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How internet helped firms cope with COVID-19*

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Abstract

This paper questions whether firms' internet connectivity and adoption helped them 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. If prior internet use had a role on the resilience of firms, this is not the case for internet access. A negative effect of firm survival and labour adjustments is indeed found, but further analysis shows that this finding is explained by the mediating effect of 4G coverage on COVID policies' stringency, suggesting that these policies were more effective in places with better internet coverage.

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

JEL classification: 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 digitalization¹ 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). Nevertheless, this work focuses primarily on a few rich countries — mainly the U.S. — in which most businesses have access to fast Internet and make extensive use of these tools. In contrast, few studies have analysed the role of ICT in business resilience from a more global perspective. Studies on large samples of countries, including developing countries (Apedo-Amah et al., 2021; Davies et al., 2021; Saka et al., 2021), have shown that the current crisis has encouraged the use of digital solutions, but without assessing their effect on business performance.

This paper examines the role of digitalization in the capacity of firms to absorb the COVID crisis, based on a sample of 31,387 firms from 39 developing and developed economies. In particular, it questions whether firms having access to and using the internet before the crisis were more resilient to the shock. Distinguishing between access to internet and usage of internet services is key since the former is a necessary but insufficient condition for internet usage if the firm has not the capacity to absorb digital technologies (Paunov and Rollo, 2015, 2016).² In

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

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).

addition, the implementation of, and compliance to, COVID policies the analysis may have been stronger in better connected places, which adds complexity to the digitalization-COVID nexus.

Therefore, our analysis aims to better understand the channels through which digitalization prior to the crisis may have played a role in business performance during the crisis. 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. On the other hand, in situations of movement restrictions, the digital link has facilitated access to additional resources, whether they be bank loans or public support (Saka et al., 2021). However, the relation may get tricky, considering that the crisis severity is higher in digitalized places, where containment policies are probably stricter and virus circulation more important. Our analysis therefore tries to consider this dimension, too.

Our results stress that companies using website before the health crisis showed higher absorption capacities than other firms. The positive role of ICT 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 digital tools is not explained by better access to external public (government support) or private (bank loan) financial resources.

If prior internet use had a role on the resilience of firms, this is not the case for internet access. Increased mobile internet coverage had no effect on the adoption of coping strategies (except for a small effect on remote working) or on access to external resources, which explains why the quality of mobile internet coverage had no effect on performances. A negative effect of firm survival and labour adjustments is even evidenced. Further analysis shows that this finding is explained by the mediating effect of internet coverage on COVID policies' stringency.

This article contributes to the literature on the role of ICT during the COVID-19 pandemic in three main ways. First, we consider a large sample of firms operating in 39 developing and developed countries, while existing evidence focuses mainly on case studies in developed countries (especially in the U.S.). Second, we distinguish between two levels of digital divide across firms. The first level focuses on connectivity as the first (geographical) level of digital divide. 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). Since the coverage of high-speed internet is often lacking in developed countries (Barrero et al., 2021), this issue is even more crucial in developing world. Moreover, one aspect proper to the

developing world that deserves attention is that due to lower state capacity and uneven internet infrastructure coverage, COVID-19 policies implementation may be heterogenous across locations. Third, the familiarity with ICT tools are 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 are not equally capable to rely to remote work (Bai et al., 2021; Mongey et al., 2021) or online sales (Alcedo et al., 2022) and individuals to self-isolate (Chiou and Tucker, 2020), exacerbating the digital divide between companies and countries. Identifying whether geographical or firm-level dimensions of the digital divide matter is of prime importance for policymakers. Improving connectivity is the most effective policy if the first level of digital divide is the primary impediment to firm's adoption of coping strategies. However, our results indicating that familiarity of ICT 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. Finally, we decompose the effect of internet on firm's ability to cope with the crisis. We indicate that the main channel is through the adoption of coping strategies.

The next section presents the conceptual framework and hypotheses. Section 3 discusses the methodology, while the fourth section displays the data and variables used in the econometric analysis. The fourth section exposes and discusses our results. The fifth section concludes.

2. Theoretical framework

Our empirical approach, which aims to disentangle the contribution of digitalization to firm performance in the pandemic context, requires first a clarification of the nexus between internet connectivity, internet technology absorption, and firm's digital resilience³. Second, it also requires elucidating how internet connectivity may shape the compliance and implementation of policies aimed at lowering the sanitary consequences of the pandemic.

³ Defined as its ability to face the COVID crisis by implementing mitigation strategies based on internet technologies.

2.1. Connectivity, digital absorptive capacity and resilience

The economic literature considers that digital technologies are different from other technologies by their strong potential to reduce costs: information costs, travel costs, tracking costs and the costs of reproducing digitised goods and services (Goldfarb et Tucker, 2019). This ability to reduce these different types of costs makes digital technologies general purpose technologies (Bresnahan & Trajtenberg, 1995), offering concrete solutions in all sectors of the economy and for all economic agents - households, businesses, administrations, governments - facing an environment marked by high transactions costs and informational asymmetries (Aker, 2017), which have been exacerbated during the COVID-19 pandemic.

