
# Productivity *Analysis*

## Indian MSMEs and Firm Productivity: COVID-19 Impact and Government Support

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# INDIAN MSMEs AND FIRM PRODUCTIVITY

## COVID-19 IMPACT AND GOVERNMENT SUPPORT

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# ABSTRACT

The MSME sector is a major contributor to India's economic growth. Despite its prominent role in the economy, the sector often faces challenges to its survival and growth. The COVID-19 pandemic added to the existing woes of MSMEs and posed a significant challenge to their survival. Realizing the magnitude of the crisis, the Government of India introduced a slew of policy measures and funding support schemes for MSMEs to lessen the adverse effects of COVID-19. With the need to reduce personal interactions, the pandemic has also resulted in a substantial expansion of digitalization. Against this backdrop, this study was conducted to analyze the impact of COVID-19 on the productivity of MSMEs and investigate whether the government's measures were successful in mitigating the impact of the pandemic on small firms.

A mixed-method approach was employed to answer the research questions. Quantitative panel data analysis for 2010–22 on Indian MSMEs from the Centre for Monitoring the Indian Economy (CMIE) Prowess database was complemented by specific case studies of two micro firms. To analyze the productivity performance of MSMEs, total factor productivity was computed using the Ackerberg–Caves–Frazer method for eight industries. To investigate the effects of COVID-19 on productivity performance, we divided the study period into 2010–19 (pre-COVID-19) and 2020–22 (COVID-19 period). Two important findings emerged: 1) there was a sharp difference in firm productivity between the two periods; and 2) the average productivity during the COVID-19 period was marginally lower than during the pre-COVID-19 period. An industry-wise detailed picture of productivity differences suggests that productivity fell in all industries except for two. Size-wise analysis showed a statistically significant productivity decline for most size groups.

After accounting for firm characteristics, we examined the role of digitalization and credit support from the government on firm productivity. Econometric analysis did not provide convincing evidence of digitalization and government policy improving the productivity of MSMEs. However, to validate the findings, we interacted with some micro units to examine whether and how government schemes had helped mitigate the adverse effects of the pandemic. One micro unit (case 1) seems to have benefited from such schemes, whereas another smaller one (case 2) did not receive such support and has yet to come out of the COVID-19 pandemic shock.

# INTRODUCTION

The MSME sector is a major contributor to India's economic growth. According to the latest estimates, MSMEs account for about 30% of GDP, nearly 48% of total exports, and employment opportunities for over 40% of India's labor force [1, 2]. The sector is dominated by microenterprises, accounting for 95% of all enterprises. Despite its prominent role in the economy, the sector often faces challenges to its survival and growth. The COVID-19 pandemic erupted in March 2020, added to the existing woes of MSMEs, and posed a significant challenge to their survival.

Based on the COVID-19 caseload and mobility restrictions imposed by the Indian federal and state governments, the period from March 2020 is divided into the pandemic period, recovery period, and postpandemic period [3]. The pandemic period, from March 2020 to July 2021, consisted of two main waves of the disease that hit India, the first in March 2020 and then in March 2021. The period from August 2021 to January 2022 was the recovery period during which COVID-19 cases started declining rapidly. February 2022 onward is the postpandemic period with the normal resumption of economic activities [3].

The pandemic was bound to have negative implications on MSMEs due to their reliance on the cash economy, which was hit by the lockdown, manpower shortages accentuated by the physical unavailability of workers, restrictions on raw material and transport infrastructure availability, increased bankruptcy rates, and export order cancellations. Despite some speculative evidence, studies probing the economic consequences of COVID-19 on MSMEs are limited. A few papers have examined the economic impact of COVID-19 on small firms, although they are largely limited to advanced countries [4–6]. In the case of developing countries, serious attempts at understanding the impact of COVID-19 on the productivity performance of MSMEs are scanty. This study attempts to fill this void in the literature by focusing on the Indian MSME sector.

Realizing the magnitude of the crisis, the Government of India (GoI) introduced a slew of policy measures and funding support schemes for MSMEs to lessen the adverse effects of the pandemic. Key measures included providing collateral-free automatic loans for MSMEs with a 100% credit guarantee, clearance of receivables to MSMEs in 45 days, and the creation of a "fund of funds" to help capacity expansion and infuse Rs.200 million in equity for stressed MSMEs by partial credit guarantee. Table A1 in Appendix A summarizes some of these initiatives. It is also interesting to see how these support schemes have helped MSMEs offset the perils of the economic crisis. Hence, this study examined whether these policy measures successfully mitigated the pandemic's impact on micro and small firms.

The remaining paper is organized as follows: Section 2 presents the research objectives of this study. A brief discussion of the methods employed is presented in Section 3. Section 4 discusses the data, their sources, and construction of variables. Section 5 reports the descriptive statistics, and Section 6 reports the main results of the productivity estimates followed by the productivity performance of different size groups. The section ends with a discussion of the factors influencing firm productivity. In Section 7, case studies of two micro firms are given. The cases look into how they were affected during the pandemic and how they responded with support from the government. We summarize the discussion and present possible policy implications of the study in Section 8.

# RESEARCH OBJECTIVES

With the need to lessen interactions among persons, the COVID-19 pandemic has seen a substantial expansion of digitalization, which helped mitigate the productivity losses resulting from the measures to cope with the pandemic. The move toward digitalization could have made some firms more productive. The pandemic-led crisis also led to the reallocation of resources across firms and sectors toward digitized firms, as we saw a shift in demand from in-person services to digital solutions during this period. On the negative side, significant job losses occurred with greater automation, and jobs in sectors requiring new skills increased. In this study, the main objective was to document how the pandemic influenced digitalization, resource allocation, and human capital accumulation and provide inputs on how policies should be devised to enhance productivity and inclusiveness.

The study had the following objectives:

a) analyze the impact of COVID-19 on the productivity of MSMEs;

b) investigate whether the policy measures announced were successful in mitigating the impact of the pandemic on small firms and document the best practices of productivity enhancement policies at firm level; and

c) ascertain the challenges encountered by MSMEs and identify key policies to mitigate the impact of the pandemic and instill business dynamism among MSMEs in the post-pandemic period.

# RESEARCH METHODOLOGY

The study employed a mixed-method approach. Quantitative and qualitative data were used to answer the research questions. For quantitative analysis, panel data analysis of Indian MSMEs was conducted on the Centre for Monitoring the Indian Economy (CMIE)'s Prowess database. Specific case studies complement this. To categorize firms into micro, small, and medium size, we followed the MSMED Act, 2006. The size-wise definition of firms is presented in Table 1.

**TABLE 1**

**CLASSIFICATION OF FIRMS BY SIZE.**

| Enterprise category | Definition based on investment in plant and machinery |
|---|---|
| Micro | ≤Rs.2.5 million |
| Small | >Rs.2.5 million–≤Rs.50 million |
| Medium | >Rs.50 million–≤Rs.100 million |
| Large | >Rs.100 million |

**Source:** MSMED Act, 2006.

To analyze the productivity performance of MSMEs, we computed total factor productivity (TFP) using the Ackerberg–Caves–Frazer [7] (ACF) method. It is argued that estimating TFP using the ordinary least-squares (OLS) method results in biased productivity estimates as it is susceptible to simultaneity bias. Typically, both firms and researchers observe output and inputs; however, productivity is observed by the firm only. The error term is neither observed by the firm nor by the researcher. As a result, the correlation between (choice of) labor and productivity renders OLS estimates biased and inconsistent [8]. To control for the correlation between the unobservable productivity shocks and the input levels, Olley and Pakes [9] suggested using a firm's investment as a proxy for its productivity. However, when firms face substantial adjustment costs, as during the COVID-19 pandemic, this variable may not fully respond to productivity changes, thus becoming severely truncated at zero. This makes the investment variable an unsuitable proxy for a firm's productivity. Levinsohn and Petrin [10] accounted for this limitation and proposed using intermediate inputs rather than investments in the control function.

Assuming a Cobb-Douglas production function, we arrive at the productivity of firm $i$ in industry $j$ at time $t$ as follows:

$$y_{ijt} = \alpha + \beta_1 l_{ijt} + \beta_2 k_{ijt} + \beta_3 m_{ijt} + w_{ijt} + \epsilon_{ijt} \quad \text{(Eq. 1)}$$

where $y$, $l$, $k$, and $m$ represent gross output, labor, capital, and intermediate inputs in log form, respectively. Firm-level productivity is denoted by $w$, and $\epsilon$ is a random error term. All variables are deflated using appropriate deflators. Studies have relied heavily on the Levinsohn and Petrin (LP) method [10] to estimate firm productivity. Relying on a two-stage estimation procedure, the LP method identifies the labor coefficient in the first stage and the capital coefficient in the second stage. It controls for firms' unobserved productivity shocks using intermediate inputs as a proxy. The ACF method, however, points out a crucial pitfall of this method wherein it fails to identify the

labor coefficient as both labor and intermediate inputs are a function of the same state variable. It is also claimed that there is hardly any independent variation in labor for its identification [11].

To address this limitation, the ACF method uses a two-stage estimation procedure where all coefficients are derived in the second stage. This method treats labor as a state variable and assumes that the decision of a firm on allocating labor is made 1) after the firm decides on its capital stock ($K$ at $t$-1) and 2) before intermediate inputs are finalized at $t$.[1] This assumption assuages the main apprehension related to the estimation of TFP using the LP method. In this paper, we used the ACF method to estimate firm productivity. Manjon and Manez [12] implemented the ACF procedure in STATA. We used the *acfest* command in STATA 17 given by Manjon and Manez [12] to estimate the production function.

## Empirical Strategy

As the main objective of this study was to gauge the effects of COVID-19 on Indian MSMEs, we employed a two-stage procedure. We first obtained the TFP estimates using the ACF method in the first stage and then regressed the change in TFP estimates over the period (i.e., pre-COVID-19 vs. during COVID-19) against the variables proxying for mitigation of the COVID-19 effect in the second stage while controlling for the influence of other variables. The model that we estimated takes the following form:

$$\Delta PR_i = \alpha_0 + \alpha_1 MODV_i + \sum \delta_k X_i + \theta_i + \epsilon \qquad \text{(Eq. 2)}$$

where ΔPR stands for the change in firm productivity as a proxy for firm performance from the pre-COVID-19 to COVID-19 period. *MODV* represents moderating variables in the pandemic performance relationship. We consider two such variables, government support and firm readiness to move to digitalization. $X_i$ is a vector of firm-specific control variables, and $\theta_i$ represents the industry effect.

To understand the role of government policy measures on MSMEs, we relied on specific support in the form of credit access. For firm readiness, we considered whether firms had websites before the pandemic.

[1] The assumption(s) may be more tenable for firms in countries having flexible labor laws or firms belonging to the unorganized sector. For firms in the organized sector, this labor adjustment may be coming through contract labor, which in the Indian context has increased dramatically in the last 15 years.

# DATA AND VARIABLES

The CMIE Prowess database was used for quantitative analysis. The database provides time-series data from 1989 and has rich information on several firm-level characteristics drawn from annual reports. Scholars have extensively relied on this dataset for analysis of Indian firms, and the dataset includes more than 70% of organized manufacturing activity in India [13].

For the analysis, we focused on eight industries with a significant presence of MSMEs: food processing (FPI); plastic packaging (PPI); paint and varnish (P&V); pharmaceuticals (Pharma); textiles; tobacco products (tobacco); cosmetics; and domestic appliances.[1]

FPI is a vital sector employing 13 million individuals directly and another 35 million indirectly in 2013 [14]. This number would have changed in the recent past, given that this is one of the sectors being promoted owing to India's large amount of postharvest wastage. Moreover, FPI also contributes significantly to exports.

A 2018–19 report from the Ministry of Food Processing Industry stated that during the last five years, the sector had grown by 8.41% per annum against 3.45% in agriculture and 6.61% in the manufacturing sector at 2011–12 prices [15]. Thus, the industry is highly relevant.

The PPI is one of the largest sectors in India's economy, experiencing the highest growth potential partly due to the presence of packaging in nearly every segment of the industrial sector. According to an estimate provided by the EXIM Bank of India [16], the Indian PPI grew at a CAGR of 18% during 2016–21. This sector is emerging as a preferential hub for the global packaging industry, according to the Packaging Industry Association of India. The outbreak of COVID-19 resulted in a rapid boom in the online food sector. Hence, it will be interesting to see the impact of COVID-19 on the performance of firms in this sector.

The Indian P&V industry has historically grown in double digits. One estimate showed that the domestic paint industry grew by 10.4% from 2007–08 to 2019–20 [17]. However, the last two years have not been the best of times for the Indian P&V industry due to the pandemic. Given that the growth of the domestic paint industry is closely linked to GDP growth, it is possible that the pandemic-led economic shock adversely affected this industry as well.

India is the fourth largest pharmaceutical producer in the world, occupying a share of around 8% of global production. Available estimates suggest that the industry has grown at a CAGR of 13% over five years up to 2013–14 [18]. In India, the Pharma industry was exempted from lockdowns as it is regarded as an "essential service," but production was still affected due to the unavailability of labor and logistical challenges, including transportation blockages and shipment delays [19]. In this context, it would be pertinent to see how Pharma firms responded to this by examining their performance during the pandemic period.

[1] We also intended to include floriculture consisting of 55 firms. However, for three of these firms only, data for 2022 were available and floriculture was excluded for consistency of the analyses.

The textile and apparel industry is one of the leading segments of the Indian economy. It also contributes greatly to foreign exchange earnings. This industry contributes 3% to GDP, 13% to industrial output, and 12% to export earnings and provides direct employment to about 45 million people [20]. There is evidence that the COVID-19 crisis significantly impacted the sector. Production activities were halted due to cancelled orders and the unavailability of raw materials. Further, mandatory lockdowns resulted in many factories being shut down, causing major disruptions in supply and demand. According to a study by the Apparel Export Promotion Council, 83% of export orders were wholly or partially cancelled [21]. Although this anecdotal evidence points to the adverse impacts of the pandemic on the industry, it is also interesting as well as important to examine the performance of textile firms in the COVID-19 period.

India is the third-largest tobacco producer and the fifth-largest exporter globally [22]. In 2012–13, the Indian tobacco industry provided direct and indirect employment to about 36 million people, including 7 million farmers [23]. This industry was not heavily hit by the COVID-19 pandemic. According to analysts, beyond the disruptions to supply chains due to lockdowns, the short-term impact of the pandemic on this industry will be relatively limited [24]. Therefore, it is interesting to see whether the tobacco industry has succeeded in mitigating pandemic-led challenges, as claimed by observers.

Finally, with lockdowns enforced and work from home becoming the new normal during the pandemic, the cosmetics and domestic appliance sectors would have been significantly affected. Due to working from home, domestic appliances, consisting of consumer electronics, telecommunications equipment, lighting, fans, etc., would have gained, whereas cosmetics would have taken a hit with mobility restrictions. Still, it will be interesting to see the impact on these industries.

## Data Cleaning

We started with all the firms in the target categories (1,672 in FPI, 238 for PPI, 77 in P&V, 892 in Pharma, 1,809 in textiles, 43 in tobacco, 158 in cosmetics, and 201 in domestic appliances) listed in the Prowess database with the starting year of 2010. These firms belong to 45 four-digit National Industrial Classification (NIC) codes, and in a few cases in textiles, only two-digit NIC codes were given (Table 2).

**TABLE 2**

**DISTRIBUTION OF FIRMS IN THE FINAL SAMPLE BY 4-DIGIT NIC CODES.**

| Industry | NIC code | Industrial classification | No. of firms |
|---|---|---|---|
| FPI (340) | 1010 | Processing and preserving of meat | 5 |
| | 1020 | Processing and preserving of fish, crustaceans, molluscs, and related products | 11 |
| | 1030 | Processing and preserving of fruit and vegetables | 7 |
| | 1040 | Manufacture of vegetable and animal oils and fats | 48 |
| | 1050 | Manufacture of dairy products | 16 |
| | 1061 | Manufacture of grain mill products | 23 |

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| Industry | NIC code | Industrial classification | No. of firms |
|---|---|---|---|
| FPI (340) | 1062 | Manufacture of starches and starch products | 6 |
| | 1071 | Manufacture of bakery products | 9 |
| | 1072 | Manufacture of sugar, molasses, and honey | 60 |
| | 1073 | Manufacture of cocoa, chocolate, and sugar confectioneries | 7 |
| | 1074 | Manufacture of macaroni, noodles, couscous, and similar farinaceous products | 2 |
| | 1075 | Manufacture of processed ready-to-eat food | 5 |
| | 1079 | Tea, coffee, condiments, salts, health supplements | 57 |
| | 1080 | Manufacture of prepared animal feed | 19 |
| | 1101 | Spirits, liquor | 22 |
| | 1103 | Beer | 7 |
| | 1104 | Manufacture of soft drinks; production of mineral water and other bottled water | 17 |
| | 1412 | Milk | 11 |
| | 1462 | Eggs | 1 |
| | 1463 | Poultry (chicken) | 5 |
| | 1492 | Honey | 2 |
| PPI (39) | 2220 | Plastic packaging goods | 39 |
| P&V (11) | 2022 | Paint and varnish | 11 |
| Pharma (259) | 2100 | Pharmaceuticals | 259 |
| Textiles (493) | 13 | Textiles | 3 |
| | 1311 | Preparation and spinning of textile fibers | 160 |
| | 1312 | Weaving and finishing of cotton textiles | 100 |
| | 1313 | Weaving and finishing of woollen and synthetic textiles | 59 |
| | 1391 | Knitted and crocheted fabric | 11 |
| | 1392 | Made-up textile articles, excluding apparel | 16 |
| | 1393 | Carpets and other textile floor coverings | 7 |
| | 1394 | Cordage, rope, twine, and netting | 1 |
| | 1399 | Other textiles | 25 |
| | 1410 | Wearing apparel (woven), excluding fur apparel | 27 |

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| Industry | NIC code | Industrial classification | No. of firms |
|---|---|---|---|
| **Textiles (493)** | 1430 | Knitted and crocheted apparel | 18 |
| | 2020 | Synthetic yarn | 53 |
| | 2030 | Viscose yarn | 13 |
| **Tobacco (10)** | 1150 | Tobacco | 2 |
| | 1200 | Tobacco products | 8 |
| **Cosmetics (33)** | 2023 | Cosmetics and toiletries | 31 |
| | 2029 | Other chemical products | 2 |
| **Domestic appliances (44)** | 2630 | Communication equipment (telephone and data communication) | 2 |
| | 2640 | Consumer electronics (televisions, VCRs, stereos, radios, CD/DVD players, etc.) | 5 |
| | 2740 | Electrical lighting equipment | 9 |
| | 2750 | Domestic appliances (refrigerators, fans, heaters) | 16 |
| | 2819 | Other general-purpose machinery | 12 |
| **Total** | | | **1,229** |

**Note:** Figure in parentheses are numbers of firms from each industry.

Several of these firms did not have consistent data for the key variables (sales, fixed assets, etc.) for all years. Moreover, this list consists of four categories of firms: private limited; public limited; government-owned; and cooperatives. Data cleaning involved removing firms that did not have data for the entire 13-year period (i.e., 2010 to 2022) and firms that operated with objectives other than profit (i.e., government-owned and cooperatives). Finally, we had a sample of 340 firms for FPI,[2] 39 firms for PPI, 11 for P&V, 259 for Pharma, 493 for textiles, 10 for tobacco, 33 for cosmetics, and 44 for the domestic appliances industry. Of the total 1,229 firms,[3] nearly 81% (999) are public limited, and the remaining 19% (230) are private limited. Tables 3a, 3b, and 3c report the distribution of firms by size and entity type for all selected industries.

Of the total firms in the sample, 842 (69%) were MSMEs. The share, however, varied from industry to industry (Tables 3a, 3b, and 3c). For instance, the share of MSMEs was the highest in the PPI (84%) and the lowest in the cosmetics industry (48.5%). The distribution of micro, small, and medium firms in MSMEs was 6.4% (54 firms), 37.9% (319 firms), and 55.7% (469 firms), respectively. Across industries, micro-firms constituted a smaller share of less than 10% in each industry. This is mainly due to the coverage of Prowess, which predominantly has listed firms, and most micro-firms are not listed.

[2] This final sample excludes a large-sized firm for which Prowess data give a negative value for raw material spending for two years (2012 and 2013). For several other firms, raw material expenses, salary and wages spending, and gross fixed assets were negative, and sometimes values were not given, although firms reported sales figures. We interpolated the data suitably to avoid losing observations to obtain the missing values.

[3] While estimating production functions, government-owned firms having data for all 13 years were retained as firms competing in the product market space even if the government owned them. However, we omitted these firms in the final analysis of factors that influenced productivity changes.

