff-furlough use	joint usage

Table 3: Parameter values

and the elasticity of job-finding probability, η , to match the observed unemployment rate and the estimated search elasticity exactly.

Fixed adjustment costs (i.e., fixed costs for layoffs, hiring, and furloughs) primarily affect the likelihood that firms will utilize the corresponding margin of adjustment. Similarly, convex adjustment costs have the greatest impact on the relative average size of the associated adjustment margin. For instance, increasing fixed layoff costs reduces the probability that firms resort to layoffs, while increasing convex layoff costs reduces the relative (average) size of layoffs. Both changes also increase firms' reliance on furloughs. In addition, the fixed cost of joint layoff-furlough use, c_{fj} , helps discipline the extent to which firms use layoffs and furloughs in the same period rather than relying on only one of the two margins. The standard deviation of the i.i.d. productivity shock, σ_ν , is also important for matching the layoff and furlough moments. A larger σ_ν increases the scope for furlough adjustments.

The calibrated fixed cost of layoffs is close to zero. This likely reflects the fact that firms can often slightly reduce their workforce at low cost by letting temporary contracts expire or by not replacing workers who leave voluntarily. In the model, we do not distinguish between job destruction due to formal layoffs and job destruction resulting from such low-cost exits. The calibration therefore assigns a low fixed layoff cost to roughly match the observed frequency and size of workforce reductions. A low fixed cost of layoffs reduces the need for a high fixed cost of furloughs to prevent excessive use of furloughs relative to layoffs.

Higher fixed operating costs directly increase the exit rate of firms, which in stationary equilibrium also increases the entry rate and shifts the size distribution toward larger firms. Entry costs significantly affect the size distribution, as higher entry barriers reduce competition and increase prices, enabling firms to grow larger. While fixed and entry costs have qualitatively similar effects on the size distribution, they have opposing effects on the entry rate.

Increasing the variance of innovations in the AR(1) productivity process shifts the firm size distribution toward the tails, creating a greater need for both furloughs and layoffs. Higher persistence in productivity influences the size distribution in a manner similar to an increase in fixed costs, while also altering all margins of adjustment. However, it is the only parameter that substantially affects the persistence of employment, making it the most critical parameter for this target.

Table 2 above also compares the targeted moments in the data and the model. The largest relative discrepancy between the model and the data remains in the entry (and exit) rate, which is 10% in the data and 6% in the model. Matching this target more closely without sacrificing other targets may require a more detailed consideration of how the size and growth rate of very young firms are determined. The model also understates the average size and frequency of hires somewhat and slightly overstates the average size of layoffs. Overall, however, the fit is fairly close. In particular, the combination of fixed and convex costs for hiring, layoffs, and furloughs, together with the fixed cost of joint layoff-furlough use and the temporary productivity shock, provides enough flexibility to match not only the main adjustment margins but also the extent to which layoffs and furloughs are used jointly.

Table 4 illustrates the model's ability to match non-targeted moments, including the average share of furloughed workers and size-related patterns in the use of hiring, layoffs, furloughs, and

Moment	Data	Model
Furloughed, %	0.78	1.11
Leave After Furlough %	10.0	13.1

Pr. to Use	Hiring		Layoffs		Furloughs		Joint Layoff-Furlough	
Size	Data	Model	Data	Model	Data	Model	Data	Model
1-5	0.41	0.38	0.47	0.52	0.06	0.05	0.04	0.01
5-10	0.50	0.47	0.48	0.44	0.17	0.15	0.09	0.08
10-20	0.53	0.48	0.45	0.44	0.22	0.21	0.11	0.15
20-50	0.54	0.49	0.44	0.43	0.23	0.26	0.12	0.20
50-	0.55	0.55	0.43	0.40	0.26	0.23	0.13	0.20

Mean Size of	Hires		Layoffs		Furloughs		Joint Layoff-Furlough	
Size	Data	Model	Data	Model	Data	Model	Data	Model
1-5	0.22	0.16	0.24	0.31	0.12	0.05	0.36	0.47
5-10	0.19	0.14	0.18	0.13	0.07	0.08	0.28	0.35
10-20	0.17	0.13	0.15	0.12	0.05	0.08	0.22	0.28
20-50	0.16	0.12	0.14	0.12	0.04	0.07	0.19	0.24
50-	0.14	0.09	0.13	0.10	0.02	0.05	0.15	0.19

Table 4: External validity

their joint use. The table reports both the probability of using each adjustment margin and the average size of adjustments across firm size groups.

