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# The impact of COVID-19 on manufacturing enterprise performance in developing and emerging economies

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# **The impact of COVID-19 on manufacturing enterprise performance in developing and emerging economies**

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## Highlights

- Manufacturing firms that were more likely to remain open in the first wave of the pandemic (June-September 2020) are associated with two key productive capabilities: having invested in new fixed capital in the past financial year (part of technological capability) and having an internationally recognized quality certification (part of production capability).
- Manufacturing firms that have sustained higher employment growth during the pandemic are on average associated with two key production capabilities: access to credit and providing formal training for employees. Furthermore, more resilient firms are those that were able to adapt their production during the pandemic, those that received direct government COVID-19 assistance, and firms that are smaller and older.
- More resilient manufacturing firms that have experienced lower employment losses are in countries with a higher Competitive Industrial Performance (CIP) score.
- Slower firm-level employment growth (or larger losses) is significantly associated with severity of the pandemic at the country-level, measured by cumulative COVID-19 deaths per million population from the start of the pandemic, as well as the average government lockdown stringency index.
- The country-level degree of industrial competitiveness (CIP score) as a positive determinant, both of firms remaining open as well as of firms' employment growth, underscores the importance of a strong and sophisticated manufacturing sector for individual enterprise outcomes.

**Keywords:** COVID-19, firm performance, productive capabilities, manufacturing, employment, developing and emerging economies

## 1. Introduction

The COVID-19 pandemic has affected manufacturing firms worldwide. Governments around the world implemented lockdown restrictions in order to curb the spread of the virus. Along with voluntary social distancing due to the public health risks of the pandemic, lockdowns contributed to a fall in demand, resulting in a reduction in sales and employment across most countries. Furthermore, global value chains (GVCs) have been disrupted, which has impacted access to key inputs to production, affecting supply. These effects have been heterogenous across countries and sectors, and along various dimensions of firm-level characteristics. The impact on firms and on the international organization of manufacturing is likely to be long-lasting, with implications for industrial policy going forward.

This paper evaluates the impact of the COVID-19 pandemic on manufacturing enterprise outcomes across a sample of developing and emerging economies. We use the World Bank Enterprise COVID-19 follow-up survey (WBES) to create a panel dataset of manufacturing firms across countries, spanning the pre- and post-COVID-19 period. We analyse the impact of the pandemic and associated lockdown measures on business closures, employment and sales.

Our empirical strategy analyses firm-level outcomes as a function of firm-level determinants (for example, size, sub-sector, some proxies of productive capabilities) and macro-level determinants in terms of both prior characteristics (such as the share of manufacturing in a country's GDP and GDP per capita) and measures of both the public health severity of the pandemic and of public economic support measures. This is intended to shed light on the ways in which both prior conditions (at the firm, sector and national levels) and policy interventions shaped firm-level outcomes during the pandemic. The paper draws out broad implications for industrialization and industrial policy going forward.

Our paper contributes to the growing literature on the short-term impact of the COVID-19 pandemic on firms around the world—some of which also use the WBES COVID-19 follow-up survey data. Apedo-Amah et al. (2020) describe the short-term impact of the pandemic on firms across all countries for which there is WBES data and find that while most business have remained open about six weeks after the pandemic, there was a large and persistent negative impact on sales, with significant heterogeneity across firms. The authors also observe that the employment effects are primarily on the intensive margin (reduction in work hours) and that smaller firms have been more negatively impacted. In a similar study, Waldkirch (2021) employs a descriptive approach and supports other findings revealing significant heterogeneity of the pandemic's effects across sectors and firms. Waldkirch (2021) observes that firms involved in international trade

have experienced greater declines in sales than domestic oriented firms and that labour-intensive sectors have been more heavily impacted compared to capital-intensive sectors. Focusing on firms in Sub-Saharan Africa (SSA), Aga and Maemir (2020) find that contractions in sales and employment are higher within the region relative to other regions of the world and that African firms have been more likely to permanently close. In contrast, firms in SSA have been more likely than firms in other regions to adapt their products, operations or services to adjust to the shock.

Among studies on developing countries, there has been a particular focus on China. Gu et al. (2020) use firm-level electricity consumption data from Suzhou, China to estimate firms' responses to the pandemic, using a difference-in-difference approach. The findings reveal that there was a large and sudden negative effect on electricity consumption in the short term (January 2020), with a swift recovery to higher levels by the end of March 2020. Manufacturing firms in the region were more affected than other sectors. Studying listed firms in China, Xiong et al. (2020) find that firms in vulnerable industries had lower returns during the period around the outbreak of COVID-19, and that larger firms had better returns.<sup>1</sup>

Our paper makes important improvements on other studies through employing more robust estimation techniques, rather than solely relying on descriptive analysis. In addition, many of the existing studies use the follow-up survey data independently, or other cross-sectional data. Instead, we have constructed a unique database by merging the COVID-19 survey data with prior WBES datasets, thus observing characteristics of the same firm over time. As such, we are able to control for a richer set of prior firm- and country-level characteristics compared to other studies, enabling a more accurate identification of the effects of the pandemic on firms.

The structure of our paper is as follows. We establish our broad conceptual approach in Section 2. Section 3 provides an overview of the empirical approach that we followed, while the data is explained in Section 4. Section 5 provides descriptive statistics, including summary statistics of firm-level and country-level variables included in the analysis, and data on changes in firms' operating status, employment and sales. Regression results are presented and discussed in Section 6, and Section 7 offers conclusions of the analysis as well as discussing implications for industrial policy.

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<sup>1</sup> Other recent empirical studies of the effects of COVID-19 on firms include those by Bartik et al (2020); Bose et al. (2021); Cirera et al (2021); Golubeva (2021); Juergensen et al. (2020); Kozeniauskas et al. (2020); Pedauga et al. (2021); and Singh et al. (2021).

## **2. Conceptual approach**

### **2.1 Heterogeneity in the effects of the pandemic on manufacturing**

Both the pandemic itself and associated containment measures have had a heterogenous impact across countries, across regions within countries, across sectors within countries, across sub-sectors within the broad sectors, and across firms within sub-sectors. This paper focuses on manufacturing enterprises.

Manufacturing firms worldwide have been affected by the pandemic through various channels, including:

- Direct effects on manufacturing firms, due to the illness and death of manufacturing workers as well as disruptions brought on by the quarantining of exposed workers or temporary firm closures due to COVID infections among employees;
- Disruptions to manufacturing production due to containment measures, including:
  - Complete temporary closures through lockdowns and;
  - Social distancing and related measures that reduce productivity and output;
- Lower domestic demand for manufactures (both intermediate and final goods) due to a decline in incomes;
- Lower external demand for manufactures (both intermediate and final goods) due to a decline in incomes internationally, as well as export and import restrictions and disrupted supply chains;
- Supply shortages due to export and import restrictions and disrupted supply chains, particularly in the early stages of the pandemic.

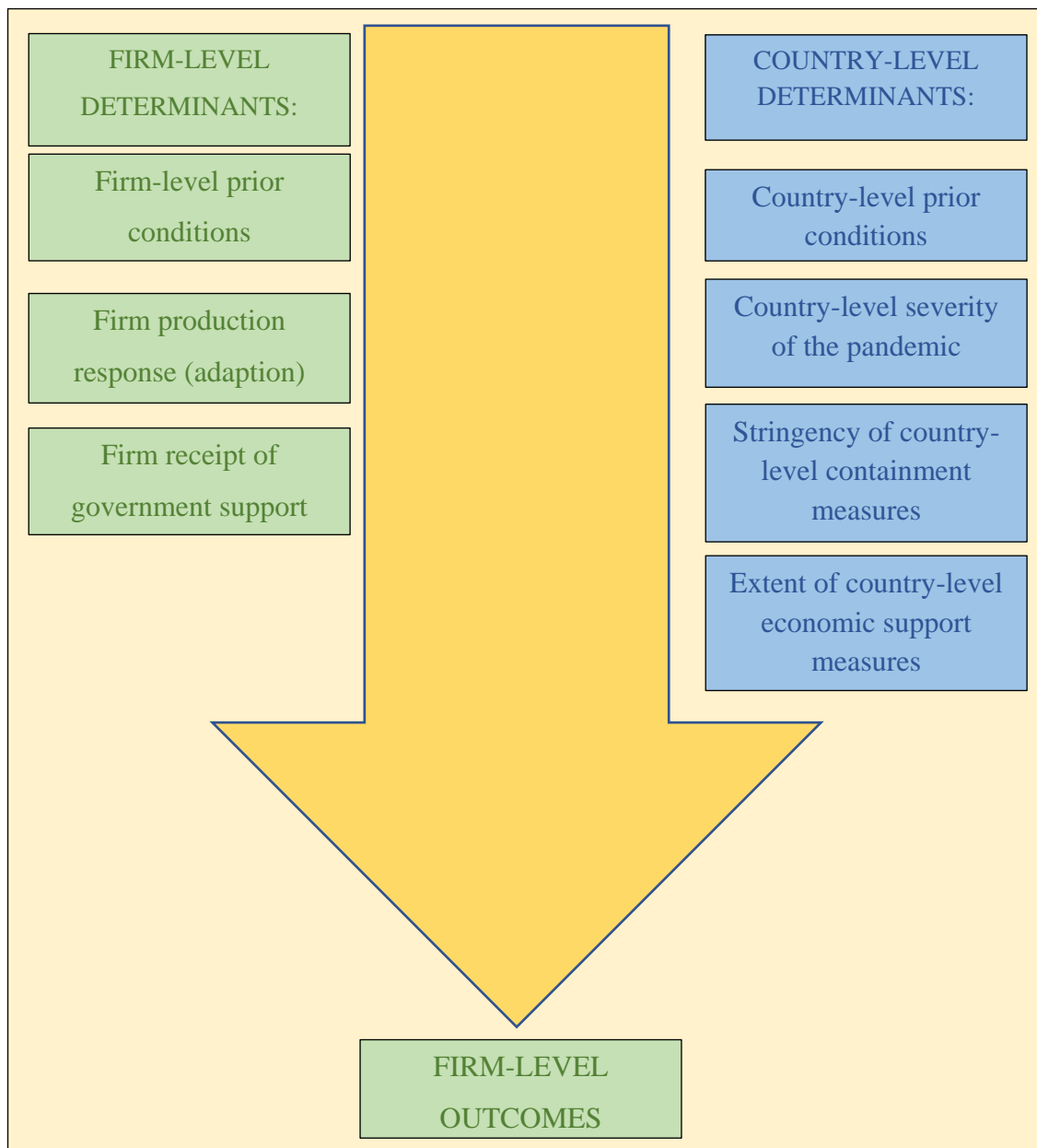
While manufacturing sectors around the world have been affected through these channels, the effects have been highly uneven. In this study, we focus specifically on understanding the heterogeneity in performance outcomes among manufacturing firms in developing and emerging economies. In broad terms, we analyse these performance outcomes as being determined by:

- Prior conditions:
  - Firm-level productive capabilities (production and technological capabilities) and other firm-level characteristics;
  - Country-level prior characteristics, including both meso-level characteristics for the manufacturing sector and aggregate characteristics;
- Country-level severity of the pandemic;
- Country-level stringency of containment and economic support measures;

- Country-level extent of economic support measures;
- Extent to which, due to the pandemic, firms have been able to adapt by converting their products;
- Whether firms have received government assistance during the pandemic.

This broad conceptual approach is depicted schematically in Figure 1, and the operationalizing of this approach (including the econometric specification) is set out in Section 3, which discusses the empirical strategy.

**Figure 1: Conceptual approach to analysing pandemic effects on manufacturing in developing and emerging economies**



Source: Authors' elaboration.

## **2.2 Firm-level productive capabilities**

Among the range of determinants of manufacturing firm-level outcomes analysed here, we pay particular attention to firms' productive capabilities. Broadly, productive capabilities can be understood as being part of firms' strategic and tacit internal resources, and as an important dimension of the internal cumulative processes that contribute to firm performance. Andreoni (2011, p.12) defines productive capabilities as “personal and collective skills, productive knowledge and experiences embedded in physical agents and organisations that firms need to perform different productive tasks; they need to furthermore adapt and implement in-house improvements across different technological and organisational functions”.

Productive capabilities can be thought of as part of the micro-foundations of structural transformation. They are crucial to firm performance, including for gaining competitive and comparative advantages, upgrading to more sophisticated and complex products, and for success in international markets (Andreoni 2010; Bell and Albu 1999; Bell and Pavitt 1993; Teece 2007). The at least partial firm-specificity of productive capabilities mean that they cannot be readily copied across firms—thus, they may serve as a basis for a firm's competitive advantage and for gaining market share.

Productive capabilities are especially important to latecomer firms and to firms in developing countries for “keeping up” and “catching up” with firms in advanced economies (Andreoni and Tregenna 2020; Fagerberg and Srholec 2017; Figueiredo 2001, 2002, 2008; Lall 1992; Nübler 2014). At the country level, strengthening firm-level productive capabilities is thus important to help developing countries catch up to advanced economies. This concept needs to be integrated into a broader understanding of structural change and processes of industrialization and development.

Productive capabilities can be built up over time through the learning process in firms, by learning from daily experiences, learning by doing, and trial and error (Bell and Pavitt 1993; Teece et al. 1997; Tidd et al. 1997). These processes are uneven across firms, contributing to heterogeneity in performance across firms. Furthermore, it is important to recognize that productive capabilities take time and effort to build (UNIDO 2019).

We also cannot ignore the complex and multidimensional nature of productive capabilities, and we must acknowledge they cannot be appropriately measured using unidimensional indicators. In this study, we follow Avenyo et al. (2021) in understanding production capabilities and technological capabilities as the two key dimensions of firm-level productive capabilities, hypothesizing that productive capabilities could be crucial to firms' robustness, resilience and

overall performance in the face of a significant shock such as COVID-19. We analyse this econometrically, using both constructed indices of production capabilities and technological capabilities, as well as with individual component variables. Technical details concerning the construction of the two capabilities' indices are provided in Annex 2.

### 3. Empirical strategy

Our empirical approach consists of both descriptive and econometric analysis. We provide an overview of the impact of the pandemic on firm outcomes across countries that aims to estimate the impact of three key dimensions of the pandemic on firm outcomes: (1) lockdown stringency, (2) the severity of the health crisis, (3) and government policy responses. To improve the accuracy of the estimated effects, we control for prior firm- and country-level factors, paying particular attention to the role of production and technological capabilities at the firm level, and the scale and quality of the industrial sector at the country level in mediating the effects of the pandemic. We also include sub-sectoral control variables to account for the uneven impact of the pandemic across different manufacturing sub-sectors.

We estimate the following regression:

$$y_{ijct} = \beta_1 D_{ct} + \beta_2 X_{ijt-1} + \beta_3 R_{ijt} + \beta_4 Z_{ct-1} + \lambda_j + \varepsilon_{ijct}$$

where:

$y_{ijct}$  represents firm outcome variables of interest for firm  $i$ , in manufacturing sub-sector  $j$ , in country  $c$ , at time  $t$ , such as the change in employment, sales or firm survival;

$D_{ct}$  is a vector of country-level variables associated with the pandemic, measuring the severity of the pandemic, stringency of containment measures and extent of government economic support measures;

$X_{it-1}$  is a vector that includes firm characteristics prior to the pandemic, such as firm technological capabilities, production capabilities and other firm characteristics;

$R_{it}$  includes variables relating to a firm's production response during the pandemic and an indicator of receipt of state support by the firm;

$Z_{ct-1}$  includes prior country characteristics such as the share of manufacturing in GDP, macroeconomic conditions and other structural features;

$\lambda_j$  controls for manufacturing sub-sectors at the 2- or 4-digit ISIC level; and  $\varepsilon_{ijct}$  is the error term.

Observing a firm's outcomes during the pandemic requires that the firm has remained fully open. As such, the estimated coefficients are likely to be biased given that the firms that have remained open are expected to be different fundamentally from those that ceased to operate during the pandemic. To address this, we first control for the selection bias of firms that were still fully operational during the pandemic through employing a Heckman selection model. We then include the selection variables in the main regression estimated. All variables used in the regression analysis are described in Table 12 (Annex 1).

#### **4. Data**

The World Bank has conducted COVID-19 follow-up enterprise surveys in selected countries, building upon their enterprise survey database. Therefore, we merge the follow-up surveys with the baseline survey for each country, allowing us to match firms across time using a unique firm identifier. This dataset is the primary source of data and includes firm outcomes during the pandemic and the prior firm characteristics from the baseline survey. We focus specifically on manufacturing firms.

Indicators of firm outcomes in the empirical estimation can be measured in various ways. The WBES COVID-19 follow-up survey asks the following questions, from which we can measure the change in sales, employment and operating status:

- Is the establishment open, temporarily closed or permanently closed?
- How many full-time employees were employed in the baseline survey period? How many full-time-employees were employed in the last month of the COVID-19 period?
- Compared to the same month in 2019, did sales increase, decrease or remain the same and by what percentage?

High-frequency data on lockdown stringency and the degree of government policy responses (economic response index) are derived from Oxford University's (2020) Government Tracker Database. Data on the severity of the pandemic, such as total deaths per 1 million population, is obtained from the Johns Hopkins Coronavirus Resource Center.<sup>2</sup> We also control for how many months into the pandemic the survey was conducted for each country.

Prior firm characteristics are obtained from the baseline WBES in each country for each uniquely matched firm. Prior country conditions are primarily sourced from various United Nations databases and from the World Bank's *World Development Indicators* database. The choice of these

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<sup>2</sup> <https://coronavirus.jhu.edu> (accessed June 2021)

variables is informed by the literature on firms' productive capabilities and country-level determinants of firm and industrial performance (in particular, Andreoni, 2011; Avenyo, Tregenna and Kraemer-Mbula, 2021).

Table 1 presents the countries included in our sample after accounting for data availability. Unfortunately, this sample represents just a small fraction of developing and emerging economies due to data availability. Worth noting in particular is the complete lack of coverage of developing Asia, only a small proportion of African countries are included, and that only three Latin American countries are covered. Thus, conclusions drawn from this analysis may have limited applicability to developing and emerging economies more broadly and should be interpreted with caution. As additional WBES COVID-19 follow-up datasets are released over time, it would be possible to expand this analysis to a more comprehensive country sample.

