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Does COVID-19 Pandemic Spur Digital **Business Transformation** in The MENA Region?



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Evidence From Firm Level Data

An ILO/ERF working paper by

Mohammed Elhaj Mustafa Ali¹ and Ebaidalla Mahjoub Ebaidalla²

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¹ Development Studies and Research Institute, University of Khartoum, Sudan, Email: mohdaj1976@gmail.com

² Department of Economics, University of Khartoum, Sudan, Email: ebaidalla@gmial.com

Abstract

The worldwide precautionary measures adopted to contain the COVID-19 pandemic in early 2020 imposed a drastic negative impact on the performance of the business sector. To avoid losses and negative consequences, many firms have adopted digital solutions. This study assesses the role of the COVID-19 outbreak in accelerating digital transformation in the Middle East and North Africa (MENA) region. The analysis relied on micro data collected from 5,480 firms surveyed by the ILO/ERF COVID-19 MENA Monitor Enterprise Survey (CMMENT) in Egypt, Jordan, Morocco, and Tunisia. The analysis shows that the characteristics of the firm, including firm size and foreign ownership, spur digital transformation in the business sector. Moreover, firms encountering challenges, complying with pandemic containment measures, receiving support from government are more likely to digitize. Furthermore, the results demonstrate a strong association between the pandemic outbreak and digitization and that the firms operating in the service sector have a higher likelihood to adopt digital solutions.

Keywords: : COVID-19, Digital transformation, Firm, MENA

Key Messages:

- The precautionary measures adopted by governments to control the spread of the COVID-19 pandemic, such as closing businesses, social distancing, and restricting mobility, led to adverse consequences on the business sector in MENA countries.
 - Digitization was an important business strategy, adopted by a sizable segment of firms in the MENA region to cope with the harmful impacts of COVID-19 pandemic.
 - Firms of large size, owned by foreigners, encountering business challenges due to the pandemic, receiving support from the government are more likely to adopt digital solutions in response to COVID-19 pandemic.
 - Firms operating in the services sector have a higher likelihood to adopt and invest in digital solutions compared to their counterparts in other sectors.
 - Intensifying internet accessibility, granting firms' subsidies and preferential tax cut, and attracting foreign direct investment would be effective measures to bridge the digital divide and enhance digital transformation in the MENA countries.
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1. Introduction

The spread of the novel coronavirus (COVID-19) in 2020 emerged as a global health crisis that led to severe disturbances in the business environment worldwide (Tucker, 2020; Shafi et al., 2020; Bartik et al., 2020, and Asmelash & Cooper, 2020). The containment measures adopted to control the pandemic, such as closing businesses, closing borders, implementing social distancing, and restricting mobility, led to negative consequences on the business sector. The sluggish performance engulfed the global economy since the spread of the pandemic in 2020 was well-manifested in business sales reductions, contractions in trade and employment, and disturbances in international supply chains (Apedo-Amah et al., 2020, and Winarsih et al., 2020). The reports indicated that world GDP dropped by -3.40% in 2020 (World Bank, 2021). The World Trade Organization reported that world trade decreased by 5.3% in 2020 (WTO, 2020). The effects of the pandemic have also manifested in labor markets as global unemployment climbed up to 6.47%, a higher rate than the world has ever seen over the three past decades (ILO, 2020). Undoubtedly, business activities that depend on face-to-face interactions such as tourism and traveling have received the heavy hit of the pandemic. The closure of borders between countries in the first eight months of 2020 pushed the international tourist arrivals to drop by 70% (Gössling et al., 2020). However, these declines in the global economic performance vary from country to country and from region to region, depending on two factors. The first is the structure of an economy and its vulnerability to external shocks. The second is the extent to which the business sector in that economy can devise strategies to overcome hindrances brought by the pandemic. Since the first factor cannot be satisfied during the period in which the pandemic ravaged the global economy, the only possible way was to implement immediate solutions based on the existing reality. In this regard, adopting digital technologies appeared as one of the most effective strategies to absorb the shock induced by the pandemic containment measures (Seetharaman, 2020; Donthu and Gustafsson, 2020; Dwivedi et al., 2020, and Thomas, 2020). The literature documented that many businesses have adopted digital transformation to reduce pandemic-induced declines and even try to go beyond that to restore the normal situation that prevailed before the pandemic (Riom and Valero, 2020; Winarsih et al., 2020, Priyono et al., 2020, and Obrenovic et al., 2020).

Amid the pandemic outbreak, the utilization of digital technologies has increased remarkably in the MENA region by individuals, governments, and businesses (World Bank, 2020). However, the far-reaching adoption of digitization in business operations is anticipated to confront many challenges, including the failure of households, employees, firms, and populations to access or effectively exploit the benefits of digital technologies (Göll and Zwiers, 2019; UNDP, 2016, and ESCWA, 2015). Thus, the old fragmented technological reality has been shocked by the new business environment created by the pandemic, as all actors were pushed to respond positively to pass the crisis. This has been the case because the catastrophic economic impact of the pandemic has been expected to be more severe on the MENA region, where oil exports, tourism, and foreign remittances represent the backbone for the majority of economies. According to the COVID-19 Business Pulse Surveys (BPS), the COVID-19 pandemic led to revenue loss, financial distress, and job loss in businesses operating in the region (BPS, 2020). These surveys also revealed that most of the firms in the region have been slow in adopting technology, remain highly uncertain about the rescue, and exposed to a great drop in demand (BPS, 2020). The BPS reported that digitization represented a coping mechanism for a negligible proportion of firms ranging between 20% and 30% from total MENA firms surveyed. These percentages indicate that the business sector has not resorted to digital solutions to lighten the pandemic consequences. The dominance of this digital divide would lead to serious consequences on the region's economy, especially with the successive waves of the pandemic. Against this backdrop, many questions can be raised about the linkage between the COVID-19 pandemic and digitization in the MENA region: (1) Does the COVID-19 pandemic accelerate digital business transformation in the region? (2) To what extent does the existing digital transformation process vary across firm sizes (i.e., small versus medium firms), firm types, and countries? (3) What are the determinants of digital transformation among businesses? (4) What are the determinants of investment in digital technologies?

To answer these questions, this study utilizes data from the ILO/ERF COVID-19 MENA Monitor Enterprise Survey (CMMENT) rapid phone surveys collected via many waves in a sample of four MENA countries, namely Egypt, Jordan, Morocco, and Tunisia. The study employs econometric regression modeling to execute the empirical investigation. Specifically, this modeling technique encompasses estimating a linear probability model (LPM) to identify the determining factors of the firm's decision to adopt digital technology.

