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ABSTRACT: The COVID-19 pandemic has resulted in an unprecedented shock to firms with adverse consequences for existing productive capacities. At the same time, digitalization has increasingly been touted as a key pathway for mitigating economic losses from the pandemic, and we expect firms facing digital constraints to be less resilient to supply shocks. This paper uses firm-level data to investigate whether digitally-enabled firms have been able to mitigate economic losses arising from the pandemic better than digitally-constrained firms in the Middle East and Central Asia region using a difference-in-differences approach. Controlling for demand conditions, we find that digitally-enabled firms faced a lower decline in sales by about 4 percentage points during the pandemic compared to digitally-constrained firms, suggesting that digitalization acted as a hedge during the pandemic. Against this backdrop, our results suggest that policymakers need to close the digital gap and accelerate firms' digital transformation. This will be essential for economies to bounce back from the pandemic, and build the foundations for future resilience.

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Digitalization and Resilience: Firm-level evidence during the COVID-19 Pandemic

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February 2022

Abstract

The COVID-19 pandemic has resulted in an unprecedented shock to firms with adverse consequences for existing productive capacities. At the same time, digitalization has increasingly been touted as a key pathway for mitigating economic losses from the pandemic, and we expect firms facing digital constraints to be less resilient to supply shocks. This paper uses firm-level data to investigate whether digitally-enabled firms have been able to mitigate economic losses arising from the pandemic better than digitally-constrained firms in the Middle East and Central Asia region using a difference-in-differences approach. Controlling for demand conditions, we find that digitally-enabled firms faced a lower decline in sales by about 4 percentage points during the pandemic compared to digitally-constrained firms, suggesting that digitalization acted as a hedge during the pandemic. Against this backdrop, our results suggest that policymakers need to close the digital gap and accelerate firms' digital transformation. This will be essential for economies to bounce back from the pandemic, and build the foundations for future resilience.

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1 Introduction

The COVID-19 pandemic has resulted in an unprecedented shock to the private sector with adverse consequences for existing productive capacities and potentially persistent effects on growth prospects. At the same time, measures to contain the COVID-19 pandemic have profoundly affected the firms' relationship with digital technologies. Teleworking and e-commerce, among others, have surged across countries. These internet-based and bandwidth-intensive activities have fueled demand for high-quality connectivity and lay bare existing digital divides between firms. While the Middle East and Central Asia region (ME&CA henceforth) made significant progress in closing the *digital gap* with the rest of the world over the 2005-2019 period (see Figure 1), fixed-broad band penetration remains low (see Figure 2), and there are significant heterogeneities of digital adoption across firms between countries and sectors (see Figures 3 and 4). As countries weather the pandemic, digital connectivity, more than ever, is essential to ensure that economic activities can continue in a remote manner. Beyond the immediate effect of digitalization, firms also need to digitalize in order to respond to long-term changes. Consumers have been active in experimenting and adopting digital services during the pandemic, which is seen as an acceleration of the existing trend. Therefore, changes to consumer behavior are likely to stick, with people continuing their online purchase habits post-COVID-19 (Charm et al., 2020).

In this paper, we study the role of digitalization on the resilience of the corporate sector in the ME&CA region. Specifically, we compare non-financial corporations (NFCs) that are digitally-enabled, and thus have alternative channels for selling their products, to those that are more digitally-constrained, before and after 2020. Comparing two firms of the same size, age, productivity, industry, and country (i.e. that are facing the same demand conditions), we find that firms that have not invested in digital technologies ex-ante were more adversely impacted by this unprecedented shock.

In response to the crisis, a growing body of literature has emerged on the impact of the pandemic on business activity. Most of these papers focus on firms either in individual countries (Dai et al., 2014 documents revenue loss, business closures and layoffs in China; see also Acharya and Steffen, 2020 and Fairlie, 2020 for evidence in the United States) or advanced economies (for example, Demmou et al., 2021; Banerjee and Kharroubi, 2020, IMF, 2021a). There have been few systematic cross-country studies of the impact of the pandemic in developing countries. For example, Beck et al. (2020) use a sample of 500 firms across 10 developing countries and find that most firms have limited layoffs and payroll reductions by reducing investment. Apedo-Amah et al. (2021) mobilize a sample of firms from 51 developing countries and document that

the COVID-19 shock has been severe on small and medium enterprises (SMEs), with persistent negative impacts on sales.

While this line of research provides a good description of how firms have responded to the crisis, it is important to extend this work and investigate how to make firms in developing countries more resilient.[1] An economic crisis comes with huge economic and social costs such as firm exits, unemployment, and lower productivity. To reduce these costs, it is important to understand what makes firms, industries and countries more resilient, that is, what fosters their ability to resist to shocks and to recover quickly afterwards. Digitalization may be an important source of firms' resilience. There are different channels through which digitalization may affect firm performance and resilience. An important link is innovation. It has been shown in the past that digitalization facilitates both product and process innovations as well as spurring (longer-term) productivity growth (Andrews et al., 2016; Cette et al., 2020; Gal et al., 2019). Specifically, firms using Information and Communication Technologies (ICT) may be able to cope with economic shocks more flexibly through easier reorganization of their production processes. They can thus achieve higher levels of productivity and competitiveness, while firms lagging in the adoption of new technology face the risk of being driven out of the market. While early evidence is emerging on the mitigating role of IT adoption for the United States (see Pierri and Timmer, 2020), to the best of our knowledge, there is so far no cross-country study investigating and quantifying the impact of the pandemic and the role of digitization in developing countries, especially for the ME&CA region.

Our paper is the first to provide systematic evidence that digitalization mitigated the impact of the pandemic on firms revenues in the ME&CA region using a novel database. We construct a new dataset using several data sources. First, to obtain pre-pandemic firm-level information on business performance (for example, sales, number of employees) and digitalization, we use the last survey (2018-20) of the EBRD-EIB-World Bank Business Environment and Enterprise Performance Survey (BEEPS). We combine the BEEPS with the ES COVID-19 Follow-up Enterprise Survey (ES COVID Survey) and the Business Pulse Survey (BPS) to obtain information on firm-level business performance during the pandemic.[2] The advantage of combining these surveys is to be able to evaluate firms' performance before and during the pandemic. Our firm-level data includes several proxies of digitalization such as usage of website, access to emails, and

[1] Resilience is a complex concept, which can be defined, e.g. as the capacity of an economy to reduce vulnerabilities, to resist to shocks and to recover quickly (see Caldera-Sánchez et al., 2016). We use the term 'resilience' in a rather specific and narrow way related to how digitalization mitigates the impact of economic shocks on firms' revenues.

[2] The World Bank has developed a brief firm survey to collect data measuring the impact of the COVID-19 pandemic on unlisted firms across 48 countries. The questionnaire collects data across different dimensions: operations of the business, sales, labor adjustments, firms expectations and uncertainty about the future, public support etc. More details can be found on: https://www.enterprisesurveys.org/en/covid-19

adoption of foreign technologies. We use additional firm-level characteristics such as access to credit, labor productivity, management practices, innovation, firm ownership and expectation on future profits to control for possible confounding factors. In addition, our dataset covers most sectors of the economy (manufacturing, wholesale and retail, hospitality and tourism, services, among others), 13 ME&CA countries with varying income levels (i.e. ranging from Morocco to Uzbekistan), and different levels of exposure to the COVID-19 shock.

We use a difference-in-differences approach to identify the effect of digitalization on the firm revenues across ME&CA countries. We exploit the COVID-19 crisis as an exogenous supply shock that substantially reduced – due to lockdowns and social distancing measures to contain the virus – the ability of firms to sell their goods and services. To capture the multidimensional nature of digitalization, we construct a novel index on firm-level digitalization, which is based on several firm-level digital indicators. Digitally-enabled firms are expected to be less affected by containment measures because they are able to maintain business operations via digital technologies (e.g., online sales) (Apedo-Amah et al., 2021). Thus, we use digitally-constrained firms as a control group and digitally-enabled firms as a treatment group. However, an important concern is that these firms may differ between each other in a variety of dimensions other than access to digital technologies, which can also affect firm performance (i.e. for instance innovative capacity). Our paper attempts to address this limitation by controlling for a large set of firm (un)observed characteristics. We specifically address three key issues. First, we look into the evolution of digitalization evolving in the MECA region and the characteristics of digitally-enabled and constrained firms in the MECA region. Second, once COVID hits, we investigate the evolution of sales growth and employment decisions of digitally-constrained firms differ from those that have invested (ex-ante) in digital technologies. Third, we reflect on the policy-mix that can enable firms to mitigate the potential costs of adopting digital technologies.

The results of our paper are the following: First, digitally-constrained firms in the ME&CA region are typically smaller, younger, and less productive. Therefore, they might also have been subject to different demand shocks, which would confound our analysis. To take this heterogeneity into account, all our analyses use a large set of firm-level control variables and country and industry fixed effects to control for unobserved time-invariant country characteristics as well as industry specific shocks (e.g. demand shocks). Second, we find that digitally-constrained firms in contact-intensive sectors experienced a larger decline in sales than the same companies in non-contact intensive sectors. Third, while the COVID-19 crisis had a negative impact on firms' performance, companies that have invested in digital technologies before the crisis were significantly less impacted. In particular, digitally-enabled firms experience a decline in their

sales that is about 4 percentage points lower than that of digitally-constrained firms. Therefore, these firms have been more resilient in mitigating the pandemic shock. These findings contribute to a better understanding of firms' performance during crises and the role of digital technologies as a mitigating factor.

We also conduct a battery of robustness checks. Specifically, we use an alternative digital index in order to avoid measurement issues and check whether our results hold to different digital measures. We also control for access to credit, optimism, labor productivity, innovation, and ability to sell new products among other firm-level characteristics in order to control for confounding effects. The results are the very similar, which lends further support to a causal interpretation of digitization as a key mitigating factor of the Covid-19 crisis.

