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Abstract

Based on the ZHAW Managers Survey (7-13 April 2020) we evaluate firm reactions towards the COVID-19 crisis. We find that the Swiss economic lockdown measures successfully froze the economy, i.e., firms show very little pro-active reactions towards the crisis, but drastically decrease their business activities. The firms in the survey report that the decline in foreign demand is the single most important reasons for their deteriorating business situation. The only significant pro-active reactions to mitigate the crisis are increased digitalization efforts. These efforts are expected to have a long-lasting impact on firms' performance due to a selection effect, i.e., firms with more positive experience of digitialization will maintain their higher levels of digitalization even after the crisis. In general we find that firms that faced a more difficult business situation before the crisis are affected more severely during the crisis. Moreover, we investigate the impact of the Swiss federal loan program (Bundeshilfe) on the business activities of Swiss firms. Specifically, we focus on the take up of firms and its interaction with the perceived business situation before and during the COVID-19 crisis. To this end, we develop a stylized theoretical model of financially constrained heterogeneous firms. We find that policy makers face a trade-off between immediate higher unemployment rates and long-term higher public spending. The former arises from a combination of a too strong economic impact of the COVID-19 lockdown and too low levels of loans provided by the government to financially distressed firms. Nevertheless, providing (too) high levels of loans to firms might create zombie firms that are going to default on their debt in the future leading to an increase in public spending.

JEL classification : D22, D25, D84, G33

Key Words : COVID-19, expectations, firm behaviour, financial constraints, zombie firms

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1 Introduction

The COVID-19 crisis does not only represents great challenges to local healthcare systems, but also puts many companies and organizations to a hard test. The arising problems are numerous and often unprecedented. This implies that during the COVID-19 crisis firms face an existential threat and might often fight for the survival of their business. Policy makers face the most severe crisis since 1930s great depression. Common economic policy instruments are untested in this special situation, thus it becomes even more important to understand the firm-level behavior by using theoretical models and empirical analysis.

In this paper we investigate the impact of the COVID-19 crisis on Swiss firms by combining empirical findings from the ZHAW managers barometer survey with a stylized theoretical model. The contribution of the study is twofold. First, we analyze the expectation and actions of firms during the crisis in detail. To this end, we also consider firm-level responses such as short-time work or digitalization efforts that could mitigate economic impact of the COVID-19 crisis on firms. Second, we develop a stylized model of financially constraint firms along the lines of Manova (2013) and Chaney (2016) that specifically focuses on guaranteed loans for firms by the (Swiss) government to support financially distressed firms during the crisis.

we find that the COVID-19 crisis dramatically impacts Swiss firms: the perceived business situation deteriorates from "Good" to "Neutral" at the median between 2019 and the expected peak economic impact of the COVID-crisis. This is mainly driven by a strong decline of foreign demand. Moreover, firms that faced a less favorable pre-crisis business situation expect a much stronger impact of the COVID-19 crisis. This is consistent with the findings of Buchheim et al. (2020) for German firms. The Swiss firms in our survey expected the peak economic impact of the COVID-19 crisis by mid July 2020 and a return to a (new) normal situation by the end of 2020. Given this rather short time horizon it is not a surprise that most firms are not changing their business model dramatically. In this sense the efforts to "freeze" the Swiss economy seemed to have worked. Still we observe a persistent long-run effect in the area of digitalization. Specifically home office is expected to increase significantly, i.e., almost 9 percentage point relative to pre-crisis levels or on average an additional half-day of home office for employees. Most of the observed firm reactions are aiming at keeping the business operating at a minimal costs, i.e., using short-time work and guaranteed loans by the federal government. In the public opinion providing government loans at very favorable terms to private companies is often seen critical. These loans could distort the market mechanism and keep firms (artificially) alive, although their business situation would not allow it. Caballero et al. (2008) coined the term zombie firms for these

kind of firms, when analyzing the Japanese firms in the 1990s.[1] Empirically, we find that the probability to take up these guaranteed loans increases with the perceived pre-crisis business situation, i.e., firms that were doing well before the crisis are more likely to use the Swiss federal loans. This implies that the Swiss federal loan program is not creating zombie firms at a large scale, but some firms (with a worse pre-crisis business situation) might actually fear the over-indebtedness due to the additional loans. We develop a stylized model of financially constraint firms that is consistent with these empirical findings. In the model policy makers simultaneously decide about the economic impact, i.e., the level of (economic) lockdown measures, and the extent of guaranteed loans provided to firms. In a normative sense, both should be positively related: a more severe economic lockdown should be accompanied by higher levels of guaranteed loans. Additionally, we find that policy makers face a trade-off between increasing unemployment during the crisis and higher public spending in the long-run due to over-indebted firms defaulting after the crisis. If guaranteed loans are under-supplied relative to the economic lockdown measures, firms will not be able to cover their fixed operational costs during the crisis and hence become insolvent leading to higher unemployment rates. Specifically, if firms are not able to roll-over their debt, they would need a productivity gain in the future (relative to the market) to repay their debt. This creates a wedge between firms that were profitable before the crisis and firms that are able to repay their debt.

The paper is structured as follows. Section 2 briefly summarizes the related literature. In section 3 we develop a model of financial constrained firms and their reaction during an economic downturn. Section 4 presents stylized facts (based on the ZHAW managers barometer survey) about the economic impact of the COVID-19 crisis on Swiss firms. Moreover, we show that the key model predicts are consistent with the empirical findings for Swiss firms. Finally, section 5 concludes.

2 Literature

The recent research in economics is focusing heavily on the economic impact of COVID-19. Most of these analyses are theoretical and often have interdisciplinary aspects by combining standard epidemiological models (Kermack and McKendrick, 1927; Ferguson et al., 2020) with macroeconomic models, see for example Eichenbaum et al. (2020) or Guerrieri et al. (2020) on the interplay epidemic and economics. While these papers take a macroeconomic perspective, others have focused more on the firm-level reactions. Bloom et al. (2019), Bartik et al. (2020), Brülhart et al. (2020), and Buchheim et al. (2020) look at firms' reaction

[1] More recently, McGowan et al. (2017) and McGowan et al. (2018) have shown that the share of such companies (the zombie share) has increased significantly in the wake of the 2007 financial crisis across advanced economies. Thus, one might expect a similar situation during the COVID-19 crisis.

towards COVID-19 in the UK, USA, Switzerland, and Germany respectively.[2] Buchheim et al. (2020) is one of the few studies looking at firm expectations, which are very important in a situation with increased uncertainty, see Binder (2020) and Dietrich et al. (2020) for individual expectations.

The two main economic policy instruments used during the crisis in Switzerland are short-time work and guaranteed loans to firms, see Eichenauer and Sturm (2020). short-time work should help to maintain employee and employer matches. Once a match is resolved unemployment can be very persistent and have a lasting negative impact on earnings of dismissed workers, see Hamermesh (1989), Gregory and Jukes (2001), and Burda and Mertens (2001). Moreover, the possible loss of firm-specific knowledge might lead to even more negative long-run effects as described by Pissarides (1992) and Edin and Gustavsson (2008). short-time work has proved to be an effective tool to mitigate negative labor market effects during an economic crisis: Kopp and Siegenthaler (2018) show that this was specifically the case for Switzerland during and after the financial crisis. While short-time work is perceived rather positive, loans to struggling firms are often seen much more critical. It is argued that these loans could distort the market mechanism and keep firms (artificially) alive although their business situation would not allow it. This firms can be seen as zombie firms (Caballero et al., 2008). These firms are in general less productive and might crowd out growth of more productive firms by locking resources, which Banerjee and Hofmann (2018) call congestion effects. They also find that zombie firms decrease employment growth.
In terms of the proposed theory model, we follow closely Manova (2013) and Chaney (2016), but adjust their model to a country in autarky and the Swiss institutional setup.

3 Model

In this section we develop a simple model of financially constrained firms. To this end, we adapt the standard model of Manova (2013) to the specific setting of Swiss federal loan program for firms during the COVID-19 crisis. Specifically, collateral for the Swiss federal loans is zero as well as the interest rate. The central government guarantees credits up to CHF 500,000, and firms could apply for these loans at their local bank without any collateral and only a minimal administrative burden. The credit contract is fully enforceable for the local bank as the federal government guarantees the loan.

In our model we consider three periods: (i) a pre-crisis period, which we take as benchmark, (ii) a crisis period, in which the demand for goods has dropped relative to the benchmark period, and (iii) a post-crisis or "new normal" period, in which demand for goods has re-

[2] Brülhart et al. (2020) focuses exclusively on self-employed individuals in Switzerland.

turn to previous levels.[3] Firms are heterogeneous as in Chaney (2008) version of the Melitz (2003) model.[4]

We rely on three main assumptions throughout the stylized model. First, the economic downturn due to COVID-19 is caused by a decline of demand and is not a supply shock. This is broadly consistent with Baqaee and Farhi (2020) and Guerrieri et al. (2020) who show that an initial supply shock can trigger a demand shock that is much bigger than the initial shock itself. Second, while the demand during the crisis is lower for all firms in our model, the demand after the crisis will be equal to the demand before the crisis.[5] Third, firms that at any point in time are not able to finance their fixed operational costs are insolvent and hence bankrupt. In this case a firm will not take up any additional credit to partially cover its fixed costs. This assumption is inline with Swiss bankruptcy laws, although the delay of a firm's bankruptcy is not a crime in itself, but knowingly worsen the over-indebtedness of the firm makes the person liable (even with their private wealth and income).