The model somewhat overstates the aggregate furlough share, at 1.11% compared with 0.78% in the data. This discrepancy stems from the fact that the calibration targets the frequency and average size of furlough events, rather than the aggregate share of furloughed workers. The model matches reasonably well the share of furloughed workers who do not return to the same employer: in the table, "Leave After Furlough" refers to furloughed workers who are not recalled by the firm that furloughed them. As in the data, this share is small, implying that most furloughed workers return to their previous employer.

At the same time, the model reproduces the relationship between firm size and the use of different adjustment margins reasonably well. While there are some discrepancies, especially for small firms and in the joint use of layoffs and furloughs, the model seems to capture the broad patterns in the probability of using hiring, layoffs, furloughs, and joint layoff-furlough adjustments across firm size groups, as well as the decline in relative adjustment sizes with firm size.

6 Layoffs: employment vs. productivity

Before evaluating whether the furlough option is socially beneficial, it is useful to highlight the trade-off between productivity and employment that arises from layoffs in the model. To this

end, we introduce a linear tax on layoffs, which firms pay in addition to the labor adjustment costs specified in the baseline calibration. The tax revenues are redistributed to all workers as lump-sum transfers. Our welfare metric is aggregate consumption net of the search costs incurred by unemployed workers, consistent with the model’s linear utility specification.

Table 5 illustrates how the stationary equilibrium changes as the layoff tax increases, with the tax expressed as a multiple of the monthly wage (wage divided by 12) per laid-off worker, and some of the measures normalized to 100 in the baseline economy without a layoff tax. Employment refers to workers in production, that is, attached workers net of furloughed workers.

A higher layoff tax reduces firm profits and labor demand at a given wage, so the equilibrium wage must fall to balance labor demand and supply in general equilibrium via firm entry. With a layoff tax equivalent to six months wages, the wage rate declines by about 2.7%.⁴

More importantly, restricting layoffs affects employment and productivity very differently. On the one hand, limiting layoffs hampers productivity-enhancing worker reallocation across firms. This is reflected in a decrease in aggregate labor productivity (‘Output/employed’), an increase in the variance of log marginal productivity, and a reduction in turnover, entry, and exit rates as the tax rate rises. The increase in the mean size of firms, measured by attached workers, also reflects this. On the other hand, it increases employment, since laid-off workers do not immediately find new jobs—a margin that firms do not internalize. Although a higher layoff tax also increases the use of furloughs somewhat, this effect is too small to offset the reduction in layoffs, so the employment rate still rises. With a layoff tax equal to six months wages, the employment rate is about 0.8 percentage points higher than in the baseline without a layoff tax. (In Table 5, and similar tables below, both the employment and unemployment rates are calculated excluding furloughed workers from the numerator.) The job-finding probability declines slightly due to reduced search effort among unemployed workers. This occurs because the value of the unemployment benefit, which is held fixed, increases relative to the wage, reducing the incentive to search.

The positive employment effect of a layoff tax is not strong enough to offset the associated decline in productivity. Output and consumption both fall monotonically with the layoff tax. Welfare also declines monotonically, although somewhat less than consumption due to the reduced search effort by the unemployed.

