On the Cleansing Effect of Recessions and Government Policy: Evidence from Covid-19*

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Abstract

Recessions can have a cleansing effect by encouraging the reallocation of resources from low-productivity firms towards higher-productivity ones. Whether this effect actually occurs is still debated. We contribute to answering this question by providing new evidence. Using a survey of firms matched with administrative data, we trace out the Covid-19 recession's effects across the productivity distribution. Higher-productivity firms are found to have been more successful at maintaining employment, but there was not a rise in exit amongst lower-productivity firms. In line with the theory that support policies offset the cleansing effect of recessions, high-productivity firms are also found to have been less likely to take up government support.

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1 Introduction

The idea that recessions can have a cleansing effect by causing resources to be reallocated from lower to higher productivity uses dates back to at least Schumpeter (1939, 1942). His view was of a world in which recessions tighten the screw on firms, causing the least successful ones to be squeezed. The decline of the lowest-productivity firms frees up resources that can then be put to better use. This theory has received considerable attention since, but the fundamental question of whether recessions actually have this silver lining is still debated.[1] This paper contributes to answering this question by providing new evidence on the reallocation effects of a recession.

A second issue is what the appropriate government policy is when a recession hits, firms are shrinking and at risk of exiting. To the extent that recessions play a role in improving the allocation of resources in the economy, a policy maker faces a tradeoff. On one hand, the opportunity cost of unemployment is low during recessions, so they are good times to allow reallocation and restructuring to occur (Caballero and Hammour 1996). On the other hand, government support to firms may be able to dampen the recession and reduce its welfare costs. An important consideration for the analysis of this issue is what types of firms take up government support when it is offered. We analyze this.

To address these questions, we study the impact of a recession across the firm productivity distribution. The data requirements for the analysis are demanding. Both firm-level information on the impact of a recession and detailed data on firm characteristics, in order to estimate productivity and control for other characteristics, are needed. We use Portuguese data as it fulfills both requirements. One dataset provides information on the evolution of firm-level sales and employment during the first contraction associated with Covid-19 in 2020. We match this data with administrative information on firm characteristics. A third dataset provides information on firm exits, to facilitate studying the extensive margin of reallocation (due to firm exits) as well as the intensive one (changes in firm size).

[1] See, for example, Caballero and Hammour (1994), Barlevy (2002), Barlevy (2003), Ouyang (2009), Kehrig (2015), Osotimehin and Pappadà (2017) and Foster, Grim, and Haltiwanger (2016).

For the intensive margin, the analysis considers how the allocation of employment and sales changed amongst firms which survived the recession. The main result is that higher-productivity firms had smaller declines in employment, on average, than lower-productivity firms. This is evidence of positive selection amongst firms during the recession, and a reallocation of resources towards more productive firms. This result is complemented by evidence that higher-productivity firms were more likely to avoid closing temporarily. To provide a sense of magnitudes, a firm one standard deviation higher in its sector's productivity distribution was 2.3 percentage points less likely to reduce its employment level by more than 10%, and 1.2 percentage points more likely to remain open. In terms of sales, the changes were similar across the productivity distribution. The fact that employment declined more at lower-productivity than higher-productivity firms, but sales changed similarly, suggests that less productive firms increased the relative efficiency of their labor.

The second part of the analysis focuses on the take up of government support. The Covid-19 recession is a particularly good context for studying this since many governments responded with broad policies to support businesses, in a way that has not been seen in recent decades. We study four policies, which were similar to those adopted by many other countries in 2020: a moratorium on debt payments, government provided credit lines, deferred tax payments, and a subsidized paid furlough scheme under which workers were temporarily laid off, but were still paid with wages subsidized by the government.

The analysis focuses on differences in the propensity of firms to use each of the support policies across the productivity distribution. For all of the policies, not only were higher-productivity firms less likely to make use of government support, but this was even true controlling for the change in sales that each firm experienced. The differences are substantial. In the specification controlling for the change in sales, a firm one standard deviation higher in its sector's productivity distribution was 2.2 to 6.6 percentage points less likely to have used each of the support policies. This result supports the theory that government assistance to firms dampens the cleansing effects of a recession.

For the effect of the recession on the exit decisions of firms, there are competing forces to consider. The recession had a large impact on the sales of firms, which

is likely to have decreased profits and increased the risk of exit. However, the government offered a broad range of support policies designed to keep firms afloat. Overall, we find that the exit rate of firms was similar to in the three years prior to the recession. Furthermore, while in these years lower-productivity firms were more likely to exit, between April 2020 and March 2021, this selection on productivity was dampened.

To guide interpretation of the main results, a simple theoretical framework is provided. The model has firms with heterogeneous productivity and a distortion, in the spirit of the misallocation literature (e.g., Hsieh and Klenow 2009), that is increasing in firm size. In this environment, higher-productivity firms change their employment less, in percentage terms, in response to an aggregate shock than lower-productivity firms. This result arises because the wedge pushes down the relative employment of higher-productivity firms, which increases the sensitivity of the marginal benefit of a worker with respect to the employment level. A negative aggregate shock pushes up aggregate productivity by shifting the distribution of employment shares towards higher-productivity firms, which have higher marginal products. Firms' decisions about whether or not to operate depend on their profits, conditional on operating, and a fixed operating cost. Absent external support, a negative aggregate shock will cause the least productive firms to choose not to operate. The government can offset this with subsidies that are concentrated amongst lower-productivity firms.

In recent decades, the question of whether recessions have a cleansing effect by causing resources to shift to more productive uses, as argued by Schumpeter (1939, 1942), has received considerable attention. Davis and Haltiwanger (1992) documented that employment reallocation in the US manufacturing sector increases in recessions, leading to theoretical investigations of its relation to productivity and its driving forces. Caballero and Hammour (1994) argue that recessions have a cleansing effect because they force the lowest-productivity production processes to cease. Several papers have subsequently argued that various features of the economy can interfere with this selection process, so that recessions are sullying instead of cleansing. Barlevy (2002) points to frictions in the labor search process, Barlevy (2003) argues that financial frictions reverse the correlation between productivity and exit, Ouyang (2009) points to poor information about productivity amongst young firms, and Kehrig (2015)

studies the effect of the supply of inputs for overhead costs being inelastic. Osotimehin and Pappadà (2017) study financial frictions as well, but argue that quantitatively their effect is not large enough to offset the productivity benefits of a recession.

In the context of this diverse set of theories, with different predictions for the sign of the effect of recessions on aggregate productivity, empirical evidence is valuable. So far such evidence has focused on the US manufacturing sector. Bresnahan and Raff (1991) present evidence that the Great Depression forced out relatively unproductive firms in the automobile industry. Foster, Grim, and Haltiwanger (2016) argue that recessions have typically been cleansing in the manufacturing sector, although the Great Recession was an exception to this. Kehrig (2015) focuses on the dispersion of the productivity distribution in the manufacturing sector and argues that recessions are not cleansing because of increasing dispersion in the left tail during these periods. We contribute to this literature by studying the impact of a recession for a much broader set of sectors and a new recession episode. Since productivity-enhancing reallocation can occur through both the intensive and extensive margins, we study both, as in Foster, Grim, and Haltiwanger (2016).

The question of policy has received less attention. Caballero and Hammour (1996) argue that recessions are a good time for reallocation because the opportunity costs of unemployment is low. At the same time, the decline in output is costly. These authors study this trade-off and argue that the optimal policy includes incentives for both restructuring and production. At the core of this issue is the negative consequences for reallocation that come from supporting production. These depend on which firms make use of government support, which is a key question that this paper addresses.

A second related literature empirically studies the impact of the Covid-19 recession. There have been studies looking at the impact on firms—Barrero, Bloom, and Davis (2020), Bartik et al. (2020b), Fairlie (2020), and Hassan et al. (2020)—as well as analysis of the effects of government support policies for them—Alstadsæter et al. (2020), Autor et al. (2020), Bartik et al. (2020a), Granja et al. (2020), and Gourinchas et al. (2020). The distinguishing feature of the present paper is that we measure productivity and study how the impact of the reces-

sion, and the use of government support, has differed across the productivity distribution.

The remainder of this paper is organized as follows. The next section introduces the data. Section 3 studies how the impact of the recession on employment and sales differed across the productivity distribution. Section 4 analyzes the use of government support and Section 5 assesses the exit decisions of firms. We finish by presenting a simple model for interpreting the data (Section 6) and concluding (Section 7).

2 Data and context

For the empirical analysis we use firm-level data from Portugal, focusing on early 2020 when the first contraction associated with Covid-19 occurred. This data is useful for studying the cleansing effect of recessions for several reasons. It provides timely and detailed information on the impact of the recession at the firm level. There is administrative information on firms from the years preceding the recession, which allows for productivity and markups to be measured and various firm characteristics to be controlled for. Finally, this is a period in which government policies supporting firms were used on a scale that has not been seen in recent decades. Thus the episode provides a unique opportunity to study the effects of these policies. To this end, the data provides information on both policy use and eligibility.

Two primary datasets are used for the analysis. The first is a survey of firms that was conducted weekly during April 2020, and every fortnight from the start of May to the middle of July.[2] The nature of the Covid-19 related restrictions was evolving over this period. From March 18 to May 3 all nonessential businesses had to cease interactions with the public, and teleworking was required wherever possible. Industries that were not public facing like manufacturing and construction were allowed to continue operating, while other non-essential businesses had to operate behind closed doors (e.g., takeout ser-

[2]The name of the survey is the *Inquérito Rápido e Excecional às Empresas—COVID-19*. It was administered to firms by the National Statistics Institute, the main body responsible for collecting firm-level statistics in Portugal.

vices for restaurants, online retail, and services firms working remotely). The restrictions were eased from May 4, with progressively larger businesses being allowed to open their public-facing operations. By June, the main restrictions that remained were social distancing rules (i.e., capacity limits and rules regarding distance between people).

The surveys asked firms a range of questions about their operations. For the purposes of this paper, the most important questions were about the evolution of sales and employment, and the use of government support policies. Each round of the survey was sent to the same 8,883 non-farm, non-financial firms and the average response rate was 60.3%.[3]

The second data source is an annual administrative dataset that provides information on the balance sheets of firms as well as some other operational variables.[4] This dataset covers the universe of firms. We use this data for the years preceding the recession to measure firm characteristics.

After merging and cleaning the datasets, the sample contains 6,939 firms. The main cleaning criteria are the omission of firms that did not respond to the survey during April, since we want at least one observation per firm during the period when the economy contracted most; we also omit the mining and utilities sectors because they have too few observations for the within-sector variation that our analysis relies on. While the panel data is unbalanced, firms responded to the surveys consistently. Fifty percent of firms responded to at least eight out of nine surveys, 76% of firms responded to at least five surveys, and observations are very evenly spaced over the survey period.[5]

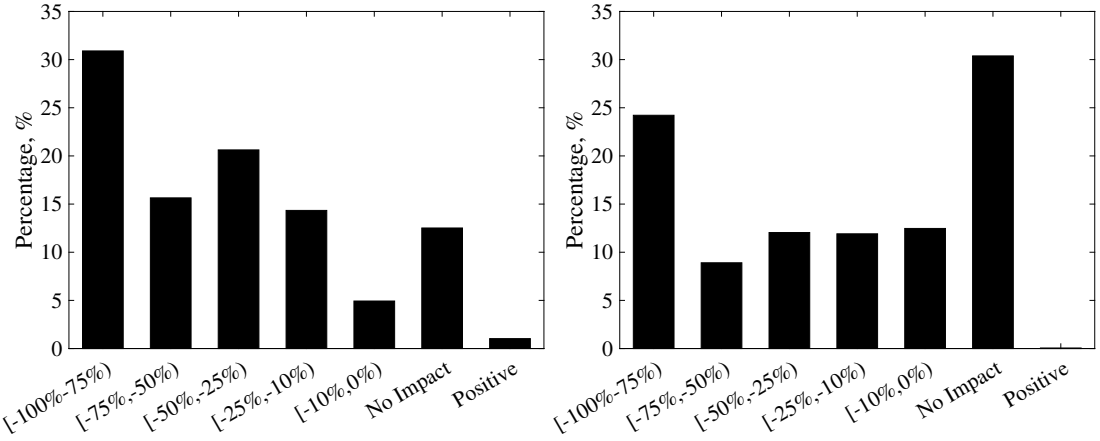
Turning to the characteristics of the sample, firms are relatively large and mature. The median sales and employment of firms are €3.5m and 28, respectively, compared with €121k and two for the population of firms. The industry composition is similar in the sample and the population, with the main difference

[3]The response rate was fairly stable over time, ranging from 54% to 66%.