3.1 Utility

The representative individual in the economy has an upper tier Cobb-Douglas utility function with share parameter λ. At the lower level the representative individual has CES (constant elasticity of substitution) preferences over a continuum of goods, $q(\omega)$, within the set of goods Ω, and a linear utility over a homogeneous good q_0 produced in an outside sector. This outside good, used as the numeraire, is produced under constant returns to scale. Thus, the individual utility is given by

$$u = q_0^{1-\lambda_j} \left(\int_{\omega \in \Omega} q(\omega)^{\alpha} \, d\omega \right)^{\frac{\lambda_j}{\alpha}}, \tag{1}$$

where $\epsilon = 1/(1-\alpha) > 1$ is the constant elasticity of substitution. We use the upper tier Cobb-Douglas share parameter, λ_j, to introduce a demand shock in our model. λ_j can be seen as a (relative) demand shifter for all differentiated goods. We assume that $0 < \lambda_C \leq \lambda_N = \lambda_B < 1$, where $j = B$ indicates before crisis values, $j = C$ indicates the values during the economic downturn, and $j = N$ after crisis (new normal) values. The pre- and post-crisis demand shifters are equal by assumption. Alternatively, we could use also an exogenous preference parameter within the CES utility function, which varies between all goods in the set ω. Using the exogenous preference shifter within the CES sub-utility

[3] As the credit does not bear any interest rate, we assume that the intertemporal discount rate is zero, which simplifies the model considerably.

[4] The Chaney (2008) model offers a great simplification to analyze the extensive margin adjustments, without fully considering wage adjustments.

[5] This assumption could be relaxed, but this would introduce a wide variety of different scenarios to the model that add very little in terms of the model intuition.

function is idiosyncratic to a productivity shock for the firm producing the respective variety. In this model we aim at modeling a demand side shock and hence the upper tier utility share parameter is more appropriate. Changes in the share parameter reflect shifts of the individual expenditures towards or away from the differentiated goods.[6] We do not differentiate between different sectors as this would only complicate the notation and add little to the model.[7]

The representative individual maximizes her CES sub-utility subject to the (residual) budget constraint

$$\lambda_j Y = \int_{\omega \in \Omega} p(\omega) q(\omega) \, d\omega, \tag{2}$$

where Y are the expenditures of the representative individual and $p(\omega)$ is the price of a good ω. The demand for a good $q(\omega, \lambda_j)$ is given by

$$q_j(\omega, \lambda_j) = \frac{p(\omega)^{-\epsilon} \lambda_j Y}{P^{1-\epsilon}}, \tag{3}$$

where

$$P = \left(\int_{\omega \in \Omega} p(\omega)^{1-\epsilon} \, d\omega \right)^{\frac{1}{1-\epsilon}}, \tag{4}$$

is the common CES price index, which all firms and individuals take as given.

3.2 Firms

A firm producing a variety ω faces fixed costs f that are re-occurring each period, see Chaney (2008). Firms are heterogeneous in terms of their productivity, a, which is drawn from a known cumulative distribution function $G(a)$ with support $0 < a_L$. As a is drawn from a continues function and each firm produces exactly one specific good, we can replace the good or firm indicator ω by the firm productivity a uniquely identifying the firm and product. Producing one unit good ω costs c/a, where $c > 0$ is the cost of a cost-minimizing bundle of inputs. The profits of a firm a in any of the three considered periods $j = B, C, N$ are given by

$$\pi_j(a) = p(a) q(a, \lambda_j) - q(a, \lambda_j) \frac{c}{a} - f + K_j, \tag{5}$$

where K_j indicates the credit taken up or repaid. Specifically, $K_N = -K_C$ corresponds to the repayment of the credit with zero interest rate in the new normal. We assume $K_B = 0$, i.e., before the crisis firms are not using any credit.

Firms are optimizing their profits considering the demand for goods (derived from the CES utility function) in equation (3), while taking the price index in equation (4) as given. Thus,

[6] Individuals might reduce their consumption of certain goods but increase others, i.e., travelling for vacation vs. buying a new computer.

[7] See Anderson and Yotov (2010) or Gopinath et al. (2014) .

the optimal price of a good provided by firm a is given by

$$p(a) = \frac{1}{\alpha}\frac{c}{a}, \tag{6}$$

which is the standard constant markup over marginal costs and independent of the actual economic situation λ_j.

We assume that there is a maximum take up of credits, $K_C \leq M \leq f$.[8]
Firms can only borrow the amount necessary to cover their fixed costs and not any variable costs.[9] This implies that during crisis there exists a cutoff productivity $\overline{a}_C > 0$ for which $\pi_C(\overline{a}_C) = 0$ given the maximum take up $K_c = M$. Firms with a lower productivity draw will not have enough earnings and credit available to them to cover their fixed costs in this period. We refer to this cutoff as the debt constraint.
Using the zero-profit condition, $\pi_C(\overline{a}_C) = 0$, yields the cutoff $\overline{a}_C$ for firms to survive the crisis by using the maximum available credit M. This cutoff is given by

$$\overline{a}_C = (f - M)^{\frac{1}{\epsilon-1}} \left(\frac{\epsilon}{\lambda_C}\right)^{\frac{1}{\epsilon-1}} Y^{\frac{1}{1-\epsilon}} \frac{\epsilon}{\epsilon - 1}\frac{1}{P_C}c, \tag{7}$$

Given the cutoff productivity and the following distribution of prices, the crisis price index $P_C(\overline{a}_C)$ can be determined analogously to Chaney (2008), see appendix A for more details.

Next, we consider the firms that do not need to take up any debt during the crisis to ensure their survival, i.e, there profits are non-negative during the crisis. In this case $\pi_C(\tilde{a}_C) = 0$ with $K_C = 0$ defines the viability cutoff for firms during the crisis, which we denote as $\tilde{a}_C$. Similarly, $\pi_B(\tilde{a}_B) = 0$ with $K_B = 0$ defines the viable firm before the crisis, and $\pi_N(\tilde{a}_N) = 0$ with $K_N = 0$ defines the viable firm in the new normal. The three cutoffs are given by

$$\tilde{a}_j = f^{\frac{1}{\epsilon-1}} \left(\frac{\epsilon}{\lambda_j}\right)^{\frac{1}{\epsilon-1}} Y^{\frac{1}{1-\epsilon}} \frac{\epsilon}{\epsilon - 1}\frac{1}{P_j}c \quad \forall\ j = B, C, N. \tag{8}$$

If a firm did take on any debt during the crisis, it has to repay it during the new normal period. A firm can afford to do so, if after repaying its debt it still has non-negative profits, i.e., $\pi_N(a) \geq 0$.[10] Notice that the amount of credit a firm would take up during the crisis can be written as

[8] The Swiss federal loan program allows firms to take up higher levels of credit, but in this case they would need to provide collateral assets. For simplicity we assume that firms are not able take up debt higher than the maximum M.

[9] The Swiss policy actually state that the loan cannot exceed 10% of firms total revenues, but loans below CHF 0.5 million are granted with a minimal administrative burden.

[10] We assume that the debt cannot be rolled over and unless repaid in full the firm will have to leave the market.

$$K_C^{\star}(a) = max\left(0, min\left(f - p(a)q(a,\lambda_C) + q(a,\lambda_C)\frac{c}{a}, M\right)\right) \quad \forall\ a \geq \overline{a}_C. \tag{9}$$

After substituting the optimal prices and quantities in equation (9) the optimal credit take up during the crisis is given by

$$K_C^{\star}(a) = max\left(0, min\left(f - \left(\frac{\epsilon-1}{\epsilon}aP_C\right)^{\epsilon-1}\frac{Y\lambda_C}{\epsilon}, M\right)\right) \quad \forall\ a \geq \overline{a}_C. \tag{10}$$

Using that $K_N(a) = -K_C(a)$ we can re-write the after-crisis profits for firms that took up any debt as

$$\pi_N(a,\lambda_N) = p(a)q(a,\lambda_N) - q(a,\lambda_N)\frac{c}{a} + p(a)q(a,\lambda_C) - q(a,\lambda_C)\frac{c}{a} - 2f \quad \forall\ a \geq \overline{a}_C. \tag{11}$$

Only if $\pi_N(a) \geq 0$ a firm will be able to repay the debt after the crisis. The profits of firms that did not take up any debt during the crisis are given by equation (5) with $K_N = K_C = 0$. The cutoff condition to repay the debt is given by

$$\pi(\overline{a}_N, \lambda_N) = \left(\frac{c}{\overline{a}_N}\right)^{1-\epsilon}\frac{1}{\epsilon}\left(\frac{\epsilon}{\epsilon-1}\right)^{1-\epsilon} Y\left(\frac{\lambda_N}{P_N^{1-\epsilon}} + \frac{\lambda_C}{P_C^{1-\epsilon}}\right) - 2f = 0. \tag{12}$$

We refer to this as repayment constraint. Equation (12) can be solved for the new normal repayment cutoff $\overline{a}_N$ and the after-crisis price index P_N can be derived. The repayment cutoff is given by

$$\overline{a}_N = (2f)^{\frac{1}{\epsilon-1}}\epsilon^{\frac{1}{\epsilon-1}}\frac{\epsilon}{\epsilon-1}Y^{\frac{1}{1-\epsilon}}\left(\frac{\lambda_N}{P_N^{1-\epsilon}} + \frac{\lambda_C}{P_C^{1-\epsilon}}\right)^{\frac{1}{1-\epsilon}} c. \tag{13}$$

As $\lambda_N = \lambda_B$, the cutoff of a firm that is able to repay its debt is $\overline{a}_N \geq \tilde{a}_B$. Intuitively, the debt carried on from the crisis, increase the necessary sales or profits of the firm to repay the debt above the pre-crisis viability threshold. This creates a productivity wedge between firms that are able to repay their debt and firms that could survive the economic downturn using the Swiss federal loan program. It is this wedge that creates zombie firms.

