Policy Research Working Paper 10949

Digitalization, Remote Work and Firm Resilience

Evidence from the COVID-19 Shock

Cristina Constantinescu
Arti Grover
Gaurav Nayyar

WORLD BANK GROUP
Prosperity Practice Group
Development Research Group &
International Finance Corporation
October 2024

Policy Research Working Paper 10949

Abstract

Using Business Pulse Survey data for 61 countries during the COVID-19 pandemic, this paper presents novel findings on remote work, enabled by digitalization, as a source of resilience for firms. The results suggest the following. First, firms in sectors with greater amenability to remote work experienced a smaller adverse impact of the pandemic in countries with better digital infrastructure. Second, these effects apply to both exporting and non-exporting firms. Third, there are differences across sectors. Among firms in the manufacturing sector, the benefits of remote work in countries with better digital infrastructure accrue more to exporters relative to non-exporters, thereby reflecting a premium to exporting. This exporting premium is not observed in the service sector, which largely comprises firms in non-knowledge intensive services in the sample. Fourth, the effects of the amenability to work remotely in countries with better digital infrastructure do not dissipate over time.

This paper is a product of the Office of the Chief Economist, Prosperity Practice Group, the Development Research Group, Development Economics, and the International Finance Corporation. It is part of a larger effort by the World Bank Group to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://www.worldbank.org/prwp. The authors may be contacted at agrover1@ifc.org; ineagu@worldbank.org; and gnayyar@worldbank.org. A verified reproducibility package for this paper is available at http://reproducibility.worldbank.org, click **here** for direct access.

Digitalization, Remote Work and Firm Resilience: Evidence from the COVID-19 Shock *

Cristina Constantinescu† Arti Grover‡ and Gaurav Nayyar§

JEL classification: D22, F14, L20, L25, O10.

Keywords: Digital, Remote work, Firms, Resilience, COVID-19, Trade

*The authors are immensely grateful to the many World Bank Group colleagues and counterpart institutions that have supported the Business Pulse Survey (BPS) data collection, without whom this work would not have been possible. Likewise, we thank the Enterprise Analysis Unit of the Development Economics Global Indicators Department of the World Bank Group for making the Enterprise Survey data available. We thank Gene Grossman, Mona Haddad, Denis Medvedev, Antonio Nucifora, Marcelo Olarreaga and Daria Taglioni for their guidance and strategic support of the BPS initiative, and the Umbrella Trade Trust Fund for financial support. We thank Yewon Choi, Shwetha Eapen, and Mauricio Latorre for their research assistance. The authors are also grateful to the following colleagues for their feedback at the concept stage of this project: Asya Akhlaque, Ana Fernandes, Caroline Freund, Mary Hallward-Driemeier, Leonardo Iacovone, Michele Ruta, Daria Taglioni, Gonzalo Varela and Erik von Uexkull. We thank Edgar Avalos and Jesica Torres for their contributions in the initial stages of the project and Arthur Johannes Giesberts for his generosity in sharing his tool for converting text variables into 4-digit industry codes. We thank Alvaro Espitia and co-authors of Espitia et al. (2021) for kindly sharing the remote work flexibility indicator and the output share of durable products by industry. The views expressed in this paper are solely those of the authors and do not necessarily reflect those of the World Bank, its Executive Directors, or the countries they represent.

†The World Bank; email: ineagu@worldbank.org

‡The World Bank; Corresponding author, email: agrover1@ifc.org

§The World Bank; email: gnayyar@worldbank.org

1. Introduction

The pandemic-induced economic crisis resulted from a chain reaction effect of global lockdowns imposed to contain the COVID-19 virus, which reverberated through demand, supply, logistics and uncertainty shocks around the world (Apedo-Amah et al., 2020). For firms, the use of digital technologies became a key pathway to mitigate the economic losses that resulted from these shocks.

There is ample evidence that illustrates the role of digitalization in improving the performance and resilience of firms during the COVID-19 pandemic. In a cross-country setting, Doerr et al. (2021) find that firms headquartered in jurisdictions with better digital infrastructure generated relatively higher revenue during the pandemic. The authors find that improving a country's digital technology capability by one standard deviation is associated with a relative increase in revenues of the average firm by around 4%. In the United States, Oikonomou et al. (2023) find that unemployment increased less in states with greater IT adoption before the pandemic. Similarly, Bellatin and Galassi (2022) find that cities in the United States with more job postings related to digital technologies before the pandemic were characterized by more jobs during the pandemic.

The relationship between digitalization and firm performance has also been analyzed using data on technology use at the industry- and firm-level. Using data from 24,000 firms in 75 countries, Copestake et al. (2022) find that firms in industries that are more digitalized experienced lower revenue losses following the COVID-19 recession. Using data from the Middle East and Central Asia region, Abrardi et al. (2022) find that digitally-enabled firms faced a lower decline in sales by about 4 percentage points during the pandemic compared to digitally-constrained firms. Cirera et al. (2022) use firm-level survey data from Brazil, Senegal, and Viet Nam to show that pre-COVID 19 digital technology sophistication helped firms mitigate the initial negative impact of the pandemic. Further, there is evidence that the COVID-19 shock accelerated the use of digital platforms and investment in digital solutions among businesses (Avalos et al., 2024), albeit more in economies with higher digital penetration before the pandemic (Cavallo et al., 2022).

There is also a burgeoning literature that focuses on the capability to work-from-home (WfH) as an implied link between digital technologies and the resilience of firms.[1] Firms with high pre-pandemic work-from-home feasibility fared significantly better during the COVID-19 pandemic in terms of sales, net incomes, and stock returns than their peers (Bai et al., 2020; Criscuolo et al., 2021; Angelici and Profeta, 2020; Zhang et al., 2022).

However, there is no systematic analysis that directly tests this mechanism, that is, whether and how digitalization affected firm resilience through remote work that allowed individuals to operate at physical distance during the pandemic. This is important for micro, small and medium enterprises (MSMEs), whose access to digital technologies in developing countries is rather limited.

There is also no systematic analysis on whether the positive effect of digitalization on firm resilience

[1] See for example Dingel and Neiman (2020); Kogan et al. (2020); Carletti et al. (2020); Acharya and Steffen (2020); Albuquerque et al. (2020); Altig et al. (2020); Bretscher et al. (2020); Tambe et al. (2020); Fahlenbrach et al. (2021); Ramelli and Wagner (2020); Mahmud et al. (2021).

through WfH practices may be further mediated by international trade. Some sectors that are most amenable to remote work are also least intensive in face-to-face interactions between producers and consumers, thereby making them more tradable internationally (Avdiu and Nayyar, 2020). Espitia et al. (2021) show that exporters in sectors that are more amenable to remote work were able to better mitigate the supply shock throughout the pandemic than exporters in other sectors. Similarly, Constantinescu et al. (2022) find that exporters in sectors more amenable to remote work experienced, on average, a decline in sales of 4 percentage points less than firms in sectors less amenable to remote work. These studies examine the importance of remote work on trade at an aggregate level or on a sample of firms trading in international markets. It is also possible that globally engaged firms have greater capabilities that facilitate implementation of remote work (Constantinescu et al., 2022) either through better management (Grover and Karplus, 2021) or technology readiness (Cirera et al., 2022).

Our work fills these gaps in the literature. *First*, it presents evidence of a specific mechanism by which digitalization affected firm resilience during the pandemic, thus providing a stronger test of causality. In doing so, we address a significant knowledge gap, particularly for MSMEs, as 66% of our sample belong to the group of micro or small firms (employing fewer than 10 individuals), while 23% are medium-sized firms (employing fewer than 50 individuals). *Second*, it examines the differential impact of this mechanism of remote work flexibility, enabled by digitalization, across exporters and non-exporters. *Third*, it distinguishes between the premium on remote work enabled by digital technologies derived from exporting, over and above the higher capabilities that help exporting firms self-select into global engagement and digital technologies that enable WfH.

Using four waves of Business Pulse Surveys (BPS) data for 61 countries during the COVID-19 pandemic, this paper presents novel findings on digitalization-enabled remote work as a source of resilience for firms. Our results suggest the following. *First,* firms in sectors with greater amenability to remote work experienced a smaller adverse impact of the pandemic in countries with better digital infrastructure. *Second,* these effects were larger, but not statistically significantly larger, for globally engaged firms vis-á-vis the domestically oriented firms. *Third,* while the benefits of remote work in countries with better digital infrastructure accrue to both exporting and non-exporting firms, exporters in the manufacturing sector benefit more, thereby reflecting a premium to exporting, per se. These results are not observed in the services sectors, which in our sample primarily comprise firms in non-knowledge intensive services. *Fourth,* the effects of the amenability to work remotely in countries with better digital infrastructure do not dissipate over time.