In our model, it is therefore not optimal to reduce layoffs by imposing a positive layoff tax. In this respect, our results differ from those of Alvarez and Veracierto (2001), who find in a model with similar frictional unemployment that a moderate layoff tax increases welfare. The key issue behind this difference appears to be the level of underlying labor adjustment costs. Figure 5 illustrates this by showing how aggregate consumption varies with layoff taxes and subsidies under different assumptions about resource adjustment costs. Under our baseline calibration, welfare is maximized at a small layoff subsidy. However, when we remove the underlying resource costs associated with layoffs, the welfare-maximizing policy switches to a layoff tax equal to about three months’ wages, broadly in line with Alvarez and Veracierto (2001), who do not include resource costs of layoffs in addition to the layoff tax. The corresponding welfare

⁴We define the layoff tax, and the furlough tax in the next section, relative to the wage rate in the baseline economy without either tax. Since the equilibrium wage varies across cases, the layoff tax in the last column of Table 5 is not exactly six months’ wage in the new equilibrium.

effects (not shown) are very similar. In this comparison, all other parameters are kept at their baseline values, except that in the economy without layoff resource costs the unemployment benefit b is adjusted to preserve the same replacement rate without a layoff tax as in the baseline calibration.

Intuitively, a layoff tax always weakens productivity-enhancing worker reallocation. When underlying adjustment costs are already high, reallocation is limited to begin with, and the marginal productivity cost of discouraging layoffs becomes relatively more important. As a result, the productivity effect is more likely to dominate the employment effect.

Variable	Unit	BM	1 month	3 months	6 months
Wage	relative	100.00	99.52	98.60	97.29
Output	relative	100.00	99.76	99.27	98.43
Output/employed	relative	100.00	99.59	98.79	97.59
Consumption	relative	100.00	99.94	99.77	99.37
Variance of log(MPL)	relative	100.00	101.22	103.65	107.58
Employed	percent	90.55	90.71	90.99	91.34
Unemployed (excl. furloughed)	percent	8.33	8.16	7.83	7.40
Furloughed	percent	1.11	1.13	1.18	1.27
Turnover	percent	11.17	10.85	10.27	9.51
Entry and exit rate	percent	6.01	5.95	5.85	5.68
Job-finding prob	percent	38.66	38.55	38.32	37.98
Welfare	relative	100.00	99.97	99.86	99.53
Mean size (attached workers)	relative	100.00	101.49	104.32	108.91

Table 5: Equilibrium effects of layoff taxes equal to 1, 3, or 6 months' wages. BM denotes the baseline economy without a layoff tax.

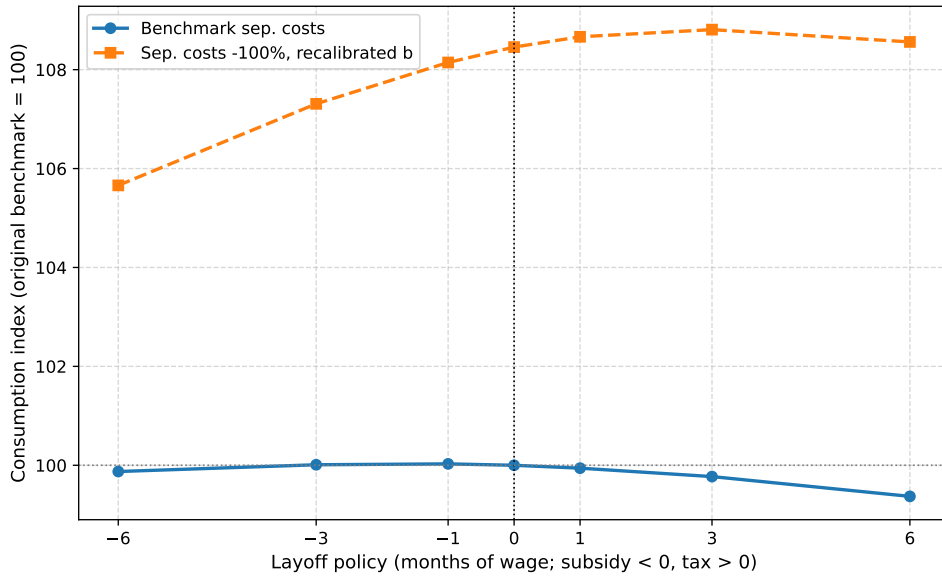


Figure 5: Aggregate consumption with different layoff taxes and subsidies: baseline calibration vs. no layoff resource costs.