In the COVID-19 context, marked in many countries by strong restrictions on merchandises, workers and customers movements, internet technologies such as websites and emails have remained among the few options to communicate and maintain interactions with suppliers and customers. In addition, internet adoption has also facilitated access to external financial resources, whether they be bank loans or public support, thereby helping firms cope with the COVID-19 crisis (Saka et al., 2021). Digitalization is therefore a critical element of the firm's resilience to the pandemic.

This contribution relies on two critical dimensions of the internet ecosystem: i) internet connectivity, and ii) the firm's capacity to absorb internet technologies.⁴ Internet connectivity relates to the capacity for communications through internet, which depends on supply side factors such as the infrastructure network capacity and access cost, and demand-side factors such as the internet's user network size. In fact, improving internet connectivity between market actors will for instance broaden the spectrum of buying and selling opportunities, and thus, reduce supply-demand imbalances and price dispersion for a given good or service. In a context of movement restrictions, improving internet connectivity through better accessibility of internet is an important policy lever for maintaining decent living conditions for producers and consumers living in remote areas with high transaction and information costs. In this paper, we apprehend the consequences of internet connectivity focusing on internet access, but we keep in mind that other dimensions such as the internet user network size are also at play.

⁴ The distinction between digital connectivity and digital technology absorption in the firm's production function has been recently formalized by Hjort and Tian (2021), who built a model where the firm's output depends on an exogenous connectivity factor, and technology parameters that reflect the extent to which improved connectivity translate into inputs use efficiency.

However, 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). This 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, as hereafter evidenced. Furthermore, the changes in the labour market induced by the digitalisation process and accelerated by the pandemic have highlighted the importance of digital skills and have contributed to the explosion of new digital tasks, that have reshaped the firm and its environment (Choi et al, 2020). Therefore, 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.

2.2. Connectivity and COVID-19 crisis severity

In the absence of vaccines, governments wishing to contain the spread of the pandemic have implemented a variety of measures that can be grouped into three categories (Hale et al., 2021): i) distancing policies aimed at reducing interactions between individuals (e.g. movement restrictions, schools and workplaces closure), ii) measures aimed at strengthening the capacity of the health system to cope with the pandemic (e.g. testing and contact-tracing policies), and iii) economic support policies put in place to absorb the impact of the recession induced by the distancing measures and to ensure their sustainability (e.g. fiscal and tax support to firms and households, credit supply).

Researches conducted on the socio-economic consequences of the COVID-19 in developed economies have pinpointed the critical role of digital technologies access in supporting related policy responses implementation (Chiou and Tucker, 2020; Bai et al., 2020; Barrero et al, 202). These studies stress that internet connectivity, and its corollary, access to internet infrastructure, is a predictive factor of the ability of individuals to comply with COVID-19 restriction measures, and therefore of governments to implement strong and credible responses to the pandemic. Tracking citizens movements thanks to data on million devices' traces within the US, Chiou and Tucker (2020) show that high-income locations are associated with an increased likelihood of citizens staying at home, and that this income effect is actually driven by high-

speed internet access. Bai et al (2021) provide similar evidence on work-from-home feasibility in the US, showing that firms with higher pre-pandemic inclination to adopt remote-work demonstrate higher resilience during the pandemic, especially firms operating in non-high-tech industries. In the same vein, Barrero et al (2021) use survey data about working attitudes in the US and show that increased home access to high-quality internet has a strong and positive effect on labour productivity and socio-economic dimensions of resilience to movement restrictions, making the case for universal access to fast and affordable internet especially during large economic shocks such as the pandemic. Saka et al (2021) investigate whether prior access to 3G infrastructure mediate the positive effect of epidemic exposure on individuals' propensity to adopt new financial technologies such as online banking, using a sample of 250,000 individuals in 140 countries. They highlight the conditioning effect of pre-pandemic internet infrastructure access on online banking adoption in response to the COVID-19 crisis.

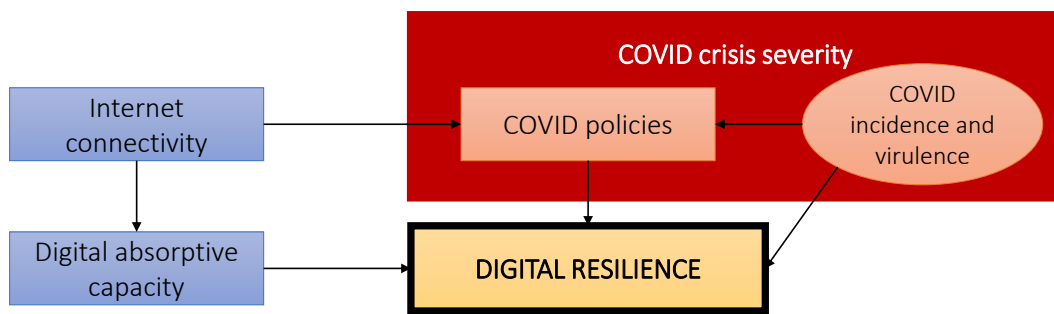
Lessons drawn from previous studies, despite being mostly conducted in the US, can be extended to developing countries' context, which were already characterized by strong obstacles to people movements before or during the pandemic. They pinpoint the critical role of internet connectivity, in particular internet access, in conditioning households and firms' capacity to absorb the COVID-19 crisis and related movement restriction policies. However, they do not consider the possibility that the stringency of policy responses to COVID-19, in particular social-distancing measures, may vary according to internet accessibility. In a context a large digital divide and State fragility, the implementation of movement restrictions will be stricter in places where fast internet is accessible, and therefore, where people and firms can maintain communications using internet. In the same way, economic support and health policies provided to the population may be easier to deploy in such well-connected places, thereby facilitating the compliance and implementation of movement restriction policies.⁵