Our paper contributes to the literature on shocks and economic resilience. This spans the role of technology use, trade policy, and access to finance across previous crises. On technology, firms with higher levels of technological readiness performed better during the pandemic (Bai et al., 2020; Cirera et al., 2022; Muzi et al., 2022). Similarly, technologically diversified firms, measured by patents in different technologies, are less affected by natural disasters (Hsu et al., 2018). On trade policy, Cali et al. (2023) show that non-tariff barriers affected the ability of Indonesian exporters to respond to foreign demand shocks driven by a depreciation of the Chinese yuan. On finance, the

resilience and recovery of firms during the 2009 global financial crisis was closely associated with access to credit and trade finance (Ahn et al., 2011; Amiti and Weinstein, 2011; Chor and Manova, 2012; Crozet et al., 2022).

Our paper also contributes to the literature that supports the benefits of remote work. In a meta-analysis of empirical studies on the topic, Martin and MacDonnell (2012) find a positive relationship between telework and organizational outcomes, including productivity, retention, organizational commitment, and performance within the organization. In a randomized controlled trial of 1,612 graduate engineers, marketing and finance employees in a large technology firm in China, Bloom et al. (2022) find that hybrid WfH has reduced attrition by 33% and improved job satisfaction measures. Using earlier experimental data for the same large technology firm in China, Bloom et al. (2015) find that home-based work led to an increase in performance by 13 percent, of which about 9 percent was from working more minutes per shift (fewer breaks and sick-days) and 4 percent from more calls per minute (attributed to a quieter working environment). Using data from over 200 million U.S. job postings, Bai et al. (2020) find that firms with high pre-pandemic WFH feasibility had significantly higher sales, net incomes, and stock returns than their peers during the pandemic.

Lastly, our paper contributes to the literature that analyzes the uneven impact of the COVID-19 crisis on the private sector, with persistent negative consequences for specific types of countries, sectors and firms. For example, the heterogeneous effects observed are based on certain country characteristics such as income, region, severity of lockdown and feasibility to work remotely (Dingel and Neiman, 2020; de Lucio et al., 2020) or sector attributes such as contract intensity, amenability to remote work, GVC intensity, intensity of durable products in output, dependence on external finance, reliance on letters of credit, product skill labor intensity and product complexity (Bas et al., 2022; Constantinescu et al., 2022; Crozet et al., 2022; Espitia et al., 2021). Among firm characteristics that matter, some are external attributes, such as size (Bricongne et al., 2012; Cirera et al., 021a), global engagement (Constantinescu et al., 2022; de Lucio et al., 2022), and intensity of GVC participation (Constantinescu et al., 2022; Borino et al., 2021; Brucal et al., 2021; de Lucio et al., 2022; Hyun et al., 2020), while others are internal traits such as management capabilities (Grover and Karplus, 2021; Hyun et al., 2020; Brucal et al., 2021; Borino et al., 2021) and pre-crisis digital readiness (Cirera et al., 2022; Constantinescu et al., 2022).

The rest of the paper is organized as follows. Section 2 describes the data. Section 3 specifies the empirical strategy. Section 4 presents the results. Section 5 concludes.

2. Data and Descriptive Statistics

Our work combines data from the World Bank Business Pulse Surveys (BPS) and the COVID-19 follow-up of the World Bank Enterprise Surveys (WBES) for the (almost) two years between April 2020 and September 2021. Since the onset of the pandemic, these surveys have been monitoring the impact of the pandemic on the private sector across the world on critical dimensions of business performance, such as sales. For most countries, the sampling frame for the BPS was based on firm censuses from Statistics Agencies or business listings from Ministries of Finance or Economy and

Business Associations. Additional details on the survey methodology are offered in Apedo-Amah et al. (2020); Cirera et al. (021b); and Cirera et al. (021a). For the WBES COVID-19 follow-up surveys, see for example Muzi et al. (2022).

Our sample covers 68,007 firm-level observations from 61 countries. The list of countries and the number of firms sampled in each country is presented in Appendix Table A1.[2] Small, medium-sized, and large firms, respectively, account for 6%, 23%, and 11% of the sample. And 19.3 % of firms in the sample are exporters. The sectoral distribution is skewed towards the non-agricultural sector that comprises 94% of firms in the sample (32% in manufacturing, 8% in hospitality services, 32% in retail services, 3% in knowledge -intensive services, and 19% in other services) (see Appendix Table A2).

We measure the amenability for remote work by the fraction of occupations that can be performed remotely in the U.S. computed in Espitia et al. (2021) using the 2017 O*NET data. This measure of amenability is computed at the level of both 2-digit and 4-digit sectors in the International Standard Industrial Classification (ISIC). The WBES already includes the 2-digit and 4-digit sector identifiers for each firm in the sample. For the BPS, we use the 2-digit and 4-digit ISIC identifiers obtained by Constantinescu et al. (2022) using the description of the economic activity for each business collected by the enumerator.[3] At the 2-digit ISIC level, the amenability to remote work ranges from 14% in crop and animal production and 32% in the manufacture of wearing apparel to 71% in computer programming services and 72% in financial services (see Appendix Table A3).

We measure internet penetration at the country level by the fraction of the population using the internet as well as by the number of secure internet servers per 1 million people for 2019 (or the latest year available before the pandemic).The share of individuals using the internet ranged from 15.0% in Madagascar and 16.5% in Mozambique to 89.9% in the Slovak Republic and 90.8 % in Cyprus. Similarly, the number of secure internet servers per 1 million people ranged from 3 in Burkina Faso and 8 in Madagascar to 83,313 in Estonia and 56,187 in Czechia (see Appendix Table A4). We measure the severity of the pandemic across countries and over time using data from Google mobility reports around transit stations (Google, 2021). For countries without available data, we impute the severity based on the Oxford Government Response Tracker index (Hale et al., 2021) following Apedo-Amah et al. (2020).

In countries among the top 5% in terms of digital infrastructure (% of the population using the internet), firms in sectors with greater amenability to remote work experienced a smaller decline in sales (Figure 1). However, in countries among the bottom 5% in terms of digital infrastructure, there is no clear relationship between greater amenability to remote work and the change in firms' sales (Figure 2).

[2]The sample includes 43,389 panel businesses, which were interviewed more than once in the 2-year span.

[3]The algorithm for allocating a 2-digit or 4-digit ISIC sector to each firm based on the firm's main activity has been developed by Giesberts and Eapen (2022) and facilitates a fast, high-quality and, in great part, automatic ISIC assignation to text from multiple languages.

Figure 1: Percentage change in sales and remote work intensity - countries with highest digital infrastructure