## TABLE 3A

### ENTITY-TYPE DISTRIBUTION: FPI, PPI, AND P&V.

| | FPI | | | PPI | | | P&V | | |
|---|---|---|---|---|---|---|---|---|---|
| | Private limited (1) | Public limited (2) | Total (3) | Private limited (1) | Public limited (2) | Total (3) | Private limited (1) | Public limited (2) | Total (3) |
| Large | 29 (8.5) | 117 (34.4) | 146 (42.9) | 1 (2.6) | 5 (12.8) | 6 (15.4) | 0 | 5 (45.5) | 5 (45.4) |
| Medium | 26 (7.6) | 93 (27.4) | 119 (35.0) | 5 (12.8) | 14 (35.9) | 19 (48.7) | 1 (9.1) | 4 (36.4) | 5 (45.4) |
| Small | 16 (4.7) | 53 (15.6) | 69 (20.3) | 0 (0) | 12 (30.8) | 12 (30.8) | 1 (9.1) | 0 | 1 (9.1) |
| Micro | 0 | 6 (1.8) | 6 (1.8) | 0 (0) | 2 (5.1) | 2 (5.1) | 0 | 0 | 0 |
| Total | 71 (20.9) | 269 (79.1) | 340 | 6 (15.4) | 33 (84.6) | 39 | 2 (18.2) | 9 (81.8) | 11 |

**Note:** Figures in parentheses are percentages of total sample firms.

## TABLE 3B

### ENTITY-TYPE DISTRIBUTION: PHARMA, TEXTILES, AND TOBACCO.

| | Pharma | | | Textiles | | | Tobacco | | |
|---|---|---|---|---|---|---|---|---|---|
| | Private limited (1) | Public limited (2) | Total (3) | Private limited (1) | Public limited (2) | Total (3) | Private limited (1) | Public limited (2) | Total (3) |
| Large | 8 (3.1) | 76 (29.3) | 84 (32.4) | 11 (2.2) | 92 (18.7) | 103 (20.9) | 0 | 5 (50.0) | 5 (50.0) |
| Medium | 21 (8.1) | 83 (32.0) | 104 (40.2) | 37 (7.5) | 167 (33.9) | 204 (41.4) | 0 | 0 | 0 |
| Small | 5 (1.9) | 51 (19.7) | 56 (21.6) | 47 (9.5) | 113 (22.9) | 160 (32.5) | 1 (10.0) | 3 (30.0) | 4 (40.0) |
| Micro | 1 (0.4) | 14 (5.4) | 15 (5.8) | 3 (0.6) | 23 (4.7) | 26 (5.3) | 0 | 1 (10.0) | 1 (10.0) |
| Total | 35 (13.5) | 224 (86.5) | 259 | 98 (19.9) | 395 (80.1) | 493 | 1 (10.0) | 9 (90.0) | 10 |

**Note:** Figures in parentheses are percentages of total sample firms.

## TABLE 3C

### ENTITY-TYPE DISTRIBUTION: COSMETICS AND DOMESTIC APPLIANCES.

| | Cosmetics | | | Domestic Appliances | | |
|---|---|---|---|---|---|---|
| | Private limited (1) | Public limited (2) | Total (3) | Private limited (1) | Public limited (2) | Total (3) |
| Large | 6 (18.2) | 11 (33.3) | 17 (51.5) | 3 (6.8) | 18 (40.9) | 21 (47.7) |
| Medium | 4 (12.1) | 1 (3.0) | 5 (15.2) | 2 (4.5) | 11 (25.0) | 13 (29.5) |
| Small | 0 | 8 (24.2) | 8 (24.2) | 2 (4.5) | 7 (15.9) | 9 (20.5) |
| Micro | 0 | 3 (9.1) | 3 (9.1) | 0 | 1 (2.3) | 1 (2.3) |
| Total | 10 (30.3) | 23 (69.7) | 33 | 7 (15.9) | 37 (84.1) | 44 |

**Note:** Figures in parentheses are percentages of total sample firms.

## Variables

All variables used in the production function estimates are measured in constant 2011–12 prices to ensure that price changes over time do not distort the estimations. Sales revenue was used as a measure of output. The output is deflated by 4-digit industry-specific wholesale price index (WPI) deflators as obtained from the index number of wholesale prices in India given by the Central Statistical Organisation (CSO). The Prowess package gives firms' expenditure on salary and wages instead of the number of workers. These salary and wage (S&W) expenses are deflated with the consumer price index of industrial workers (CPI-IW). Similarly, raw material, power, and fuel expenses are deflated with suitable price deflators. Finally, we used two measures for fixed capital: gross fixed assets; and plant and machinery. Both of these are deflated with the WPI of machinery for respective industries. Table 4a presents the definition of these variables.

**TABLE 4A**

**DESCRIPTION OF VARIABLES: PRODUCTION FUNCTION ESTIMATES.**

| S. no. | Variable | Notation | Description |
|---|---|---|---|
| 1 | Output | Sales | Sales revenue of a firm deflated at 2011–12 WPI at 4-digit NIC for the respective industry |
| 2 | Labor | S&W | Salary and wages deflated by CPI-IW at 2011–12 prices |
| 3 | Capital | GFA | Gross fixed assets deflated by WPI of machinery for respective industries (e.g., food-processing machinery, pharmaceutical machinery, tobacco making machinery, etc.) |
| 4 | | P&M | Gross plant and machinery deflated by WPI of machinery for respective industry (same as GFA) |
| 5 | Materials | RM | Raw material expenses deflated by WPI of raw materials for different industries at 2011–12 prices |
| 6 | Age | Age | Age of the firm in years |

**Notes:** S&W, salaries and wages; GFA, gross fixed assets; P&M, plant and machinery; RM, raw materials.

For the second-stage analysis, i.e., factors influencing productivity change, our key variable reflecting digitalization was whether a firm had a website. We hypothesized that a firm having a website would try to rationalize activities faster during lockdowns [25, 26]. Regarding our other key variable, access to government schemes, we could not get information on receiving various support measures announced by the government for businesses during COVID-19. However, Prowess provides data on short-term borrowings from banks, and we examined whether this borrowing had gone up during the COVID-19 period for the sample firms and how this borrowing had affected productivity change. As can be seen from our case later, although firms benefited from deferred loan payments and increased loans to tide over current liquidity, in reality, these measures increased the short-term liability of firms.

As firm-specific controls, we included "entity type" (whether the firm is private limited or public limited), size (whether the firm belongs to a micro, small, or medium group), ownership type (standalone vs. group firm), age of the firm, and location of the firm (metro vs. nonmetro). An older firm, due to long-term relationships with vendors and suppliers and with banks, may have a greater chance of surviving the crisis. Similarly, the location of the firm has a two-way effect. Locating in a metro or capital city bridges information asymmetry of accessing loans or any other information, and thus would have enabled firms to overcome the crises faster. This would have a

positive impact on productivity. On the other hand, being in a metropolitan area or capital binds firms to adhere to lockdown restrictions, having a detrimental impact on productivity. Which of these two effects dominate is worth exploring? Table 4b gives a definition of different variables used in the second stage.

**TABLE 4B**

**DESCRIPTION OF VARIABLES: FACTORS INFLUENCING PRODUCTIVITY.**

| S. no. | Variable | Notation | Description |
|---|---|---|---|
| 1 | Digtialization | Website | Whether a firm has a website or not: 1 = yes, 0 = no |
| 2 | Entity type | Entity | Dummy, which takes the value of 1 if the firm is private limited and 0 if public limited |
| 3 | Organization type | Type | Does the firm belong to a group, or is it standalone? 0 = standalone, 1 = group firm |
| 4 | Size group | Size | Ordered variable for different size groups: 0 = large, 1 = medium, 2 = small, and 3 = micro |
| 5 | Age | Age | Age of the firm in years |
| 6 | Location | Metro | A firm has a registered office in a metro or capital city = 1, others = 0 |
| 7 | Govt. policy access | Short-term borrowing | Increased short-term borrowing from banks in 2020 compared with 2019* |

**Note:** *We wanted to take the average borrowing of 2017–19 for the pre-COVID-19 period and 2020–22 for the post-COVID-19 period. Since the data had several missing values, we restricted it to 2019 and 2020.

# DESCRIPTIVE STATISTICS

We start with a descriptive analysis of the output and input variables used. In Tables 5a to 5h, we compare the trends in these variables before and during COVID-19 for each of the eight industries. We see a significant increase for all variables (sales, GFA, P&M, procurement of RM, and S&W) during the COVID-19 period for two key industries: FPI (Table 5a) and Pharma (Table 5d). For three industries, PPI (Table 5b), tobacco (Table 5f), and domestic appliances (Table 5h), there was no difference in any of the variables in statistical terms. There was increased investment (in GFA and P&M) by firms in statistical terms for the remaining three industries.

**TABLE 5A**

**DESCRIPTIVE STATISTICS FOR PRODUCTION FUNCTION VARIABLES (FPI).**

| S. no. | Variable (Rs. million) | Complete sample | | Pre-COVID-19 | | During COVID-19 | |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | Mean | SD |
| 1 | Sales | 8,054.8 | 22,283.2 | 7,451.4 | 21,107.4 | 10,066.1* | 25,728.1 |
| 2 | GFA | 2,884.9 | 7,063.0 | 2,664.1 | 6,633.3 | 3,620.8* | 8,298.1 |
| 3 | P&M | 1,794.5 | 4,370.4 | 1,698.2 | 4,252.2 | 2,115.8* | 4,731.4 |
| 4 | RM | 3,884.0 | 10,727.4 | 3,551.2 | 9,170.1 | 4,993.6* | 14,729.2 |
| 5 | S&W | 247.8 | 559.9 | 233.7 | 538.5 | 294.8* | 623.8 |
| | Observations (NxT) | 4420 = 340 × 13 | | 3400 = 340 × 10 | | 1020 = 340 × 3 | |

**Note:** *Differences in means between pre-COVID-19 and COVID-19 periods are significant at the 5% level.

**TABLE 5B**

**DESCRIPTIVE STATISTICS FOR PRODUCTION FUNCTION VARIABLES (PPI).**

| S. no. | Variable (Rs. million) | Complete sample | | Pre-COVID-19 | | During COVID-19 | |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | Mean | SD |
| 1 | Sales | 2145.6 | 2821.3 | 2,060.60 | 2,736.40 | 2,428.90 | 3,083.10 |
| 2 | GFA | 1379.7 | 2334 | 1,333.40 | 2,259.60 | 1,534.10 | 2,570.60 |
| 3 | P&M | 1049.6 | 1981.8 | 1,035.10 | 1,955.80 | 1,098.00 | 2,074.10 |
| 4 | RM | 1,197.70 | 1696.8 | 1,137.50 | 1,580.70 | 1,398.10 | 2,031.70 |
| 5 | S&W | 111.8 | 158.8 | 109.5 | 164.7 | 119.6 | 137.5 |
| | Observations (NxT) | 507 = 39 × 13 | | 390 = 39 × 10 | | 117 = 39 × 3 | |

**Note:** Differences in means between pre-COVID-19 and COVID-19 periods are significant at the 5% level.

## TABLE 5C

### DESCRIPTIVE STATISTICS FOR PRODUCTION FUNCTION VARIABLES: P&V.

| S. no. | Variable (Rs. million) | Complete sample | | Pre-COVID-19 | | During COVID-19 | |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | Mean | SD |
| 1 | Sales | 22,618.10 | 39,751.10 | 20,115.10 | 33,637.10 | 30,961.40 | 55,358.50 |
| 2 | GFA | 6,640.60 | 11,692.00 | 5,390.70 | 8,863.40 | 10,807.1* | 17,769.40 |
| 3 | P&M | 3,648.80 | 6,561.80 | 3,010.10 | 5,043.10 | 5,777.7* | 9,917.60 |
| 4 | RM | 9,187.40 | 14,850.70 | 8,374.30 | 13,078.00 | 11,897.70 | 19,652.70 |
| 5 | S&W | 765.8 | 1,240.50 | 699.8 | 1,091.90 | 985.9 | 1,643.70 |
| | Observations (NxT) | 143 = 11 × 13 | | 110 = 11 × 10 | | 33 = 11 × 3 | |

**Note:** *Differences in means between pre-COVID-19 and COVID-19 periods are significant at the 5% level.

## TABLE 5D

### DESCRIPTIVE STATISTICS FOR PRODUCTION FUNCTION VARIABLES: PHARMA.

| S. no. | Variable (Rs. million) | Complete sample | | Pre-COVID-19 | | During COVID-19 | |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | Mean | SD |
| 1 | Sales | 5,931.70 | 14,738.50 | 5,277.20 | 12,821.30 | 8,113.5* | 19,687.30 |
| 2 | GFA | 3,767.60 | 10,576.70 | 3,310.20 | 9,031.90 | 5,292.4* | 14,492.90 |
| 3 | P&M | 1,990.00 | 5,087.80 | 1,797.40 | 4,547.70 | 2,631.7* | 6,538.20 |
| 4 | RM[1] | 1,995.70 | 4,777.40 | 1,804.00 | 4,227.90 | 2,634.6* | 6,231.30 |
| 5 | S&W | 533.7 | 1,314.50 | 484.1 | 1,206.50 | 699.0* | 1,613.30 |
| | Observations (NxT) | 3367 = 259 × 13 | | 2590 = 259 × 10 | | 777 = 259 × 3 | |

**Note:** *Differences in means between pre-COVID-19 and COVID-19 periods are significant at the 5% level.

## TABLE 5E

### DESCRIPTIVE STATISTICS FOR PRODUCTION FUNCTION VARIABLES: TEXTILES.

| S. no. | Variable (Rs. million) | Complete sample | | Pre-COVID-19 | | During COVID-19 | |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | Mean | SD |
| 1 | Sales | 3,421.50 | 9,146.80 | 3,385.70 | 8,822.20 | 3,540.80 | 10,156.60 |
| 2 | GFA | 2,637.50 | 8,635.90 | 2,521.50 | 7,932.50 | 3,024.0* | 10,644.30 |
| 3 | P&M | 1,887.30 | 5,907.80 | 1,841.20 | 5,577.60 | 2,040.80 | 6,895.30 |
| 4 | RM | 1,875.30 | 4,875.20 | 1,914.10 | 4,976.20 | 1,745.90 | 4,521.50 |
| 5 | S&W | 190.9 | 452.5 | 186.8 | 419.3 | 204.8 | 548.8 |
| | Observations (NxT) | 6409 = 493 × 13 | | 4930 = 493 × 10 | | 1479 = 493 × 3 | |

**Note:** *Differences in means between pre-COVID-19 and COVID-19 periods are significant at the 5% level.

[1] For one firm, the RM expenses were reported as negative. To not lose the observation, an average of preceding and succeeding years was taken. For three firms in later years, RM values were given as zero. The assumed figures are based on preceding share of RM in total cost.

## TABLE 5F

### DESCRIPTIVE STATISTICS FOR PRODUCTION FUNCTION VARIABLES: TOBACCO.

| S. no. | Variable (Rs. million) | Complete sample | | Pre-COVID-19 | | During COVID-19 | |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | Mean | SD |
| 1 | Sales | 38,765.00 | 99,076.00 | 40,292.70 | 1,01,924.20 | 33,672.80 | 90,362.20 |
| 2 | GFA | 18,712.30 | 52,074.40 | 16,966.40 | 46,391.50 | 24,532.20 | 68,336.90 |
| 3 | P&M | 11,112.70 | 30,340.20 | 10,631.60 | 28,787.80 | 12,716.60 | 35,526.80 |
| 4 | RM | 11,239.90 | 29,695.60 | 10,551.20 | 27,571.50 | 13,535.80 | 36,337.30 |
| 5 | S&W | 1,680.90 | 3,519.50 | 1,623.20 | 3,341.70 | 1,873.20 | 4,114.30 |
| | Observations (NxT) | 130 = 13 × 10 | | 100 = 10 × 10 | | 30 = 3 × 10 | |

**Note:** Differences in means between pre-COVID-19 and COVID-19 periods are significant at the 5% level.

## TABLE 5G

### DESCRIPTIVE STATISTICS FOR PRODUCTION FUNCTION VARIABLES: COSMETICS.

| S. no. | Variable (Rs. million) | Complete sample | | Pre-COVID-19 | | During COVID-19 | |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | Mean | SD |
| 1 | Sales | 16,849.60 | 51,227.50 | 15,506.60 | 46,913.30 | 21,326.30 | 63,609.30 |
| 2 | GFA | 4,503.00 | 9,465.80 | 3,958.50 | 8,475.30 | 6,318.2* | 12,076.70 |
| 3 | P&M | 2,271.60 | 6,148.40 | 1,908.00 | 4,926.40 | 3,483.6* | 9,038.50 |
| 4 | RM | 5,232.30 | 14,195.90 | 4,950.50 | 13,604.80 | 6,171.80 | 16,049.50 |
| 5 | S&W | 674.6 | 1,732.60 | 645.1 | 1,713.70 | 773.2 | 1,799.30 |
| | Observations (NxT) | 429 = 13 × 33 | | 330 = 10 × 33 | | 99 = 3 × 33 | |

**Note:** *Differences in means between pre-COVID-19 and COVID-19 periods are significant at the 5% level.

## TABLE 5H

### DESCRIPTIVE STATISTICS FOR PRODUCTION FUNCTION VARIABLES: DOMESTIC APPLIANCES.

| S. no. | Variable (Rs. million) | Complete sample | | Pre-COVID-19 | | During COVID-19 | |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | Mean | SD |
| 1 | Sales | 11,950.80 | 26,402.70 | 11,901.40 | 26,911.20 | 12,115.40 | 24,729.10 |
| 2 | GFA | 4,548.20 | 15,340.90 | 4,218.60 | 14,188.40 | 5,646.70 | 18,697.60 |
| 3 | P&M | 3,457.40 | 13,122.30 | 3,316.00 | 12,494.80 | 3,928.90 | 15,069.30 |
| 4 | RM | 5,299.30 | 12,157.50 | 5,022.30 | 11,850.30 | 6,222.50 | 13,135.10 |
| 5 | S&W | 549.5 | 1,209.30 | 531.9 | 1,162.60 | 608.1 | 1,356.40 |
| | Observations (NxT) | 572 = 13 × 44 | | 440 = 10 × 44 | | 132 = 3 × 44 | |

**Note:** Differences in means between pre-COVID-19 and COVID-19 periods are significant at the 5% level.

As the aggregate picture is likely to mask substantial heterogeneity across firms, we carried out an additional investigation to see whether this trend is confined to any specific size categories of firms. We compared the average values of the input and output variables before and during COVID-19 for micro, small, medium, and large firms. The results are presented separately in Tables 6a to 6h for each industry. Our size-wise analysis revealed an interesting picture. We can see that during and postpandemic, the sales of large and medium firms went up for FPI. Conversely, we see a decline in sales revenue for micro and small firms. As revealed by the t-test statistic, the decline was significant for micro firms. The FPI also saw an increase in the procurement of RM and payment of S&W for large and medium firms. However, these variables showed a decline in micro firms. These observations point to the shifting of business activities toward large firms during the pandemic. These findings are also corroborated by the k-density plots for sales revenue, expenditure on RM, and S&W in Figures B1 to B3 in the appendix, respectively.[2]

For the PPI, sales revenues increased during the pandemic period in all the size categories of firms, except for small firms (row 1, Table 6b). However, the increase was statistically significant for micro and medium-sized firms only. The increase in sales could be due to increased reliance on online shopping by households during the pandemic, having positive implications for the PPI. There was, however, no statistically significant difference in sales, GFA, or spending on RM and S&W between the pre-COVID-19 and during the COVID-19 period for small-sized firms (Table 6b).

**TABLE 6A**

**PERFORMANCE COMPARISON ACROSS SIZE GROUPS PRE-COVID-19 VS. DURING COVID-19: FPI.**

| S. no. | Variable (Rs. million) | Large | | Medium | | Small | | Micro | |
|---|---|---|---|---|---|---|---|---|---|
| | | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 |
| 1 | Sales | 15,756.6 (30,245.0) | 21,658.1* (36,128.0) | 1,739.4 (1,356.1) | 1,981.6* (1,284.8) | 368.6 (411.8) | 351.5 (243.7) | 98.4 (82.0) | 56.6* (48.7) |
| 2 | GFA | 5,470.6 (9,380.3) | 7,514.4* (11,531.6) | 784.9 (837.7) | 997.9* (954.0) | 187.9 (186.9) | 211.1 (179.7) | 121.1 (163.6) | 110.1 (150.5) |
| 3 | P&M | 3,502.7 (6,006.7) | 4,394.1* (6,534.5) | 496.3 (580.8) | 591.5* (609.5) | 93.7 (97.4) | 101.8 (99.9) | 76.0 (135.7) | 71.3 (126.3) |
| 4 | RM | 7,363.0 (13,017.3) | 10,679.8* (21,171.2) | 982.0 (942.0) | 1,053.1 (864.4) | 220.3 (352.9) | 190.5 (194.7) | 55.2 (57.6) | 20.1* (15.4) |
| 5 | S&W | 467.9 (754.9) | 596.3* (858.5) | 76.2 (99.5) | 90.1* (101.6) | 29.2 (40.6) | 34.5 (47.5) | 11.8 (10.4) | 10.1 (10.0) |
| | Observations (NxT) | 1,460 | 438 | 1,190 | 357 | 690 | 207 | 60 | 18 |

**Notes:** Figures in parentheses are standard deviations. *Differences in means between pre-COVID-19 and COVID-19 periods are significant at the minimum 10% level. Light-shaded cells imply an increase in value during the COVID-19 period compared with pre-COVID-19 period, whereas dark-shaded cells imply a decline in value during the COVID-19 period.

[2] To conserve space, this paper does not present the density plots for inputs and outputs for other industries.

## TABLE 6B

### PERFORMANCE COMPARISON ACROSS SIZE GROUPS PRE-COVID-19 VS. DURING COVID-19: PPI.

| S. no. | Variable (Rs. million) | Large | | Medium | | Small | | Micro | |
|---|---|---|---|---|---|---|---|---|---|
| | | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 |
| 1 | Sales | 6,942.5 (3,716.6) | 7,533.5 (4,640.9) | 1,659.8 (1,174.2) | 2,304.4* (1,287.0) | 576.2 (562.2) | 452.8 (249.6) | 129.3 (30.9) | 153.8* (25.7) |
| 2 | GFA | 5,271.0 (3,410.1) | 5,965.0 (4,167.3) | 911.6 (913.4) | 1,102.3 (770.8) | 241.2 (177.4) | 248.0 (201.8) | 79.7 (23.0) | 60.8* (18.9) |
| 3 | P&M | 4,287.9 (3,192.7) | 4,489.8 (3,642.0) | 653.3 (777.5) | 716.0 (601.9) | 176.1 (135.5) | 182.8 (169.8) | 57.6 (23.2) | 42.3 (19.2) |
| 4 | RM | 3,734.5 (2,429.0) | 4,491.7 (3,599.8) | 918.8 (712.3) | 1,277.1* (704.9) | 361.5 (405.7) | 260.7 (150.2) | 81.3 (26.5) | 91.2 (29.3) |
| 5 | S&W | 383.0 (243.5) | 382.3 (146.6) | 90.9 (82.8) | 107.9 (55.2) | 19.2 (12.2) | 25.1* (17.6) | 7.9 (2.4) | 9.1 (4.0) |
| | Observations (NxT) | 60 | 18 | 190 | 57 | 120 | 36 | 20 | 6 |

**Notes:** Figures in parentheses are standard deviations. *Differences in means between pre-COVID-19 and COVID-19 periods are significant at the minimum 10% level. Light-shaded cells imply an increase in value during the COVID-19 period compared with pre-COVID-19 period, whereas dark-shaded cells imply a decline in value during the COVID-19 period.

When we look at the P&V industry, sales increased during the COVID-19 period. Still, the increase was primarily confined to large-sized firms, as indicated by statistically significant sales revenue (row 1, Table 6c). We notice increased investment across all size categories of firms, possibly due to increased access to bank borrowings through government schemes. The increase, however, was statistically significant only for small and large firms. We see an interesting phenomenon in the Pharma sector (Table 6d) as both output and input variables reported an increase for large and medium firms and a decline for micro firms. However, the changes were significant only for large and medium firms. It can be inferred from the table that COVID-19 resulted in a surge in demand for Pharma products, but the surge mostly aided large and medium-sized firms rather than small and micro firms.