The contribution and novelty of this study is threefold. First, examining the COVID-19 impact on digital transformation among MENA businesses would support the efforts endeavor to minimize the pandemic-induced troubles in the business sector. Despite the positive role of digital transformation on firms' performance, there is little knowledge about its impact on businesses operation in the MENA region, particularly during the COVID-19 pandemic. To the best of our knowledge, this is the first study on the digitization impact of COVID-19 in the context of the region. Second, this study helps policymakers understand the role of digitization in post-COVID-19 recovery plans. Third, this study employs cross-country data for four MENA countries over three waves, hence counting for the problem of unobserved heterogeneity between firms, countries, and time.

The rest of this paper is structured as follows: Section 2 introduces some relevant literature. Section 3 covers data, method, and empirical strategies. While Section 4 provides the results and discussion, Section 5 ends with conclusion and provides some policy recommendations.

2. Literature review

The utilization of digitized technologies expand products and services in a manner that humanity has never seen before (Frank et al., 2019; Salkin et al., 2018; Liao et al., 2017; Majchrzak et al., 2016; Sedera et al., 2016; Zhen, 2012, and Grover and Segars, 2005). With these technological advancements, it has become imperative for all economic activities in different sectors to pursue digital transformation to sustain continuity and rescue competitive advantage (Aly, 2020; Lokuge et al., 2019; Lu, 2017; Rose et al., 2016). Undeniably, this transformation is attributable to unprecedented growth in digitized technologies such as social media, smartphone technologies, cloud computing, analytics, advanced robotics, and the internet of things (Vial, 2019; Lokuge et al., 2019; Lusch and Nambisan, 2015, and Porter and Heppelmann, 2014). Several studies have attempted to explore the motives that push firms to adopt digital transformation. These studies can be grouped under two strands. The first includes studies attributing digital transformation to internal factors, including profit maximization, minimizing losses, enhancing managerial capabilities, and the availability of highly skilled employees. The second strand, in contrast, sees that digitization is driven by external factors evolve in the business environment. These factors include competition by highly skilled actors, the affordability of technologies that spur digitization, or in response to disasters that emerge suddenly and disturb the business performance. However, it is hard to draw a clear demarcation line between these two strands of research, as the factors spurring digital transformation may overlap. Perhaps, the main difference between these two strands lies in the driving factors themselves. According to the first strand, for instance, the digital transformation is mainly stimulated by internal factors that are linked to the firms' evolution, while in the second strand it will be imposed by uncontrollable external factors. Picking the second, the outbreak of the COVID-19 in early 2020 has created a turbulent business environment in the whole World (Nicola et al., 2020; UNDP, 2020, and Brammer et al., 2020). The rapid spread of the pandemic, along with the higher death rates, led countries to follow strict containment measures, including closing businesses, curfew, imposing social distancing, and adopting stay at home strategies (Bennett et al., 2021; Neeley and Beard, 2020; Gardner and Matviak, 2020, and Bennett, 2018). These measures have negatively affected the developed and developing economies alike.

The evidence documented significant contractions in business performance due to the impact of the pandemic-containment measures on both the supply and demand sides (Maulani et al., 2020; Battistini and Stoevsky, 2020, and Cutler and summers, 2020). To exit this bottleneck, countless firms have altered their business models to maintain the pre-COVID-19 positions or, at least, avoid reaching the shutdown point. Adopting digital transformation represented one of the options available to businesses to transcend boundaries emerging with these uncontrolled changes (Muragu et al., 2021, and Bailey, 2020). Thus, work from home (WFH), private delivery service, telemedicine, e-learning, e-commerce, online marketing, and other modern digital technologies have become successful tools for effective communication during the mandatory quarantines imposed by the pandemic (Tortora et al., 2021; Savić, 2020, and Schilirò, 2020).

In the literature, evidence has documented that adopting digital solutions represented the most common firms' response strategies to cope with the disruptive changes in the business environment resulting from the COVID-19 crisis (Klein and Todesco, 2021; Mhlanga and Moloi, 2020; Riom and Valero, 2020; Kraus et al., 2020; Apedo-Amah et al., 2020; Winarsih et al., 2020, Priyono et al., 2020, Obrenovic et al., 2020). For instance, Klein and Todesco (2021) conducted a literature search to investigate how SMEs responded to the pandemic. The authors found that among other coping mechanisms, the SMEs resort to bootstrapping digitalization to lighten the financial impact of the pandemic. Riom and Valero (2020) investigated the effect of the pandemic on digitalization and innovation using a survey of 375 businesses in the UK. The authors documented that 60% of the respondents have adopted digital technologies to mitigate the negative consequences arising from measures enacted to contain the pandemic. In the same context, Kraus et al. (2020) found that the outbreak of COVID-19 enhances firms' digitization processes in five Western European countries and that adopting digital technologies represents a strategy to respond to the crisis.

In a diversified context, Apedo-Amah et al. (2020) analyzed the impact of the pandemic on business firms using a survey conducted by the World Bank and its partners in 51 countries for 100,000 firms during April through August 2020. Their results indicated that the pandemic shock has speeded digital adoption and augmented investment in digital technologies. In the developing country's context, Guo et al. (2020) employed data set from a survey collected from 518 Chinese SMEs to examine the connection between SMEs' digitalization and public crisis responses. The empirical results show that digitalization has enabled SMEs to respond effectively to the public crisis by spurring dynamic capabilities and improving SMEs' performance.

Departing from examining the role of the pandemic in stimulating digitization in business firms, some authors have endeavored to inspect the contribution of digital technologies in supporting firms to cope with the negative consequences of the pandemic. For instance, Priyono et al. (2020) attempted to assess the role of digital transformation in assisting small and medium enterprises (SMEs) to cope with business changes stirred by the COVID-19 pandemic. Using data from seven manufacturing SMEs in Indonesia, their results indicated that SMEs adopt varying digital transformations depending on contextual factors. Specifically, the authors claim that the SMEs with a high level of digital maturity accelerate the transition toward becoming fully digitalized firms, while the SMEs with liquidity issues and lower level of digital maturity decide to digitalize the sales function only. Moreover, the authors concluded that SMEs with a limited digital literacy but possess a high level of social capital have tried to cope with challenges by finding partners who maintain excellent digital capabilities.

Some researchers narrowed the analysis by focusing on the impact of the pandemic-containment measures on a certain aspect of business activities, such as reshaping the workplace and marketing the products (Subramaniam et al., 2021; Molino et al., 2020; Nagel et al., 2020; Savić, 2020, and Kim, 2020). Nagel et al. (2020) investigated whether the COVID-19 pandemic has accelerated digital transformation in workplaces. Their study was based on a survey conducted during the COVID-19 pandemic from March to April 2020 on the crowdsourcing platform Amazon Mechanical Turk. Their findings showed that the number of people working from home has increased and that digital transformation of work has accelerated in response to the pandemic. In the same way, Subramaniam et al. (2021) inspected whether COVID-19 was one of the drivers of digital transformation. Based on data collected from employees in an enterprise environment with different levels of experience, the authors concluded that the presence of the pandemic boosts digital transformation among studied enterprises and that digital technologies boosted remote work from home and work from anywhere. Kim (2020) examined the role of the pandemic in accelerating digital transformation in the marketplace. He claimed that managers might adopt digitization in the marketplace to recover the pre-pandemic sales or even realize higher sales after the pandemic.