Note that the viability cutoff in the new normal is different from the repayment cutoff, as the former only considers if a firm is able to cover its current fixed costs, but excludes any debt repayments. Given a positive debt level the following relationship can be established: $\overline{a}_N > \tilde{a}_N$. A post-crisis viable firm might not be able to repay its debt. Given that $\lambda_N = \lambda_B$ the viability cutoffs must be equal as well, i.e., $\tilde{a}_N = \tilde{a}_B$.[11]

[11] This would not be the case if $\lambda_N \neq \lambda_B$.

3.3 The good, the zombies and the ones left behind

We have to distinguish three cases depending on the relationship of different productivity cutoffs. In the first case, we consider $\overline{a}_N > \overline{a}_C \geq \tilde{a}_N$, i.e., the repayment constraint is binding for the firm, but not all viable firms have access to sufficient loans to survive the crisis. In the second case $\overline{a}_N > \tilde{a}_N \geq \overline{a}_C$ all viable firms are able to take up debt to survive the crisis. In the last case, the debt constraint is binding and hence $\overline{a}_C > \overline{a}_N > \tilde{a}_N$. We assume that firms will take up the guaranteed credit unless the debt constraint becomes binding, i.e., even the maximum amount of credit would not be sufficient to ensure the survival of the firm during the crisis. If a firm survives the crisis, it needs the resources to repay its debt, otherwise it would have to default. Last, we assume that the viability cutoff during the crisis $\tilde{a}_C > max(\overline{a}_j)$, i.e., the economic downturn of the crisis makes it necessary for (some) firms to take up loans to survive the crisis.

A priori it is not clear which case is relevant for the economy, thus we will analyze all cases and derive their policy implications. Figure 1 shows the cutoffs and the resulting four firm types for all cases.

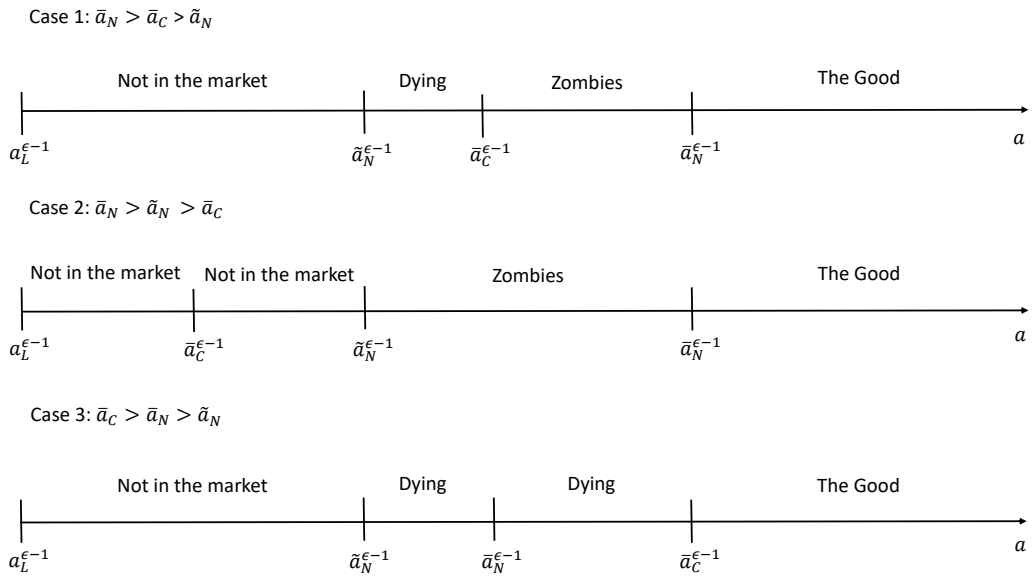


Figure 1: This figure plots the different firm types based on their productivity and the relationship of cutoffs of the debt, repayment constraints, and viability condition.

Recall that we assumed the viability cutoffs before and after the crisis to be equal, but lower than during the crisis, i.e., $\tilde{a}_B = \tilde{a}_N < \tilde{a}_C$. Thus, all firms that can be observed during the crisis will have a productivity level of at least $\tilde{a}_N$, all other firms will not be in the market.

Case 1: $\overline{a}_N > \overline{a}_C > \tilde{a}_N$

In this scenario the repayment condition is the strictest. Three types of firms will be present in this case.

The good: $a \geq max(\overline{a}_N, \overline{a}_C)$
Given the high productivity level of the firm (low costs), the maximum amount of credit available to the firm is sufficient to deal with the negative impact of the crisis and the firm will either not need any credit or be able to repay all the debt after the crisis. These firms use the guaranteed credit as indented. Within the good, there will be some firms with a productivity $a > \tilde{a}_C$ that do not need any credit at all during the crisis.

Zombie firms: $\overline{a}_N > a \geq \overline{a}_C$
Firms will be able to survive with the credit during the crisis, but they will not be able to repay the debt in the future. Thus, the guaranteed credit during the crisis leads to an over-indebtedness of the firm. This would be commonly referred to as zombie firms, that are kept alive only because of the government intervention. These exist due to the productivity wedge between $\overline{a}_N$ and $\overline{a}_C$.

Dying firms: $\overline{a}_N < \overline{a}_C < a$
Note that in this scenario the repayment constraint is stricter than the new normal viability condition, i.e., $\overline{a}_N > \tilde{a}_N$. Thus, in this case all firms with a productivity $\overline{a}_C > a > \tilde{a}_N$ would be viable in the new normal, but have to default as they are unable to finance their fixed operational costs during the crisis with federal loans. We refer to this firms as "dying". For these firms higher federal loans would not ensure their long-term survival, but these loans would turn them into zombies.

Case 2: $\overline{a}_N > \tilde{a}_N > \overline{a}_c$

As in the first case the repayment constraint is binding, but now $\tilde{a}_N > \overline{a}_C$, i.e., all firms that are in the market have access to sufficient credit. This implies that only good firms and zombie exist in this case. If policy makers intend to freeze the economy, i.e., this scenario would represent a situation in which the market structure is persevered during the crisis. Although, in the new normal none of the zombie firms would be able to repay its debt. To defrost the economy and keep the current industry structure the government would need to implement a debt-relief for all firms. Alternatively, firms could undertake transformative investments to increase their new normal sales, i.e, a higher λ_N.

Case 3: $\overline{a}_C > \overline{a}_c > \tilde{a}_N$

In case 3 the debt constraint becomes binding. The guaranteed credit is not sufficient to

ensure the survival of the firm during the crisis, although it could repay the credit in the future.[12] These firms are left behind from the federal loan program and are defaulting during the crisis, although all of them would be viable firms in the new normal.

From a policy maker perspective two facts are important. First, the level of guaranteed debt is crucial. If it is too low, the number of firm left behind to die increases. But on the other hand, a high level of guaranteed credit will create more zombie firms. Thus, it is important to determine in which situation the economy is, i.e., are more or less loans needed. Second, all zombie firms could in principle be resurrected by forgiving their debt, as they are all viable firms in the new normal. This is due to the assumption that $\lambda_B = \lambda_N$. Thus, once the economic situation has improved to previous levels, an ex-post debt-relief could be a valuable policy instrument. The former situation implies high unemployment rates during the crisis, while the later leads to higher public spending as the government covers the guaranteed loans of defaulting firms. Another solution could be possible, firms could change their business model during the crisis to obtain higher post-crisis sales and thus be able to repay their debt in the new normal. Thus, the federal loans could be used to nudge firms to undertake these transformative investments.

3.4 Closing the model

The model follows closely the standard Chaney (2008) model for a closed economy. To derive the equilibrium we need to consider the binding zero profit conditions for each case and period.

Table 1: Binding zero profit cutoffs

	Pre-crisis	Crisis	New Normal
Case 1	$\tilde{a}_B = \tilde{a}_N$	$\overline{a}_C$	$\overline{a}_N$
Case 2	$\tilde{a}_B = \tilde{a}_N$	$\tilde{a}_N$	$\overline{a}_N$
Case 3	$\tilde{a}_B = \tilde{a}_N$	$\overline{a}_C$	$\overline{a}_C$

The equilibrium solution of the model for the pre-crisis and the crisis cutoffs can be derived analogously to the Chaney (2008) model. The same applies to the new normal in the case 3, where we assume that there is no immediate new entry in the new normal. In this paper we focus on the behavior of firms during and directly after the crisis and less on the dynamic

[12] The situation changes slightly if we allow firms to take up higher levels of debt at a positive interest rate (and possibly using collateral assets), i.e, $K^\star > M$. In this case the federal government is not guaranteeing the whole credit, but a bank will evaluate the credit application and charge some interest. This implies different cutoffs, i.e., the bank will demand a higher new normal productivity $\hat{a}_N$ to ensure the repayment. Hence the cutoff for firms will be higher $\hat{a}_N > \overline{a}_N$. This implies that there will be some firms that could use a higher additional credit to survive the crisis, but would not be able repay the debt in the new normal, although they would be viable firms, $\hat{a}_N > \tilde{a}_N$. The bank would not allow them to take up sufficient credit and some firms would still be left behind to die. Formally extending the model in this regard will not change the general mechanism and intuition of the model.

adjustments of new firms entering after the crisis.[13] In the cases 1 and 2 the cutoff $\overline{a}_N$ depends on the past debt level, which is a function of the economic downturn λ_C and the associated price index. From the perspective of firms in the new normal this will be an exogenous (past) additive component for the cutoff value, i.e., the repayment of the federal loans can be seen as additional fixed operational costs. Specifically, for the case 1 these additional fixed costs are M for the marginal firm.
Appendix A derives the analytical closed form solutions for cases 1 and 3 in more detail.