7 Aggregate effects of the furlough option

In this section, we present our main results. Our primary focus is on assessing whether the furlough option is socially beneficial. We also aim to identify the factors and mechanisms that shape its impact. To this end, we introduce a linear furlough tax, similar to the layoff tax discussed in the previous section, and compare the equilibrium under different tax rates, including rates high enough to effectively eliminate the use of furloughs altogether. Again, tax revenues are redistributed to workers in a lump-sum fashion. Apart from the tax, the model aligns with the baseline calibration described in Section 5. In particular, firms continue to incur the same resource costs associated with workforce adjustments.

Table 6 summarizes how taxing furloughs affect the stationary equilibrium. The option to furlough is valuable from the perspective of an individual firm. For a given wage level, taxing furloughs reduces firms' expected profits and labor demand, putting downward pressure on the equilibrium wage. As a result, the equilibrium wage rate declines. However, these wage reductions are very small, suggesting that the furlough option is not particularly valuable to firms on average. This conclusion is also in line with the finding that a furlough tax equal to just one month's wage reduces the share of furloughed workers by over 50%.

Taxing furloughs decreases output per employed worker, increases the variance of the log marginal productivity of labor, and increases employment. In these respects, taxing furloughs has qualitatively similar effects to taxing layoffs. However, the welfare implications differ sharply. As shown in the previous section, the employment gains from discouraging layoffs are not large enough to offset the associated productivity losses in the baseline calibration, so welfare is maximized at a small layoff subsidy rather than a positive layoff tax. By contrast, restricting furloughs increases welfare, and the welfare-maximizing furlough tax is high enough to eliminate furloughs altogether.

A central reason for this result is that the furlough option reduces employment, or hours worked, almost one-for-one. (Recall that employment refers to workers in production.) The potential benefit of furloughs highlighted by the stylized model is that they can prevent workers from entering unemployment after adverse temporary shocks. In the calibrated economy, however, this channel is quantitatively weak. When the furlough tax is increased from zero to a level that eliminates the use of furloughs altogether, the share of furloughed workers falls by 1.11 percentage points, whereas the unemployment rate excluding furloughed workers rises by only 0.05 percentage points. Thus, eliminating furloughs mainly moves workers from furlough into production rather than into unemployment. Put differently, the furlough option mainly leads firms to keep workers attached but out of production, rather than preventing unemployment spells. This makes the unemployment channel highlighted by the stylized model quantitatively weak in the calibrated economy.

This small unemployment response reflects the fact that, in the model economy, furloughs are only very imperfect substitutes for layoffs. Most aggregate job destruction is driven by persistent productivity shocks, which call for persistent workforce reductions. Furloughs are not a useful way for firms to respond to such shocks, since repeated furloughs would become costly. The margin where furloughs are most relevant is instead the response to adverse transitory shocks. In these states, the firms' policy functions show that the furlough option often reduces

layoffs. However, even in those cases, firms often use furloughs together with layoffs. Moreover, transitory shocks account for only a limited share of aggregate job destruction. For these reasons, the furlough option reduces layoffs only modestly in aggregate.

Moreover, even when furloughs do replace layoffs, the associated gains are limited because the calibrated labor market friction is not very severe. Laid-off workers are re-employed relatively quickly, so avoiding an unemployment spell is less valuable than it would be in an economy with longer unemployment durations.