Based on the above studies, many conclusions can be drawn. First, these studies were executed in developed contexts, where digital literacy and digitization have intensified the matter that facilitates the process of digital transformation. Whereas, developing countries exhibit higher rates of digital illiteracy and lack technological infrastructures, making digital transformation unaffordable. This digital gap reduces the degrees of generalization and calls to analyze the impact of this phenomenon according to different contexts. Second, in the presence of the Covid-19 pandemic, resorting to digital transformation might depend on the seriousness of the particular country in adopting pandemic-precautionary measures. Thus, the probable negative impact of these measures on businesses' performance, as a driver for digital transformation, may vary from one country to another depending on the strictness of precautions enacted. Third, there are many countries and regional groups that have not seen any analysis on the digitization impact of the COVID-19. For example, no single study has attempted to probe this impact in the MENA region context. The evidence belonging to the region has concentrated exclusively on exploring the socioeconomic and health impact of the pandemic (Hassan et al., 2021; Al Dhaheri et al., 2021; Solomon and Tausch, 2021, and Al Hashmi et al., 2020). These studies have missed investigating the digitization impact of COVID-19-containment measures. Studying this issue in the region is of great importance. The region has been occupied by higher illiteracy rates and lacks digital maturity.

Therefore, analyzing the impact of COVID-19 containment measures in spurring digital transformation in the MENA region would highlight the readiness of the business environment to absorb crises such as one caused by the COVID-19 pandemic.

3. Data and Stylized facts

3.1 Data source

The data for this study is sourced from the ILO/ERF COVID-19 MENA Monitor Enterprise rapid phone surveys collected from four countries, namely Egypt, Jordan, Morocco, and Tunisia. Specifically, the study relies on the repeated cross-section data collected via the following waves: Jordan (3 waves), Morocco (3 waves), Tunisia (3 waves), and Egypt (2 waves). The data is accessed through the ERF open data portal (www.erfdataportal.com). The surveys covered 5480 firms scattered in these four countries. The firm's questionnaire brings all information needed by this study, including firm characteristics, workforce, revenues, business operations status, digital technology adoption, coping strategies, expectations, and government responses to contain COVID-19 impact on firms. To ensure that samples are nationally representative, we employ sampling weights in all analyses (i.e., descriptive statistics and regression analysis).

3.2 Descriptive statistics

Before examining the factors that influence firms' decision to adopt digitization in response to the consequences resulted from the Covid-19 pandemic, it is crucial to understand the characteristics of the firms under study. Table 1 presents the number and percentage of firms that have adopted and invested in digitalization out of the total firms surveyed in the concerned countries.

Table 1: Number and percentage of firms adopted digitalization across countries

Country	Adopt digitalization			Invested in digital technologies		
	Total	Adopted (number)	Adopted (%)	Total	Invested (number)	Invested (%)
Jordan	1,502	717	48	611	166	27
Morocco	1,500	796	53	703	266	38
Tunisia	1,477	496	34	514	177	34
Egypt	1,001	649	65	472	146	31
Total	5,480	2,658	49	2,300	755	33

Source: Authors' calculations from COVID-19 MENA Monitor (ILO/ERF, 2021) ³

As shown in Table 1, about half (49%) of the total firms have adopted digital technology to cope with troubles caused by the pandemic. Specifically, about 65% of the firms surveyed in Egypt have resorted to digitization, followed by Morocco (53%) and Jordan (48%). Compared to other countries, Tunisia reported the lowest rate of digital adoption (34%). The table also shows that about one-third (i.e., 33%) of the total firms have invested in digitization. This outcome implies that digitization acts as a business strategy to mitigate the pandemic-induced effects. Morocco ranks first in terms of investment in digital equipment, as about two-fifth (i.e., 38%) of

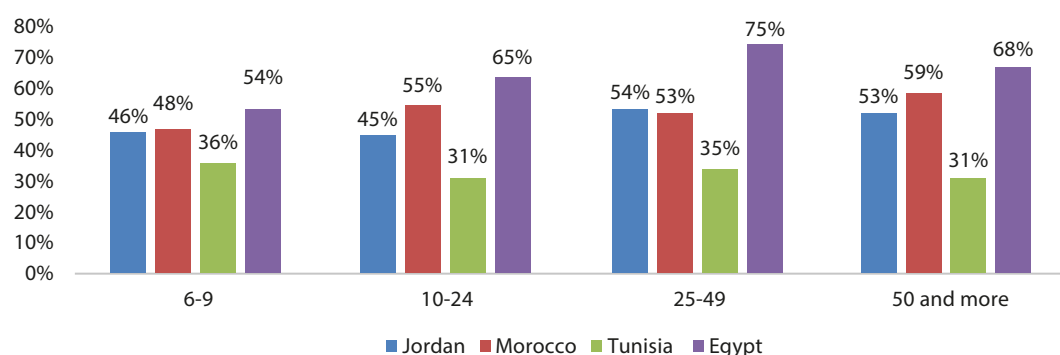
³ Jordan survey is funded by the Foreign, Commonwealth, and Development Office (FCDO)

the Moroccan firms have invested in digitization. Overall, the statistics reveal that a sizable segment of the firms in the sample has invested in digital equipment. This proportion may indicate that the COVID-19 pandemic pushed a considerable portion of the firms in the MENA region to adopt and invest in digitization as a survival business strategy during the lockdown period.

These outcomes may also imply that digitization represented a solution to keep businesses open and avoid permanent shutdown due to the COVID-19 pandemic. Hence, the presence of the COVID-19 pandemic increased the pace of digitalization in MENA countries, supporting the initial hypothesis postulated by this study.

It is important to shed some light on the pattern of digitization to see whether it varies across firm sizes. Taking such a step would highlight the extent to which firm size, as measured by the number of permanent employees, affects its digital adoption decisions. Figure 1 depicts the percentage of firms engaging in digitization according to firm size. The figure shows that the rate of adopting digitized technologies is not fully correlated with the firm's size. In the case of Egypt and Jordan, for instance, the digitization rate increases as a firm size increases up to the three categories of the firms sizes. However, for the largest firms (i.e., 50 workers and more), it shrinks back significantly. Surprisingly, the rate of digitization among smaller and medium Tunisian firms is higher than the larger ones. For the case of the Moroccan firms, it seems that there is a consistency between firm size and digitization. Specifically, excluding semi larger firms (i.e., firms that employ between 25 and 49 workers), there is a positive correlation between firm size and digital solutions.