## TABLE 6C

### PERFORMANCE COMPARISON ACROSS SIZE GROUPS PRE-COVID-19 VS. DURING COVID-19: P&V.

| S. no. | Variable (Rs. million) | Large | | Medium | | Small | | Micro | |
|---|---|---|---|---|---|---|---|---|---|
| | | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 |
| 1 | Sales | 42,344.5 (39,862.9) | 66,040.9* (67,712.5) | 1,881.2 (1,707.1) | 2,042.4 (1,377.0) | 137.0 (25.2) | 158.8 (37.8) | | |
| 2 | GFA | 10,893.0 (10,834.7) | 22,436.8* (21,331.8) | 955.0 (768.3) | 1,324.5 (852.2) | 57.8 (2.5) | 71.5* (4.1) | | |

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| S. no. | Variable (Rs. million) | Large | | Medium | | Small | | Micro | |
|---|---|---|---|---|---|---|---|---|---|
| | | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 |
| 3 | P&M | 6,177.1 (6,125.9) | 12,180.5* (12,002.8) | 443.7 (501.3) | 527.6 (422.9) | 7.1 (0.5) | 14.2* (1.5) | | |
| 4 | RM | 17,462.4 (15,000.8) | 25,128.3 (23,198.5) | 943.0 (894.8) | 1,025.1 (798.8) | 89.9 (20.2) | 107.2 (29.7) | | |
| 5 | S&W | 1,445.5 (1,267.1) | 2,,054.9 (1,981.1) | 92.6 (72.8) | 113.1 (65.1) | 7.2 (1.0) | 5.1* (3.2) | | |
| | Observations (NxT) | 50 | 15 | 50 | 15 | 10 | 3 | Nil | Nil |

**Notes:** Figures in parentheses are standard deviations. *Differences in means between pre-COVID-19 and COVID-19 periods are significant at the minimum 10% level. Light-shaded cells imply an increase in value during the COVID-19 period compared with pre-COVID-19 period, whereas dark-shaded cells imply a decline in value during the COVID-19 period.

## TABLE 6D

### PERFORMANCE COMPARISON ACROSS SIZE GROUPS PRE-COVID-19 VS. DURING COVID-19: PHARMA.

| S. no. | Variable (Rs. million) | Large | | Medium | | Small | | Micro | |
|---|---|---|---|---|---|---|---|---|---|
| | | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 |
| 1 | Sales | 14,071.5 (19,625.4) | 22,363.8* (29,831.6) | 1,194.2 (1,162.5) | 1,541.8* (1,039.1) | 950.2 (2,793.6) | 1,045.6 (2,710.9) | 492.1 (1,758.1) | 263.2 (694.1) |
| 2 | GFA | 8,688.3 (14,233.9) | 14,497.1* (22,742.0) | 759.1 (1,280.0) | 963.5* (1,223.5) | 770.6 (2,443.0) | 845.0 (2,497.3) | 362.2 (1,144.3) | 363.8 (1,139.8) |
| 3 | P&M | 4,667.6 (7,010.9) | 7,067.4* (10,015.7) | 427.8 (755.6) | 532.3* (804.6) | 466.1 (1,587.0) | 526.9 (1,610.1) | 191.7 (596.4) | 205.4 (608.0) |
| 4 | RM | 4,543.6 (6,501.8) | 6,918.4* (9,547.3) | 559.9 (668.0) | 703.5* (621.9) | 399.3 (1,136.5) | 466.3 (1,263.7) | 332.4 (1,376.6) | 129.3 (340.7) |
| 5 | S&W | 1,292.4 (1,859.7) | 1,907.7* (2,410.0) | 106.5 (109.7) | 136.6* (113.1) | 94.8 (268.3) | 110.8 (272.1) | 28.7 (78) | 26.5 (74.2) |
| | Observations (NxT) | 840 | 252 | 1,040 | 312 | 560 | 168 | 150 | 45 |

**Notes:** Figures in parentheses are standard deviations. *Differences in means between pre-COVID-19 and COVID-19 periods are significant at the minimum 10% level. Light-shaded cells imply an increase in value during the COVID-19 period compared with pre-COVID-19 period, whereas dark-shaded cells imply a decline in value during the COVID-19 period.

## TABLE 6E

### PERFORMANCE COMPARISON ACROSS SIZE GROUPS PRE-COVID-19 VS. DURING COVID-19: TEXTILE INDUSTRY.

| S. no. | Variable (Rs. million) | Large | | Medium | | Small | | Micro | |
|---|---|---|---|---|---|---|---|---|---|
| | | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 |
| 1 | Sales | 11,807.9 (16,641.5) | 13,049.1 (19,383.9) | 1,834.5 (1,423.1) | 1,625.9* (1,227.0) | 472.8 (352.6) | 427.7* (283.4) | 117.0 (184.0) | 54.4* (46.1) |
| 2 | GFA | 9,001.7 (15,628.3) | 11,402.6* (21,249.0) | 1,281.3 (1,211.1) | 1,298.3 (1,014.8) | 320.8 (355.5) | 308.0 (255.4) | 123.5 (149.2) | 84.5* (54.3) |
| 3 | P&M | 6,598.1 (10,859.7) | 7,706.1 (13,628.4) | 919.1 (965.4) | 859.6 (787.7) | 239.4 (291.0) | 221.8 (200.3) | 89.3 (132.0) | 58.4* (48.1) |
| 4 | RM | 6,658.5 (9,368.3) | 6,419.7 (8,320.7) | 1,040.7 (917.2) | 803.4* (619.1) | 273.6 (238.3) | 218.4* (171.1) | 66.4 (111.5) | 26.6* (23.3) |
| 5 | S&W | 573.0 (774.6) | 694.7* (1,052.7) | 135.6 (142.5) | 121.2* (107.7) | 31.4 (35.5) | 28.6* (28.4) | 14.4 (44.0) | 5.2* (4.2) |
| | Observations (NxT) | 1,030 | 309 | 2,040 | 612 | 1,600 | 480 | 260 | 78 |

**Notes:** Figures in parentheses are standard deviations. *Differences in means between pre-COVID-19 and COVID-19 periods are significant at the minimum 10% level. Light-shaded cells imply an increase in value during the COVID-19 period compared with pre-COVID-19 period, whereas dark-shaded cells imply a decline in value during the COVID-19 period.

There was a significant decline in the performance of MSMEs in the textile industry during COVID-19 (Table 6e). The sector suffered the most as there was a decline in sales, RM use, and S&W paid to workers in MSMEs. Further, the differences in these variables between the pre-COVID-19 and COVID-19 periods were also statistically significant. There was an increase in sales for large firms, but the increase was not statistically significant (row 1). On the other hand, there was a statistically significant increase in employee compensation during the COVID-19 period for large firms (row 5). In the case of the tobacco industry, sales revenues declined drastically for small and micro firms, but the decline was significant for small-sized firms only (row 1, Table 6f). RM use and employee compensation also declined for small-sized firms, but the difference was not statistically significant.

## TABLE 6F

### PERFORMANCE COMPARISON ACROSS SIZE GROUPS PRE-COVID-19 VS. DURING COVID-19: TOBACCO INDUSTRY.

| S. no. | Variable (Rs. million) | Large | | Medium | | Small | | Micro | |
|---|---|---|---|---|---|---|---|---|---|
| | | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 |
| 1 | Sales | 79,500.8 (133603.8) | 67,068.1 (120,515.1) | | | 1,339.3 (1,413.2) | 335.3* (467.8) | 66.2 (32.1) | 46.4 (1.4) |
| 2 | GFA | 33,714.4 (61,447.6) | 48,884.9 (91,665.7) | | | 268.5 (99.6) | 221.1 (99.2) | 17.6 (2.7) | 13.4* (0.2) |

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| S. no. | Variable (Rs. million) | Large | | Medium | | Small | | Micro | |
|---|---|---|---|---|---|---|---|---|---|
| | | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 |
| 3 | P&M | 21,127.0 (38,073.3) | 25,328.0 (47,682.7) | | | 169.5 (75.2) | 130.7 (74.1) | 2.4 (0.9) | 2.8 (0.1) |
| 4 | RM | 20,783.4 (36,359.8) | 26,920.0 (48,488.7) | | | 388.3 (455.7) | 181.5 (334.6) | 41.9 (22.3) | 31.6 (2.0) |
| 5 | S&W | 3,225.2 (4,162.3) | 3,728.0 (5,262.4) | | | 25.3 (11.2) | 21.8 (15.6) | 4.6 (1.8) | 5.0 (0.3) |
| | Observations (NxT) | 50 | 15 | Nil | Nil | 40 | 12 | 10 | 3 |

**Notes:** Figures in parentheses are standard deviations. *Differences in means between pre-COVID-19 and COVID-19 periods are significant at the minimum 10% level. Light-shaded cells imply an increase in value during the COVID-19 period compared with pre-COVID-19 period, whereas dark-shaded cells imply a decline in value during the COVID-19 period.

## TABLE 6G

## PERFORMANCE COMPARISON ACROSS SIZE GROUPS PRE-COVID-19 VS. DURING COVID-19: COSMETICS INDUSTRY.

| S. no. | Variable (Rs. million) | Large | | Medium | | Small | | Micro | |
|---|---|---|---|---|---|---|---|---|---|
| | | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 |
| 1 | Sales | 29,488.4 (62,276.6) | 40,720.5 (84,484.9) | 1,179.8 (1,032.1) | 1,728.9 (1,845.9) | 521.3 (472.5) | 330.0* (259.3) | 115.5 (115.3) | 77.6 (60.6) |
| 2 | GFA | 7,447.2 (10,700.3) | 12,006.6* (14,755.0) | 460.1 (408.0) | 435.1 (263.9) | 194.5 (199.7) | 260.8 (296.2) | 57.0 (21.7) | 42.7* (24.6) |
| 3 | P&M | 3,571.0 (6,439.2) | 6,626.4* (11,802.9) | 273.3 (296.4) | 222.1 (147.8) | 98.0 (154.2) | 139.2 (225.8) | 35.0 (25.9) | 28.1 (29.1) |
| 4 | RM | 9,258.8 (17,932.9) | 11,604.7 (21,031.7) | 721.4 (671.5) | 988.4 (994.5) | 284.4 (277.1) | 165.8* (167.5) | 28.5 (37.3) | 39.7 (31.2) |
| 5 | S&W | 1,220.7 (2,242.6) | 1,464.5 (2,310.5) | 52.9 (37.4) | 69.6 (54.1) | 31.2 (18.3) | 31.8 (17.1) | 7.6 (5.8) | 5.1 (3.6) |
| | Observations (NxT) | 170 | 51 | 50 | 15 | 80 | 24 | 30 | 9 |

**Notes:** Figures in parentheses are standard deviations. *Differences in means between pre-COVID-19 and COVID-19 periods are significant at the minimum 10% level. Light-shaded cells imply an increase in value during the COVID-19 period compared with pre-COVID-19 period, whereas dark-shaded cells imply a decline in value during the COVID-19 period.

**TABLE 6H**

**PERFORMANCE COMPARISON ACROSS SIZE GROUPS PRE-COVID-19 VS. DURING COVID-19: DOMESTIC APPLIANCES INDUSTRY.**

| S. no. | Variable (Rs. million) | Large | | Medium | | Small | | Micro | |
|---|---|---|---|---|---|---|---|---|---|
| | | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 | Pre-COVID-19 | During COVID-19 |
| 1 | Sales | 24,067.4 (35,159.3) | 24,307.8 (31,659.5) | 1,189.4 (648.7) | 1,569.8* (695.2) | 289.0 (233.3) | 228.6 (193.5) | 183.8 (72.7) | 151.4 (22.4) |
| 2 | GFA | 8,418.4 (19,715.7) | 11,269.3 (26,018.5) | 606.2 (514.6) | 808.1* (452.3) | 84.3 (83.5) | 123.3* (113.8) | 194.2 (17.9) | 184.1 (19.7) |
| 3 | P&M | 6,699.9 (17,486.5) | 7,948.4 (21,173.2) | 366.1 (421.0) | 416.4 (304.0) | 34.3 (36.6) | 43.6 (35.4) | 136.2 (19.1) | 149.2 (15.2) |
| 4 | RM | 10,032.4 (15,702.0) | 12,377.7 (17,044.4) | 670.3 (379.4) | 982.6* (515.9) | 166.0 (154.1) | 112.4 (145.9) | 94.1 (59.0) | 71.8 (10.0) |
| 5 | S&W | 1,042.9 (1,527.1) | 1,188.0 (1,796.6) | 101.0 (73.3) | 125.8* (69.4) | 19.1 (13.4) | 17.9 (13.6) | 19.9 (8.1) | 12.5 (2.9) |
| | Observations (NxT) | 210 | 63 | 130 | 39 | 90 | 27 | 10 | 3 |

**Notes:** Figures in parentheses are standard deviations. *Differences in means between pre-COVID-19 and COVID-19 periods are significant at the minimum 10% level. Light-shaded cells imply an increase in value during the COVID-19 period compared with pre-COVID-19 period, whereas dark-shaded cells imply a decline in value during the COVID-19 period.

For the cosmetics industry, small firms suffered a decline in sales (row 1, Table 6g) and in the use of RM (row 4, Table 6g). Both of these variables were lower in terms of magnitude during COVID-19 as compared to the pre-COVID-19 period. An increase in sales revenue was noticed for large and medium-sized firms, but the difference was not statistically significant. For micro firms, the decline in sales was also not statistically significant (row 1, Table 6g). We see a distinct scenario for domestic appliances. There was no impact of COVID-19 on the outcome for all size categories in this segment, barring medium-sized firms. The group gained during COVID-19 with an increase in sales but simultaneous investment in GFA and S&W (Table 6h).

The descriptive analysis suggests that during COVID-19, in several sectors (FPI, P&V, Pharma, domestic appliances), demand shifted to large or medium-sized firms at the expense of micro and small firms. The results, however, were suggestive and demanded a much deeper analysis of the role of the COVID-19 outbreak on the productivity performance of firms, especially on MSMEs, which we performed next.

# RESULTS

The main results of this study are given in this section. Subsection 6.1 reports the industry-wise estimates of the ACF production function, subsection 6.2 reports the size-wise productivity estimates, and subsection 6.3 analyzes the factors influencing productivity with a focus on MSMEs.

## Production Function Estimates

We present the production function estimates obtained using the ACF method in Table 7 for all the industries together. Two different specifications were estimated. In the first specification, GFA and age were included as state variables, whereas in the second, in place of GFA, P&M was used.[1] Since the models were identified for each industry, we could not test for overidentifying restrictions [13]. This is reflected in Sargan-Hansen tests for each industry, which provide the test statistics but not the p-value.

For FPI, RM and S&W were significant determinants of production function. However, expenditure on RM is found to be the only significant determinant in the case of PPI, P&V, cosmetics, and domestic appliances. For Pharma, the main driver of the production function was S&W.

## Size-wise Productivity Estimates

To investigate whether the onset of COVID-19 had impacted firms' productivity performance, we bifurcated the entire study period into two: period one from 2010 to 2019 (pre-COVID-19 period); and period two from 2020 to 2022 (COVID-19 period). Firm productivity in the eight industries in these two periods was compared. As it is argued that the impact of COVID-19 might vary across firms of different sizes, we repeated this exercise separately for micro, small, medium, and large firms.

Figure 1 shows kernel density (K-density) plots that present the differences in firm productivity between the two periods for all the industries. The mass of the productivity distribution for firms before the onset of COVID-19 is slightly to the left of that for the COVID-19 period. Two important findings emerge: 1) there is a sharp difference in firm productivity between the two periods; and 2) the average productivity during the pre-COVID-19 period was marginally higher than that in the COVID-19 period. A more detailed picture of productivity differences is captured in Tables 8a to 8h. When we look at the magnitude of decline between the two subperiods, productivity fell in all industries except PPI and cosmetics. The decline was severe for tobacco (19.6%), FPI (9.8%), and textiles (3.5%), whereas it increased substantially for the cosmetics industry (9.5%) and marginally for PPI (0.43%).

[1] Results mostly remained the same irrespective of whether we used GFA or P&M. We present results using GFA only. The results using P&M are available from the authors on request.

**TABLE 7**

**PRODUCTION FUNCTION ESTIMATES, BALANCED PANEL: 2010–22 (ACF ESTIMATES).**

| Variable | FPI | PPI | P&V | Pharma | Textiles | Tobacco | Cosmetics | Domestic appliances |
|---|---|---|---|---|---|---|---|---|
| lnGFA | 0.00422<br>(0.0704) | 0.00800<br>(0.0572) | 0.0219<br>(0.234) | 0.0735<br>(0.0541) | –0.0230<br>(0.115) | 0.512***<br>(0.188) | –0.0440<br>(0.0849) | 0.0131<br>(0.205) |
| lnAge | 0.210<br>(11.62) | –0.125<br>(0.162) | –0.0308<br>(9.134) | 0.112<br>(0.188) | 1.233<br>(0.949) | –0.136<br>(1.461) | 0.0970<br>(0.190) | 0.0112<br>(4.262) |
| lnRM | 0.654***<br>(0.0525) | 0.754***<br>(0.176) | 0.780***<br>(0.128) | 0.412<br>(0.301) | 1.059<br>(1.049) | 0.304<br>(0.213) | 1.284***<br>(0.420) | 0.528**<br>(0.254) |
| lnS&W | 0.421***<br>(0.116) | 0.232<br>(0.190) | 0.269<br>(0.266) | 0.516**<br>(0.213) | 0.0233<br>(0.993) | 0.0671<br>(0.234) | –0.272<br>(0.451) | 0.428<br>(0.445) |
| Observations | 4,080 | 468 | 132 | 3108 | 5916 | 120 | 396 | 528 |
| Wald test of CRS (chi-square) | 0.00<br>(0.98) | 0.73<br>(0.39) | 0.00<br>(0.99) | 0.26<br>(0.61) | 1.9<br>(0.168) | 0.03<br>(0.873) | 0.13<br>(0.715) | 0.00<br>(0.9962) |
| Sargan-Hansen J-statistics | 0.151 | 0.00 | 0.00 | 0.00 | 0.00 | 0.125 | 0.038 | 0.212 |

**Notes:** For definition of different variables, see Table 4a. *, **, ***Significant difference at 10%, 5%, and 1%, respectively. Figures in parentheses are standard errors.

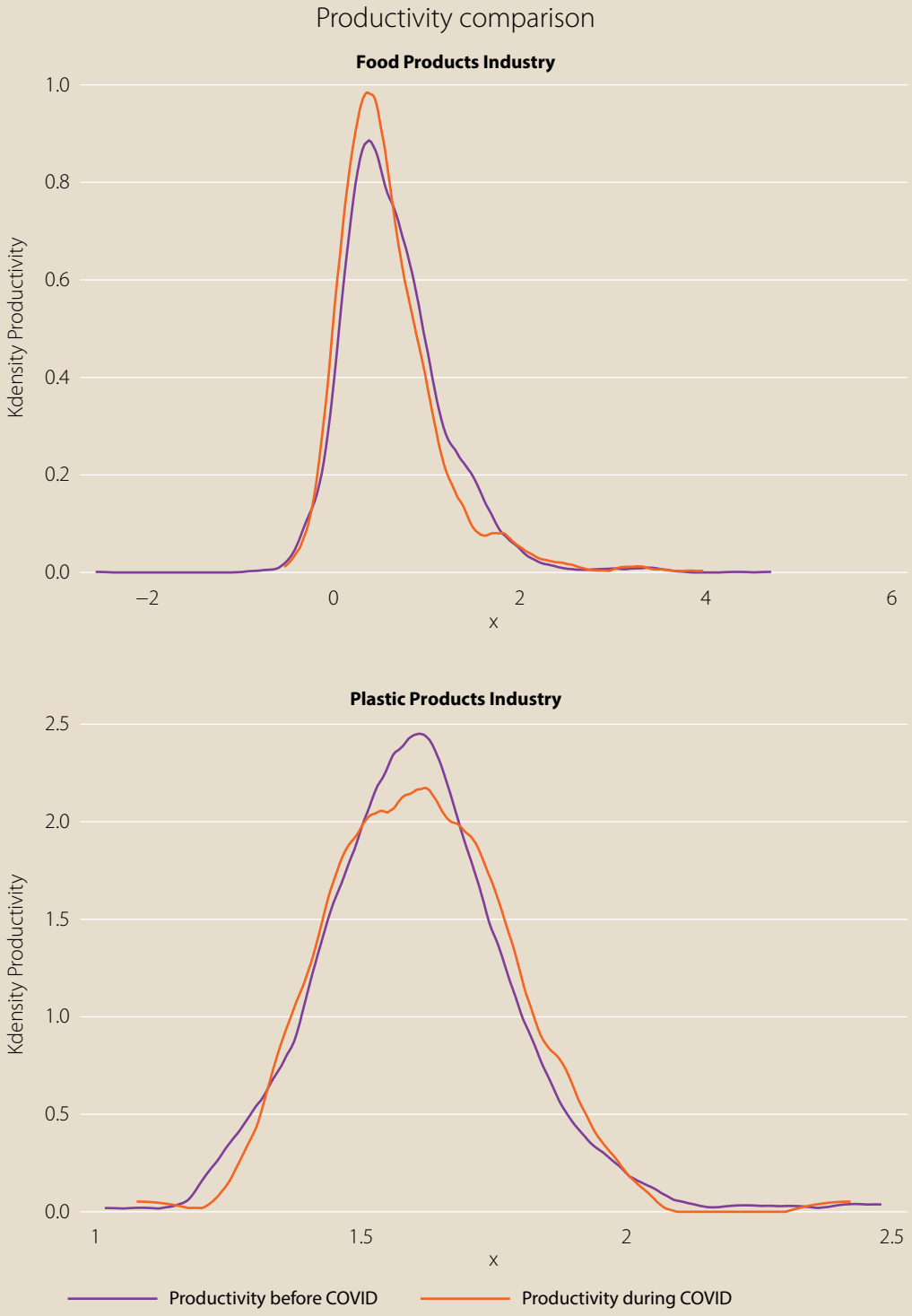
According to our results, micro and small firms primarily bore the brunt of COVID-19. The K-density plots presenting the differences in productivity between the two subperiods for different size groups are displayed in Figures 2a to 2h for each of the eight industries. Tables 8a to 8h compare the productivity differences across each size group for each industry separately.

In all size categories, the distribution of firm productivity for the COVID-19 period is to the left of that for the pre-COVID-19 period, suggesting a decline in productivity for firms of all sizes for FPI. However, the drop in productivity was statistically significant only for small firms (Table 8a). Our computations suggest that the average productivity witnessed a fall of 22% in the COVID-19 period for micro firms, although the decline was not statistically significant. In comparison, the magnitude of the decline is estimated to be 20% for small firms, which is statistically significant. On the other hand, the fall was substantially lower for medium and large firms at 5.6% and 7.6%, respectively, with the decline being statistically significant for medium-sized firms only. We did not find a statistically significant change in productivity for PPI. However, there was a decline in productivity for small and large firms and an increase in productivity for micro and medium-sized firms (Table 8b). This is also evident from the density plots for different size groups (Figure 2b).

