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How internet helped firms to cope with COVID-19*

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Abstract

This paper questions whether familiarity with digital technologies helped firms cope with the COVID-19 pandemic. Using data on 31,387 firms from 39 developing and developed economies, our results stress that businesses using website before the crisis showed higher absorption capacities than other firms during the crisis. The positive role of website use was mainly through the adoption of coping strategies, in particular home-delivery services, online sales or remote work. In contrast, the positive effect played by the prior use of internet is not explained by better access to external public (government support) or private (bank loan) financial resources.

Keywords: Covid-19, Internet, Firm, Shock, Resilience.

JEL classication: F61, L25, O33, O18.

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1. Introduction

Since the onset of the pandemic in 2020, the stringent distancing measures put in place around the world in response to the spread of the COVID virus have highlighted the vital importance of digital technologies for maintaining economic exchanges and social interactions. Increased digitalization[1] would probably soften the deleterious impact of containment measures on economic activity and human capital in southern countries (Guillaumont, 2020; Ma et al, 2021). This is particularly true for the private sector, for whom the adoption and diffusion of digital technologies has deeply changed the way firms and industries interact (Marsh et al, 2017). By reducing transaction costs and informational asymmetries (Aker, 2017: Goldfarb & Tucker, 2019), digital technologies are expected to boost firms' organizational and production capacities, to improve goods and service and financial markets functioning, to correct government failures, and therefore, to help them coping with the COVID crisis.

Many companies have responded to containment and distancing measures by adopting new organisational methods based on digital technologies (remote work, online sales, and takeaway sales). Several studies have shown that the use of digital tools has helped maintain economic activity during the crisis (e.g., Bloom et al., 2021; Fairlie & Fossen, 2021: Doerr et al., 2021). These works focus primarily on a few rich countries — mainly the U.S. — in which most businesses have access to fast internet and make extensive use of digital tools. However, not all firms have the same ability to use these digital tools, especially in developing countries. The digital absorptive capacity is generally found to be higher in large, exporting, foreign or multi-plant firms, and supported by strong digital skills (Farole and Winkler, 2015; Paunov and Rollo, 2016). Going back to the COVID-19 crisis, firms that were able to adapt to this shock were those resorting to teleworking or online sales, and probably those that were already using digital technologies prior to the pandemic. In other words, the digital divide between firms before the crisis may play a role in firm's ability to cope with COVID-19 shock.

This paper examines the role of digitalization in the capacity of firms (before the crisis) to absorb the COVID shock, based on a sample of 31,387 firms from 39 developing and developed economies. In particular, it questions whether firms relying on digital tools before the crisis were more resilient to the shock. We proxy firm's degree of digitalization before the crisis by a variable indicating whether a firm has a website in 2019. We also control for connectivity in location where the firm operates, proxied by the local mobile internet network coverage.

[1] Defined in this paper as the increasing resort by the firm to internet-based technologies in the conduct of business.

Distinguishing between internet connectivity and usage is key since the former is a necessary but insufficient condition for the latter if the firm has not the capacity to absorb digital technologies (Paunov and Rollo, 2015, 2016).[2] Internet connectivity (or access to) will be of little use if the firm does not have the capacity to absorb internet technologies, that is, the capacity to assimilate internet-related knowledge and to apply it within its production process (Marsh et al., 2017). Our results stress that companies using website before the health crisis showed higher absorption capacities than other firms. Having a website indeed increases the probability of staying open by 3 percentage points, and sales by 1.2%. We nonetheless do not see a difference in terms of workforce adjustment (hours worked or staffs).

In a second step, we examine the channels through which digitalization prior to the crisis may have played a role in business performance during the crisis. With data in hand, we are able to test two main channels. On the one hand, better connected companies can more easily implement adaptation strategies that have required the use of digital tools such as online sales or remote work. The use of digital tools has not only allowed the company to adapt its internal organization (remote work) but also to facilitate the maintenance of business relations with suppliers and customers (online sales, home-delivery services). On the other hand, in situations of movement restrictions, the digital link has facilitated access to additional financial resources, whether they be bank loans or public support (Saka et al., 2021). Econometric results indicate that the positive role of digitalization was mainly through the adoption of coping strategies, in particular home-delivery services, online sales or remote work. In contrast, the positive effect played by the prior use of digital tools is not explained by better access to external public (government support) or private (bank loan) financial resources.

This article is a part of a growing literature on the role of internet to mitigate the negative impact of COVID-19. Evidence from developed countries indicates that firms located in better connected areas performed better during the crisis (Pierri and Timmer, 2020; Doerr et al., 2021). Beyond connectivity, the familiarity with digital tools is of prime importance to implement coping strategies and therefore to cope with the crisis. Connectivity is a necessary but possibly insufficient conditions for leveraging the potential of internet in times of crisis as the current living one. But conversely, digital skills are also worthless if one is confined at home with slow connectivity. As a result, all firms facing social distancing measures are not equally capable to rely on remote work (Bai et al., 2021; Mongey et al., 2021) or online sales (Alcedo et al., 2022)

[2] Internet coverage is often used as identification channel for digital technology adoption in recent empirical studies (Hjort and Poulsen, 2019; Manacorda and Tesei, 2020; Guriev et al 2021).

and individuals to self-isolate (Chiou and Tucker, 2020), exacerbating the digital divide between companies and countries. In the same way, firms have not been equally able to access financial resources, whether from private financial institutions or from the government, if they were not able get access to internet and use it fluently in a context of movement restrictions.

This paper contributes to this literature by focusing on the firm's ability to exploit digital tools before the crisis in a context of a large range of solutions relying on internet technology. Existing evidence on the relationship between internet and resilience to COVID-19 focuses mainly on case studies in developed countries (especially in the U.S.). Some papers have scrutinized how firms from low and middle-income countries perform and adapt their organization during the pandemic (Aga and Maemir, 2021; Apedo-Amah et al., 2021; Davies et al., 2021). Some researches examine how pre-crisis characteristics as access to finance (Amin and Viganola, 2021; Khan, 2022) or initial performance (Muzi et al., 2021) impact firm's ability to absorb the consequences of the pandemic. However, to your knowledge, our paper is the first one to scrutinize the role of previous usage of digital tools to document heterogeneity across firms in their ability to cope with COVID-19 through digital strategies for a large range of firms and countries.

Findings provided in this paper are of prime interest for policymakers. Our results indicating that familiarity with digital tools is an essential aspect raising concerns about the limitations of connectivity measures. Policymakers should not only improve connectivity but also reinforce firms' digital absorptive capacity.

The next section presents discusses the methodology, while the following section displays the data and variables used in the econometric analysis. The fourth section exposes and discusses our results. The fifth section concludes.

2. Methodology

The starting point of this paper consists in examining whether firm's familiarity with digital tools before the crisis helped them to cope with COVID-19 shock. The baseline model is as follows:

$$Y_{ict} = \beta Website_i + \Upsilon \boldsymbol{C}_{ct} + \Omega \boldsymbol{X}_i + \alpha_c + \mu_t + \varepsilon_{ict} \quad (1)$$

where *i, c*, and *t* refer to firm *i* located in country *c* interviewed during the week *t*. We consider different metrics of performances (Y_{ict}) capturing several aspects of business activity and labor adjustments. Variables of interest is a proxy of firm's previous use of digital tools (existence of

a website) before the COVID crisis started. Prior internet usage has a positive impact on performance during the COVID crisis if $\beta > 0$[3].

We also control for country-week indicators of COVID-19 strength ($\boldsymbol{C}_{ct}$) by incorporating in our model information on the severity of the health shock and the effectiveness of government's measures implemented since the beginning of the crisis. We also control for initial (i.e., measured before 2020) firm-level characteristics ($\boldsymbol{X}_i$) that may influence both usage of digital tools and firm performance during the crisis (see below). In particular, we add the degree of connectivity, measured by the share of the firm's location covered by the 4G network, that could influence digital uses and could be correlated with other infrastructures impacting firms during the crisis. We also add firm-level control as their initial performance.

We add country (α_c) and time (week) fixed effects (μ_t). The country fixed effects allow us controlling for time-invariant characteristics but also in factors that change slowly such as level of income or macroeconomic indicators because we compare firms interviewed within a few months in the same country. The inclusion of country fixed effects implies that we compare firms within the same country (and often the same year) but surveyed at different weeks. To control for time dimension, we also include week dummies. The set of time dummies allow us to control for global shocks, such as international recovery or general reinforcement of stringency policies at some points of time, but also to consider the time that has elapsed since the beginning of the pandemic.[4]

In a second step, we study whether prior digitalization influences the adoption of coping strategies or the access to external funds during the COVID-19. To do so, we keep the same model as in Eq. 1 but we change the dependent variables (Z_{irct}) as follows:

$$Z_{ict} = \beta' Website_i + \Upsilon' \boldsymbol{C}_{ct} + \Omega' \boldsymbol{X}_i + \alpha'_c + \mu'_t + \varepsilon'_{ict} \quad (2)$$

We run six different estimations because we consider four coping strategies (innovation; home delivery service; online sales and remote work) and two measures of access to external funds

[3] All dependent variables are constructed so that an increase indicates an improvement in performance.

[4] In robustness analysis (Appendix A.3), our results hold when we replace country and week fixed-effects by country-week fixed effects. However, due the incidental parameter problem related to the inclusion of a large number of dummy variables in nonlinear models, the model with country and week separate dummies remain our preferred one. In unreported analysis, we also replace week dummies by different measures of time elapsed since the beginning of the declaration of the pandemics by the WHO, or since the peak of the pandemics based on the weekly number of deaths or the peak of stringency measures. The different measures are strongly correlated and results (available upon request) are unchanged.

(from private lenders and from the government). Internet usage has a positive impact on adoption of a coping strategy or access to (public or private) funds if $\beta' > 0$.