In sum, digitalization, COVID-19 crisis severity and the firm's capacity to mitigate its adverse effects on operations, hereafter termed digital resilience, are interrelated, as represented in the Figure 1 below. Lessons from the literature indeed suggest that, on the one hand, internet connectivity is a necessary (but not sufficient) condition to the firm's digital absorptive capacity, and thereby, to digital resilience. On the other hand, improved internet connectivity also enables government to put in place more stringent restrictions on citizens movements, and

⁵ Although there is so far, to our knowledge, no proper empirical analysis of the implementability of policy responses in a context of digital divide.

to better target and disburse economic support to firms, in a timely manner⁶, i.e. when COVID-19 incidence and virulence is at a peak. Last, COVID-19 propagation will also directly affect firms' and workers' behaviours, irrespective of COVID-19 policies, by inciting them to take ex-ante and ex-post digital strategies on their own to contain the pandemic. As a result, firms are more likely to be resilient to the COVID-19 crisis in environments where the crisis will be the most severe. In the following empirical analysis, we try to disentangle the intricate firm digitalization-COVID crisis nexus.

Figure 1. Digitalization, COVID-19 crisis severity, and digital resilience.



3. Methodology

Based on this theoretical framework, the starting point of this paper consists in separating the internet access and usage effects on COVID-19 firm performance during the crisis. The baseline model is as follows:

$$Y_{irct} = \beta_{Use} Use_i + \beta_{Acc} Access_r + \gamma C_{ct} + \Omega X_i + \alpha_c + \mu_t + \varepsilon_{irct} \quad (1)$$

where i , r , c , and t refer to firm i located in region r of country c interviewed during the week t . We consider different metrics of performances (Y_{irct}) capturing several aspects of business activity and labor adjustments. Variables of interest are two indicators capturing usage of ICT by firm i (Use) and access to internet in region r ($Access$) the year before the COVID crisis started. Prior internet usage (respectively internet access) has a positive impact on performance during the COVID crisis if $\beta_{Use} > 0$ (respectively, $\beta_{Acc} > 0$)⁷.

We also control for country-week indicators of COVID-19 strength (C_{ct}) by incorporating in our model information on the severity of the health shock and the effectiveness of government's

⁶ Which in turn makes strict containment policies more sustainable.

⁷ All dependent variables are constructed so that an increase indicates an improvement in performance.

measures implemented since the beginning of the crisis. We also control for initial (i.e., measured before 2020) firm-level characteristics (\mathbf{X}_i) that may influence both internet usage and access as well as performance during the crisis (see below). In particular, we add firm- and region-level control variables that influence both adoption of ICT and connectivity as well as firm's ability to rebound (e.g., initial performance and city size).

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, that we alternatively replace by month dummies when justified in some econometric specifications. 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.⁸

In a second step, we investigate the indirect effect of internet connectivity passing through the implementation of and the compliance to more effective containment and economic support policies. To do this, we augment Eq. 1 by adding interaction terms between 4G coverage and COVID-19 policy variables, as follows:

$$Y_{irct} = \beta_{Use} Use_i + \beta_{Acc} Access_r + \beta_{Cov} Access_r \times C_{ct} + \gamma C_{ct} + \Omega \mathbf{X}_i + \alpha_c + \mu_t + \varepsilon_{irct} \quad (2)$$

In a third step, we study whether prior digitalization, i.e. access to and usage of internet, 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:

$$Z_{irct} = \beta'_{Use} Use_i + \beta'_{Acc} Access_r + \gamma' C_{ct} + \Omega' \mathbf{X}_i + \alpha'_c + \mu'_t + \varepsilon'_{irct} \quad (3)$$

⁸ In unreported analysis, we 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.

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

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 controls. The estimated model becomes:

$$Y_{irct} = \beta''_{Use} Use_i + \beta''_{Acc} Access_r + \delta Z_{irct} + \Upsilon'' C_{ct} + \Omega'' X_i + \alpha''_c + \mu''_t + \varepsilon''_{irct} \quad (4)$$

Where Z_{irct} is a measure of coping strategy or of access to external funds. We expect that the (positive) impact of internet transits through 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 and access).

In the three models, COVID-19 we rely on OLS when the dependent variables is 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 weight to each country.⁹

4. Data and variables

4.1. Dependent variables: Performance, coping strategy and access to funds during the crisis

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 2021.¹⁰

⁹ 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.

¹⁰ Data were retrieved in July 2021.