A comparison of the total sample of baseline firms and the sample that successfully matches with completed 2020 follow-up survey data is presented in Table 10 (Annex 1). This matched sample remains similar to the baseline surveys regarding the distribution of firms by main sector, firm size and firm age. This reduces the concerns around sample selection bias due to attrition. Furthermore, a comparison of the baseline firm characteristics of non-responding firms (Table 11, Annex 1) to the matched sample do not indicate systematic differences between the two sets of firms.

**Table 1: Final sample, after accounting for missing data**

<b>Region/Country</b>	<b>Baseline survey period</b>	<b>COVID-19 follow up survey period</b>	<b>Number of manufacturing firms</b>
<i><b>Africa</b></i>			
Mozambique	2018	Aug-Sept 2020	126
Niger	2017	June 2020	20
Zambia	2019	June-July 2020	163
Zimbabwe	2016	June-July 2020	268
<i><b>MENA</b></i>			
Morocco	2019	July-Aug 2020	357
Jordan	2019	July-Aug 2020	271
<i><b>LAC</b></i>			
El Salvador	2016	June-Aug 2020	226
Guatemala	2017	June-Aug 2020	79
Honduras	2016	June-Aug 2020	58
<i><b>Transition economies</b></i>			
Albania	2019	June 2020	132
Belarus	2018	Aug 2020	314
Georgia	2019	June 2020	182
Moldova	2019	May 2020	110
Russia	2019	June 2020	815
<b>Total</b>			<b>3,121</b>

*Source:* Authors' elaboration based on World Bank Enterprise Surveys (WBES) COVID-19 follow-up surveys and baseline surveys.

*Note:* The sample of firms in the WBES COVID-19 follow-up survey are drawn from the latest baseline survey. MENA =- Middle East and North Africa; LAC = Latin America and the Caribbean. *Transition economies* refers to countries in South-Eastern Europe and the Commonwealth of Independent States and Georgia, as classified by the United Nations.

## 5. Descriptive statistics

### 5.1 Summary statistics

Summary statistics are presented in Table 2 (firm-level variables) and Table 3 (country-level variables). Correlation matrices are presented in Tables 13 and 14 (Annex 1).

Firm-level summary statistics in Table 2 show that the average firm in our sample experienced a decline in both employment and sales over the period analysed. The sample includes a wide range of firms, differentiated by size and age. Most firms did not undertake innovation or expenditure on research and development (R&D). For the average firm in the sample, approximately 18% of sales are exports. The *Production response* variable indicates that 41% of firms in the sample converted their product or service in response to the pandemic, suggesting a high degree of adaptation. Only 13% of firms received assistance from the government during the COVID pandemic (*Gov. COVID support* variable).

**Table 2: Summary statistics for employment and sales regressions: Firm-level variables**

Variable	Obs.	Mean	Std. Dev.	Min	Max
Firm employment growth (log)	2,554	-0.15	0.63	-3.09	1.05
Firm sales growth (%)	2,233	-0.34	0.29	-1.00	0.08
Firm size (log)	2,554	4.31	1.43	0.88	10.60
Firm size	2,554	124.03	494.51	1.00	20,000.00
Firm age (log)	2,554	2.70	0.82	0.00	4.43
Firm age	2,554	20.06	15.96	1.00	84.00
Credit line	2,554	0.49	0.50	0.00	1.00
R&D	2,554	0.13	0.34	0.00	1.00
Innovator	2,554	0.37	0.48	0.00	1.00
New asset purchase	2,554	0.40	0.49	0.00	1.00
% foreign ownership	2,554	9.30	26.40	0.00	100.00
International quality certification	2,554	0.19	0.39	0.00	1.00
Export intensity	2,554	17.85	31.06	0.00	100.00
Manager experience (log)	2,554	2.70	0.73	0.00	4.25
Formal training	2,554	0.26	0.44	0.00	1.00
Production response	2,554	0.41	0.49	0.00	1.00
Gov. COVID support	2,554	0.13	0.34	0.00	1.00
Months since March 2020	2,554	2.65	1.01	1.00	9.00

*Source:* Authors' elaboration based on World Bank Enterprise Surveys (WBES) COVID-19 follow-up surveys and baseline surveys. *Note:* R&D = research and development.

The country-level summary statistics presented in Table 3 illustrate that the share of manufacturing in the GDP of countries in the sample ranges between 6% and 21%, with a mean of 13%. *CIP score* (using UNIDO’s Competitive Industrial Performance Index) has a mean value of 4.5. *Stringency index* and *Economic response index* show the diversity in the containment measures imposed in response to the pandemic and the extent of government responses to the pandemic, respectively.

**Table 3: Summary statistics for employment and sales regressions: Country-level variables**

Variable	Obs.	Mean	Std. Dev.	Min	Max
GDP per capita (log)	2,554	8.36	0.85	6.28	9.39
GDP per capita	2,554	5,775.43	4,066.08	535.17	12,011.53
Manuf. share of GDP (%)	2,554	13.48	4.14	6.27	21.26
CIP score (x 100)	2,554	4.468	3.543	0.387	9.626
Capital account openness	2,554	0.27	1.29	-1.22	2.33
5-year avg. inflation (%)	2,554	4.94	2.98	0.41	10.24
Gov. consumption (% of GDP)	2,554	16.74	2.56	10.56	21.84
Stringency index (log)	2,554	4.84	0.59	3.25	5.25
Economic response index (log)	2,554	3.57	1.60	0.00	4.93
Cumulative COVID deaths per 1 million ppl (log)	2,554	6.15	1.69	3.26	8.78

*Source:* Authors’ elaboration based on World Bank Enterprise Surveys (WBES) COVID-19 follow-up surveys and baseline surveys.

*Note:* GDP = gross national product; CIP = Competitive Industrial Performance (referring to UNIDO’s CIP Index).

## 5.2 Changes in firms’ operating status

Table 4 describes the distribution of firms in all countries in the sample by operating status, according to the 2020 WBES COVID-19 follow-up survey. On average, a large majority of firms remained fully open during the early pandemic period. However, there is considerable country-level heterogeneity, with the percentage of firms remaining open ranging from a low of approximately 67% in Honduras to 95% in Belarus. Across the entire sample, 89% of firms remained open.

**Table 4: Distribution of manufacturing firms by operating status, 2020**

	<b>Permanently closed (%)</b>	<b>Temporarily closed (%)</b>	<b>Open (%)</b>
Albania	0.86	12.68	86.46
Belarus	3.81	0.73	95.46
El Salvador	3.46	22.96	73.58
Georgia	2.53	21.6	75.88
Guatemala	1.97	16.26	81.77
Honduras	3.55	29.59	66.86
Jordan	11.70	4.79	83.51
Moldova	1.05	13.29	85.66
Morocco	10.54	7.56	81.9
Mozambique	6.44	8.15	85.41
Niger	5.56	12.5	81.94
Russia	3.86	4.11	92.02
Zambia	5.33	16.16	78.51
Zimbabwe	2.37	10.38	87.25
<i>Total</i>	<i>5.06</i>	<i>10.60</i>	<i>84.34</i>

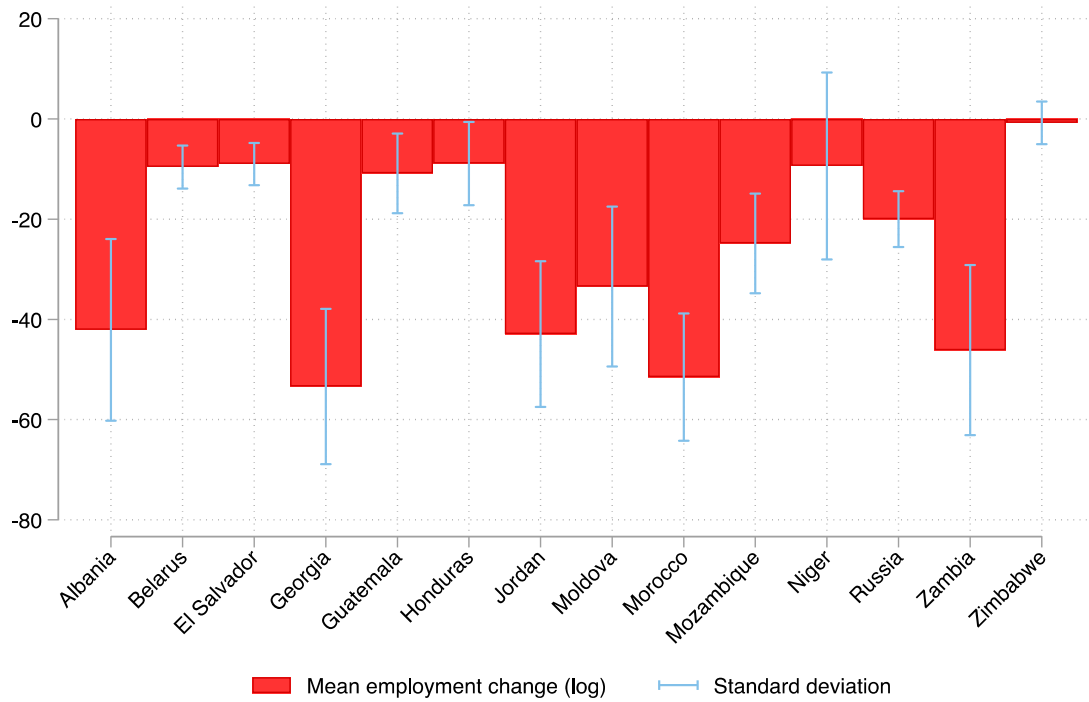
*Source:* Authors' elaboration based on WBES baseline and COVID-19 follow-up surveys.