In a final step, we study whether coping strategies or access to (public and private) funds explain the impact of internet on performance. In doing so, we re-run Eq. 1 but we add coping strategies (resp. access to external funds) as additional interest variables and examine how their inclusion affects *Website* coefficient's (β'') strength, and significance. The estimated model becomes:

$$Y_{ict} = \beta'' Website_i + \delta Z_{ict} + \Upsilon'' \boldsymbol{C}_{ct} + \Omega'' \boldsymbol{X}_i + \alpha''_c + \mu''_t + \varepsilon''_{irct} \quad (3)$$

Where Z_{ict} is a measure of coping strategy or of access to external funds. We expect that the (positive) impact of internet transits trough coping strategies (resp., access to external resources) if $\delta > 0$ (i.e., coping strategy/access to funds improves performance) and $\beta'' < \beta$ (inclusion of coping strategy/access to funds attenuates the impact of internet usage).

In the three models, we rely on OLS when the dependent variable a continuous and on binary model (Probit) when the dependent variable is a dummy (marginal effects are displayed). We correct standard errors for heteroscedasticity. Finally, we use weight observations to assign to each the inverse of the number of firms per country (see Table 1) and therefore to give the same weigh to each country.[5]

3. Data and variables

3.1. Sample attrition

The primary data are drawn from the *COVID-19 Impact Follow-up Surveys* (*CIFS* henceforth). The Enterprise Analysis Unit of the World Bank (using phone interviews, emails and self-administrated questions) conducted surveys in 44 countries from April 2020 to June 2021.[6] From an initial sample of 49,681 observations, we first exclude firms when the government responses to the crisis from Hale et al. (2021) is unavailable. We therefore drop four countries (Armenia, Montenegro, North Macedonia and Somalia) representing 2,770 observations. We also exclude firms when information on internet mobile coverage is unavailable in the country (El Salvador, 1,438 observations) or because we cannot identify firm precise location (1,130 firms in four countries: Belarus, Bangladesh, Nicaragua, Romania). We exclude firms that did

[5] An alternative to be used weight given in the WBES. However, weigh in the WBES allow to provide a representative sample based on stratification at three levels (sector, location, size). However, the CIFS is not built to insure representativeness. The previous weigh are no longer valid.

[6] Data were retrieved in July 2021.

not answer because the interviewers were not able to contact them after several tries or because line is out of order (4,273) or for other non-identified reasons (277)[7]. We then merged CIFS with World Bank Enterprise Surveys by exploiting unique firm id available in both datasets. We finally drop firms for which we lack information regarding firm level control variables are unavailable (8,406 observations). Our final sample therefore includes 31,387 observations from 39 countries. The number of observations per country ranges from 76 in Togo to 2,857 in Poland. The list of countries, as well as the number of observations per country, is given in Table 1.

Table 1: Sample composition.

Country	Obs.	Country	Obs.
Albania	355	Lebanon	378
Azerbaijan	104	Lithuania	590
Bangladesh	1183	Malta	528
Belarus	523	Moldavia	814
Bosnia	203	Mongolia	401
Chad	113	Morocco	1759
Croatia	1003	Mozambique	373
Cyprus	494	Nicaragua	314
Czech Rep.	1192	Niger	64
Estonia	569	Poland	2857
Georgia	1067	Portugal	2311
Greece	1538	Romania	1294
Guatemala	487	Russia	1098
Guinea	98	Serbia	280
Honduras	364	Slovakia	974
Hungary	1870	Slovenia	904
Italy	1260	Togo	76
Jordan	683	Zimbabwe	1094
Kazakhstan	723	Zambia	1004
Latvia	445		

[7] We also consider a large definition of exit including some of these firms as exit enterprises (see below) that increases the sample from 31,387 to 35,660 observations.

3.2. Dependent variables

3.2.1. Performance of firms during the crisis

We extract four metrics of firm outcomes during the pandemic from the *CIFS* covering three main aspects of firm performance*:* firm survival, evolution of activity for surviving firms and labor adjustments.[8]

Firm survival: We first consider a variable measuring whether a firm has continued its activity during the crisis. In line with Aga and Francis (2017), we classify firms into three categories: (i) confirmed active firms; (ii) confirmed exit, and (iii) probably exit but unconfirmed. The first group assembles firms for which we are certain that they continued operations at the moment of the interview. We first consider firms answering to the interview and stating that they continued their operations. We also include firms refusing to answer but for which we know that they continued to operate (eligibility status is "refuses to answer"). We then classify firms for which we know that they stop (temporary or definitively) their operations. We group together firms answering to the interview but declaring that they ceased their activity during the COVID-19 and firms unable to reach for an interview because they stop their business. Finally, there is a group of firms whose status is unclear. We are not certain that these companies stopped their activity but interviewers were unable to contact them after several tries. We therefore classify these businesses as "probably exit but unconfirmed". Based on the three groups, we create two measures of firm survival. Our preferred measure (*Survival - strict*) is a conservative measure of survival. It is a dummy equal to one if a firm is a confirmed active firm and 0 if the firm is a confirmed exit firm. We also consider a less conservative measure by adding unconfirmed exit firm in the group of non-survival firms (*Survival – large*).

Business dynamics for surviving firms: We then create a continuous proxy variable assessing the level of firm activity for surviving firms. We consider the evolution of sales, computed as the percentage of sales in the month before the survey, in comparison with the same month in 2019 (*Sales*).

Labor adjustments: Workforce evolution is considered by two variables capturing both extensive and intensive margins. The ratio of permanent workers in the previous month to the number of permanent workers in the end-2019 (*Workers*) allows us to proxy the adjustment

[8] All variables, described below, are built to increase with an improvement of performance to facilitate the results' interpretation.

made on the staff number (extensive margin). The intensive margin focuses on the evolution of hours worked. We created a dummy equal to one if the firm has not changed (or increased) the hours worked, and zero if the number of hours has been reduced (*Hours*).

3.2.2. Coping strategy and access to external funds

The CIFS asked enterprises about the ways in which they responded to the crisis. Specifically, companies were asked if they had adopted any of the following strategies: (i) development of a new product or a new process (*Innovation*); (ii) implementation of a home delivery or take-out service (*Delivery*); (iii) implementation (or increase) of online sales (*Online sales*); and, (iv) use of remote work arrangement (*Remote work*). For each coping measure, we create a dummy equal to one if the firm relied on the strategy and zero otherwise. In addition, for two strategies, namely online sales and remote work arrangement, we obtain a measure of intensity use. For online sales, we have information on the percentage of production sold online. For remote work arrangement, we know the percentage of workers who have teleworked during the pandemic.

Next, we exploit an information on the ways used by firms to deal with cash flow shortages. In particular, we know if a firm has obtained a loan from a financial institution to tackle cash flow shortages, or public support from (local or national) government in response to the crisis. We therefore create two dummy variable equals to one if a firm has obtained a formal loan/public support since the beginning of the crisis.

3.3. Usage of internet (before the crisis)

The paper's aim consists in evaluating how previous use of internet helps firms to absorb the COVID-19 shock. To proxy firm's familiarity with internet usage, we exploit firm-level information before the crisis provided by the World Bank Enterprise Surveys (*WBES*). The sample of firms included in the *CIFS* has been extracted from the respondents of the previous waves of *WBES*. We therefore exploit *WBES* to know if interviewed enterprise used digital technologies before the COVID-19 crisis. Specifically, internet use is measured through the existence of an enterprise's own website when the firm were previously interviewed (between 2017 and 2019).[9] We are interested in firm's website use since this usage of internet, adopted

[9] The WBES provide another information on digital tools : email use. Unfortunately, this information is poorly documented, making it impossible to use in our empirical work. Moreover, website use is also generally associated with email use for both internal and external communication purpose, since according to our data, only 2% of firms using a website does not rely on email. In our baseline sample, 97% of firms using website also use email, while only 60% of firms using emails use a website for their operations.

for external communication purpose, reflects firm's capacity to make strategic use of internet (Sadowski et al, 2002) and readiness to adapt to COVID-related social distancing measures (Muzi et al, 2021; Wagner, 2021). Moreover, firms using website generally use email for the conduct business but the reciprocal is not necessarily true, which makes website adoption a better indicator of the firm's digital absorptive capacity than email adoption. Firms are therefore separated into those that have already set up a website before the COVID (digital technology users) and the other enterprises (non users).

3.4. Control variables

3.4.1. Internet connectivity

Lack of connection is a barrier to the use of digital tools and may also reflects a lack of other infrastructures impeding firm development. We therefore proxy internet connectivity through a measure of internet accessibility at the sub-national level (city or province). We exploit a rich dataset on mobile internet coverage collected by GSMA-Collins Bartholomew, which provides at a high-resolution geo-coded information on the mobile internet coverage by technology type (2G, 3G and 4G) and signal strength (strong, intermittent/weak, and null).[10] [11]

Based on this dataset, we construct the percentage of location (city, and in some cases provinces) covered by a strong mobile internet signal (2G, 3G and 4G). We exploit coverage information in 2019, i.e. the year before the COVID-19 outbreak. The coverage is hence measured at the location level, allowing us to consider within country spatial inequalities in internet access. We measure internet access by the percentage of location in which the company operates covered by a strong 4G signal.[12] Since coping strategies to the crisis (remote work, online sales) require broadband internet access, we focus on the 4G technology, considering the 3G coverage in the robustness checks.

[10] Finally, only information on mobile internet is employed here due to the lack of data on wired internet. Nonetheless, mobile internet is less costly to implement and therefore more diffused than wired internet. In many (low- and middle-income) countries, wired internet is almost inexistent, which makes mobile internet access a better standard for international comparisons.