[4]This dataset is called the *Informação Empresarial Simplificada* (IES).

[5]Other filters applied to the data are that we drop firms with annual sales less than the minimum wage because they are unlikely to be businesses operating at any scale and firms that cannot be matched to the administrative firm data because they are too young (did not exist in 2018) or their data are otherwise missing. The Appendix provides additional details of the sample construction, details on the number of surveys that each firm in the sample responded to, the total number of responses to each survey by firms in our sample, and details on the industry and geographic compositions of the sample and the population of firms.

Figure 1: Impact on sales and employment



(a) Change in sales (b) Change in employment

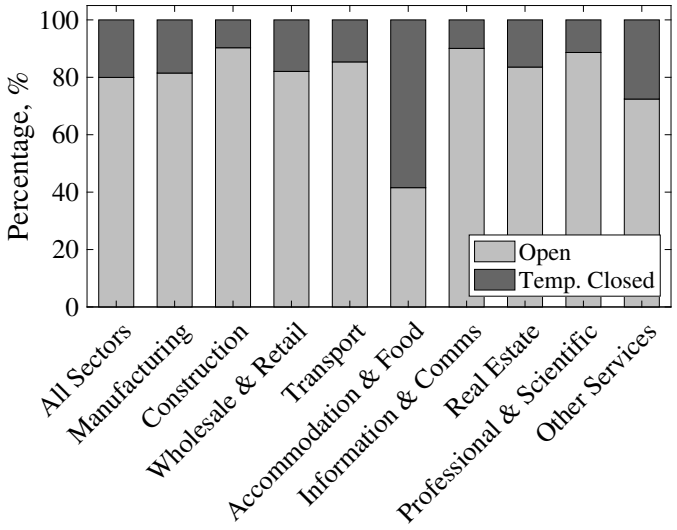
Notes: Panel (a) presents the distribution of the percentage change in sales of firms. Panel (b) presents the distribution of the percentage change in employment (defined as people actively working). All changes are relative to what firms expected in the absence of Covid-19.

being that manufacturing is overrepresented. It accounts for 35% of sales compared to 27% for the population. The geographic distribution of the sample is very close to that of the firm population, with the main difference being that the capital, Lisbon, is slightly overrepresented (it has 34% of firms in the sample, compared to 29% in the population). Full details of these distributions are in the Appendix.

To provide a sense of the recession that occurred during the survey period, we start by presenting evidence of the impact on firm-level sales and employment. Since we are interested in measures of economic activity, we use the number of people working as the measure of employment, omitting people on furlough. This will be the measure of employment throughout the paper. Sales and employment changes are both measured relative to what firms would have expected in the absence of Covid-19. For the purpose of assessing the cross-sectional distribution of the shock, we measure the effect on each firm with the maximum negative impact on its sales and employment during the survey period (April-July, 2020).

The distribution of sales and employment impacts are presented in Figure 1. The distributions are discrete since the survey asked firms to quantify changes

Figure 2: Temporary closures



Notes: This figure presents the share of firms that remained open at all times during the survey period, or closed temporarily. One bar is for the aggregate (*All Sectors*) and the remainders are for the sectors.

to their business in ranges, rather than exact numbers (e.g., a change in sales of 26%–50% rather than 37%). The figure shows that the shock was large and heterogeneous. Thirty-one percent of firms experienced a decline in sales of more than 75%, while 14% had flat or increasing sales. The effects on employment were somewhat smaller. 24% of firms reduced their workforce by more than 75%, while 30% had no change. There is a lot of heterogeneity across sectors, but all sectors suffered significant shocks. The accommodation and food services sector shrunk the most, with the sales of 86% of firms decreasing by more than half. This was also true for 27% of firms in construction, which was the sector that declined the least.[6] Some of the difference across sectors is of course due to differing effects of government restrictions. Our analysis will therefore focus on within sector variation across firms.

To provide further evidence on the degree of sectoral heterogeneity and the magnitude of the shock, Figure 2 presents the share of firms in each sector and the aggregate that closed temporarily at some point during the survey period. Again, accommodation and food services was the sector that was affected the

[6]The full picture of sectoral heterogeneity is presented in the Appendix, where Figures 1(a) and 1(b) are replicated for each sector.

most with 58% of firms closing temporarily. The rest of the sectors were much more similar, with temporary closure rates from 10% to 28%. The rate of actual exits in the sample is low, at 0.4%. We treat this number with caution because firms that exit may have been less likely to respond to the survey. For the exit analysis, discussed below, we use data on the population of firms.

The analysis of government support focuses on four policies.[7] On March 16, the government commenced a policy of subsidizing employee salaries at firms severely affected by the pandemic to try to prevent layoffs. Employees at eligible companies were entitled to two-thirds of their salary, subject to a cap of €1905 per month. The government paid 70% of this and the employer the remainder. Firms were not allowed to fire any of their employees while receiving this benefit, or for 60 days afterwards. This resulted in many people being employed and paid during the pandemic, but not actually working. We will call this employment state *paid furlough*.[8]

A moratorium on loan repayments was adopted on March 27 under which all firms were effectively entitled to suspend their loan repayments until the end of September if they wished. During the course of this policy, interest was capitalized on loans and banks were prohibited from revoking credit lines. In June, this measure was extended until the end of March 2021.

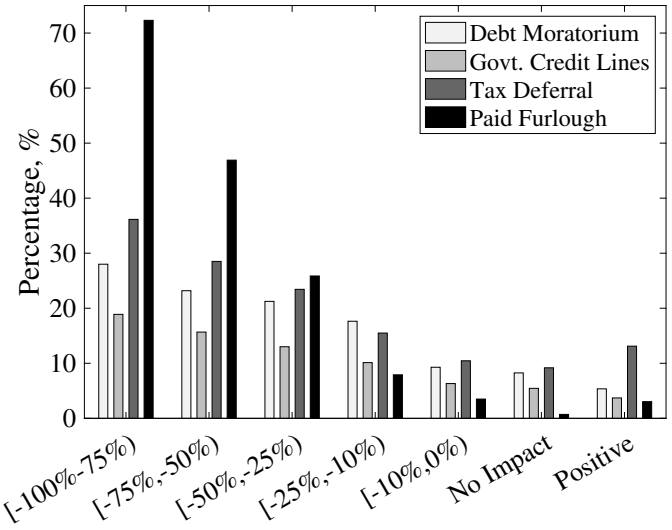
To further support firm financing, the government also provided credit lines. On March 12, several lines of credit were implemented focusing particularly on small and medium sized enterprises of the most affected sectors: restaurants, tourism and manufacturing. Loans had a maturity of up to four years and low interest rate spreads. In early April, the program was expanded to all sectors and the volume of funds was increased in partnership with the European Commission.

For the fourth policy, the government allowed firms to defer the payment of income, value-added and social security taxes for April, May and June without any interest accrual. Alternatively, firms could opt for a longer time limit of six

[7] We provide brief descriptions of these policies in this section. Additional details are available in the Appendix.

[8] Unlike the other policies considered in the paper, firms were only asked whether they had used the government's paid furlough scheme in the final survey in the first half of July. Therefore, analysis of the use of this policy is restricted to the sample of 4,340 firms that answered this round of the survey.

Figure 3: Policy use by change in sales



Notes: We divide the sample according to the percentage change in sales of each firm (horizontal axis) and present the share of firms in each category using each of the four government policies.

months, with interest accruing for the last three months.

Similar policies to all of these were also used in other countries in 2020. The paid furlough scheme was similar to Germany's *Kurzarbeitergeld* and the United Kingdom's Job Retention Scheme. The US Paycheck Protection Program also had similar features and objectives. Several other countries allowed for deferred payments of various taxes, such as Social Security (e.g., France), value-added (e.g. United Kingdom) and income taxes (e.g., Germany). Government-provided credit lines were widespread. For example, the UK implemented the Coronavirus Business Interruption Loan Schemes and Germany started several lines of credit through the Federation (*Bund*) and through its state-owned development bank (*Kreditanstalt für Wiederaufbau*). A moratorium on debt payments by firms was also adopted in Italy, while in Australia creditors were prevented from enforcing repayment for six months.

All of the policies were widely used during the survey period. Thirty-six percent of firms benefited from at least one of the debt moratorium, government credit lines or tax deferral policies, and the same share made use of the subsidized paid furlough. In Figure 3, we break down the use of the four poli-

cies conditional on the size of the change in sales that firms experienced. Even amongst firms whose sales did not change, the policies were used by up to 9% of firms. Firms with worse shocks had much higher rates of policy use. For firms with shocks to sales of more than 75%, the take-up rates of the policies varied between 19% and 72%. Regarding the role of eligibility in these results, virtually all firms reported being eligible for the debt moratorium, government credit lines and tax deferral policies.[9] Eligibility is more important for use of the paid furlough policy. Firms needed to have a decline in sales of more than 40% relative to the two months prior to Covid-19 arriving, or to have been forced to shut down, to use this policy.[10] This eligibility criteria will be taken into account in the later analysis.

The final component of the analysis focuses on firms permanently shutting down. On one hand, firms experienced a large negative shock which could have driven up exit. On the other, the government offered extensive support to keep firms afloat. To assess the overall impact on exit, we use a third dataset that provides administrative information on firm exit for the universe of firms in Portugal.[11] By combining this with the firm balance sheet data, we can analyze how firm exit behaved during the recession. To get the exit period to align with the pandemic, we look at exits occurring between April of year t and March $t+1$ and restrict the sample to firms aged at least 1 to ensure a sample that can be constructed consistently over time.[12] The aggregate exit rate for 2016 to 2020 is presented in Figure 4. The main message from the figure is

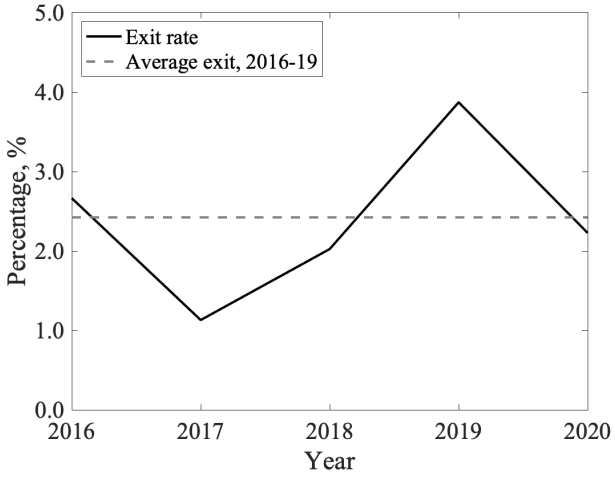
[9]The ineligibility rates of firms in our sample for these policies were 2.1%, 1.6% and 1.8% respectively. Firms directly reported this in the survey.

[10]See the Appendix for a detailed discussion of the eligibility criteria for this policy.

[11]This dataset is called *Sistema de Partilha de Informação* (SPAI). We do not use the Covid-19 survey to analyze exit since it provides a smaller sample and may have response bias because firms that exit may have been less likely to respond to the survey. Sample bias could also affect the analysis of other outcomes, however it would need to take a very specific form to affect our results. Response bias that is correlated with changes in sales or employment, or government policy use, is not an issue by itself. Since our analysis compares firms across the productivity distribution within sectors, with an array of controls, we just require that the response probability is uncorrelated with productivity after conditioning on the outcomes of interest and the control variables that are used.