### **5.3 Changes in employment and sales**

Figure 2 illustrates the unconditional average annual change in employment for all firms, based on responses in the baseline survey compared to responses in the 2020 COVID-19 follow-up survey (closed firms have employment and sales set to zero). This again shows a high degree of heterogeneity across countries—in this case, in the extent to which employment in manufacturing firms has been affected.

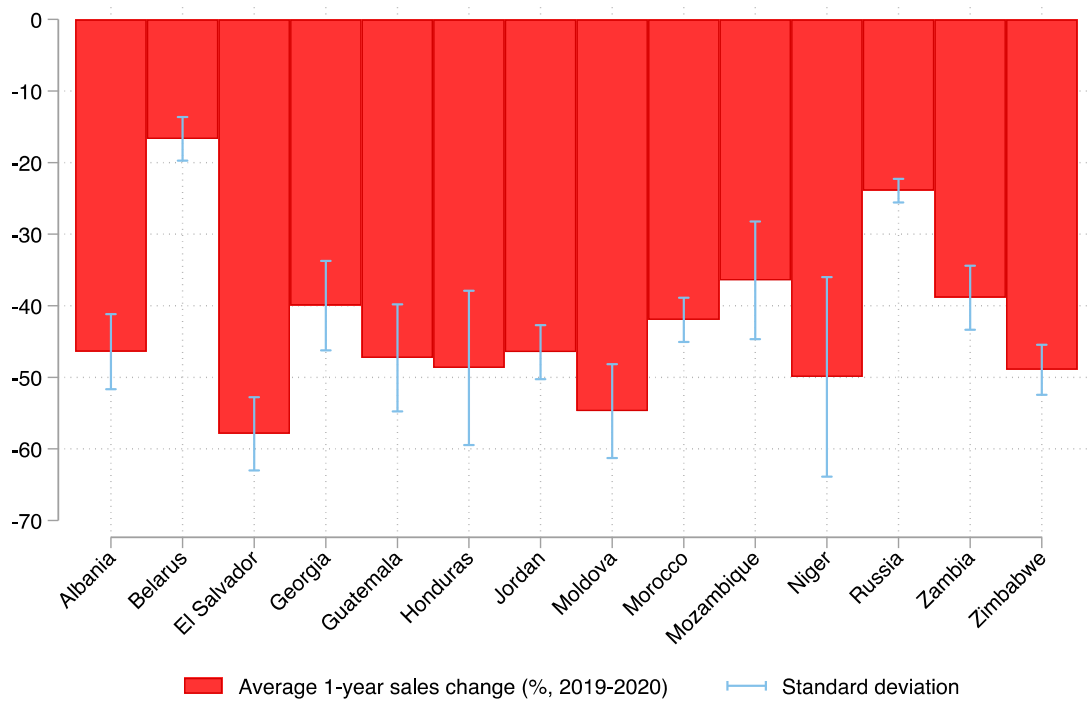
Figure 3 presents the average one-year change in sales across all firms in the sample by country—specifically, the change between the same survey month of the previous year and 2020. Sales have been significantly more negatively affected by the pandemic across countries over this period when compared to employment. Once again, a high degree of heterogeneity across countries is evident.

**Figure 2: Manufacturing firms' average annual change in employment, baseline survey results vs. COVID-19 follow-up survey results (log points)**



Source: Authors' elaboration based on WBES baseline and COVID-19 follow-up surveys.

**Figure 3: Average one-year sales change (percentage point), 2019-2020**



Source: Authors' elaboration based on WBES baseline and COVID-19 follow-up surveys.

## 6. Regression results

Based on the empirical strategy outlined earlier, the first set of regression results presented in the following section analyses determinants of firm survival during the pandemic period. Next, Section 6.2 presents the results for second-stage regressions analysing determinants of changes in employment levels among firms that remained open, controlling for selection; these are our main results for firm performance. Finally, Section 6.3 presents supplementary results of firm sales as a secondary measure of performance.

### 6.1 Determinants of firm survival

The first part of the analysis is an estimation of the likelihood of firm survival during the early phase of the COVID-19 pandemic. The dependent variable in our analysis is a dummy variable equal to 1 if the firm is fully open at the time of the survey and equal to 0 if the firm is closed or temporarily closed. Table 5 presents the results of both a linear probability model (LPM) and a probit model reporting the marginal effects. Results are highly consistent between the two models.

The results suggest that, for manufacturing firms, the production capability that is most significantly associated with a higher likelihood of remaining open is whether the firm has an internationally recognized quality certification. In addition, larger firms are more likely to have remained open relative to smaller firms.

One of the important country-level determinants of the likelihood of manufacturing firm survival in the early pandemic phase is the *CIP score*, indicating that countries with more competitive industrial sectors are associated with lower rates of manufacturing firm closures. At the same time, firm survival is also negatively associated with more stringent government lockdown measures, the greater the severity of the pandemic (measured by cumulative deaths), and a higher level of capital account openness.

**Table 5: Determinants of firm survival during pandemic's early phase**

	(1)	(2)	(3)	(4)
	(LPM)	(Probit)	(LPM)	(Probit)
<i>Technological capabilities</i>				
R&D	0.008 (0.015)	0.007 (0.019)	0.016 (0.015)	0.018 (0.022)
Innovator	-0.011 (0.014)	-0.018 (0.013)	-0.013 (0.014)	-0.018 (0.014)
New fixed assets	0.020 (0.012)	0.021 (0.013)	0.021 (0.013)	0.022 (0.014)
% foreign ownership	-0.000 (0.000)	-0.000** (0.000)	-0.000 (0.000)	-0.000* (0.000)
<i>Production capabilities</i>				
International quality certification	0.034*** (0.012)	0.049*** (0.019)	0.040*** (0.013)	0.059*** (0.021)
Credit line	-0.027** (0.012)	-0.026** (0.012)	-0.026** (0.012)	-0.030** (0.013)
Export intensity	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
Manager experience (log)	0.004 (0.009)	0.007 (0.009)	0.003 (0.009)	0.008 (0.010)
Formal training	0.005 (0.015)	0.004 (0.014)	0.004 (0.015)	0.002 (0.016)
<i>Other firm characteristics</i>				
Firm size (log)	0.021*** (0.004)	0.025*** (0.005)	0.021*** (0.005)	0.029*** (0.006)
Firm age (log)	-0.009 (0.008)	-0.005 (0.008)	-0.011 (0.008)	-0.008 (0.009)
<i>Country-level variables</i>				
Months since March 2020	0.038*** (0.012)	0.026*** (0.010)	0.039*** (0.012)	0.029*** (0.011)
GDP per capita (log)	0.093* (0.050)	0.051* (0.030)	0.088* (0.052)	0.049 (0.034)
Manufacturing share of GDP (%)	-0.039 (0.045)	-0.018 (0.027)	-0.043 (0.046)	-0.031 (0.031)

	(1)	(2)	(3)	(4)
	(LPM)	(Probit)	(LPM)	(Probit)
CIP score	0.013 (0.009)	0.014** (0.006)	0.016 (0.010)	0.020*** (0.008)
Capital account openness	-0.033** (0.014)	-0.020** (0.010)	-0.031** (0.014)	-0.019* (0.011)
Inflation 5-yr avg.	-0.000 (0.006)	0.001 (0.003)	-0.001 (0.006)	0.001 (0.004)
Gov consumption (% of GDP)	-0.008 (0.006)	-0.008 (0.005)	-0.010 (0.007)	-0.009* (0.005)
Stringency index	-0.077*** (0.030)	-0.070*** (0.026)	-0.076** (0.030)	-0.076*** (0.029)
Economic response index	0.012 (0.011)	0.005 (0.009)	0.011 (0.011)	0.006 (0.010)
COVID deaths per 1m ppl (log)	-0.067*** (0.019)	-0.043*** (0.013)	-0.068*** (0.020)	-0.049*** (0.014)
Constant	0.927* (0.475)		0.972* (0.499)	
2-digit ISIC dummy	Yes	Yes	No	No
4-digit ISIC dummy	No	No	Yes	Yes
Observations	2 554	2 539	2 554	2 217
R <sup>2</sup>	.086		.121	

*Note:* Robust standard errors in parenthesis. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . LPM = linear probability model. R&D = research and development; CIP = competitive industrial performance; GDP = gross domestic product.

## 6.2 Determinants of firm employment changes

### 6.2.1 Main results

To estimate the determinants of firm-level employment growth between the baseline period and the COVID-19 pandemic period, we first control for selection bias. Since we focus on the firms that have remained open during the pandemic, we first control for firm survival. A two-step Heckman selection model is estimated, using additional selection variables such as net profit and a dummy variable if the establishment is part of a larger firm. The inverse Mills ratio is then included in the second and final stage regression of employment growth on firm-level and country-level variables, which is presented in Table 6.