The quantitative model also contains an additional force that weakens the unemployment channel: the furlough option lowers the search effort of unemployed workers. The possibility of becoming furloughed reduces the value of being attached to a firm, and therefore weakens the incentive to search. This works to increase unemployment, offsetting part of the layoff-substitution effect of furloughs. In the model, this mechanism is reflected in the job-finding probability reported in Table 6: when the furlough option is effectively eliminated, the job-finding probability rises from 38.66% to 38.76%. Holding fixed the inflow into unemployment, the increase in the job-finding probability lowers the unemployment rate by about 0.04 percentage points relative to the baseline economy without a furlough tax.⁵

The furlough option does raise output per employed worker. However, this effect is not large enough to compensate for the decline in employment in production that it induces. First, furloughs contribute little to productivity-enhancing reallocation because furloughed workers usually return to the same employer rather than moving to expanding firms. This is reflected in the fact that taxing furloughs has virtually no effect on worker turnover or firm entry and exit. Second, as in the stylized model, the furlough option increases average firm size measured by attached workers, implying also a smaller mass of firms. This reflects firms' incentive to carry larger workforces when they can temporarily remove some workers from production and from the wage bill after adverse shocks. Together, these mechanisms help explain why the increase in output per employed worker is modest relative to the employment loss.

Overall, the furlough option reduces employment in production and increases average firm size measured by attached workers, while raising output per employed worker only modestly. This explains why eliminating the furlough option raises output, consumption, and welfare in the calibrated model. The contrast with layoffs is instructive. Both furloughs and layoffs reduce employment in production, but layoffs generate substantial productivity gains by reallocating workers toward more productive firms and do not increase average firm size. Furloughs, by contrast, mostly keep workers attached to the same firms, increase average firm size, and therefore provide little support for productivity-enhancing reallocation.

One might expect the added flexibility provided by the furlough option to be socially more beneficial, or at least less harmful, in a context where layoffs are heavily restricted. To explore this possibility, we compare the model equilibrium with and without the furlough option while also varying the layoff tax.

Table 7 reports results for layoff tax rates equivalent to 1 and 6 months' wages. The layoff tax has little effect on the welfare gain from eliminating the furlough option. If anything, the

⁵To get this number, we use the steady-state relation $U = (1 - q)JD/q$, where q is the job-finding probability. The baseline values $U = 8.33$ and $q = 0.3866$ imply $JD \approx 5.25$. Raising q to 0.3876 then implies $U \approx 8.29$, or about 0.04 percentage points less than in the baseline.

Variable	Unit	BM	1 month	3 months	6 months
Wage	relative	100.00	99.95	99.93	99.93
Output	relative	100.00	100.57	100.91	100.94
Output/employed	relative	100.00	99.91	99.79	99.77
Consumption	relative	100.00	100.64	101.03	101.07
Variance of log(MPL)	relative	100.00	100.69	101.41	101.50
Employed	percent	90.55	91.15	91.57	91.62
Unemployed (excl. furloughed)	percent	8.33	8.37	8.38	8.38
Furloughed	percent	1.11	0.48	0.05	0.00
Turnover	percent	11.17	11.16	11.15	11.15
Entry and exit rate	percent	6.01	6.00	6.00	6.00
Job-finding prob	percent	38.66	38.71	38.75	38.76
Welfare	relative	100.00	100.64	101.02	101.06
Mean size (attached workers)	relative	100.00	99.41	99.03	99.01

Table 6: Equilibrium effects of furlough taxes equal to 1, 3, or 6 months' wages. BM denotes the baseline economy without a furlough tax.

cost of the furlough option increases slightly with the layoff tax, from 1.11% with a layoff tax equivalent to one month's wage to 1.23% with a layoff tax equivalent to 6 months' wages. This small increase reflects greater use of furloughs as layoffs become more expensive, which amplifies their negative effects on output and welfare. The share of furloughed workers rises from 1.13% to 1.27% as the layoff tax increases from one to six months' wages.