[11] The geographical precision of the data ranges between 260m on the ground, for high-quality data extraction based on a geographic information system (GIS) vector format, to 12 km, for extraction based on the location of antennas and their corresponding radius of coverage. See: https://www.collinsbartholomew.com/mobile-coverage-maps/

[12] Figure A1 (in Appendix) shows that access to 2G is widespread, making it impossible to distinguish between areas according to their coverage in this technology. There is more heterogeneity in 3G and 4G network coverage.

3.4.2. COVID-19 crisis indicators

We also combine data with information about the severity of the pandemic. We rely on the total number of deaths per million in the week of the interview[13] to proxy the lethality of the health crisis. Data are extracted from *Our World in Data* (2021) and initially compiled by the Center for Systems and Engineering (CSSE) from Johns Hopkins University.

We also consider the importance of government's responses to the COVID-19 influencing negatively (lockdown measures) or positively (public support) firm performances. We employ indices provided by the Oxford COVID-19 Government Response Tracker (OxCGRT) presented in Hale et al. (2021). The OxCGRT tracks three types of government responses to the pandemic: (i) containment and closure measures (e.g., workplace closing); (ii) economic response (e.g., income support); and (iii) health measures (e.g., testing campaign). To measure the importance of stringency measures, we rely on stringency index provided in the OxCGRT that comprises nine indicators: school closing, workplace closing, cancel public events, restrictions on gathering size, close public transport, stay-at-home requirements, restrictions on internal movement, restriction on international travel, and public information campaign. Economic response to the crisis is proxied by the OxCGRT economic support index, which considers two variables: income support and debt or contract relief for households. For each index, the OxCGRT provide a score (per day for each country) ranging from zero (no measure implemented) to 100 (maximum of constraints/support). In the analysis, we ignore health policy because they are not expected to exert a direct and short-run influence on firm's operations. Controlling for mortality rates is nevertheless expected to capture global health systems' response capacity, in addition to COVID-19 incidence and virulence and the resulting self-containment behaviors (despite being imperfectly measured across countries and time).

For both policy indexes (stringency and economic support), we compute the average value of index since the January 1, 2020 and the week of the survey in the country. Indeed, there are strong spatial and temporal disparities in the government measures taken (Hale et al., 2021).[14]

[13] It should be noted that for the firms not interviewed (a part of exit firms) we do not have a precise date of interview. We consider that these firms were interviewed in the median week for firms surveyed during the same wave. For instance, in Armenia, 3 firms were interviewed in week number 23 (from June, 8 to June, 14, 2020), 176 firms in week 24, 103 in week 25, and 65 in week 26. The median firm was therefore surveyed in week 24. We therefore consider that exit firms without a precise date of interview were surveyed in week 24.

[14] Contemporary measure is a bad proxy of current situation faced by firms because government measures have changed over time within a country. A firm interviewed just after a relaxation of stringency measures has supported strong policies, even if the contemporaneous index reflects weak constraints. The opposite is true if measures become more stringent just before the survey. Several studies (Apedo-Amah et al., 2021; Davies et al., 2021) propose to consider the time since the peak of the stringency measures. This approach has a threefold flaw. Most countries had a peak in measurements at the beginning of the epidemic episode (in March or April 2020). Second,

In particular, we compute the area under the curve and dividing it by the duration (number of days) since January 1, 2020. We consider the same initial date to normalize the duration and avoid bias induced by countries implemented measures later or sooner. This measure provides a normalized index of the average intensity of distancing and economic support measures for each country in each period considered, and thus makes it possible to compare firms within the same country.

3.4.3. Firm-level control variables

The *World Bank Enterprise Surveys (*WBES) allow us to obtain a rich information on firm's characteristics before the crisis. We control for usual firm's characteristics that may influence both internet access and usage and performance, including size, age[15], sector (*Manufacturing*, *Services* and *Trade*) manager's experience (*Experience*) and gender (*Female*). We also include dummy variables equal to one if foreign investors own the firm (*Foreign*); if the firm is an exporter (*Exporter*); and, is a part of a larger firm (*Multi-plant*). We also consider the share of input imported because the COVID-19 disrupted worldwide supply chain (*Imported input*).

We also add some location-level control variables. First, we control for the city size where the firm is located. Resilience to COVID-19 can be correlated with city size due to access to infrastructures (e.g., roads) or to major markets. We therefore consider the size of the city where the firm operates with four categorical variables: *Mega City* (population exceeds 1 million inhabitants), *Big City* (between 250 000 and 1 million), *Medium City* (between 50 000 and 250 000), and *Small City* (less than 50 000). We also add a dummy if the firm is located in the country capital city (*Capital*).

Second, internet usage and performance during the crisis can be related to obstacles faced by the firm in normal times. For instance, a firm experiencing frequent power shortages can have fewer incentives to use digital technology and may suffer more during the crisis. In the same way, access to finance is required to invest (in digital technologies) and has been shown to

this approach neglects the intensity of distancing and support measures over time. Finally, and more fundamentally, the role of duration is unclear. On the one hand, it allows for a growing adaptation to the situation, which implies an improvement in the situation of firms as time goes by. On the other hand, more than the intensity of the measures taken, it is the maintenance over time that can make life increasingly difficult for firms. Firms would thus face increasing difficulties as time passes.

[15] We add firm size measured by four classes: *Micro* for firms with less than 9 workers (omitted variable), *Small* for firms having between 10 and 19 workers the number of employees, *Medium* for firms between 20 and 49 workers, and *Large* for firms with more than 50 workers. We also distinguish between *Start-Ups* firms being less than 9 year-old, *Young* firms being between 10 and 19-year old, *Old* firms being between 20 and 49 year-old and *Very Old* firms being more than 50 year-old.

explain why some firms are more able to cope with shocks, notably during the COVID-19 (Amin and Viganola, 2021; Khan, 2022). We therefore add two variables capturing whether power shortages and financial access are an impediment for business operations. We include subjective measures of perceptions based on manager's evaluation of whether access to finance (*Finance*) and electricity (*Electricity*) are an obstacle to their operation. We consider a Likert scale ranging from 0 (no obstacle) to 4 (very strong obstacle).

Finally, the best performers before the crisis are more likely to have adopted digital tools and certainly to absorb the shock (Muzi et al., 2021). We therefore add a variable measuring whether the firm was more productive than their national counterparts were before the crisis. We create a dummy equal to one if the labor productivity of the firm before the crisis is in the top quartile of firms from the same country, and zero otherwise (*Top Performer*).[16] Previous performances are potentially correlated with digital use and firm's ability to absorb the COVID-19 crisis (ability to mobilize external funds and networks of clients and suppliers).

Description of all variables are provided in Table A1 in Appendix.

4. Results

4.1. Descriptive statistics

The Table 2 displays the descriptive statistics for dependent and interest variables. Regarding firm performance, we see that nine firms to ten remained open during the crisis if we consider the conservative measure of exit. When we include unconfirmed exit firms, we see than 80% of firms maintain their operation during the COVID-19 crisis. On average, during the crisis, sales have decreased by 20%. These figures, however, hide strong disparities across firms. For instance, 40% of firms have not experienced reduction in sales. At the opposite, for firms suffering from a reduction of activity, the average level of contraction of sales is 40%. Finally, labor adjustments have been mainly done by diminishing the number of hours, rather than cutting in the staff. Two thirds of enterprises have reduced worked hours, while only 5% of them have laid off their employees. These findings are in line with previous papers on firm performances during the COVID (Apedo-Amah et al., 2020; Bloom et al., 2021; Davies et al., 2021).[17]

[16] The variable is built on the full sample of firms included in the WBES. In robustness checks, we consider alternative measures of *ex-ante* performances.

[17] However, Bartik et al. (2020) point out that US firms suffered severely in the beginning of the crisis with occurrence of mass layoffs and closures just a few weeks into the crisis.

Turning to coping strategy, we point out that more than 40% of firms have created a new product or a new process. Only one quarter of firms have developed (or accentuated) home-delivery service and online sales. For enterprises that used online sales, this channel accounted for one fifth of sales. Finally, 37% of firms have adopted remote work and if so, this concerns 12% of workforce. Only one enterprise into five received a bank loan since the beginning of the crisis. Public supports concern a larger share of firms (42%).

Table 2: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Dependent variables					
Survival (strict)	31,387	90.50	29.32	0	100
Survival (large)	35,660	79.66	40.26	0	100
Sales	27,151	-19.45	33.72	-100	400
Workers	27,069	94.46	30.04	0	300
Hours	27,165	63.04	48.27	0	100
Digitalization					
Use (Website)	31,387	0.66	0.47	0	1
Access (4G)	31,387	0.40	0.41	0	1
Mitigation strategy					
Innovation	27,622	0.42	0.49	0	1
Delivery	27,585	0.26	0.44	0	1
Online sales (Y/N)	27,249	0.28	0.45	0	1
Online sales (%)	6,948	18.06	23.87	0	100
Remote work (Y/N)	27,379	0.37	0.48	0	1
Remote work (%)	9,893	12.54	21.79	0	100
Access to funds					
Bank loan	17,308	0.20	0.40	0	1
Public support	27,237	0.42	0.49	0	1

The main interest variable is the use of a website before the crisis. We observe that two thirds of firms had a website before the COVID-19 crisis. Table 2 also presents descriptive statistics for connectivity. The coverage of strong signal of 4G in on average at 40%, but with a wide heterogeneity as indicated in Figure A1 in Appendix.