In these regressions, we show results for the individual variable components of the dimensions of productive capabilities (production capabilities and technological capabilities). Our results suggest that the manufacturing firms that have been more resilient regarding employment growth over this period are those with the following key production capabilities: firms that have access to credit and firms that upskill employees through formal training. Access to credit could assist firms in riding out the difficult conditions of the pandemic and, potentially, in undertaking continuous upgrading. Training underscores the importance of skills among manufacturing workers as an element of productive capabilities and as a determinant of firm performance in the face of pandemic shock.

Importantly, manufacturing firms that have been able to adapt their production of goods to the pandemic and those that have received specific COVID-19 support from the government have sustained higher employment over time. These two results draw attention to the importance of state actions and interventions in response to pandemic conditions. Furthermore, stronger productive capabilities are likely to better equip firms to adapt their activities in response to the difficult conditions of the pandemic.

In addition, larger manufacturing firms appear to be associated with poorer employment outcomes, whereas older firms, which have been in existence for longer, have shown more resilience regarding employment.

The coefficients on the country-level variables indicate that firms in countries with a higher CIP score are associated with stronger employment growth (or less job losses). This clearly points to the importance of competitiveness and upgrading of manufacturing for resilience through the pandemic. Furthermore, since *CIP score* is a country-level variable, we must point out that it is not just a manufacturing firm's own characteristics that matter for its outcomes, but also the competitiveness and sophistication of the manufacturing sector across the entire country.

As might be expected, the severity of the pandemic measured by both total deaths per 1 million people and the stringency of government lockdowns are negatively associated with firms' employment over this period.

Equivalent regressions, in which these variables are combined into two distinct capabilities indexes, are shown in Table 16 in Annex 2. Those results show the production capabilities index to be positively and significantly related to more resilient firm growth.

**Table 6: Second-stage regression: Determinants of employment changes in firms that remained open during the pandemic (baseline vs. COVID-19 follow-up survey), controlling for selection**

	(1)	(2)
<i><b>Technological capabilities</b></i>		
R&D expenditure	0.033 (0.038)	0.048 (0.037)
Innovator	-0.013 (0.034)	-0.006 (0.034)
New fixed assets	0.013 (0.030)	0.009 (0.031)
% foreign ownership	0.001 (0.001)	0.001 (0.001)
<i><b>Production capabilities</b></i>		
International quality certification	0.048 (0.041)	0.042 (0.044)
Credit line	0.073** (0.031)	0.065** (0.031)
Export intensity	-0.001 (0.001)	-0.001 (0.001)
Manager experience (log)	0.009 (0.022)	0.012 (0.022)
Training	0.074** (0.035)	0.069* (0.036)
<i><b>Other firm characteristics</b></i>		
Firm size (log)	-0.107*** (0.014)	-0.106*** (0.013)
Firm age (log)	0.050** (0.022)	0.045** (0.022)
Production response	0.058** (0.029)	0.058* (0.029)
COVID government support	0.089* (0.051)	0.102* (0.053)

*Country-level variables*

Months since March 2020	0.002 (0.022)	-0.001 (0.021)
GDP per capita (log)	-0.184** (0.074)	-0.218*** (0.076)
Manufacturing share of GDP (%)	0.081 (0.100)	0.078 (0.103)
CIP score	0.096*** (0.019)	0.096*** (0.019)
Capital account openness	-0.080*** (0.027)	-0.056** (0.028)
Inflation 5-yr avg.	-0.009 (0.011)	-0.011 (0.012)
Gov consumption (% of GDP)	-0.040*** (0.011)	-0.037*** (0.012)
Stringency index	-0.181*** (0.066)	-0.144** (0.065)
Economic response index	0.047* (0.026)	0.031 (0.026)
COVID deaths per 1m ppl (log)	-0.097*** (0.031)	-0.070*** (0.029)
Mills ratio	-0.011 (0.232)	0.041 (0.142)
Constant	3.112*** (0.850)	3.101*** (0.886)
2-digit ISIC dummy	Yes	No
4-digit ISIC dummy	No	Yes
Observations	2 228	2 228
R <sup>2</sup>	.1133	.1620

*Note:* Robust standard errors in parenthesis. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . R&D = research and development; CIP = competitive industrial performance; GDP = gross domestic product.

### 6.2.2 *Heterogeneity by sector*

Next, we explore how the determinants of firm-level employment outcomes vary by type of sector. In our main regressions, we control for sector with the inclusion of sectoral dummies (alternatively at the 2- and 4-digit ISIC levels of disaggregation). In these extensions, we run split-sample regressions with firms split by type of sector: first, by technology intensity; second, by vulnerable versus resilient sectors.

First, we classify firms into technology classes using UNIDO's classification schema (see UNIDO 2019), with the results shown in Table 7. This extension seeks to analyse how the determinants of manufacturing firm performance vary between low-tech firms and medium- and high-tech (MHT) firms. Here, we show in the same table the results for the production capabilities and technological capabilities indices, as well as for the individual component variables of each.

These results suggest that a technological capabilities index is an important determinant of firm resilience for firms in MHT sectors, whereas a production capabilities index is a significant determinant of resilience for firms in low-tech sectors. This difference between the two categories of firms by technological class highlights the relative importance of technological capabilities in MHT industries. The pattern of results regarding country-level variables is consistent with the results presented in Table 6.

When dividing the sample between the group of sectors that are more vulnerable to the pandemic and sectors that are more resilient, we find that the production capabilities index is significantly and positively related to higher firm employment growth (see Table 8). As pointed out earlier in this paper, firms in countries with a higher CIP score are associated with lower employment losses, including those firms in vulnerable sectors. As expected, the stringency index and severity of the pandemic are found to have more significant effects on firms in vulnerable sectors, and government policy responses are also shown to positively contribute to employment resilience among this group of firms.

**Table 7: Determinants of employment growth in manufacturing firms, by technology class (baseline vs. COVID-19 follow-up survey), controlling for selection**

	(1)	(2)	(3)	(4)
	Low tech	MH tech	Low tech	MH tech
Technological capabilities index			0.008 (0.018)	0.060** (0.026)
R&D expenditure	0.049 (0.050)	0.027 (0.060)		
Innovator	-0.042 (0.040)	0.080 (0.061)		
New fixed assets	0.004 (0.036)	0.077 (0.059)		
% foreign ownership	0.001 (0.001)	-0.000 (0.001)		
Production capabilities index			0.049** (0.022)	0.031 (0.034)
International quality certification	0.052 (0.051)	0.048 (0.067)		
Credit line	0.071* (0.038)	0.054 (0.055)		
Export intensity	-0.001* (0.001)	-0.000 (0.001)		
Manager experience (log)	0.009 (0.026)	0.014 (0.040)		
Training	0.094** (0.043)	0.021 (0.063)		
<i>Other firm characteristics</i>				
Firm size (log)	-0.113*** (0.017)	-0.068*** (0.024)	-0.113*** (0.017)	-0.071*** (0.024)
Firm age (log)	0.071*** (0.024)	-0.040 (0.046)	0.067*** (0.022)	-0.032 (0.036)
Production response	0.084** (0.035)	-0.010 (0.053)	0.086** (0.036)	-0.009 (0.051)
COVID government support	0.096 (0.067)	0.111* (0.065)	0.099 (0.067)	0.108* (0.064)

	(1)	(2)	(3)	(4)
	Low tech	MH tech	Low tech	MH tech
<i>Country-level variables</i>				
Months since March 2020	-0.005 (0.021)	-0.016 (0.047)	-0.005 (0.021)	-0.016 (0.045)
GDP per capita (log)	-0.042 (0.078)	-0.298 (0.359)	-0.060 (0.082)	-0.355 (0.361)
Manufacturing share of GDP (%)	0.151 (0.104)	-0.112 (0.302)	0.182* (0.105)	-0.155 (0.301)
CIP score	0.075*** (0.019)	0.152** (0.065)	0.082*** (0.019)	0.161** (0.065)
Capital account openness	-0.099*** (0.035)	-0.149 (0.099)	-0.100*** (0.036)	-0.136 (0.100)
Inflation 5-yr avg.	-0.012 (0.011)	-0.024 (0.037)	-0.008 (0.011)	-0.026 (0.037)
Gov consumption (% of GDP)	-0.045*** (0.016)	-0.080*** (0.026)	-0.048*** (0.016)	-0.081*** (0.025)
Stringency index	-0.006*** (0.002)	-0.006 (0.005)	-0.006*** (0.002)	-0.006 (0.004)
Economic response index	0.004* (0.002)	0.006 (0.007)	0.005** (0.002)	0.005 (0.007)
COVID deaths per 1m ppl (log)	-0.149*** (0.045)	-0.158 (0.150)	-0.163*** (0.047)	-0.134 (0.149)
Mills ratio	0.139 (0.268)	-0.079 (0.203)	0.176 (0.299)	-0.072 (0.189)
Constant	1.815** (0.715)	4.937* (2.975)	2.043*** (0.725)	5.462* (2.961)
4-digit industry dummy	Yes	Yes	Yes	Yes
Observations	1657	571	1657	571
R <sup>2</sup>	.118	.128	.111	.125

*Note:* Robust standard errors in parenthesis. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . R&D = research and development; CIP = competitive industrial performance; GDP = gross domestic product.