[12]For the exit analysis, the sample is restricted to firms aged at least one because of data availability. The latest year of the balance sheet data that is available is 2018, which means that for exit in 2020 we only have information for firms that are at least one (born at the end of 2018 or earlier). We impose this age restriction in earlier years as well so that exit is being measured consistently over time.

Figure 4: Exit rate



Notes: Exit rate for year t is the share of firms aged at least one that exit between April of year t and March of year $t+1$. The average exit rate is for years 2016–2019.

that the exit rate was similar to the value from recent years during the recession. At 2.2%, it was slightly below the average exit rate for 2016–19 of 2.4%.[13] Therefore the recession did not generate a wave of exits, as often occurs during downturns. The extensive support that the government provided to firms is an obvious candidate for explaining this. In Section 5, we will assess changes in exit in more detail, focusing on how the distribution of exiters changed across the productivity distribution.

3 Sales and employment effects

The objective of this section is to assess whether or not the Covid-19 recession caused economic activity to reallocate towards more productive firms on the intensive margin. To do this, we use the data to assess the impact of this recession on the sales and employment of firms across the productivity distribution.

[13]This pattern also holds at the sectoral level. For the nine sectors in Figure 2, only two had a higher exit rate in 2020 than the 2016–2019 average, and in these cases the exit rate was only modestly above the average. Manufacturing had the highest exit rate relative to its average average: 2.5% compared to an average of 2.1%.

The first step for the analysis is to measure productivity. We follow the approach of Foster, Haltiwanger, and Krizan (2001) and Foster, Grim, and Haltiwanger (2016) by assuming a Cobb-Douglas production function with labor, capital and materials as inputs and measure the TFP of firm i in sector s, in log units, as:

$$TFP_i = \ln Y_i - \alpha_K^s \ln K_i - \alpha_L^s \ln L_i - \alpha_M^s \ln M_i. \quad (1)$$

Y_i is the value of output, L_i is hours of paid employees and M_i is the value of intermediate inputs (i.e., materials). To measure the capital stock, we follow Hsieh and Klenow (2009) and use the average book value of capital from the start and end of 2018.

The weights on the inputs in equation (1) are measured for the nine sectors covered by our sample. Given the assumption of a Cobb-Douglas production function, the weights are equal to the share of revenue spent on each input. Specifically, α_L^s is the total wage bill as a share of output; α_M^s is the total cost of intermediates as a share of output; and, assuming constant returns to scale, $\alpha_K^s = 1 - \alpha_L^s - \alpha_M^s$. We estimate these using industry cost shares.[14] According to our estimates, sectors have the expected characteristics. The most material-intensive sectors are manufacturing and construction, while the services sectors and wholesale and retail trade are the most labor intensive. Real estate—which encompasses firms in the business of renting, trading and managing real estate—is the most capital intensive. The average labor share across sectors is 61%.[15]

Revenue-based TFP measures like the one just outlined capture variation in prices across firms as well as productivity variation. Since there is no price data and we are working with a sample of firms producing heterogeneous goods, we do not attempt to correct for this directly. However, to evaluate the relevance of price variation, we will use a measure of markups in the analysis. Markup measurement follows the approach of De Loecker and Warzynski (2012), using the production function specified in equation (1). Under this approach, firm i's

[14]The estimated values of these parameters are presented in the Appendix. We estimate productivity for all firms in the population and then, to prevent outliers significantly impacting the results, drop firms in our sample that are in the top or bottom 1% of the population productivity distribution. Due to missing data for some firms and the omission of outliers, for the productivity analysis the sample reduces from 6,939 to 6,618.

[15]For the production function being used, the labor share for sector s is $\alpha_L^s/(\alpha_L^s + \alpha_K^s)$.

markup can be measured as:

$$Markup_i = \alpha_M^s \left(\frac{M_i}{Y_i} \right)^{-1}. \tag{2}$$

The markup measurement is based on the materials input since this is the most flexible input in the production function and therefore most closely satisfies the assumptions of the De Loecker and Warzynski (2012) method.[16]

For the analysis, we standardize productivity and markups within sectors since technologies and the characteristics of demand can differ substantially between them. In particular, we remove differences in the level and dispersion of these variables with the following normalization:

$$\widehat{X}_i = \frac{1}{\sigma_X^s} \Big(X_i - \frac{1}{N_s} \sum_{j \in \mathcal{S}} X_j \Big) \tag{3}$$

where $X_i \in \{TFP_i, Markup_i\}$, s is the sector of firm i, $\mathcal{S}$ is the set of firms in sector s, N_s is the number of such firms and σ_X^s is the standard deviation of variable X for these firms. Thus $\widehat{TFP}_i$, for example, is the deviation of firm i's productivity from its sector's mean, in units of that sector's TFP standard deviation.

With measures of TFP and markups in hand, we turn to assessing the impact of the recession across the productivity and markup distributions. The aim is to assess how the distribution of economic activity reallocated across the productivity and markup distributions during the recession. Since the data provides information on changes in sales and employment in discrete categories rather than as continuous variables, we address this question by evaluating whether firms with different productivity and markup levels were more or less likely to have declines in sales and employment beyond particular thresholds. Specifically, we assess the probability of declines in employment and sales of more than 10% and more than 50%.

[16]The average markup for each sector is presented in the Appendix. We estimate markups for all firms in the population and then, to prevent outliers significantly impacting the results, drop firms in our sample that are in the top or bottom 1% of the population markup distribution. Due to missing data for some firms and the omission of outliers, for the markup analysis the sample reduces from 6,939 to 6,879. For analysis that uses both markups and productivity, both productivity and markup outliers are removed, resulting in a sample of 6,604 firms.

To perform this analysis, the baseline regressions have the following form and are estimated using Ordinary Least Square (OLS):[17]

$$y_i = \beta_0 + \boldsymbol{\beta}_1' \mathbf{TFP}_i + \boldsymbol{\beta}_2' \mathbf{Markup}_i + \boldsymbol{\beta}_3' \mathbf{Sector}_i + \boldsymbol{\beta}_4' \mathbf{X}_i + \varepsilon_i, \tag{4}$$

where y_i is a variable indicating whether a firm's sales or employment declined by more than 10% or more than 50% at some point during the survey period (April to mid-July, 2020). $\mathbf{TFP}_i$ contains a measure of firm i's productivity. In the baseline specification this is the normalized measure of firm i's productivity specified in equation (3) and in an alternative specification it is a vector of dummy variables indicating which productivity quartile firm i is in within its sector. To focus on differences between firms due to productivity, we control for several other factors that could have affected their sales and employment outcomes during the pandemic. $\mathbf{Markup}_i$ takes the same form as $\mathbf{TFP}_i$, either being the normalized measure of markups or a vector of dummy variables indicating the markup quartile that a firm is in within its sector. $\mathbf{Sector}_i$ is a vector of sector dummies to control for sectoral heterogeneity in the impact of the pandemic, including differences in government restrictions.[18] With the exception of essential services, the restrictions applied to the whole economy. So, while their impact may have differed across sectors, we are assuming that within sectors their effects were homogeneous. $\mathbf{X}_i$ is a vector of additional control variables containing age, size, leverage (debt to assets ratio) and a dummy for whether the firm was in Lisbon. Age and size are included because differences between firms along these dimensions have been documented extensively. Leverage accounts for the fact that higher-leverage firms may be more constrained during a downturn, affecting their ability to produce. We include the control for Lisbon since it is the largest city in the country, where 29% of firms are located, and has a disproportionate share of high-productivity firms.

All right-hand side variables are measured using the most recent available administrative data, from 2018. In the Appendix, we show that, for the firms in

[17] An advantage of OLS in the present context in which the focus will be on marginal effects is that they are easy to interpret. Nevertheless, we have also estimated logit regressions using the same specification and the results (available upon request) are robust to this.

[18] The sectors are manufacturing; construction; wholesale and retail trade; transport; accommodation and food services; information and communication; real estate; professional, scientific and technical activities; and other services.

Table 1: Employment changes

	Employment contracted $> 10\%$					Employment contracted $> 50\%$				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\widehat{TFP}_i$	-0.019***				-0.023***	-0.017***				-0.011*
	(0.006)				(0.007)	(0.006)				(0.007)
TFP Q2		0.017					-0.001			
		(0.017)					(0.016)			
TFP Q3		0.023					-0.008			
		(0.017)					(0.016)			
TFP Q4		-0.056***					-0.046***			
		(0.017)					(0.016)			
$\widehat{Markup}_i$			-0.003		0.006			-0.014**		-0.010
			(0.006)		(0.007)			(0.006)		(0.007)
$Markup$ Q2				0.028*					0.026*	
				(0.017)					(0.016)	
$Markup$ Q3				0.003					-0.006	
				(0.017)					(0.016)	
$Markup$ Q4				-0.013					-0.035**	
				(0.017)					(0.016)	
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	6499	6499	6747	6747	6486	6499	6499	6747	6747	6486
R^2	0.053	0.055	0.054	0.054	0.053	0.076	0.076	0.076	0.077	0.076

Notes: All regressions take the form specified in equation (4). The dependent variable y_i is an indicator variable for employment contract by more than a certain threshold. The thresholds are 10% for columns (1)–(5) and 50% for columns (6)–(10). Sector FE are sector fixed effects. The Controls are age, sales, debt to assets, and an indicator for whether a firm is located in the Lisbon region. Robust standard errors are used and are in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

the sample, these variables were quite stable from 2016 to 2018, so the 2018 data provides good measures of firms' characteristics at the start of the recession.

Table 1 reports the baseline results for employment. The table includes results for versions of regression (4) in which $\mathbf{TFP}_i$ and $\mathbf{Markup}_i$ are included on their own, and when they are both included. For the cases where they are included on their own, results are provided for both the normalized and quartile specifications of these variables. The main result is that higher-productivity firms decreased their employment less than lower-productivity firms. Columns (1), (2) and (5) show that higher-productivity firms were less likely to have employment declines of more than 10%, while columns (6), (7) and (10) show that

Table 2: Employment changes, subsamples

	Employment contracted					Employment contracted $> 10\%$				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\widehat{TFP}_i$	-0.032**				-0.060***	-0.020***				-0.027***
	(0.015)				(0.017)	(0.008)				(0.009)
TFP Q2		0.024					0.023			
		(0.040)					(0.018)			
TFP Q3		0.003					0.029			
		(0.040)					(0.018)			
TFP Q4		-0.052					-0.069***			
		(0.041)					(0.020)			
$\widehat{Markup}_i$			0.020		0.051***			0.006		0.016*
			(0.013)		(0.015)			(0.006)		(0.008)
$Markup$ Q2				-0.049					0.018	
				(0.040)					(0.018)	
$Markup$ Q3				-0.001					0.009	
				(0.040)					(0.019)	
$Markup$ Q4				0.008					0.001	
				(0.040)					(0.019)	
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	1219	1219	1262	1262	1216	2981	2981	3079	3079	2979
R^2	0.041	0.040	0.041	0.041	0.048	0.033	0.041	0.028	0.028	0.034
Sample	Firms with sales declines up to 25%					Firms with sales declines $> 50\%$				

Notes: All regressions take the form specified in equation (4). The dependent variable y_i is an indicator variable for employment contract by more than a certain threshold. The thresholds are 0% for columns (1)–(5) and 10% for columns (6)–(10). Sector FE are sector fixed effects. The Controls are age, sales, debt to assets, and an indicator for whether a firm is located in the Lisbon region. Robust standard errors are used and are in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

this is also true for employment declines of more than 50%. Under the full specification in which both TFP and markups are included (columns 5 and 10), firms with one standard deviation higher productivity in their sector were 2.3 percentage points less likely to cut employment by more than 10%, and 1.1 percentage points less likely to do so by more than 50%. The results for the quartile specification of TFP indicate that this effect was particularly driven by firms in the top productivity quartile. These firms were 5 to 7 percentage points less likely to reduce their employment by more than 10% or 50%, compared with firms in the first quartile (columns 2 and 7).