Figure 1: Firms adopted digitalization by firm size (%)

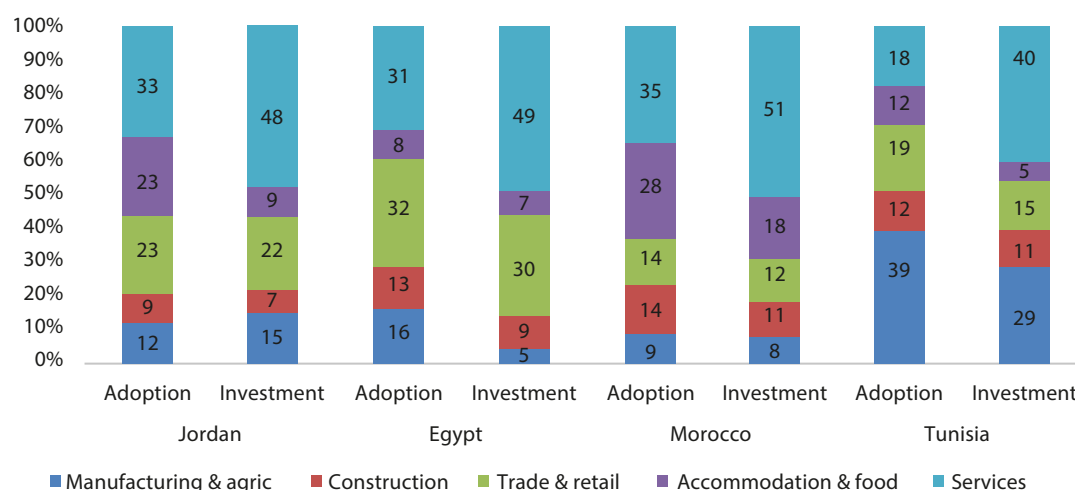


Source: Authors' calculations from COVID-19 MENA Monitor (ILO/ERF, 2021)

Moreover, large firms may engage in international supply value chains, which require innovative solutions to react to lockdown and precautionary measures; hence digitization would be an effective strategy. This finding corresponds to the evidence generated by many empirical studies (Raimo et al., 2021; Renz, 2019, and Zhu, 2006). The weaker tendency to digitize among small firms may indicate the huge shock experienced by MENA's economy due to the pandemic, particularly on the labor market front. This is because small firms, together with self-employment, account for 70% of the total employment in the region (OECD, 2021).

To understand the impact of the pandemic on digitization, it will also be useful to break down firms according to industry. This is delivered by Figure 2, which shows the percentage of firms adopting and investing in digitization by industry sector and country.

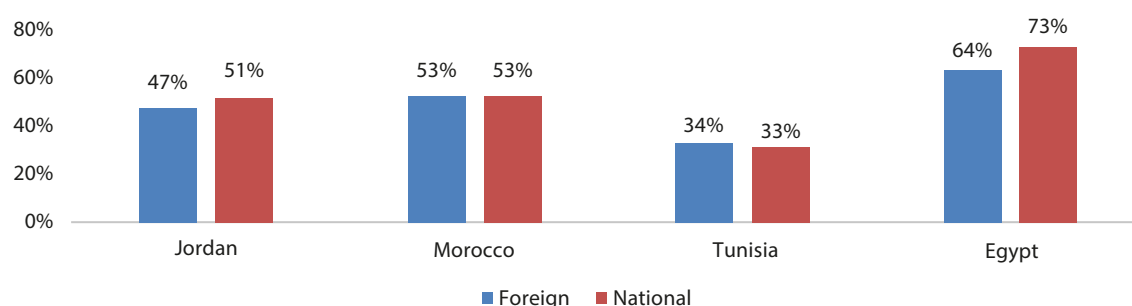
Figure 2: Distribution of digital adoption and investment by type of industry sector and country



Source: Authors' calculations from COVID-19 MENA Monitor (ILO/ERF, 2021)

As can be seen, the figure reveals that most of the firms that adopt and invest in digitization are operating in the services sector. It also shows that about 33%, 31%, 35%, and 18% of the firms adopting digitization work in the service sector in Jordan, Egypt, Morocco, and Tunisia, respectively. Likewise, a sizable portion of firms investing in digitization operates in service sectors in the four countries. Specifically, 48%, 49%, 51%, and 40% of the firms in Jordan, Egypt, Morocco, and Tunisia are, respectively, investing in digital solutions. This result is consistent with statistics in Appendix (B-1), which show that a significant number of the firms are working in the service sector. That is to say, with Tunisia as an exception, about one-third of the surveyed establishments in other countries are operating in services (see Appendix B-1).

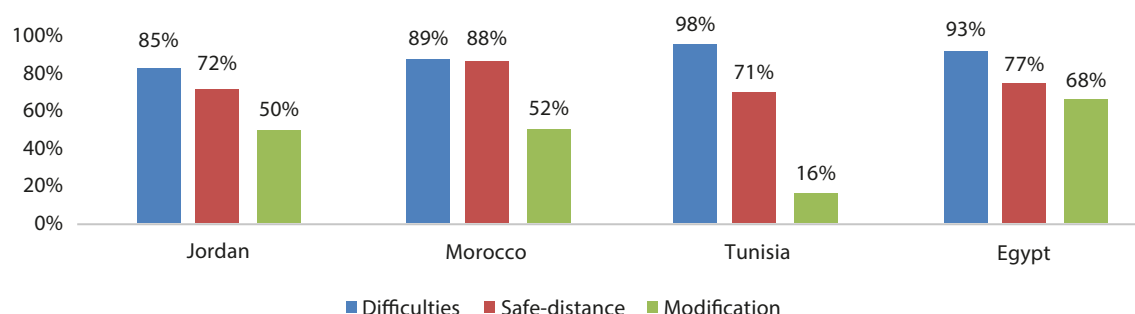
On average, the trade, retail, and wholesale sectors rank second in adopting and investing in digital technologies. These results imply that the wave of digital transformation has intensified in the service and retail sectors, both of which were the most affected sectors by the troubled business environment created by the pandemic. Globally, the statistics show that accommodation and foods are the most hit sectors during the first wave of the COVID-19 pandemic (UNWTO, 2020). Undoubtedly, the MENA region was an exception. The tourist arrivals in the Middle East, for instance, dropped by 69% between January and August 2020 (Gössling et al., 2020). This high percentage of reduction in tourist arrivals represents overwhelming losses to the MENA region's GDP and the labor market as travel and tourism activities represented about 5.3% of the GDP and secured about 6.7 million jobs (OECD, 2020). The figure also indicates that the digitization rate in manufacturing and construction sectors is relatively slow, as they reported the lowest rates compared to other sectors. Based on sketched statistics, it can be concluded that the high rate of digitization in services, trade, and retail industries suggests that adopting digital facilities represents an effective business solution, as these sectors were drastically affected by social distancing and movement restrictions. This outcome lends support to what this study hypothesizes that the presence of COVID-19 pandemic spurs digital transformation.