The *CIFS* aim to capture timely information on (i) how the pandemic has affected business operations and (ii) how firms responded to these challenges.

4.1.1. 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.¹¹

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*).

¹¹ All variables, described below, are built to increase with an improvement of performance to facilitate the results' interpretation.

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 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*).

4.1.2. 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) or public support from (local or national) government. 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.

4.2. Access to and usage of internet

The paper's aim consists in evaluating how internet helps firms to absorb the COVID-19 shock. A major contribution to this paper consists in distinguishing between the firm-level usage of internet and the location-level access to internet infrastructure.

4.2.1. Usage of internet

To measure Internet use, 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).¹² We are interested in firm's website use since this usage of internet, adopted 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 (ICT users) and the other enterprises (non-ICT users).

4.2.2. Internet connectivity (access to internet)

We proxy internet connectivity through a measure of internet accessibility at the location level. 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).^{13 14}

Based on this dataset, we construct the percentage of location (city, and in some cases regions) 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.¹⁵ Since coping strategies to the crisis (remote work, online sales) require

¹² The WBES provide other information on ICT use such as email use. Unfortunately, this information is poorly documented in 2019, 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.

¹³ 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.

¹⁴ 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/>

¹⁵ 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.

broadband internet access, we focus on the 4G technology, considering the 3G coverage in the robustness checks.

4.3. COVID-19 crisis indicators

We also combine data with information about the importance of the pandemic. We rely on the total number of deaths per million in the week of the interview¹⁶ to proxy the importance 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 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

¹⁶ 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.

strong spatial and temporal disparities in the government measures taken (Hale et al., 2021).¹⁷ 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.

4.4. 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, age¹⁸, 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. Access to internet, measured at the location (city or region) level, can be correlated with city size and therefore may capture not only access to internet but also access to other 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

¹⁷ 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, 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.

¹⁸ 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.

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 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 access to ICT and certainly to absorb the shock. 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*).¹⁹ 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 and the sample composition documented in Table A2 in Appendix.

5. Results

5.1. Descriptive statistics

The Table 2 displays the descriptive statistics. 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 that 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. As a result, for firms suffering from a reduction of activity, the

¹⁹ 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.

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).²⁰

Table 2: Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
<i>Dependent variables</i>					
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
<i>Digitalization</i>					
Use (Website)	31,387	0.66	0.47	0	1
Access (4G)	31,387	0.40	0.41	0	1
<i>Mitigation strategy</i>					
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 (%)	26,455	6.23	16.50	0	100
Remote work (Y/N)	27,379	0.37	0.48	0	1
Remote work (%)	27,016	5.21	15.41	0	100
<i>Access to funds</i>					
Bank loan	17,308	0.20	0.40	0	1
Public support	27,237	0.42	0.49	0	1
<i>Country-week crisis exposure</i>					
Gov stringency measures	31,387	7.15	1.30	1.66	10.38
Gov economic support	31,387	6.07	2.52	0	12.32
Mortality	31,387	633.2	791.4	0	3067.7

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

²⁰ 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.

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%).

The main interest variable is the access to internet and use of ICT. The coverage of strong signal of 4G is on average at 40%. For information, the coverage of strong 3G is 72% and 91% for 2G coverage. As indicated in Figure A1 in Appendix, there is a strong heterogeneity in distribution of 4G coverage. Twenty percent of firms have no access to 4G technology, while 30% of firms operated in areas with almost complete coverage (defined as more than 80% of region covered by a strong signal).

We observe that two thirds of firms had a website before the COVID-19 crisis. In Figure A2 in Appendix we point out that use of ICT is not randomly distributed. The empirical analysis on the determinants of ICT usage highlights the role of determinants of the firm's digital absorptive capacity, such as the size, outward orientation (foreign ownership and exporter status), the multi-plant status and the age of the firms, on the probability of having a website. Firms located in capital cities and in bigger cities are more likely to have a website. However, after controlling for city characteristics, we fail to find an effect of 4G coverage on website use (using 3G coverage provides a similar finding).²¹

5.2. The effect of internet on firm performance

5.2.1. Baseline results

Table 3 displays the marginal effects of internet use (website) and access (4G coverage) on the four business outcomes (survival, sales evolution, workers and worked hours).²² 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.

²¹ We also run the similar analysis on the use of email and find consistent results in Panel B of Figure A2. However, the number of observations is sharply decreased (from 39,860 to 3,212), explaining why we do not rely on this indicator in our analysis.

²² The effects are not directly comparable between both indicators because they depend on the measure of the interest variable considered. The estimates reported for 4G represent a shift from zero coverage to full coverage (100%), which is not very credible in the short term. For the use of a website, the coefficients represented measure the effect of Internet adoption.

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 3. From an economic point of view, the effect of website adoption is however relatively modest. Having a website indeed increases the probability of staying open by 3 percentage points, and sales by 1.2%. The second row of the Table 3 does not highlight a positive effect of internet access on firm performance during the crisis. Indeed, mobile internet coverage exert 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. 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. This hypothesis is tested in the next subsection.

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-cut. 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.²³ 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.