**Table 8: Determinants of employment growth in manufacturing firms, by sector resilience (baseline vs. COVID-19 follow-up survey), controlling for selection**

	(1) Vulnerable sectors	(2) Resilient sectors	(3) Vulnerable sectors	(4) Resilient sectors
Technological capabilities index			0.022 (0.021)	0.019 (0.022)
R&D expenditure	0.053 (0.060)	0.044 (0.052)		
Innovator	-0.027 (0.045)	-0.017 (0.052)		
New fixed assets	0.015 (0.043)	0.035 (0.045)		
% foreign ownership	0.001 (0.001)	-0.000 (0.001)		
Production capabilities index			0.045 (0.029)	0.093*** (0.025)
International quality certification	-0.033 (0.065)	0.211*** (0.050)		
Credit line	0.124*** (0.045)	-0.002 (0.042)		
Export intensity	-0.002** (0.001)	-0.000 (0.001)		
Manager experience (log)	-0.012 (0.034)	0.010 (0.026)		
Training	0.064 (0.053)	0.092* (0.048)		
<i><b>Other firm characteristics</b></i>				
Firm size (log)	-0.097*** (0.020)	-0.091*** (0.024)	-0.088*** (0.019)	-0.091*** (0.024)
Firm age (log)	0.071** (0.034)	0.012 (0.027)	0.053** (0.027)	0.012 (0.025)
Production response	0.077* (0.041)	0.017 (0.055)	0.109** (0.045)	0.027 (0.052)
COVID government support	0.086 (0.073)	0.054 (0.071)	0.099 (0.074)	0.057 (0.070)

*Country-level variables*

Months since March 2020	-0.013 (0.029)	-0.010 (0.026)	0.002 (0.029)	-0.007 (0.025)
GDP per capita (log)	-0.007 (0.106)	-0.165* (0.096)	0.038 (0.114)	-0.158* (0.093)
Manufacturing share of GDP (%)	0.269* (0.138)	0.062 (0.133)	0.242* (0.143)	0.095 (0.132)
CIP score	0.088*** (0.027)	0.080*** (0.025)	0.114*** (0.031)	0.083*** (0.024)
Capital account openness	-0.149*** (0.048)	-0.047 (0.042)	-0.163*** (0.051)	-0.056 (0.043)
Inflation 5-yr avg.	-0.001 (0.017)	-0.002 (0.013)	-0.007 (0.018)	-0.002 (0.013)
Gov consumption (% of GDP)	-0.068*** (0.020)	-0.019 (0.021)	-0.068*** (0.020)	-0.023 (0.021)
Stringency index	-0.007** (0.003)	-0.002 (0.003)	-0.009*** (0.003)	-0.002 (0.003)
Economic response index	0.006 (0.003)	0.003 (0.003)	0.006* (0.003)	0.002 (0.003)
COVID deaths per 1m ppl (log)	-0.225*** (0.068)	-0.059 (0.056)	-0.283*** (0.076)	-0.074 (0.056)
Mills ratio	0.130 (0.378)	0.234 (0.463)	- (-)	0.253 (0.452)
Constant	1.815* (0.942)	1.817** (0.921)	1.784* (0.928)	1.900** (0.903)
Observations	1378	800	1378	800
R <sup>2</sup>	.1099931	.0943173	.097003	.0848192

*Note:* Robust standard errors in parenthesis. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . R&D = research and development; CIP = competitive industrial performance; GDP = gross domestic product.

### **6.3 Determinants of firm sales changes**

We also analyse determinants of manufacturing enterprise performance in terms of changes in sales, although the employment results presented in section 6.2 are our preferred results, given the superior data quality regarding employment and as they provide a clearer picture of the socioeconomic effect of the pandemic on the individual worker.

To estimate the determinants of firm-level annual sales change, we first control for selection bias. Since we focus on firms that have remained open during the pandemic, we first control for firm survival. A two-step Heckman selection model is estimated, using additional selection variables such as net profit and a dummy variable if the establishment is part of a larger firm. The inverse Mills ratio is then included in the final stage regression of sales growth on firm-level and country-level variables, and results are presented in Table 9.

Our analysis shows that higher sales growth at the firm-level for manufacturing firms are positively associated with two main production capabilities: having an internationally recognized quality certification and access to credit. In addition, larger manufacturing firms are also associated with better sales performance over the previous year. While the coefficient on whether the firm received government support during the pandemic is negative, this could suggest that support was targeted to the most vulnerable firms. Furthermore, government support across countries was often provided via wage support, which could underpin the different results found for employment growth compared to sales growth, where firms were able to sustain employment in the face of sales losses.

Finally, when using the technological and production capabilities indices, results suggest that the production capabilities index is positively and significant associated with firm sales growth (see Table 17 in Annex 2).

**Table 9: Second-stage regression: Determinants of sales changes in firms that remained open during the pandemic (baseline vs. COVID-19 follow-up survey), controlling for selection**

	(1)	(2)
<i>Technological capabilities</i>		
R&D expenditure	0.077 (0.169)	0.085 (0.177)
Innovator	-0.045 (0.132)	-0.032 (0.135)
New fixed assets	0.118 (0.122)	0.090 (0.125)
% foreign ownership	-0.004* (0.002)	-0.004* (0.002)
<i>Production capabilities</i>		
International quality certification	0.560*** (0.178)	0.592*** (0.181)
Credit line	0.360*** (0.118)	0.311*** (0.118)
Export intensity	-0.000 (0.002)	0.000 (0.002)
Manager experience (log)	-0.075 (0.087)	-0.074 (0.089)
Training	-0.011 (0.136)	-0.014 (0.139)
<i>Other firm characteristics</i>		
Firm size (log)	0.178*** (0.055)	0.162*** (0.050)
Firm age (log)	-0.106 (0.083)	-0.130 (0.083)
Production response	0.036 (0.121)	-0.013 (0.117)
COVID government support	-0.270 (0.171)	-0.303* (0.179)

*Country-level variables*

Months since March 2020	0.051 (0.112)	0.041 (0.110)
GDP per capita (log)	-0.292 (0.352)	-0.338 (0.350)
Manufacturing share of GDP (%)	-0.036 (0.029)	-0.046 (0.029)
CIP score	0.057 (0.065)	0.071 (0.063)
Capital account openness	0.314*** (0.114)	0.308*** (0.113)
Inflation 5-yr avg.	-0.001 (0.041)	-0.013 (0.042)
Gov consumption (% of GDP)	0.092* (0.050)	0.073 (0.051)
Stringency index	0.268 (0.321)	0.314 (0.322)
Economic response index	-0.354*** (0.108)	-0.382*** (0.109)
COVID deaths per 1m ppl (log)	0.426*** (0.165)	0.443*** (0.165)
Mills ratio	-0.380 (0.828)	-0.738 (0.638)
Constant	-4.750* (2.826)	-3.299 (2.763)
2-digit ISIC dummy	Yes	No
4-digit ISIC dummy	No	Yes
Observations	1959	1959
R <sup>2</sup>	.1758	.2232

*Note:* Robust standard errors in parenthesis. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . R&D = research and development; CIP = competitive industrial performance; GDP = gross domestic product.

## 7. Conclusion

In this paper, we have econometrically analysed the determinants of firm-level outcomes among manufacturing enterprises in developing and emerging economies for the pandemic period compared to the pre-pandemic period. This analysis is intended to shed light on the heterogeneity in firm-level outcomes within and between countries, understanding these differences as arising from both firm-level and country-level factors.

The WBES provide a rich source of firm-level data for this analysis, although limited country coverage at the time of writing—and, relatedly, incomplete coverage of certain variables for some of the countries included in the survey—limit the number of countries in the sample available for this analysis. This suggests that results should be interpreted with caution when drawing conclusions and implications for developing and emerging economies more widely.

Overall, the results are fairly noisily estimated, pointing to the strongly idiosyncratic aspect of enterprise performance outcomes over the period of the pandemic. This may be related to the unique characteristics of the COVID-19 pandemic and of the associated containment measures, which are unprecedented worldwide and which have affected national economies and firms in ways that are not always easy to understand and to neatly model econometrically. Nonetheless, the regressions have produced some interesting and intuitive results, with relevance for policy.

Our main results analyse the determinants of firm status (open or closed during or due to the pandemic) and of employment outcomes among open firms. We also present a secondary set of results analysing determinants of sales outcomes among open firms.

The elements of productive capabilities that appear to have the strongest effect on whether firms managed to stay open through the pandemic are: (1) investment in new fixed capital in the past financial year (part of technological capabilities), and (2) having an internationally recognized quality certification (part of production capabilities). Among firms that remained open, the elements of productive capabilities with the strongest positive effects on employment are: (1) access to credit, and (2) the provision of formal training for employees. When firms are disaggregated by technological class, it emerges that technological capabilities are especially important for medium- and high-tech (MHT) firms, while production capabilities are particularly important for low-tech firms, which seems intuitive.