The rest of this paper is structured as follows. Section 2 describes the data. Section 3 discusses some descriptive statistics of digitalization in the region. Section 4 presents the empirical strategy and section 5 presents the results. The last section concludes and presents policy recommendations to harness the digital potential of the region.

2 Data

In order to assess the role played by digital technologies on business performance during the pandemic, we use the EBRD-EIB-World Bank Business Environment and Enterprise Performance Survey (BEEPS), which is a firm-level survey for unlisted firms that has been conducted since 2002. For our empirical analysis, we use the last BEEPS wave from 2018-20 in 13 economies of ME&CA region from non-agricultural and non financial sectors (i.e. manufacturing, services, petroleum, etc.).[3] The sample of countries and territories includes: Azerbaijan, Armenia, Egypt, Georgia, Jordan, Kazakhstan, Kyrgyz Republic, Lebanon, Morocco, Tajikistan, Tunisia, Uzbekistan, and West Bank and Gaza. The survey features information on firm characteristics (i.e. age, size), ownership details, sales, employees' training and skills levels, access to credit, infrastructure, competition, green governance, organizational and marketing innovation, and R&D spending. Most importantly for our study, the BEEPS contains information on digitalization (further details can be found in the Appendix).[4] To the extent that most of the digital connectivity variables in the BEEPS have a large number of missing observations, we will use "website"

[3]Sampling weights are provided in the survey and ensure that the sample is representative of the non-agricultural private sector of the economy

[4]In the BEEPS, digital connectivity is assessed via the following questions: Whether or not the company has its own website? Whether or not firms use email to communicate with clients? Whether or not the firm has high speed internet on the premise? Whether or not this establishment use cell phone for operations? Whether or not the lack of ICT is an obstacle for current business operation? Digital adoption/diffusion: Whether or not the company is using a technology from foreign-owned company?

and "foreign technology" as baseline indicators to construct our digital index. Foreign technology is considered as a proxy of digitalization because it could signal (i) the existence of payment systems that might be integrated into a website and (ii) the degree of commitment of the firm to digital technologies.

Second, we complement the BEEPS with the ES COVID-19 Follow-up Enterprise Survey (ES COVID Survey) to understand the impact of the pandemic on business performance for several countries (i.e. Armenia, Azerbaijan, Jordan, Georgia, Lebanon and Morocco). Specifically, firms report whether their sales have remained the same, increased or decreased, and by how much. We use this information to compute the level of firms sales in 2020.[5] Then we merge the dataset from BEEPS and ES COVID Survey thanks to a common firm identifier and therefore obtain a comprehensive panel dataset including pre-COVID and post-COVID information on firm performance.

Finally, to complement information on post-pandemic business performance (i.e. sales) for countries not covered in the ES COVID Survey, we use the Business Pulse Survey (BPS) implemented by the World Bank, which gathered firm-level information on 21 harmonized indicators about the impact on business operations during the pandemic. So far, indicators are only available at the country level.[6] We calibrate firm-level revenues in 2020 by using two approaches: First, we use the variable from the BPS which asks the firm the average percentage change in monthly sales compared to 1 year before the interview. Second, we use the country-specific economic growth rate in 2020. Specifically, we use the following expression to apply the estimated drop in sales:

$$SalesDrop_{i,c,t} = \omega_t * \underbrace{\%\Delta S_{c,t}}_{\text{A}} + (1 - \omega_t) * \underbrace{g_{c,t}}_{\text{B}} \tag{1}$$

where $SalesDrop_{i,c,t}$ refers to the estimated drop in sales applied for firm i, located in country c at time t. Given data availability for most of the firms in our sample, the haircuts are applied for a small subset of firms in 2020. $S_{c,t}$ indicates the average percentage change in monthly sales compared to 1 year before the interview obtained from the BPS, and $g_{c,t}$ is the country-level growth rate retrieved from the IMF World Economic Outlook (WEO). In the baseline specification, the weight ω_t assigned to term A in expression 1 is 0.25, which means that it is assumed that the economy was at a standstill for a quarter of the year, i.e. three months drop in sales. The remaining three-fourths of the mean decline in sales is attributed to the economic growth

[5] Over 50% of the firms were surveyed in the first half of 2020.

[6] For more information, please visit: https://www.worldbank.org/en/data/interactive/2021/01/19/covid-19-business-pulse-survey-dashboard.print

the country has experienced in 2020.[7] This is obviously an ad hoc procedure but we also use the Oxford Stringency Index, which measures more precisely the severity of containment policies, as an additional sensitivity test.

To the best of our knowledge, this is the most comprehensive assessment of the short-term impact of digitalization on businesses during the pandemic in terms of number of firms and countries covered. We cover 13 ME&CA countries with over 18,000 firm-level observations.

3 Descriptive statistics

Figure 1 shows the number of internet users across Africa, Europe, Asia & Pacific, the Americas, and the Middle-East and North Africa (MENA) region. MENA has made remarkable progress in the past in terms of internet usage. The share of individuals using the internet has risen quickly fast from only 8.3 percent in 2005 to 54.6 percent in 2019, ahead of Africa and the Asia-Pacific region. However, looking at other indicators such as fixed-broadband subscriptions per capita (see Figure 2), internet usage is lagging behind other major regions. We also find significant heterogeneities in digital adoption across firms between ME&CA countries and sectors (see Figures 3 and 4).

Generally, the share of firms across ME&CA countries having a website is higher than foreign technology adoption even though there seems to be a relationship between these two variables. The higher the share of firms with a website, the higher the likelihood of technology adoption. At the country-level, the share of firms with a website ranges between 30 and 65 percent. Jordan, Azerbaijan, Armenia, and Lebanon have the highest share of firms with a website (close to 60 percent of all firms). Exceptionally, firms in Jordan display a larger share of firms with foreign technology adoption than having a website (almost 80 percent). At the lower end, firms in Tajikistan and Uzbekistan have the lowest share of firms with a website (just above 30 percent). Figure 4 depicts the share of firms with a website and foreign technology across industries. The manufacturing, wholesale and retail, other services, and machinery and electronics sector have the highest share of digitally connected firms; while firms operating in the metal sector have the lowest shares of firms with a website and foreign technology adoption.

Table 1 establishes an initial relationship between digitalization and sales. It shows the difference in the level of firms' sales in 2019 and 2020 for digitally-enabled and digitally-constrained firms. Both before and after the crisis, digitally-enabled firms have a higher average level of sales compared to digitally-constrained firms. While sales have dropped for both groups, the

[7] It is important to notice that the estimated drop in sales was also conducted backward, that is, for firms whose sales were only available in 2020.

drop was relatively more important for digitally-constrained than digitally-enabled firms. Table 2 displays the main observable characteristics and difference between digitally-enabled and digitally-constrained firms before the crisis: age, size, access to credit, ownership, expectations, and innovation. It suggests that digitally-enabled firms are, on average, older, larger, have a better access to credit, more likely to be foreign-owned, more optimistic regarding future sales, and more innovative than digitally-constrained firms. The *t-test* values depicted for each variable suggests that there is a significant difference between the means of the two groups.

The main research question addressed in this paper is to analyze the differentiated effect of the COVID-19 shock on firms' performance, conditioning on their pre-pandemic digital preparedness. A preliminary way to look at this relationship consists in tracing out firms' sales in 2020 and 2019 for both the digitally-enabled and digitally-constrained groups. Figure 5 plots the sales (log) of firms in 2019 versus 2020 for both groups and shows that the number of firms witnessing a significant drop in sales are over-represented for the digitally-constrained group. If we consider, for instance, two firms – one digitally-enabled and another one that is digitally-constrained – whose (log) sales level in 2019 is at "10", we notice that the firm that has not invested in digital technologies experiences a larger decline in sales in 2020 compared to the digitally-enabled one (see also Figure A1 in the Appendix). This provides evidence that digitally-enabled companies seem to be more resilient than digitally-constrained companies. This question will be empirically investigated in our regression analysis.

4 Empirical strategy

The key identification issue we face consists in separating supply (e.g. ability to serve consumers) from the demand conditions (e.g. ability to access internet) of the COVID-19 shock that hit the ME&CA region. In order to tackle this issue, we introduce a difference-in-differences specification and control for demand effects (e.g., industry, country, age, size along other determinants of digitalization) in order to examine the sales of the digitally-enabled firms against those of digitally-constrained firms.

Our main identification strategy consists in comparing ME&CA digitally enabled firms with those that were more digitally constrained (e.g. no use of websites, foreign technologies, etc.). The COVID-19 financial crisis reduced the ability of firms to access their consumers and sell their goods and services, especially when containment measures were introduced. While those that have ex-ante invested in digital technologies maintained a certain ability to access their consumers, non-digitally enabled firms faced lower demand for their products. In our context, the key challenge is that firms in the digitally-enabled and digitally-constrained groups are dif-

ferent along many dimensions besides access to consumers (size, age, expectation, innovation, etc.). The aim of all our analysis is to tackle this challenge.

In order to control for ex-ante differences between digitally-enabled and digitally-constrained firms, we use two types of fixed effects. First, country-fixed effects allow us to control for unobserved, time invariant country characteristics. Second, industry fixed effects allow for an adjustment of industry-specific shocks that were caused by the crisis. Our baseline regression is as follows:

$$Y_{i,t} = \alpha + \beta_1 COVID19_t + \beta_2 Digital_i + \beta_3 COVID19_t * Digital_i + \Gamma X_{i,t} + FEs + \varepsilon_{i,t} \quad (2)$$

where $Y_{i,t}$ is the logarithm of total sales of firm i at date t, $COVID19_t$ is a time-dummy that captures the start of the COVID-19 (year 2020), $Digital_i$ is a firm-level dummy which equals one if the firm was digitally-enabled before the pandemic, and $X_{i,t}$ is a vector of firm-level control variables (e.g., age, firm size). Since digitalization is a multidimensional process, it cannot be studied only through website and foreign technology. That is why we construct a digital index based on the Principal Component Analysis (PCA), which is a dimensionality-reduction method that transforms our digital connectivity variables into an index that still contains most of the information. In all regressions, standard errors are clustered at the firm level to account for the panel structure of the data and allow for a correlation of the error within firms across years.