Table 3 presents mean (or proportion[18]) difference test for performance and adaptative strategies between firms with a website before COVID-19 and firms without a website. Firms

[18] Proportion test is implemented for dummy variable and allows us to compare differences in proportions rather than in means.

having a website, and therefore more likely to relying on digital tools had better performance during the crisis as indicated in Panel A. For instance, 93% of firms having a website before the crisis remain open and their sales have been reduced by 17%, contrary to 86% and minus 25%, respectively, for firms that did not have a website in 2019. In terms of coping strategies, we do not see statistical differences for adoption of innovation or delivery. However, firms having a website before COVID-19 are more likely to develop online sales (+7 percentage points) and remote work (+15 pp). Finally, we see a slight difference, in favor of connected firms, for access to private loan but a larger impact on access to public support.

Table 3: Means and proportion differences

	No website			Have a website			t-value
	Mean	Std. Err.	Obs.	Mean	Std. Err.	Obs.	
Panel A) Performance							
Survival (strict)	85.59	0.342	10,557	92.99	0.177	20,830	21.26***
Sales	-25.13	0.374	8,635	-16.80	0.242	18,518	19.08***
Workers	92.55	0.367	8,637	95.36	0.206	18,434	7.17***
Hours	56.17	0.534	8,627	66.22	0.347	18,541	16.06***
Panel B) Coping strategies							
Innovation[a/]	0.421	0.005	8,858	0.416	0.004	18,772	0.83
Delivery[a/]	0.257	0.005	8,837	0.254	0.003	18,753	0.71
Online sales[a/]	0.227	0.005	8,676	0.298	0.003	18,584	12.17***
Online sales (%)	19.30	0.563	1,817	17.62	0.332	5,131	2.57**
Remote work[a/]	0.271	0.005	8,762	0.420	0.004	18,631	23.84***
Remote work (%)	12.69	0.481	2,251	12.50	0.245	7,642	0.38
Panel C) Access to funds							
Bank loan[a/]	0.190	0.005	6,428	0.210	0.003	11,845	3.22***
Public support[a/]	0.326	0.005	8,715	0.461	0.004	18,538	21.05***

The table presents means differences and proportion differences (the latter is indicated by a/) between firms without a website before COVID-19 and firms with a website before COVID-19. *, **, *** indicate statistical significance at 10, 5 and 1% respectively.

4.2. The effect of internet on firm performance

4.2.1. Baseline results

Table 4 displays the marginal effects of the impact of having a website (adopting digital tools) before the COVID-19 on the four business outcomes (survival, sales evolution, workers and worked hours). All dependent variables are built to increase with better performance to facilitate results' readings. All estimations include control variables (internet connectivity, COVID-19 crisis indicator and firm-level controls) as well as country and week fixed effects.

The use of the website before the crisis plays a positive role on business survival and sales growth but no effect on labor adjustments, as indicated in the first row of Table 4. Having a website indeed increases the probability of staying open by 3 percentage points, and sales by 1.2%.

Turning to the control variables, the second row of the Table 4 does not highlight a positive effect of internet access on firm performance during the crisis. Indeed, mobile internet coverage exerts a negative influence on business outcomes (except the firm workforce size), suggesting that firms located in areas with a better access to internet seem to suffer more than firms located in areas with a lower coverage. Although statistically significant, the effect of 4G coverage is economically very low, since increasing 4G coverage by 10% (which is the median) reduces the probability of remaining open and sales by less than one percent point.[19] At this point, we cannot determine the mechanism underlying this *a priori* surprising negative relationship, though one intuitive explanation would point to the detrimental effect of more stringent policies in better connected places on firm performance. We provide some evidence in favor of this hypothesis in Appendix B.

For the time being, it is useful to look at the effect of the other variables included in the model to explain firm performance. It is worth noting that small and female-led firms have performed less well than other firms have during the crisis. The effect of age is less clear. We also point out that top performers before the crisis are more able to absorb the shock. Exporting and importing firms tend to cope better with the crisis.[20] Financially constrained firms face higher difficulties during the crisis, in line with previous findings (Amin and Viganola, 2021; Khan, 2022). It is unclear whether city size matters. The extent of containment measures taken have negatively and strongly affected business outcomes, at the exception of the likelihood to remain open. Economic support measures have had an ambiguous role, possibly explained by the reverse causation hypothesis (stronger support in the most affected areas). Beyond government measures, the strength of the health crisis (death rates) played an independent and negative role on firm sales evolution.

[19] It should be noted that estimates associated to the 4G coverage variable represent a shift from zero coverage to full coverage (100%), which is not very credible in the short term while for the use of a website, the coefficients measure the effect of having or not a website for business operations.
[20] We also observe that firms in manufacturing, services and trade perform better than firms in other industries do (omitted variable). However, "other industries" assembles many different SMEs, including those in tourism.

Table 4: Effect of internet use and access on firm performance

	(1)	(2)	(3)	(4)
Dep. Var:	**Survival**	**Sales**	**Workers**	**Hours**
Internet				
Internet use (website)	3.160***	1.208**	0.782	0.529
	(6.82)	(2.30)	(1.59)	(0.74)
Control variables				
Internet access (4G)	-5.834***	-8.565***	-1.521	-7.810***
	(-4.07)	(-5.07)	(-1.02)	(-3.19)
Small size	3.327***	2.384***	0.161	0.873
	(5.47)	(3.66)	(0.25)	(0.98)
Medium size	4.959***	5.360***	0.757	2.503***
	(8.77)	(8.10)	(1.21)	(2.84)
Large size	6.007***	7.801***	0.601	4.648***
	(10.53)	(11.78)	(0.96)	(5.10)
Teen	2.186***	0.803	0.447	0.476
	(3.14)	(1.07)	(0.62)	(0.48)
Old	2.173***	0.879	0.675	1.601
	(3.18)	(1.15)	(0.94)	(1.58)
Very Old	3.557***	-0.531	0.209	-0.189
	(4.03)	(-0.47)	(0.20)	(-0.12)
Female	-0.444	-1.627***	-0.636	-2.229***
	(-1.16)	(-3.54)	(-1.53)	(-3.52)
Experience	0.0713***	-0.0103	-0.0263	-0.0396
	(3.91)	(-0.45)	(-1.27)	(-1.28)
Top performer	3.098***	5.534***	3.411***	7.196***
	(7.58)	(10.88)	(7.37)	(10.30)
Foreign	-1.727**	-0.182	0.0615	-1.901*
	(-2.51)	(-0.22)	(0.08)	(-1.80)
Export	-0.0260	-0.0595	1.770***	1.508**
	(-0.06)	(-0.11)	(3.52)	(1.99)
Imported input	0.0158***	0.0232***	-0.00481	0.00601
	(2.71)	(3.44)	(-0.75)	(0.66)
Multiplant	0.764	1.852***	-0.521	0.953
	(1.29)	(2.89)	(-0.83)	(1.10)
Manufacturing	33.72***	38.52***	27.48***	21.61***
	(10.63)	(12.93)	(7.69)	(6.19)
Services	31.88***	35.39***	24.54***	20.17***
	(10.10)	(11.97)	(6.92)	(5.88)
Trade	29.11***	32.04***	24.57***	19.93***
	(9.19)	(10.78)	(6.90)	(5.79)
Electricity obs.	0.209	-0.116	0.255*	-0.327
	(1.60)	(-0.70)	(1.72)	(-1.47)
Finance obs.	-0.786***	-0.813***	-0.588***	-0.516*
	(-4.36)	(-4.22)	(-3.07)	(-1.93)
Big city	-0.859	0.224	-0.136	-1.378
	(-1.26)	(0.26)	(-0.17)	(-1.27)

Medium city	-0.0337	-0.893	-1.319	-1.788
	(-0.04)	(-0.94)	(-1.38)	(-1.43)
Small city	-0.303	1.136	0.242	-0.0831
	(-0.35)	(1.11)	(0.24)	(-0.06)
Capital city	0.133	-1.172	-1.483*	-1.165
	(0.20)	(-1.38)	(-1.86)	(-1.08)
Stringency measures	3.783***	-2.387**	-1.550*	-6.653***
	(4.41)	(-2.28)	(-1.70)	(-4.69)
Economic support	-2.073***	-0.607	-0.640	2.255***
	(-5.68)	(-1.44)	(-1.48)	(3.83)
Mortality rates	0.000328	-0.00369***	-0.00103	0.00217*
	(0.52)	(-4.45)	(-1.34)	(1.95)
Obs.	31,387	27,153	27,071	27,168
R2	0.14	0.22	0.06	0.21

The table presents the factors affecting ex-post performance of firms. Four indicators of performances are considered: the probability to remain open (column 1), the sales evolution between the month before the survey and the same month in 2019 (column 2), the evolution of permanent workers between the end of 2019 and the month before the survey (column 3) and the likelihood to maintain the same level of worked hours (column 4). All indicators are built so that an increase indicates improved performance. Country fixed effects and week dummies are included but not reported. Standard errors are corrected for heteroscedasticity (robust t-test reported in parentheses) and estimations are weighted by the inverse of the number of firms per country. *, ** and *** signal significance at 10, 5, and 1%, respectively.

5.2.2. Sensitivity checks

We run some sensitivity tests displayed in the Appendix. We first document in Table A2 that econometric results are not due to the inclusion of website and 4G coverage in the same model. When we include only one indicator, we get very similar findings. In Table A3, we provide additional checks. Panel A employs 3G coverage instead of 4G. Coefficients associated to connectivity become statistically insignificant, but those associated with website usage are unchanged. We then add time duration since the beginning of the pandemic in Panel B without altering conclusions regarding internet[21]. The length of time since the beginning of the epidemic tended to improve business outcomes. In Panel C, we saturate the models with country-week dummies. Results are unchanged. In Panel D, we consider alternative measures of *ex-ante* performances that are crucial to control for differences in pre-crisis business outcomes. We compute the three-year growth of firms before the crisis using information on sales and employment provided in the *WBES.* Findings are in line with baseline results not only for

[21] We consider alternative measures of duration based on global index or a country-specific index. For the global index, we measure duration since the declaration of epidemics by the World Health Organization (WHO). For country-specific indexes, we consider the time lapse since the beginning or the peak of the crisis. The beginning of the crisis is measured by the first stringency measures implemented in the country or health situation (day when the number of deaths exceeds 10 or 100). For the definition of the peak, we consider the maximum of stringency measures or the weekly evolution in the number of deaths. Insofar as results are very close (because dates considered change a little), we only report the model with the time lapse since the declaration of epidemics by the WHO.

internet measures but also for the impact of top performers (who suffer less during the crisis).[22] Finally, we change the definition of exit firms by including the group of unconfirmed exit firms. Results, available upon request, confirm the baseline estimations.