In our main employment regressions, firms that adapted their production activities during the pandemic fared relatively better in employment outcomes. This points to the importance of agility and dynamism in firms responding proactively to shocks. The ability of firms to do so is likely to be affected in part by their prior productive capabilities.

Similarly, firms that received direct government COVID-19 assistance had superior employment outcomes. This shows the importance of government financial support for protecting employment in the face of the pandemic. It may also be the case that more sophisticated firms are better placed to access government support that has been made available.

At the country level, one key determinant that emerges is the CIP score. This is positive in all regressions and highly significant in almost all regressions, demonstrating the importance of a strong and sophisticated manufacturing sector for firm-level outcomes.<sup>3</sup>

Key policy implications of these findings can be summarized at both the firm- and country-levels. For firms, resilience to the shock of the pandemic is influenced by firms' prior characteristics, including their productive capabilities. The individual elements of productive capabilities that strongly matter vary across regressions but include investment in new fixed capital, having an internationally recognized quality certification, access to credit, and the provision of formal training for employees. This underscores the importance of productive capabilities for firms' resilience, potential and prosperity. Productive capabilities cannot be built overnight to respond to a crisis; they are developed through active and continuous processes of learning. Furthermore, these results also draw attention to the importance of firms adapting their production activities during the pandemic in order to protect their employment levels. Receipt of direct government assistance also matters significantly for firms' employment outcomes.

Key policy implications at the country-level centre on the importance of the CIP score for firm-level outcomes, especially employment outcomes. The CIP score, proxying the strength and sophistication of a country's manufacturing sector, is influenced by policy choices, including industrial policy as well as policy in other relevant domains, over an extended period of time. The more robust a country's manufacturing sector as a whole, the better the employment outcomes are likely to be for individual manufacturing firms, even controlling for relevant firm-level

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<sup>3</sup> It is worth noting is that, in alternative specifications (not shown here) in which the CIP score is omitted, the share of manufacturing in GDP shows up as positive and significant; this effect seems to become insignificant (and even turn negative in the case of the second-stage sales regressions) once the CIP score is included.

characteristics. This underscores the ongoing importance of industrial development, structural transformation and industrial policy.

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## Appendix 1: Additional tables

**Table 10: Comparison of baseline and matched samples**

	Full baseline sample				
	Number of firms	Manufacturing (% of firms)	Services (% of firms)	Average firm size by employment	Average firm age
Albania	377	38.73	61.27	72.03	14.95
Belarus	600	55.00	45.00	165.31	21.10
El Salvador	719	56.33	43.67	107.39	23.00
Georgia	581	35.28	64.72	70.90	11.28
Guatemala	345	41.45	58.55	113.77	29.61
Honduras	332	27.71	72.29	65.24	24.18
Moldova	360	38.33	61.67	88.71	18.46
Morocco	1,096	42.24	57.76	105.94	20.05
Mozambique	601	47.75	52.25	54.04	16.17
Niger	151	27.15	72.85	39.17	15.87
Russia	1,323	67.20	32.80	142.00	14.06
Zambia	601	29.95	70.05	78.97	17.90
Zimbabwe	600	48.17	51.83	105.19	28.46

	Matched sample					
	Number of firms	% of full sample	Manufacturing (% of firms)	Services (% of firms)	Average firm size by employment	Average firm age
Albania	347	92.04	38.04	61.96	69.65	14.78
Belarus	551	91.83	56.99	43.01	168.60	21.30
El Salvador	405	56.33	55.80	44.20	104.03	23.72
Georgia	514	88.47	35.41	64.59	70.57	11.44
Guatemala	203	58.84	38.92	61.08	117.82	30.11
Honduras	169	50.90	34.32	65.68	43.03	25.85
Moldova	286	79.44	38.46	61.54	87.16	18.85
Morocco	873	79.65	40.89	59.11	94.09	20.15
Mozambique	236	39.27	53.39	46.61	42.80	17.35
Niger	75	49.67	26.67	73.33	38.86	14.26
Russia	1,191	90.02	68.43	31.57	142.55	14.13
Zambia	563	93.68	28.95	71.05	76.59	17.65
Zimbabwe	549	91.50	48.82	51.18	110.26	28.05

*Source:* Authors' elaboration based on WBES baseline surveys and COVID-19 follow-up surveys.

*Note:* The matched sample represents the sample of baseline firms that have completed the COVID-19 follow-up survey. Thus, Jordan is not represented in either the matched sample or the full baseline sample in this table.

**Table 11: Characteristics of non-responding firms**

	Manufacturing (% of firms)	Services (% of firms)	Average firm size by employment	Average firm age
Albania	46.67	53.33	99.6	16.87
Belarus	32.65	67.35	128.2	18.92
El Salvador	57.01	42.99	111.7	22.09
Georgia	34.33	65.67	73.5	10.02
Guatemala	45.07	54.93	107.9	28.89
Honduras	20.86	79.14	88.1	22.41
Moldova	37.84	62.16	94.7	16.96
Morocco	47.53	52.47	152.5	19.66
Mozambique	44.11	55.89	61.3	15.40
Niger	27.63	72.37	39.5	17.48
Russia	56.06	43.94	137.1	13.39
Zambia	44.74	55.26	114.2	21.39
Zimbabwe	41.18	58.82	50.6	33.02

*Note:* Data represents firms from countries in the baseline sample that did not complete the WBES COVID-19 follow-up survey.

**Table 12: Variable descriptions**

<b>Variable</b>	<b>Description</b>
<b>Firm-level variables</b>	
Firm employment growth (log)	Log average annual change in employment from baseline to COVID-19 follow-up survey
Firm sales growth (%)	% change in sales from the same month of the previous year
Firm size (log)	Log number of employees
Firm age (log)	Log age of firm
Credit line	Dummy equal to 1 if the firm has access to a formal credit facility
% foreign ownership	% of firm owned by a foreign individual or corporation
R&D	Dummy equal to 1 if the firm invests in R&D
Innovator	Dummy equal to 1 if the firm introduced new products or services
Export intensity	% of sales that are exported
International quality certification	Dummy equal to 1 if the firm has an internationally recognized quality certification
New asset purchase	Dummy equal to 1 if the firm has purchased new fixed assets in the last financial year
Manager experience	Years of experience of top manager
Formal training	Dummy equal to 1 if the firm conducted formal training for full-time employees
Production response	Dummy equal to 1 if the firm converted its product or services due to the COVID-19 pandemic
Gov. COVID support	Dummy equal to 1 if the firm received assistance from the government during the COVID-19 pandemic
Months since March 2020	Control for the survey month
<b>Country-level variables</b>	
GDP per capita (log)	GDP per capita in 2010 US\$ (log)
Manuf. employment share	% of manufacturing employment in total employment
CIP score	UNIDO Competitive Industrial Performance score
Capital account openness	Index of capital account openness - Chinn-Ito index
5-year avg. inflation (%)	Average inflation over 2015-2019
Gov. consumption (% of GDP)	Size of government measured by government consumption (% of GDP)
Stringency index	Average stringency index since 11 March 2020

Variable	Description
Economic response index	Average economic response index since 11 March 2020
Cumulative COVID deaths per 1 million ppl (log)	Total COVID-19 deaths per 1 million ppl since 11 March 2020

*Note:* R&D = research and development; CIP = Competitive Industrial Performance (referring to UNIDO's CIP Index); GDP = gross domestic product.

**Table 13: Correlation matrix of firm-level variables**

	Employment growth	Sales change	R&D	Innovator	New asset purchase	% foreign ownership	International quality certification	Credit line	Export intensity	Manager experience	Formal training	Firm size	Firm age	Production response	COVID support	Pandemic months
Employment growth	1															
Sales change	0.1890*	1														
R&D	0.0217	0.0904*	1													
Innovator	-0.0234	0.0238	0.2777*	1												
New asset purchase	-0.0394	0.0669*	0.2098*	0.3492*	1											
% foreign ownership	-0.0423	-0.0092	0.0548*	0.0397	0.0966*	1										
International quality certification	0.0097	0.1382*	0.1803*	0.1879*	0.1401*	0.1387*	1									
Credit line	-0.004	0.0969*	0.1415*	0.1891*	0.2059*	0.0749*	0.1396*	1								
Export intensity	-0.1298*	-0.0207	0.0712*	0.1090*	0.1307*	0.2907*	0.2463*	0.1435*	1							
Manager experience	-0.0105	-0.0914*	0.0425	0.0986*	0.0767*	-0.0111	0.0515*	0.0784*	0.0612*	1						
Formal training	0.0005	0.0294	0.2540*	0.2462*	0.2463*	0.1382*	0.2379*	0.2079*	0.1612*	0.0972*	1					
Firm size	-0.1382*	0.2030*	0.1980*	0.1245*	0.1990*	0.2533*	0.3426*	0.2923*	0.3677*	0.1030*	0.2979*	1				
Firm age	0.0365	-0.0382	0.0536*	0.0884*	-0.0206	-0.0237	0.1752*	0.0968*	0.0318	0.4653*	0.1357*	0.2224*	1			

Production response	0.0156	0.0562*	0.0351	0.0528*	0.0408	0.0173	-0.0083	0.021	0.0069	-0.023	0.0446	0.0732*	-0.0196	1		
COVID support	-0.0158	-0.0847*	-0.0234	-0.0309	-0.0285	-0.0294	0.033	0.0441	0.1057*	0.012	0.0061	0.0502	-0.0204	0.0183	1	
Pandemic months	0.0434	0.0612*	-0.0073	0.0243	-0.0508	0.0254	0.0843*	-0.0399	0.0592*	-0.016	-0.006	0.0223	0.1156*	-0.0146	-0.0144	1

*Note:* R&D = research and development; CIP = Competitive Industrial Performance (referring to UNIDO's CIP Index); GDP = gross domestic product. \* indicates significance at the 1% level.