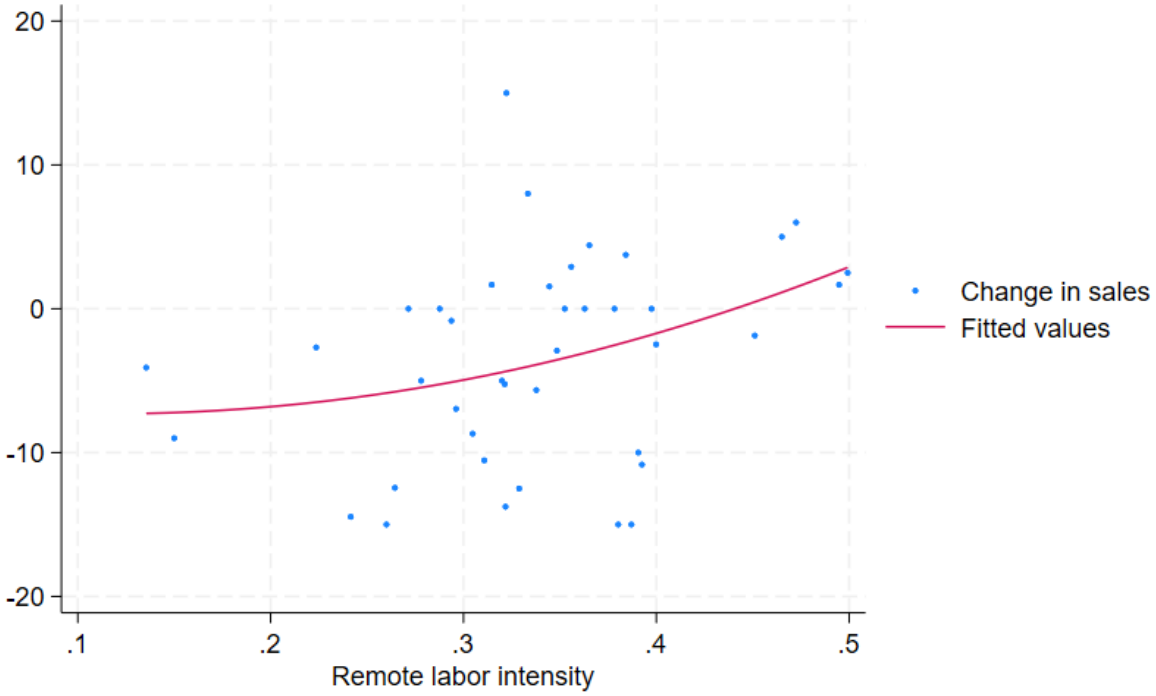
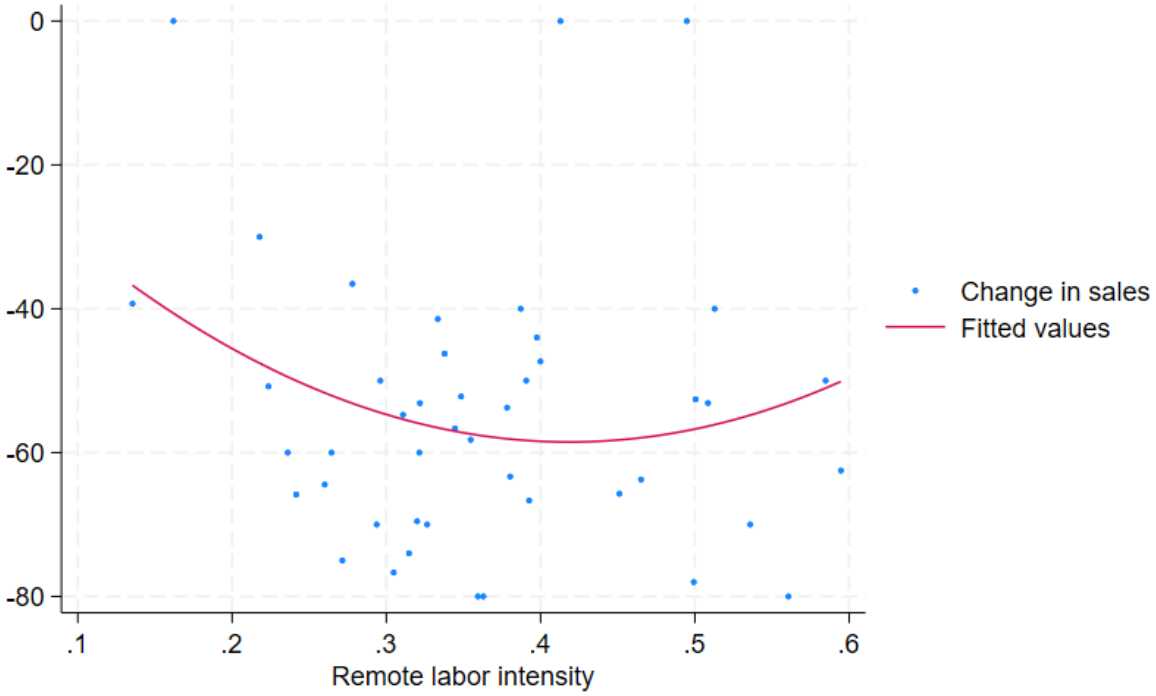


Figure 2: Percentage change in sales and remote work intensity - countries with lowest digital infrastructure



3. Empirical Strategy

During the pandemic, WfH practices helped firms overcome constraints of social distancing through digital solutions that substituted for face-to-face interactions. So, the development of digital infrastructure should disproportionately help firms (or industries) more amenable to remote working arrangements. To assess this effect, we exploit the variation in firm sales across sectors with different amenability to remote work, and across countries with different levels of internet penetration. In other words, we assess whether firms in sectors with higher feasibility to work remotely were more resilient during the pandemic in countries with higher levels of internet penetration. In doing so, we examine the interaction between internet penetration by country and remote flexibility by sector in a regression explaining changes in sales by firm during the pandemic period. This is helpful because it looks for evidence of a specific mechanism by which digitalization affects firm resilience, thereby providing a stronger test of causality.

This approach was successfully applied in Rajan and Zingales (1998) - to show that industries dependent on external finance grow faster in countries with higher financial development - and in subsequent contributions to the financial development literature (Beck, 2003; Fisman and Love, 2003, 2007; Beck and Demirgüç-Kunt, 2008; Hur et al., 2006; Manova, 2008, 2013). This approach has also been applied to analyze topics as diverse as the linkages between property rights and growth, firm entry costs and firm creation, contract enforcement and comparative advantage, uncertainty aversion and growth, road networks and trade, and digital infrastructure and trade (Claessens and Laeven, 2003; Claessens and Klapper, 2005; Levchenko, 2007; Nunn, 2007; Jaimovich, 2019; Paunov, 2016; Fernandes et al., 2019).

Our specification is as follows:

$$Y_{isct} = \alpha + \beta_1 size_{it} + \beta_2 mobility_{ct} + \gamma \left[remote_s * internet_c\right] + \delta_s + \delta_c + \delta_t + \epsilon_{isct}. \qquad (1)$$

Y_{isct} denotes, for firm *i* in sector *s* and country *c*, the reported percent change in sales, 30 days prior to the interview at time *t*, relative to the same period in 2019. $Size_{ict}$ denotes the size of the firm (log of the number of employees); $mobility_{ct}$ gauges the country-specific severity of the shock through the average mobility around transit stations 30 days prior to the interview as measured in the Google mobility reports (Google, 2021). The amenability of remote work at the 4-digit sector level is denoted by $remote_s$ while $internet_c$ denotes internet penetration at the country level.[4] We include fixed effects for 2-digit sectors δ_s and country fixed effects δ_c to correct for potentially omitted country and sector specific time-invariant covariates. We also include quarter fixed effects δ_t (April-June 2020, July-September 2020, etc.) to capture the changing severity of the shock.

We estimate equation 1 by least squares for exporters and non-exporters, together and separately, to compare estimates of the coefficient γ across samples. Since sampling weights are not consistently available across data sets, we weight the estimates using the inverse of the number of observations

[4] Both enter the regression as z-scores.

in each country.

We then introduce a triple interaction term between amenability of remote work at the sector level, internet penetration at the country level, and an exporter dummy variable at the firm level. This helps establish whether or not there is an exporter premium on the effect of a country's digital infrastructure on firm performance, conditional on a sector's amenability to remote work.

4. Results

This section presents the baseline results, robustness of those results and the heterogeneity in the effects.

4.1 Baseline specification

The results from estimation of equation (1) presented in Table 1 show that firms in sectors more amenable to remote working experienced, on average, a more resilient sales performance during the pandemic in countries with better digital infrastructure compared to other countries, when controlling for country and sector fixed effects. For the full sample, the interactions between the amenability of remote work at the sector-level (measured as the share of remote workers) and the country-level quality of digital infrastructure (measured as the percentage of population using the internet) yields a positive and statistically significant coefficient of 0.979 for the change in firms' sales (Table 1, column 1).[5]

Table 1: **Change in Sales**

	Full	Exporters	Non-Exporters	Full
	(1)	(2)	(3)	(4)
Exporter				1.739***
				(0.550)
WfH x digital infra.	0.979***	1.607**	0.923***	0.980***
	(0.254)	(0.626)	(0.280)	(0.278)
WfH x digital infra. X exporter				0.076
				(0.605)
Country F.E.	Yes	Yes	Yes	Yes
Sector F.E.	Yes	Yes	Yes	Yes
R-squared	0.262	0.308	0.241	0.262
Observations	68,007	13,145	54,862	68,007

The F-stat testing the equality of coefficients in columns 2 and 3 is 0.998, with p value 0.318.
Estimations also control for (log) firm's size, quarter F.E, and Google's Mobility index. Estimations are weighted using country weights.
Standard errors in parentheses. Significance levels ***, **, and *, correspond to p<0.01, p<0.05, p<0.1, respectively.
The amenability of remote work and internet use/penetration do not enter the regression individually because the former are absorbed in sector fixed-effects and the latter in country fixed-effects.