4.3. Channels through which digital technology influences business outcomes

The use of digital technologies plays a role on business outcome during the COVID-19 with the risk of increasing the digital divide across firms. Several channels can explain why firms relying *ex-ante* on digital tools have been more able to cope with the shock. With data in hand, we are able to test two possible channels. On the one hand, internet adoption prior to the crisis may encourage the implementation of coping strategies by the firm, such as remote work or online sales. On the other hand, internet is a way to link the SMEs to its financiers, both public (public aid) and private (banks). In the face of distancing measures, digitalized firms have been able to take advantage of these internet-based strategies. For each explanation, we test whether website ownership increases the likelihood of adopting coping strategy or accessing to external funds (Eq. 2). We then examine if firms adopting these solutions perform better and if the impact of website use is reduced (Eq. 3).

4.3.1. Coping strategies

Internet and the adoption of coping strategy

We first study the role of internet use on the likelihood to adopt the different coping strategy by running Eq. 2. In doing so, we exploit a module included in the *CIFS* about how firms cope with the shock. As indicated above, we consider four different coping strategies: (i) innovation, (ii) home-delivery services, (iii) online sales, and (iv) remote work.

Results based on Probit estimation of equation (2) are displayed in Table 5. They indicate that firm usage of website before the pandemic increases the likelihood of adopting three coping strategies out of four, namely home-delivery service, online sales and remote work. Firms having a website are 3 percentage points (pp.) more likely to adopt home-delivery services (which represents an increase of 13% in comparison with the sample mean[23]). These firms are also 10 pp. (+35%) more likely to implement online sales and 5 pp. (+15%) more likely to rely

[22] In an unreported test, we also changed the cut-off to define the top performers by using the median and results are similar.

[23] In the bottom of Table 3, we report the percentage evolution in comparison with sample mean to gauge the economic impact.

on remote work. The impact on innovation is lower in both statistically and economically sense (1 pp., +2%).

For sake of transparency, we also display the role of connectivity for adoption of coping strategies. The effect of 4G coverage is less clear-cut, suggesting that connectivity is less important than internet absorptive capacity to adopt coping strategies based on digital technologies. A better connectivity only improves the likelihood to adopt remote work but has a negative effect on online sales (and no effect on home-delivery and innovation). Evidence in appendix B.1 suggests that this negative effect could be explained by the stronger stringency of and compliance with movement restrictions in better connected places, which would mechanically slow down firms' operations, especially if government support is better channeled in places with greater connectivity. On the other hand, even if statistically significant, the economic impact of a better access to internet on remote work adoption is rather modest. An increase of 10% of internet coverage (e.g., the median) increase the likelihood to rely on remote work by 1 pp. (+2.6% in comparison with the sample mean).

Table 5: Internet and adoption of coping strategies

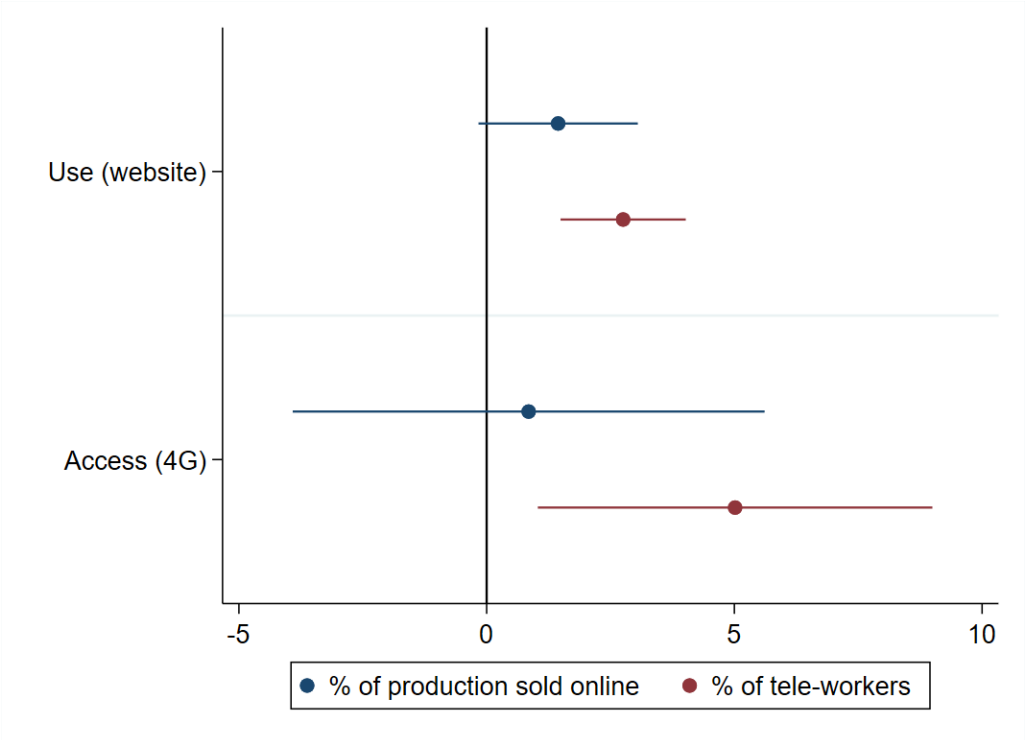
	Innovation (1)	Delivery (2)	Online (3)	Remote work (4)
Internet				
Website use	0.0077	0.0334***	0.0947***	0.0546***
	(1.16)	(5.70)	(15.48)	(8.48)
Internet access (4G)	0.0257	-0.0269	-0.0934***	0.0925***
	(1.18)	(-1.41)	(-4.76)	(4.25)
Obs.	27,630	27,590	27,968	27,393
Economic impact (in percentage of the sample mean)				
Use (0 -> 1)	1.83	12.85	33.82	14.76
Access (+10% in coverage)	0.61	-1.03	-3.34	2.50
Average(Y)	0.42	0.26	0.28	0.37

The table presents the marginal effect induced by the prior use of internet (website) and by the quality of coverage (4G) on the adoption of four coping strategies: innovation (column 1), delivery (column 2), online sales (column 3) and remote work (column 4). Robust t-value are reported in parentheses. The estimated model includes firm-, region-, and country-week-level control variables as well as country fixed and week effects. The bottom of the table assesses the economic impact (in percentage of the average adoption of each strategy in the sample) for a firm with a website (Use) and for an increase of internet coverage of strong 4G of 10%.

In regards to two coping strategies (online sales and remote work), we get additional information on the intensity of adoption. We estimate whether having a website and a better connectivity affect the intensity of online sales and remote work, focusing exclusively on firms adopting these coping strategies. Results, reported in Figure 1 below, indicate that neither the use of nor the access to internet statistically influence the share of production sold online.

However, internet usage and internet access positively trigger the percentage of staff working from home. Therefore, it appears that firms already familiar with digital technologies have not increased their online presence as a response to the pandemic, but resorted more intensively on remote work as main adjustment strategy.

Figure 1. Internet and intensity of production sold online and remote work



The figure represents the marginal effect of the internet usage (website) and connectivity (4G) on the intensity of production sold online (in blue, N=7,134) and the share of workers working from home during the COVID-19 (in red, N=10,160). The estimated model includes firm-, region-, and country-week-level control variables as well as country and week fixed effects. Bars display robust confidence intervals at 5%.

Finally, we examine whether the impact of the website has a heterogeneous impact on the adoption of coping strategies. We first consider firm size. The results, presented in Appendix Table A4, show that pre-crisis Internet use increases the adoption of online sales and delivery for all firms, regardless of size. But the impact of the website dummy variable is stronger for small firms. Conversely, we find that the positive impact of website on telecommuting adoption is increased for large firms (but remains positive for all firms). We also investigate whether the most productive firms before the crisis benefited more from the Internet in terms of adoption of coping strategies. All firms, regardless of their performance before the crisis, benefited from the use of the Internet. However, the most successful companies gain additional benefit from the adoption of remote working solutions.

Coping strategies and firm performance

We then scrutinize whether the positive effect of website use on performance during the pandemic is due to adoption of previously-mentioned coping strategies, especially strategies favored by a previous use of digital technology: home-delivery, online sales and remote work. To do so, we run Eq. 3 and compare in Table 6 the resulting estimates with and without including coping strategies in the econometric model.

First, we display baseline econometric results (i.e., without coping strategies) before including coping strategies to be ascertain that changes are not due reduction in the number of observations. The positive effect of a previous usage of a website on sales is reduced when we add coping strategies, as expected. Though non-significant for most dependent variables except total sales (columns (3) and (4)), estimand associated to website adoption is reduced by one quarter when we include coping strategies. Regressions also stress that internet access marginally influences firm's adoption of coping strategies, thereby supporting that coping mechanisms rely on firm's absorptive capacity rather than local internet connectivity.