Regarding markups, the evidence indicates that they were not closely related to changes in employment. When markups are included on their own, there is a negative relationship with employment declines of more than 50%, but this relationship disappears once TFP is included as a control. This strengthens the case that it really was higher-productivity firms that were successful at maintaining their employment, rather than firms with high measured productivity due to high markups.

One important question about these results is whether they could be driven by the government's paid furlough scheme. Specifically, the concern would be that higher-productivity firms were less likely to be eligible to use this scheme, and therefore reduced their employment less. The main eligibility criterion for this policy was that a firm's sales declined by more than 40% relative to the previous two months, or that it was forced to close by the pandemic (in which case its sales would have likely fallen by much more than 40%). To the extent that higher-productivity firms were less likely to have declines in sales in excess of 50% (more on this below), this is a valid concern. To address this, we redo the analysis for the contraction in employment restricting the sample to firms whose sales declined by up to 25% and to those whose sales declined by more than 50%. Firms in the first subsample are unlikely to have been eligible for the paid furlough policy, while all those in the second are likely to have been. This effectively removes heterogeneity in policy access amongst firms in the analysis.[19] The results are presented in Table 2 and are similar to the baseline. For firms with a decline in sales of less than 25%, a firm with one standard deviation higher productivity in its sector is 6.0 percentage points less likely to have had a decline in employment (column 5). Amongst firms with a decline in sales of more than 50%, the marginal effect of normalized productivity on the probability of a decline in employment of more than 10% is -2.7 percentage points (column 10). Again, we do not find that markups are negatively related to employment contractions. In fact, higher-markup firms are now found to be more likely to have had employment contractions (columns 5 and 10). This indicates that the recession not only caused labor reallocation towards higher-

[19]For the first subsample we asses the probability of firms having a decrease in employment rather than a decrease of more than 10%, as in the baseline analysis, because this subsample on average had smaller declines in employment. This approach therefore provides more variation in the dependent variable for identifying the coefficients.

Table 3: Sales changes

	Sales contracted $> 10\%$					Sales contracted $> 50\%$				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\widehat{TFP}_i$	0.006				0.013**	-0.016***				-0.001
	(0.005)				(0.006)	(0.006)				(0.007)
TFP Q2		0.016					-0.002			
		(0.014)					(0.017)			
TFP Q3		0.027**					-0.009			
		(0.014)					(0.017)			
TFP Q4		0.022					-0.027			
		(0.014)					(0.017)			
$\widehat{Markup}_i$			-0.012**		-0.015**			-0.028***		-0.031***
			(0.005)		(0.006)			(0.006)		(0.007)
$Markup$ Q2				0.019					0.027	
				(0.013)					(0.017)	
$Markup$ Q3				0.006					-0.000	
				(0.013)					(0.017)	
$Markup$ Q4				-0.017					-0.048***	
				(0.014)					(0.017)	
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	6378	6378	6618	6618	6366	6378	6378	6618	6618	6366
R^2	0.028	0.029	0.030	0.030	0.029	0.064	0.064	0.066	0.066	0.067

Notes: All regressions take the form specified in equation (4). The dependent variable y_i for columns (1)–(5) is an indicator variable for whether a firm's sales contracted by more than 10%, and for columns (6)–(10) is as an indicator for whether sales contracted by more than 50%. Sector FE are sector fixed effects. The Controls are age, sales, debt to assets ratio and an indicator for whether a firm is located in the Lisbon region. Robust standard errors are used and are in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

productivity firms, but also away from high-markup firms.

For sales, the results are presented in Table 3. We find that there are modest differences across the productivity distribution, and only for relatively small changes in sales. Under the full specification, lower-productivity firms were slightly less likely to have sales declines of more than 10%, but for larger sales declines of at least 50% there was no significant differences (column 6). Unlike for employment, markups play a role in sales outcomes. We consistently find that firms with higher markups had smaller sales declines. Under the main specification, firms that were one standard deviation higher in their sector's

Table 4: Operating decisions

	Operating				
	(1)	(2)	(3)	(4)	(5)
$\widehat{TFP}_i$	0.012**				0.012**
	(0.005)				(0.006)
TFP Q2		0.029**			
		(0.014)			
TFP Q3		0.026*			
		(0.014)			
TFP Q4		0.027*			
		(0.014)			
$\widehat{Markup}_i$			0.002		-0.002
			(0.005)		(0.006)
$Markup$ Q2				0.002	
				(0.014)	
$Markup$ Q3				0.011	
				(0.013)	
$Markup$ Q4				0.007	
				(0.013)	
Sector FE	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes
Obs.	6609	6609	6866	6866	6595
R^2	0.081	0.081	0.079	0.079	0.081

Notes: All regressions take the form specified in equation (4). The dependent variable y_i is an indicator variable for whether a firm remained open throughout the survey period. Sector FE are sector fixed effects. The Controls are age, sales, debt to assets ratio and an indicator for whether a firm is located in the Lisbon region. Robust standard errors are used and are in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

markup distribution were 1.5 and 3.1 percentage points less likely to have had sales declines of at least 10% and 50%, respectively (columns 5 and 10). These results are primarily driven by firms in the highest markup quartile (columns 4 and 9).

Another way to look at the change in sales is to take the extreme case of firm closures (temporary or permanent), in which sales decline by 100%. For this analysis, we set the dependent variable in equation (4) to be an indicator for whether a firm remained open through the survey period. The results broadly concur with those for employment. Higher-productivity firms were more likely to remain open, with a firm that was one standard deviation higher in its sec-

tor's productivity distribution 1.2 percentage points more likely to have stayed open (Table 4, column 5). The results for the alternative specification of the TFP control (column 2) indicate that most of this effect is coming from a difference between the first quartile of the productivity distribution and the higher quartiles. Firms in the second, third and fourth quartiles were all 2.6–2.9 percentage points more likely to remain open than firms in the first quartile (these coefficients are significant at 5% or just below this threshold). As for markups, they have no relationship with whether firms remained open (columns 3–5).

To summarize, the results indicate that higher-productivity firms maintained higher employment levels and, while sales outcomes were similar across the productivity distribution, higher-productivity firms were more successful at avoiding closures during the recession. We interpret this labor reallocation as being consistent with the recession having a cleansing effect. The fact that lower-productivity firms cut employment by more without larger sales declines would be consistent with the recession forcing them to use their labor more efficiently. Higher-markup firms had similar employment outcomes to others and were no better at avoiding closures. However, higher-markup firms were able to maintain higher sales levels.

4 Use of government support

We now turn attention to the use of government support. In the context of a recession, a government faces a tradeoff. Supporting firms can be beneficial by reducing the size of the contraction but, to the extent that this support disproportionately benefits lower-productivity firms, it can dampen the cleansing effect of the recession (Caballero and Hammour 1996). The objective of this section is to assess the existence of the second effect, by evaluating whether lower-productivity firms were more likely to use government support in our data.

To perform the analysis, we use regressions of the form specified in equation (4). The dependent variables now are indicators for whether firm i made use of each of the four government policies discussed in Section 2 during the survey period (April to mid-July, 2020): the debt moratorium, government credit lines,

Table 5: Policy use: debt moratorium and credit lines

	Debt Moratorium					*Govt. credit lines*				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\widehat{TFP}_i$	-0.064***				-0.066***	-0.025***				-0.022***
	(0.005)				(0.006)	(0.004)				(0.005)
TFP Q2		-0.038**					0.016			
		(0.017)					(0.015)			
TFP Q3		-0.125***					-0.029**			
		(0.016)					(0.014)			
TFP Q4		-0.179***					-0.070***			
		(0.016)					(0.013)			
$\widehat{Markup}_i$			-0.032***		0.002			-0.016***		-0.007
			(0.004)		(0.005)			(0.004)		(0.005)
$Markup$ Q2				0.054***					0.017	
				(0.016)					(0.013)	
$Markup$ Q3				0.035**					0.024*	
				(0.016)					(0.013)	
$Markup$ Q4				-0.039***					-0.021*	
				(0.015)					(0.013)	
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
%Δ Sales FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	5253	5253	5446	5446	5242	5223	5223	5421	5421	5213
R^2	0.073	0.079	0.053	0.056	0.074	0.042	0.046	0.040	0.040	0.042

Notes: All regressions take the form specified in equation (4). In columns (1)–(5) and (6)–(10) the dependent variable y_i is an indicator for whether a firm used the government's debt moratorium and credit line policies, respectively. Sector FE are sector fixed effects. The Controls are age, sales and an indicator for whether a firm is located in the Lisbon region. %Δ Sales FE denotes fixed effects for a firm's percentage change in sales. In all columns the sample is restricted to firms which were eligible to use the relevant policy. Robust standard errors are used and are in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

tax deferral and the paid furlough scheme. We restrict the sample for each policy to firms that were eligible to use it, so that the results inform us about firms' choices to use policies, rather than eligibility. For the first three policies, this restriction to the sample is innocuous since virtually all firms in the sample were eligible for them (see Section 2). For the paid furlough scheme, we restrict the sample to firms with a decline in sales of more than 50%, as these firms are all likely to have been eligible to use it. On the right-hand side of the regression,

Table 6: Policy use: tax deferral and paid furlough

	Tax Deferral					*Paid Furlough*				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\widehat{TFP}_i$	-0.031***				-0.031***	-0.044***				-0.043***
	(0.006)				(0.007)	(0.011)				(0.013)
TFP Q2		-0.016					-0.030			
		(0.017)					(0.030)			
TFP Q3		-0.067***					-0.004			
		(0.016)					(0.030)			
TFP Q4		-0.079***					-0.130***			
		(0.017)					(0.031)			
$\widehat{Markup}_i$			-0.021***		-0.003			-0.017		-0.003
			(0.006)		(0.007)			(0.011)		(0.013)
$Markup$ Q2				0.020					0.019	
				(0.016)					(0.030)	
$Markup$ Q3				0.007					-0.001	
				(0.016)					(0.030)	
$Markup$ Q4				-0.037**					0.009	
				(0.016)					(0.030)	
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
%Δ Sales FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	5428	5428	5625	5625	5418	1866	1866	1928	1928	1865
R^2	0.072	0.073	0.062	0.062	0.073	0.100	0.104	0.093	0.092	0.101

Notes: All regressions take the form specified in equation (4). In columns (1)–(5) and (6)–(10) the dependent variable y_i is an indicator for whether a firm used the government's tax deferral and paid furlough policies, respectively. Sector FE are sector fixed effects. The Controls are age, sales and an indicator for whether a firm is located in the Lisbon region. %Δ Sales FE denotes fixed effects for a firm's percentage change in sales. For columns (1)–(5) the sample is restricted to firms which were eligible to use the tax deferral policy. In columns (6)–(10) the sample is restricted to firms that had a decline in sales of more than 50%. Robust standard errors are used and are in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

we include a vector of dummy variables for the size of a firm's change in sales. To the extent that sales changes are correlated with productivity, this control strips out the effect of sales changes so that the results tell us about the role of productivity above and beyond this. The results also hold for weaker tests without controls for eligibility or changes in sales (see Appendix).

Tables 5 and 6 present the results. More productive firms were less likely to

use all policies, and this holds even when markups are included in the regression. In the main specification, firms one standard deviation higher in their industry's productivity distribution were 6.6, 2.2, 3.1 and 4.3 percentage points less likely to make use of the debt moratorium, government credit lines, tax deferral and government-subsidized paid furlough, respectively (columns 5 and 10 of the two tables). To put these numbers in perspective, the unconditional shares of firms using these policies were 20.5%, 13.2%, 24.4% and 35.5%, respectively. Looking at the results by TFP quartile, we see that the probability of using each policy is almost perfectly monotonically decreasing in productivity.[20] For markups, there is a negative relationship between markups and policy use for all policies except the paid furlough when TFP is excluded from the regression. However, once TFP is controlled for, policy use is unrelated to markups across the board.

These results have a few implications. First, they rule out the possibility that higher-productivity firms had smaller declines in employment because they received more support from the government—they actually received less support. Therefore it is not policy driving the reallocation effects documented in the previous section. Second, the results provide evidence supporting the concern that government assistance to firms dampens the cleansing effects of a recession. For all policies, less productive firms were more likely to take up the support, even after controlling for the decline in sales and the markup levels of each firm.