For P&V, changes in productivity between the two periods were statistically significant only for small firms, which saw their productivity rise by 13.4% in the COVID-19 period (Table 8c). Although not statistically significant, there was a decline in productivity during the COVID-19 period for medium firms. These findings for the P&V industry are also confirmed by K-density plots in Figure 2c. All size categories witnessed a decline in productivity in the COVID-19 period

**FIGURE 1**

**K-DENSITY PLOTS OF FIRM PRODUCTIVITY BEFORE AND DURING COVID-19 FOR DIFFERENT INDUSTRIES (FPI, PPI, P&V, PHARMA, TEXTILES, TOBACCO, COSMETICS, AND DOMESTIC APPLIANCES IN THAT ORDER).**




**Note:** Period before and during COVID-19 is 10 years (2010–19) and three years (2020–22) respectively.

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**Note:** Period before and during COVID-19 is 10 years (2010–19) and three years (2020–22) respectively.

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**Note:** Period before and during COVID-19 is 10 years (2010–19) and three years (2020–22) respectively.

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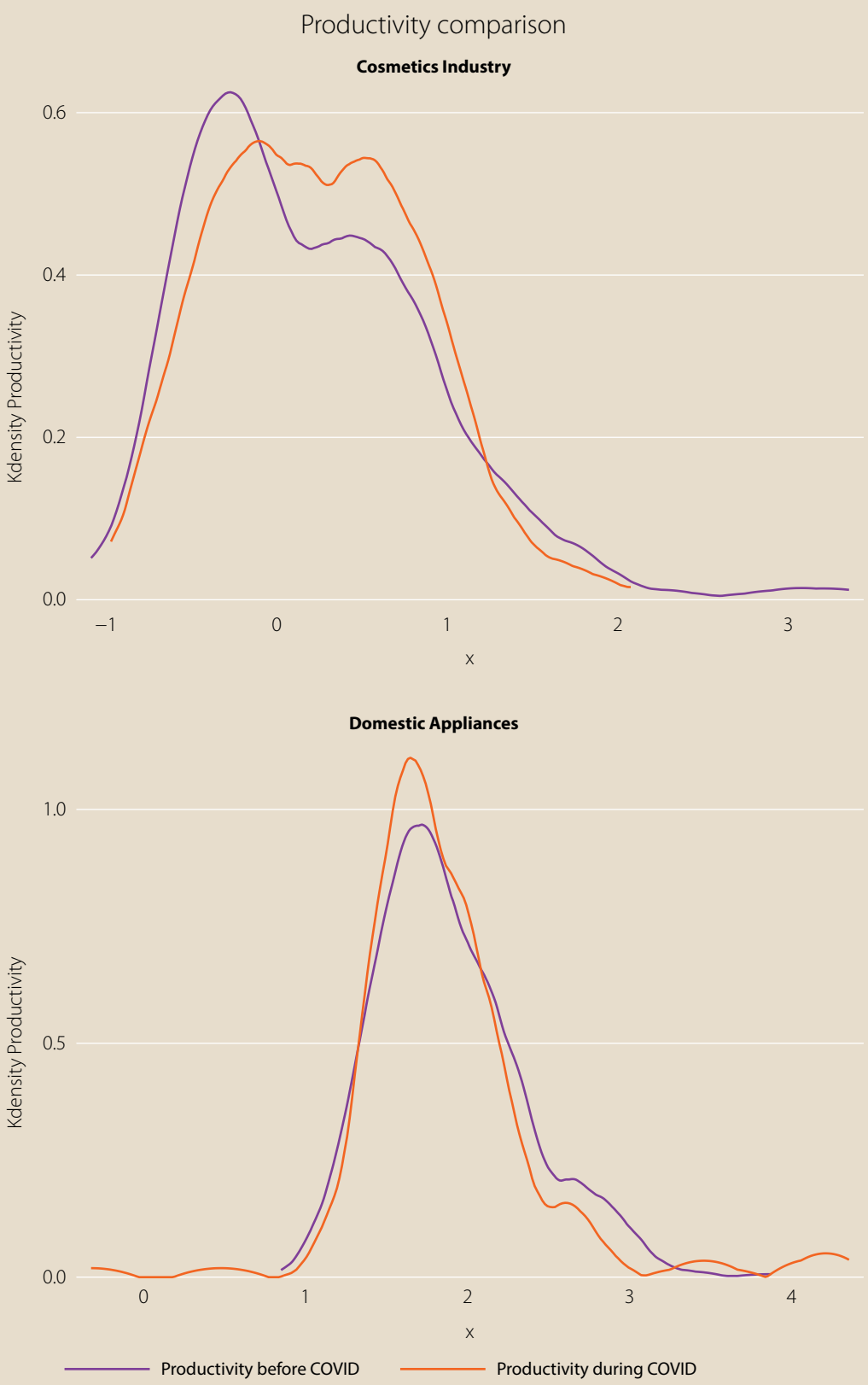


**Note:** Period before and during COVID-19 is 10 years (2010–19) and three years (2020–22) respectively.

in the Pharma industry (Table 8d). However, the fall in productivity was statistically significant only for medium firms. Although there was a substantial decline in the productivity of micro firms in the COVID-19 period, it was not statistically significant. The density plots in Figure 2d also reinforce our findings for the Pharma industry.

Our comparison of productivity estimates for textiles and tobacco showed that productivity declined in all size categories (Tables 8e and 8f). Further, barring micro firms, the productivity decline in the COVID-19 period was statistically significant for all size categories. These findings are also corroborated by the K-density plots in Figures 2e and 2f. In cosmetics, small, medium, and large firms experienced an increase in productivity during the COVID-19 period, while a decline in productivity was noticed for micro firms (Table 8g). However, the changes in productivity were statistically significant only for micro firms. K-density plots in Figure 2g confirm this finding. For the domestic appliances industry, productivity declined in large and medium firms while increasing in micro and small firms (Table 8h). These changes in productivity were statistically significant only for small and large firms. Findings on similar lines can also be found in the density plots in Figure 2h.

## TABLE 8A

### SIZE-WISE PRODUCTIVITY DISTRIBUTION BEFORE AND DURING COVID-19: FPI.

| Size | Before COVID-19 | | | | | During COVID-19 | | | | | Change in productivity (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | NxT | Mean | SD | Min | Max | NxT | Mean | SD | Min | Max | |
| Large | 1,460 | 0.606 | 0.591 | −0.900 | 4.336 | 438 | 0.573 | 0.612 | −0.532 | 3.433 | −5.59 |
| Medium | 1,190 | 0.660 | 0.515 | −2.557 | 2.326 | 357 | 0.609* | 0.517 | −0.387 | 3.683 | −7.61 |
| Small | 690 | 0.734 | 0.554 | −0.794 | 4.701 | 207 | 0.589* | 0.506 | −0.269 | 3.972 | −19.73 |
| Micro | 60 | 0.660 | 0.602 | −0.105 | 3.029 | 18 | 0.514 | 0.298 | 0.033 | 1.148 | −22.00 |
| All firms | 3,400 | 0.652 | 0.560 | −2.557 | 4.701 | 1,020 | 0.588* | 0.555 | −0.532 | 3.972 | −9.83 |

**Notes:** T for before COVID-19 is 10 years (2010–19); T during COVID-19 is 3 years (2020–22). *Significant difference in mean in the two periods (minimum 10%).

## TABLE 8B

### SIZE-WISE PRODUCTIVITY DISTRIBUTION BEFORE AND DURING COVID-19: PPI.

| Size | Before COVID-19 | | | | | During COVID-19 | | | | | Change in productivity (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | NxT | Mean | SD | Min | Max | NxT | Mean | SD | Min | Max | |
| Large | 60 | 1.646 | 0.152 | 1.27 | 2.04 | 18 | 1.612 | 0.149 | 1.32 | 1.84 | −2.06 |
| Medium | 190 | 1.619 | 0.188 | 1.15 | 2.48 | 57 | 1.649 | 0.188 | 1.37 | 2.42 | 1.86 |
| Small | 120 | 1.598 | 0.189 | 1.02 | 2.46 | 36 | 1.571 | 0.169 | 1.08 | 1.97 | −1.70 |
| Micro | 20 | 1.435 | 0.165 | 1.22 | 1.9 | 6 | 1.548 | 0.212 | 1.35 | 1.82 | 7.87 |
| All firms | 390 | 1.607 | 0.186 | 1.017 | 2.48 | 117 | 1.614 | 0.18 | 1.08 | 2.42 | 0.43 |

**Notes:** T for before COVID-19 is 10 years (2010–19); T during COVID-19 is 3 years (2020–22). *Significant difference in mean in the two periods (minimum 10%).

## TABLE 8C

### SIZE-WISE PRODUCTIVITY DISTRIBUTION BEFORE AND DURING COVID-19: P&V.

| Size | Before COVID-19 | | | | | During COVID-19 | | | | | Change in productivity (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | NxT | Mean | SD | Min | Max | NxT | Mean | SD | Min | Max | |
| Large | 50 | 0.995 | 0.094 | 0.865 | 1.271 | 15 | 0.999 | 0.085 | 0.847 | 1.137 | 0.38 |
| Medium | 50 | 1.051 | 0.259 | 0.637 | 1.753 | 15 | 1.002 | 0.16 | 0.742 | 1.237 | –4.66 |
| Small | 10 | 0.928 | 0.032 | 0.89 | 0.977 | 3 | 1.052* | 0.178 | 0.869 | 1.225 | 13.38 |
| Micro | | | | | | | | | | | |
| All firms | 110 | 1.014 | 0.189 | 0.637 | 1.753 | 33 | 1.005 | 0.129 | 0.742 | 1.237 | –0.92 |

**Notes:** T for before COVID-19 is 10 years (2010–19); T during COVID-19 is 3 years (2020–22). *Significant difference in mean in the two periods (minimum 10%).

## TABLE 8D

### SIZE-WISE PRODUCTIVITY DISTRIBUTION BEFORE AND DURING COVID-19: PHARMA.

| Size | Before COVID-19 | | | | | During COVID-19 | | | | | Change in productivity (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | NxT | Mean | SD | Min | Max | NxT | Mean | SD | Min | Max | |
| Large | 840 | 1.426 | 0.307 | –0.587 | 2.438 | 252 | 1.416 | 0.326 | 0.286 | 2.525 | –0.73 |
| Medium | 1,040 | 1.378 | 0.347 | –0.141 | 2.914 | 312 | 1.332* | 0.339 | –0.222 | 2.753 | –3.38 |
| Small | 560 | 1.275 | 0.556 | –1.520 | 3.393 | 168 | 1.266 | 0.454 | –0.335 | 3.537 | –0.70 |
| Micro | 150 | 1.304 | 0.546 | –0.068 | 3.155 | 45 | 1.166 | 0.738 | –1.835 | 2.3 | –10.63 |
| All firms | 2590 | 1.367 | 0.408 | –1.520 | 3.393 | 777 | 1.335* | 0.401 | –1.835 | 3.537 | –2.35 |

**Notes:** T for before COVID-19 is 10 years (2010–19); T during COVID-19 is 3 years (2020–22). *Significant difference in mean in the two periods (minimum 10%).

## TABLE 8E

### SIZE-WISE PRODUCTIVITY DISTRIBUTION BEFORE AND DURING COVID-19: TEXTILES.

| Size | Before COVID-19 | | | | | During COVID-19 | | | | | Change in productivity (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | NxT | Mean | SD | Min | Max | NxT | Mean | SD | Min | Max | |
| Large | 1,030 | –3.900 | 0.787 | –5.961 | –0.829 | 309 | –4.019* | 0.957 | –6.033 | 1.453 | –3.05 |
| Medium | 2,040 | –3.819 | 0.855 | –6.514 | 1.142 | 612 | –3.938* | 0.835 | –6.188 | 1.899 | –3.14 |
| Small | 1,600 | –3.558 | 0.833 | –5.819 | 1.237 | 480 | –3.728* | 0.769 | –5.783 | 2.949 | –4.78 |

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| Size | Before COVID-19 | | | | | During COVID-19 | | | | | Change in productivity (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | NxT | Mean | SD | Min | Max | NxT | Mean | SD | Min | Max | |
| Micro | 260 | –3.624 | 0.851 | –5.678 | –0.236 | 78 | –3.647 | 0.888 | –5.638 | 0.306 | –0.66 |
| All firms | 4,930 | –3.741 | 0.845 | –6.514 | 1.237 | 1,479 | –3.872* | 0.853 | –6.188 | 2.949 | –3.50 |

**Notes:** T for before COVID-19 is 10 years (2010–19); T during COVID-19 is 3 years (2020–22). *Significant difference in mean in the two periods (minimum 10%).

## TABLE 8F

### SIZE-WISE PRODUCTIVITY DISTRIBUTION BEFORE AND DURING COVID-19: TOBACCO.

| Size | Before COVID-19 | | | | | During COVID-19 | | | | | Change in productivity (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | NxT | Mean | SD | Min | Max | NxT | Mean | SD | Min | Max | |
| Large | 50 | 2.921 | 0.482 | 1.789 | 3.599 | 15 | 2.548* | 0.239 | 2.079 | 2.83 | –12.77 |
| Medium | | | | | | | | | | | |
| Small | 40 | 2.359 | 0.765 | 0.928 | 4.019 | 12 | 1.572* | 0.429 | 1.075 | 2.432 | –33.35 |
| Micro | 10 | 1.967 | 0.341 | 1.26 | 2.475 | 3 | 1.874 | 0.037 | 1.839 | 1.912 | –4.71 |
| All firms | 100 | 2.601 | 0.687 | 0.928 | 4.019 | 30 | 2.091* | 0.567 | 1.075 | 2.83 | –19.62 |

**Notes:** T for before COVID-19 is 10 years (2010–19); T during COVID-19 is 3 years (2020–22). *Significant difference in mean in the two periods (minimum 10%).

## TABLE 8G

### SIZE-WISE PRODUCTIVITY DISTRIBUTION BEFORE AND DURING COVID-19: COSMETICS.

| Size | Before COVID-19 | | | | | During COVID-19 | | | | | Change in productivity (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | NxT | Mean | SD | Min | Max | NxT | Mean | SD | Min | Max | |
| Large | 170 | 0.301 | 0.569 | –1.090 | 1.729 | 51 | 0.364 | 0.558 | –0.548 | 1.575 | 21.11 |
| Medium | 50 | –0.266 | 0.501 | –0.946 | 1.223 | 15 | –0.269 | 0.393 | –0.973 | 0.489 | 1.04 |
| Small | 80 | 0.157 | 0.867 | –0.810 | 3.356 | 24 | 0.356 | 0.501 | –0.518 | 1.371 | 127.24 |
| Micro | 30 | 0.729 | 0.897 | –0.780 | 2.707 | 9 | 0.069* | 0.913 | –0.920 | 2.076 | –90.54 |
| All firms | 330 | 0.219 | 0.72 | –1.090 | 3.356 | 99 | 0.239 | 0.601 | –0.973 | 2.076 | 9.41 |

**Notes:** T for before COVID-19 is 10 years (2010–19); T during COVID-19 is 3 years (2020–22). *Significant difference in mean in the two periods (minimum 10%).

**TABLE 8H**

**SIZE-WISE PRODUCTIVITY DISTRIBUTION BEFORE AND DURING COVID-19: DOMESTIC APPLIANCES.**

| Size | Before COVID-19 | | | | | During COVID-19 | | | | | Change in productivity (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | NxT | Mean | SD | Min | Max | NxT | Mean | SD | Min | Max | |
| Large | 210 | 2.173 | 0.371 | 1.44 | 3.141 | 63 | 1.990* | 0.476 | –0.324 | 2.812 | –8.42 |
| Medium | 130 | 1.623 | 0.26 | 1.067 | 3.029 | 39 | 1.581 | 0.146 | 1.203 | 1.892 | –2.59 |
| Small | 90 | 1.662 | 0.492 | 0.848 | 3.872 | 27 | 2.026* | 0.96 | 1.132 | 4.354 | 21.88 |
| Micro | 10 | 1.568 | 0.36 | 1.142 | 2.208 | 3 | 1.582 | 0.134 | 1.495 | 1.736 | 0.89 |
| All firms | 440 | 1.892 | 0.458 | 0.848 | 3.872 | 132 | 1.867 | 0.579 | –0.324 | 4.354 | –1.32 |

**Notes:** T for before COVID-19 is 10 years (2010–19); T during COVID-19 is 3 years (2020–22). *Significant difference in mean in the two periods (minimum 10%).

Table 9 summarizes the significant changes in productivity for different size groups for various industries. For most size groups across industries, we observed a productivity decline, which was statistically significant. Only in the P&V and domestic appliances industries did small firms report an increase in productivity in the COVID-19 period (rows 3 and 8). In contrast, large firms showed declining productivity in textiles, tobacco products, and domestic appliances. Small firms' productivity declined in the FPI, textiles, and tobacco products (rows 1, 5, and 6). Medium-sized firms showed a decline in productivity in the FPI, Pharma, and textile industries (rows 1, 4, and 5). Although Prowess does not include enough micro firms, our analysis showed declining productivity for this size group in cosmetics (row 7).

**TABLE 9**

**INDUSTRY-WISE SUMMARY OF PRODUCTIVITY CHANGE: PRE- AND DURING COVID-19.**

| S. no. | Industry | Productivity increase | Productivity decrease |
|---|---|---|---|
| 1 | FPI | | Medium, small, overall |
| 2 | PPI | * | * |
| 3 | P&V | Small | |
| 4 | Pharma | | Medium, overall |
| 5 | Textiles | | Large, medium, small, overall |
| 6 | Tobacco products | | Large, small, overall |
| 7 | Cosmetics | | Micro |
| 8 | Domestic appliances | Small | Large |

**Notes:** Only statistically significant productivity changes are shown. *None of the size groups showed statistically significant changes in productivity over the period.

**FIGURE 2A**

**PRODUCTIVITY COMPARISONS OF DIFFERENT CATEGORIES OF FIRMS IN THE FPI PRE- AND DURING COVID-19.**


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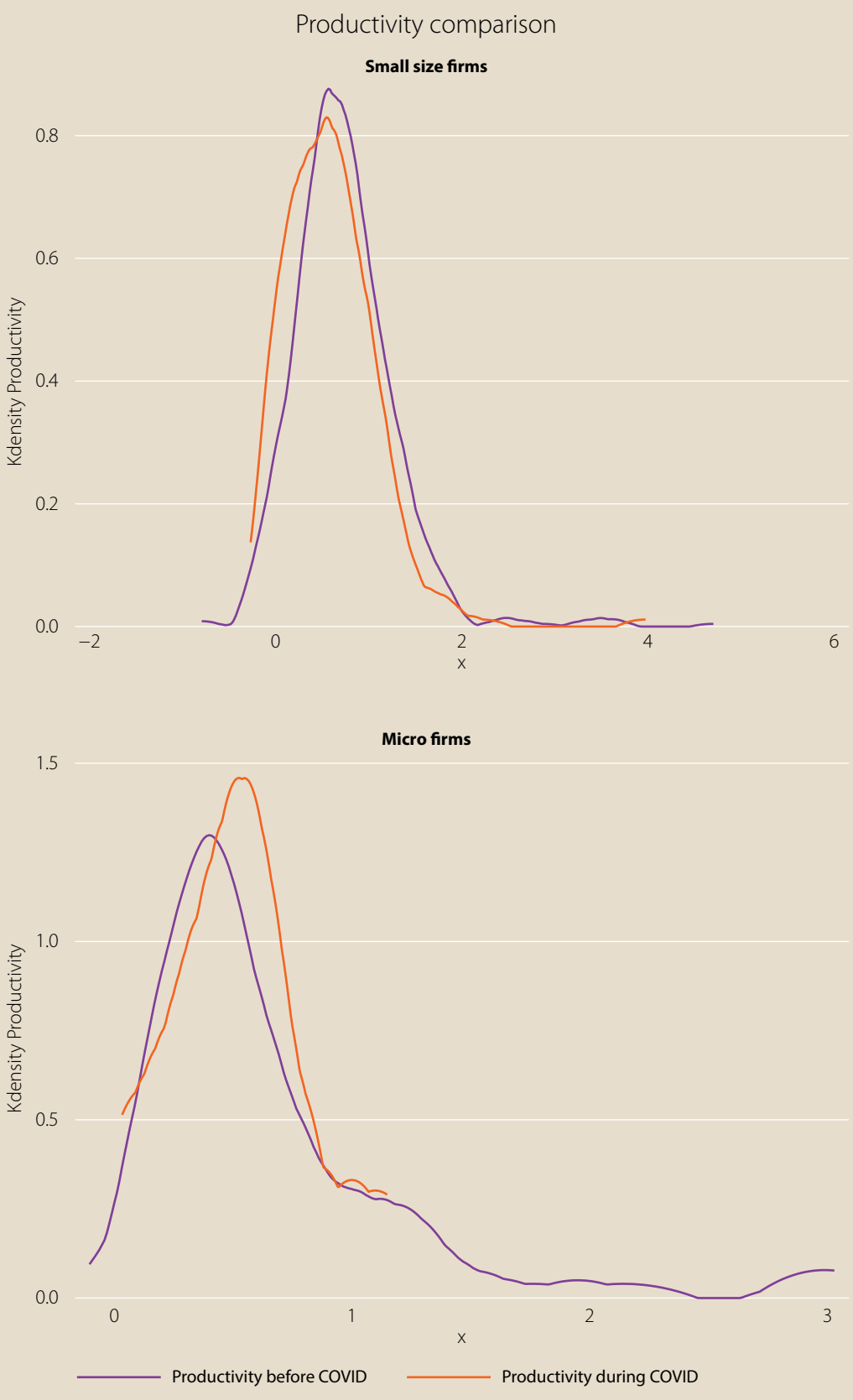