3.5 Comparative statics

Understanding the impact of different variables on the cutoffs within the model is essential. In this section we discuss the impact of the two policy variables: λ_C and M. By implementing lockdown measures such as social distancing or even banning certain business activities the government indirectly determines the degree of economic downturn λ_C. The maximum amount of loans available for firms are an essential part of the federal loan program.
For simplicity we are only considering the first order (direct) effect and neglecting the (indirect) effects via the price indices.

Economic downturn: λ_C
All other things being equal, a greater drop of the demand during crisis, lower λ_C, will increase the cutoff $\overline{a}_C$ to take up debt during the crisis, i.e., some firms with lower productivity $a < \overline{a}_C$ will not be able to take up enough debt to cover their fixed operational costs during crisis:

$$\frac{\partial \overline{a}_C}{\partial \lambda_C} < 0.$$

λ_C does not only impact the debt constraint, but also the repayment constraint in equation (13).

$$\frac{\partial \overline{a}_N}{\partial \lambda_C} < 0.$$

A more severe recession, i.e., lower λ_C will increase the repayment cutoff $\overline{a}_N$. Intuitively, a bigger decline of the demand for goods during the crisis implies a greater demand for credits, given the firm level productivity a, see equation (10). Intuitively, if a firm needs to take up high levels of debt during the crisis, repayment becomes harder. Thus, a lower λ_C implies also a higher $\overline{a}_N$, i.e., only more productive firms are able to repay their debts in the new normal.

Guaranteed credits: M

[13] Note that the cutoff for viable firms in the new normal $\tilde{a}_N < \overline{a}_N$ and hence new firms should enter.

Providing higher guaranteed credits to companies will increase the debt cutoff $\overline{a}_C$, i.e., a greater share of (less productive) firms will be able to cover the fixed costs with a loan. This ultimately might create more zombie firms in the economy.

3.6 Policy space

In our model it is crucial to distinguish between all cases. In case 3 a potentially larger share of firms that could repay their debt in the future is left behind to default during the crisis, $\overline{a}_N < \overline{a}_C$. Considering the negative effects of job losses see Hamermesh (1989) or Pissarides (1992), policy makers might want to avoid this scenario. On the other hand, in case 1 zombie firms are created.
The two policy variables M and λ_C impact the two cutoffs and hence potentially determine in which case the economy is. As long as

$$\overline{a}_C > \overline{a}_N,$$

the economy is in case 3, where some firms will not be able to obtain sufficient credit to survey the crisis, although they could repay their debt in the future. Substituting the cutoffs from equations (7) and (13) yields the condition for the economy to be in a case 3 scenario:

$$(2f)^{\frac{1}{\epsilon-1}} \left(\frac{\lambda_N}{P_N^{1-\epsilon}} + \frac{\lambda_C}{P_C^{1-\epsilon}} \right)^{\frac{1}{1-\epsilon}} \leq (f-M)^{\frac{1}{\epsilon-1}} \left(\frac{\lambda_C}{P_C^{1-\epsilon}} \right)^{\frac{1}{1-\epsilon}}. \tag{14}$$

Given that the elasticity of substitution is greater than unity, we simplify the expression to obtain

$$\lambda_C \leq \lambda_N \left(\frac{P_C}{P_N} \right)^{1-\epsilon} \frac{f-M}{f+M}. \tag{15}$$

Everything else equal, a higher level of guaranteed federal loans pushes the economy towards case 1 and hence potentially creates zombie firms. On the other hand, a stronger economic downturn, i.e., lower λ_C, moves the economy in the direction of case 3. One might argue that a case 3 scenario should be avoided, as (some of) the firms left behind to die during the crisis would be viable and able to repay their debt in the future, which would suggest a higher M. On the other hand, if M is too high it will result in a situation in which $\overline{a}_C < \overline{a}_N$. In this case zombie will be created.
If $\overline{a}_N = \overline{a}_C$, all firms that take up loans during the crisis are able to repay the debt and no zombie firms will be created. Still, in this situation some firms are left behind to die, although they would be viable firms in the new normal:

$$\tilde{a}_N \leq \overline{a}_C.$$

Substituting equation (8) for $j = N$ and equation (7) yields the following inequality

$$f^{\frac{1}{\epsilon-1}} \left(\frac{\lambda_N}{P_N^{1-\epsilon}} \right)^{\frac{1}{1-\epsilon}} \leq (f - M)^{\frac{1}{\epsilon-1}} \left(\frac{\lambda_C}{P_C^{1-\epsilon}} \right)^{\frac{1}{1-\epsilon}}. \tag{16}$$

After simplifying we obtain

$$\lambda_C \leq \lambda_N \left(\frac{P_C}{P_N} \right)^{1-\epsilon} \frac{f - M}{f}. \tag{17}$$

These two inequalities determine the policy space for guaranteed federal loans. If the maximum amount of loans relative to the economic downturn (caused by lockdown measures) λ_C is too low, this will create firms left behind to die. If the maximum amount of loans is too high relative to the economic downturn, zombie firms are created. Figure 2 plots the two equations (14) and (17). Both are convex and the relationship described by equation (14) is always weakly below the condition described by equation (17). While the two conditions coincide at the intercepts of the x- and y-axis they diverge for intermediate values of M and λ_C. In terms of our model all λ_C and M combinations to the left of the blue dashed line depict a case 3 scenario. All λ_C and M combinations to the right of the red dotted line represent case 2 scenarios and all points between the two lines are case 1 scenarios.
This implies a trade-off between leaving firms behind (not preserving the industry structure before the crisis) and creating zombie firms. If policy makers want to avoid the creation of zombie firms and hence minimize its costs due to (zombie) firms defaulting on the guaranteed loans, they have to choose a λ_C and M combinations on the blue dashed line. If policy makers want to preserve the industry structure and include all firms that would be viable in the new normal, they have to choose λ_C and M combinations on the red dotted line. Note that the possible policy space gets smaller for more extreme values of λ_C and M.

3.7 Model predictions

The stylized model of financially constraint firms in a COVID-19 induced economic downturn gives some insightful predictions of firm behavior.
First, in a scenario of case 1 or 2 for any given level of demand higher productivity firms will be more profitable before the crisis and more likely to be of the "good" type, i.e., able to obtain sufficient credit and to repay it. In the same scenarios low productivity firms, i.e., firms facing low demand already before the crisis, will not be able or willing to take up federal loans.
Second, the recession curve matters. The more severe the downtown, the less firms will be of the "good" type. Similarly, a better expected new normal situation facilitates the repayment of the debt and hence increases the share of good firms and decreases the share of zombies. We can think of the current business situation as the best predictor of the new

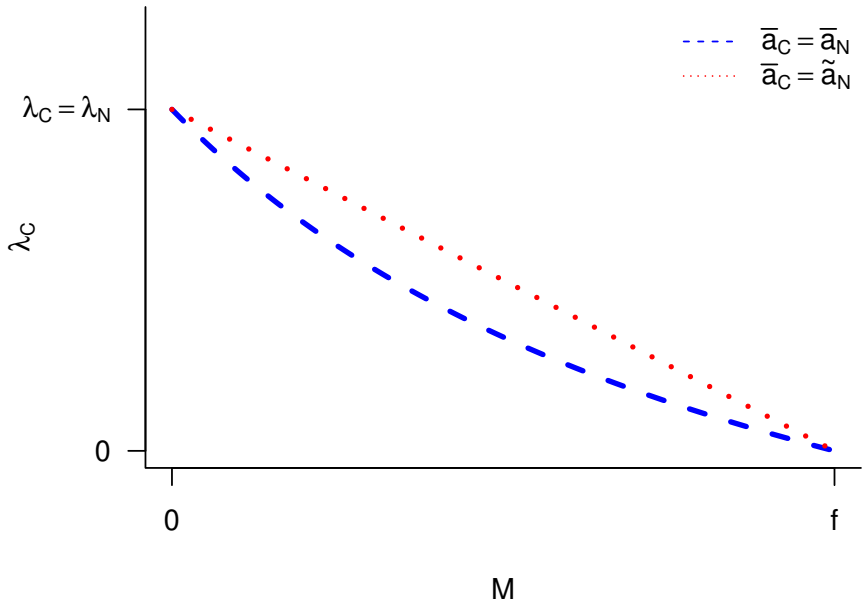


Figure 2: Relationship between the degree of lockdown, λ_C, and the maximum amount of loans to firms, M. Combinations of M and λ_C below the blue dashed line imply a case 2 scenario. Combinations of M and λ_C above the red dotted line imply the creation of maximum number of zombie firms. All combination of f M and λ_C in the area between the curves indicate the co-existence of zombie firms and firms with insufficient access to loans and hence leaving the market during the crisis.

normal situation, i.e., $E(\lambda_N) = \lambda_B$. Thus, a better initial business situation of firms will increase the take up of debt, while a worse current situation decreases it.

4 Empirical analysis

In this section we provide some empirical evidence that are consistent with our stylized theoretical model.

4.1 Data

From April 7 to April 13 2020 we surveyed 205 managers of Swiss companies about their perception and expectation of the past, current and future business situation of their companies. We also asked a rich set of complementary questions about their firm's reaction towards the COVID-19 crisis. The collected data cover a wide range of sectors and firms of different sizes, see Figures 3, 4, and 5

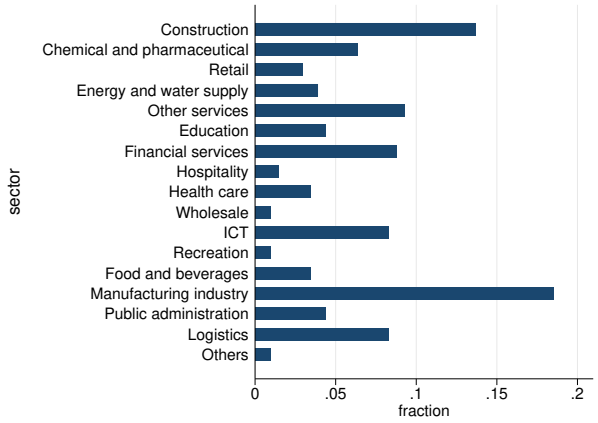


Figure 3: Distribution of firms by sector. Aggregated Swiss NOGAS classification.