²³ 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 3: 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*** (6.82)	1.208** (2.30)	0.782 (1.59)	0.529 (0.74)
Internet access (4G)	-5.834*** (-4.07)	-8.565*** (-5.07)	-1.521 (-1.02)	-7.810*** (-3.19)
Firm-level controls				
Small size	3.327*** (5.47)	2.384*** (3.66)	0.161 (0.25)	0.873 (0.98)
Medium size	4.959*** (8.77)	5.360*** (8.10)	0.757 (1.21)	2.503*** (2.84)
Large size	6.007*** (10.53)	7.801*** (11.78)	0.601 (0.96)	4.648*** (5.10)
Teen	2.186*** (3.14)	0.803 (1.07)	0.447 (0.62)	0.476 (0.48)
Old	2.173*** (3.18)	0.879 (1.15)	0.675 (0.94)	1.601 (1.58)
Very Old	3.557*** (4.03)	-0.531 (-0.47)	0.209 (0.20)	-0.189 (-0.12)
Female	-0.444 (-1.16)	-1.627*** (-3.54)	-0.636 (-1.53)	-2.229*** (-3.52)
Experience	0.0713*** (3.91)	-0.0103 (-0.45)	-0.0263 (-1.27)	-0.0396 (-1.28)
Top performer	3.098*** (7.58)	5.534*** (10.88)	3.411*** (7.37)	7.196*** (10.30)
Foreign	-1.727** (-2.51)	-0.182 (-0.22)	0.0615 (0.08)	-1.901* (-1.80)
Export	-0.0260 (-0.06)	-0.0595 (-0.11)	1.770*** (3.52)	1.508** (1.99)
Imported output	0.0158*** (2.71)	0.0232*** (3.44)	-0.00481 (-0.75)	0.00601 (0.66)
Multiplant	0.764 (1.29)	1.852*** (2.89)	-0.521 (-0.83)	0.953 (1.10)
Manufacturing	33.72*** (10.63)	38.52*** (12.93)	27.48*** (7.69)	21.61*** (6.19)
Services	31.88*** (10.10)	35.39*** (11.97)	24.54*** (6.92)	20.17*** (5.88)
Trade	29.11*** (9.19)	32.04*** (10.78)	24.57*** (6.90)	19.93*** (5.79)
Electricity obs.	0.209 (1.60)	-0.116 (-0.70)	0.255* (1.72)	-0.327 (-1.47)
Finance obs.	-0.786*** (-4.36)	-0.813*** (-4.22)	-0.588*** (-3.07)	-0.516* (-1.93)

<i>Location controls</i>				
Big city	-0.859 (-1.26)	0.224 (0.26)	-0.136 (-0.17)	-1.378 (-1.27)
Medium city	-0.0337 (-0.04)	-0.893 (-0.94)	-1.319 (-1.38)	-1.788 (-1.43)
Small city	-0.303 (-0.35)	1.136 (1.11)	0.242 (0.24)	-0.0831 (-0.06)
Capital city	0.133 (0.20)	-1.172 (-1.38)	-1.483* (-1.86)	-1.165 (-1.08)
<i>Covid shocks</i>				
Stringency measures	3.783*** (4.41)	-2.387** (-2.28)	-1.550* (-1.70)	-6.653*** (-4.69)
Economic support	-2.073*** (-5.68)	-0.607 (-1.44)	-0.640 (-1.48)	2.255*** (3.83)
Mortality rates	0.000328 (0.52)	-0.00369*** (-4.45)	-0.00103 (-1.34)	0.00217* (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 A3 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 A4, we provide additional checks. Panel A employs 3G coverage instead of 4G. Coefficients associated to internet access become statistically insignificant but those associated with ICT usage are unchanged. We then add time duration since the beginning of the pandemic in Panel B without altering conclusions regarding internet²⁴. 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*

²⁴ 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.

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 internet measures but also for the impact of top performers (who suffer less during the crisis).²⁵ Finally, we change the definition of exit firms by including the group of unconfirmed exit firms. Results, available upon request, confirm the baseline estimations.

5.3. 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 (Eq. 2). We therefore investigate in Table 4 local heterogeneous 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 (Eq. 2). 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.

²⁵ In an unreported test, we also changed the cut-off to define the top performers by using the median and results are similar.

Table 4. 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*** (6.84)	3.256*** (6.98)	1.329** (2.52)	0.965** (1.97)	0.638 (0.88)
Internet access (4G)	-4.695 (-0.65)	8.317 (1.18)	16.40* (1.76)	2.155 (0.26)	-13.41 (-1.00)
Covid-severity channel					
Internet access x stringency	-1.994* (-1.65)	-3.585*** (-3.00)	-1.685 (-1.17)	0.766 (0.56)	2.464 (1.22)
Internet access x econ support	1.666*** (2.69)	1.557*** (2.58)	-1.597** (-2.33)	-1.524*** (-2.61)	-2.130** (-2.21)
Internet access x mortality	0.00323** (2.57)	0.00282** (2.23)	-0.00200 (-1.28)	0.00206 (1.43)	0.00359* (1.70)
Covid severity					
Stringency index	3.229*** (3.22)	3.437*** (3.67)	-0.196 (-0.17)	-2.110** (-2.05)	-8.402*** (-5.38)
Econ. support index	-2.836*** (-5.03)	-2.202*** (-4.11)	0.474 (0.86)	0.474 (0.88)	3.046*** (3.74)
Mortality rate	-0.00104 (-1.00)	-0.00155 (-1.45)	-0.00257** (-2.04)	-0.00253** (-2.18)	-0.00004 (-0.02)
<i>N</i>	31,387	31,202	26,991	26,919	27,006
adj. <i>R</i> 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.