Variable	Unit	1 month		6 months	
		Furloughs	No furloughs	Furloughs	No furloughs
Wage	relative	100.00	99.93	100.00	99.92
Output	relative	100.00	100.99	100.00	101.10
Output/employed	relative	100.00	99.80	100.00	99.79
Consumption	relative	100.00	101.11	100.00	101.24
Variance of log(MPL)	relative	100.00	101.66	100.00	101.73
Employed	percent	90.71	91.79	91.34	92.54
Unemployed (excl. furloughed)	percent	8.16	8.21	7.40	7.46
Furloughed	percent	1.13	0.00	1.27	0.00
Turnover	percent	10.85	10.83	9.51	9.51
Entry and exit rate	percent	5.95	5.96	5.68	5.68
Job-finding prob	percent	38.55	38.64	37.98	38.08
Welfare	relative	100.00	101.11	100.00	101.23
Mean size (attached workers)	relative	100.00	98.77	100.00	98.68

Table 7: Equilibrium effects of eliminating the furlough option under layoff taxes. The layoff tax is set equal to either one or six months' wages.

The results reported above suggest that maximizing welfare requires completely removing the furlough option. To assess the robustness of this conclusion, we consider two alternative calibrations that make the potential benefits of furloughs stronger. The first increases the utility cost of job search, denoted by γ , so that the labor market friction is much more severe and the

unemployment rate is about 20 percent. This exercise is motivated by the stylized model, which shows that the case for furloughs becomes stronger when layoffs generate more costly unemployment spells. Increasing γ makes search more costly and lengthens unemployment spells following layoffs, while furloughed workers are not directly affected by this friction. The second calibration combines this higher search cost with larger i.i.d. productivity shocks. This increases the importance of temporary adverse shocks, which is likely to make the furlough option more useful at least from the firms' perspective.

Table 8 shows the results. In both alternative calibrations, the furlough option has a larger effect on unemployment than in the baseline calibration, as expected. When unemployment spells are made longer by increasing the search cost, the potential value of avoiding layoffs rises. Eliminating the furlough option then increases unemployment by 0.12 percentage points, compared with 0.05 percentage points in the baseline calibration. However, this effect remains too small to overturn the welfare result: eliminating furloughs still raises output, consumption, and welfare, with welfare increasing by 0.96 percent.

When the variance of the i.i.d. shock is also increased, furloughs are used more extensively and the unemployment effect becomes somewhat larger. In this calibration, eliminating the furlough option increases unemployment by 0.15 percentage points. This is consistent with the idea that furloughs are more useful when temporary shocks are more important. Nevertheless, eliminating furloughs still raises employment in production, output, consumption, and welfare. Welfare increases by 1.32 percent, more than in the calibration with only a higher search cost. This reflects the fact that furloughs are used more extensively when temporary shocks are larger, so the adverse effects of the furlough option are also larger. Thus, even when the labor market friction is made much more severe and temporary shocks are made more important, the furlough option mainly acts as an additional margin for reducing labor input and carrying larger attached workforces, rather than as an effective way of avoiding unemployment spells.

8 Substitutability between layoffs and furloughs in the data: empirical results

As discussed above, a key feature of our model is the limited substitutability between layoffs and furloughs. Because the furlough option does not meaningfully reduce layoffs, it fails to mitigate the core friction in the labor market—namely, that laid-off workers take time to find new jobs. To assess the credibility of this model-based result, we empirically examine the relationship between furloughs and layoffs in our data.

Ideally, we would exploit exogenous variation in the cost of furloughs across firms. However, we are not aware of such variation in our data. In the absence of a quasi-experimental setup, we provide correlative evidence by exploiting the fact that statutory layoff regulations in Finland vary with worker tenure. Specifically, the minimum notice period for layoffs increases from two weeks for workers with less than one year of tenure to six months for those with more than 12 years. We interpret this as an increase in effective layoff costs for firms with a more senior workforce. In contrast, the notice period for furloughs does not vary with worker tenure. If furloughs and layoffs were close substitutes, we would expect firms with longer-tenured workers