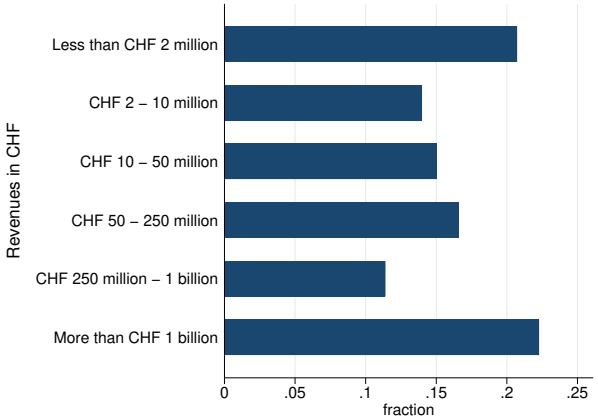


Figure 4: Distribution of firms by level of revenues in CHF

The detailed descriptive statistics are provided in the appendix B. The complete survey questionnaire is available in an online appendix.

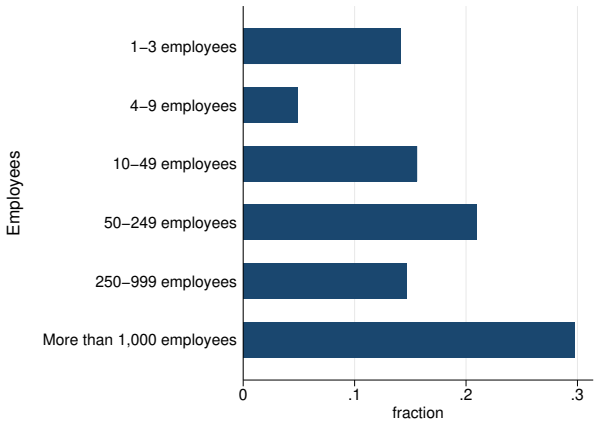


Figure 5: Distribution of firms by number of employees.

4.2 Analysis

Managers were asked to assess their past business situation (in 2019), their current business situation (7.-13. April 2020) and the business situation they expect at the peak economic impact of the COVID-19 crisis. While the median firms in our survey assessed its business situation in 2019 as good, this deteriorated significantly over time, see Figure 6. More importantly, while in 2019 no firm perceived its business situation as threatening the firm's survival (existential threat), this increased to 7% of firms at the point of the survey and more than 12% of firms expected to fight for their survival at the peak economic impact of the COVID-19 crisis.

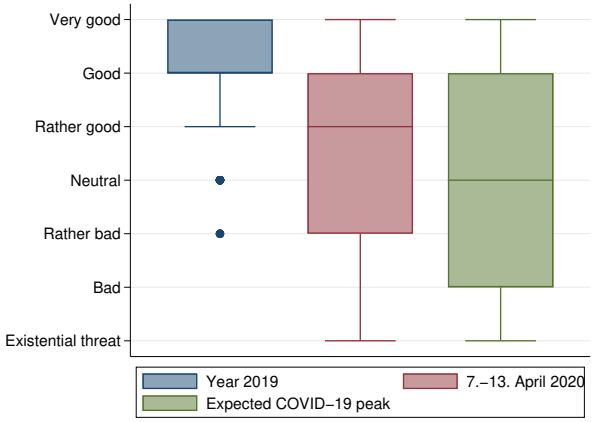


Figure 6: Whisker plot: Business situation in 2019, at the current point in time and expectation during the COVID-19 crisis. Ratings on a scale of -3 (existential threat to +3 (very good).

Table 2 shows the unconditional correlation between the three answers regarding the perceived business situation in 2019, at the moment of the survey and the expected business situation at the peak economic impact of the COVID-19 crisis. Firms that had a more positive perception of their business situation expected a smaller impact of the crisis. Even when controlling for industry and MNE fixed effects this positive relationship persists: coefficient 0.525 and standard error 0.138. Thus, the COVID-19 crisis seems to have a more

severe impact on firms that were already under-performing before the crisis.[14]

Table 2: Correlation matrix business situation

		Business situation		
		2019	April 2020	Peak
Business situation	2019	1.000		
	April 2020	0.241	1.000	
	Peak	0.257	0.868	1.000

Correlation matrix of the business situation in 2019, during the survey (April 2020), and expected business situation at the peak economic impact of the COVID-19 crisis.

Table 3 shows the estimation of the determinants of the current and expected business situations for the firms in our survey. Note that the perceived and expected business situation are strongly impacted by the foreign demand, i.e., a higher foreign demand improves the business situation. It appears that firms in a small and very open economy such as Switzerland depend to a great extend on the foreign demand. On the other hand, neither domestic nor foreign supply of production inputs seem to be a mayor issue for the firms in the survey. There are some weak evidence that firms that prepared more for possible COVID-19 disruptions - before the first Swiss COVID-19 case was detected - were doing better during the crisis.[15] In terms of specific reactions only offering home office has a positive impact on the perceived current business situation, but this effect becomes insignificant at the peak economic impact of the COVID-19 crisis. In general we have to be careful to interpret this regression table as many variable are likely to be biased due to endogeneity, i.e., reducing the business activity of course dramatically changes the perceived and expected business situations, but also might be the result of low demand due to a worse business situation. The same applies to the usage of guaranteed federal loans (Bundeshilfe).

To construct a recession curve based on firm-level answers we asked the managers when they are expecting the peak economic impact of the COVID-19 crisis and when their company expects to return to a normal business environment. Figures 7 and 8 show the distribution of answers.

As the answer options for the survey participants were ordinal with a varying range and a right-censoring (more than two years) we follow Wooldridge (2013) and Startz (2005) and estimate the mean and standard deviation of the distribution and account for the varying censoring limits by using a generalized tobit model. This allows us to compute the unconditional mean and the standard deviation in the presence of right-censoring. The peak economic impact of the crisis is expected after 14.4 weeks (standard error 0.99) and the

[14] In terms of our model we could interpret the perceived business situation as a combination of the demand shift λ_j and the firm-specific productivity, a. Specifically, we could could use a multiplicative function $a\lambda_j$, which would be consists with these correlations.

[15] China reported the first COVID-19 cases to the WHO on the 1 January 2020 and Switzerland reported the first cases at the end of February 2020.

Table 3: Estimation: Business situation

	Current Business			Peak COVID		
	Problems	Reaction	All	Problems	Reaction	All
	(1)	(2)	(3)	(4)	(5)	(6)
Ban business activties	0.199		0.011	0.198		0.073
	(0.158)		(0.161)	(0.171)		(0.182)
Domestic demand	0.265		0.176	0.151		0.030
	(0.163)		(0.153)	(0.172)		(0.168)
Foreign demand	0.433**		0.378*	0.481**		0.452**
	(0.204)		(0.198)	(0.215)		(0.219)
Domestic supply	-0.069		-0.145	-0.017		0.020
	(0.188)		(0.185)	(0.197)		(0.203)
Foreign supply	0.004		-0.070	-0.102		-0.226
	(0.205)		(0.193)	(0.214)		(0.212)
Workers at home	0.007		-0.017	-0.088		-0.134
	(0.161)		(0.161)	(0.168)		(0.177)
Finance	0.067		0.083	0.132		0.076
	(0.145)		(0.144)	(0.155)		(0.161)
Preparation		0.161*	0.033		0.165*	-0.021
		(0.088)	(0.129)		(0.099)	(0.142)
Stop business		-1.196***	-1.405**		-1.138**	-0.949
		(0.442)	(0.601)		(0.497)	(0.660)
Cost reduction		-1.263***	-1.091**		-1.094***	-1.349***
		(0.301)	(0.434)		(0.338)	(0.478)
Reduce business		-0.279	-0.401		0.017	-0.288
		(0.291)	(0.414)		(0.328)	(0.459)
Bundeshilfe		-1.027*	-0.912		-1.245**	-0.867
		(0.537)	(0.794)		(0.603)	(0.869)
Home Office		1.122***	1.466**		0.383	0.651
		(0.424)	(0.623)		(0.477)	(0.684)
Change of BM		-0.237	-0.315		-0.312	-0.999
		(0.752)	(1.236)		(0.845)	(1.357)
New products/services		-0.371	-0.852		-0.181	-0.386
		(0.401)	(0.650)		(0.451)	(0.711)
Digitalization		-0.072	0.256		-0.127	0.759
		(0.346)	(0.469)		(0.389)	(0.516)
Delivery		-1.067	-0.469		-1.077	-0.211
		(1.433)	(1.737)		(1.610)	(1.903)
Obs.	104	163	101	104	162	100
adj. R^2	.237	.353	.38	.176	.246	.267

Fixed effect estimation of the current and expected business situation. Sector fixed effects and MNE fixed effects. Standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

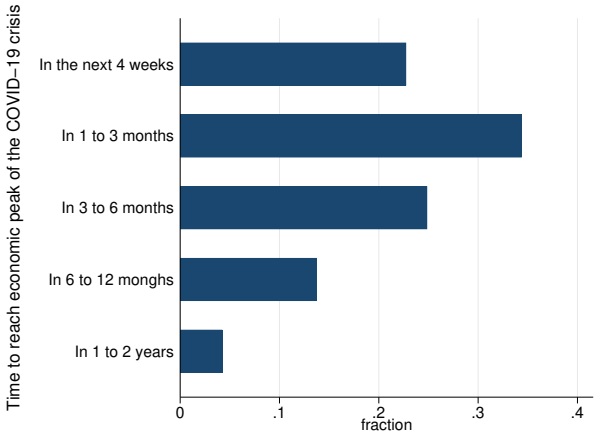


Figure 7: Time a firm expects to reach the peak economic impact starting from the week 7. to 13. of April 2020.