Notably, both exporting and non-exporting firms in sectors that are amenable to remote work enjoy a premium in countries with larger penetration of internet users (columns 2 and 3 in Table 1) although the coefficient is smaller for the latter. This is consistent with the evidence that even when remote work is feasible in a given sector, the drop in sales was 6%-7% higher for non-exporters compared with exporters (Constantinescu et al., 2022). However, the difference in this coefficient across the samples of exporters and non-exporters is not statistically significant.

[5]The amenability of remote work and internet use/penetration enter the regression individually because the former are absorbed in sector fixed-effects and the latter in country fixed-effects.

It is possible that the larger coefficient on the interaction term for the exporter sample is driven by stronger firm capabilities associated with exporters.[6] During the pandemic, although all firms invested extensively in digital technologies to enable WfH among other things, the larger, innovative or globally engaged firms have invested relatively more (Bellmann and Hübler, 2021; Riom and Valero, 2020; Constantinescu et al., 2022). To test the differences between exporters and non-exporters, we combine the sample and run the model with the triple interaction between sectoral amenability to remote work, digital infrastructure at country level, and an exporter dummy. The triple interaction term is not statistically significant (Table 1, column 4). The exporter dummy is itself statistically significant. This suggests that the larger effect on sales for exporters, relative to non-exporters, in sectors more amenable to remote work and in countries with greater internet penetration reflects their better capabilities.

In terms of magnitude, the benefits on trade from working remotely are considerably larger in countries with good internet infrastructure. For instance, the baseline regression reported in Table 1, column 4, suggests that the gap between the average sales decline of exporting firms in apparel manufacturing (a sector in the 25th percentile for remote flexibility) and the smaller average sales decline of exporting firms in computer programming and related services (a sector in the 75th percentile for remote flexibility) is 7.4 percentage points wider in Zambia (a country in the 25th percentile for internet usage) compared to Latvia (which is in the 75th percentile for internet usage).[7] The impact is also economically meaningful, accounting for about 50 percent of the mean difference between the average changes in the sales of the exporting firms in the two sectors, across the countries in the sample.

4.2 Robustness checks

4.2.1 Measuring remote work and internet penetration

We test the robustness of our measures for remote work and digital penetration. A qualitatively similar set of results holds when internet penetration is measured by the number of secure internet servers per 1 million people (Table 2, column 1), although the coefficient is smaller compared to the baseline specification in Table 1.

The gap between the average decline in sales of exporting firms in apparel manufacturing (a sector in the 25th percentile of the remote flexibility measure) and the relatively smaller average sales decline of exporting firms in computer programming and related services (a sector with remote flexibility level in the 75th percentile) is wider by 2.3 percentage points in Zambia (a country in the 25th percentile of the share of population using internet), compared to Latvia (which is in the 75th percentile of the same measure). The impact is again economically meaningful, accounting for

[6] Evidence suggests that firms with better management practices and technology use tend to cope better than others during periods of turmoil (Grover and Karplus, 2021; Cirera et al., 021a), and it is usually the globally engaged firms that have stronger capabilities (Grover and Torre, 2019; Tanaka, 2020), stronger technology readiness (Bustos, 2011) and higher levels of productivity (Melitz, 2003).

[7] The 7.4 percentage point difference is calculated as the product of three factors: the effect of the interaction between remote flexibility and internet penetration for exporting firms (1.056=.980+.076); the difference between the flexibility measures of the two sectors (2.587, z-score based); and the difference between the internet penetration of the two countries (2.719, z-score based). This calculation is necessary because the interaction coefficients alone do not give the magnitude of the impact on trade, although they do indicate its direction and significance.

Table 2: **Alternative measures of remote work and internet penetration**

Panel A. Internet Servers

	Full	Exporters	Non-Exporters	Full
	(1)	(2)	(3)	(4)
Exporter				1.698***
				(0.559)
WfH x digital infra.	0.644***	1.072***	0.590**	0.707***
	(0.186)	(0.336)	(0.237)	(0.237)
WfH x digital infra. x exporter				−0.090
				(0.353)
Country F.E.	Yes	Yes	Yes	Yes
Sector F.E.	Yes	Yes	Yes	Yes
R-squared	0.260	0.307	0.239	0.261
Observations	65,742	12,910	52,832	65,742

The F-stat testing the equality of coefficients in columns 2 and 3 is 1.375, with p value 0.241.
Estimations also control for (log) firm's size, quarter F.E, and Google's Mobility index. Estimations are weighted using country weights. Standard errors in parentheses. Significance levels ***, **, and *, correspond to p<0.01, p<0.05, p<0.1, respectively.

Panel B. Remote work defined at granular sector level

	Full	Exporters	Non-Exporters	Full
	(1)	(2)	(3)	(4)
Exporter				1.930***
				(0.577)
WfH x digital infra.	1.956***	3.065***	1.898***	1.945***
	(0.441)	(1.054)	(0.500)	(0.480)
WfH x digital infra. x exporter				0.220
				(0.759)
Country F.E.	Yes	Yes	Yes	Yes
Sector F.E.	Yes	Yes	Yes	Yes
R-squared	0.267	0.312	0.245	0.267
Observations	63,126	12,180	50,946	63,126

The F-stat testing the equality of coefficients in columns 2 and 3 is 1.001, with p value 0.317.
Estimations also control for (log) firm's size, quarter F.E, and Google's Mobility index.
Estimations are weighted using country weights.
Standard errors in parentheses. Significance levels ***, **, and *, correspond to p<0.01, p<0.05, p<0.1, respectively.
The amenability of remote work and internet use/penetration do enter the regression individually because the former are absorbed in sector fixed-effects and the latter in country fixed-effects.

about 15 percent of the mean difference between the average changes in the sales of the exporting firms in the two sectors (based on the coefficients reported in Table 2, Panel A, column 4).

The positive and statistically significant coefficient on the interaction between remote work and digital penetration also holds when the amenability to remote work variable is defined at the 4-digit level of classification. (Table 2, Panel B).

4.2.2 Endogeneity

Reverse causality is less of a concern in our empirical specification because our interaction variables remote work and digital infrastructure, respectively defined at the sector and country levels, are exogenous to individual firm performance.

However, omitted variable bias might still be a concern, that is, if additional explanatory variables that vary both with industry and country are correlated with the interaction between amenability to

remote work and digital penetration. We, therefore, include average firm sales by industry in each country as an additional regressor. The interaction between the share of remote workers and the share of the population using the internet remains positive and statistically significant. Here too, the coefficient is larger for exporters relative to non-exporters and the triple interaction with the exporter dummy is not statistically significant (See Table 3, Panel A).

Table 3: **Robustness checks**

Panel A. Check for omitted variable bias

	Full	Exporters	Non-Exporters	Full
	(1)	(2)	(3)	(4)
Exporter				1.502***
				(0.547)
WfH x digital infra.	0.852***	1.335**	0.802***	0.906***
	(0.262)	(0.619)	(0.300)	(0.295)
WfH x digital infra. x exporter				−0.146
				(0.603)
Log (Av. sales by country-sector)	0.614***	0.433**	0.633***	0.604***
	(0.097)	(0.221)	(0.108)	(0.097)
Country F.E.	Yes	Yes	Yes	Yes
Sector F.E.	Yes	Yes	Yes	Yes
R-squared	0.272	0.312	0.249	0.272
Observations	56,548	12,710	43,838	56,548

The F-stat testing the equality of coefficients in columns 2 and 3 is 0.600, with p value 0.439.

Panel B. Check for human capital as confounding factor

	Full	Exporters	Non-Exporters	Full
	(1)	(2)	(3)	(4)
Exporter				1.769***
				(0.575)
WfH x digital infra.	0.857**	0.717	0.848**	0.818**
	(0.363)	(0.940)	(0.383)	(0.377)
WfH x digital infra. x exporter				0.215
				(0.663)
Country schooling years x Sh. remote workers	0.046	0.447**	−0.003	0.050
	(0.095)	(0.228)	(0.103)	(0.096)
Country F.E.	Yes	Yes	Yes	Yes
Sector F.E.	Yes	Yes	Yes	Yes
R-squared	0.267	0.314	0.243	0.267
Observations	61,995	12,490	49,505	61,995

The F-stat testing the equality of coefficients in columns 2 and 3 is 0.016, with p value 0.898.