Variable	Unit	High γ		High γ and high σ_ν	
		Furloughs	No furloughs	Furloughs	No furloughs
Wage	relative	100.00	99.93	100.00	99.87
Output	relative	100.00	100.85	100.00	101.15
Output/employed	relative	100.00	99.77	100.00	99.65
Consumption	relative	100.00	100.97	100.00	101.33
Variance of log(MPL)	relative	100.00	101.50	100.00	102.47
Employed	percent	79.75	80.61	79.27	80.46
Unemployed (excl. furloughed)	percent	19.27	19.39	19.39	19.54
Furloughed	percent	0.98	0.00	1.35	0.00
Turnover	percent	11.17	11.15	11.34	11.31
Entry and exit rate	percent	6.01	6.00	6.02	6.03
Job-finding prob	percent	19.36	19.40	19.41	19.47
Welfare	relative	100.00	100.96	100.00	101.32
Mean size (attached workers)	relative	100.00	99.01	100.00	98.43

Table 8: Equilibrium effects of eliminating the furlough option in two alternative calibrations. In the first calibration, the search cost parameter γ is raised to generate an unemployment rate of about 20 percent. In the second calibration also the standard deviation of the i.i.d. productivity shock is scaled by 1.5.

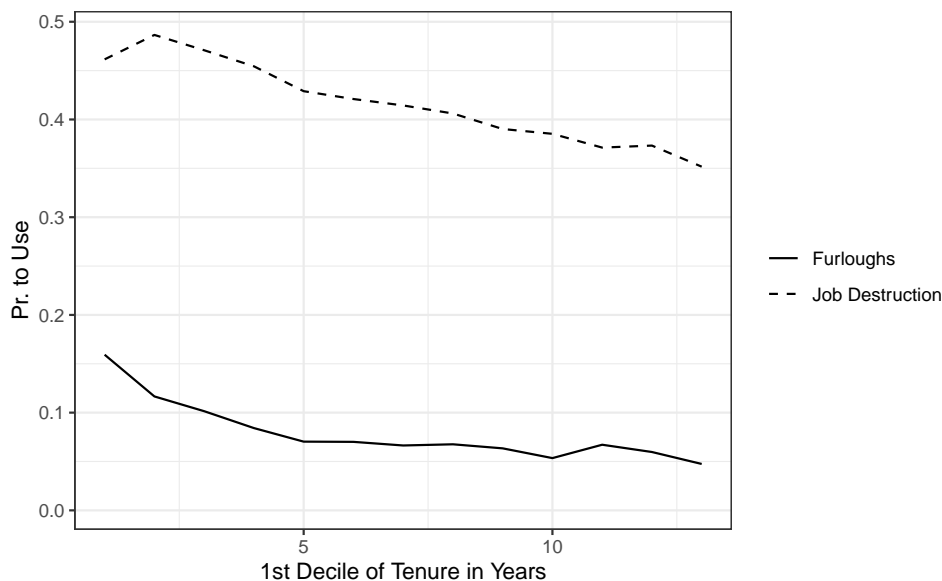


Figure 6: Probability of job destruction and furloughs conditional on the 1st decile of the tenure distribution

(and thus higher layoff costs) to rely more heavily on furloughs.

Figure 6 shows the probability of job destruction (a proxy for layoffs) and furloughs for firms with different tenure profiles, measured by the first decile of the tenure distribution. Here, as in Section 3, we only count job destruction and furlough events that amount to at least 0.1% of the firm's labor force. We focus on the first decile to capture the "marginal" workers whom firms might lay off first, as they have the shortest notice periods. The figure shows that

	(1)	(2)	(3)	(4)
Tenure at p10	-0.0021 (0.0001)	-0.0091 (0.0002)	-0.0026 (0.0001)	-0.0097 (0.0002)
Size & VA controls	YES	YES	YES	YES
Num. obs.	365225	365225	365225	365225
R ²	0.1471	0.0257	0.1213	0.0273
Num. groups: Industry	658	658	658	658
Num. groups: Year	6	6	6	6

Robust standard errors in parentheses.