**Table 14: Correlation matrix of country-level variables**

	GDP per capita	Manuf. Share of GDP	CIP	Capital account openness	Inflation	Government consumption (%)	Stringency index	Economic response index	COVID deaths per 1m pop.
GDP per capita	1								
Manuf. Share of GDP	0.2858*	1							
CIP	0.8574*	0.3770*	1						
Capital account openness	0.0503	-0.2721*	-0.1407*	1					
Inflation	0.1822*	-0.0631*	0.3622*	-0.1358*	1				
Government consumption (%)	-0.1327*	-0.0115	0.3174*	-0.3664*	0.2800*	1			
Stringency index	0.0042	-0.4362*	-0.1275*	0.3390*	-0.6529*	-0.0858*	1		
Economic response index	0.3136*	-0.0559*	0.2283*	0.0927*	-0.5782*	0.018	0.7406*	1	
COVID deaths per 1m pop.	0.7765*	0.5640*	0.6616*	-0.4368*	0.1330*	-0.1831*	-0.2818*	0.1987*	1

*Note:* CIP = Competitive Industrial Performance (referring to UNIDO's CIP Index); GDP = gross domestic product. \* indicates significance at the 1% level.

## **Appendix 2: Technological and production capabilities indices**

Building on Avenyo et al. (2021), we capture productive capabilities through two indicators: technological capabilities and production capabilities. In line with the literature (see also Section 2.2), we construct the technological capabilities index using variables identified in the literature—indicators for R&D expenditure, innovation (measured by the firm introducing new and/or significantly improved products and processes), if the firm purchased new fixed assets, and proportion of foreign ownership of the firm. The production capabilities index is constructed from the following variables: if the firm has an internationally recognized quality certification, access to a credit line, export intensity (exports as a ratio of sales), and if the firm has formal training programmes for full-time employees,

The technological and production capabilities indices are each constructed using both continuous and dummy variables, which are not handled well by standard principal component analysis. To construct the indices, we first construct a polychoric correlation matrix (which is an inferred Pearson correlation matrix) of the variables within each index and then conduct the factor analysis to derive the overall index score for each firm from the underlying contribution of each factor.

**Table 15: Determinants of firm survival using capabilities indices**

	(1)	(2)	(3)	(4)
	(LPM)	(Probit)	(LPM)	(Probit)
Technological capabilities	0.002 (0.006)	-0.000 (0.007)	0.003 (0.006)	0.001 (0.007)
Production capabilities	0.005 (0.007)	0.005 (0.008)	0.008 (0.007)	0.007 (0.008)
<i>Other firm characteristics</i>				
Firm size (log)	0.020*** (0.005)	0.024*** (0.005)	0.020*** (0.005)	0.027*** (0.006)
Firm age (log)	-0.008 (0.007)	-0.002 (0.007)	-0.011 (0.007)	-0.005 (0.008)
<i>Country-level variables</i>				
Months since March 2020	0.037*** (0.012)	0.025** (0.010)	0.038*** (0.012)	0.027** (0.011)
GDP per capita (log)	0.104** (0.050)	0.059** (0.028)	0.102* (0.052)	0.062* (0.033)
Manufacturing share of GDP (%)	-0.027 (0.044)	-0.006 (0.026)	-0.032 (0.046)	-0.017 (0.030)
CIP score	0.012 (0.009)	0.014** (0.006)	0.014 (0.010)	0.019*** (0.007)
Capital account openness	-0.036*** (0.014)	-0.023** (0.010)	-0.034** (0.014)	-0.023** (0.011)
Inflation 5-yr avg.	-0.000 (0.006)	0.001 (0.003)	-0.001 (0.006)	0.001 (0.004)
Gov consumption (% of GDP)	-0.008 (0.006)	-0.008 (0.005)	-0.010 (0.006)	-0.009 (0.006)
Stringency index	-0.074** (0.030)	-0.066** (0.026)	-0.074** (0.031)	-0.074** (0.029)
Economic response index	0.010 (0.011)	0.003 (0.009)	0.009 (0.011)	0.002 (0.010)
COVID deaths per 1m ppl (log)	-0.071*** (0.019)	-0.047*** (0.013)	-0.073*** (0.019)	-0.053*** (0.014)
Constant	0.838* (0.470)		0.880* (0.492)	

2-digit ISIC dummy	Yes	Yes	No	No
4-digit ISIC dummy	No	No	Yes	Yes
Observations	2554	2539	2554	2217
R <sup>2</sup>	.0807		.1149	

*Note:* LPM = linear probability model; GDP = gross domestic product; CIP = Competitive Industrial Performance (referring to UNIDO's CIP Index). Robust standard errors in parenthesis. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

**Table 16: Second-stage regression: Determinants of employment growth in firms that remained open during the pandemic (baseline vs. COVID-19 follow-up survey), controlling for selection and using capabilities indices**

	(1)	(2)
Technological capabilities	0.016 (0.015)	0.020 (0.015)
Production capabilities	0.050*** (0.019)	0.044** (0.020)
<i>Other firm characteristics</i>		
Firm size (log)	-0.105*** (0.014)	-0.109*** (0.013)
Firm age (log)	0.048** (0.019)	0.047** (0.019)
Production response	0.066** (0.030)	0.059** (0.030)
COVID government support	0.090* (0.052)	0.101* (0.053)
<i>Country-level variables</i>		
Months since March 2020	0.006 (0.021)	-0.001 (0.021)
GDP per capita (log)	-0.198*** (0.073)	-0.245*** (0.076)
Manufacturing share of GDP (%)	0.091 (0.100)	0.092 (0.103)
CIP score	0.103*** (0.019)	0.101*** (0.019)
Capital account openness	-0.082*** (0.029)	-0.054* (0.028)
Inflation 5-yr avg.	-0.006 (0.011)	-0.008 (0.011)
Gov consumption (% of GDP)	-0.042*** (0.012)	-0.038*** (0.012)
Stringency index	-0.195*** (0.068)	-0.142** (0.066)
Economic response index	0.057**	0.038

	(0.025)	(0.026)
COVID deaths per 1m ppl (log)	-0.107***	-0.070**
	(0.032)	(0.029)
Mills ratio	0.090	0.022
	(0.233)	(0.149)
Constant	3.336***	3.347***
	(0.853)	(0.893)
2-digit ISIC dummy	Yes	No
4-digit ISIC dummy	No	Yes
Observations	2228	2228
R <sup>2</sup>	.1088	.1580

*Note:* GDP = gross domestic product; CIP = Competitive Industrial Performance (referring to UNIDO's CIP Index). Robust standard errors in parenthesis \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

**Table 17: Second-stage regression: Determinants of sales changes of firms that remained open during the pandemic (baseline vs. COVID-19 follow-up survey), controlling for selection and using capabilities indices**

	(1)	(2)
Technological capabilities index	0.021 (0.066)	0.018 (0.067)
Production capabilities index	0.251*** (0.076)	0.256*** (0.077)
<i>Other firm characteristics</i>		
Firm size (log)	0.164*** (0.054)	0.150*** (0.049)
Firm age (log)	-0.130* (0.072)	-0.157** (0.073)
Production response	0.052 (0.125)	0.005 (0.119)
COVID government support	-0.234 (0.173)	-0.269 (0.182)
<i>Country-level variables</i>		
Months since March 2020	0.058 (0.111)	0.049 (0.111)
GDP per capita (log)	-0.238 (0.354)	-0.256 (0.353)
Manufacturing share of GDP (%)	-0.038 (0.028)	-0.048* (0.028)
CIP score	0.090 (0.065)	0.102 (0.063)
Capital account openness	0.279** (0.115)	0.266** (0.113)
Inflation 5-yr avg.	-0.013 (0.041)	-0.026 (0.042)
Gov consumption (% of GDP)	0.078 (0.051)	0.060 (0.052)
Stringency index	0.173 (0.315)	0.204 (0.321)
Economic response index	-0.366***	-0.396***

	(0.106)	(0.109)
COVID deaths per 1m ppl (log)	0.354**	0.357**
	(0.169)	(0.165)
Mills ratio	-0.070	-0.361
	(0.940)	(0.722)
Constant	-3.918	-2.531
	(2.816)	(2.769)
2-digit ISIC dummy	Yes	No
4-digit ISIC dummy	No	Yes
Observations	1959	1959
R <sup>2</sup>	.1678	.2157

*Note:* GDP = gross domestic product; CIP = Competitive Industrial Performance (referring to UNIDO's CIP Index). Robust standard errors in parenthesis. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .



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