Panel C. Digitalization as proxy for frontier industry maturity

	Full	Exporters	Non-Exporters	Full
	(1)	(2)	(3)	(4)
Exporter				1.804***
				(0.551)
WfH x digital infra.	−0.367	2.334**	−1.004**	−0.394
	(0.431)	(1.086)	(0.469)	(0.431)
WfH x digital infra. x exporter				−0.119
				(0.613)
Log(GDP per capita) x Sh. remote workers	1.319***	−0.654	1.958***	1.389***
	(0.376)	(0.785)	(0.440)	(0.383)
Country F.E.	Yes	Yes	Yes	Yes
Sector F.E.	Yes	Yes	Yes	Yes
R-squared	0.262	0.308	0.241	0.262
Observations	68,007	13,145	54,862	68,007

The F-stat testing the equality of coefficients in columns 2 and 3 is 0.769, with p value 0.005. Estimations also control for (log) firm's size, quarter F.E, and Google's Mobility index. Estimations are weighted using country weights.

Standard errors in parentheses. Significance levels ***, **, and *, correspond to p<0.01, p<0.05, p<0.1, respectively.

The amenability of remote work and internet use/penetration do enter the regression individually because the former are absorbed in sector fixed-effects and the latter in country fixed-effects.

Another concern is whether the amenability to remote work or digital penetration is a proxy for some other related factors. In principle, there may be several determinants of firm performance that are correlated with firms' dependence on remote work and digital penetration. We rule out two such possibilities below. First, industries that are more amenable to remote work – financial and business services, for example – could also be relatively more intensive in the use of human capital. To the extent that digital penetration and the availability of human capital are correlated, the observed interaction between amenability to remote work and digital penetration may proxy for the interaction between human capital dependence and the availability of trained human capital. We therefore include an interaction term between the industry's amenability to remote work and a measure of the country's stock of human capital proxied by average years of schooling in population over the age of 25.

In the full sample, the coefficient on the human capital interaction term is small and not statistically significant, while the digital penetration interaction remains positive and statistically significant (see Table 3, Panel B, column 1). These results are mostly driven by non-exporters (Table 3, Panel B, column 3), while the coefficient for exporters is insignificant. (Table 3, Panel B, column 2). The latter is not surprising, given the evidence on a positive association between the share of white collar, skilled employees and exporting (Bernard and Jensen, 2004); as a result, interacting human capital with the share of remote workers absorbs the distinct effects coming from exporters. Overall, these results are consistent with the finding that digital penetration is not a proxy for the industry's dependence on human capital.

Another possibility is that greater amenability to remote work in advanced economies simply reflects the greater maturity of the industry. And since developing countries are more likely to have lower levels of digital penetration, the interaction effect may simply reflect the maturity of technological development in advanced economies. We therefore test if digital penetration is a proxy for frontier industry maturity by including additional interaction term between the industry's amenability to remote work and a country's log of per capita GDP. The coefficient on the interaction between amenability to remote work and digital penetration is now close to zero and not statistically significant (Table 3, Panel C, column 1). However, the coefficient on this interaction term is positive and statistically significant only for the sample of exporters (Table 3, Panel C, column 2). This is expected, given the spatial concentration of digital infrastructure and of exporters, both in dense and developed parts of the countries. For non-exporters, our previously observed effects are absorbed by the interaction term with GDP per capita suggesting that their benefits from digital penetration is perhaps correlated with broader development.

4.3 Heterogeneous effects

The importance of digital connectivity and remote work in lending resilience to firms varies across sectors. In the manufacturing sector, the coefficient on the interaction term between amenability to remote work and the digital infrastructure is statistically significant for exporters and non-exporters, with the coefficient being larger for exporters (Table 4, Panel A, columns 2 and 3). The triple interaction is also positive and statistically significant (Table 4, Panel A, column 4), thereby suggesting

that there is a premium to exporting per se. Thus, for manufacturers, the benefit from opportunities in sectors amenable to remote work located in countries with better internet penetration is higher for exporters relative to non-exporters. For firms in the services sector, the triple interaction term is not statistically significant. In fact, the coefficient on the interaction term between amenability to remote work and internet penetration is statistically significant only for the sample of non-exporters. Only around 10% of services sector firms in the sample are exporters (Table 4, Panel B).[8]

Table 4: **Heterogenous effects, by sector**

Panel A. Manufacturing

	Full	Exporters	Non-Exporters	Full
	(1)	(2)	(3)	(4)
Exporter				3.230***
				(0.950)
WfH x digital infra.	2.966***	5.172***	2.331**	1.465*
	(0.836)	(1.710)	(0.954)	(0.882)
WfH x digital infra. x exporter				4.553***
				(1.466)
Country F.E.	Yes	Yes	Yes	Yes
Sector F.E.	Yes	Yes	Yes	Yes
R-squared	0.282	0.303	0.245	0.284
Observations	21,628	6,956	14,672	21,628

The F-stat testing the equality of coefficients in columns 2 and 3 is 2.104, with p value 0.147
Estimations also control for (log) firm's size, quarter F.E, and Google's Mobility index. Estimations are weighted using country weights. Standard errors in parentheses. Significance levels ***, **, and *, correspond to p<0.01, p<0.05, p<0.1, respectively.

Panel B. Services (excluding hospitality)

	Full	Exporters	Non-Exporters	Full
	(1)	(2)	(3)	(4)
Exporter				0.860
				(0.798)
WfH x digital infra.	0.793**	0.078	1.104**	0.995**
	(0.401)	(0.958)	(0.446)	(0.436)
WfH x digital infra. x exporter				−0.907
				(0.784)
Country F.E.	Yes	Yes	Yes	Yes
Sector F.E.	Yes	Yes	Yes	Yes
R-squared	0.255	0.330	0.240	0.255
Observations	37,106	5,194	31,912	37,106

The F-stat testing the equality of coefficients in columns 2 and 3 is 0.945, with p value 0.331
Estimations also control for (log) firm's size, quarter F.E, and Google's Mobility index.
Estimations are weighted using country weights.
Standard errors in parentheses. Significance levels ***, **, and *, correspond to p<0.01, p<0.05, p<0.1, respectively.

Our data also provides indicative evidence that the benefits of digitalization on firms' sales in sectors that are more amenable to remote work have not dissipated since the pandemic started. The coefficient on the interaction between amenability to remote work and digital infrastructure (whether the share of internet users or the number of secure internet servers per 1 million people) (Table 5) is consistently positive and significant after the first quarter April-June 2020 until April-September 2021. This stands in contrast to a study on German firms which finds the impact of regional differences in digital capital endowment and WfH on local employment to be larger in the short-run. After the

[8]Hospitality services firms were excluded from the sample of Table 4, Panel B, due to the lower prevalence of exporters (6.7% compared to 13.6% or higher in other service categories). If these firms are included, the triple interaction term is negative and statistically significant at the 10% level of significance. This may reflect extended travel restrictions, which persisted long after the lifting of lockdowns, and disproportionately affected hospitality firms dependent on foreign visitors.

relaxation of the first lockdown restrictions in Germany, a region's WfH potential did not matter for its employment outcomes, even if remote work remained a common practice (Arntz et al., 2022). The difference in our results from that observed in Germany (acknowledging that the outcome variable and data are different) is suggestive that while WfH via digital adoption among firms in developing countries was possibly boosted by the COVID-19 shock, it may have still been below the optimal level such that the returns to WfH continued through all periods in our database.

Table 5: **Heterogenous effects, by time**

	Internet Users			**Internet Secure Servers**		
	Full	Exporters	Non-Exporters	Full	Exporters	Non-Exporters
	(1)	(2)	(3)	(4)	(5)	(6)
Sh. remote workers x Internet x Apr-Jun '20	1.175	2.096	1.098	0.405	1.723	−0.103
	(0.781)	(1.888)	(0.848)	(0.846)	(1.529)	(1.008)
Sh. remote workers x Internet x Jul-Sep '20	2.704***	2.974***	2.545***	1.555***	1.079	2.022***
	(0.557)	(1.148)	(0.637)	(0.435)	(0.693)	(0.549)
Sh. remote workers x Internet x Oct '20-Mar '21	1.476***	1.609**	1.579***	0.417*	1.116***	0.178
	(0.415)	(0.695)	(0.481)	(0.227)	(0.303)	(0.321)
Sh. remote workers x Internet x Apr-Sep '21	2.088***	3.058*	1.760***	2.344**	3.336**	1.677
	(0.579)	(1.711)	(0.605)	(1.022)	(1.630)	(1.224)
Country F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Sector F.E.	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.155	0.221	0.135	0.158	0.222	0.137
Observations	61,951	11,622	50,329	59,886	11,412	48,474

Estimations also control for (log) firm's size, round F.E, and Google's Mobility index. Estimations are weighted using country weights.

The sample only includes country-quarters with more than 100 observations.

Standard errors in parentheses. Significance levels ***, **, and *, correspond to p<0.01, p<0.05, p<0.1, respectively.