Table 6: Coping strategy, internet and firm performance

	Survival		Sales		Workers		Hours	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Internet								
Website	0.415	0.291	1.180**	0.862	0.526	0.425	0.565	0.688
	(1.03)	(0.73)	(2.22)	(1.63)	(1.05)	(0.85)	(0.78)	(0.94)
Access	-5.482***	-5.456***	-8.692***	-8.649***	-1.528	-1.756	-8.620***	-8.277***
	(-3.94)	(-3.92)	(-5.09)	(-5.07)	(-1.01)	(-1.16)	(-3.48)	(-3.34)
Coping strategy								
Innovation		-0.411		-3.459***		-0.915**		-6.508***
		(-1.13)		(-7.24)		(-1.98)		(-9.92)
Delivery		1.437***		2.641***		0.392		-0.883
		(3.05)		(4.37)		(0.67)		(-1.09)
Online sales		0.512		1.384**		-0.357		0.109
		(1.16)		(2.38)		(-0.61)		(0.14)
Remote work		0.296		1.787***		2.335***		-0.874
		(0.85)		(3.68)		(5.02)		(-1.28)
Obs.	26720	26720	26492	26492	26105	26105	26599	26599

The table presents the role of coping strategies and internet measures on performance of firms. Six indicators of performances are considered: the probability to remain open (columns 1 and 2), the sales evolution between the month before the survey and the same month in 2019 (columns 3 and 4), the evolution of permanent workers (columns 5 and 6) and the likelihood to maintain the same level of worked hours (columns 7 and 8). All indicators are built so that an increase indicates improved performance. The estimated model includes firm-, region-, and country-week-level control variables as well as country fixed and week effects. Standard errors are corrected for heteroscedasticity (robust t-test reported in parentheses). *, ** and *** signal significance at 10, 5, and 1%, respectively.

Second, we observe that the adoption of home-delivery services and remote work has been effective to limit degradation of firm performance during the COVID-19. Online sales have only allowed firms to maintain firm sales but have a limited impact on other outcomes. Finally, adoption of innovation does not play a role in cushioning the negative impact of the COVID-19 shock on business operations, possibly due to a time lag between the short-term consequences of the crisis and the medium-term benefits of innovation policy. At the opposite, firms developing a new product tend to suffer more, possibly due to cash-flow deterred by low or lagging investment returns.

To sum up, we provide some evidence in favor of the hypothesis stating that firms adopting digital technology perform better because they adopt coping strategies (e.g., remote work). The adoption of coping strategies is strongly affected by the previous use of digital tools (proxied by website usage). These coping strategies, especially delivery and remote work, have a positive effect on firm performance, explaining why firms with a previous experience with digital tools have better absorbed the COVID shock. Findings are in line with previous papers pointing out that US companies relying on remote work (Bai et al., 2021; Mongey et al., 2021) or online sales (Bloom et al., 2021) before the crisis have suffered less. It should be noted that both remote work and online sales are different in nature. While the former makes it possible to modify the internal organization of the company by connecting workers, the latter aims above all to maintain an external link with the firm's partners (particularly its consumers).

4.3.2. Access to external funds

This final part investigates the second potential channel through which digital technology may influence firm performances during the pandemic. Obtaining bank loans in times of social distancing and financial distress can be helpful if firms can maintain communication with their bank, even if the bank is not an online bank (Saka et al., 2021). Internet allows for the sharing of information that is useful for the loan officer. Similarly, the digitization of public administrations may facilitate the steps required to obtain public aid. To test this assumption, we apply the same approach as above, considering two measures of access to external funds provided in the COVID surveys. A dummy equal to one if a firm got a loan and a dummy equal to one if a firm obtained public support, as responses to the liquidity constraint caused by the pandemic and related stringency measures.

Internet and access to private and public funds during the COVID-19

Table 7 displays the impact of the use and access to internet on the likelihood to get access to a private loan and a public support. Digital technology has a positive impact on access to external

resources during the COVID-19, irrespective of sources of financing and measurement of ICT (use or access). Nonetheless, the positive impact is rather negligible. Having a website before the crisis increases the likelihood to obtain a bank loan by only 2.3 percent points (10% of the mean) and by 1.7 percent for public support (4% of the mean).

Table 7: Internet and access to public and private funds during the COVID-19

	Bank loan (1)	Public support (2)
Use (Website)	0.0208***	0.0168***
	(3.08)	(2.68)
Access (4G)	0.0586**	0.0646***
	(2.33)	(3.18)
Obs.	18,273	27,253
Use (0 -> 1)	9.90	4.05
Access (+10% in coverage)	2.79	1.54
Average(Y)	0.21	0.42

The table presents the marginal effect induced by the prior use of internet (website) and by the quality of coverage (4G) on the likelihood to obtain a bank loan (column 1) or public support (column 2) during the COVID crisis. Robust t-value are reported in parentheses. The estimated model includes firm-, region-, and country-week-level control variables as well as country fixed and week effects. The bottom of the table assesses the economic impact (in percentage of the average adoption of each strategy in the sample) for a firm with a website (Use) and for an increase of internet coverage of strong 4G of 10%.

As previously for coping strategies, we examine whether Internet use is more important in accessing funds for larger or more productive firms. The results, presented in Appendix Table A4, do not indicate strong heterogeneity by characteristics of these firms.

Access to external funds during the COVID and performances

We finally scrutinize whether the access to external funds explains the positive impact of internet on firm outcomes. Results in Table 8 indicate that access to private funds has a small impact on the likelihood to remain open and to limit layoffs. However, firms having access to private funds during the COVID-19 do not significantly perform better according to other metrics (business activity, reduction in the number of hours worked). Firms relying on public support tend to suffer more than their counterparts do. However, this finding is certainly due to reverse causation. Indeed, firms in dire straits are more likely to ask for public support.

In line with previous results, we find that including the two measures of financial access do not change the coefficient associated with variables of previous usage a website (both statistically and economically).

Table 8: Access to funds, internet and firm performance

	Survival		Sales		Workers		Hours	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Internet								
Use	1.209**	1.233**	1.353**	1.421**	0.309	0.251	0.998	1.195
	(2.11)	(2.16)	(2.13)	(2.24)	(0.47)	(0.38)	(1.09)	(1.31)
Access to private and public funds								
Bank loan		1.095*		0.588		1.372**		-2.581**
		(1.74)		(0.82)		(2.06)		(-2.52)
Public support		-1.694***		-2.979***		1.009		-5.579***
		(-3.10)		(-4.58)		(1.58)		(-5.79)
Obs.	16719	16719	16519	16519	16265	16265	16515	16515

The table presents the role of coping strategies and internet measures on performance of firms. Six indicators of performances are considered: the probability to remain open (columns 1 and 2), the sales evolution between the month before the survey and the same month in 2019 (columns 3 and 4), the evolution of permanent workers (columns 5 and 6) and the likelihood to maintain the same level of worked hours (columns 7 and 8). All indicators are built so that an increase indicates improved performance. The estimated model includes firm-, region-, and country-week-level control variables as well as country fixed and week effects. Standard errors are corrected for heteroscedasticity (robust t-test reported in parentheses). *, ** and *** signal significance at 10, 5, and 1%, respectively.

To sum up, the analysis presented in the last sub-section points out that internet usage has increased the likelihood to get access to public and private funds. However, the role of internet is rather modest. In addition, having access to external funds does not help firms to perform better during the pandemic. As a consequence, we cannot give strong support for the second hypothesis.

5. Conclusion

The paper analyses the consequences of the digital divide on firms' capacity to cope with the current pandemic. Using survey sample of 31,387 firms from 39 developing and transitions economies, it is found that firms' prior use of website enabled them to soften the consequences of the health crisis on their business. We examine the role of internet usage – measured by the adoption of the website technology (before the COVID-19). We find strong evidence of a positive contribution of website adoption prior to the COVID-19 crisis to the firm's resilience to the pandemic shock, as measured by its survival likelihood, and by the surviving firms' ability to maintain an activity during the pandemic. Further analysis shows that the positive role of a previous usage of digital tools by firms was mainly through the adoption of coping strategies, in particular take-out, online sales and remote working. Moreover, the positive effect played by the use of digital tools is only marginally explained by better access to external public (government support) or private (bank loan) financial resources. Our findings indicate that digital divide across firms before the crisis has played a role in heterogeneity of reaction during

the crisis. From a policy perspective, these results highlight good internet connectivity is a necessary but not sufficient condition for increasing firm's digital resilience to shocks induced by the COVID-19 pandemic. Digital technology absorption is also essential and policies should promote upgrade of digital skills of firms.

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Appendix

A. Additional tables and figures

Table A.1: Definition of variables

Variable	Type	Decription	Source
Firm performance during the COVID crisis			
Survival strict	Y/N	1 if the firm is open during the survey (excl. unconfirmed exit firms)	CIFS
Survival large	Y/N	1 if the firm is open during the survey (incl. unconfirmed exit firms)	CIFS
Sales	%	Sales in the previous month, in comparison with the same month in 2019	CIFS
Workers	%	workers in the previous month, in comparison with the end-2019	CIFS
Hours	Y/N	1 if the firm has not changed (or increased) the hours worked	CIFS
Coping strategy			
Innovation	Y/N	1 if the firm has developed a new product or process	CIFS
Delivery	Y/N	1 if the firm has implemented a home delivery or take-out service	CIFS
Online sales	Y/N	1 if the firm has implemented (or increased) of online sales	CIFS
Online sales	%	% of production sold online (only for firm with online sales solution)	CIFS
Remote work	Y/N	1 if the firm has implemented (or increased) of remote work	CIFS
Remote work	%	% of production sold remote (only for firm with remote work)	CIFS
Access to funds			
Bank loan	Y/N	1 if the firm has obtained a formal loan since the beginning of the crisis	CIFS
Public support	Y/N	1 if the firm has obtained a public support since the beginning of the crisis	CIFS
		Panel B: Internet (interest variables)	
Use (Website)	Y/N	1 if the firm had a website before 2020	WBES
Access (4G)	Y/N	Share of territory covered by a strong 4G internet mobile	GSMA
		Panel C: Control variables	
Country-week crisis exposure			
Stringency measures	Cont.	Average value of stringency index in the week of the interview	Hale et al.
Economic support	Cont.	Average value of economic support index in the week of the interview	Hale et al.
Mortality rates	Cont.	Total number of deaths per million in the week of the interview	Hale et al.
Firm-level characteristics			
Micro	Y/N	1 if the firm has less than 9 workers	WBES
Small	Y/N	1 if the firm has between 10 and 19 workers	WBES
Medium	Y/N	1 if the firm has between 20 and 49 workers	WBES
Large	Y/N	1 if the firm has between 50 and 250 workers	WBES
Young	Y/N	1 if the firm is less than 9 years old	WBES
Teen	Y/N	1 if the firm is between 10 and 19-year old	WBES
Old	Y/N	1 if the firm is between 20 and 49-year old	WBES
Very old	Y/N	1 if the firm is more than 20-year old	WBES
Manufacturing	Y/N	1 if the firm operates in manufacturing	WBES
Services	Y/N	1 if the firm operates in services	WBES
Trade	Y/N	1 if the firm operates in trade	WBES