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 striking 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.

5.4. Channels through which digital technology influences business outcomes

The use of digital technologies may play a role on business outcome during the COVID-19 crisis by two possible channels. On the one hand, better connectivity 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, the well-connected firms have been able to take advantage of this digital link. We test the two possible channels in the following. For each explanation, we test whether internet access and website ownership increase the likelihood of adopting coping strategy or accessing to external funds (Eq. 3). We then examine if firms adopting these solutions perform better and if the impact of ICT is reduced (Eq. 4).

5.4.1. Coping strategies

Internet and the adoption of coping strategy

We first study the role of internet access and internet use on the likelihood to adopt the different coping strategy by running Eq. 3. In doing so, we exploit a module included in the *CIFS* about how firms cope with the shock. As indicated in Section 2.1, we consider four different coping strategies: (i) innovation, (ii) home-delivery services, (iii) online sales, and (iv) remote work.

Results based on probit estimation are displayed in Table 5. Results indicate that firm usage of website before the pandemic increases the likelihood to adopt three coping strategies out of four, namely home-delivery service, online sales and remote work. Firms having a website are 3 percentage points more likely to adopt home-delivery services (which represents an increase of 13% in comparison with the sample mean²⁶). These firms are also 10 pp. (+35%) more likely to implement online sales and 5 pp. (+15%) more likely to rely on remote work. The impact on innovation is lower in both statistically and economically sense (1 pp., +2%).

The effect of 4G coverage is less clear-cut, suggesting that internet access is less important than internet absorptive capacity to adopt coping strategies based on digital technologies. A better

²⁶ In the bottom of Table 3, we report the percentage evolution in comparison with sample mean to gauge the economic impact.

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). 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 (1.16)	0.0334*** (5.70)	0.0947*** (15.48)	0.0546*** (8.48)
Internet access (4G)	0.0257 (1.18)	-0.0269 (-1.41)	-0.0934*** (-4.76)	0.0925*** (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. We focus exclusively on firms adopting these coping strategies. Results, reported in Figure A3, indicate that neither the use 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.

Coping strategies and firm performance

In a final step we scrutinize whether the positive effect of ICT usage is due to adoption of coping strategies, especially those favored by a previous use of digital technology (home-delivery, online sales and remote work). To do so, we run Eq. 4. Table 6 displays econometric findings when we incorporate all coping strategies in the same model.

COVID Table 6: Coping strategy, internet and firm performance

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

We first see that the adoption of home-delivery services and remote work has been efficient 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 to limit 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.

Turning to internet measures, we first 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. We point out that inclusion of coping strategies does not affect coefficients associated with internet access. On the other hand, the positive impact of ICT usage on sales is reduced when we add coping strategies, as expected. The marginal effect of internet usage is reduced by one quarter when we include coping strategies. This econometric finding is in line with previous analysis pointing out that internet access marginally influences firm's

adoption of coping strategies, thereby confirming that coping mechanisms rely on firm's absorptive capacity rather than local internet connectivity.

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 ICT but a better access to internet have not favored the adoption of coping strategies (at the exception of remote work but with a limited impact). These coping strategies, especially delivery and remote work, have a positive impact on firm performance, explaining why firms with a previous experience with ICT 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.

5.4.2. Access to external funds

The 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 can be helped 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 than above. We consider two measures of access to external funds. A dummy equal to one if a firm gets a loan and a dummy equal to one if a firm obtained public support.

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). Internet access has a smaller impact. For instance, expanding coverage by 10% increases the likelihood to get access to a bank loan and public support by 0.7 percent point for both. In other words, while digital technology helps to obtain financial support during the COVID-19, the estimated impact is rather low.

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

	Bank loan (1)	Public support (2)
Use (Website)	0.0208*** (3.08)	0.0168*** (2.68)
Access (4G)	0.0586** (2.33)	0.0646*** (3.18)
Obs.		
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%.

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 ICT usage and internet access (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** (2.11)	1.233** (2.16)	1.353** (2.13)	1.421** (2.24)	0.309 (0.47)	0.251 (0.38)	0.998 (1.09)	1.195 (1.31)
Access	-7.361*** (-3.53)	-7.455*** (-3.57)	-8.294*** (-3.90)	-8.371*** (-3.95)	-2.706 (-1.35)	-2.800 (-1.40)	-9.086*** (-2.78)	-8.943*** (-2.73)
Access to private and public funds								
Bank loan		1.095* (1.74)		0.588 (0.82)		1.372** (2.06)		-2.581** (-2.52)
Public support		-1.694*** (-3.10)		-2.979*** (-4.58)		1.009 (1.58)		-5.579*** (-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 access and usage have 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.