There is still a concern that digitally-enabled firms might not be a suitable counterfactual group, as they tend to be larger and more productive than the average ME&CA firm. We include different variables to control for such differences. We pursue the analysis adjusting for a large set of possible confounding factors to make sure that the firms are comparable both in terms of their corporate structure and outcomes, including to innovation, access to credit, expectations, firm ownership, management practices and skill composition of workers. We also use an alternative digitalization index in order to assess the robustness of our results to different measures of digitalization and expand our definition of resilience by using employment as an outcome variable (e.g., the number of full-time employed workers as the outcome variable) instead of firms sales. The joint effect of digitalization and COVID-19 (i) across contact and non-contact intensive sectors (ii) excluding the estimated drop in sales are also investigated.

5 Results

Table 3 compares the economic resilience of digitally-enabled and digitally-constrained firms in the ME&CA region. The dependent variable is the logarithm of the total sales, and the main

regressor is the interaction term between a firm-level digital index and a time dummy for the COVID-19 crisis.[8] Columns (4) to (6) include firm-specific characteristics such as age and size as time varying controls, which may determine sales besides digitalization. We also include industry and country-level fixed effects, which allow us to control for any other time invariant unobserved country and industry heterogeneities.

First, we find across all regressions that the COVID-19 crisis negatively affected the sale performance of all firms. Second, digitalization is positively associated with firms' sales. Finally, and most importantly, comparing two firms of the same size, age, country, and industry that are facing the same demand conditions, digitally-enabled firms' experienced a decline in their sales that is about 4.4 percentage points lower than that of digitally-constrained firms. Adding industry and country-specific fixed effects in column (9), the results remain similar to column (4), with digitally-enabled firms facing a lower decline in their sales in 2020 that amounts to 3.8%.

While the baseline result displays correlation but not yet a causal relationship, it shows that the coefficient of our interaction term is not flawed by some confounding factors. However, there may still be some unobserved factors affecting the process of firms digitalization. Specifically, while the COVID-19 shock is exogenous to firms conditions, the fact that a firm decides to invest in digital technology is not an orthogonal process. Our aim here is to exploit the rich set of variables in our combined data-sets and control as much as possible for factors that simultaneously affect firms sales and the decision to invest in digital technologies.

In order to do so, we proceed in the following steps: First, we introduce proxies of firm-level innovation. The idea behind such controls is that digitally-enabled firms can also be the most innovative since empirical evidence has shown that ICT adoption coincides with process and product innovation as well as increased human capital (Bartel et al., 2007; Bloom et al., 2014). Innovation is constructed using dummy variables that take the value of one if the firm has introduced a new product over the last three years or reports any Research and Development (R&D) expenses during the last fiscal year. The results are reported in Tables 4 and 5 and confirm the previous results: digitally-enabled firms were more resilient to the COVID-19 shock than those that have not invested in digital technologies after controlling for innovation and R&D expenses. With respect to the coefficient estimates of the variables on innovation, the introduction of a new product by a firm is positively associated with higher sales, although this does not hold across all specifications. Interestingly, we find that the coefficient for R&D spending is higher than that for product innovation.

[8]The digital index is a dummy variable that is equal to 1 if the firm has a website and uses a foreign technology.

The second set of control relates to the confounding effect that access to credit can have on the digitalization process. As a matter of fact, one can conjecture that investing in digital technologies requires a non-negligible amount of capital that could be acquired mainly through access to credit markets. This holds especially for SMEs, which face severe barriers to adopt new digital technologies due to the difficulty in accessing finance to make the necessary investments (EIB, 2019). In such a case, firms would only be digitalized because they have easier access to credit. To test this assumption, we estimate our empirical model and introduce a variable measuring whether the firm has a line of credit or loan from a financial institution. Table 6 reports the results and confirms that the resilience of digitally-enabled firms to the COVID-19 shock is not driven by their potential access to credit markets. Furthermore, that factor is positively and significantly associated with firms' performance, regardless of the specification retained.

Another important factor in the decision to invest in digital technologies is expectations. If a firm has optimistic expectations in the medium term about the evolution of its total sales, it may have more incentives to increase investment and improve its production capacities. Table 7 presents the regression results, controlling for whether the firm expects its total sales to increase, decrease, or remain the same. The results do not depart from the baseline findings: digitally-enabled firms experienced in 2020 a lower decline in sales than those that have not invested in digital technologies.

As discussed in the data section, our measure of digitalization considers that a firm is digitally enabled if it has a website alongside foreign technology. However, the adoption of foreign technology depends on several factors, including firm's ownership. As a case in point, foreign-owned companies can experience an easier technology transfer, especially in the context of Foreign Direct Investments (FDI) (see Newman et al., 2015, among others). To test whether the results are robust to a firm's ownership, we construct a dummy variable that equals one if the percentage owned by private foreign individuals, companies, or organizations is positive and zero otherwise. Table 8 shows that foreign ownership of a firm is associated with a higher level of total sales and also confirms that digitally-enabled firms were more resilient to the COVID-19 shock.

It should also be noted that digitalization is unlikely to produce positive effects on business performance if the workforce does not have the appropriate skills. To test whether digitally-enabled firms' resilience to the COVID-19 shock is not driven by those who employ skilled workers, we mobilize two variables: (1) a dummy indicating whether the firm has introduced a formal training program for permanent, full-time employees in the last fiscal year and (2) the number of permanent full-time employees with a university degree at the end of the fiscal year.

The results are reported in Tables 9 and 10. Both variables are significantly associated with an increase in firms' sales and do not affect the main finding on the resilience of digitally-enabled firms.

5.1 Robustness analysis

We perform several sensitivity analyses to check the robustness of our results. First, we use an alternative principal component measure of digitalization based on the use of cellphones and emails to communicate with clients. Even though we have less observations for these proxies, the results continue to hold when we replicate the baseline estimations using this alternative indicator. These are shown in Table 11. The number of observations drops to 3,624 but the interaction term between digitalization and the COVID-19 dummy remains positive across all specifications. The coefficient is, however, more sizeable: digitally-enabled firms experienced a lower decline of sales by about 9 percentage points compared to digitally-constrained firms.

Second, we study the impact of digitalization on economic resilience during the COVID-19 crisis across sectors. To this end, we focus particularly on contact and non-contact intensive sectors. The main assumption is that, in the context of the COVID-19 crisis and subsequent lockdown measures, digitally-constrained firms operating in high contact-intensive sectors would have more difficulty reaching their customers and would, as a result, experience a greater decline in sales. Table 12 presents the baseline results focusing on two high contact-intensive sectors: (1) wholesale and retail and (2) hospitality and tourism; while Table 13 shows the findings for low contact intensive sectors (i.e. manufacturing, textiles and garments, chemicals, construction, petroleum, plastics and rubber, basic metals, machinery and electronics) and the use of the baseline digital index.[9] The results unequivocally demonstrate that digitally-constrained firms in contact-intensive sectors experienced a greater decline in sales (-19%) than the same companies in non-contact intensive industries (-16%) but that digitalization helped to mitigate the impact of the pandemic shock.

Third, we approach economic resilience through employment. Particularly, we use the number of full-time workers as the outcome variable and estimate equation 2. The results are reported in Table 14. The coefficient estimates do not depart from those obtained in the baseline findings reported in Table 3. However, we note that the interaction term between digital connectivity and the COVID-19 dummy is positive – suggesting that digitally-enabled firms have laid off

[9]The distinction between contact and non-contact intensive industries is based on the classification adopted in the 2021 October issue of the Regional Economic Outlook (REO) on the Middle-East and Central Asia: high-contact-intensive sectors include services, retail, health, and transportation, while low-contact-intensive ones comprise consumer durables and nondurables, manufacturing, chemicals, business equipment, telecommunication, and utilities (IMF, 2021b).

less workers in the aftermath of the crisis – but not statistically significant. Such a result can speak to the fact that employment is perhaps less sensitive in the short-run to the joint effect of digitalization and the crisis, which could be related to the significant policy support measures implemented following the crisis, such as job retention schemes, which were primarily aimed at securing employment rather than maintaining sales. Overall, we find that 10% of firms report to have benefited from furlough schemes. Another explanation could be that employment may not be the appropriate indicator to measure the impact of digitalization on employment due to the implementation of job retention schemes which helped to prevent large scale employment losses. Instead, hours worked could be a more precise measure – however – we do not have information on hours worked.

Fourth, we alternatively use the Oxford Stringency Index in order to calibrate firms' sales for countries where sales are not available in 2019 or 2020. In fact, one important limitation of the empirical analysis so far was the ad hoc weight applied to the drop in sales for some countries. For instance, in the case of Tunisia, we deliberately assumed that the economy was closed during three (over 12) months in 2020. Using the Stringency Index helps better calibrate weight in the formula for the estimation of drop sales. Again, in the case of Tunisia, the Stringency Index informs us that the country was shut down on average 44% of the year. The results of this procedure are reported in Table 15, which shows strong consistency with the baseline findings: digitally-enabled firms experience a lower decline of their sales in 2020 compared to digitally-constrained firms firms. Furthermore, in view of the relatively high-level of digital connectivity among firms in Jordan, we also estimate our baseline model while omitting Jordanian firms from our sample. Table 16 confirms that our main results are not impacted. Finally, Table 17 shows that our findings continue to hold when we estimate the baseline specification using a reduced set of the sample that excludes the estimated drop in sale.[10]

6 Conclusion and policy implications

In this paper, we show that digitalization can act as an important mitigating factor when the economy is hit by a pandemic. The results are robust to a battery of exercises including controlling for a large set of confounding factors such as innovation and firm's optimism, as well as other firms' (un)observable characteristics.