Figure 3: firms adopted digitalization by ownership and country (%)

Source: Authors' calculations from COVID-19 MENA Monitor (ILO/ERF, 2021)

As can be indicated from the figure, there is a variation in the levels of digitization across according to ownership and countries. While the digitization rate among local firms is higher in Jordan and Egypt, it is slightly high among foreign owners in Tunisia and equally undertaken by both national and foreign owners in Morocco.

Finally, to get some insights into the link between digitization and firm circumstances during the COVID-19 pandemic, Figure 4 presents the percentage of the firms adopting digital solutions and, concurrently, confronting business difficulties, implementing safe-distance, and pursuing product modification.

Figure 4: Digitized firms which face difficulties, adopt safe distance product modification by country (%)

Source: Authors' calculations from COVID-19 MENA Monitor (ILO/ERF, 2021)

The figure shows that more than 85% of the firms adopting digitization in the concerned countries confront business difficulties due to the COVID-19 pandemic. This implies that difficulties induced by the pandemic were a key driver for adopting digital technology to keep businesses open. In addition, the figure reveals that more than 70% of the firms adopting digitization across the four countries have arranged workplaces to maintain a safe distance. Moreover, a considerable segment of the digitized firms in Jordan (50%), Morocco (52%), and Egypt (68%) were adopted product modification in response to the COVID-19 pandemic. The correlation between digitization and three firm statuses has been tested by the Chi-square test and presented in Appendix C. The results of the test are significant for all relationships, suggesting the existence of a strong association between COVID-19 and digitization across the four countries. Overall, the sketched statistics suggest that the unfavorable business conditions induced by the COVID-19 acted as a crucial factor in pushing firms to digitize. This outcome also confirms the hypothesis that the COVID-19 pandemic enhances the digital process in the MENA countries.

4. Methodology

To investigate the factors that influence a firm's decision to adopt and invest in digital solutions, we estimate the following econometric model:

$$Dig_{icw} = \alpha + X_{icw} + FE_{f(i);c \times w} + \varepsilon_{icw} \quad (1)$$

Where Dig_{icw} represents the dependent variable i.e., whether the firm i adopts or invests in digitization, in country c , surveyed in wave w ⁴. This outcome variable is a dummy variable equal to 1 if the firm adopts/ invests in digitization and 0 otherwise. The dependent variable is explained by a set of explanatory variables

(X_{icw}) , a vector of the fixed effects $FE_{f(i);c \times w}$ and ε_{icw} an error term with a mean zero. The explanatory variables include firm size, firm ownership, firm export status, whether the firm faces business challenges due to COVID-19, and whether the firm is receiving government support to relieve pandemic effects. The definition and descriptive statistics of the variables used in the analysis are presented in Appendix A.

The multilevel fixed effects $FE_{f(i);c \times w}$ are used to control for the country and wave of the survey fixed effects. This modeling technique allows us to absorb time-invariant observable and unobservable differences across countries and time that may correlate with digital adoption/investment. Country fixed effects absorb country-specific effects, while the wave of survey fixed effects immunizes analysis from time-varying country specifications that may correlate with digital adoption. Robust standard errors are clustered at the firm level to allow for spatial correlation in the residuals within firms and thus do not contain as much information as unclustered errors.

Since the dependent variable is binary variable, the appropriate estimation technique will be non-linear models, such as probit and logit models. However, equation (1) is estimated using ordinary least squares (OLS) - the linear probability model (LPM). A wide range of literature documented that LPM has several advantages over the traditional non-linear models such as logit or probit (Bellemare et al., 2015; Angrist and Pischke, 2008, and Greene, 2004). First, the LPM is better-suited to address fixed effects given the incidental parameters problem associated with the probit (Greene 2004 and Heckman, 1981). Second, the LPM prevents identification via the specific functional form (e.g., normal or logistic) assumed in a probit or logit models. Finally, LPM coefficients are directly interpretable as marginal effects, i.e., as a change in the probability that $Pr(Dig_{icw} = 1)$, whereas probit and logit coefficients have to be transformed before they can be interpreted as marginal effects. Although the LPM might be biased and inconsistent relative to non-linear models like probit or logit (Horrace and Oaxaca, 2006), we adopt it for two reasons. First, because we use country-wave fixed effects, LPM performs better than non-linear models, which fail to handle the fixed effects (Greene, 2004). Second, using probit or logit models instead of LPM would generate more biased particularly when specifying the model without fixed effects (Angrist and Pischke, 2008).

⁴ Adopting digitalization refers to the use of digital solution measures in response to the pandemic. The variable is developed from the answers to the following two questions: 1. "Has this establishment use phone for marketing, placing orders, etc"; 2. "Has this establishment used the Internet, online social media, specialized apps, or digital platforms". While investing in digital technology variable reflects the answer to the question that "has this establishment invested in any new equipment, software, or digital solution to allow people to work from home".

5. Empirical Results and Discussion

This section presents the estimation results of the linear probability model (LPM) for equation (1). The estimation results of the digital adoption and investment in digitization models are presented in Table 2. We run regressions using the sampling weights provided in the dataset.

The LPM estimates for the digital adoption model are displayed in column 2, while the results for investing in the digitalization model are provided in column 3. These two models are estimated using both countries and wave fixed effects. Standard errors are presented in parentheses and are clustered at the firm level.

Table 2: Estimation results of linear probability model for the full sample

Variables	Digital adoption	Digital investment
Firm Size	0.000441 (0.00034)	0.00112** (0.00044)
Foreign ownership	0.0262 (0.0263)	0.0597* (0.0352)
Exporting	0.0269 (0.0252)	0.0185 (0.0347)
Importing	0.0777*** (0.0184)	-0.0348 (0.0261)
Large size*exporting	-0.0311 (0.0457)	0.0451 (0.0669)
Large size*importing	0.0484 (0.0387)	-0.0442 (0.0540)
Manufacturing	-0.0730*** (0.0212)	-0.0480 (0.0357)
Facing difficulties	0.111*** (0.0235)	0.0361 (0.0363)
Modification	0.0625*** (0.0169)	0.000898 (0.0258)
Government support	0.0569*** (0.0150)	0.0333 (0.0226)
Safe distance	0.0798*** (0.0173)	0.149*** (0.0265)
Revenues decrease	0.0254 (0.0178)	-0.0454* (0.0251)
Inventory	-0.0119 (0.0171)	0.0594** (0.0265)
Constant	0.246*** (0.0264)	0.172*** (0.0411)
Country & Wave fixed effects	Yes	Yes
Observations	5,480	5,480
R-squared	0.083	0.038

Robust standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

All estimates account for clustering at the firm level

The reported results indicate that many variables of interest carry the expected signs and are consistent with previous studies. Specifically, adopting digitization is positively and significantly affected by whether a firm imports inputs from abroad. Moreover, the conditions and circumstances induced by the COVID-19 pandemic, such as facing difficulties, modifying business, receiving government support, and implementing safe distancing are found to stimulate digital transformation. In contrast, the coefficient of the manufacturing variable is negative and statistically significant. This outcome suggests that manufacturing firms are less likely to adopt digital solutions, indicating that the digitization rate among this division of firms was low compared to those operating in the service sector. Overall, these findings suggest that the outbreak of the COVID-19 pandemic represented a significant factor in encouraging digitization in MENA countries.