While our results speak to the effect of policies on the cleansing effect of recessions, this is not the only outcome that is relevant for their formulation. While it is beyond the scope of this paper to assess these policies in general, one other consideration that our results provide insight on is the effect on markups. Our results indicate that policy use did not vary systematically with markups. This suggests that policies may not have distorted the markup distribution, although additional information on how intensively each firm made use of government support and its effects would be needed to definitively answer this. Assuming that this is true, through the lens of Edmond, Midrigan, and Xu (2018) it im-

[20] The one exception is that the point estimate for TFP Q3 is lower than the point estimate for TFP Q2 for the paid furlough policy—but both coefficients are insignificantly different from zero.

plies that losses from the aggregate markup, and markup dispersion, should not have changed. If, additionally, the policies prevented some firms from exiting, the policies may have also avoided losses due to less competition.[21] However, at least for the US, the potential gains from this channel relative to the total costs of markups is small (Edmond, Midrigan, and Xu 2018).

5 Firm exit

The final component of the empirical analysis considers the effect of the recession on the exit (permanent closure) of firms. As discussed in Section 2, Figure 4 shows that the aggregate exit rate did not increase relative to recent years during the recession. The focus of the analysis in this section is therefore on how the distribution of exit across productivity and markups changed. The previous two sections have shown that lower-productivity firms had larger declines in employment and were more likely to close temporarily, which suggests that they may have been at greater risk of exiting. However, their sales changes were similar and they also made greater use of government support. This section will present the overall effects on firm exit.

As discussed in Section 2, the analysis of exit uses the firm balance sheet data and a registry that tracks the exit of firms.[22] In order to assess how exit changed across the productivity and markup distributions during the recession, relative to recent years, we use the following regression:

$$\begin{aligned} exit_{i,t} = \beta_0 &+ \beta_1 \widehat{TFP}_{i,t-2} + \beta_2 \widehat{Markup}_{i,t-2} \\ &+ \mathbb{1}_{t=2020}(\beta_3 \widehat{TFP}_{i,t-2} + \beta_4 \widehat{Markup}_{i,t-2}) \\ &+ \boldsymbol{\beta}_5' \mathbf{Sector\text{-}year}_{i,t-2} + \boldsymbol{\beta}_6' \mathbf{X}_{i,t-2} + \varepsilon_{i,t}. \end{aligned} \tag{5}$$

$exit_{i,t}$ is an indicator for whether firm i exited in the 12 months starting on April 1st of year t. We use this timing in order to capture exits that occurred after the

[21] Note that whether the number of firms in the economy is inefficiently small or large, is a quantitative question. Edmond, Midrigan, and Xu (2018) find that for the US there are too few firms.

[22] Sample construction follows the same procedure as for the Covid-19 survey. Full details are in the Appendix.

pandemic started in year 2020, and maintain this timing for previous years for consistency.[23] All firms that were operating at the end of December in year $t-1$ are included in the sample for year t. The right-hand side variables are measured in year $t-2$ since two years is the minimum lag that is possible with the data. This is because we include exit in 2020 in the analysis and the most recent balance sheet data is for 2018, so the lag must be two years for these observations. We maintain this lag for all other years for consistency. As explained in Section 3, the main variables are quite stable over time so firm characteristics are well-measured despite the two year lag.[24] $\widehat{TFP}_{i,t-2}$ and $\widehat{Markup}_{i,t-2}$ are defined in the same way as described in Section 3, although now they are indexed by time as well as the firm. The regression pools exit data for 2016–2020 and $\mathbb{1}_{t=2020}$ is an indicator function for 2020. $\mathbf{Sector\text{-}year}_{i,t-2}$ is a vector of sector-year fixed effects and $\mathbf{X}_{i,t-2}$ includes the same controls as in regression (4). Productivity and markups are computed using the same method as described in Section 3, repeated for each year of data used in this analysis.

Under this specification, β_1 and β_2 tell us how the exit probability varied with TFP and markups in the four years prior to the recession, and β_3 and β_4 provide the changes in these relationships during the recession. The results for these coefficients are presented in Table 7.

Focus on the results for the full specification in column (3). For the pre-recession period, exit is negatively correlated with TFP. A firm that is one standard deviation higher in its sector's productivity distribution is 0.7 percentage points less likely to exit, indicating that exit generates reallocation to higher-productivity firms. Recall that the average exit rate over the sample period is 2.5%, so this corresponds to a 28% change in the exit probability. During the recession, the selection of low-productivity firms into exit was dampened. A firm with one standard deviation higher productivity was 0.4 percentage points less likely to exit during this period, compared to 0.7 percentage points in the pre-recession period. Controlling for markups has little impact on the results for productivity. Looking at exit across the markup distribution, the results show that higher-markup firms were more likely to exit in the pre-recession period, and this did not change during the recession. The difference across the markup distribution

[23] The results are robust to alternative timings of the exit year.

[24] See appendix for details on this.

Table 7: Exit

	Exit		
	(1)	(2)	(3)
$\widehat{TFP}_i$	-0.0064***		-0.0073***
	(0.0002)		(0.0002)
$\mathbb{1}_{t=2020} \times \widehat{TFP}_i$	0.0030***		0.0030***
	(0.0004)		(0.0004)
$\widehat{Markup}_i$		-0.0015***	0.0020***
		(0.0002)	(0.0002)
$\mathbb{1}_{t=2020} \times \widehat{Markup}_i$		0.0013***	0.0000
		(0.0004)	(0.0005)
Sector-year FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes
Obs.	1,110,793	1,373,634	1,106,574
R^2	0.007	0.006	0.007

Notes: All regressions take the form specified in equation (5). The dependent variable $exit_{i,t}$ is an indicator variable for whether a firm closed in the 12 months starting from April of year t. Sector-time FE are sector-year fixed effects. The Controls are age, sales, debt to assets ratio and an indicator for whether a firm is located in the Lisbon region. Robust standard errors are used and are in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

is less than one-third as large as it is across the productivity distribution.

These results, together with the evidence that lower-productivity firms were more likely to make use of government support, suggest that these policies dampened the selection process that usually occurs through exit.

6 Model

In this section we present a stylized model as a framework for interpreting the empirical results. The aim is to provide an environment in which a negative aggregate shock has the following features, consistent with the data: employment declines more at higher-productivity firms, the differences in sales changes across firms are dampened relative to the differences in employment changes, and the selection of low productivity firms into exit is weaker than expected.

The economy features M firms, indexed by $i \in \{1, \ldots, M\}$. Each firm needs to pay a fixed operating cost $\gamma \geq 0$ in order to produce with a decreasing returns to scale production function:

$$y_i = a z_i n_i^{\alpha}, \tag{6}$$

where $a > 0$ is aggregate productivity, $z_i > 0$ is idiosyncratic productivity, $\alpha \in (0, 1)$, and n_i is the number of workers employed by firm i. Firms sell their output at price p and the wage is w, with both prices exogenously determined. There is a size-dependent distortion in the economy that takes the form of a linear wedge on labor. This wedge can be thought of as representing any distortion in the economy that increases in firm size, such as taxes, government regulations that depend on a firm's number of employees, and non-policy frictions like adjustment costs; see Guner, Ventura, and Xu (2008) for a discussion of size-dependent distortions. This wedge can also accommodate subsidies to firms. In the same spirit as Chari, Kehoe, and McGrattan (2007), and Hsieh and Klenow (2009), we do not take a stand on the specifics underlying this wedge.

Conditional on operating, the profit maximization problem of firm i is:

$$\pi_i = \max_{n_i} p a z_i n_i^{\alpha} - w n_i - \left(\lambda + \frac{\tau n_i}{2}\right) w n_i, \tag{7}$$

where $\lambda \in \mathbb{R}$ and $\tau > 0$ define the wedge. A firm will choose to operate if $\pi_i > \gamma$.

The focus of the analysis is on how changes in aggregate variables, summarized by changes in the price p, aggregate productivity a and the wage w, affect the decisions of agents across the distribution of idiosyncratic productivity. Since the profit maximization problem can be rewritten as

$$\max_{n_i} \tilde{p} z_i n_i^{\alpha} - \left(1 + \lambda + \frac{\tau n_i}{2}\right) n_i,$$

where $\tilde{p} \equiv pa/w$, declines in p and a, and increases in w are isomorphic. We therefore focus on changes in $\tilde{p}$ for the analysis. In terms of outcomes, to get the model to speak to the empirical results we will focus on the effect of a negative shock to $\tilde{p}$ on employment, sales and whether firms operate. Let sales be defined as $s_i \equiv \tilde{p} z_i n_i^{\alpha}$.

While this analysis is in partial equilibrium, the results extend to a model in

which the wage is endogenous as long as the equilibrium wage effect is not too large. To see this, consider a negative shock to the economy, in the form of a negative shock to p or a. Such a shock will decrease the demand for labor from all firms. Assuming an upward sloping labor supply curve, this will decrease the wage. As long as labor supply is sufficiently elastic that the impact of the shock on the wage is smaller than the impact of the shock on p or a, in percentage terms, the results of the model will hold qualitatively. So, it is just necessary that the equilibrium wage effect does not overwhelm the direct effect of the shock. Taking an example, this condition amounts to requiring that a negative aggregate TFP shock in the model decreases output, rather than increasing it.

Turning to results, consider the effects of a shock to $\tilde{p}$ on employment (all proofs are in the Appendix).

Proposition 1 *Amongst firms that operate (i.e., $\pi_i > \gamma$), the percentage change in employment in response to a change in $\tilde{p}$ is decreasing in idiosyncratic productivity:*

$$\frac{\partial\left(\frac{\partial n_i/\partial\tilde{p}}{n_i}\right)}{\partial z_i} < 0.$$

This proposition implies that higher-productivity firms will make smaller percentage changes to their employment in response to an aggregate shock than lower-productivity firms. For the case of a negative shock, all firms will decrease their employment, but the percentage decreases will be smaller for higher-productivity firms, exactly as occurred in the data.

The feature of the model that drives this result is the size-dependent wedge. If $\tau = 0$ then the percentage change in employment in response to a change in $\tilde{p}$ is independent of idiosyncratic productivity. This is because the production function is Hicks-neutral, so all firms need the same relative change in labor in response to a price shock to balance marginal product and marginal cost. With $\tau > 0$, the labor choices of higher-productivity firms do not change as much in response to the shock. The wedge pushes down the employment of higher-productivity firms relative to lower-productivity firms. This increases the magnitude of the derivative of the marginal benefit of a worker for these firms. Consequently, these firms need to change their employment less to equate marginal

benefit and cost of a worker when $\tilde{p}$ changes.

The second result considers how the size of changes in sales and employment relate to each other.

Proposition 2 *Amongst firms that operate (i.e. $\pi_i > \gamma$), the percentage change in sales in response to a change in $\tilde{p}$ varies less with idiosyncratic productivity than the percentage change in employment:*

$$\left| \frac{\partial \left(\frac{\partial s_i / \partial \tilde{p}}{s_i} \right)}{\partial z_i} \right| < \left| \frac{\partial \left(\frac{\partial n_i / \partial \tilde{p}}{n_i} \right)}{\partial z_i} \right|.$$

In this model the sign of changes in sales and employment in response to a change in $\tilde{p}$ are the same. This result says that the percentage change in sales varies less across the idiosyncratic productivity distribution than the percentage change in employment. This property of the model is a direct result of decreasing returns to scale. If a firm adjusts its employment by a factor of $\theta > 0$ then its output change by a factor of θ^α. Thus differences in changes in employment across firms are dampened by a factor of α when one looks at output. This is consistent with the data to the extent that we consistently found that higher-productivity firms had smaller declines in employment, while the results for sales were more mixed.