Our findings can be generalized beyond the firm-level sample and have several important policy implications. It is unlikely that economies and societies will return to "pre-COVID" patterns;

[10] The results do not change when controlling for management practices, which are proxied using a dummy variable indicating whether the firm has a formalized written business strategy (available upon request).

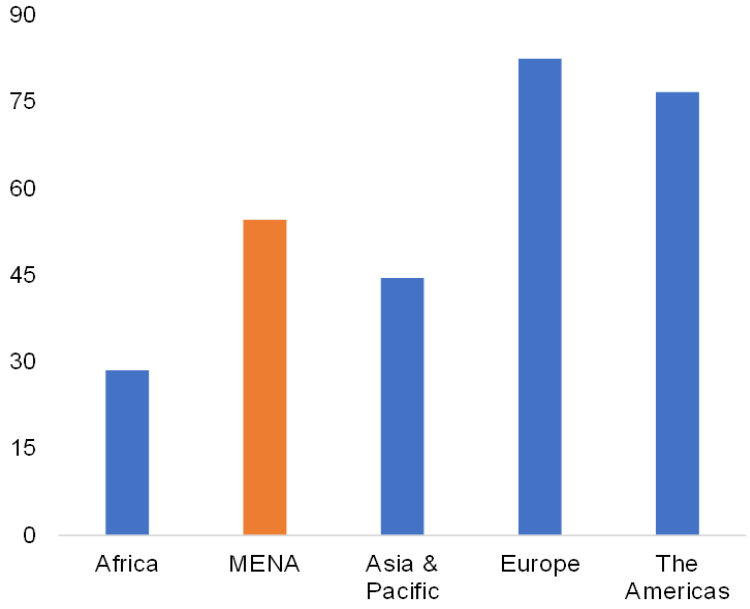
the crisis has vividly demonstrated the potential of digital technologies and some changes may now be too deep to reverse. In fact, around 35% of all firms in the ME&CA region report to have increased or started their online activity as a result of the pandemic. Therefore, in a future where jobs, education, health, government services, and even social interactions may be more dependent on digital technologies than ever before, failing to ensure widespread and trustworthy digital access and its effective use risks deepening inequalities, and may hinder countries' efforts to emerge stronger from the pandemic. Therefore, governments need to develop and put digital strategies at the centre of their policy agendas across several dimension: *access*, *diffusion*, and *skills*.

With lockdowns and social distancing measures forcing many businesses and schools online, the COVID-19 crisis has reinforced the importance of communications infrastructures and services, as well as robust governance of data. Unleashing the potential of digital tools for firms requires successful diffusion, which crucially depends on firms' investment in ICTs. Countries may promote ICT investment through monetary support or incentives to buy ICT equipment or services, as well as non-financial support (e.g. targeted training), especially to SMEs which have limited collateral to take risk and access finance for investing in ICTs. Technology diffusion is also linked to business dynamism (Andrews et al., 2016; Diez et al., 2021). Reducing barriers to firm entry and strengthening insolvency regimes, can affect positively affect competition and resource allocation. The success of firms in the digital age also depends on workers with good literacy, numeracy, problem solving and generic ICT skills used at work. Increasingly, it also requires ICT specialists and data specialists. Ensuring the provision of relevant skills for the digital age requires investments in education and training. Primary education needs to deliver sound literacy and numeracy skills. Subsequently, students need options to develop ICT and complementary skills, including social, communication and management skills.

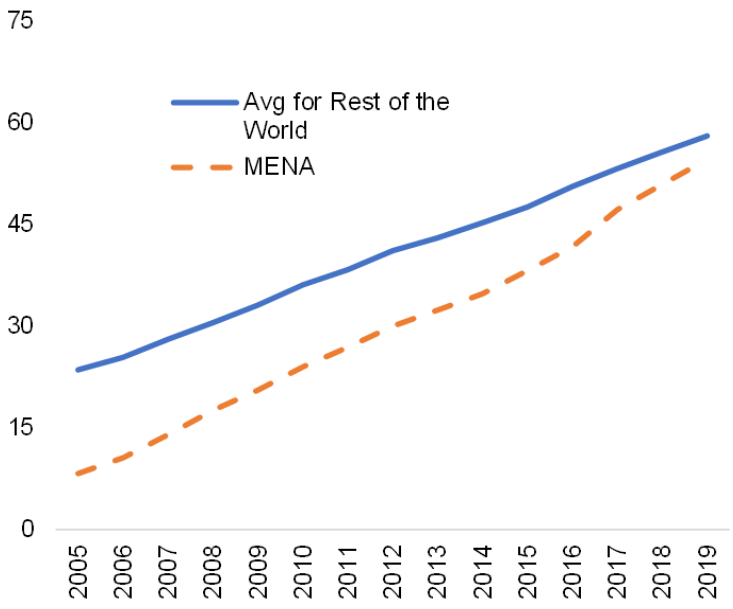
While our paper focuses only on the short-term impact of digitalization, several factors may play a role in the future which can be interesting avenues for research. For instance, what is the impact of digitalization on the labor market in the medium to long-term? On the one hand, digitalization and subsequent automation can lead to job losses (Acemoglu and Restrepo, 2020). On the other hand, digital innovation and digital transformation are fundamental drivers of new business models and markets, thus, employment generating that can be critical for the post-COVID recovery (Autor, 2015, 2019).

Figure 1: Individuals using the Internet (Per 100 Inhabitants)

(a) Individuals using the Internet in 2019

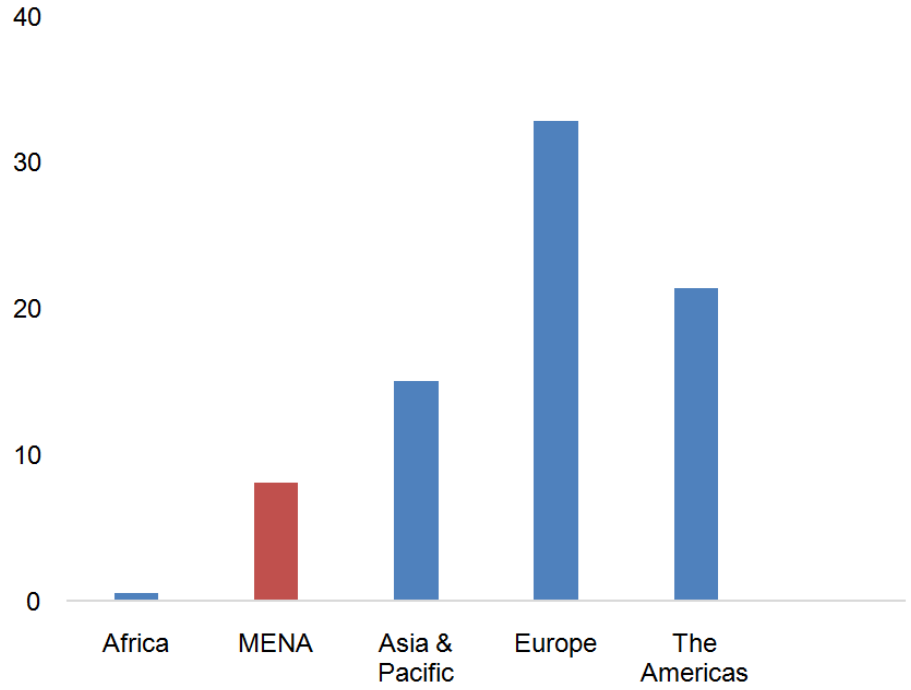


(b) MENA and the rest of the world



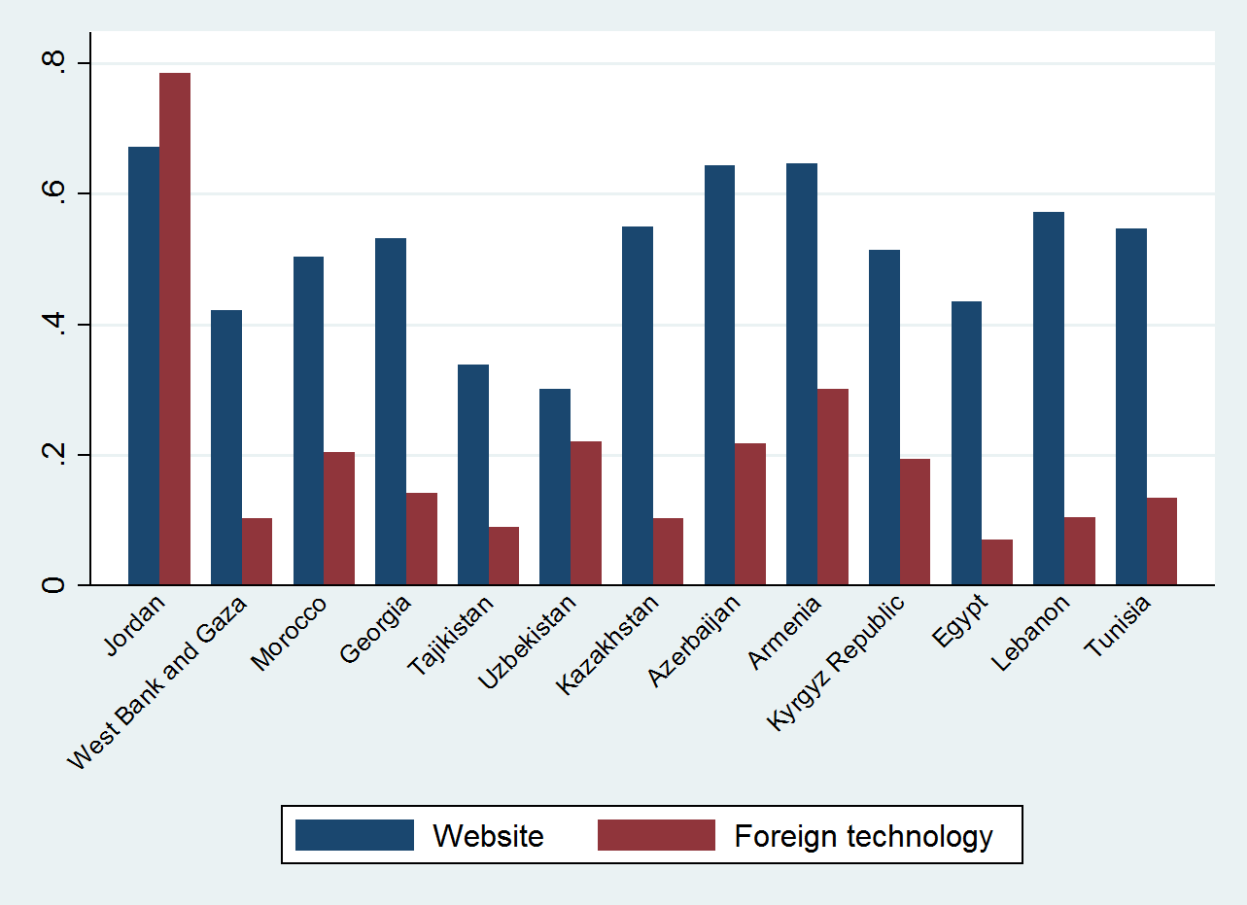
Source: ITU World Telecommunication/ICT Indicators database. MENA = Algeria, Bahrain, Djibouti, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, Palestine, Qatar, Saudia Arabia, Somalia, Sudan, Syria, Tuninisa, UAE, Yemen.