6. 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 both internet access - measured in terms of 4G network coverage – and 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 to the firm's resilience to the pandemic shock, but no evidence of mobile internet coverage. The positive role of ICT use 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 not explained by better access to external public (government support) or private (bank loan) financial resources. Therefore, policies aiming at reinforcing the private sector resilience to health crisis such as the Covid through digitalization should devote effort on improving firm's digital technology absorptive capacity.

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Appendix

Table A.1: Definition of variables

Variable	Type	Description	Source
<i>Firm performance during the COVID crisis</i>			
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
<i>Coping strategy</i>			
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
<i>Access to funds</i>			
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
<i>Panel B: Internet (interest variables)</i>			
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
<i>Panel C: Control variables</i>			
<i>Country-week crisis exposure</i>			
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.
<i>Firm-level characteristics</i>			
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 obstacle to 4)	WBES
Finance	Cat.	Managers' perception of finance has an obstacle (from 0, no obstacle 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 A2: 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		

Table A.3: 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	2707	27071	2716	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.

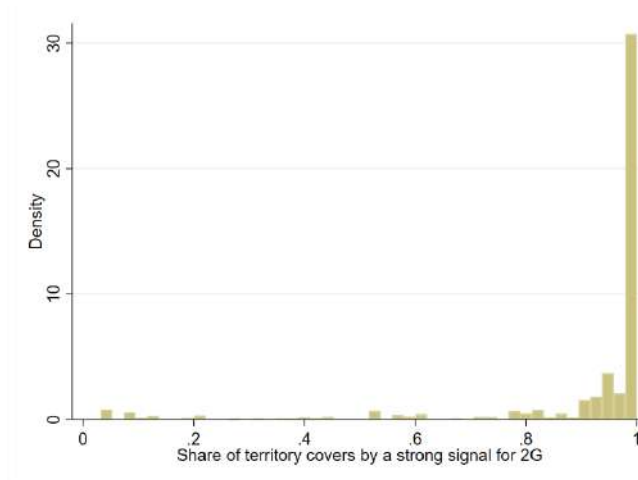
Table A4: Robustness checks

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

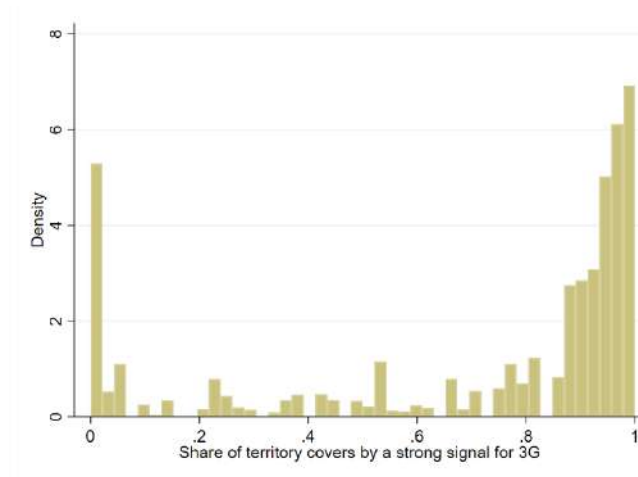
The table presents the factors affecting ex-post performance of firms. Four indicators of performances are considered: the probability to remain open (column 1), the sales evolution between the month before the survey and the same month in 2019 (column 2), the evolution of permanent workers between the 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.