To understand the implications of intensive margin reallocation for aggregate productivity, assume an aggregate production function of the form

$$Y = ZN^\alpha,$$

where $N = \sum_{i=1}^{M} n_i$ and $Y = \sum_{i=1}^{M} y_i$. The following result characterizes the relationship between changes in $\tilde{p}$ and aggregate productivity.[25]

Proposition 3 *Aggregate productivity is negatively related to $\tilde{p}$:*

$$\frac{\partial Z}{\partial \tilde{p}} < 0.$$

[25]For this result, we are assuming that a marginal change in $\tilde{p}$ does not affect any firm's decision about whether or not to operate. For this, it is sufficient that there exists some $\varepsilon > 0$ such that $|\pi_i - \gamma| > \varepsilon$ for all i.

This result implies that when there is a negative shock to the economy, aggregate productivity increases. The intuition for this relates to the correlation between the marginal product of labor and the percentage change in employment in the cross-section of firms. Proposition 1 provides that a negative shock to the economy has a smaller effect on the employment of higher-productivity firms, so the distribution of employment shifts towards them. Since the wedge is increasing in firm size, the level of employment at these firms is further below its efficient level than at lower-productivity firms. Thus, these firms have higher marginal products, and the increase in their share of labor increases productivity.

The final outcome that we consider with the model the decisions of firms about whether to operate. Since profit is strictly increasing in productivity, there is a threshold level of idiosyncratic productivity that is a function of $\tilde{p}$, denote it $z^*(\tilde{p})$, such that for all firms with $z_i > z^*(\tilde{p})$ choose to operate (i.e., $\pi_i > \gamma$). When there is a decrease in $\tilde{p}$, $z^*(\tilde{p})$ increases. This means that, in the absence of government support, a negative shock to the economy will cause more of the lowest productivity firms to choose not to operate. Through the lens of this model, an interpretation of the empirical results for government policy and exit is that some of the lowest productivity firms made use of government support policies to offset their costs—increasing π_i, decreasing the fixed cost γ, or both—so that exit was less concentrated amongst them than would have been expected.

7 Conclusion

The question of whether recessions have a cleansing effect by reallocating resources towards more productive firms is a source of ongoing debate. We contribute to answering this by providing new empirical evidence. For the intensive margin of reallocation, the analysis shows that during the Covid-19 recession, higher-productivity firms experienced smaller declines in employment. In relative terms, production resources reallocated towards them. For the extensive margin, there was not an appreciable increase in the exit rate during the recession and, in fact, the pruning of low-productivity firms through the exit

process, that was occurring in the pre-recession years, was dampened during the recession.

This recession has also provided a unique case study of government policies supporting firms. One concern with such policies is that they could support lower-productivity firms and thereby offset the reallocation gains from a recession. We find support for this, showing that lower-productivity firms were consistently more likely to take up government support, even after controlling for the impact of the recession on firms' sales.

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Appendix

A Covid-19 firm survey

To construct our sample we start with the dataset from the Covid-19 firm survey, which had at least one response from 7,816 firms. Firms that did not respond to at least one of the four surveys in April are dropped since since we want at least one observation per firm during the period when economy contracted most. The second stage of sample construction is to match this data with administrative data on firms. Since the most recent year of this data is 2018 some young firms are lost in this step. A few firms are also lost because their data for 2018 is incomplete. Since our analysis exploits within sector variation, the third step is to drop two sectors with too few observations for this kind of analysis: mining and utilities. Finally, for the construction of the main sample we drop firms with sales in 2018 that were less than the annual salary of a person earning the minimum wage, since such firms are unlikely to be fully functioning firms. The sample contains relatively large firms, so this is a minor concern and only 16 firms are dropped due to this criteria. The size of the sample at each of these steps is detailed in Table A1. In section 2 of the main text sample 4 is used for the analysis.

Since responses to the survey are voluntary, the dataset is an unbalanced panel. However, most firms in the sample responded to most of the surveys and, to the extent that this was not the case, responses were quite evenly spread over the survey period. The distribution of the number of surveys that each firm responded to is presented in Table A2(b). 31% of firms responded to all nine surveys and 69% of firms responded to at least 6 surveys. The number of responses to each survey from firms in our sample is in Table A2(a). These numbers are quite even over the survey period, with slightly lower values at the beginning and end.

The composition of the sample by industry and firm size is presented in Figure A1. We present both the distributions of sales and of firms, and to put the sample in perspective include analogous distributions for the population of firms from the administrative data.[26] Panels (a) and (b) show that the distributions of sales and firms, respectively, by industry. In terms of sales, the distribution matches the population quite closely. In terms of firms, the manufacturing and wholesale and retail trade sectors are overrepresented. For the size distributions, size is measured with the number of paid employees at a firm. The survey is clearly tilted towards larger firms relative to the population. Addi-

[26]The administrative data is for 2018. To be consistent with the sample from the survey, firms with annual sales less than the minimum wage are dropped.

Table A1: Construction of sample

Sample construction step		*Sample size*
0	Full Covid survey sample	7,816
1	Delete firms that did not answer in April	7,425
2	Merge with administrative data	7,156
3	Drop mining and utilities sectors	6,955
4	Drop if sales $<$ minimum wage	6,939
5a	Drop missing and extreme productivity observations	6,618
5b	Drop missing and extreme markup observations	6,879
5c	Drop missing and extreme productivity and markup observations	6,604

Notes: Steps 5a, 5b and 5c each follow separately from step 4. Extreme productivity (markup) observations are those in the bottom 1% and top 1% of the productivity (markup) distribution for the population of firms.

tional cross-sectional moments of the sample and the population are in Table A3. Consistent with firms in the survey being larger than the population, they are also older. The geographic distribution of the sample closely matches the population.

In terms of the construction of variables, we define a firm as having closed permanently if it says that this is its state in the last survey that it answers. Firms who report being in this state are not asked about their sales, employment or use of government policies. Therefore these firms are only included in the analysis of whether firms remained open throughout the survey period, in Table 4.

For the construction of the variables for the maximum declines in sales and employment, a few cases require special treatment. These variables are defined as the maximum declines in sales and employment reported by firms over the nine surveys. An issue arises when a firm reports closing permanently in one survey, but then reports being open or only closed temporarily in later surveys. We register such a firm as being closed temporarily in the period in which it reports being closed permanently and impute declines in sales and employment of more than 75% for this period. A second case arises where a firm reports being closed temporarily and fails to provide information about its sales and employment. In this situation we also impute declines in sales and employment of more than 75%. The change in sales in imputed for 96 firms and the change in employment for 193 firms.

For the analysis involving productivity in Sections 3 and 4 we make use of the administrative data for 2018 to compute firm level productivity. The data required to do this is missing for 203 firms so the sample size reduces by this

Table A2: Distribution of sample observations

(a) *Number of responses per survey*

April				May		June		July
6–12	13–19	20–26	27–3	4–17	18–31	1–14	15–28	29–12
4,673	5,562	5,545	5,206	5,148	4,937	5,222	4,453	4,333

(b) *Distribution of firms by number of survey responses*

1	2	3	4	5	6	7	8	9
6.3%	6.1%	5.7%	6.0%	6.9%	8.6%	10.6%	18.5%	31.3%

Notes: Panel (a) is the number of responses from firms in our sample to each wave of the Covid-19 firm survey. Panel (b) is the distribution of firms in our sample by the number of surveys that they responded to. E.g., 31.3% of firms responded to all 9 surveys that were conducted.

amount. We also drop firms with productivity in the top and bottom 1% of the productivity distribution of the population to prevent outliers impacting the results. The sample used for all analysis involving productivity is therefore sample 5a in table A1. We follow the same procedure for the analysis involving markups, resulting in sample 5b for this analysis. When productivity and markups are used, missing observations and outliers for both variables are dropped, resulting in sample 5c.

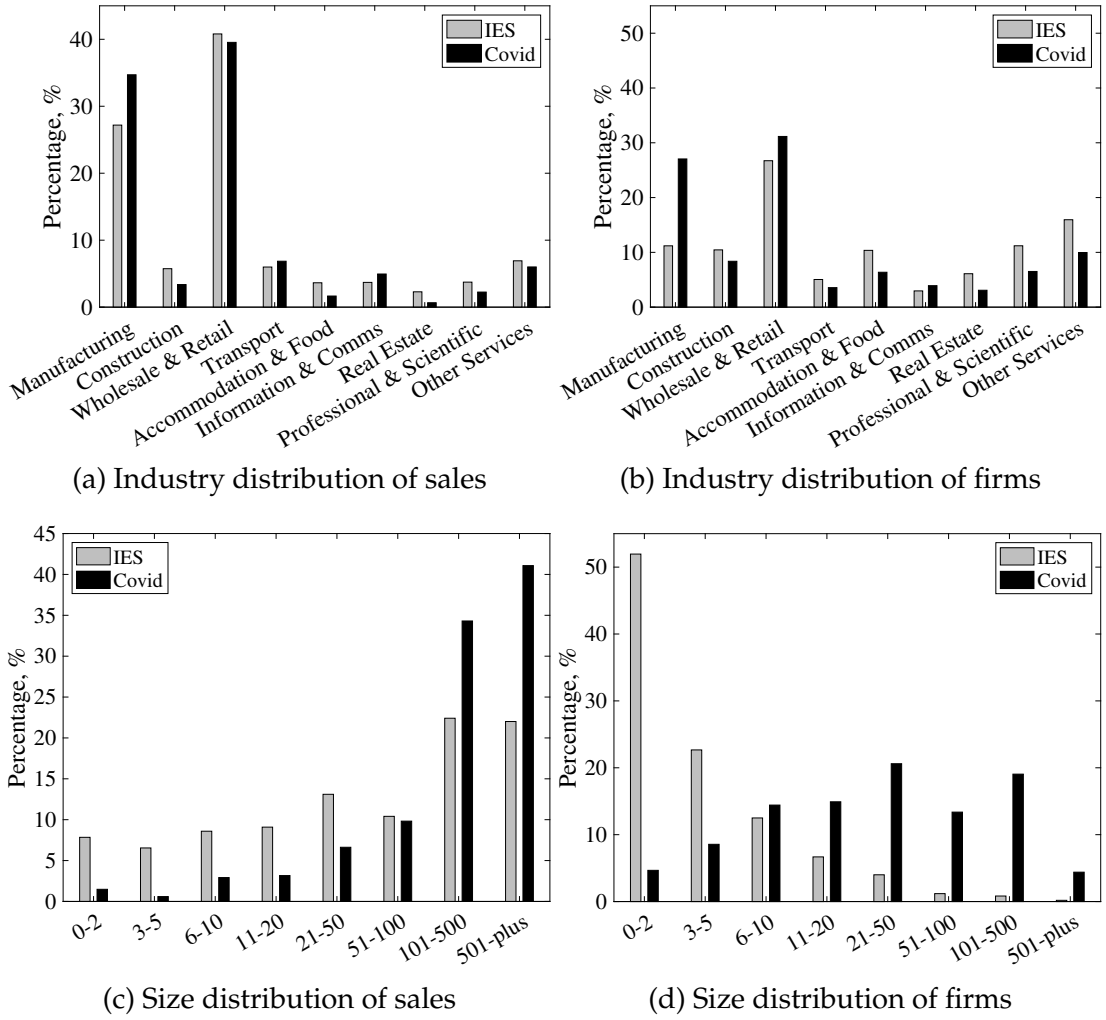
An additional point regarding the sample is that, for most questions on the survey, firms have the option to not respond. Throughout the analysis, firms without a response to a question being used are dropped. Similarly, firms were only asked about whether they used the government's paid furlough scheme in the final round of the survey, so the sample for the analysis of the use of this policy is restricted to firms answering that survey.

B Government policy details

Paid furlough

On March 26, 2020, the government implemented a paid furlough scheme to help firms keep employees and pay them a reduced salary. To be eligible for this policy, a firm had to satisfy at least one of the following three conditions: 1) the firm was forced to close (partially or completely) due to lockdown measures; 2) the firm was forced to close (partially or completely) due to problems in its supply chains; or 3) the firm suffered a drop of 40% or more of its sales compared to the previous two months.