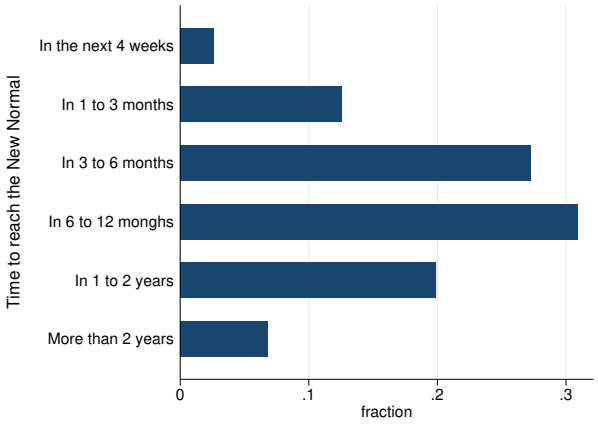


Figure 8: Time a firm expects to reach the new normal starting from the week 7. to 13. of April 2020.

new normal is reached after 39.6 weeks (standard error 2.28). Figure 9 shows the stylized recession curve akin to Baldwin (2020) and Gourinchas (2020).

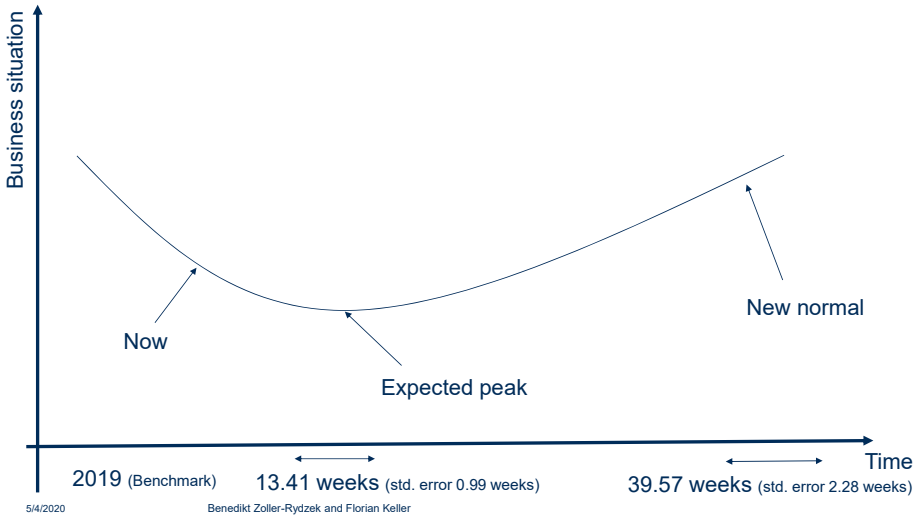


Figure 9: Firm-level recession curve. Weeks to peak economic impact and the the new normal. Based on the April 7-13 2020 survey.

Figure 9 shows the stylized economic recession curve. The managers in our survey expected the peak economic impact in July 2020, indicating that firms were still in crisis mode during the survey.

In general firms could try to react more pro-actively to the COVID-19 crisis, e.g., they could move to more digital business models. In our survey the most favored reactions are trying to mitigate the impact of the crisis, i.e., home office followed by short-time work. Only a few firms pro-actively engaged the crisis situation and tried to gain market shares by changing their business model or introducing new products. Figure 10 shows the fraction of firms in the survey using different actions to deal with the crisis. This indicates that the economic activity of most firms were actually frozen and no mayor transition of activities occurred during the lockdown period before the survey took place.

This shows that most firms perceive the COVID-19 crisis as transitory, i.e., once lockdown measures would be lifted their business situation would return to normal levels. This is consistent with our assumption regarding the pre- and post-crisis business situations, i.e., $\lambda_B = \lambda_N$. On the other hand, from a policy perspective a radical change of business models could increase the new normal business situation for firms and hence enable more firms to repay their debt.

Digitization is the most important pro-active response with over 20% of firms naming it. Figure 11 shows development in four areas of digitalization relevant for firms. We observe clearly that during the crisis digital production, digital marketing, digital sales, and home

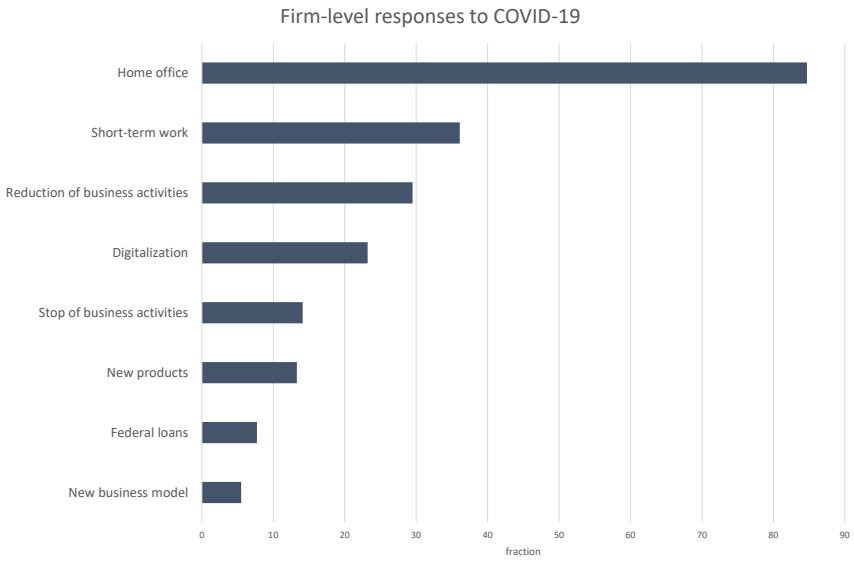


Figure 10: Share of firms using _____ as a response to mitigate the impact of COVID-19 on their business. Multiple responses were allowed.

office have increased relative to the 2019 baseline. Firms expect this to be a long lasting effect, although at slightly lower levels than during the COVID-19 crisis.

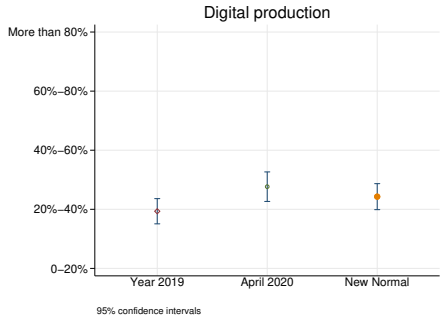
Table 4 presents a t-test for differences in means between expected new normal and pre-crisis values. All differences are positive and highly significant. While the impact on digital sales is only moderate with an increase of about 3 percentage points, digital marketing and communication with customers is expected to increase by over 6 percentage points. The greatest effect is expected in terms of home office: an increase of almost 9 percentage points.

Table 4: T-test of mean differences

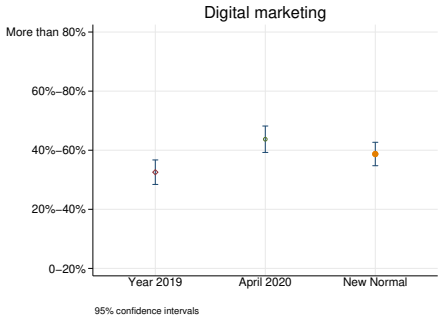
Variable	New Normal	Year 2019	Difference	Diff. percentage points
Digital production	2.214	1.968	0.247***	4.935
	(0.111)	(0.108)	(0.043)	
Digital marketing	2.936	2.628	0.308***	6.154
	(0.100)	(0.105)	(0.050)	
Digital sales	1.928	1.778	0.150***	3.007
	(0.105)	(0.101)	(0.032)	
Home office	1.761	1.316	0.445***	8.903
	(0.073)	(0.064)	(0.051)	

t-test of mean differences between year 2019 and new normal digitalization levels
for digital production, digital marketing, digital sales, and home office.
Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

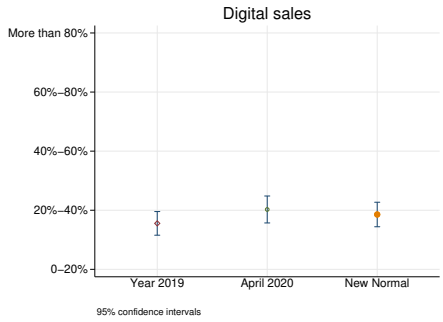
The shift in home office appears to be even more dramatic if we consider the distribution at the firm level. In 2019 over 80% of firms offered only 20% or less home office opportunities (maximum of one day a week). This is expected to change dramatically in the future, i.e., we observe a considerable shift from the left tail of the distribution towards the center. While



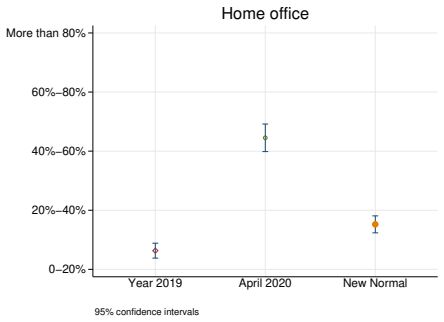
(a) Share of digital production.



(b) Share of digital marketing.



(c) Share of digital revenues.



(d) Share of home office.