Table 9: Regression results. Dependent variable: (1) Probability of furlough, threshold level 0.1% of workforce; (2) Prob. of job destruction, 0.1% threshold level; (3) Prob. of furlough, 1% threshold level; (4) Prob. of job destruction, 1% threshold level

the probability of job destruction decreases as the first decile of a firm’s tenure distribution increases, likely reflecting longer notice periods. However, a lower probability of job destruction is not associated with a higher probability of furloughs. This pattern suggests that firms facing higher layoff costs do not systematically resort to furloughs more often. In other words, in line with our model economy (in particular with Table 5), there appears to be little substitutability between layoffs and furloughs.

Table 9 presents regression results that corroborate this pattern. The probability of job destruction decreases with the first decile of a firm’s tenure distribution, even after controlling for firm size, value added, and industry and year fixed effects. The probability of furloughs also declines with the first decile of the tenure distribution, but the relationship is much weaker. The table reports results using two different minimum thresholds for counting job destruction and furlough events—0.1% and 1% of the firm’s workforce. The choice of threshold has little effect on the overall results, indicating that the observed patterns are not driven by small employment adjustments.

9 Conclusion

We study the aggregate effects of furloughs under normal business cycle conditions. We first use a stylized model to clarify the central trade-off. Furloughs can raise output by preventing workers from entering unemployment after temporary firm-level shocks, especially when re-employment is slow. At the same time, they can reduce output by allowing firms to keep attached workers out of production after adverse shocks, which in equilibrium also affects the allocation of labor across firms. The stylized model also shows that strict layoff restrictions alone do not necessarily make furloughs beneficial: if layoffs are already limited, the potentially useful unemployment channel is weak, while the adverse affects may remain important.

We then quantify these forces in a general equilibrium model of firm dynamics with labor adjustment costs and frictional unemployment, calibrated to Finnish register data. In the model, firms can reduce their workforce either through layoffs or through furloughs. Furloughs allow firms to temporarily reduce labor input without incurring rehiring or retraining costs when workers are recalled. However, furloughed workers remain attached to the firm, so keeping

them out of production in later periods requires the firm to furlough them again or lay them off, incurring the corresponding costs.

In the calibrated stationary equilibrium, the furlough option has only a small effect on layoffs and therefore does little to address the main labor market friction: laid-off workers take time to find new jobs. Instead, furloughs mainly allow firms to keep workers attached while temporarily removing them from production and from the wage bill. As a result, the furlough option reduces employment in production and increases average firm size measured by attached workers. It also contributes little to productivity-enhancing reallocation, since furloughed workers typically return to the same firms that furloughed them rather than moving to expanding firms. Overall, the furlough option reduces output, employment in production, and welfare. These results hold even when layoffs are made substantially more costly, suggesting that furloughs are not a socially useful margin of adjustment even when firms face tight restrictions on layoffs.

This conclusion should be interpreted in light of the environment we study. Our analysis focuses on normal business cycle conditions in the sense that employment is not constrained by insufficient aggregate labor demand. Although the model features firm-level wage rigidity after idiosyncratic shocks, it does not feature an aggregate demand channel in which downward nominal wage rigidity keeps the economy-wide real wage too high and generates broad-based unemployment. Nor does it capture situations such as lockdowns in which some workers are simply not allowed to work. In our environment, firms always have productive uses for labor, and the main potential benefit of furloughs is to prevent temporary firm-level shocks from generating unemployment spells. Our results suggest that this benefit is quantitatively small relative to the costs created by lower active employment and weaker productivity-enhancing reallocation.

The analysis therefore does not imply that furlough schemes are never useful. During exceptional aggregate disruptions, such as lockdowns or deep recessions, preserving worker-firm attachments may be much more valuable, especially if job opportunities elsewhere in the economy are scarce. A natural policy implication is that furlough schemes should be designed to limit routine use in normal times while preserving the option for exceptional circumstances. Our results indicate that even a rather small tax on furloughs substantially reduces their use in normal times, when furloughs are mainly used for relatively small workforce adjustments. At the same time, such a tax would still leave the option available in situations where furloughs are especially valuable to firms, such as large but temporary disruptions. A small furlough tax could therefore discourage routine use without eliminating the role of furloughs as a crisis-mitigation tool.

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