Expectedly, the results reported in column 3 show that firm size and foreign ownership significantly boost investment in digitization. This implies that, compared to their local counterparts, foreign firms and firms with larger sizes tend to invest more in digital technologies. This outcome diverges from that emerged with adoption model. The positive and significant coefficient in front of the firm size variable in column 3 may reflect the fact that the firms with larger sizes prioritize and strategizes the digitization progression. Unexpectedly, the coefficient of the importing variable is negative but statistically insignificant. This suggests the absence of association between importing inputs and a firm's tendency to invest in digitization. One possible interpretation for this finding is that the declines in domestic and external demand due to the pandemic have reduced firms' imported inputs and thus discouraged investment in digitization. As expected, the coefficient of adopting safe distance (health precautions) and inventory variables are positive and statistically significant, suggesting that firms adhering to safe distancing and keeping inventories are more likely to invest in digital solutions. The coefficient of revenue decreasing dummy variable is negative and statistically significant, indicating that a firm that suffers revenue reductions is less likely to invest in digitization. This finding implies that COVID-19 induced revenues reductions might push firms to bankruptcy and low liquidity, hence undermining their capacity to invest in digital technology. Therefore, one can conclude that despite the correlation between the COVID-19 pandemic and digitization, the pandemic-induced revenues reduction lowers firms' tendency to invest in digital solutions.

For comparison purposes, equation (1) is estimated for each country separately to ensure the robustness of the analysis. The estimation results pertain to each country are presented in Appendix D. As can be seen, the results show that the determinants of digital adoption and investment vary across countries. Like the outcome emerged with the total sample, there is a positive and significant association between firm size and digital investment in Jordan and Tunisia. However, the influence of foreign ownership on investing in digitization is positive and statistically significant only for Tunisia. In most countries, encountering difficulties and receiving government support are associated with digital adoption, supporting total sample analysis. Likewise, the coefficient of the safe distancing variable is positive and significant in all model specifications. This outcome may indicate that despite the variation in findings across countries, the variables related to the COVID-19 pandemic, including facing difficulties arising from lockdown and precautionary measures and adopting safe distancing, play a significant role in pushing firms towards adopting and investing in digital solutions. This outcome confirms the results generated from total sample analysis, giving validity to generalize for the rest of MENA countries. For more robustness, we furthermore split the total sample into two sub-samples. The first sample comprises firms using mobile phones in marketing, while the second includes those firms utilizing the internet in business activities. Thus, equation (1) is estimated for these two samples using the same specification applied in the total sample regressions (i.e., country and wave fixed effects). The estimates of the LPM are presented in Table 3.

Similar to the results of the total sample, using the phone in business operations is positively affected by imports, business difficulties, safe distancing, modifications, governmental supports, and, to some extent, inventories. The coefficient of the manufacturing variable is negative and statistically significant, indicating that the manufacturing firms are less likely to use the phone in running business activities during the pandemic. This finding aligns with the outcome reported in Table 2, which signifies the negative correlation between adopting digitization and being a manufacturer. This unexpected outcome may be attributed to the fact that the majority of the firms operating in the region are small, undercapitalized, and surrounded by poor infrastructures.

Table 3: Estimation results of linear probability models for phone and internet use

Variables	Digital adoption	Digital investment
Firm Size	3.21e-05 (0.000337)	0.00100*** (0.000293)
Foreign ownership	0.0256 (0.0260)	0.0107 (0.0255)
Exporting	0.0187 (0.0249)	0.0660*** (0.0244)
Importing	0.0736*** (0.0180)	0.0706*** (0.0176)
Large size*exporting	-0.0549 (0.0452)	-0.0314 (0.0432)
Large size*importing	0.0460 (0.0375)	0.0212 (0.0359)
Manufacturing	-0.0534** (0.0211)	-0.0965*** (0.0209)
Facing difficulties	0.124*** (0.0240)	0.0837*** (0.0241)
Modification	0.0489*** (0.0165)	0.0949*** (0.0162)
Government support	0.0463*** (0.0145)	0.0568*** (0.0145)
Safe distance	0.0889*** (0.0173)	0.0695*** (0.0171)
Revenues decrease	0.0304* (0.0173)	0.0148 (0.0176)
Inventory	0.00596 (0.0164)	-0.0240 (0.0165)
Constant	0.310*** (0.0270)	0.392*** (0.0271)
Country & wave fixed effects	Yes	Yes
Observations	5,480	5,480
R-squared	0.095	0.098

Robust standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

All estimates account for clustering at the firm level

In addition, firms engaged in manufacturing are expected to have recognized workers and, thus, have limited physical interactions. Under such conditions, the initiative to digitize among this group of firms is anticipated to be very low. Moreover, the table shows that using the internet as a digitization facility is positively influenced by firm size, importing, facing business difficulties, government support, and adopting health precautions. Similar to the total sample model, the impact of manufacturing is negative and significant, signifying the low percentage of manufactured firms that use the internet in their operations. This outcome also implies that manufacturing firms are less likely to adopt digitization contrasting services firms, which were hit severely by the pandemic.

Overall, the firm characteristics and business conditions associated with the COVID-19 pandemic play a critical role in a firm's digitization. This suggests that COVID-19 has a significant impact in spurring the digital process among firms operating in MENA countries.

6. Conclusion and Policy recommendations

This study examines the impact of COVID-19 and its health precautions on firms' digital adoption and digital investment in the MENA region. The study used the COVID-19 MENA Monitor Enterprise Survey data collected by the Economic Research Forum (ERF) in collaboration with international labour organization (ILO), during 2020-2021. The study employs econometric model to analyze a sample comprising 5480 firms in four countries, namely Egypt, Jordan, Morocco, and Tunisia. The descriptive statistics show that there is a strong association between firms' tendency to digitize, as about half of the surveyed firms adopt digital technologies during the outbreak of the pandemic. Specifically, the statistics indicates that most of the firms that confronted business challenges during the pandemic have adopted or invested in digitization. Moreover, the results reveal majority of the firms operating in the services sector have adopted digital solutions.