**FIGURE 2B**

**PRODUCTIVITY COMPARISONS OF DIFFERENT CATEGORIES OF FIRMS IN THE PPI PRE- AND DURING COVID-19.**


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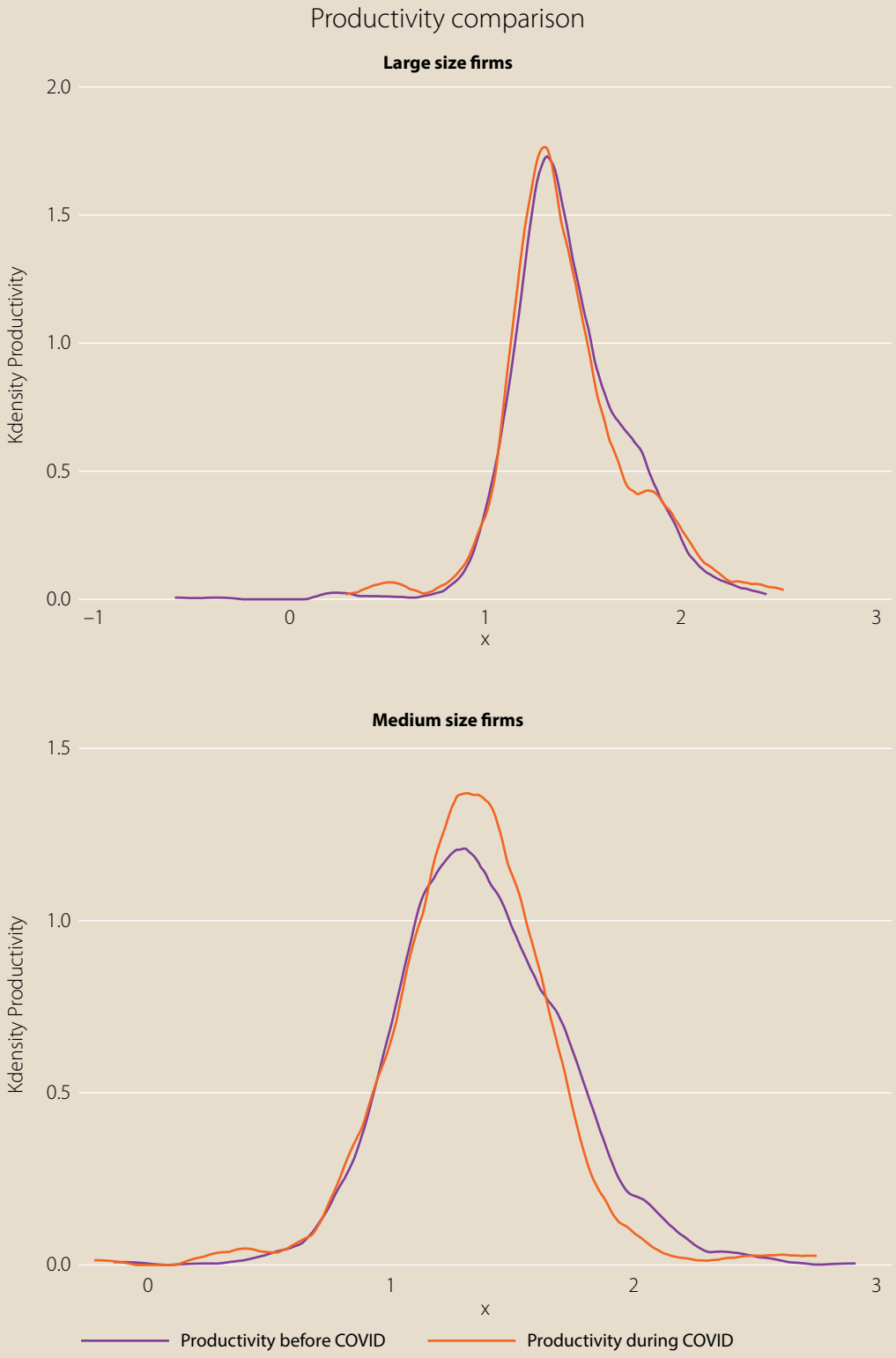
**FIGURE 2C**

**PRODUCTIVITY COMPARISONS OF DIFFERENT CATEGORIES OF FIRMS IN P&V PRE- AND DURING COVID-19.**

**FIGURE 2D**

**PRODUCTIVITY COMPARISONS OF DIFFERENT CATEGORIES OF FIRMS IN THE PHARMA INDUSTRY PRE- AND DURING COVID-19.**

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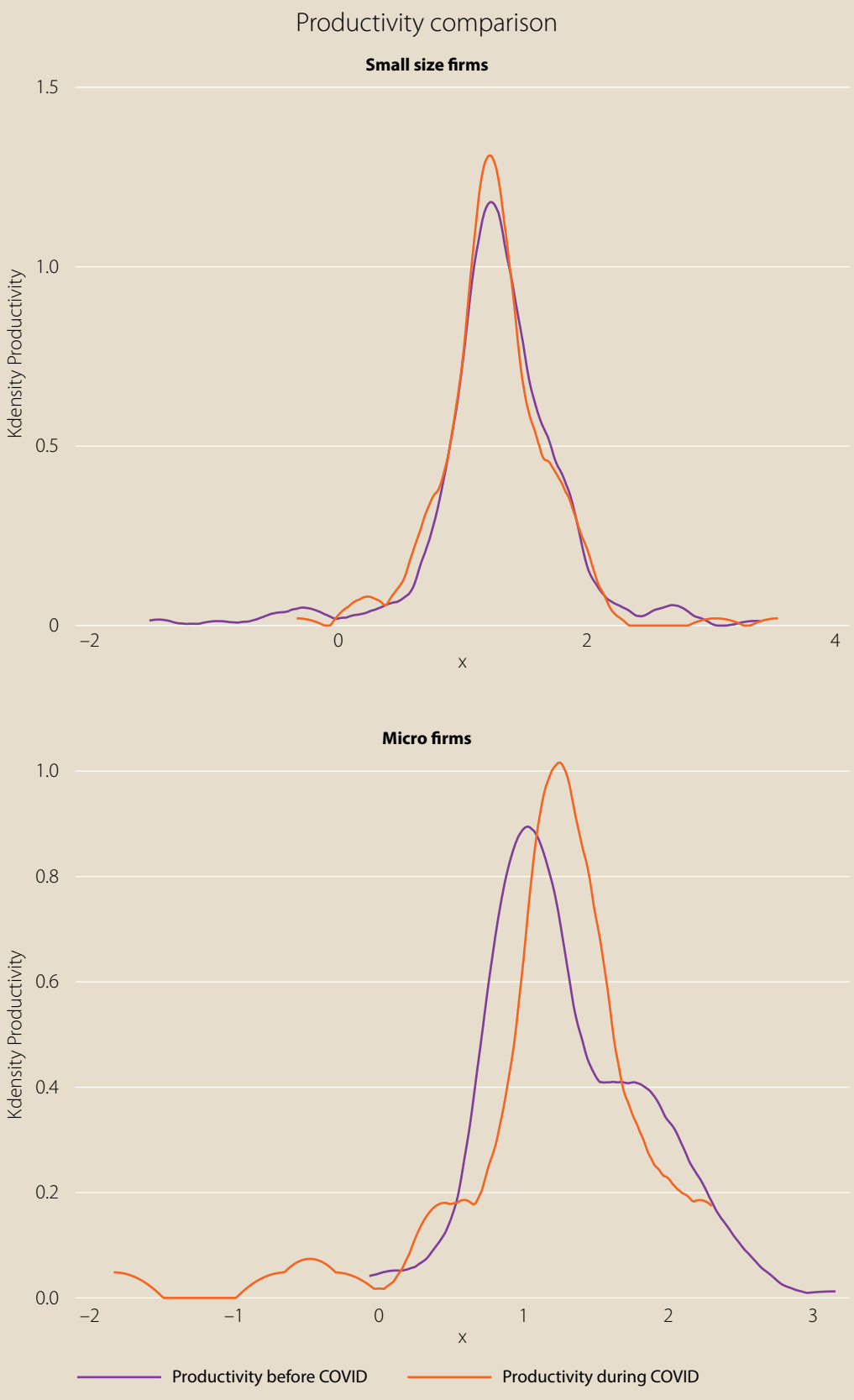
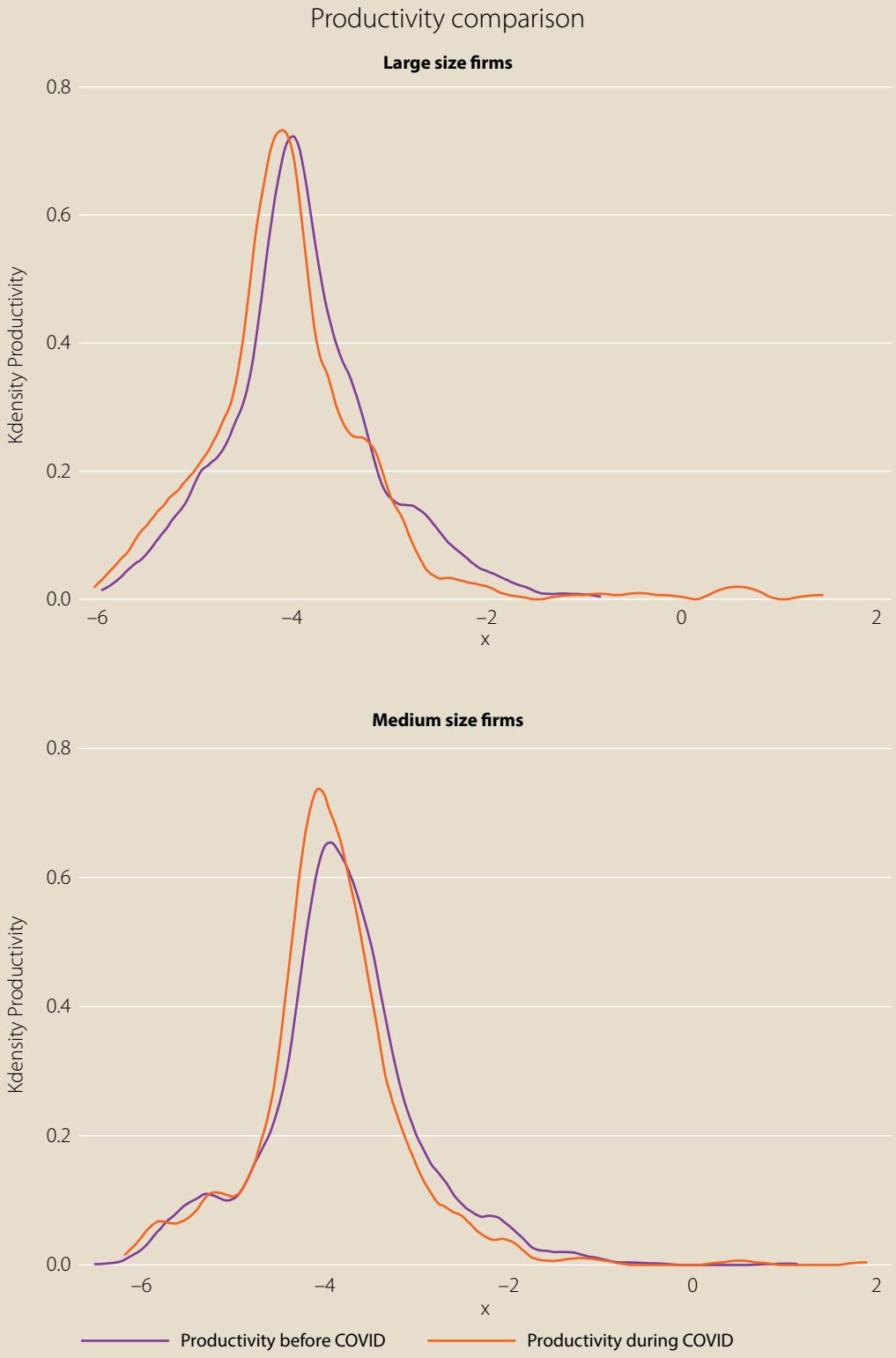


**FIGURE 2E**

**PRODUCTIVITY COMPARISONS OF DIFFERENT CATEGORIES OF FIRMS IN THE TEXTILE INDUSTRY PRE- AND DURING COVID-19.**

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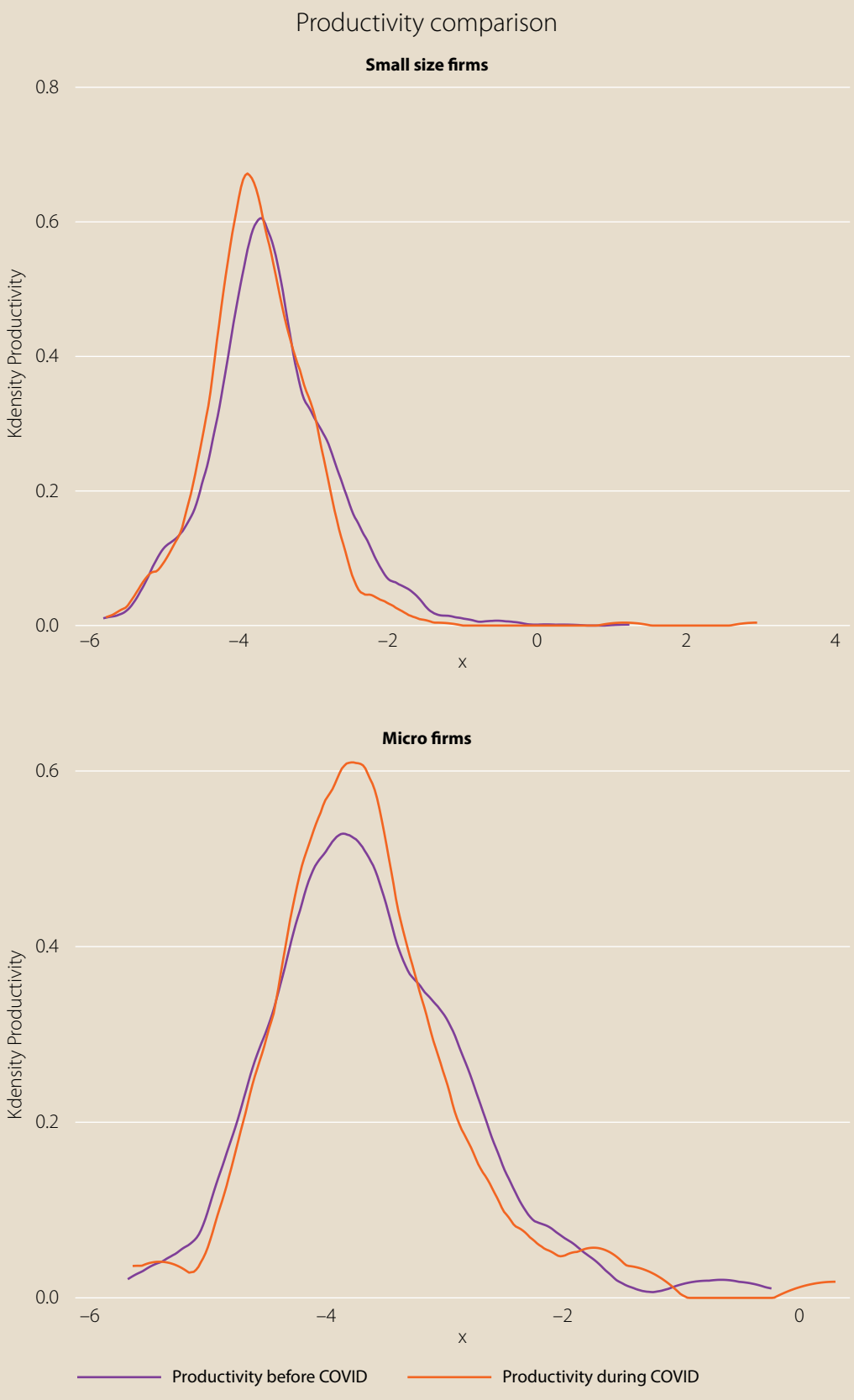

**FIGURE 2F**

**PRODUCTIVITY COMPARISONS OF DIFFERENT CATEGORIES OF FIRMS IN THE TOBACCO INDUSTRY PRE- AND DURING COVID-19.**

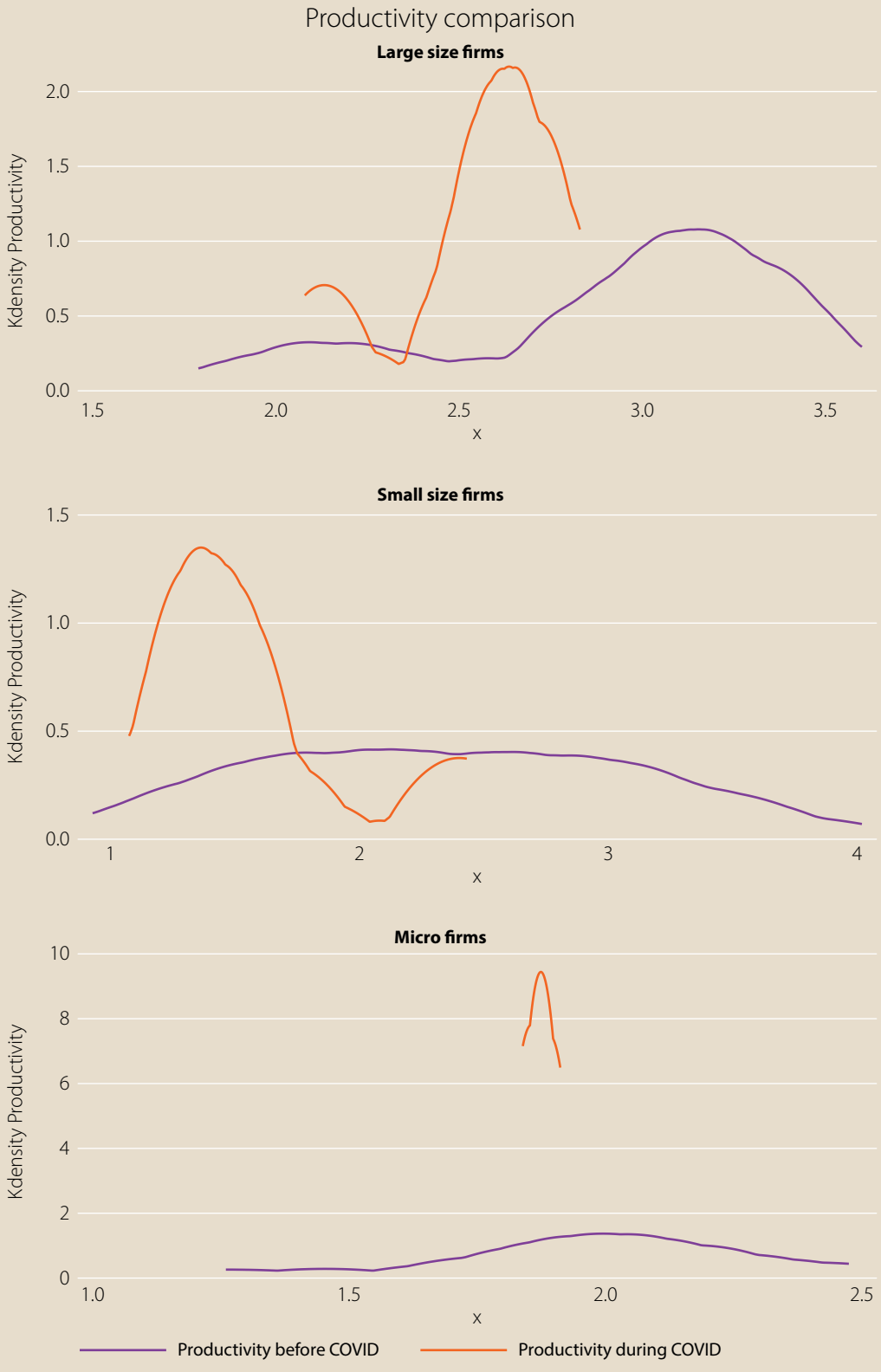

**FIGURE 2G**

**PRODUCTIVITY COMPARISONS OF DIFFERENT CATEGORIES OF FIRMS IN THE COSMETICS INDUSTRY PRE- AND DURING COVID-19.**


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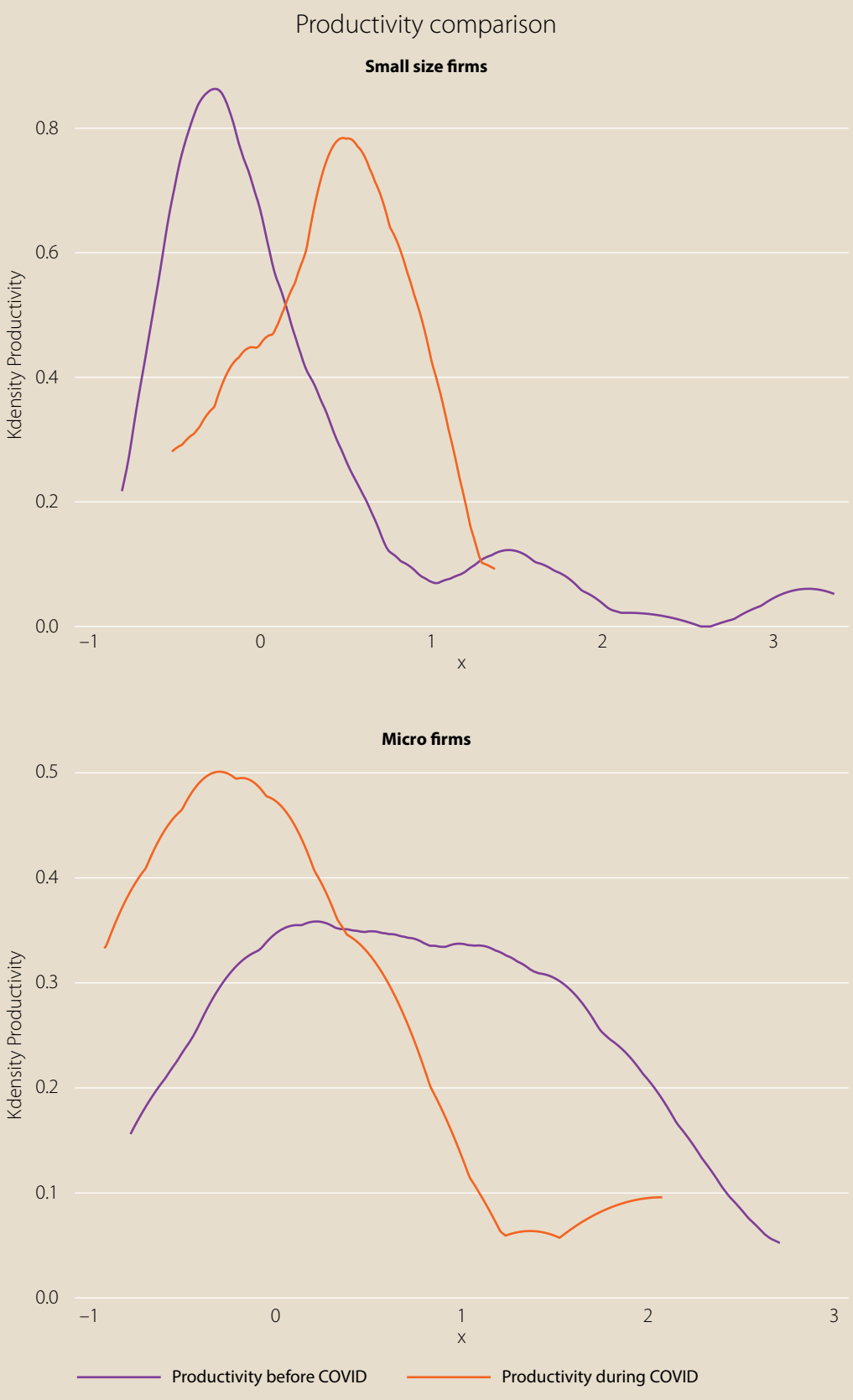

**FIGURE 2H**

**PRODUCTIVITY COMPARISONS OF DIFFERENT CATEGORIES OF FIRMS IN THE DOMESTIC APPLIANCES INDUSTRY PRE- AND DURING COVID-19.**


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## Factors Influencing Productivity: Role of Digitalization and Government Policy

Although our analysis suggests a significant decline in productivity during the COVID-19 period for six of the eight industries and for large and small firms alike, there could be other factors driving the productivity performance of firms. This requires controlling for the influence of possible factors impacting firm productivity. We carried out cross-sectional analysis at two levels: first, by pooling firms in all the industries; and second, for MSMEs alone. Since COVID-19 has resulted in increased digitalization, we hypothesized that digitalization might have played a role in mitigating the impact of the pandemic on firm performance. We therefore examined the role of digitalization on firm productivity. To do this, we proxied digitalization using a binary variable representing whether or not a firm had a website and examined its influence on firm productivity, since the presence of a website would have helped firms to rationalize their sales. The variable is a dummy that takes the value 1 if the firm had a website and 0 otherwise.