Figure A.1. Coverage of mobile internet by technology

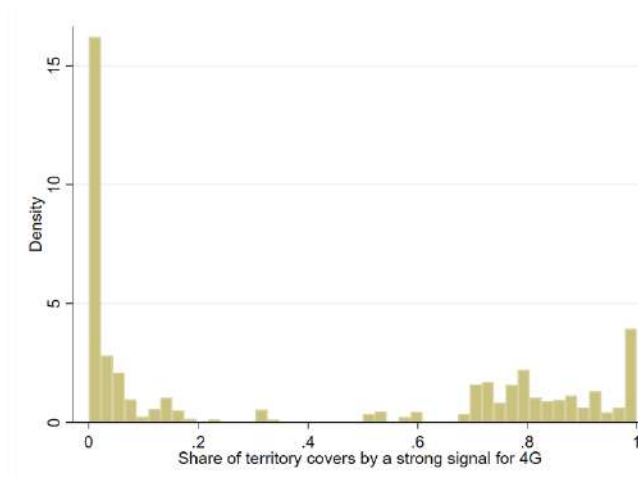
Panel a: 2G



Panel b: 3G



Panel c: 4G

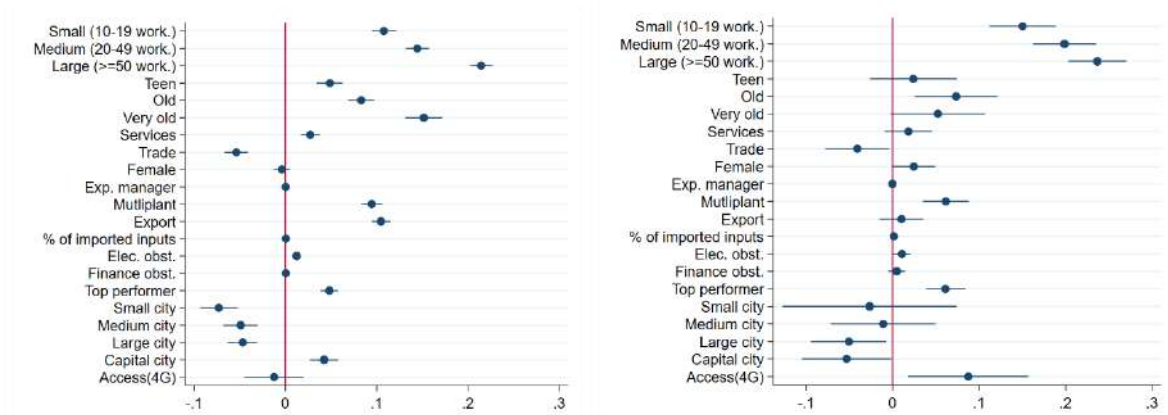


The figure displays the distribution of the share of territory covered by a strong signal of mobile internet (2G in panel a, 3G in panel b and 4G in panel C).

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

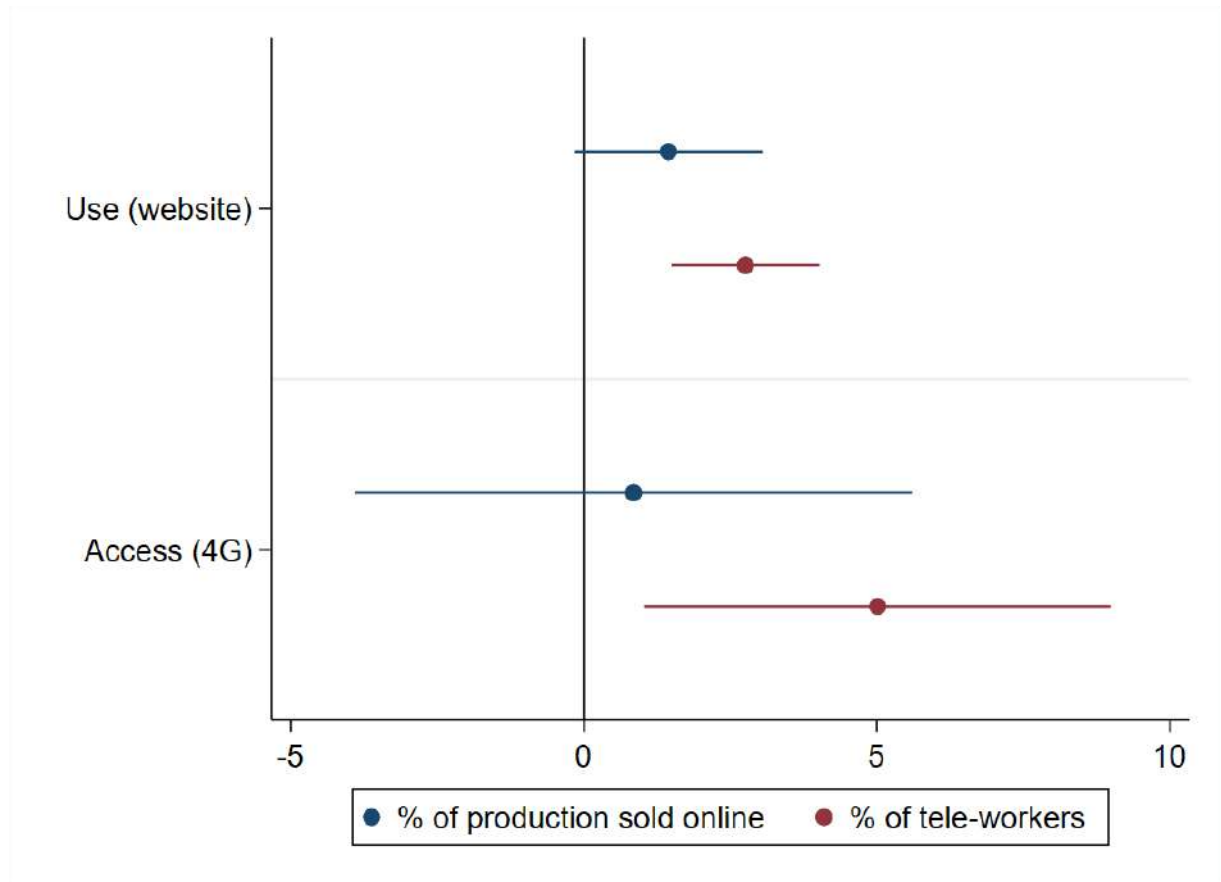
Panel a: Website use (N=39,860)

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).

Figure A.3. Internet and intensity of production sold online and remote work



The figure represents the marginal effect of the internet usage (website) and internet access (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%. Marginal effects are multiplied by 100 for dummy variables (indicated as prob.).

“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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