Similarly, the econometric results indicate that firm characteristics, including firm size and type of firm ownership, have a positive and significant impact on adopting and investing in digitization. Specifically, firms with more employees are more likely to adopt and invest in digital technologies. In addition, the firm's characteristics, such as facing business challenges, implementing safe distancing, and receiving support from government are among the significant factors that encourage digitization among the surveyed firms. Overall, these findings held for different specifications, supporting the initial hypothesis that COVID-19 plays a key role in the firms' digitization in the MENA region.

Based on the above findings, some recommendations can be proposed. First, since digital technology plays a crucial role in mitigating the negative consequences of the pandemic on business firms, policymakers in MENA countries need to devote more efforts to facilitate the adoption of digital technologies. The initiatives may include making internet and communication accessible to all businesses at competitive prices. Second, businesses firms should be encouraged to move towards full digital transformation by granting subsidies, a preferential tax cut, and tax breaks to firms that take such initiatives. However, these concessions should be granted to the firms that invest extensively in localizing and diffusing digital technologies. Taking such a step is likely to enhance digital adoption and build an effective precaution for future pandemics. Third, governments in MENA countries should reduce the digital gap by encouraging foreign direct investment in the digital sector. The presence of those investors would generate huge benefits on the digitization front. For instance, the local investors will copy the digital practices brought in and instigated by foreign investors and then implement in their own firms. Moreover, the competitive environment created by the presence of foreign companies motivates local enterprises to keep pace with new developments, especially in the field of digital technologies. Finally, serious initiatives must be taken to reform education in the MINA region. Specifically, the educational curriculum must be reformed in a manner that bridges the existing digital divide among population.

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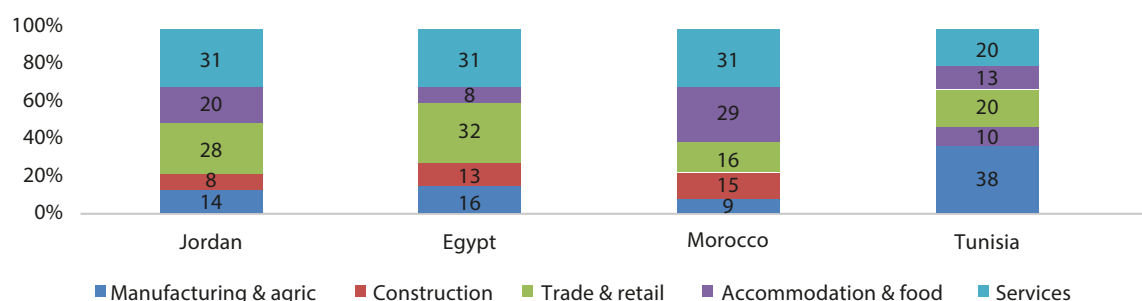
Appendices

Appendix A: Definitions and descriptive statistics of the variables used in the analysis

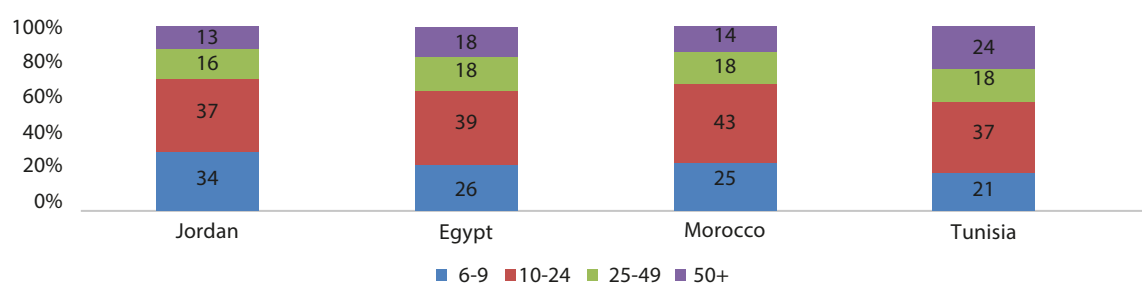
Variable	Definition	Mean	Std. Dev.
Digital adoption	Refers to adopting of digital technology by the firm. This reflects the answers of the question that has this establishment: 1. Use of phone for marketing, placing order etc.; 2. Use of Internet, online social media, specialized apps or digital platforms.	0.4850	0.4998
Digital investment	invested in any new equipment, software or digital solution. Is constructed from the answer of the question that "has this establishment invested in any new equipment, software or digital solution to allow people to work from home"	0.3283	0.4697
Use phone	Use of phone for marketing, placing order etc	0.5602	0.4964
Use internet	Use of Internet, online social media, specialized apps or digital platforms	0.6102	0.4877
Firm size	Number of permanent employees	14.4480	23.0959
Foreign ownership	Dummy variable (1=fully or partly owned by a foreign entity; 0= otherwise))	0.0914	0.2882
Exporting	Dummy variable (1=if firm is exporting; 0= otherwise)	0.1502	0.3573
Importing	Dummy variable (1=if firm is importing inputs; 0= otherwise)	0.2754	0.4467
Manufacturing	Dummy variable (1= operate in manufacturing sector; 0= otherwise)	0.1675	0.3735
Difficulties	Dummy variable, reflects the difficulties due to the coronavirus/COVID-19 outbreak and related restrictions? These includes difficulties in accessing customers due to mobility restrictions imposed by government and Difficulties in accessing suppliers due to mobility restrictions imposed by government	0.8933	0.3087
Modification	Dummy variable, refers to any modifications adopted in business in response to pandemic and movement restrictions. Examples for modifications are change in product; re-arrangement of the workplace and change in transportation/delivery	0.4016	0.4903
Government support	Dummy variable (1= if firm received government support; 0= otherwise)	0.4186	0.4934
Safe distance	Dummy variable (1= if firm rearranged workplace for safe distance; 0= otherwise)	0.7263	0.4459
Revenues decrease	Dummy variable (1= if firm suffered from revenues decrease; 0= otherwise)	0.7695	0.4212
Inventory	Dummy variable (1= if firm kept inventory of finished product; 0= otherwise)	0.2653	0.4415