5. Conclusion

This paper provides novel evidence on the benefits of digitalization, through the remote work channel, on firms' resilience during the pandemic. While there is literature on the benefits of remote work on trade, our analysis finds that both exporters and non-exporters benefit in a way that is not significantly larger for exporters. However, there are some differences between the manufacturing and services sectors. In the manufacturing sector, a positive and significant triple interaction between country-level digital infrastructure quality, sector-level amenability to remote work, and firm-level global engagement suggests a premium to exporting in explaining firms' resilience to shocks. By comparison, services firms, mostly in the non-knowledge intensive sector, do not get this additional kick from exporting when faced with shocks. Furthermore, the benefits of digital adoption through the WfH channel remained persistent through the duration of the pandemic and were not contingent on the definition of digital infrastructure penetration at the country-level or the granularity of the sector for defining remote work amenability.

These findings have policy implications for addressing adaptation to shocks. Public support to firms can be targeted to the most affected sectors where a viable solution for introducing flexibility can be introduced. In the case of the pandemic, these were sectors with high amenability to remote work where firms could be trained for technologies (e.g., digital) and practices (e.g., human resources management) that would facilitate remote working arrangements.[9] Building capabilities at the firm-, sector- and country-level to respond to shocks matters. Boosting investments in (digital) infrastructure and supporting the development of firm capabilities through solving information failures and financial constraints in order to facilitate technology adoption could also help prepare for future shocks. To the extent that there is an export premium for digital adoption that enables WfH practices in the manufacturing sector, export promotion policies that provide information, skills and technology for facilitating remote working arrangements can help exporters mitigate the adverse impacts of economic shocks and contribute to a more resilient recovery. For example, Choi et al. (2023) find that trade promotion organizations (TPOs) heightened their efforts to support both the non-exporters and non-exporters through e-commerce type of training programs across sectors.

The identification of other channels, such as online sales and e-commerce, through which the adoption of digital technologies can boost the resilience of firms would be an important extension of this work. Related research in the future can also focus on the many benefits that WfH practices had during the pandemic and beyond. This includes productivity growth and sustainability in the context of the green and digital transitions.

[9] Sectors with low amenability to remote work would likely need a different type of intervention in a shock that requires physical distancing.

References

Abrardi, L., E. Grinza, A. Manello, and F. Porta (2022). Work from home arrangements and organizational performance in italian smes: Evidence from the covid-19 pandemic. *Available at SSRN 4264159*.

Acharya, V. V. and S. Steffen (2020). The risk of being a fallen angel and the corporate dash for cash in the midst of covid. *The Review of Corporate Finance Studies 9*(3), 430–471.

Ahn, J., M. Amiti, and D. E. Weinstein (2011). Trade finance and the great trade collapse. *American Economic Review 101*(3), 298–302.

Albuquerque, R., Y. Koskinen, S. Yang, and C. Zhang (2020). Resiliency of environmental and social stocks: An analysis of the exogenous covid-19 market crash. *The Review of Corporate Finance Studies 9*(3), 593–621.

Altig, D., S. Baker, J. M. Barrero, N. Bloom, P. Bunn, S. Chen, S. J. Davis, J. Leather, B. Meyer, E. Mihaylov, et al. (2020). Economic uncertainty before and during the covid-19 pandemic. *Journal of Public Economics 191*, 104274.

Amiti, M. and D. E. Weinstein (2011). Exports and financial shocks. *The Quarterly Journal of Economics 126*(4), 1841–1877.

Angelici, M. and P. Profeta (2020). Dondena working papers.

Apedo-Amah, M. C., B. Avdiu, X. Cirera, M. Cruz, E. Davies, A. Grover, L. Iacovone, U. Kilinc, D. Medvedev, F. O. Maduko, et al. (2020). Unmasking the impact of covid-19 on businesses. Working Paper 9434, The World Bank.

Apedo-Amah, M. C., B. Avdiu, M. C. Xavier Cirera, E. Davies, A. Grover, L. Iacovone, U. Kilinc, D. Medvedev, F. O. Maduko, S. Poupakis, J. Torres, and T. T. Tran (2020, October). Businesses through the COVID-19 Shock: Firm-Level Evidence from Around the World. Policy Research Working Paper 9434, World Bank.

Arntz, M., S. B. Yahmed, and F. Berlingieri (2022). Working from home, hours worked and wages: Heterogeneity by gender and parenthood. *Labour Economics 76*, 102169.

Avalos, E., X. Cirera, M. Cruz, L. Iacovone, D. Medvedev, G. Nayyar, and S. R. Ortega (2024). Firms' digitalization during the covid-19 pandemic: a tale of two stories. *Science and Public Policy*.

Avdiu, B. and G. Nayyar (2020). When face-to-face interactions become an occupational hazard: Jobs in the time of covid-19. *Economics Letters 197*, 109648.

Bai, J., E. Brynjolfsson, W. Jin, S. Steffen, and C. Wan (2020). The future of work: Work from home preparedness and firm resilience during the covid-19 pandemic.

Bas, M., A. Fernandes, and C. Paunov (2022). How resilient was trade to COVID-19? Tech report, World Bank.

Beck, T. (2003). Financial dependence and international trade. *Review of international Economics 11*(2), 296–316.

Beck, T. and A. Demirgüç-Kunt (2008). Access to finance: An unfinished agenda. *The world bank economic review 22*(3), 383–396.

Bellatin, A. and G. Galassi (2022). What covid-19 may leave behind: Technology-related job postings in canada. IZA Discussion Papers 15209, Institute of Labor Economics (IZA).

Bellmann, L. and O. Hübler (2021). Working from home, job satisfaction and work–life balance–robust or heterogeneous links? *International Journal of Manpower 42*(3), 424–441.

Bernard, A. B. and J. B. Jensen (2004). Why some firms export. *Review of economics and Statistics 86*(2), 561–569.

Bloom, N., R. Han, and J. Liang (2022). How hybrid working from home works out. Technical report, National Bureau of Economic Research.

Bloom, N., J. Liang, J. Roberts, and Z. J. Ying (2015). Does working from home work? evidence from a chinese experiment. *The Quarterly journal of economics 130*(1), 165–218.

Borino, F., E. Carlson, V. Rollo, and O. Solleder (2021). International firms and covid-19: Evidence from a global survey. *Covid Economics 75*, 30–59.

Bretscher, L., A. Hsu, P. Simasek, and A. Tamoni (2020). Covid-19 and the cross-section of equity returns: Impact and transmission. *The Review of Asset Pricing Studies 10*(4), 705–741.

Bricongne, J.-C., L. Fontagné, G. Gaulier, D. Taglioni, and V. Vicard (2012). Firms and the global crisis: French exports in the turmoil. *Journal of international Economics 87*(1), 134–146.

Brucal, A., A. Grover, and S. Reyes Ortega (2021). Damaged by the disaster. Working Paper 9604, The World Bank.

Bustos, P. (2011). Trade liberalization, exports, and technology upgrading: Evidence on the impact of MERCOSUR on Argentinian firms. *American Economic Review 101*(1), 304–40.

Cali, M., D. Ghose, A. Montfaucon, X. Cirera, M. Cruz, L. Iacovone, D. Medvedev, G. Nayyar, and S. R. Ortega (2023, January). Firms' digitalization during the covid-19 pandemic: A tale of two stories. Policy Research Working Paper 10284, World Bank.

Carletti, E., T. Oliviero, M. Pagano, L. Pelizzon, and M. G. Subrahmanyam (2020). The covid-19 shock and equity shortfall: Firm-level evidence from italy. *The Review of Corporate Finance Studies 9*(3), 534–568.

Cavallo, A., P. Mishra, and A. Spilimbergo (2022, January). E-commerce during covid: Stylized facts from 47 economies. IMF Working Papers 2022/019, International Monetary Fund.

Choi, Y., A. Fernandes, A. Grover, L. Iacovone, and M. Olarreaga (2023). Trade promotion organizations in the pandemic world.

Chor, D. and K. Manova (2012). Off the cliff and back? credit conditions and international trade during the global financial crisis. *Journal of international economics 87*(1), 117–133.

Cirera, X., D. Comin, and M. Cruz (2022). Digital technologies and resilience to shocks.

Cirera, X., M. Cruz, E. Davies, A. Grover, L. Iacovone, J. E. L. Cordova, D. Medvedev, F. O. Maduko, G. Nayyar, S. Reyes Ortega, and J. Torres (2021b). Policies to Support Businesses through the COVID-19 Shock: A Firm Level Perspective. *The World Bank Research Observer 36*(1), 41–66.