Figure A1: Sample composition



(a) Industry distribution of sales

(b) Industry distribution of firms

(c) Size distribution of sales

(d) Size distribution of firms

Notes: This figure presents four distributions from the Covid-19 firm survey and the administrative data (IES) for the population of firms. Panel (a) and (b) are the distributions of sales and firms, respectively, across industries. Panel (c) and (d) are the distributions of sales and firms, respectively, across firm size. The firm size categories are measured with the number of paid employees.

The firm could use this paid furlough scheme for all of its employees or for a fraction of them. The employees under this scheme had two-thirds of their gross salary covered, subject to a floor equal to the minimum wage (€635) and a ceiling of €1905. The government paid 70% of this value whereas the firm was responsible for the remaining 30%. More details are available from the Portuguese Labor agency: https://www.dgert.gov.pt.

Debt moratorium

Table A3: Additional moments of sample and population

	Covid-19 Survey	*Population*
Age		
Mean	26	14
Median	23	10
Std.	17	13
Geographic distribution		
Aveiro	8%	6%
Beja	1%	1%
Braga	8%	8%
Bragança	1%	1%
Castelo Branco	1%	1%
Coimbra	3%	3%
Évora	1%	1%
Faro	4%	5%
Guarda	1%	1%
Leiria	5%	5%
Lisbon	34%	29%
Portalegre	1%	1%
Porto	19%	19%
Santarém	4%	3%
Setúbal	4%	6%
Viana do Castelo	2%	2%
Vila Real	1%	1%
Viseu	2%	3%
Ponta Delgada	1%	1%
Funchal	1%	2%

Notes: For the geographic distribution the country is divided into regions around each of the major cities.

Starting on March 27, 2020, firms and individuals could request a debt moratorium. Firms were eligible to take advantage of this policy if they were not delinquent on their debt and had all their obligations with the Social Security agency met. The policy was originally supposed to last until September 2020, but, in June 2020, it was extended until March 2021.

A firm that opted for this policy could have all debt payments suspended for the duration of the policy. Interest would be capitalized at the contracted interest rate during the period. Alternatively, the firm could opt to pay only the interest. The maturity of the contract was also extended by the same length of time. More information is available from the Portuguese central bank.[27]

[27] See https://www.bportugal.pt/page/o-banco-de-portugal-e-o-covid-19.

Government credit lines

On March 12, the government implemented different credit lines focusing on small and medium enterprises of the sectors most affected by the pandemic: restaurants, tourism and manufacturing. Each firm could borrow up to €1.5 million. The maturity was up to 4 years, with a 1-year grace period on interest and principal payments. The interest rate could be either fixed or variable and the spread varied up to 1.5 percentage points.

In early April, these special credit lines were expanded to all sectors in the economy and more resources were devoted to them according to an agreement with the European Commission.[28]

Tax deferral

On March 26, the Ministry of Finance issued a decree allowing individuals and firms to delay payment of several taxes without any penalty. Firms could delay the payment of income and value added taxes owed in April, May and June, and start repayment afterward in either three interest-free installments or in six installments where interest only accrued on the last three payments. Social security contributions could also be partially delayed. Throughout March, April and May, firms only had to pay one-third of these contributions. The remaining two-thirds could be paid in three or six monthly installments without interest accrual. These payments were supposed to start in July. Finally, payments related to fiscal debt with the government were suspended until July.

Firms were eligible to use these policies if they had yearly sales of no more than €10 million, had been forced to close due to the pandemic, or had a decline in sales of at least 20%.[29]

C Sector level statistics

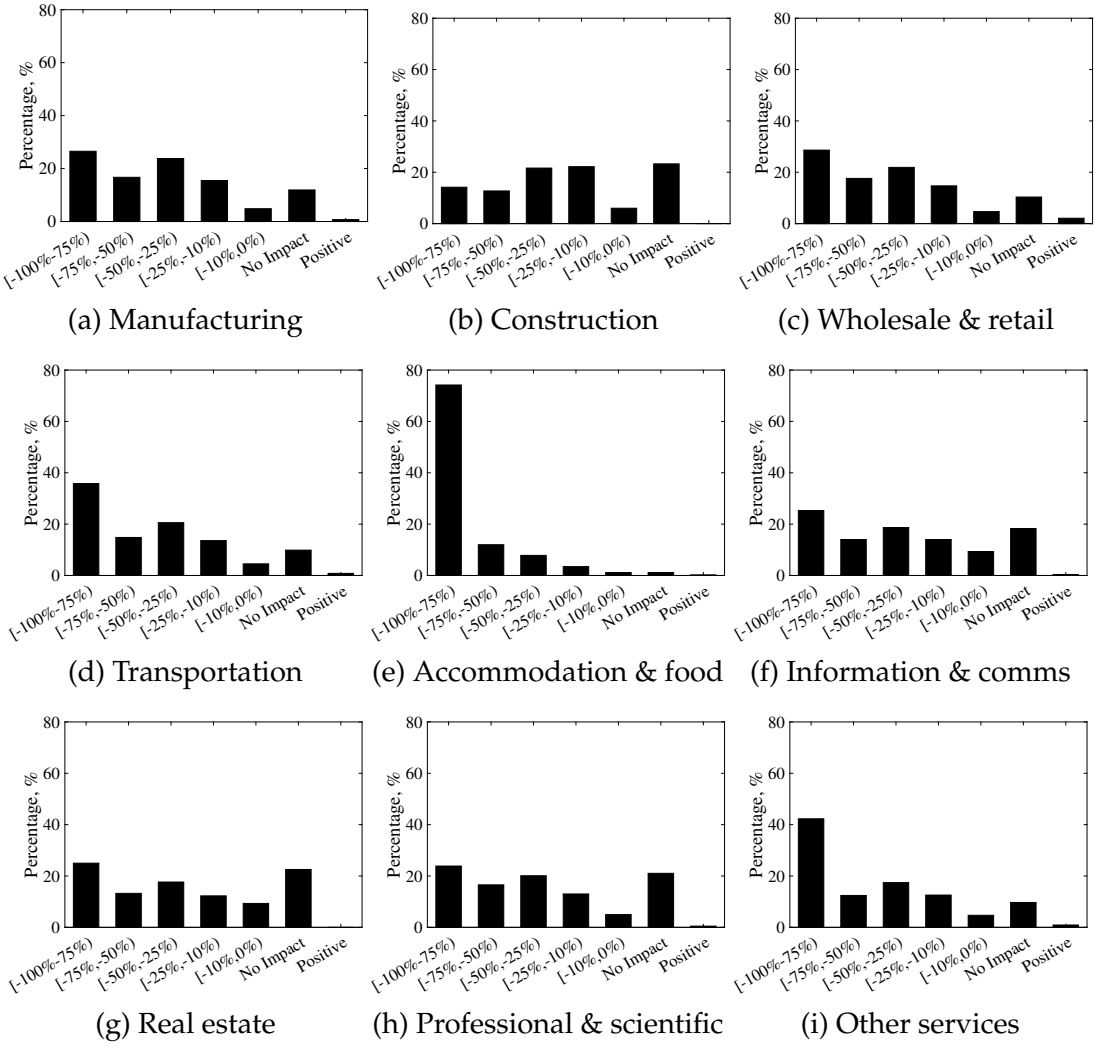
Figures C2 and C3 present the distribution of changes in sales and employment for firms by sector.

D Sample construction for exit analysis

The sample for the exit analysis is based on the balance sheet data. The baseline sample contains all firm-year observations for 2014–18 excluding: the agriculture, finance, utilities and mining sectors; observations for which the firm's

[28] See https://covid19estamoson.gov.pt/medidas-excecionais/empresas.
[29] See https://dre.pt/application/conteudo/130779505.

Figure C2: Impact on sales by sector



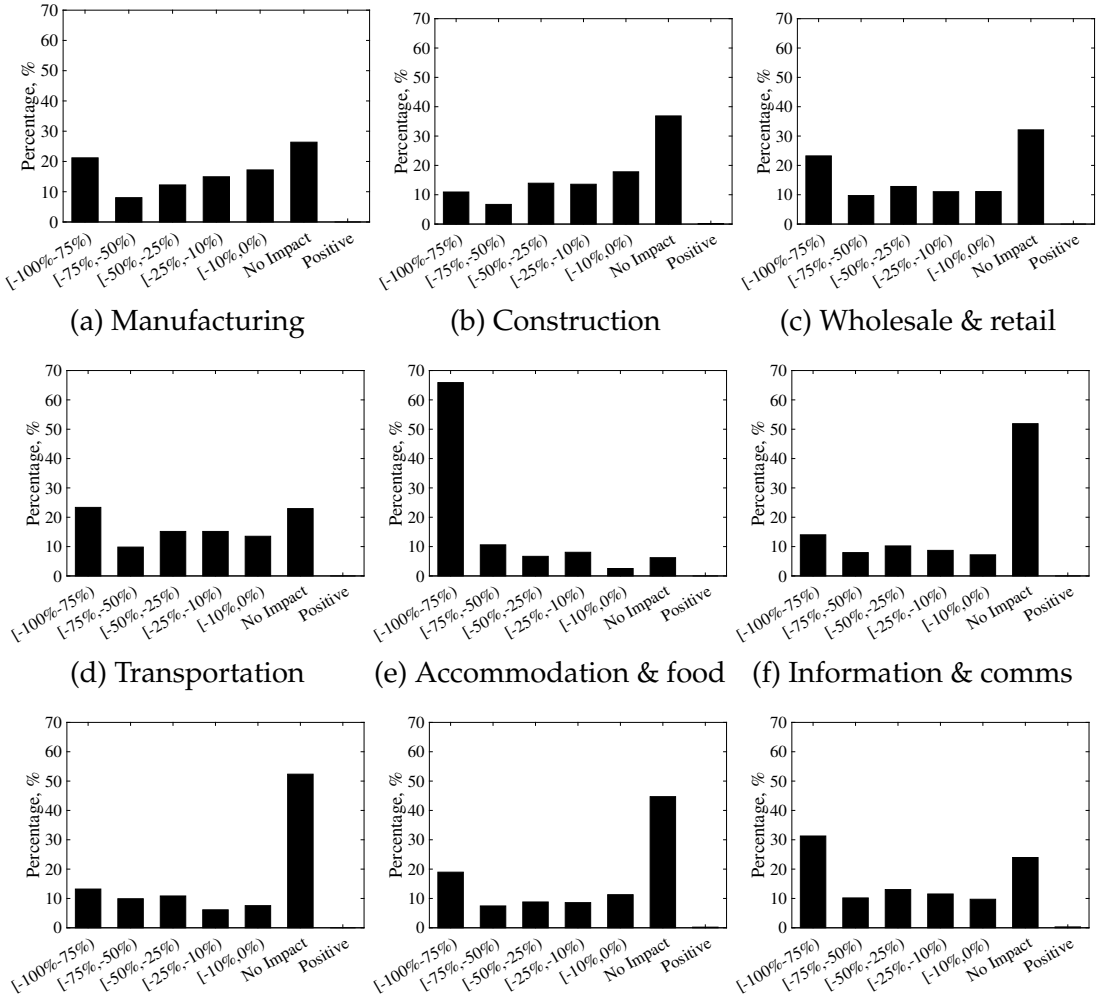
(a) Manufacturing (b) Construction (c) Wholesale & retail

(d) Transportation (e) Accommodation & food (f) Information & comms

(g) Real estate (h) Professional & scientific (i) Other services

Notes: This figure presents the distribution of the percentage change in sales for each sector. The horizontal axis is bins for the percentage change in sales and the vertical axis is the share of firms in each category. A firm's change in sales is measured as its minimum reported in the Covid-19 firm survey (i.e., the maximum decline it experienced).

Figure C3: Impact on employment by sector



(a) Manufacturing (b) Construction (c) Wholesale & retail

(d) Transportation (e) Accommodation & food (f) Information & comms

(g) Real estate (h) Professional & scientific (i) Other services

Notes: This figure presents the distribution of the percentage change in employment for each sector. The horizontal axis is bins for the percentage change in employment and the vertical axis is the share of firms in each category. Employment is measured as the number of employees actively working, which excludes employees on paid furlough. A firm's change in employment is measured as its minimum reported in the Covid-19 firm survey (i.e., the maximum decline it experienced).