Female	Y/N	1 if the firm is managed by a female	WBES
Experience	Cont.	Experience of the manager in the same industry (in years)	WBES
Foreign	Y/N	1 if ten percent of capital (or more) is owned by foreigners	WBES
Multiplant	Y/N	1 if the firm is a member of a larger firm	WBES
Exporter	Y/N	1 if the firm exports its production (no threshold)	WBES
Imported input	%	Share of imported inputs in total inputs	WBES
Electricity	Cat.	Manager's perception of electricity has an obstacle (from 0, no ostacle to 4)	WBES
Finance	Cat.	Managers' perception of finance has an obstacle (from 0, no ostacle to 4)	WBES
Top performer	Y/N	1 if the firm has a productivity level in the top quarter of firms (in country)	WBES
Capital city	Y/N	1 if the firm is located in the capital	WBES
Small city	Y/N	1 if the firm is located in city with less than 50,000 inhabitants	WBES
Medium city	Y/N	1 if the firm is located in city between 50k and 250k inhabitants	WBES
Big city	Y/N	1 if the firm is located in city between 250k and 1M inhabitants	WBES
Mega City	Y/N	1 if the firm is located in city with more than 1 million inhabitants	WBES

Table A.2: Inclusion of internet access and internet usage separately

	Survival		Sales		Workers		Hours	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Internet use	3.152***		1.186***		0.778		0.507	
	(6.80)		(2.25)		(1.58)		(0.71)	
Internet access		-5.769***		-8.521***		-1.492		-7.790***
		(-4.03)		(-5.04)		(-1.00)		(-3.18)
CV	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Week FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	31387	31387	27153	27153	27071	27071	27168	27168
R2	0.14	0.14	0.22	0.22	0.06	0.06	0.21	0.21

The table presents the factors affecting ex-post performance of firms. Four indicators of performances are considered: the probability to remain open (column 1), the sales evolution between the month before the survey and the same month in 2019 (column 2), the evolution of permanent workers between the end of 2019 and the month before the survey (column 3) and the likelihood to maintain the same level of worked hours (column 4). All indicators are built so that an increase indicates improved performance. Models include sets of fixed effects (country and week) and control variables. Standard errors are corrected for heteroscedasticity (robust t-test reported in parentheses) and are weighted by the inverse of the number of firms per country. *, ** and *** signal significance at 10, 5, and 1%, respectively.

Table A.3: Robustness checks

	Survival	Sales evol.	Workers	Hours
	(1)	(2)	(3)	(4)
Panel A: 3G coverage				
Internet use (website)	3.151***	1.188**	0.778	0.508
	(6.80)	(2.26)	(1.58)	(0.71)
Internet access (3G)	-0.226	-1.655	0.0637	-2.119
	(-0.15)	(-0.96)	(0.04)	(-1.02)
Obs.	31387	27153	27071	27168
Panel B: Time duration since the beginning of the pandemic				
Internet use (website)	3.196***	1.248**	0.821*	0.666
	(6.87)	(2.35)	(1.66)	(0.91)
Internet access (4G)	-5.850***	-8.554***	-1.568	-7.557***
	(-4.05)	(-5.08)	(-1.05)	(-3.08)
Duration (in weeks)	0.0289	0.760***	0.186***	0.686***
	(0.87)	(18.29)	(4.96)	(12.04)
Obs.	31387	27153	27071	27168
Panel C: Add country-week dummies				
Internet use (website)	2.911***	1.206**	0.734	0.489
	(6.33)	(2.29)	(1.48)	(0.68)
Internet access (4G)	-5.098***	-9.013***	-0.852	-7.803***
	(-3.59)	(-5.25)	(-0.57)	(-3.15)
Obs.	31387	27153	27071	27168
Panel D1: Alternative proxies of top performers (growth)				
Internet use (website)	2.676***	1.064*	0.0389	-0.520
	(5.38)	(1.86)	(0.07)	(-0.66)
Internet access (4G)	-6.193***	-10.85***	-2.536	-11.69***
	(-3.57)	(-5.22)	(-1.42)	(-3.96)
Top Performers (LP)	3.022***	5.338***	3.378***	7.175***
	(7.08)	(9.96)	(6.86)	(9.53)
Growth of sales	2.398*	0.833	2.516*	0.620
	(1.87)	(0.61)	(1.91)	(0.33)
Growth of staff	6.764***	9.188***	9.366***	8.098***
	(3.72)	(4.63)	(4.59)	(3.01)
Obs.	25487	22308	22340	22319

The table presents the factors affecting ex-post performance of firms. Four indicators of performances are considered: the probability to remain open (column 1), the sales evolution between the month before the survey and the same month in 2019 (column 2), the evolution of permanent workers between the end of 2019 and the month before the survey (column 3) and the likelihood to maintain the same level of worked hours (column 4). All indicators are built so that an increase indicates improved performance. Models include sets of fixed effects (country and week) and control variables. Standard errors are corrected for heteroscedasticity (robust t-test reported in parentheses) and are weighted by the inverse of the number of firms per country. *, ** and *** signal significance at 10, 5, and 1%, respectively.

Table A4. Heterogeneity in the determinants of coping strategies adoption and funds access

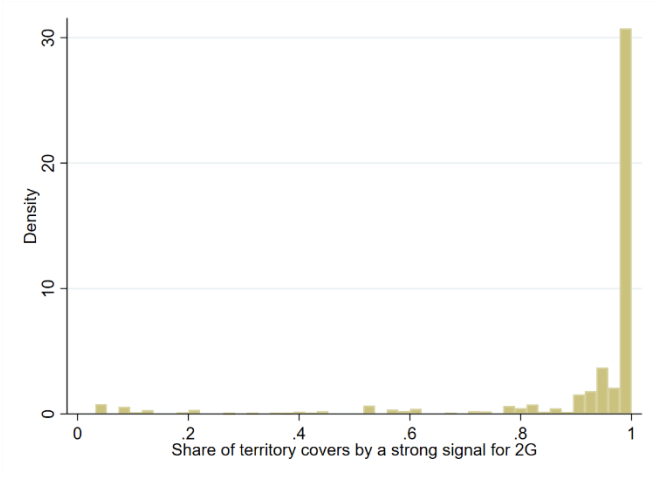
PANEL A: SIZE						
	Coping strategies				Access to funds	
	Innovation	Delivery	Online	Remote	Bank	Pub. Support
Website	0.0000701	0.0577***	0.108***	0.0226**	0.0307***	0.0383***
	(0.01)	(5.78)	(11.17)	(2.29)	(3.00)	(3.81)
Website * Small	**-0.0149**	**-0.0251***	**-0.0137**	**0.0205**	**-0.0199**	**-0.0531*** **
	(-0.89)	**(-1.67)**	**(-0.92)**	**(1.33)**	**(-1.27)**	**(-3.49)**
Website * Medium	**0.0309***	**-0.0414*** **	**-0.0250***	**0.0555*** **	**-0.00642**	**-0.0186**
	(1.85)	**(-2.74)**	**(-1.68)**	**(3.58)**	**(-0.39)**	**(-1.22)**
Website * Large	**0.0137**	**-0.0381** **	**-0.0288***	**0.0495*** **	**-0.0214**	**-0.0254**
	(0.79)	**(-2.43)**	**(-1.85)**	**(3.00)**	**(-1.19)**	**(-1.58)**
Small	0.0232*	0.0208*	0.0365***	0.0389***	0.0159	0.0480***
	(1.79)	(1.77)	(3.25)	(3.32)	(1.33)	(4.15)
Medium	0.0116	0.0551***	0.0674***	0.0794***	0.0539***	0.0568***
	(0.87)	(4.55)	(5.80)	(6.54)	(4.11)	(4.74)
Large	0.0390***	0.0587***	0.0820***	0.215***	0.0978***	0.0700***
	(2.59)	(4.31)	(6.16)	(15.06)	(6.25)	(5.12)
Obs.	27,630	27,590	27,968	27,393	18,273	27,253

PANEL B: PERFORMANCE						
	Coping strategies				Access to funds	
	Innovation	Delivery	Online	Remote	Bank	Pub. Support
Website	0.0120	0.0343***	0.0955***	0.0441***	0.0317***	0.0190***
	(1.63)	(5.14)	(14.70)	(6.44)	(4.45)	(2.80)
Website * Top	**-0.0238***	**-0.000914**	**-0.0117**	**0.0318** **	**-0.0589*** **	**-0.0126**
	(-1.65)	**(-0.07)**	**(-0.89)**	**(2.30)**	**(-3.67)**	**(-0.94)**
Top	-0.0203	-0.0203*	-0.00125	0.0546***	0.0696***	-0.0263**
	(-1.64)	(-1.83)	(-0.11)	(4.70)	(5.17)	(-2.34)
Obs.	27,630	27,590	27,968	27,393	18,273	27,253