Figure 2: Fixed-broadband subscriptions (Per 100 inhabitants)



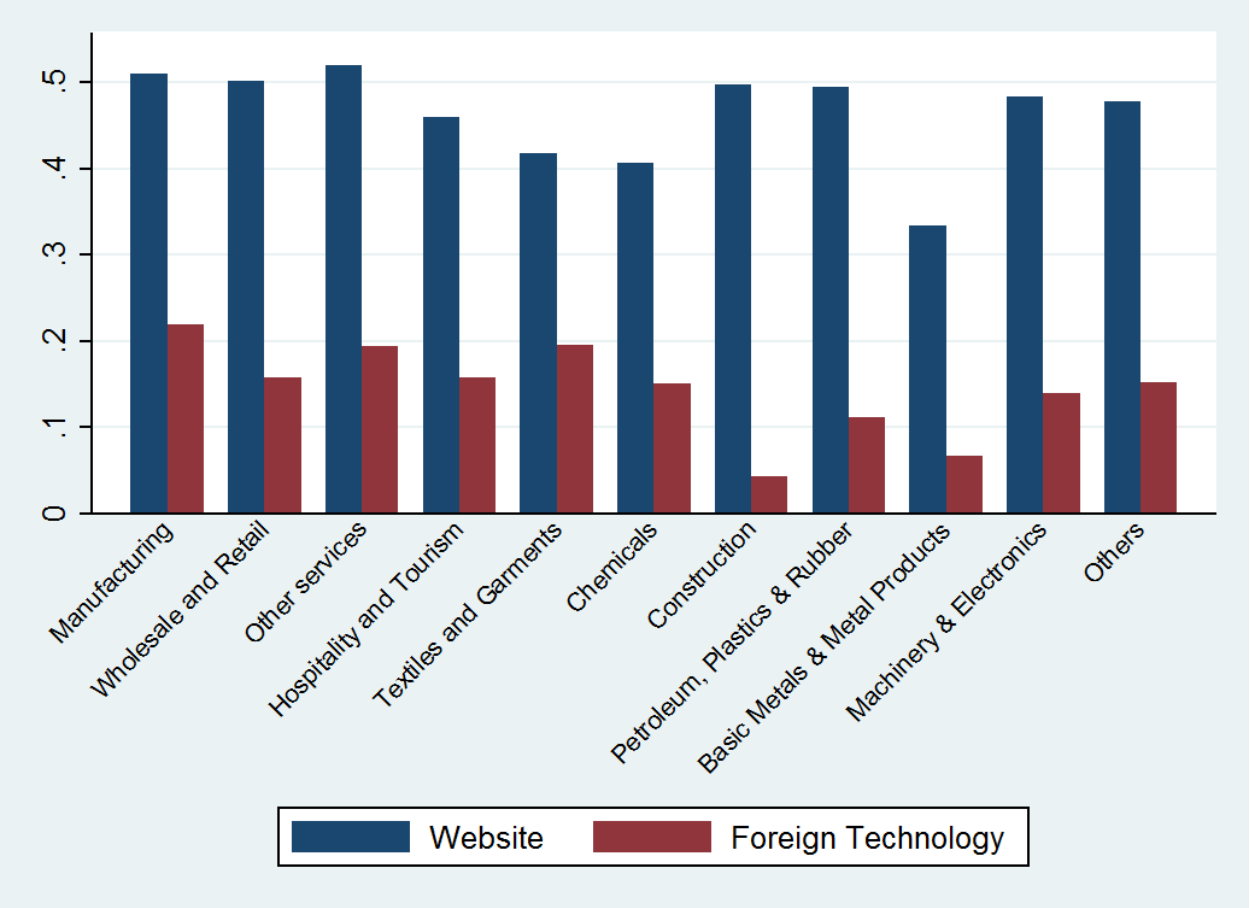
Source: ITU World Telecommunication/ICT Indicators database. Latest observation is 2020. MENA countries: Algeria, Bahrain, Djibouti, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, Palestine, Qatar, Saudia Arabia, Somalia, Sudan, Syria, Tunisia, UAE, Yemen.

Figure 3: Share of firms with website and foreign technology at the country-level



Source: BEEPS, ES COVID Survey, BPS

Figure 4: Share of firms with website and foreign technology at the industry-level



Source: BEEPS, ES COVID Survey, BPS

Table 1: Summary statistics - Firms (log) sales in USD

Firms (log) sales	2019	2020
1-*Digitally enabled firms*		
Mean	13.79	13.53
	(0.04)	(0.045)
Std. Deviation	1.75	1.80
2-*Non-Digitally enabled firms*		
Mean	11.71	11.23
	(0.045)	(0.045)
Std. Deviation	1.67	1.78
t-test	-34.23***	-36.65***

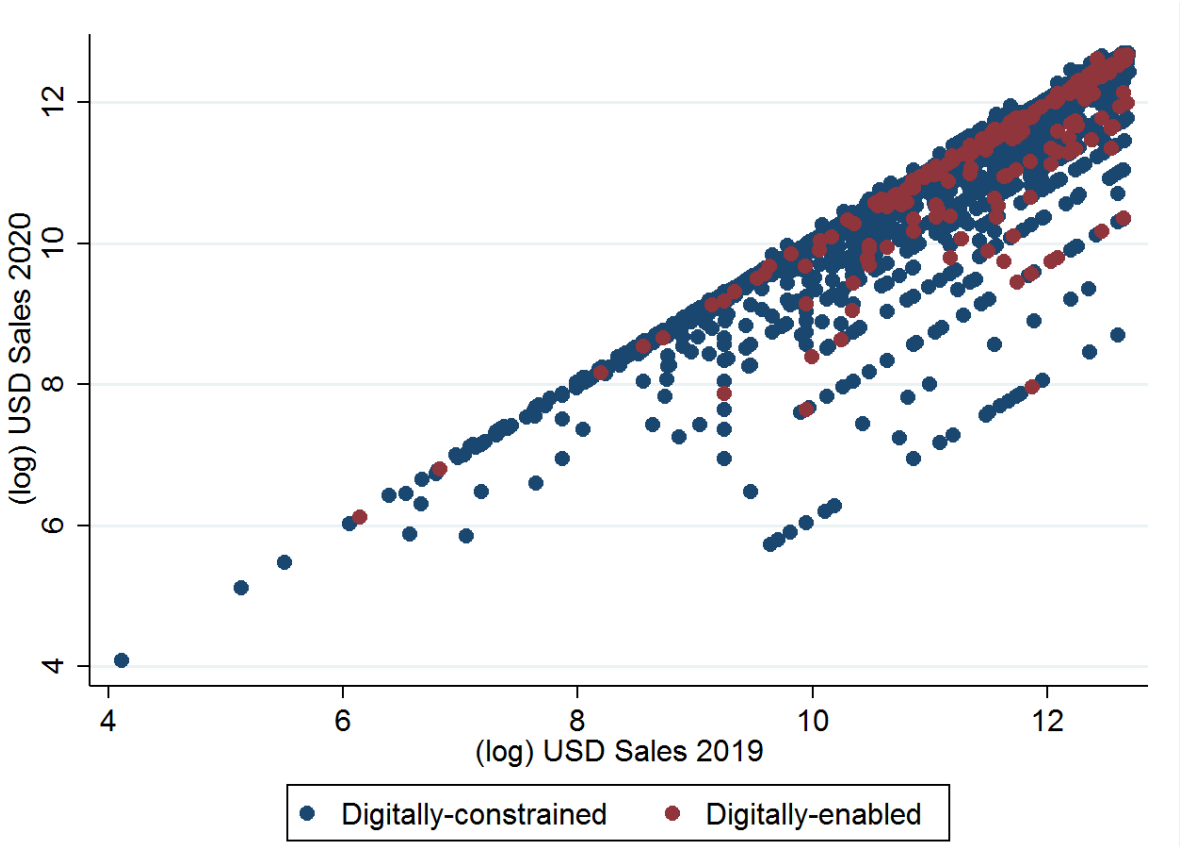
Notes: The treatment (digitally-enabled firms) and control groups (digitally-constrained firms) are based on the digital index from the Principal Component Analysis (PCA). Standard errors are reported in parentheses. The statistics are based on the countries of our sample reporting sales in both 2019 and 2020: Jordan, Lebanon, Morocco, Kazakhstan, Armenia, Azerbaijan.