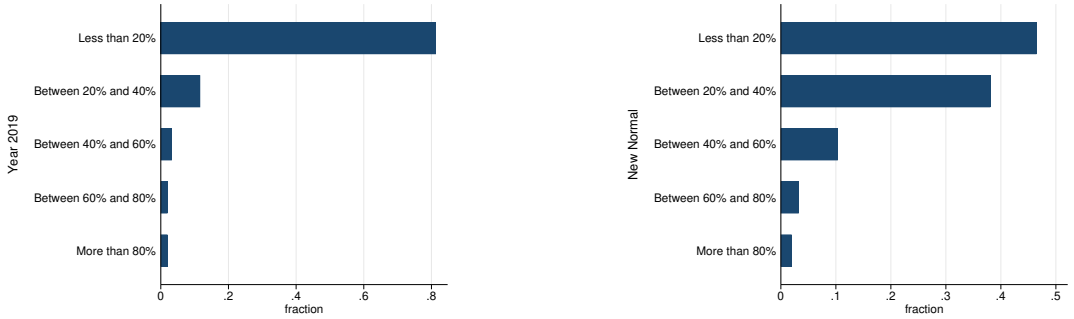
Figure 11: Digitalization shares for digital production, digital marketing, digital sales, and home office. In the past, during the crisis, and the expected long-term effect. Linearized scale for answers. 95% confidence intervals.

in 2019 only about 15% of firms offered between 2 and 3 days of home office per week, this share is expected to increase to almost 50%, see Figure 12.

While in the public perception digitalization is often seen as less effective, specifically home office, this opinion is not shared by the managers in our survey. The median answer regarding the performance of digital relative to traditional methods is neutral. Even about 5% of firms believe that the digital tools deliver better or much better results.

The development we observe in Figure 11 is driven by a selection effect. Now all firms are forced to rely more on digital tools, but some will return to traditional approaches in the future. The long-term higher levels of digitalization is driven by firms that have a more positive experience during the crisis. This is consistent with the fixed effects regression results presented in Table 5. Firms that experience a more positive effect of digitalization are expecting a greater positive change of digital production, digital sales, and home office in the long-run. For example, a firm that has a slightly better experience of digital solutions in contrast to one that sees no change (neutral) will have on average a 3.2 percentage point higher level of home office.[16] This finding is also consistent with the estimates presented in Table 3. While having workers at home and not at the work place was not perceived as a significant problem for for the surveyed firms, home office actually helped to mitigate the

[16] $0.162 \times 0.20 = 0.032$.



(a) Home office in 2019.

(b) Home office in the new normal.

Figure 12: Distribution of firms by the share of home office offered pre-crisis (2019) and expected in the new normal.

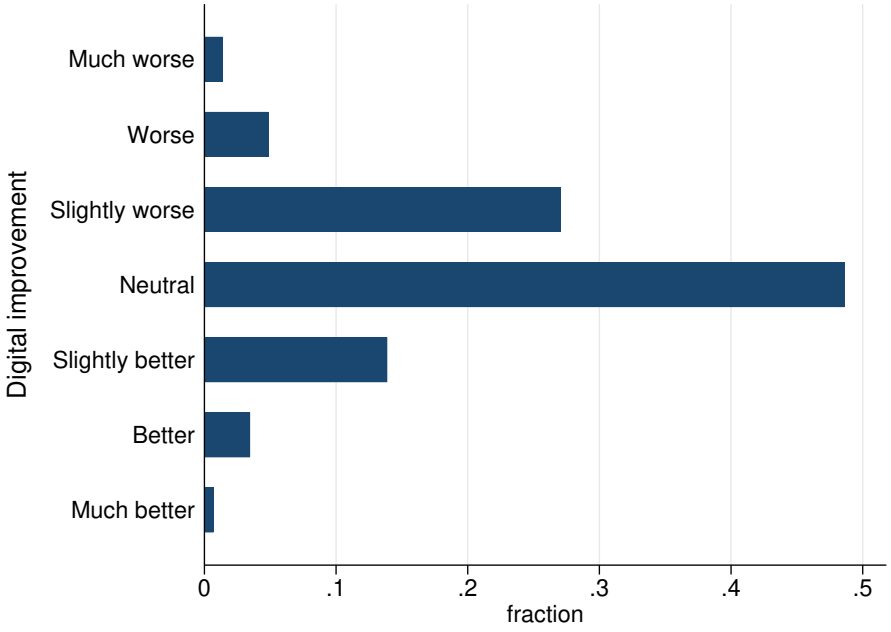


Figure 13: Do digital solutions such as digital marketing or home office give better results than traditional solutions?

impact of the crisis in the short-term.

Last, we are investigating the take up of the Swiss federal guaranteed loan program. The theoretical model in section 3 predicted that firms with a better business situation are more likely to take up loans during the crisis, while firms in a worse business situation would be over-indebted with the federal loans and hence would not take up any debt. Table 6 shows the estimation results of a linear probability model. Clearly the business situation in 2019 has a positive impact on the probability to take up federal loans. Also a more severe drop in the business situation between 2019 and the time of the survey leads to a higher take up probability, see column (4) in Table 6. These results are only consistent with case 1 and case 3 scenarios, as in case 2 all firms in the market would take up credits.

Table 7 shows the estimation results of a linear probability model with an indicator for

Table 5: Estimation: Long-run digitization effect

	(1) Difference digital production	(2) Difference digital marketing	(3) Difference digital sales	(4) Difference home office
Employees	0.039	-0.096	-0.052	0.048
	(0.062)	(0.076)	(0.050)	(0.078)
Revenues	-0.080	0.126*	0.049	-0.000
	(0.061)	(0.074)	(0.049)	(0.076)
Digital improvement	0.122***	-0.006	0.066*	0.162***
	(0.046)	(0.057)	(0.038)	(0.059)
Obs.	135	137	136	137
adj. R^2	.234	.323	.376	.353

Notes: Fixed effect regression of differences between new normal and year 2019 share of digital production, digital marketing, digital sales, and home office. Sector fixed effects. Standard errors in parenthesis. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively.

Table 6: Estimation: Federal loan take up

	(1)	(2)	(3)	(4)
Employees	0.026	0.041	0.046	0.044
	(0.031)	(0.038)	(0.038)	(0.038)
Revenues	-0.049	-0.059	-0.057	-0.053
	(0.030)	(0.038)	(0.038)	(0.037)
Domestic demand		-0.031	-0.016	-0.015
		(0.021)	(0.022)	(0.022)
Foreign demand		-0.017	0.000	0.005
		(0.025)	(0.026)	(0.025)
Business situation 2019	0.042**	0.039	0.055**	
	(0.021)	(0.025)	(0.026)	
Business situation now			-0.020	
			(0.028)	
Business situation peak			-0.017	
			(0.025)	
Diff. business 2019 and now				0.041***
				(0.015)
Diff. business now and peak				0.017
				(0.025)
Obs.	169	132	130	130
R^2	.233	.151	.192	.189

Notes: Linear probability model. Sector fixed effects and MNE fixed effects. Firm level controls are included. Standard errors in parenthesis. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively.

Table 7: Estimation: short-time work take up

	(1)	(2)	(3)	(4)
Employees	0.016	0.059	0.067	0.077
	(0.055)	(0.066)	(0.065)	(0.065)
Revenues	0.017	-0.024	-0.020	-0.038
	(0.054)	(0.065)	(0.064)	(0.064)
Domestic demand		-0.053	-0.018	-0.021
		(0.036)	(0.037)	(0.038)
Foreign demand		-0.101**	-0.066	-0.090**
		(0.043)	(0.045)	(0.044)
Business situation 2019	-0.034	-0.044	-0.015	
	(0.037)	(0.044)	(0.044)	
Business situation now			-0.078	
			(0.048)	
Business situation peak			0.001	
			(0.043)	
Diff. business 2019 and now				0.057**
				(0.026)
Diff. business now and peak				-0.003
				(0.044)
Obs.	169	132	130	130
R^2	.234	.323	.376	.353

Notes: Linear probability model. Sector fixed effects and MNE fixed effects. Firm level controls are included. Standard errors in parenthesis. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively.

short-time work in the firm as dependent variable. In contrast to Table 6 the business situation in 2019 does not have any impact on the use of short-time work in the firm, see columns (1) to (3). As short-time work is financed through the unemployment insurance of the workers, no (long-term) financial risk arises for the firms. This favors the usage of short-time work by all firms independent of their past business situation. Although in column (4) we observe a significant positive impact of the change of business situation on short-time work indicating that short-time work is likely to be used to reduce business activities. In a sector fixed effect regression reducing the business activity during the crisis is positively linked to short-time work: coefficient 0.161 and standard error 0.078. In terms of our model we could interpret short-time work as a way to reduce fixed costs of production, f.

In the appendix C we provide estimation results of a probit model for tables 6 and 7 as a robustness check.