We also examined how credit support helped firms to ease the challenges encountered during the pandemic. As the dataset does not provide direct information on the receipt of credit support by firms during the pandemic, we proxied this variable using short-term borrowings by firms, assuming that most government support during COVID-19 was to take care of short-term liquidity problems. Using this information, we classified the firms into those with no borrowings before and during COVID-19, firms with increased borrowing during COVID-19, and firms with decreased borrowing during COVID-19. We introduced two binary variables for firms with increased and reduced borrowing, with firms with no borrowing as the benchmark category. We also controlled for the influence of ownership type, i.e., if the firm is part of a business group or a standalone company, entity type (private limited vs. public limited), age, the size profile of the firm (micro, small, medium vs. large) and location (metro vs. nonmetro area). To account for industry heterogeneity, we also included dummies for each of the NIC 2-digit industries.

Table 10 gives the basic characteristics of second-stage sampled firms. There was a decline in productivity during the COVID-19 period (row 1). Of the total 1,213 firms, a significant proportion (81%) are listed (row 4), and nearly 30% (366 firms) did not have a website (row 3). Interestingly, of the 366 firms with no website, over 70% (258) were listed. Importantly, three-fourths of the sampled firms were standalone entities (row 5). Of the 909 standalone firms, 95% (860) were Indian-owned, and the remaining 49 foreign-owned. The distribution was mostly the same for group firms, with 96% (293) belonging to the Indian group and the remaining 4% (11) being part of the foreign group. In terms of coverage, nearly 32% were large, and the remaining were MSMEs, although the share of micro firms was relatively small (4.4%). Nearly 65% of the firms had registered offices in metro areas and capital cities. When we look at the classification of firms by short-term borrowing, 31% reported no borrowings before and during COVID-19. Among the firms with short-term borrowings, 44% reported an increase in short-term borrowings during COVID-19, while the remaining 56% had seen a decline in short-term borrowings during the pandemic. The average age of the sampled firms was nearly 39 years, with the oldest firm being 157 years old.

**TABLE 10**

**BASIC DESCRIPTIVE STATISTICS (N = 1,213).**

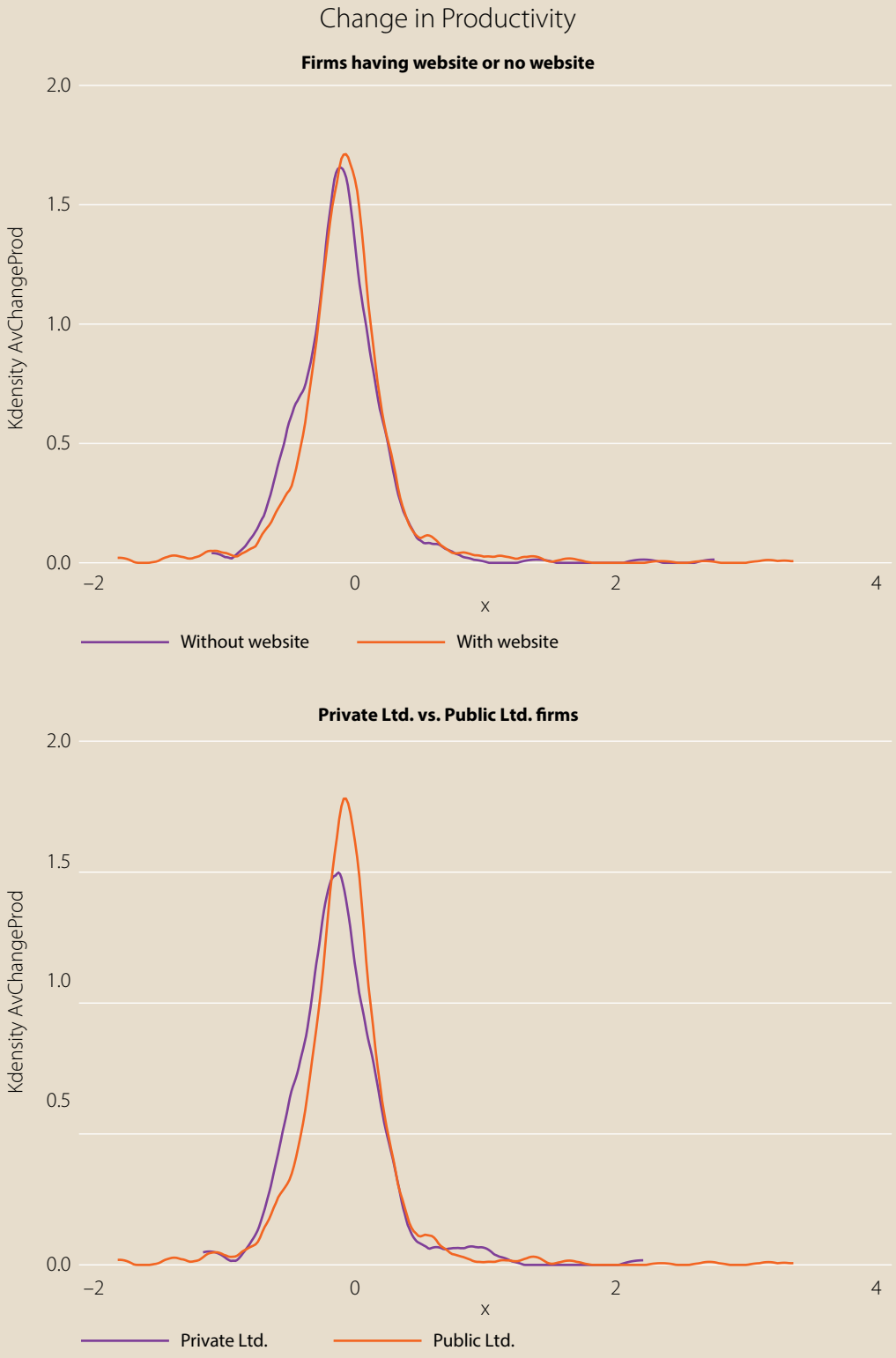
| S. no. | Variable | Mean | SD | Min | Max |
|---|---|---|---|---|---|
| 1 | Change in productivity over the period | –0.078 | 0.413 | –1.82 | 3.36 |
| 2 | Age (years) | 38.61 | 22.44 | 11 | 157 |
| 3 | Firms with websites (no.) | Yes | 847 (69.8) | | |
| | | No | 366 (30.2) | | |
| 4 | Firm type (no.) | Private Ltd. | 229 (18.9) | | |
| | | Public Ltd. | 984 (81.1) | | |
| 5 | Organization type (no.) | Standalone | 909 (74.9) | | |
| | | Group | 304 (25.1) | | |
| 6 | Size (no.) | Large | 384 (31.7) | | |
| | | Medium | 460 (37.9) | | |
| | | Small | 316 (26.0) | | |
| | | Micro | 53 (4.4) | | |
| 7 | Location (no.) | Metro | 781 (64.4) | | |
| | | Nonmetro | 432 (35.6) | | |
| 8 | Short-term borrowing (no.)* | No borrowing | 377 (31.2) | | |
| | | Increased borrowing | 368 (30.5) | | |
| | | Reduced borrowing | 462 (38.3) | | |
| 9 | Industry | NIC 10 | 270 (22.3) | | |
| | | NIC 11 | 48 (4.0) | | |
| | | NIC 12 | 8 (0.7) | | |
| | | NIC 13 | 378 (31.2) | | |
| | | NIC 14 | 64 (5.3) | | |
| | | NIC 20 | 109 (9.0) | | |
| | | NIC 21 | 254 (20.9) | | |
| | | NIC 22 | 38 (3.1) | | |
| | | NIC 26 | 7 (0.6) | | |
| | | NIC 27 | 25 (2.1) | | |
| | | NIC 28 | 12 (1.0) | | |

**Notes:** Figures in parentheses are the percentages of total observations. *There was a discrepancy in short-term borrowing figures for six firms. Hence they were not considered in the final analysis.

Before analyzing the factors influencing changes in productivity, we visually examined how having a website and the nature and type of firm and location affected productivity performance. Figures 3a to 3d show density plots of changes in the productivity of sample firms when they owned a website, whether they were listed, whether they belonged to a group or were standalone, and whether they were in a metro or nonmetro city. Figure 4 shows the productivity changes in different size groups.

**FIGURE 3**

**CHANGES IN PRODUCTIVITY FROM THE PRE-COVID-19 PERIOD TO THE COVID-19 PERIOD BY FIRM CHARACTERISTICS.**

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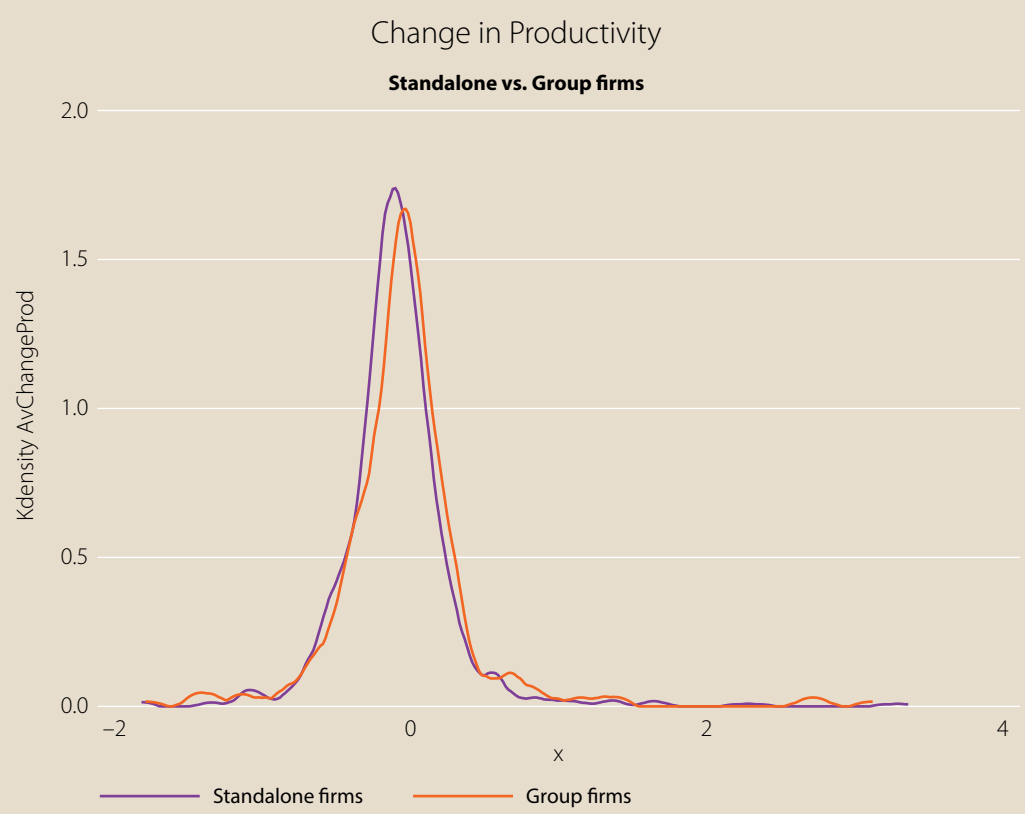


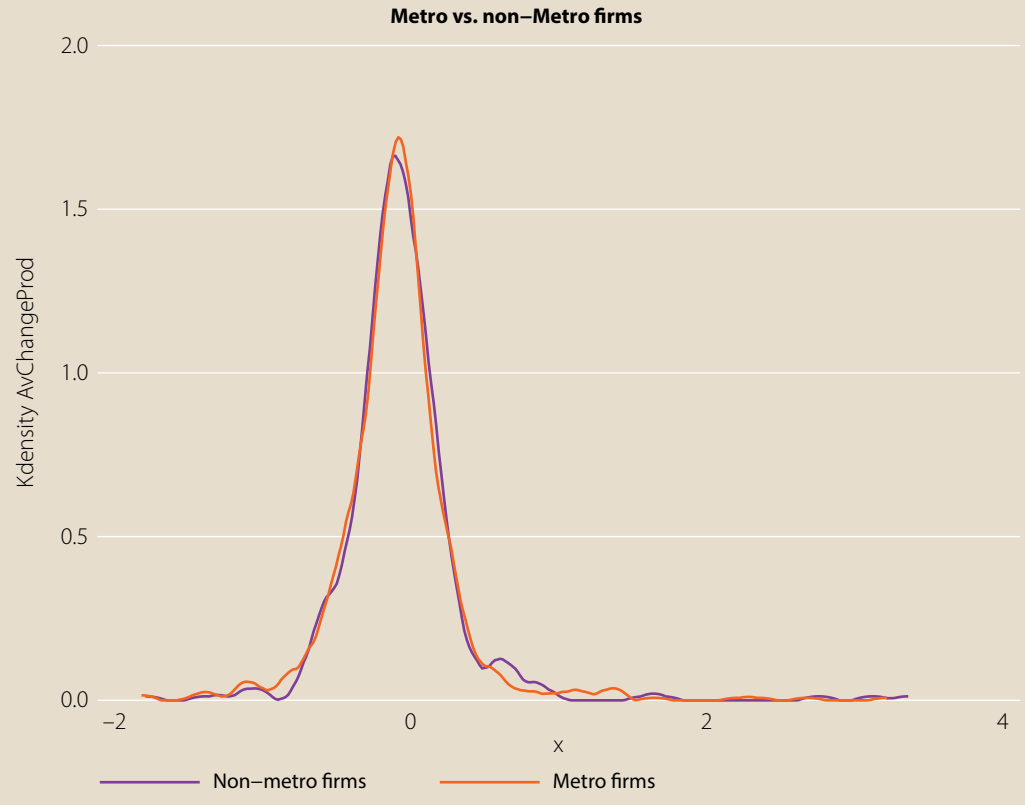
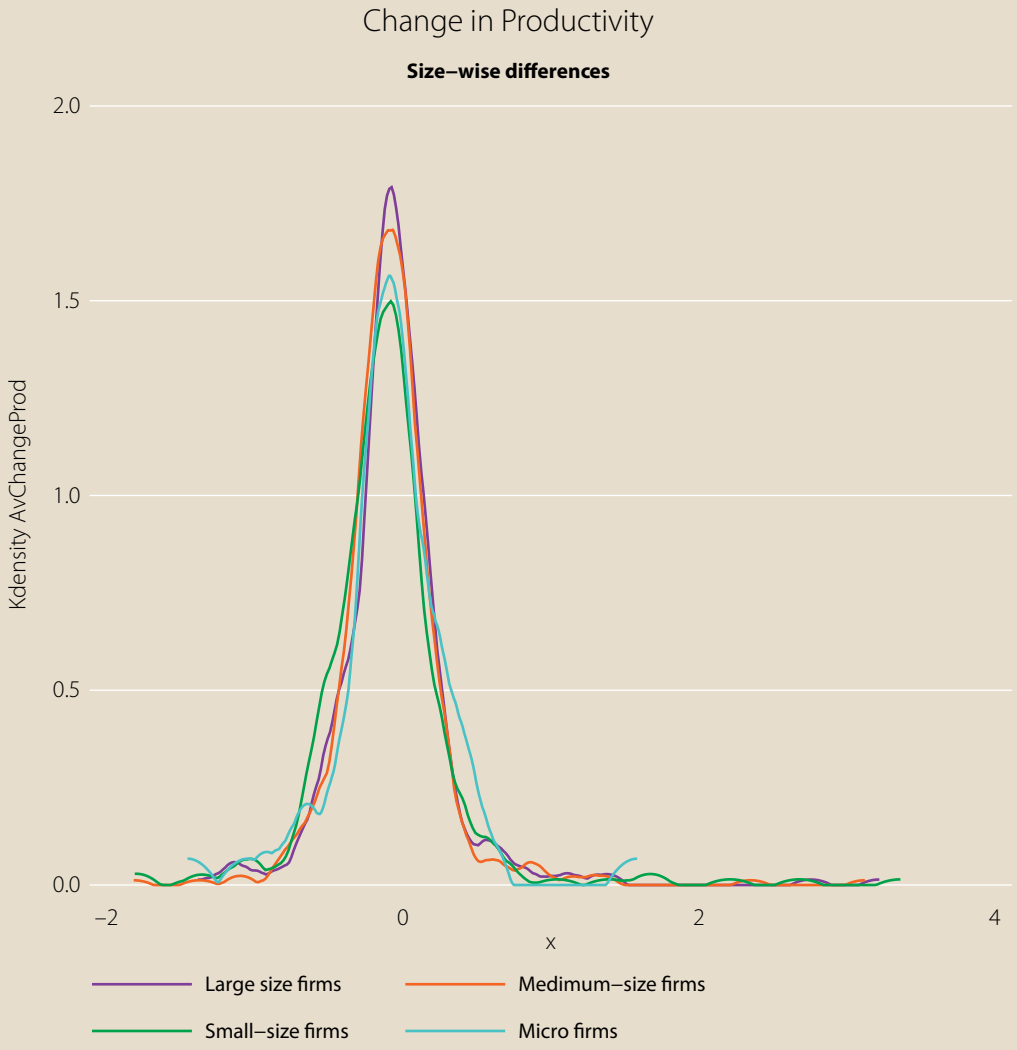



**FIGURE 4**

**CHANGES IN PRODUCTIVITY ACROSS SIZE GROUPS.**




As is evident from the density plots, and as hypothesized, firms more oriented toward digitalization, listed firms, and firms that are part of a group were able to derive productivity gains during the COVID-19 period. However, we found little difference in productivity performance based on firm location, suggesting that none of the location-specific effects dominate. We also performed a simple t-test to see whether these productivity differences were significant. Table 11 reports the results, showing that productivity declines were evident across the board. However, the productivity decline in firms that are older (row 5), with websites (row 1), listed firms (row 2), and belonging to a group (row 3) was not statistically different from that of their counterparts (younger, without websites, unlisted, and standalone). Location, however, did not result in a differential impact on productivity (row 4). Surprisingly, firms with short-term borrowings (row 6) also witnessed a decline in productivity, and the fall was more pronounced for firms with increased short-term borrowings during COVID-19. Although there was an overall decline in productivity from the pre-COVID-19 to COVID-19 period for all categories of firms, those (except large ones) with websites did relatively better than those without (Figure 5).

**TABLE 11**

**PRODUCTIVITY CHANGE FROM THE PRE-COVID-19 TO COVID-19 PERIOD: ROLE OF FIRM CHARACTERISTICS.**

| S. no. | Characteristic | | No. of firms | Mean | SD |
|---|---|---|---|---|---|
| 1 | Website | Yes | 847 | –0.062* | 0.433 |
| | | No | 366 | –0.115 | 0.359 |
| 2 | Entity type | Private Ltd. | 229 | –0.119 | 0.366 |
| | | Public Ltd. | 984 | –0.068* | 0.423 |
| 3 | Organization type | Standalone | 909 | –0.091 | 0.389 |
| | | Group firm | 304 | –0.039* | 0.477 |
| 4 | Location | Metro | 781 | –0.087 | 0.408 |
| | | Nonmetro | 432 | –0.061 | 0.423 |
| 5 | Age** | Young | 283 | –0.166 | 0.427 |
| | | Middle-aged | 627 | –0.076* | 0.44 |
| | | Old | 309 | –0.006* | 0.324 |
| 6 | Short-term borrowing# | No borrowing | 377 | –0.0036 | 0.549 |
| | | Increased borrowing | 368 | –0.127* | 0.353 |
| | | Decreased borrowing | 462 | –0.099* | 0.309 |

**Notes:** *The mean productivity change is significantly different for the category of firms than the other category at a minimum 10% level.
**For age, the statistical sign for middle-aged firms implies that the average productivity change in this group is different than that of young firms and also that of old firms. Similarly, a statistically significant value for older firms implies that the productivity change in this group was different from that in the other two groups.
#There was no difference in productivity change for firms whose borrowings increased versus firms whose borrowings decreased, although borrowers had poorer productivity performance than nonborrowers.

Figure 6 shows how productivity performance varied for different size categories of firms depending upon their dependence on short-term borrowings from banks during the COVID-19 period. Ideally, we would expect firms that availed of short-term loans during COVID-19 would perform better. There is an alternative view that firms with weaker balance sheets in pre-COVID-19 times might find it challenging to cope with the pandemic and thus might do worse. We also find that firms that did not borrow performed relatively better in terms of productivity vis-à-vis borrowers. Unlike poor performers, the better-performing firms might not have required credit support and hence might not have sought financial support.

We then examined whether the observed relationship between digitalization and bank support and productivity survived the scrutiny of regression analysis. Table 12 gives the regression results by pooling firms in all industries. As mentioned earlier, we first tested this relationship for all firms without and with accounting for industry heterogeneity (columns 1 and 2). Subsequently, we analyzed only MSMEs. Columns 3 and 4 report the results for MSMEs.