Table 2: Summary statistics - Pre-crisis controls

	Age	Size	Credit access	Ownership	Expectations	Innovation
1-*Digitally enabled firms*						
Mean	21.08	3.58	0.29	0.11	1.38	0.23
	(0.15)	(0.013)	(0.004)	(0.003)	(0.007)	(0.004)
Std. Deviation	15.70	1.39	0.45	0.32	0.79	0.42
2-*Non-Digitally enabled firms*						
Mean	19.3	2.55	0.15	0.04	1.35	0.11
	(0.15)	(0.011)	(0.004)	(0.002)	(0.008)	(0.003)
Std. Deviation	14.21	1.01	0.36	0.19	0.79	0.32
t-test	-8.54***	-57.10***	-24.75***	-20.41***	-3.23***	-22.34***

Notes: Size refers to the (log) number of permanent, full-time employees. Credit access is a dummy variable that equals 1 if the firm has a line of credit or loan from a financial institution. Ownership equals 1 if the firm is owned by private foreign individuals, companies or organizations and 0 otherwise. Expectation measures whether the firm expects its total sales to increase, decrease or stay the same. Innovation is a dummy variable that equals 1 if the firm has introduced new products/services over the three years. Standard errors are reported in parentheses. All the variables are obtained from the pre-crisis wave of the BEEPS.

Figure 5: Digitalization and firms sales



Source: BEEPS, ES COVID Survey, BPS, own calculations

Table 3: Digitalization and economic resilience - Baseline specification

Dependent variable: (log) sales									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
COVID-19	-0.167***		-0.156***	-0.159***	-0.168***	-0.170***	-0.167***	-0.168***	-0.168***
	(0.005)		(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Digital		2.266***	2.242***	1.819***	2.207***	1.793***	1.757***	1.786***	1.748***
		(0.036)	(0.036)	(0.035)	(0.036)	(0.034)	(0.035)	(0.035)	(0.035)
COVID-19*Digital			0.044***	0.038***	0.041***	0.035***	0.038***	0.033***	0.038***
			(0.013)	(0.012)	(0.013)	(0.012)	(0.012)	(0.012)	(0.012)
Small				-1.346***		-1.331***	-1.386***	-1.339***	-1.381***
				(0.034)		(0.034)	(0.033)	(0.034)	(0.034)
Young					-0.432***	-0.383***	-0.239***	-0.360***	-0.239***
					(0.035)	(0.033)	(0.033)	(0.033)	(0.033)
Country FE							X		X
Industry FE								X	X
Observations	18,074	18,074	18,074	18,074	18,074	18,074	18,074	18,070	18,070
R-squared	0.002	0.300	0.301	0.395	0.312	0.404	0.423	0.410	0.428

Notes: This table shows baseline results from the estimation of equation 2. Columns (1) and (2) separately depict the correlation between firms' sales and the COVID-19 as well digitalization, respectively. Column (3) evaluates the joint effect of digitalization and COVID-19 on firm performance. Columns (4) to (6) introduces size and age controls. Columns (7) to (9) use country and industry fixed effects. Robust standard errors are reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 4: Digitalization and economic resilience - New products

Dependent variable: (log) sales					
	(1)	(2)	(3)	(4)	(5)
COVID-19	-0.170***	-0.170***	-0.168***	-0.168***	-0.168***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Digital	1.793***	1.793***	1.738***	1.781***	1.727***
	(0.034)	(0.035)	(0.035)	(0.035)	(0.035)
COVID-19*Digital	0.035***	0.038***	0.042***	0.036***	0.042***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Small	-1.331***	-1.328***	-1.381***	-1.336***	-1.378***
	(0.034)	(0.034)	(0.033)	(0.034)	(0.034)
Young	-0.383***	-0.379***	-0.235***	-0.358***	-0.236***
	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)
New Products		-0.000	0.150***	0.036	0.164***
		(0.046)	(0.049)	(0.047)	(0.049)
Country FE			X		X
Industry FE				X	X
Observations	18,074	18,002	18,002	17,998	17,998
R-squared	0.404	0.404	0.424	0.410	0.429

Notes: This table shows the results from the estimation of equation 2, controlling for product innovation. Column (1) replicates the baseline results with size and age controls. Column (2) introduces product innovation as a control variable. Columns (3) to (5) product innovation as a control as well as country and industry fixed effects. Robust standard errors are reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 5: Digitalization and economic resilience - Research & Development

Dependent variable: (log) sales					
	(1)	(2)	(3)	(4)	(5)
COVID-19	-0.170***	-0.300***	-0.302***	-0.295***	-0.299***
	(0.008)	(0.032)	(0.031)	(0.031)	(0.031)
Digital	1.793***	1.836***	1.593***	1.800***	1.583***
	(0.034)	(0.107)	(0.105)	(0.106)	(0.104)
COVID-19*Digital	0.035***	0.115***	0.119***	0.108***	0.115***
	(0.012)	(0.040)	(0.038)	(0.039)	(0.038)
Small	-1.331***	-1.419***	-1.502***	-1.424***	-1.509***
	(0.034)	(0.090)	(0.090)	(0.091)	(0.091)
Young	-0.383***	-0.610***	-0.455***	-0.579***	-0.458***
	(0.033)	(0.092)	(0.093)	(0.093)	(0.093)
R&D		0.274***	0.147	0.278***	0.148
		(0.095)	(0.094)	(0.095)	(0.094)
Country FE			X		X
Industry FE				X	X
Observations	18,316	2,930	2,930	2,930	2,930
R-squared	0.398	0.338	0.395	0.356	0.403

Notes: This table shows the results from the estimation of equation 2, controlling for R&D expenses. Column (1) replicates the baseline results with size and age controls. Column (2) introduces R&D expenses as a control variable. Columns (3) to (5) product R&D expenses as a control as well as country and industry fixed effects. Robust standard errors are reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 6: Digitalization and economic resilience - Access to credit

Dependent variable: (log) sales					
	(1)	(2)	(3)	(4)	(5)
COVID-19	-0.170***	-0.171***	-0.167***	-0.169***	-0.167***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Digital	1.793***	1.731***	1.698***	1.723***	1.689***
	(0.034)	(0.035)	(0.035)	(0.035)	(0.035)
COVID-19*Digital	0.035***	0.040***	0.040***	0.037***	0.040***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Small	-1.331***	-1.293***	-1.352***	-1.296***	-1.350***
	(0.034)	(0.034)	(0.034)	(0.035)	(0.034)
Young	-0.383***	-0.388***	-0.228***	-0.363***	-0.229***
	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)
Access to credit		0.465***	0.524***	0.486***	0.517***
		(0.042)	(0.043)	(0.042)	(0.043)
Country FE			X		X
Industry FE				X	X
Observations	18,074	17,838	17,838	17,834	17,834
R-squared	0.404	0.412	0.433	0.419	0.437

Notes: This table shows the results from the estimation of equation 2, controlling for access to credit. Column (1) replicates the baseline results with size and age controls. Column (2) introduces access to credit as a control variable. Columns (3) to (5) product access to credit as a control as well as country and industry fixed effects. Robust standard errors are reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 7: Digitalization and economic resilience - Optimism

Dependent variable: (log) sales					
	(1)	(2)	(3)	(4)	(5)
COVID-19	-0.170***	-0.174***	-0.172***	-0.173***	-0.172***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Digital	1.793***	1.793***	1.735***	1.785***	1.727***
	(0.034)	(0.035)	(0.036)	(0.035)	(0.036)
COVID-19*Digital	0.035***	0.036***	0.039***	0.035***	0.039***
	(0.012)	(0.013)	(0.012)	(0.013)	(0.012)
Small	-1.331***	-1.326***	-1.372***	-1.336***	-1.370***
	(0.034)	(0.035)	(0.034)	(0.035)	(0.035)
Young	-0.383***	-0.401***	-0.277***	-0.380***	-0.276***
	(0.033)	(0.034)	(0.034)	(0.034)	(0.034)
Optimism		0.049**	0.176***	0.052**	0.173***
		(0.022)	(0.023)	(0.022)	(0.023)
Country FE			X		X
Industry FE				X	X
Observations	18,074	17,142	17,142	17,138	17,138
R-squared	0.404	0.405	0.428	0.412	0.432

Notes: This table shows the results from the estimation of equation 2, controlling for expectations. Column (1) replicates the baseline results with size and age controls. Column (2) introduces expectations as a control variable. Columns (3) to (5) product expectations as a control as well as country and industry fixed effects. Robust standard errors are reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 8: Digitalization and economic resilience - Ownership

Dependent variable: (log) sales					
	(1)	(2)	(3)	(4)	(5)
COVID-19	-0.170***	-0.167***	-0.165***	-0.166***	-0.165***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Digital	1.793***	1.768***	1.729***	1.756***	1.716***
	(0.034)	(0.035)	(0.035)	(0.035)	(0.035)
COVID-19*Digital	0.035***	0.031**	0.035***	0.029**	0.035***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Small	-1.331***	-1.323***	-1.376***	-1.333***	-1.374***
	(0.034)	(0.034)	(0.033)	(0.034)	(0.034)
Young	-0.383***	-0.398***	-0.250***	-0.377***	-0.252***
	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)
Ownership		0.355***	0.388***	0.403***	0.423***
		(0.074)	(0.075)	(0.074)	(0.075)
Country FE			X		X
Industry FE				X	X
Observations	18,074	17,836	17,836	17,832	17,832
R-squared	0.404	0.411	0.431	0.418	0.436

Notes: This table shows the results from the estimation of equation 2, controlling for ownership. Column (1) replicates the baseline results with size and age controls. Column (2) introduces ownership as a control variable. Columns (3) to (5) product ownership as a control as well as country and industry fixed effects. Robust standard errors are reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 9: Digitalization and economic resilience - Formal training