Cirera, X., M. Cruz, A. Grover, L. Iacovone, D. Medvedev, M. Pereira-Lopez, and S. Reyes (2021a). Firm recovery during covid-19: Six stylized facts. Working Paper 9810, The World Bank.

Claessens, S. and L. F. Klapper (2005). Bankruptcy around the world: Explanations of its relative use. *American Law and Economics Review 7*(1), 253–283.

Claessens, S. and L. Laeven (2003). Financial development, property rights, and growth. *the Journal of Finance 58*(6), 2401–2436.

Constantinescu, C., A. M. Fernandes, S. Poupakis, A. G. Goswami, and S. Reyes (2022). Globally engaged firms in the covid-19 crisis.

Copestake, A., J. Estefania-Flores, and D. Furceri (2022, October). Digitalization and resilience. IMF Working Papers 2022/210, International Monetary Fund.

Criscuolo, C., P. Gal, T. Leidecker, F. Losma, and G. Nicoletti (2021). The role of telework for productivity during and post-covid-19: Results from an oecd survey among managers and workers.

Crozet, M., B. Demir, and B. Javorcik (2022). International trade and letters of credit: A double-edged sword in times of crises. *IMF Economic Review*, 1–27.

de Lucio, J., R. Mínguez, A. Minondo, and F. Requena (2022). Impact of covid-19 containment measures on trade. *International Review of Economics & Finance 80*, 766–778.

de Lucio, J., R. Mínguez, A. Minondo, and A. F. Requena (2020). Impact of Covid-19 containment measures on trade. Working Papers 2101, Department of Applied Economics II, Universidad de Valencia.

Dingel, J. I. and B. Neiman (2020). How many jobs can be done at home? *Journal of public economics 189*, 104235.

Doerr, S., M. Erdem, G. Franco, L. Gambacorta, and A. Illes (2021). Technological capacity and firms' recovery from covid-19. *Economics Letters 209*, 110102.

Espitia, A., A. Mattoo, N. Rocha, M. Ruta, and D. Winkler (2021). Pandemic trade: Covid-19, remote work and global value chains. *The World Economy*.

Fahlenbrach, R., K. Rageth, and R. M. Stulz (2021). How valuable is financial flexibility when revenue stops? evidence from the covid-19 crisis. *The Review of Financial Studies 34*(11), 5474–5521.

Fernandes, A. M., A. Mattoo, H. Nguyen, and M. Schiffbauer (2019). The internet and chinese exports in the pre-ali baba era. *Journal of Development Economics 138*, 57–76.

Fisman, R. and I. Love (2003). Trade credit, financial intermediary development, and industry growth. *The Journal of finance 58*(1), 353–374.

Fisman, R. and I. Love (2007). Financial dependence and growth revisited. *Journal of the European Economic Association 5*(2-3), 470–479.

Giesberts, A. J. and S. Eapen (2022). Industry (isic) classification tool. Technical report, Mimeo, World Bank DECDG.

Google (2021). Covid-19 community mobility reports.

Grover, A. G. and V. J. Karplus (2021, January). Coping with COVID-19: Does Management Make Firms More Resilient? Policy Research Working Paper Series 9514, The World Bank.

Grover, A. G. and I. Torre (2019). Management capabilities and performance of firms in the Russian Federation. Working Paper 8996, The World Bank.

Hale, T., N. Angrist, R. Goldszmidt, B. Kira, A. Petherick, T. Phillips, S. Webster, E. Cameron-Blake, L. Hallas, S. Majumdar, et al. (2021). A global panel database of pandemic policies (Oxford COVID-19 Government Response Tracker). *Nature Human Behaviour 5*(4), 529–538.

Hsu, P.-H., H.-H. Lee, S.-C. Peng, and L. Yi (2018). Natural disasters, technology diversity, and operating performance. *The Review of Economics and Statistics 100*, 619–630.

Hur, J., M. Raj, and Y. E. Riyanto (2006). Finance and trade: A cross-country empirical analysis on the impact of financial development and asset tangibility on international trade. *World Development 34*(10), 1728–1741.

Hyun, J., D. Kim, and S.-R. Shin (2020). The role of global connectedness and market power in crises: Firm-level evidence from the covid-19 pandemic. *Covid Economics: Vetted and Real-Time Papers 49*.

Jaimovich, E. (2019). Roadways, input sourcing, and patterns of specialization. *European Economic Review 120*, 103319.

Kogan, L., D. Papanikolaou, L. D. Schmidt, and J. Song (2020). Technological innovation and labor income risk. Technical report, National Bureau of Economic Research.

Levchenko, A. A. (2007). Institutional quality and international trade. *The Review of Economic Studies 74*(3), 791–819.

Mahmud, A., D. Ding, and M. M. Hasan (2021). Corporate social responsibility: Business responses to coronavirus (covid-19) pandemic. *SAGE open 11*(1), 2158244020988710.

Manova, K. (2008). Credit constraints, equity market liberalizations and international trade. *Journal of International Economics 76*(1), 33–47.

Manova, K. (2013). Credit constraints, heterogeneous firms, and international trade. *Review of Economic Studies 80*(2), 711–744.

Martin, B. H. and R. MacDonnell (2012). Is telework effective for organizations? a meta-analysis of empirical research on perceptions of telework and organizational outcomes. *Management Research Review 35*(7), 602–616.

Melitz, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica 71*(6), 1695–1725.

Muzi, S., F. Jolevski, K. Ueda, and D. Viganola (2022). Productivity and firm exit during the covid-19 crisis: cross-country evidence. *Small Business Economics 60*, 1719–1760.

Nunn, N. (2007). Relationship-specificity, incomplete contracts, and the pattern of trade. *The Quarterly Journal of Economics 122*(2), 569–600.

Oikonomou, M., N. Pierri, and Y. Timmer (2023). It shields: Technology adoption and economic resilience during the covid-19 pandemic. *Labour Economics 81*(102330).

Paunov, C. (2016). Corruption's asymmetric impacts on firm innovation. *Journal of Development Economics 118*, 216–231.

Rajan, R. G. and L. Zingales (1998). Financial dependence and growth. *The American Economic Review 88*(3), 559–586.

Ramelli, S. and A. F. Wagner (2020). Feverish stock price reactions to covid-19. *The Review of Corporate Finance Studies 9*(3), 622–655.

Riom, C. and A. Valero (2020). The business response to covid-19: the cep-cbi survey on technology adoption. Working Paper 009, Centre for Economic Performance, London School of Economics and Political Science.

Tambe, P., L. Hitt, D. Rock, and E. Brynjolfsson (2020). Digital capital and superstar firms. Technical report, National Bureau of Economic Research.

Tanaka, M. (2020). Exporting sweatshops? Evidence from Myanmar. *Review of Economics and Statistics 102*(3), 442–456.

Zhang, T., D. Gerlowski, and Z. Acs (2022). Working from home: small business performance and the covid-19 pandemic. *Small Business Economics 58*, 611–636.

Appendices

A. BPS Data (Sample, Summary Statistics); Sectoral and Country Attributes

Table A1: Number of firms in the BPS data sample per country

Country	Firm Number	Country	Firm Number	Country	Firm Number
Afghanistan	595	Hungary	706	Poland	1,824
Algeria	340	India	2,956	Portugal	853
Argentina	210	Indonesia	768	Romania	1,373
Bangladesh	899	Italy	487	Senegal	377
Benin	814	Jordan	48	Sierra Leone	432
Brazil	1,009	Kenya	1,721	Slovak Republic	346
Bulgaria	1,357	Kosovo	1,663	Slovenia	314
Burkina Faso	507	Kyrgyzstan	1,248	South Africa	1,760
Chile	214	Latvia	325	Sri Lanka	436
Cóte d'Ivoire	339	Lithuania	229	Sudan	414
Croatia	381	Madagascar	329	Tajikistan	1,237
Cyprus	201	Malta	39	Tanzania	874
Czechia	458	Moldova	309	Togo	150
El Salvador	474	Mongolia	290	Tunisia	481
Estonia	297	Morocco	900	Türkiye	1,444
Gabon	110	Mozambique	2	Uzbekistan	1,264
Georgia	619	Nepal	1,510	Viet Nam	492
Ghana	3,890	Nicaragua	228	Zambia	564
Greece	576	Nigeria	296	Zimbabwe	87
Guatemala	232	Pakistan	508	*Total*	*43,389*
Honduras	198	Paraguay	385		