Table D4: Construction of sample for exit analysis

Sample construction step		*Sample size*
0	Baseline sample	1,420,857
1	Drop if exit occurs in current or following year	1,407,151
2	Drop unreliable exit data	1,407,110
3a	Drop missing and extreme productivity observations	1,112,642
3b	Drop missing and extreme markup observations	1,377,883
3c	Drop missing and extreme productivity and markup observations	1,108,407

Notes: Steps 3a, 3b and 3c each follow separately from step 2. Extreme productivity (markup) observations are those in the bottom 1% and top 1% of the productivity (markup) distribution for the population of firms.

sales are less than the income of a worker earning the minimum wage; and observations where the firm is inactive. Since we are measuring exit at a two year lag, we drop any observation for which the firm exits in the current or following year. There are a small number of cases (41) in which there is a discrepancy between the exit information in the firm registry and the presence of a firm in the balance sheet data—these observations are dropped.[30] Finally, for analysis involving productivity, markups, or both, observations are dropped for which the necessary data to compute these variables is missing. Outliers for these variables (top and bottom 1%), assessed for each sector in each year, are dropped as well. The sample sizes corresponding to each of these steps are reported in Table D4. Sample 2 is used for Figure 4 and samples 3a–3c are used for the regression analysis reported in Table 7.

E Measurement of firm characteristics

For all regressions using data from the Covid-19 survey (everything except the exit analysis in Section 5), firm characteristics are being measured with data from 2018, because this is the most recent available. This raises the concern that firms could have changed between 2018 and March 2020 and, if this was the case, then we would not have good measures of firm characteristics at the start of the recession. The fact that firms in our sample are relatively large and mature (see Figure A1 and Table A3) somewhat ameliorates this concern. To further address this issue, we use earlier years of the administrative data to show that the characteristics of the firms in our sample were very stable from 2016–

[30] This occurs when a firm is reported in the registry as exiting in year t but then appears in the balance sheet data in subsequent years.

Table E5: Sales, debt to assets and productivity correlations, 2016–18

	Productivity		*Markups*		*Sales*		*Debt to Assets*	
	2017	2018	2017	2018	2017	2018	2017	2018
2016	0.918	0.880	0.836	0.812	0.977	0.954	0.937	0.910
2017	1.000	0.926	1.000	0.883	1.000	0.990	1.000	0.935

2018. Since there was no significant shock to the economy between 2018 and the start of the pandemic, this provides evidence that the 2018 results should be a good measure of pre-pandemic firm characteristics.

The firm characteristics that are used in the analysis are productivity, markup, sector, age, sales, debt to assets ratio and whether a firm is in the Lisbon region or not. Of these, sector, age and geographic location are very sticky characteristics so changes in them are not a large concern. Productivity, markup, sales and debt to assets are more prone to change over time. To test their stability, we compute them for firms in our sample for 2016, 2017 and 2018, and present their correlations over time in Table E5. The three TFP correlations range from 0.88 to 0.91, the markup correlations are between 0.81 and 0.88, the sales correlations are all 0.95 and above, and the debt to assets correlations are between 0.82 and 0.93. These correlations show that these characteristics have been very stable in recent years.

For the analysis of exit in Section 5, firm characteristics are also measured at a two year lag, but the sample is different and the period of analysis is longer (from 2016–2020). For this analysis we use data for 2014–2018 to measure firm characteristics. The production function is re-estimated for each sector for each year for the purpose of productivity and markup measurement. Since firm characteristics are being measured at a two year lag, we have tested how stable these are in this sample. The within-firm correlations of productivity, markup, sales and the debt to assets ratio at a two year interval are 0.71, 0.65, 0.96, and 0.06, respectively. The most important characteristics for our analysis—productivity and markups—have quite high correlations, and so does sales. The debt to assets ratio is more volatile.

The inputs weights for each sector that are used to estimate TFP for 2018 with equation (1) are presented in Table E6. Markups are estimated at the firm level using equation (2) and the average markup in each sector for 2018 for the sample that we use from the Covid-19 survey is reported in the same table. For earlier years the values of the production function parameters are very similar.

Table E6: Input weights for TFP estimation and average markups

Sector	α_L	α_M	α_K	*Markup*
Manufacturing	0.15	0.76	0.10	1.37
Construction	0.24	0.66	0.10	1.38
Wholesale and retail trade	0.32	0.49	0.19	1.51
Transportation	0.21	0.65	0.14	1.42
Accommodation and food services	0.29	0.56	0.15	1.22
Information and communication	0.26	0.52	0.22	1.37
Real estate	0.12	0.51	0.37	1.75
Professional, scientific and technical activities	0.31	0.54	0.15	1.37
Other services	0.36	0.51	0.13	1.61

Notes: The α values are the estimates for 2018. The Markup column contains the average markup for each sector for 2018 for the sample that is used from the Covid-19 survey.

F Additional policy use results

Tables F7 and F8 reproduce Tables 5 and 6 from the main text with two changes. The full sample is used, rather than being restricted to firms who are eligible to use the policies. The controls for the change in sales of firms are dropped. The main result that higher-productivity firms were less likely to use all policies holds.

Table F7: Policy use: debt moratorium and credit lines

	Debt Moratorium					*Govt. credit lines*				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\widehat{TFP}_i$	-0.063***				-0.063***	-0.025***				-0.021***
	(0.005)				(0.006)	(0.004)				(0.005)
TFP Q2		-0.032*					0.020			
		(0.017)					(0.014)			
TFP Q3		-0.120***					-0.028**			
		(0.016)					(0.014)			
TFP Q4		-0.174***					-0.069***			
		(0.015)					(0.013)			
$\widehat{Markup}_i$			-0.033***		-0.003			-0.018***		-0.010**
			(0.004)		(0.005)			(0.003)		(0.004)
$Markup$ Q2				0.058***					0.020	
				(0.016)					(0.013)	
$Markup$ Q3				0.036**					0.025*	
				(0.015)					(0.013)	
$Markup$ Q4				-0.043***					-0.026**	
				(0.015)					(0.012)	
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
%Δ Sales FE	No	No	No	No	No	No	No	No	No	No
Obs.	5387	5387	5583	5583	5376	5319	5319	5519	5519	5309
R^2	0.049	0.054	0.030	0.033	0.049	0.027	0.031	0.026	0.027	0.027

Notes: All regressions take the form specified in equation (4). In columns (1)–(5) and (6)–(10) the dependent variable y_i is an indicator for whether a firm used the government's debt moratorium and credit line policies, respectively. Sector FE are sector fixed effects. The Controls are age, sales and an indicator for whether a firm is located in the Lisbon region. %Δ Sales FE denotes fixed effects for a firm's percentage change in sales—these are not included in the regressions presented in this table. The sample includes all firms, whether or not they were eligible to use the relevant policy. Robust standard errors are used and are in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table F8: Policy use: tax deferral and paid furlough

	Tax Deferral					*Paid Furlough*				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$\widehat{TFP}_i$	-0.032***				-0.029***	-0.040***				-0.036***
	(0.006)				(0.007)	(0.007)				(0.008)
TFP Q2		-0.012					-0.022			
		(0.017)					(0.021)			
TFP Q3		-0.066***					-0.004			
		(0.017)					(0.021)			
TFP Q4		-0.078***					-0.102***			
		(0.017)					(0.021)			
$\widehat{Markup}_i$			-0.026***		-0.010			-0.027***		-0.014*
			(0.005)		(0.006)			(0.007)		(0.008)
$Markup$ Q2				0.025					0.035*	
				(0.016)					(0.020)	
$Markup$ Q3				0.006					0.004	
				(0.016)					(0.020)	
$Markup$ Q4				-0.046***					-0.030	
				(0.016)					(0.019)	
Sector FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
%Δ Sales FE	No	No	No	No	No	No	No	No	No	No
Obs.	5539	5539	5737	5737	5529	4098	4098	4283	4283	4091
R^2	0.032	0.032	0.022	0.022	0.033	0.093	0.094	0.093	0.092	0.094

Notes: All regressions take the form specified in equation (4). In columns (1)–(5) and (6)–(10) the dependent variable y_i is an indicator for whether a firm used the government's tax deferral and paid furlough policies, respectively. Sector FE are sector fixed effects. The Controls are age, sales and an indicator for whether a firm is located in the Lisbon region. %Δ Sales FE denotes fixed effects for a firm's percentage change in sales—these are not included in the regressions presented in this table. The sample includes all firms, whether or not they were eligible to use the relevant policy. Robust standard errors are used and are in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

G Proofs

Proposition 1 It follows from the first order condition of firm i's problem that

$$\frac{\partial n_i/\partial \tilde{p}}{n} = \frac{1}{(1-\alpha)\tilde{p} + \frac{\tau n_i^{2-\alpha}}{\alpha z_i}},$$

and therefore the proposition holds if and only if

$$\frac{\partial}{\partial z_i}\left(\frac{n_i^{2-\alpha}}{z_i}\right) > 0.$$

This is equivalent to

$$(2-\alpha)\frac{\partial n_i}{\partial z_i} > n_i.$$

One can derive $\partial n_i/\partial z_i$ using the first order condition and verify that this inequality is satisfied.

Proposition 2 It follows from the definition of s_i that

$$\frac{\partial s_i/\partial \tilde{p}}{s_i} = \frac{1}{\tilde{p}} + \alpha\frac{\partial n_i/\partial \tilde{p}}{n_i} \implies \frac{\partial\left(\frac{\partial s_i/\partial \tilde{p}}{s_i}\right)}{\partial z_i} = \alpha\frac{\partial\left(\frac{\partial n_i/\partial \tilde{p}}{n_i}\right)}{\partial z_i}.$$

Since $\alpha < 1$, the result follows.

Proposition 3 Aggregate productivity can be expressed as

$$Z = \frac{\sum_i z_i n_i^\alpha}{(\sum_i n_i)^\alpha} = \sum_i z_i \omega_i^\alpha,$$

where $\omega_i = n_i/N$ is the share of labor used by firm i. If labor share shifts from firm i to firm j, aggregate productivity increases if firm j has a higher marginal product from its labor share: $\alpha z_j \omega_j^{\alpha-1} > \alpha z_i \omega_i^{\alpha-1}$. This is equivalent to it having a higher marginal product of labor: $\alpha z_j n_j^{\alpha-1} > \alpha z_i n_i^{\alpha-1}$. Let $MPL_i \equiv \alpha z_i n_i^{\alpha-1}$.

Under the equilibrium allocation, marginal products are strictly increasing in productivity:

$$\frac{\partial MPL_i}{\partial z_i} > 0. \tag{8}$$

From the derivative of MPL_i with respect to z_i, one can see that this inequality holds if an only is $n_i > (1-\alpha) z_i \frac{\partial n_i}{\partial z_i}$. This inequality can be verified using the first order condition of firm i's problem.

Proposition 1 implies that a marginal increase in $\tilde{p}$ causes smaller percentage increases in n_i at higher productivity firms, so lower productivity firms have larger increases in employment share:

$$\frac{\partial\left(\frac{\partial\omega_i}{\partial\tilde{p}}\right)}{\partial z_i} < 0.$$

Let the M firms in the economy be ordered according to productivity, so that $z_{i+1} \geq z_i$ for all $i \in \{1, \ldots, M-1\}$. Since $\sum_i \omega_i = 1$, there exists an index i^* creating a partition of the set of firms such that $\partial\omega_i/\partial\tilde{p} \geq 0$ for all $i \leq i^*$ and $\partial\omega_i/\partial\tilde{p} < 0$ for all $i > i^*$. It follows from condition (8) that, for any $i \leq i^*$ and $j > i^*$, $MPL_i < MPL_j$. Since all firms that increase their labor share in response to a marginal increase in $\tilde{p}$ have lower MPL_i than those that lose labor share, therefore $\partial Z/\partial\tilde{p} < 0$.