Dependent variable: (log) sales					
	(1)	(2)	(3)	(4)	(5)
COVID-19	-0.170***	-0.171***	-0.168***	-0.170***	-0.168***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Digital	1.793***	1.734***	1.685***	1.727***	1.678***
	(0.034)	(0.035)	(0.035)	(0.035)	(0.035)
COVID-19*Digital	0.035***	0.038***	0.040***	0.036***	0.039***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Small	-1.331***	-1.304***	-1.358***	-1.303***	-1.348***
	(0.034)	(0.034)	(0.033)	(0.034)	(0.034)
Young	-0.383***	-0.391***	-0.245***	-0.365***	-0.244***
	(0.033)	(0.033)	(0.033)	(0.033)	(0.033)
Formal training		0.333***	0.425***	0.360***	0.425***
		(0.047)	(0.048)	(0.048)	(0.048)
Country FE			X		X
Industry FE				X	X
Observations	18,074	17,974	17,974	17,970	17,970
R-squared	0.404	0.407	0.429	0.414	0.434

Notes: This table shows the results from the estimation of equation 2, controlling for formal training. Column (1) replicates the baseline results with size and age controls. Column (2) introduces formal training as a control variable. Columns (3) to (5) product formal training as a control as well as country and industry fixed effects. Robust standard errors are reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 10: Digitalization and economic resilience - Workers' skills

Dependent variable: (log) sales					
	(1)	(2)	(3)	(4)	(5)
COVID-19	-0.170***	-0.144***	-0.143***	-0.143***	-0.143***
	(0.008)	(0.010)	(0.010)	(0.010)	(0.010)
Digital	1.793***	1.184***	1.062***	1.187***	1.066***
	(0.034)	(0.046)	(0.046)	(0.047)	(0.046)
COVID-19*Digital	0.035***	0.029*	0.036**	0.028*	0.036**
	(0.012)	(0.015)	(0.014)	(0.015)	(0.014)
Small	-1.331***	-0.769***	-0.739***	-0.794***	-0.723***
	(0.034)	(0.050)	(0.050)	(0.051)	(0.051)
Young	-0.383***	-0.251***	-0.086**	-0.230***	-0.081**
	(0.033)	(0.042)	(0.041)	(0.042)	(0.041)
Workers degree		0.644***	0.710***	0.635***	0.711***
		(0.026)	(0.027)	(0.026)	(0.027)
Country FE			X		X
Industry FE				X	X
Observations	18,074	8,692	8,692	8,692	8,692
R-squared	0.404	0.469	0.511	0.473	0.514

Notes: This table shows the results from the estimation of equation 2, controlling for workers' skills. Column (1) replicates the baseline results with size and age controls. Column (2) introduces formal workers' skills as a control variable. Columns (3) to (5) product workers' skills as a control as well as country and industry fixed effects. Robust standard errors are reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 11: Digitalization and economic resilience: Alternative digitalization index

Dependent variable: (log) sales									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
COVID-19	-0.222***		-0.240***	-0.240***	-0.264***	-0.256***	-0.255***	-0.254***	-0.255***
	(0.011)		(0.023)	(0.022)	(0.023)	(0.023)	(0.022)	(0.022)	(0.022)
Digital		2.235***	2.186***	1.743***	2.124***	1.710***	1.610***	1.740***	1.619***
		(0.088)	(0.090)	(0.085)	(0.089)	(0.084)	(0.082)	(0.085)	(0.083)
COVID-19*Digital			0.091***	0.078**	0.103***	0.086***	0.091***	0.083***	0.091***
			(0.033)	(0.031)	(0.035)	(0.032)	(0.031)	(0.031)	(0.031)
Small				-1.681***		-1.647***	-1.678***	-1.612***	-1.655***
				(0.080)		(0.080)	(0.078)	(0.082)	(0.079)
Young					-0.524***	-0.359***	-0.186**	-0.350***	-0.185**
					(0.088)	(0.081)	(0.082)	(0.081)	(0.082)
Country FE							X		X
Industry FE								X	X
Observations	3,624	3,624	3,624	3,624	3,624	3,624	3,624	3,624	3,624
R-squared	0.003	0.256	0.258	0.396	0.271	0.402	0.445	0.409	0.452

Notes: This table shows baseline results from the estimation of equation 2 with an alternative digital index. The latter consists of the use of emails and cellphones. Robust standard errors are reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 12: Digitalization and economic resilience - High contact-intensive sectors

Dependent variable: (log) sales									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
COVID-19	-0.177***	-0.144***	-0.165***	-0.172***	-0.182***	-0.187***	-0.186***	-0.187***	-0.186***
	(0.008)	(0.008)	(0.013)	(0.013)	(0.014)	(0.013)	(0.013)	(0.013)	(0.013)
Digital		1.982***	1.960***	1.563***	1.913***	1.529***	1.479***	1.522***	1.477***
		(0.056)	(0.056)	(0.054)	(0.056)	(0.053)	(0.053)	(0.054)	(0.053)
COVID-19*Digital			0.044**	0.046**	0.046**	0.047**	0.053***	0.047**	0.053***
			(0.022)	(0.021)	(0.022)	(0.021)	(0.020)	(0.021)	(0.020)
Small				-1.265***		-1.244***	-1.301***	-1.257***	-1.307***
				(0.055)		(0.055)	(0.054)	(0.055)	(0.055)
Young					-0.464***	-0.407***	-0.262***	-0.405***	-0.263***
					(0.055)	(0.051)	(0.050)	(0.051)	(0.050)
Country FE							X		X
Industry FE								X	X
Observations	6,758	6,758	6,758	6,758	6,758	6,758	6,758	6,758	6,758
R-squared	0.002	0.270	0.270	0.369	0.285	0.380	0.417	0.380	0.417

Notes: This table shows baseline results from the estimation of equation 2 focusing on two contact-intensive sectors: (i) Wholesale and retail and (ii) hospitality and tourism. Robust standard errors are reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 13: Digitalization and economic resilience - Low contact-intensive sectors

Dependent variable: (log) sales									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
COVID-19	-0.161***		-0.150***	-0.150***	-0.160***	-0.159***	-0.155***	-0.157***	-0.156***
	(0.006)		(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Digital		2.426***	2.403***	1.970***	2.375***	1.948***	1.918***	1.943***	1.905***
		(0.047)	(0.047)	(0.045)	(0.047)	(0.045)	(0.046)	(0.045)	(0.046)
COVID-19*Digital			0.042***	0.032**	0.037**	0.026*	0.029*	0.024	0.028*
			(0.016)	(0.015)	(0.016)	(0.015)	(0.015)	(0.015)	(0.015)
Small				-1.409***		-1.398***	-1.439***	-1.390***	-1.436***
				(0.044)		(0.044)	(0.044)	(0.044)	(0.044)
Young					-0.412***	-0.377***	-0.192***	-0.339***	-0.203***
					(0.046)	(0.043)	(0.044)	(0.043)	(0.044)
Country FE							X		X
Industry FE								X	X
Observations	11,316	11,316	11,316	11,316	11,316	11,316	11,316	11,312	11,312
R-squared	0.001	0.317	0.318	0.410	0.327	0.418	0.437	0.427	0.442

Notes: This table shows baseline results from the estimation of equation 2 focusing on non-contact intensive sectors: (i) Wholesale and retail and (ii) hospitality and tourism. Robust standard errors are reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 14: Digitalization and economic resilience - Employment

Dependent variable: (log) number of employees							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
COVID-19	-0.212***		-0.199***	-0.230***	-0.219***	-0.233***	-0.223***
	(0.023)		(0.035)	(0.032)	(0.032)	(0.031)	(0.031)
Digital		0.898***	0.851***	0.430***	0.544***	0.413***	0.531***
		(0.057)	(0.060)	(0.041)	(0.044)	(0.041)	(0.043)
COVID-19*Digital			0.073	0.070	0.061	0.075	0.065
			(0.053)	(0.049)	(0.049)	(0.048)	(0.048)
Small				-1.511***	-1.388***	-1.450***	-1.340***
				(0.045)	(0.044)	(0.044)	(0.044)
Young				-0.171***	-0.225***	-0.162***	-0.222***
				(0.047)	(0.047)	(0.047)	(0.047)
Country FE					X		X
Industry FE						X	X
Observations	2,752	2,752	2,752	2,752	2,752	2,750	2,750
R-squared	0.007	0.117	0.121	0.444	0.486	0.469	0.505

Notes: This table shows baseline results from the estimation of equation 2 using firm employment as the outcome variable. Robust standard errors are reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 15: Digitalization and economic resilience - Oxford Stringency Index

Dependent variable: (log) sales				
	(1)	(2)	(3)	(4)
COVID-19	-0.181***	-0.179***	-0.180***	-0.179***
	(0.008)	(0.008)	(0.008)	(0.008)
Digital	1.790***	1.752***	1.783***	1.743***
	(0.034)	(0.035)	(0.035)	(0.035)
COVID-19*Digital	0.034***	0.038***	0.032***	0.037***
	(0.012)	(0.012)	(0.012)	(0.012)
Small	-1.331***	-1.388***	-1.339***	-1.383***
	(0.034)	(0.033)	(0.034)	(0.034)
Young	-0.387***	-0.240***	-0.363***	-0.240***
	(0.033)	(0.033)	(0.033)	(0.033)
Country FE		X		X
Industry FE			X	X
Observations	18,074	18,074	18,070	18,070
R-squared	0.403	0.423	0.409	0.427

Notes: This table shows baseline results from the estimation of equation 2 using the Oxford Stringency Index to calibrate firms sales for missing observations. Robust standard errors are reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 16: Digitalization and economic resilience - Without Jordan

Dependent variable: (log) sales				
	(1)	(2)	(3)	(4)
COVID-19	-0.163***	-0.161***	-0.162***	-0.161***
	(0.008)	(0.008)	(0.008)	(0.008)
Digital	1.780***	1.736***	1.771***	1.728***
	(0.035)	(0.035)	(0.036)	(0.035)
COVID-19*Digital	0.057***	0.061***	0.056***	0.061***
	(0.012)	(0.012)	(0.012)	(0.012)
Small	-1.336***	-1.397***	-1.347***	-1.392***
	(0.035)	(0.034)	(0.035)	(0.035)
Young	-0.378***	-0.227***	-0.355***	-0.228***
	(0.033)	(0.034)	(0.033)	(0.034)
Country FE		X		X
Industry FE			X	X
Observations	17,400	17,400	17,396	17,396
R-squared	0.405	0.426	0.412	0.430