Table A2: Summary statistics for BPS sample

	Number of obs. (number of firms)	Mean (unweighted)	Standard Deviation	% of exporters in each category
Firm outcome				
Change in sales (% relative to 2019)	68,007(43,389)	-33	37.823	
Firm characteristics				
Exporter =1, non-exporters =0	68,007(43,389)	19%	0.395	
Micro/small (0-19 workers) =1, 0 otherwise	68,007(43,389)	66%	0.473	10%
Medium (20-99 workers) =1, 0 otherwise	68,007(43,389)	23%	0.423	30%
Large (100+ workers) =1, 0 otherwise	68,007(43,389)	11%	0.307	53%
Agriculture and mining =1, 0 otherwise	68,007(43,389)	6%	0.232	16%
Manufacturing =1, 0 otherwise	68,007(43,389)	32%	0.466	32%
Hospitality =1, 0 otherwise	68,007(43,389)	8%	0.269	7%
Retail and wholesale =1, 0 otherwise	68,007(43,389)	32%	0.467	14%
Knowledge intensive services =1, 0 otherwise	68,007(43,389)	3%	0.179	18%
Other services =1, 0 otherwise	68,007(43,389)	19%	0.395	14%

Table A3: Summary statistics for remote workers by sector

ISIC 2 digits

Sector	N	Mean	Sector	N	Mean
Crop and animal production	2695	0.14	Retail trade, except vehicles/motorcycles	13140	0.51
Forestry and logging	149	0.15	Land transport and transport via pipelines	1581	0.32
Fishing and aquaculture	151	0.16	Water transport	96	0.35
Mining of coal and lignite	12	0.37	Air transport	34	0.29
Extraction crude petroleum/gas	4	0.47	Warehousing and support for transport.	346	0.31
Mining of metal ores	526	0.28	Postal and courier activities	273	0.36
Other mining and quarrying	324	0.26	Accommodation	1492	0.33
Mining support service activities	24	0.28	Food and beverage service activities	3832	0.35
Manuf. of food products	3991	0.22	Publishing activities	89	0.69
Manuf. of beverages	620	0.33	Motion picture/television/music	66	0.56
Manuf. of tobacco products	24	0.22	Programming and broadcasting activities	30	0.68
Manuf. of textiles	781	0.34	Telecommunications	286	0.49
Manuf. of wearing apparel	2377	0.32	Computer programming, and consultancy	875	0.71
Manuf. of leather	575	0.38	Information service activities	20	0.71
Manuf. of wood and cork	1440	0.32	Financial services (no insurance/pension)	863	0.72
Manuf. of paper	190	0.33	Insurance, reinsurance/pension funding	185	0.71
Printing/reproduction of media	341	0.39	Activities auxiliary to financial and insurance	26	0.71
Manuf. coke and refined petrol.	6	0.36	Legal and accounting activities	288	0.58
Manuf. of chemicals	301	0.36	Head offices; management consultancy	217	0.67
Manuf. of pharmaceuticals	305	0.4	Architectural and engineering	218	0.5
Manuf. of rubber and plastics	616	0.31	Scientific research and development	11	0.59
Manuf. other non-metallic mineral	681	0.39	Advertising and market research	217	0.59
Manuf. of basic metals	784	0.27	Other professional, scientific and technical	297	0.59
Manuf. of fabricated metal prod.	1318	0.34	Veterinary activities	19	0.47
Manuf. computer/electr./optical	375	0.53	Rental and leasing activities	278	0.47
Manuf. of electrical equipment	243	0.41	Employment activities	53	0.32
Manuf. of machinery and equip.	1044	0.39	Travel agency, tour operator	366	0.38
Manuf. of motor vehicles, trailers	450	0.31	Security and investigation activities	215	0.24
Manuf. of other transport equip.	83	0.38	Services to buildings and landscape activities	235	0.26
Manuf. of furniture	1321	0.3	Office administrative, office support	468	0.6
Other manufacturing	3507	0.4	Public admin./defence/compulsory social secur.	64	0.59
Repair machinery and equipment	255	0.37	Creative, arts and entertainment activities	108	0.44
Sewerage	7	0.31	Libraries/archives/museums/other culture	7	0.64
Construction of buildings	3023	0.35	Gambling and betting activities	55	0.34
Civil engineering	486	0.29	Sports activities and recreation activities	174	0.36
Specialized construction activities	808	0.3	Activities of membership organizations	178	0.54
Whsle/retail vehicles/motorcycles	2345	0.45	Repair of personal and household goods	448	0.51
Wholesale trade	6299	0.5	Other personal service activities	2376	0.24
			Total	*68007*	*0.4*

Table A4: Summary statistics for internet services by country

Individuals using Internet (% of population)								
Country	N	Mean	Country	N	Mean	Country	N	Mean
Afghanistan	731	18.4	Hungary	1,256	84.8	Poland	3,572	83.2
Algeria	340	62.9	India	3,369	43.0	Portugal	1,505	78.3
Argentina	210	85.5	Indonesia	1,425	53.7	Romania	2,797	78.5
Bangladesh	1,225	24.8	Italy	843	70.5	Senegal	634	42.6
Benin	814	25.8	Jordan	71	66.1	Sierra Leone	668	18.0
Brazil	1,859	81.3	Kenya	4,221	29.5	Slovak Republic	619	89.9
Bulgaria	2,355	70.2	Kosovo	2,265	89.4	Slovenia	475	86.6
Burkina Faso	507	22.0	Kyrgyzstan	1,497	51.0	South Africa	2,552	70.0
Chile	214	88.3	Latvia	492	88.9	Sri Lanka	685	35.0
Cóte d'Ivoire	339	36.3	Lithuania	343	83.1	Sudan	777	28.4
Croatia	677	78.3	Madagascar	519	15.0	Tajikistan	1,505	22.0
Cyprus	334	90.8	Malta	68	86.9	Tanzania	1,298	22.0
Czechia	785	81.3	Moldova	544	76.1	Togo	150	24.0
El Salvador	786	54.6	Mongolia	489	62.5	Tunisia	752	71.9
Estonia	494	89.1	Morocco	1,478	84.1	Türkiye	1,747	77.7
Gabon	110	62.0	Mozambique	2	16.5	Uzbekistan	1,354	71.1
Georgia	1,071	72.5	Nepal	1,834	37.7	Viet Nam	1,602	70.3
Ghana	6,926	58.0	Nicaragua	368	45.2	Zambia	1,054	19.8
Greece	1,071	78.1	Nigeria	296	35.5	Zimbabwe	87	29.3
Guatemala	381	50.0	Pakistan	865	25.0	*Total*	*68,007*	*58.9*
Honduras	315	42.1	Paraguay	385	74.0			
Secure Internet servers (per 1 million people)								
Country	N	Mean	Country	N	Mean	Country	N	Mean
Afghanistan	731	28	Hungary	1,256	26,241	Portugal	1,505	19,151
Algeria	340	50	India	3,369	389	Romania	2,797	19,165
Argentina	210	3,018	Indonesia	1,425	1,684	Senegal	634	19
Bangladesh	1,225	100	Italy	843	15,313	Sierra Leone	668	5
Benin	814	10	Jordan	71	108	Slovak Republic	619	20,091
Brazil	1,859	2,741	Kenya	4,221	248	Slovenia	475	42,530
Bulgaria	2,355	40,238	Kyrgyzstan	1,497	288	South Africa	2,552	14,353
Burkina Faso	507	3	Latvia	492	19,858	Sri Lanka	685	328
Chile	214	11,014	Lithuania	343	31,455	Sudan	777	4
Cóte d'Ivoire	339	45	Madagascar	519	8	Tajikistan	1,505	71
Croatia	677	22,756	Malta	68	10,840	Tanzania	1,298	39
Cyprus	334	8,221	Moldova	544	4,525	Togo	150	20
Czechia	785	56,187	Mongolia	489	1,690	Tunisia	752	271
El Salvador	786	94	Morocco	1,478	370	Türkiye	1,747	5,438
Estonia	494	83,313	Mozambique	2	21	Uzbekistan	1,354	453
Gabon	110	25	Nepal	1,834	189	Viet Nam	1,602	2,597
Georgia	1,071	2,776	Nicaragua	368	86	Zambia	1,054	36
Ghana	6,926	45	Nigeria	296	75	Zimbabwe	87	68
Greece	1,071	6,647	Pakistan	865	63	*Total*	*65,742*	*8123*
Guatemala	381	94	Paraguay	385	348			
Honduras	315	93	Poland	3,572	20,606			