Appendix B: Some descriptive statistics on the data set

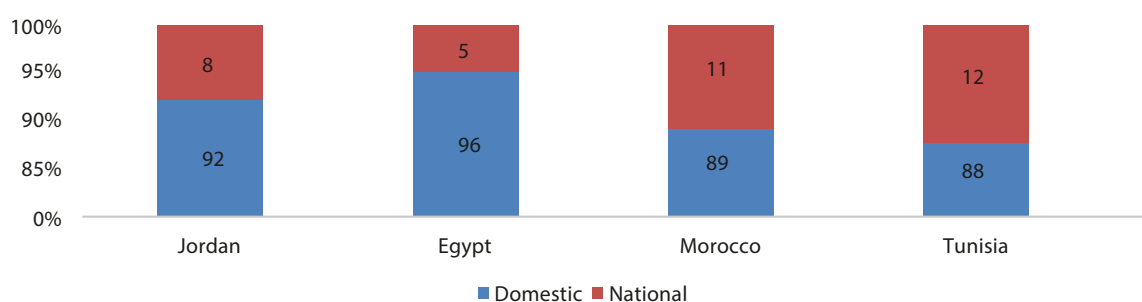
Appendix B-1: Distribution of firms by type of industry sector and country



Appendix B-2: Distribution of firms by size and country



Appendix B-3: Distribution of firms by ownership (foreign vs domestic) and country



Appendix C: Chi square test (Ho: no association between digitization and (Difficulties, Safe-distance, Modification)

Digital adoption			
Country	Difficulties	Safe-distance	Modification
Jordan	2.329(0.127)	18.251(0.000)	31.220(0.000)
Morocco	18.204(0.000)	7.540(0.006)	3.588(0.058)
Tunisia	9.320(0.002)	7.557(0.006)	11.982(0.000)
Egypt	4.475(0.034)	26.026(0.000)	14.291(0.000)

• Value between parentheses are P-values

Appendix D: Estimation results of linear probability models by country

Variable	Jordan			Egypt			Morocco			Tunisia		
	Digital adoption	Digital Investment	Digital adoption	Digital adoption	Digital Investment	Digital adoption	Digital adoption	Digital Investment	Digital adoption	Digital adoption	Digital Investment	Digital Investment
Firm Size	0.000307 (0.000573)	0.00142* (0.000730)	0.0005 (0.0006)	0.0005 (0.0006)	-0.0004 (0.0008)	0.0006 (0.0006)	0.0006 (0.0006)	0.0009 (0.0010)	0.0002 (0.0006)	0.0002 (0.0006)	0.0016** (0.0008)	0.0016** (0.0008)
Foreign ownership	0.0427 (0.0472)	0.0362 (0.0635)	0.0824 (0.0749)	0.0824 (0.0749)	0.132 (0.0969)	-0.0177 (0.0469)	-0.0177 (0.0469)	-0.0255 (0.0642)	0.0317 (0.0459)	0.0317 (0.0459)	0.142** (0.0645)	0.142** (0.0645)
Exporting	0.0523 (0.0392)	0.00724 (0.0485)	0.0240 (0.0582)	0.0240 (0.0582)	-0.111 (0.0714)	0.0932 (0.0668)	0.0932 (0.0668)	-0.0224 (0.0883)	-0.0256 (0.0358)	-0.0256 (0.0358)	0.122** (0.0593)	0.122** (0.0593)
Importing	0.0470 (0.0307)	-0.0431 (0.0442)	0.122*** (0.0353)	0.122*** (0.0353)	0.00685 (0.0496)	0.0278 (0.0390)	0.0278 (0.0390)	-0.0611 (0.0526)	0.0514 (0.0324)	0.0514 (0.0324)	-0.0937* (0.0499)	-0.0937* (0.0499)
Manufacturing	-0.124*** (0.0408)	-0.0167 (0.0647)	-0.0278 (0.0505)	-0.0278 (0.0505)	-0.182** (0.0755)	0.0150 (0.0614)	0.0150 (0.0614)	0.0760 (0.0950)	-0.0718** (0.0309)	-0.0718** (0.0309)	-0.103* (0.0624)	-0.103* (0.0624)
Facing difficulties	0.0730* (0.0388)	0.0562 (0.0541)	0.0914 (0.0616)	0.0914 (0.0616)	-0.0370 (0.114)	0.167*** (0.0405)	0.167*** (0.0405)	0.0341 (0.0578)	0.0953* (0.0539)	0.0953* (0.0539)	0.107 (0.0872)	0.107 (0.0872)
Modification	0.123*** (0.0289)	0.0656 (0.0446)	0.0361 (0.0403)	0.0361 (0.0403)	0.0211 (0.0647)	0.0412 (0.0301)	0.0412 (0.0301)	-0.103** (0.0440)	-0.00509 (0.0421)	-0.00509 (0.0421)	0.196*** (0.0660)	0.196*** (0.0660)
Government support	0.0794*** (0.0267)	0.0260 (0.0396)	-0.0253 (0.0355)	-0.0253 (0.0355)	-0.00773 (0.0499)	0.0983*** (0.0314)	0.0983*** (0.0314)	0.0644 (0.0446)	0.0139 (0.0265)	0.0139 (0.0265)	0.0475 (0.0445)	0.0475 (0.0445)
Safe distance	0.0807*** (0.0302)	0.132*** (0.0452)	0.139*** (0.0438)	0.139*** (0.0438)	0.0320 (0.0699)	0.0688 (0.0439)	0.0688 (0.0439)	0.226*** (0.0631)	0.0704** (0.0276)	0.0704** (0.0276)	0.179*** (0.0446)	0.179*** (0.0446)
Revenues decrease	-0.0330 (0.0300)	-0.0102 (0.0409)	0.0442 (0.0403)	0.0442 (0.0403)	-0.0187 (0.0541)	0.0363 (0.0391)	0.0363 (0.0391)	-0.0787 (0.0547)	0.0373 (0.0330)	0.0373 (0.0330)	-0.116** (0.0513)	-0.116** (0.0513)
Inventory	-0.0209 (0.0310)	0.0474 (0.0492)	-0.0147 (0.0361)	-0.0147 (0.0361)	0.0950* (0.0523)	-0.000790 (0.0364)	-0.000790 (0.0364)	0.0436 (0.0567)	0.0114 (0.0327)	0.0114 (0.0327)	0.0312 (0.0540)	0.0312 (0.0540)
Wave fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.298*** (0.0434)	0.0708 (0.0558)	0.384*** (0.0659)	0.384*** (0.0659)	0.317*** (0.122)	0.226*** (0.0587)	0.226*** (0.0587)	0.223*** (0.0827)	0.180*** (0.0541)	0.180*** (0.0541)	0.0952 (0.0883)	0.0952 (0.0883)
Observations	1502	1502	1001	1001	1001	1500	1500	1500	1477	1477	1477	1477
R-squared	0.082	0.058	0.049	0.049	0.039	0.064	0.064	0.038	0.175	0.175	0.123	0.123



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- ▶ **Email:** adwa@ilo.org
- ▶ **Address:** 13 Brazil St., Zamalek, 11211, Cairo, Egypt
- ▶ ilo.org/Cairo | [Twitter](#) | [Facebook](#) | [YouTube](#)