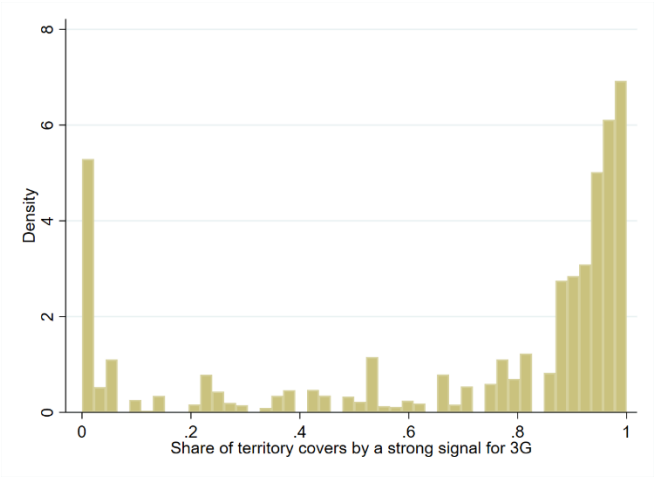
The table presents the marginal effect induced by the prior use of internet (website) adoption of four coping strategies: innovation (column 1), delivery (column 2), online sales (column 3) and remote work (column 4) and on Access to private (column 5) and public funds (column 6). Website dummy is interacted with firm size class in Panel A (omitted category is very small firms) and with a dummy for top performing firms before the crisis (firms with a productivity in the top 25% of firms in the same country-sector). The estimated model includes firm-, region-, and country-week-level control variables as well as country fixed and week effects. Models is estimated using OLS method to facilitate interpretation of interactions. Robust t-value are reported in parentheses. *, ** and *** signal statistical significance at 10, 5, and 1% respectively.

Figure A.1. Coverage of mobile internet by technology

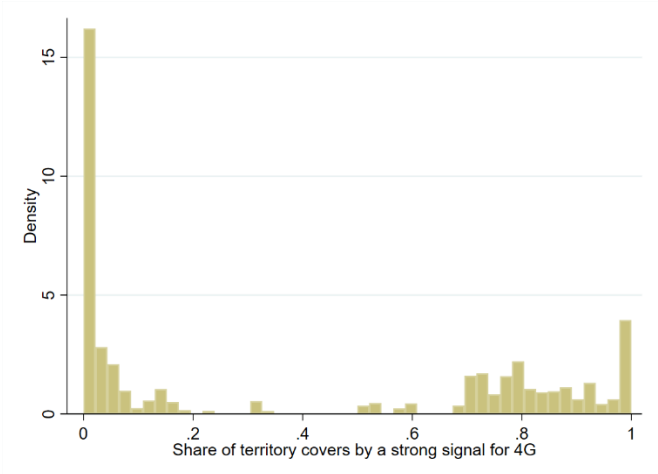
Panel a: 2G



Panel b: 3G



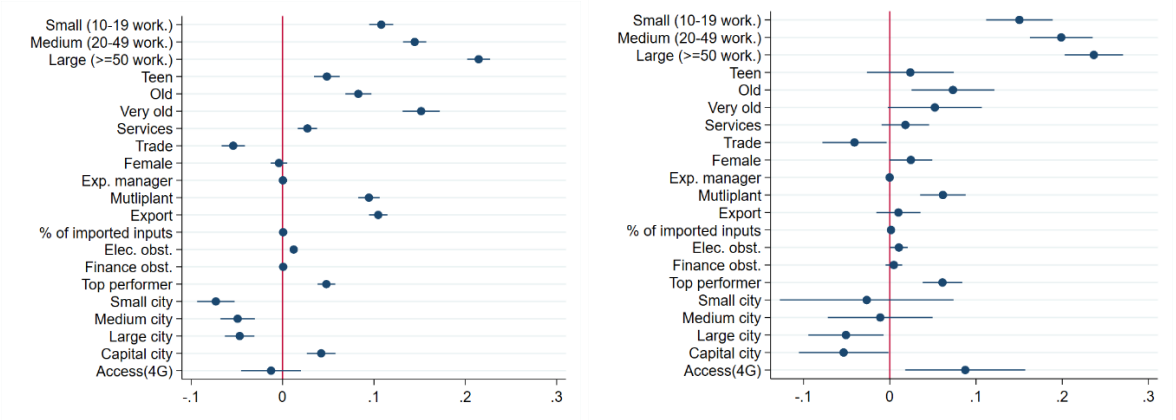
Panel c: 4G



The figure displays the distribution of the share of territory covered by a strong signal of mobile internet (2G in panel a, 3G in panel b and 4G in panel C).

Figure A.2. Determinants of the use of information and communication technology

Panel a: Website use (N=39,860) Panel b: Email use (N=3,212)



The figure represents the marginal effect of the different determinants of the probability of having set up a website in Panel a or to use email in Panel b (always before the pandemic). Each point gives the average effect level as well as the confidence interval with a 5% risk of error. If a coefficient is one the left of red line, this indicates that the determinants has a negative impact on the likelihood to use ICT. The estimated model includes country fixed effects (unreported). For categories, the omitted variables are Micro firms (for size), Young firms (for age), Manufacturing (for industry), Mega city (for city size).

B. The COVID-19 crisis severity and internet access

A surprising finding of Table 3 is the negative impact of internet access on firm performances during the COVID-19. One explanation is that better connectivity may facilitate the implementation of COVID-19 policies by the government. We study this hypothesis by examining whether local internet access conditions COVID-19 crisis severity, proxied by COVID-19 policy variables and mortality rates. We therefore investigate in Table below local heterogenous effects of COVID-19 policies on firm performance during the crisis, depending on 4G internet access. In a first step (column (1)), we add to equation (1) the interaction between the 4G coverage variable and the government stringency and economic support indexes. Because these policy variables may not fully capture the extent of governments' response to the crisis, by for instance omitting to consider self-inclination to isolate thanks to internet access, we also interact the mortality rate variable with the network coverage variable and add this interaction term to previous ones. In a second step (column (2)), we rerun estimations replacing week dummies by month dummies, to ensure that our model is not saturated by the simultaneous inclusion of interaction policy variables and week fixed-effects. Policy responses may indeed vary from week to another, and their implementation may progressively improve as governments and populations get more familiar with the pandemic. In the remaining columns, we extend the analysis using the firm's sales and labor adjustment dependent variables, using month dummies as time fixed-effects.

Estimation conducted with week fixed-effects indicates that the negative effect of 4G coverage on firm survival is explained by the role played by local connectivity in mediating the adverse effect of stringency and economic support policies on firm survival. Estimations using month fixed-effects confirm this interpretation of the adverse effect of 4G coverage evidenced in Table 3, showing that the role of internet access in mediating policy responses gets striker once considering common weekly variations in COVID-19 policies. This bunch of results therefore support that movement restriction policies have been harsher in well-connected places. Results also highlight the positive effect of economic support on firm survival in locations with greater internet coverage. However, further estimations using other firm outcomes (and keeping month fixed-effects) stress that only economic support effects on sales and labor adjustments are mediated by internet connectivity. We indeed find that increased economic support has had a deterrent effect on sales evolution and workforce solicitation in better connected places, which is coherent since economic slow-down might be conditioned by receiving government support, which in turn may depend on access to internet communications.

Table B1. Government policies, internet access and firm outcomes during the pandemic

	(1)	(2)	(3)	(4)	(5)
Dep. Var:	**Survival**		**Sales**	**Workers**	**Hours**
FEs:	**Week**		**Month**		
Internet					
Website use	3.168***	3.256***	1.329**	0.965**	0.638
	(6.84)	(6.98)	(2.52)	(1.97)	(0.88)
Internet access (4G)	-4.695	8.317	16.40*	2.155	-13.41
	(-0.65)	(1.18)	(1.76)	(0.26)	(-1.00)
Covid-severity channel					
Internet access x stringency	-1.994*	-3.585***	-1.685	0.766	2.464
	(-1.65)	(-3.00)	(-1.17)	(0.56)	(1.22)
Internet access x econ support	1.666***	1.557***	-1.597**	-1.524***	-2.130**
	(2.69)	(2.58)	(-2.33)	(-2.61)	(-2.21)
Internet access x mortality	0.00323**	0.00282**	-0.00200	0.00206	0.00359*
	(2.57)	(2.23)	(-1.28)	(1.43)	(1.70)
Covid severity					
Stringency index	3.229***	3.437***	-0.196	-2.110**	-8.402***
	(3.22)	(3.67)	(-0.17)	(-2.05)	(-5.38)
Econ. support index	-2.836***	-2.202***	0.474	0.474	3.046***
	(-5.03)	(-4.11)	(0.86)	(0.88)	(3.74)
Mortality rate	-0.00104	-0.00155	-0.00257**	-0.00253**	-0.00004
	(-1.00)	(-1.45)	(-2.04)	(-2.18)	(-0.02)
N	31,387	31,202	26,991	26,919	27,006
adj. R^2	0.140	0.135	0.211	0.057	0.201

The table presents the factors affecting ex-post firm survival (probability to remain open. Remaining control variables are not reported in the table. Standard errors are corrected for heteroscedasticity (robust t-test reported in parentheses) and estimations are weighted by the inverse of the number of firms per country. *, ** and *** signal significance at 10, 5, and 1%, respectively.

"Sur quoi la fondera-t-il l'économie du monde qu'il veut gouverner? Sera-ce sur le caprice de chaque particulier? Quelle confusion! Sera-ce sur la justice? Il l'ignore."

Pascal

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