Notes: This table shows baseline results from the estimation of equation 2 while excluding Jordanian firms from our sample. Robust standard errors are reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 17: Digitalization and economic resilience - Excluding estimated drop in sales

Dependent variable: (log) sales									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
COVID-19	-0.616***		-0.619***	-0.586***	-0.643***	-0.608***	-0.653***	-0.617***	-0.654***
	(0.035)		(0.043)	(0.043)	(0.043)	(0.042)	(0.042)	(0.042)	(0.042)
Digital		2.273***	2.161***	1.852***	2.125***	1.823***	1.806***	1.809***	1.798***
		(0.063)	(0.060)	(0.059)	(0.060)	(0.058)	(0.060)	(0.058)	(0.060)
COVID-19*Digital			0.233***	0.192***	0.238***	0.197***	0.222***	0.205***	0.226***
			(0.063)	(0.060)	(0.063)	(0.060)	(0.060)	(0.060)	(0.059)
Small				-1.204***		-1.192***	-1.231***	-1.224***	-1.257***
				(0.060)		(0.060)	(0.061)	(0.060)	(0.061)
Young					-0.382***	-0.344***	-0.270***	-0.314***	-0.270***
					(0.063)	(0.059)	(0.063)	(0.059)	(0.063)
Country FE							X		X
Industry FE								X	X
Observations	4,990	4,990	4,990	4,990	4,990	4,990	4,990	4,987	4,987
R-squared	0.021	0.297	0.312	0.389	0.320	0.396	0.405	0.402	0.410

Notes: This table shows baseline results from the estimation of equation 2 while excluding firms for which we estimated the drop in sales. Columns (1) and (2) separately depict the correlation between firms' sales and the COVID-19 as well digitalization, respectively. Column (3) evaluates the joint effect of digitalization and COVID-19 on firm performance. Columns (4) to (6) introduces size and age controls. Columns (7) to (9) use country and industry fixed effects. Robust standard errors are reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

References

Acemoglu, D. and Restrepo, P. (2020). Financing the digitalisation of small and medium-sized enterprises. *Journal of Political Economy*, 128(6):2188–2242.

Acharya, V. and Steffen, S. (2020). The risk of being a fallen angel and the corporate dash for cash in the midst of covid. *NBER Working Paper 276018*.

Andrews, D., Criscuolo, C., and Gal, P. (2016). The global productivity slowdown, technology divergence and public policy: a firm level perspective. *OECD Productivity Working Papers 5*.

Apedo-Amah, M. C., Avdiu, B., Cirera, X., Cruz, M., Davis, E., Grover, A., Iacovone, L., Kilinc, U., Medvedev, D., Okechukwu Maduko, F., Poupakis, S., Torres, J., and Thu Tran, T. (2021). Unmasking the impact of covid-19 on businesses. *Policy Research Working Paper 9434*.

Autor, D. (2015). Why are there still so many jobs? the history and future of workplace automation. *Journal of Economic Perspectives*, 29(5):3–30.

Autor, D. (2019). Work of the past, work of the future. *American Economic Association: Papers and Proceeding*, 109(5):1–32.

Banerjee, R. N. and Kharroubi, E. (2020). The financial vulnerabilities driving firms to the exit. *BIS Quarterly Review*.

Bartel, A., Ichniowski, C., and Shaw, K. (2007). Thow does information technology affect productivity? plant-level comparisons of product innovation, process improvement, and worker skills. *Quarterly Journal of Economics*, 122(4):1721–58.

Beck, T., Flynn, B., and Homanen, M. (2020). Covid-19 in emerging markets: Firm-survey evidence. *Covid Economics, Vetted and Real-Time Papers 38*.

Bloom, N., Garicano, L., Sadun, R., and Van Reenen, J. (2014). The distinct effects of information technology and communication technology on firm organization. *Management Science*, 60(12):2859–2885.

Caldera-Sánchez, A., de Serres, A., Gori, F., Hermansen, M., and Röhn, O. (2016). Strengthening economic resilience: Insights from the post-1970 record of severe recessions and financial crises. *OECD Economic Policy Papers No.20*.

Cette, G., Nevoux, S., and Py, L. (2020). The impact of icts and digitalization on productivity and labor share: Evidence from french firms. *Banque de France Working Paper, 785*.

Charm, T., Coggins, B., Robinson, K., and Wilkie, J. (2020). The great consumer shift: Ten charts that show how us shopping behavior is changing. *Mckinsey&Company: Insights*.

Dai, M., Yotov, Y., and Zylkin, T. (2014). The macroeconomic impacts of digitalization in subsaharan africa: Evidence from submarine cables. *Economics Letters*, 122(2):321–325.

Demmou, L., Calligaris, S., Franco, G., Dlugosch, D., McGowan, M. A., and Sakha, S. (2021). Insolvency and debt overhang following the covid-19 outbreak: Assessment of risks and policy responses. *OECD Economics Department Working Papers No. 1651*.

Diez, F., Duval, R. A., Fan, J., Garrido, J., Kalemli-Ozcan, S., Maggi, C., and Pierri, N. (2021). Insolvency prospects among small-and-medium-sized enterprises in advanced economies: Assessment and policy options. *IMF Staff Discussion Notes, 002*.

EIB (2019). Financing the digitalisation of small and medium-sized enterprises. *European Investment Bank Report*.

Fairlie, R. (2020). The impact of covid-19 on small business owners: The first three months after social-distancing restrictions. *NBER Working Paper 27462*.

Gal, P., Nicoletti, G., Renault, T., Sorbe, S., and Timiliotis, C. (2019). Digitalisation and productivity: In search of the holy grail – firm-level empirical evidence from eu countries. *OECD Economics Department Working Papers, 1533*.

IMF (2021a). Global financial stability report, april 2021: Preempting a legacy of vulnerabilities. chapter 2: Nonfinancial sector: Loose financial conditions, rising leverage, and risks to macro-financial stability. *IMF, Global Financial Stability Report*.

IMF (2021b). Regional economic outlook, middle east and central asia, october 2021: Trade-offs today for transformation tomorrow. chapter 1: Regional developments and outlook: From crisis management to transformational recovery. *IMF, Regional Economic Outlook, Middle East and Central Asia*.

Newman, C., Rand, J., Talbot, T., and Tarp, F. (2015). Technology transfers, foreign investment and productivity spillovers. *European Economic Review*, 76(C):168–187.

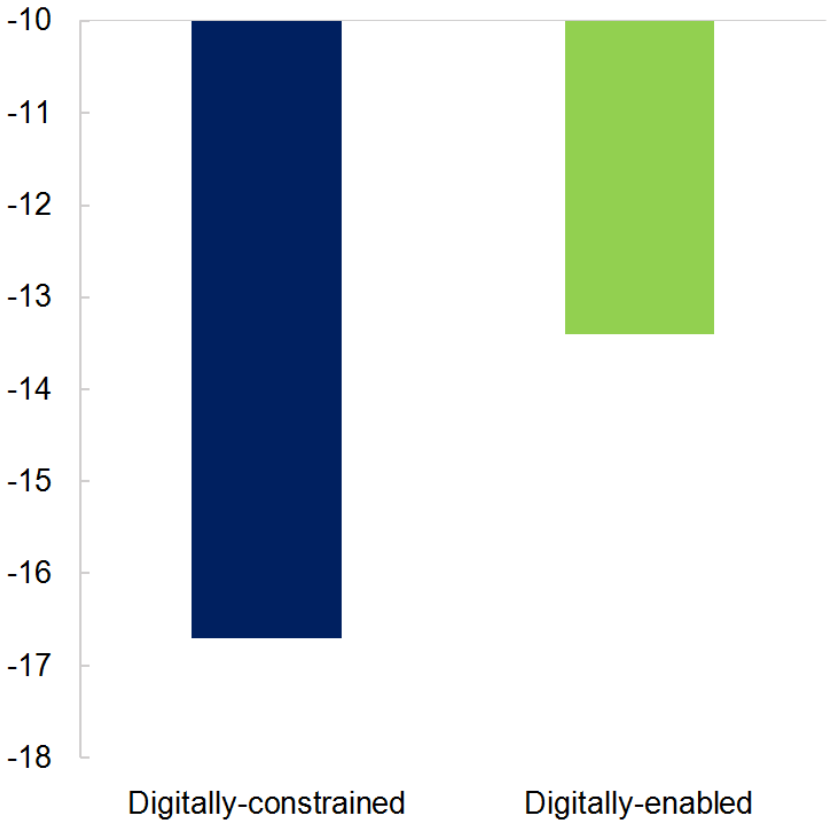
Pierri, N. and Timmer, Y. (2020). It shields:technology adoption and economic resilience during the covid-19 pandemic. *IMF Working Paper 20/208*.

Appendix

Table A1: Digital connectivity and control variables used from the BEEPS

Variable	Variable description
Website	Establishment Has Its Own Website
Foreign technology	Do You Use Technology Licensed From A Foreign-Owned Company?
Cellphone	Does this establishment currently use cell phones for the operations?
Email	Use e-mail to communicate with clients or suppliers?
New products	New Products/Services Introduced Over Last 3 Years
R&D	During Last Fiscal Year, Establishment Spent On R&D (Excl Market Research)?
Access to credit	Establishment Has A Line of Credit or Loan From A Financial Institution?
Optimism	Total sales expected to increase, decrease, or stay the same?
Foreign ownership	% Owned By Private Foreign Individuals, Companies or organizations
Formal training	Formal Training Programs For Permanent, Full-Time Employees In Last FY
Workers skills	Num. of Permanent Full-Time Employees At The End of FY Had A University Degree?
Management practices	Does the Firm have a Formalized Written Business Strategy?

Figure A1: Digitalization and firms sales
(Decline in sales in 2020 compared to 2019)



Source: BEEPS, ES COVID Survey, BPS, own calculations

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