**FIGURE 5**

**PRODUCTIVITY CHANGES ACROSS SIZE GROUPS: ROLE OF DIGITALIZATION.**

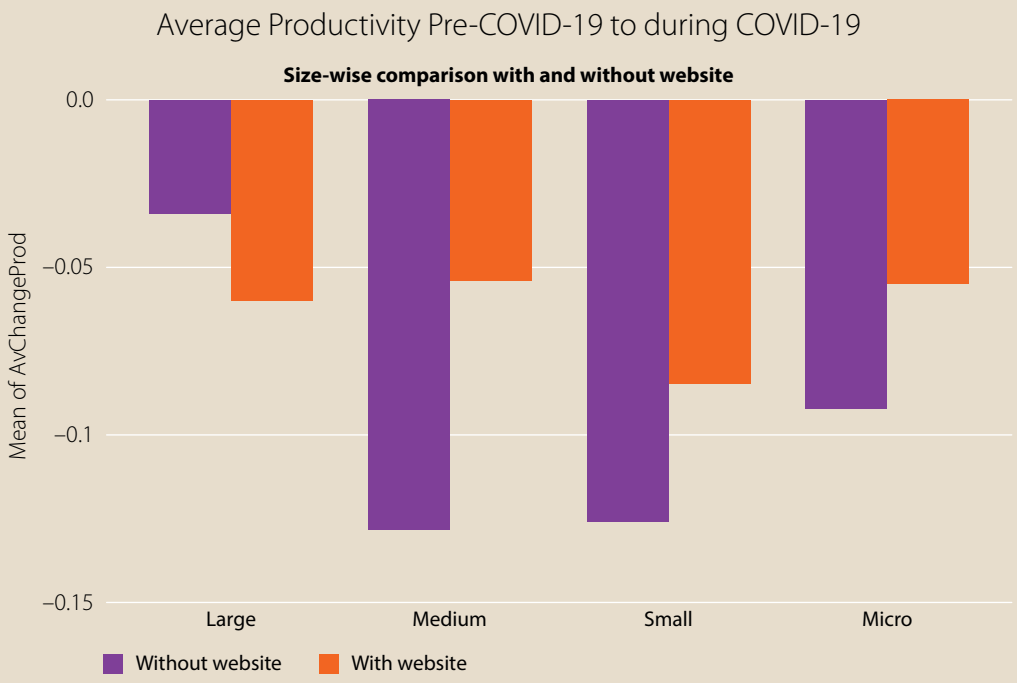



**FIGURE 6**

**PRODUCTIVITY CHANGES ACROSS SIZE GROUPS: ROLE OF SHORT-TERM BANK BORROWINGS.**

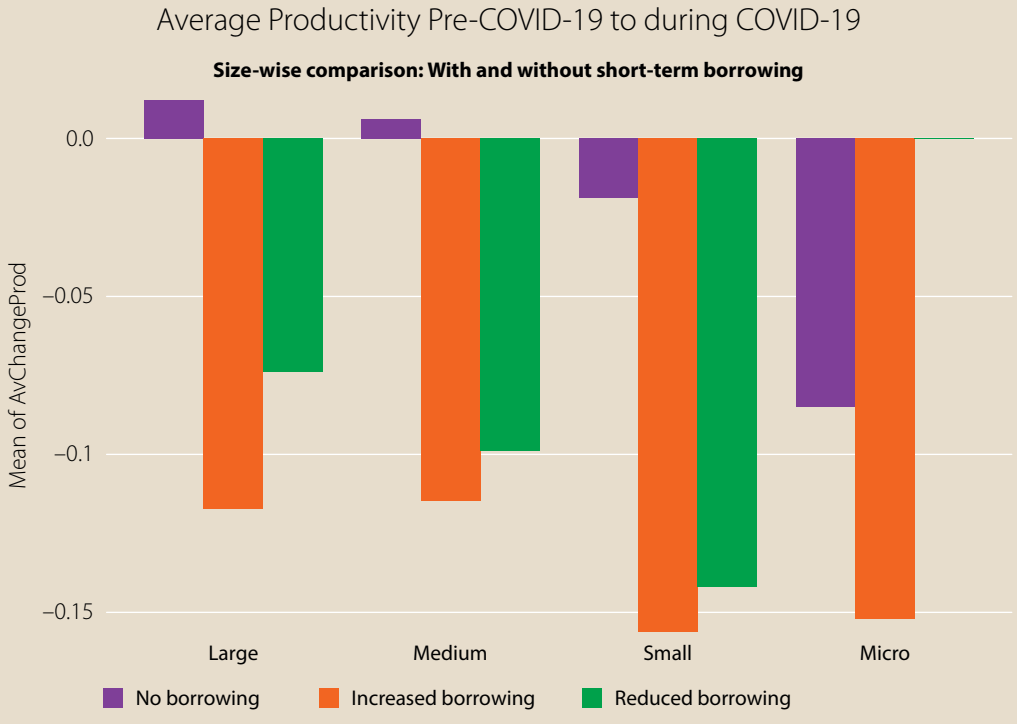


**TABLE 12**

**FACTORS AFFECTING PRODUCTIVITY (PRODUCTIVITY CHANGE FROM PRE-COVID-19 TO THE COVID-19 PERIOD): ROLE OF DIGITALIZATION.**

| Variable | | | All Firms | | Only MSMEs | |
|---|---|---|---|---|---|---|
| | | | (1) | (2) | (3) | (4) |
| 1 | Digitalization | Website | 0.0376<br>(0.0287) | 0.0257<br>(0.0281) | 0.0472<br>(0.0297) | 0.0310<br>(0.0281) |
| 2 | Short-term borrowing | Increased borrowing | –0.121***<br>(0.0338) | –0.110***<br>(0.0334) | –0.122***<br>(0.0415) | –0.106***<br>(0.0401) |
| | | Decreased borrowing | –0.0891***<br>(0.0318) | –0.0803**<br>(0.0318) | –0.0910**<br>(0.0390) | –0.0839**<br>(0.0378) |
| 3 | Entity | Public Ltd. | 0.0182<br>(0.0273) | 0.0179<br>(0.0271) | 0.0134<br>(0.0290) | 0.0105<br>(0.0283) |
| 4 | Ownership | Group firm | –0.00244<br>(0.0329) | 0.0133<br>(0.0331) | 0.0257<br>(0.0466) | 0.0418<br>(0.0466) |
| 5 | Size | Medium | 0.00562<br>(0.0284) | 0.0120<br>(0.0299) | | |
| | | Small | –0.0212<br>(0.0397) | –0.00907<br>(0.0408) | –0.0214<br>(0.0338) | –0.0154<br>(0.0325) |
| | | Micro | –0.00819<br>(0.0662) | 0.00779<br>(0.0710) | –0.00609<br>(0.0645) | 0.000350<br>(0.0686) |
| 6 | Location | Metro/state capital | –0.0375<br>(0.0248) | –0.0439*<br>(0.0247) | –0.0468<br>(0.0303) | –0.0613**<br>(0.0295) |
| 7 | Age | ln Age | 0.116***<br>(0.0278) | 0.130***<br>(0.0278) | 0.139***<br>(0.0329) | 0.165***<br>(0.0319) |
| 8 | | Constant | –0.429***<br>(0.108) | –0.496***<br>(0.109) | –0.506***<br>(0.116) | –0.616***<br>(0.112) |
| 9 | Industry dummy | | No | Yes | No | Yes |
| | | Observations | 1,207 | 1,207 | 824 | 824 |
| | | R-squared | 0.040 | 0.080 | 0.049 | 0.105 |
| | | F-value | 5.84 (0.0) | 5.67 (0.0) | 4.77 (0.0) | 7.81 (0.0) |

**Notes:** The base category for digitalization, short-term borrowing, entity, ownership, location, and size is firms with no websites, no borrowing, private ltd., standalone, in nonmetro areas, and large size.
*Significant at the 10% level;
**Significant at the 5% level;
***Significant at the 1% level. The dependent variable is the average change in productivity over the period. Robust standard errors are in parentheses.

Our results indicate that having a website (row 1) positively impacted productivity performance although the effect was not statistically significant. This is irrespective of whether or not we control for industry heterogeneity in our model. The plausible explanation for the insignificant role of digitalization on productivity is that the proxy we used considers only the availability and not the website's content. It is possible that an incomplete or nonfunctioning website may give a signal in the opposite direction. We do not have adequate benchmark information about the extent of information and navigability of the websites. Our regression estimates also confirmed that short-term borrowings and firm productivity move in opposite directions. The coefficients of increased and decreased borrowing are negative and significant, suggesting that, compared with the benchmark category of firms with no borrowings, firms with increased and reduced borrowings during COVID-19 experienced a decline in productivity. In terms of magnitude, the drop was more apparent in firms with increased borrowing during COVID-19. It is not an unexpected result, as it has been argued that firms with weaker balance sheets during the prepandemic period would be more impacted during COVID-19.

Regarding other variables, the productivity of a listed firm (row 3) or a group firm (row 4) increased post-COVID-19, but the effect is not statistically significant. Of the key firm characteristics that have positively influenced productivity change during the period, age was statistically significant (row 7). Older firms seem to have gained more in terms of productivity change than the younger or middle-aged firms. Location in a metro area negatively affected productivity (row 5). The coefficient of location is negative and significant in the full specification, where we also included industry dummies. As hypothesized, being in a metro area or capital city bound firms to adhere to lockdown restrictions, having a detrimental impact on productivity. Regarding firm size, once other firm-specific characteristics are accounted for, there was no differential impact on productivity performance for different size groups. The results remained the same when we only analyzed MSMEs (columns 3 and 4).

During the downturn, the role of digitalization and credit support in productivity may have varied across industries. We conducted analysis separately for all but two industries to investigate the link among these variables in each industry. Due to fewer observations, we could not analyze the P&V and tobacco industries. Table 13 gives the results individually for each of the six industries for which there are sufficient degrees of freedom. Interesting differences emerge when the analysis is carried out separately.

Digitalization is positive but not significant for most industries. For the PPI, we found that a firm with a website (row 1) experienced a greater productivity decline during COVID-19. The inverse relationship between short-term borrowings and firm productivity is evident in all industries, but the coefficients are insignificant. While the coefficient of increased borrowings was significant only in the textile and cosmetics industries, the coefficient of decreased borrowings was significant in the Pharma and textile industries. Group firms could derive productivity gains in FPI, PPI, and Pharma, whereas being in a group negatively influenced domestic appliance industry firms' productivity (row 4). Again, there was hardly any productivity difference between listed and nonlisted firms (row 3) except for PPI (column 2), where the listed firms experienced a significant decline in productivity during COVID-19. Contrary to our aggregate results, age was significant only in the textile industry (row 7, column 4). Location in a metro area or capital city adversely affected productivity in FPI more than in any other industry.

**TABLE 13**

**FACTORS AFFECTING PRODUCTIVITY (PRODUCTIVITY CHANGE FROM PRE-COVID-19 TO THE COVID-19 PERIOD): ROLE OF DIGITALIZATION AND CREDIT SUPPORT.**

| | Variables | | FPI (1) | PPI (2) | Pharma (3) | Textiles (4) | Cosmetics (5) | Domestic Appliances (6) |
|---|---|---|---|---|---|---|---|---|
| 1 | Digitalization | Website | 0.0295<br>(0.0407) | −0.183**<br>(0.0812) | 0.0219<br>(0.0596) | 0.0559<br>(0.0518) | 0.0470<br>(0.199) | 0.0562<br>(0.222) |
| 2 | Short-term borrowing | Increased borrowing | −0.0665<br>(0.0485) | −0.115<br>(0.0821) | −0.0184<br>(0.0509) | −0.165**<br>(0.0745) | −0.574***<br>(0.202) | −0.102<br>(0.165) |
| | | Decreased borrowing | −0.00653<br>(0.0479) | −0.0448<br>(0.0641) | −0.108*<br>(0.0566) | −0.133*<br>(0.0705) | −0.243<br>(0.144) | −0.160<br>(0.168) |
| 3 | Entity | Public Ltd. | 0.0493<br>(0.0525) | −0.0715<br>(0.0684) | −0.0176<br>(0.0483) | 0.0147<br>(0.0400) | −0.149<br>(0.161) | 0.0417<br>(0.127) |
| 4 | Ownership | Group firm | 0.104**<br>(0.0487) | 0.131***<br>(0.0430) | 0.129*<br>(0.0751) | −0.0321<br>(0.0603) | −0.319*<br>(0.157) | −0.362*<br>(0.183) |
| 5 | Size | Medium | −0.00432<br>(0.0430) | 0.0735<br>(0.0544) | −0.00692<br>(0.0426) | −0.00728<br>(0.0692) | −0.278<br>(0.164) | 0.0546<br>(0.126) |
| | | Small | −0.0818<br>(0.0506) | 0.0194<br>(0.0715) | 0.0289<br>(0.0976) | −0.00798<br>(0.0807) | 0.163<br>(0.189) | 0.467<br>(0.317) |
| | | Micro | −0.112<br>(0.139) | 0.105<br>(0.175) | 0.00597<br>(0.0803) | 0.0749<br>(0.113) | −0.733<br>(0.464) | −0.0724<br>(0.123) |
| 6 | Location | Metro | −0.0626*<br>(0.0349) | 0.0231<br>(0.0468) | −0.0326<br>(0.0497) | −0.0527<br>(0.0451) | 0.00950<br>(0.201) | 0.0687<br>(0.215) |
| 7 | Age | ln Age | 0.00583<br>(0.0424) | 0.165*<br>(0.0950) | 0.0541<br>(0.0449) | 0.244***<br>(0.0468) | 0.0162<br>(0.153) | 0.214<br>(0.160) |
| 8 | | Constant | −0.0924<br>(0.166) | −0.377<br>(0.294) | −0.174<br>(0.152) | −0.88***<br>(0.210) | 0.408<br>(0.531) | −0.801<br>(0.601) |
| | | Observations | 335 | 38 | 254 | 489 | 32 | 44 |
| | | R-square | 0.056 | 0.455 | 0.043 | 0.070 | 0.410 | 0.284 |
| | | F-value | 2.49 (0.0) | 2.15<br>(0.056) | 1.8<br>(0.058) | 7.1<br>(0.0) | 5.7<br>(0.06) | 1.7<br>(0.12) |

**Notes:** The base category for digitalization, borrowing, entity, ownership, location, and size is firms having no websites, no short-term borrowing, private ltd., standalone, in nonmetro areas, and large size.
*Significant at the 10% level;
**Significant at the 5% level;
***Significant at the 1% level. The dependent variable is the average change in productivity over the period. Robust standard errors are in parentheses.

## Benchmarking Productivity

Based on our analysis, only ownership and age, but not short-term borrowing, facilitated the improvement in productivity in general. Digitalization and short-term support from the government did not help the firms. Despite these results, an important question is if we can benchmark productivity performance. What are the characteristics of firms that performed exceedingly well in terms of productivity from the pre-COVID-19 to the COVID-19 period? Table 14a gives industry-wise characteristics of firms that showed maximum improvement in productivity over the period, while Table 14b lists the characteristics of firms that showed the largest declines in productivity over the period.

**TABLE 14A**

**CHARACTERISTICS OF BEST PERFORMERS IN TERMS OF PRODUCTIVITY CHANGE.**

| Industry (1) | Entity Type (2) | Ownership Type (3) | Location (RO)# (4) | Size (5) | Short-term Borrowing (6) | Age (Years) (7) |
|---|---|---|---|---|---|---|
| FPI | Public Ltd. | Group | Kolkata (M) | Large | No | 26 |
| PPI | Private Ltd. | Standalone | Mumbai (M) | Medium | No | 51 |
| P&V | Public Ltd. | Group | Kolkata (M) | Medium | No | 98 |
| Pharma | Public Ltd. | Group | Hyderabad (M) | Small | No | 31 |
| Textiles | Public Ltd. | Standalone | Rajgarh | Small | No | 40 |
| Tobacco | Public Ltd. | Group | New Delhi (M) | Large | Increased | 48 |
| Cosmetics | Private Ltd. | Standalone | Gurgaon | Large | No | 69 |
| Domestic Appliances | Public Ltd. | Standalone | Mapusa (M) | Small | No | 28 |

**Note:** Figures in parentheses mean that the registered office of the firm is in a metro area or capital city. All these firms were digitalized pre-COVID-19.

Interesting differences emerge when we compare the two categories. The best performers are mixed, with some listed on the stock market and some not (column 2, Table 14a), whereas the worst performers are listed firms alone (Table 14b). Consequently, the dependence on short-term borrowings was less for better performers (column 6). Location-wise, there was not much difference between the two. Regarding size, large firms were better performers in three industries (FPI, tobacco, and cosmetics). In contrast, in Pharma, textiles, and domestic appliances, small firms performed well in terms of productivity change (column 5). Middle-sized firms (small and medium) fared poorly among poor performers. Having a website is not a differentiator as, barring one, all the firms had websites irrespective of whether their productivity declined or increased during COVID-19.

**TABLE 14B**

**CHARACTERISTICS OF WORST PERFORMERS IN TERMS OF PRODUCTIVITY CHANGE.**

| Industry (1) | Entity Type (2) | Ownership Type (3) | Location (RO)* (4) | Size (5) | Short-term Borrowing (6) | Age (years) (7) |
|---|---|---|---|---|---|---|
| FPI | Public Ltd. | Standalone | Kolkata (M) | Small | Increased | 125 |
| PPI | Public Ltd. | Standalone | Ahmedabad (M) | Small | Increased | 36 |
| P&V | Public Ltd. | Standalone | Kachigam | Medium | No | 27 |

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| Industry (1) | Entity Type (2) | Ownership Type (3) | Location (RO)* (4) | Size (5) | Short-term Borrowing (6) | Age (years) (7) |
|---|---|---|---|---|---|---|
| Pharma | Public Ltd. | Standalone | Mumbai (M) | Medium | No | 37 |
| Textiles | Public Ltd. | Standalone | Ahmedabad (M) | Medium | No | 38 |
| Tobacco | Public Ltd. | Standalone | Kanpur (M) | Small | No | 13 |
| Cosmetics | Public Ltd. | Group | Mumbai (M) | Micro | Increased | 72 |
| Domestic Appliances | Public Ltd. | Group | Mapusa (M) | Large | Increased | 31 |

**Note:** Figures in parentheses mean that the registered office of the firm is in a metro area or capital city.

# CASES: RATIONALIZATION OF MICRO UNITS DURING COVID-19

Our econometric analysis does not provide convincing evidence of digitalization and government policy in improving the productivity of MSMEs. However, we interacted with some micro units to see whether and how government schemes had helped them mitigate the adverse effects of COVID-19 challenges. One micro unit (case 1) benefited from such a scheme, whereas another (case 2) did not receive such support.

## Case 1

### Background

SB is a microenterprise based in Mumbai, with a turnover of nearly Rs.60 million and 60 employees in 2019–20. Of those 60 employees, one-fourth were women from local tribal areas, one-fourth were locals, and nearly half were from outside Maharashtra (mainly from the neighboring state of Madhya Pradesh). The firm specializes in manufacturing and supply of unbreakable drinking glasses, teacups, and wineglass gift sets. Established in 2013, the company was working in the three domains of food, aviation, and beverages with tie-ups with large companies like Burger King, Tata Vistara, and Sula wines to diversify risk. The first wave of COVID-19, resulting in a complete shutdown from March to June 2020, affected the firm badly as the business in all three spaces was affected with all restaurants being closed, airlines not operating, and no significant event involving beverage consumption. The lockdown resulted in the plant's closing during the period, with liabilities and obligations toward employees remaining.

### Government Support and Implications

As per the founder, there were two critical support-cum-interventions provided by banks (that he was aware of) to help MSMEs to ward off the crisis. The first was a moratorium on EMIs on existing loans (announced in April 2020) but with higher interest to be paid in the future for deferred payments. The second was the Guaranteed Emergency Credit Line (GECL) (announced in June 2020), where banks provided working capital loans (i.e., short-term loans) of up to 20% of outstanding loans with reduced interest rates and a 12-month moratorium. For example, if an SME had already availed of Rs.1 million loans under the scheme, Rs.0.2 million would be further provided at an 8.5% rate per annum (principal amount to be paid in 36 months after the moratorium period) against 9.5% for regular loans. The first scheme was not beneficial as it would mean an additional outflow of interest payments in the near future. However, the GECL was beneficial for several micro and small enterprises, including SB, as postlockdown it helped the firm to pay quasi-fixed expenses like salaries and rent.

### Other Steps by the Firm: Rejigging and Renegotiation

The firm undertook two key steps: 1) buying private insurance for employees; and 2) renegotiating quasi-fixed services. Although all workers were covered by the mandatory social scheme of the GoI (through the Employee State Insurance Corporation, ESIC), the company took additional insurance coverage from private insurance companies, which covered both workers and their

families. The second essential step was renegotiating rent and other quasi-fixed services. The rental payments for the premises were negotiated and brought down by 50%. Other quasi-fixed expenses, like payment for housekeeping services, pest control, etc., were also renegotiated as the services were not used during the lockdown. Similar practices were being followed in other factories in the industrial estate where this factory is located.

The first step, although it increased expenses, resulted in building workers' confidence in staying in place rather than returning to their villages. The second step facilitated reducing the need for working capital. Both helped improve the productivity of the firm.

### Back to Normal

Since several of SB's products are used for packaging food and milk-based products, they fall in the "essential goods" category. A government order allowed factories producing these essential goods to be operational from June 2020 onward. Accordingly, in late June 2020, the factory restarted initially with one shift, and subsequently, around October 2020, full production resumed. With the economy returning to normal in 2022, the company completely turned around, with turnover reaching Rs.150 million in 2022–23 and employee numbers rising to 140. Consequently, in April 2023, the company paid back the loan received under the GECL.

## Case 2

### Background

MM is a microenterprise based in Palghar district, Maharashtra, and is headed by a female entrepreneur. The company was established in 2016 and had seven employees with a turnover of nearly Rs.3.7 million at the time of the COVID-19 lockdown in April 2020. Of these seven employees, one hailed from Nasik in Maharashtra, and the remaining were local. The firm specializes in the manufacturing and supply of laboratory process equipment and customized instrumentation systems. The firm's key products are a peristaltic pump, data acquisition system, granulator, spray dryer, etc. As these products are customized, they have been supplied to specialized research organizations like BARC, DRDO, and IITs. The first wave of COVID-19, resulting in a complete shutdown from March to June 2020, affected the firm badly. The lockdown resulted in the firm closing during the period, with liabilities and obligations toward employees remaining.

### Whither Support?

Since the company was producing extremely specialized equipment, the lockdown resulted in orders drying up. According to the founder, with no business coming in during COVID-19, she wanted to diversify into making sanitizers and dispensers. The company applied to the Centre for Augmenting WAR with COVID-19 Health Crises (CAWACH), an initiative by the National Science & Technology Entrepreneurship Development Board (NSTEDB), Department of Science and Technology (DST), GoI, for funding. The DST had nominated the Society for Innovation and Entrepreneurship (SINE), IIT Bombay, to implement CAWACH to source and support startups (from Rs.5 million to 20 million) to find solutions to fight the pandemic by way of funding. Despite being eligible, the firm did not receive any financial support pertaining to this. During the pandemic, the firm had to rely on its resources to pay salaries and other quasi-fixed services. The firm encouraged its employees to acquire skills while working from home. One such employee ventured into web design and eventually into digital marketing. During the lockdown phase, the company paid salaries.

Unlike SB, the company did not receive any emergency bank credit, as it did not have prior exposure.

### Other Steps by the Firm: Renegotiation

Like SB, the firm also negotiated its rent and other quasi-fixed services. The rental payments for the premises were brought down by nearly 50%. Other quasi-fixed expenses, like payment for housekeeping services, were also renegotiated as these services were not employed during the lockdown.