5 Conclusion

In this paper we developed a stylized model of financially constraint firms during the COVID-19 crisis. Firms are able to take up debt guaranteed by the (Swiss federal) government to pay for fixed costs during the crisis. We find that three scenarios are possible. First, the amount of guaranteed loans is too low to cover all firms that would be viable or even able to repay

the debt after the crisis. This would lead to many firms leaving the market and potentially high unemployment rates during the crisis. Second, the guaranteed loans are more than sufficient for all firms to cover their fixed operational costs, but not all firms will be able to pay back their debt after the crisis. In this case the loans will create a large amount of zombie firms in the economy that would default after the crisis due to their high levels of debt. These could be resurrected with an ex-post debt relief. Nevertheless, firms defaulting or providing a government paid debt-relief imply a considerable (additional) spending of public resources. Last, an intermediate situation could be possible, i.e., loans are sufficient for some (post-crisis viable) firms, but not for all. In this case we would expect some firms to leave the market as credits are not sufficient for them, while other firms become zombies. It turns out that policy makers face a trade-off between providing large amount of loans and the degree to which a lockdown is worsening the business situation.
In general even a loan with a zero interest rate creates a repayment wedge and can lead to over-indebtedness of firms. Two possible solutions arise to this problem. First, the government could use an ex-post debt-relief to avoid zombie firms defaulting. Second, loans could be conditioned on changes of the business model, i.e., they cannot be exclusively used to cover fixed costs, but to make transformative changes that enable the firm to generate higher profits in the future and hence to repay its debt.[17]

We use a firm-level survey of Swiss managers to confirm our model predictions. Specifically, we find that firms that faced a favorable business situation before the crisis are more likely to take up loans during the COVID-19 crisis. This implies that the Swiss economy is likely to be in a situation similar to case 1 in Figure 1. By adjusting the lockdown or the amount of guaranteed loans policy makers would be able to change the share of zombie firms and firms leaving the market. In this sense the policy makers have a trade-off between higher unemployment rates during the crisis and higher public spending after the crisis due to firms defaulting in their loans or an ex-post debt relief.
We also analyse firm level responses during the COVID-19 crisis in more detail. We observe that during our survey most firms were still in a reactive crisis mode. Firms were not proactively changing their business model but tried to minimize costs by reducing their business activities or using short-time work. Only in the area of digitalization we find some long-term reactions. In the new normal firms will use more digital tools and specifically much more home office than before the COVID-19 crisis. In the light of the possible presence of zombie firms the firm-level responses seem to be insufficient to be able to generate long-term higher profits after the COVID-19 crisis. This would imply that the government only delays unemployment or is willing to finance a debt-relief for zombie firms.

[17]Note that in our stylized model the business situation before and after the crisis are identical.

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A Equilibrium price indices and aggregated profits

To derive the equilibrium we follow Chaney (2008) for an economy in autarky, but allowing for a variable share parameter of the upper tier utility function. We assume that the productivity a is Pareto distributed with an minimum a_L and a shape parameter $\gamma > 0$. The cutoffs derived in section 3. As in Chaney (2008) we assume that the mass of potential firms in the economy is proportional to the (exogenously) given population L in the economy. The price index in the economy in state $j = B, C, N$ is given by

$$P_j^{1-\epsilon} = L \int_{\zeta}^{\infty} p(a)^{1-\epsilon} dG(a), \tag{18}$$

$$= L \int_{\zeta}^{\infty} \left(\frac{\epsilon - 1}{\epsilon} \frac{a}{c} \right)^{\epsilon - 1} dG(a), \tag{19}$$

$$= L \frac{\gamma}{\gamma - (\epsilon - 1)} \left(\frac{\epsilon - 1}{\epsilon} \frac{1}{c} \right)^{\epsilon - 1} \zeta^{\epsilon - 1 - \gamma}, \tag{20}$$

where ζ is the productivity cutoff for the corresponding state and case for firms to be present in the market as shown in table 1, i.e., $\tilde{a}_N, \overline{a}_C$, and $\overline{a}_N$.
Substituting in the expression for the productivity cutoff and rearranging we can obtain the equilibrium solution for the price index as

$$P_j^{1-\epsilon} = \kappa_1 L^{-\frac{1}{\epsilon - 1}} \theta, \tag{21}$$

where $\theta^{-\gamma} = \rho(\zeta)^{-\left(\frac{\gamma}{\epsilon - 1} - 1\right)}$ and $\kappa_1 = \left(\frac{\epsilon}{\lambda_j}\right)^{\frac{1}{\epsilon - 1}} \left(\frac{\epsilon}{\epsilon - 1}\right) \left(1 + \frac{\Pi}{L}\right)$. ρ is a function of ζ, which is either $f + M$ or $f - M$ if $\zeta = \overline{a}_N$ or $\zeta = \overline{a}_C$, respectively. To this end, we discard case 2, as a too high level of available credits is not very likely.[18] Moreover, this facilitates the derivation of the cutoffs and equilibrium price indices. Specifically, only the cutoffs $\overline{a}_C$, and $\overline{a}_N$ are relevant. For these cutoffs the marginal firm always takes up the maximum amount of debt, M. This implies that equation (11) simplifies to

$$\pi_N(a, \lambda_N) = p(a) q(a, \lambda_N) - q(a, \lambda_N) \frac{c}{a} - (f + M). \tag{22}$$

Now the solution of the model follows exactly Chaney (2008).

$$r(a) = \kappa_2 \theta^{\epsilon - 1} a^{\epsilon - 1} \quad \text{if} a \geq \zeta, \tag{23}$$

and zero otherwise. Where $\kappa_2 = \epsilon \left(\frac{\epsilon}{\lambda_j} \frac{\gamma}{\gamma - (\epsilon - 1) \frac{1}{1 + \kappa_3}} \right)^{1 - \epsilon}$ and $\kappa_3 = \frac{\lambda_j (\epsilon - 1)}{\gamma \epsilon - \lambda_j (\epsilon - 1)}$. The aggregate profits Π are given by the marked-up average revenues multiplied by the number of firms in

[18] Excluding case 2 seems to be justified based on the empirical findings in section 4. In case 2 we expect to observe a general up take of federal loans, and no firm being in a situation that would lead to immediate bankruptcy.

the market. This can be written in terms of exogenous parameters and the population size of the economy.

$$\Pi = \kappa_3 L. \tag{24}$$

Clearly, aggregate profits increase with the share parameter of the upper tier utility function, λ_j, i.e., a better economic situation raises the aggregated profits in the economy.

B Descriptive statistics

Table 8: Descriptive statistics

Variable	Obs.	Mean	Std. dev.	Min	Max
Revenues	193	3.51	1.83	1	6
Employees	205	4.06	1.72	1	6
Business situation 2019	189	2.11	1.04	-1	3
Business situation April 2020	189	0.5	1.9	-3	3
Expected business situation	189	0.06	1.98	-3	3
Ban of business activities	154	2.82	1.5	1	7
Domestic demand	170	2.95	1.34	0	8
Foreign demand	145	3.06	1.17	1	7
Domestic supply	152	3.81	1.19	1	7
Foreign supply	152	3.2	1.16	1	7
Worker not at work place	176	3.7	1.22	1	7
Financial problems	164	3.43	1.5	1	7
Preparedness	175	3.34	1.56	1	6
Stop business activities	183	0.14	0.35	0	1
Cost reduction or short-time work	183	0.36	0.48	0	1
Reduce business activities	183	0.3	0.46	0	1
Bundeshilfe or credits	183	0.08	0.27	0	1
Home office	183	0.85	0.36	0	1
Change of business model	181	0.06	0.23	0	1
New products or services	181	0.13	0.34	0	1
Digitalization	181	0.23	0.42	0	1
Delivery	181	0.02	0.15	0	1
Expected peak timing	189	2.42	1.11	1	5
Expected new normal timing	191	3.73	1.19	1	6
Digital production 2019	155	1.97	1.34	1	5
Digital production April 2020	156	2.38	1.56	1	5
Digital production future	155	2.21	1.38	1	5
Digital marketing 2019	156	2.63	1.31	1	5
Digital marketing April 2020	156	3.19	1.41	1	5
Digital marketing future	156	2.94	1.25	1	5
Digital sales 2019	153	1.78	1.25	1	5
Digital sales April 2020	153	2.01	1.43	1	5
Digital sales future	153	1.93	1.3	1	5
Home office 2019	155	1.32	0.8	1	5
Home office April 2020	156	3.24	1.47	1	5
Home office future	155	1.76	0.91	1	5
Digital improvement	144	3.82	0.95	1	7

Descriptive statistics of variables used. The survey questions are available in an online appendix.

C Robustness: Probit estimations

Estimation of an probit model.

Table 9: Estimation: Federal loan take up

	(1)	(2)	(3)	(4)
Employees	0.249	0.513	0.870*	0.837*
	(0.323)	(0.358)	(0.449)	(0.473)
Revenues	-0.455	-0.662*	-0.983**	-0.955*
	(0.342)	(0.393)	(0.472)	(0.494)
Domestic demand		-0.299	-0.126	-0.130
		(0.191)	(0.180)	(0.183)
Foreign demand		-0.260	0.122	0.089
		(0.225)	(0.246)	(0.253)
Business situation 2019	0.389*	0.319	0.433*	
	(0.229)	(0.225)	(0.227)	
Business situation now			-0.067	
			(0.218)	
Business situation peak			-0.440**	
			(0.211)	
Diff. business 2019 and now				0.477***
				(0.153)
Diff. business now and peak				0.416*
				(0.216)
Obs.	117	93	91	91
Pseudo R^2	0.244	0.246	0.355	0.354

Notes: Probit model. Sector fixed effects and MNE fixed effects. Firm level controls are included. Standard errors in parenthesis. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively.

Table 10: Estimation: short-time work take up

	(1)	(2)	(3)	(4)
Employees	0.074	0.291	0.288	0.348
	(0.178)	(0.228)	(0.244)	(0.242)
Revenues	0.036	-0.157	-0.105	-0.184
	(0.169)	(0.225)	(0.241)	(0.236)
Domestic demand		-0.192	-0.086	-0.089
		(0.126)	(0.126)	(0.135)
Foreign demand		-0.461**	-0.328*	-0.410**
		(0.179)	(0.186)	(0.179)
Business situation 2019	-0.100	-0.125	-0.029	
	(0.110)	(0.134)	(0.139)	
Business situation now			-0.250	
			(0.164)	
Business situation peak			0.010	
			(0.143)	
Diff. business 2019 and now				0.187**
				(0.088)
Diff. business now and peak				-0.009
				(0.141)
Obs.	164	128	126	126
Pseudo R^2	0.192	0.286	0.323	0.311

Notes: Probit model. Sector fixed effects and MNE fixed effects. Firm level controls are included. Standard errors in parenthesis. ***, **, * denote statistical significance at the 1%, 5%, and 10% level, respectively.