### Limping to Normal

Since several of MM's products are specialized, the revival happened only after the economy was fully operational. Incidentally, all the employees working before the lockdown left the company, and it had to start fresh by hiring new talent. In 2022–23, the company's turnover was Rs.5 million, with nine employees.

# CONCLUSIONS AND FURTHER WORK

The study contributes to the existing literature in the following ways. First, anecdotal evidence points to the adverse impacts of COVID-19 on MSMEs. However, a serious empirical study gauging the impact of the pandemic on MSME productivity performance, especially for a developing country like India, is lacking. Second, a host of support measures was announced to help firms tide over the crisis. It is therefore important to understand how far those policies succeeded in aiding the recovery. This would allow us to understand financing behavior better and identify obstacles encountered by enterprises and their resilience. The results of this study could serve as valuable pointers for evolving a policy matrix to enhance the sector's growth. Finally, we also linked the survival of firms with government support after controlling for different firm-specific factors during the pandemic-related crisis.

The study employed a mixed-method approach using quantitative and qualitative data to answer the research questions. For quantitative analysis, we conducted panel data analysis for 2010–22 on Indian MSMEs from the CMIE Prowess database. This was complemented by specific case studies of two micro firms. To analyze the productivity performance of MSMEs, we computed TFP using the ACF method [8] for eight industries. Our final data set consisted of 1,229 firms with a sample of 340 firms for the FPI, 39 firms for the PPI, 11 firms for P&V, 259 for Pharma, 493 for textiles, 10 for tobacco, 33 for cosmetics, and 44 for the domestic appliances industry. Of the total firms in the sample, 842 (69%) were MSMEs.

The descriptive analysis suggested that during COVID-19 demand shifted to large or medium-sized firms in several sectors (FPI, P&V, Pharma, domestic appliances) at the expense of micro and small firms. ACF estimates showed the relevance of different inputs for different industries. For the FPI, we found that RM and S&W were significant determinants of sales revenue. However, expenditure on RM was found to be the only significant determinant in the case of the PPI, P&V, cosmetics, and domestic appliances industries. For Pharma, the main driver of sales revenue was S&W.

To investigate whether the onset of COVID-19 impacted the productivity performance of firms, we divided the study period into 2010–19 (pre-COVID-19) and 2020–22 (COVID-19 period). Two important findings emerged: 1) there was a sharp difference in firm productivity between the two periods; and 2) the average productivity during the COVID-19 period was marginally lower than that during the pre-COVID-19 period. An industry-wise detailed picture of productivity differences suggests that productivity fell in all industries except for the PPI and cosmetics. The decline was severe for tobacco (19.6%), the FPI (9.8%), and textiles (3.5%), whereas it increased substantially for the cosmetics industry (9.5%) and marginally for the PPI (0.43%). Size-wise analysis showed a statistically significant productivity decline for most industry groups. Only in the P&V and domestic appliance industries did small firms report an increase in productivity during the COVID-19 period. In contrast, large firms showed declining productivity in textiles, tobacco products, and domestic appliances. Small firms' productivity in the FPI, textiles, and tobacco products declined. Medium-sized firms witnessed a decline in productivity in the FPI, Pharma, and textiles.

Subsequently, we examined the role of digitalization and credit support from the government on firm productivity after accounting for firm type (private ltd. vs. public ltd.), organization type

(standalone vs. group firm), location (metro vs. nonmetro area), size (large, medium, small, and micro), and age. We hypothesized that digitalization and credit support might have played a role in mitigating the impact of the pandemic on firm performance.

Our econometric analysis did not provide convincing evidence of digitalization and government policy in improving the productivity of MSMEs. However, to validate the findings, we interacted with some micro units to see whether and how government schemes had helped them mitigate the adverse effects of the COVID-19 challenge. One micro unit (case 1) seems to have benefited from such schemes, whereas another smaller micro unit (case 2) did not receive any such support and had yet to recover from the COVID-19 pandemic shock.

Our firm-level study on firm responses to the pandemic and interactions with owners of some micro firms yielded several policy implications. As we found significant heterogeneity in firm responses (even within the micro-size category), more than a one-size-fits-all solution is needed, and different categories of businesses will require different support measures. Given that micro and small firms are more vulnerable to economic downturns and decreases in revenues, there is a need for specific governmental initiatives to assist them to be resilient during such crises in the future.

A critical role for the provision of working capital to micro and small firms clearly emerged during our interactions with firm owners. Therefore, support measures should include initiatives such as grants, low-interest loans, and loan guarantees to facilitate access to working capital and bridge funding shortages. Given the positive role of digitalization on firm performance, policymakers should help firms adopt digital platforms and technology. This would help them expand their funding networks, contact more investors, and enhance operational efficiency. There is also a need for the government to offer incentives and organize training programs to promote the use of digital technologies, e-commerce platforms, and online payment systems [27]. Another policy suggestion is the need for an emergency fund for MSMEs to meet the financial needs of small firms during such business uncertainties. Once the financial needs of micro firms were met, job security would be enhanced, thereby reducing labor attrition, which has implications for the survival of technology-oriented MSMEs.

A key limitation of the present study was the inability to capture specific government support for MSMEs, as mentioned in Appendix 1. We could not find any source specifically listing the beneficiaries and extent of benefits provided to MSMEs. Since the data used for the present work were from Prowess, which covers primarily listed firms, the omission of micro firms was unavoidable. Carrying out a primary survey of microunits to fathom the role of government and how microunits survived the COVID-19 challenge is another area for further work.

The third scope for improvement comes from adequately measuring input variables like capital and labor. In the present study, the real value of GFA was obtained by deflating with appropriate industry-specific WPIs. An alternate way is to compute capital stock using the perpetual inventory method. Similarly, person-days better indicate labor used in the production process. Finally, due to time limitations, we could interact with only a few microunits. Ideally, we should have covered all size categories of firms to gain a comparative perspective.

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# APPENDIX A

**TABLE A1**

**KEY FISCAL GOVERNMENT INITIATIVES TO SUPPORT MSMES DURING COVID-19.**

| S. no. | Scheme | Details | Launched | Comment | Likely Impact | Source |
|---|---|---|---|---|---|---|
| 1 | Collateral-free loans | Rs.3 trillion collateral for free bank loans to MSMEs with 100% credit guarantee | May 2020 | Guarantee provided by NCGTCL to enhance the liquidity and working capital base of MSMEs | Street vendors given Rs31.19 billion collateral-free working loans under the Prime Minister Street Vendor's Atmanirbhar Nidhi Scheme to restart their businesses (https://theprint.in/economy/street-vendors-given-rs-3119-crore-collateral-free-loans/881912/ ).<br>Of 44.8 million applications received, 33.4 million approved | https://loksabhadocs.nic.in/lsscommittee/Finance/17_Finance_46.pdf |
| 2 | Subordinate debt for "stressed" MSMEs | Rs.200 billion credit guarantee scheme for subordinate debt issued by banks/ other financial institutes (e.g., SIDBI) for stressed MSMEs | June 2020 | Govt. to refinance Rs.40 billion to help financially stressed MSMEs, expected to benefit 0.2 million stressed MSMEs to restart business and create new jobs | 36 banks registered as member lending institutions and 18 started offering credit;<br>754 guarantees equivalent to Rs.814.7 million issued as of 2 Nov. 2021 (https://loksabhadocs.nic.in/lsscommittee/Finance/17_Finance_46.pdf) | Same as above |
| 3 | Equity infusion into MSMEs via Fund of Funds (FoF) | Equity infusion of Rs.500 billion for MSMEs through FoF | May 2020 | Cater to 2.5K MSMEs that have an AAA rating. Fund is expected to address equity funding challenges of MSMEs, encourage corporatization and allow them to grow to their full potential; provide opportunities for stock exchange listing | As of 31 Dec. 2022, a total of 34 daughter funds has been empanelled with Venture Capital Fund Limited (mother fund) and by investing Rs.27.9 billion, 140 potential MSMEs had been assisted | Source: https://msme.gov.in/sites/ default/files/MSMEANNUALREPORT2022-23ENGLISH.pdf |

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| S. no. | Scheme | Details | Launched | Comment | Likely Impact | Source |
|---|---|---|---|---|---|---|
| 4 | Partial credit guarantee scheme | Rs.450 billion partial credit guarantee scheme for NBFCs | July 2020 | First 20% loss to be borne by the govt. | Pooled assets of Rs.117.69 billion purchased by public-sector banks (PSBs) with guarantees by the Department of Financial Services | Source 1 |
| 5 | Special liquidity scheme | Rs.300 billion for infusing equity in NBFCs/ HFCs/MFIs | July 2020 | Securities fully guaranteed by govt. to boost liquidity | As of 30 Sept. 2020, 39 proposals amounting to Rs.111.2 billion had been approved and Rs.72.27 billion disbursed. The scheme is closed | (https://www.businesstoday.in/ union-budget-2022/ expectations/story/ economic-survey-2022-govts-safety-net-to-cushion-COVID-19-distress- 320939-2022-01-31) |
| 6 | TDS/TCS rate reduction | TDS/TCS reduced by 25% for FY2020–21 | May 2020 | | Expected to release liquidity equivalent to Rs.500 billion | |
| 7 | Ceiling on global tenders | Global tenders up to Rs.2 billion disallowed | May 2020 | Reducing competition and creating opportunities for domestic MSMEs in govt. contracts | As there is a lack of formalization among MSMEs, especially micro firms, the benefits from this initiative are likely to be availed by small and medium firms (https://journals.sagepub.com/doi/full/10.1177/02560909221078460) | https://pib.gov.in/ |
| 8 | Clearance of dues | MSME dues by the government and PSUs to be cleared within 45 days | May 2020 | Help to overcome financial distress | The government created a web portal, launched on 14 June 2022, to implement it. Dues worth Rs.771.71 billion of MSE vendors have been cleared by various ministries and government departments | Same as above |
| 9 | Moratorium on loans | RBI announced moratorium on loan repayments falling due between March–August 2020 | March 2020 | Postmoratorium EMI would increase to recover the (waived) lost interest | Eases financial burden for a short period, especially helpful to small firms | |

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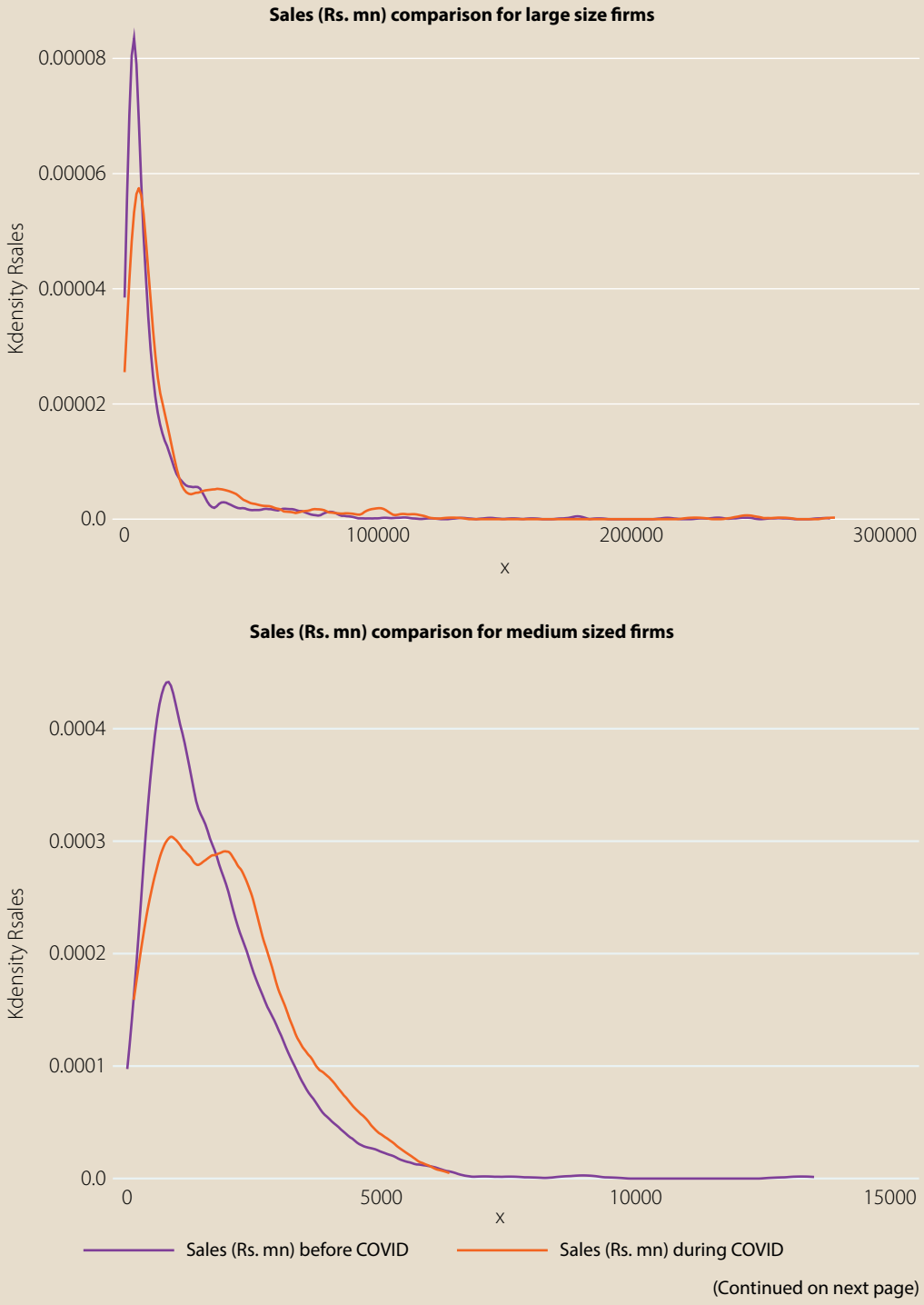
| S. no. | Scheme | Details | Launched | Comment | Likely Impact | Source |
|---|---|---|---|---|---|---|
| 10 | Emergency Credit Line Guarantee Scheme (ECLSGS) | 100% guarantee coverage to banks to provide emergency credit facilities to MSMEs (20% of outstanding loans, 12-month moratorium on principal to be paid in next 3 years) | May 2020 | To augment working capital requirement to enable MSMEs to meet operating liabilities and restart/increase operations | As of 31 Jan. 2023, guarantees amounting to Rs.36,100,000 million had been issued under ECLGS, benefiting 11.9 million borrowers (thenewsagency.in/India/119-crore-borrowers-benefit-from-guarantees-amounting-to-rs-361-lakh-crore-under-eclgs). The number was Rs.35,800,000 million with the same number of borrowers (11.9 million) as of 30 Nov. 2022 (https://www.livemint.com/news/india /ECLGS benefitted nearly 1.2 crore MSMEs, other businesses till Nov-end) | https://www.eclgs.com/ gives details about the scheme |

**Note:** NBFC, nonbanking financial company; NCGTCL, National Credit Guarantee Trust Co. Ltd.

# APPENDIX B

**FIGURE B1**

**SIZE-WISE SALES (RS. MILLION) DURING AND PRE-COVID-19 FOR THE FPI.**

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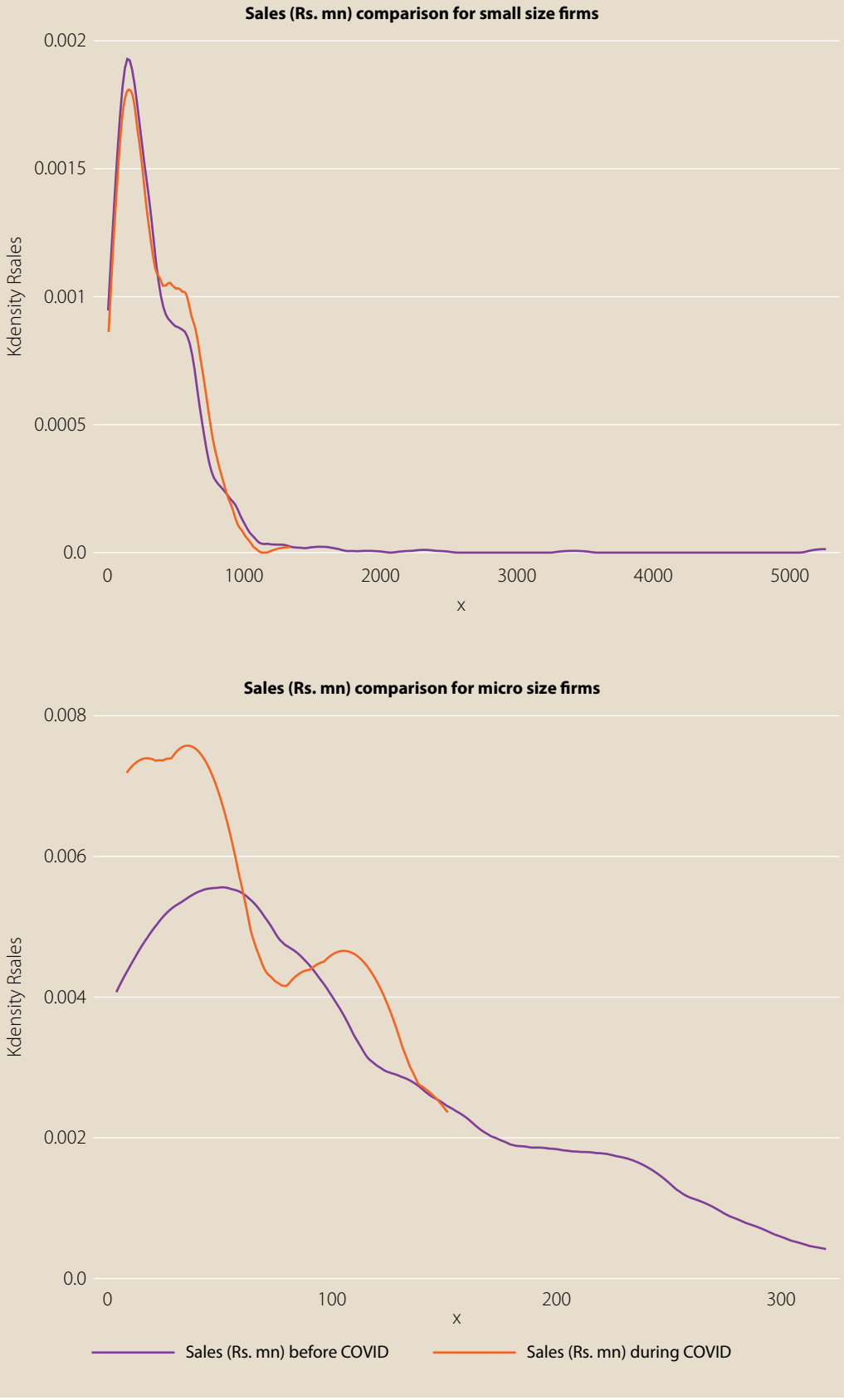
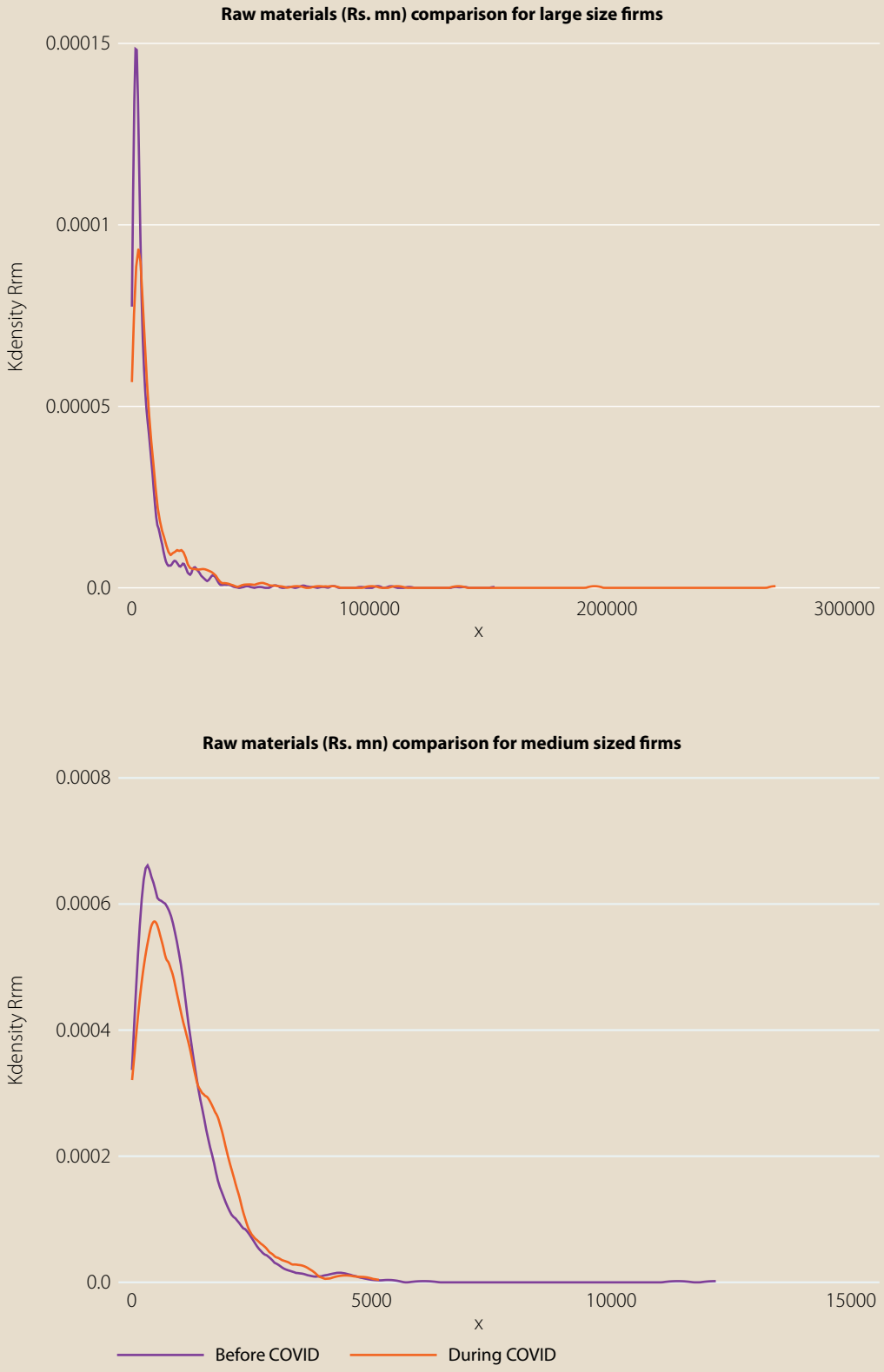


**FIGURE B2**

## SIZE-WISE SPENDING (RS. MILLION) ON RM DURING AND PRE-COVID-19 FOR THE FPI.

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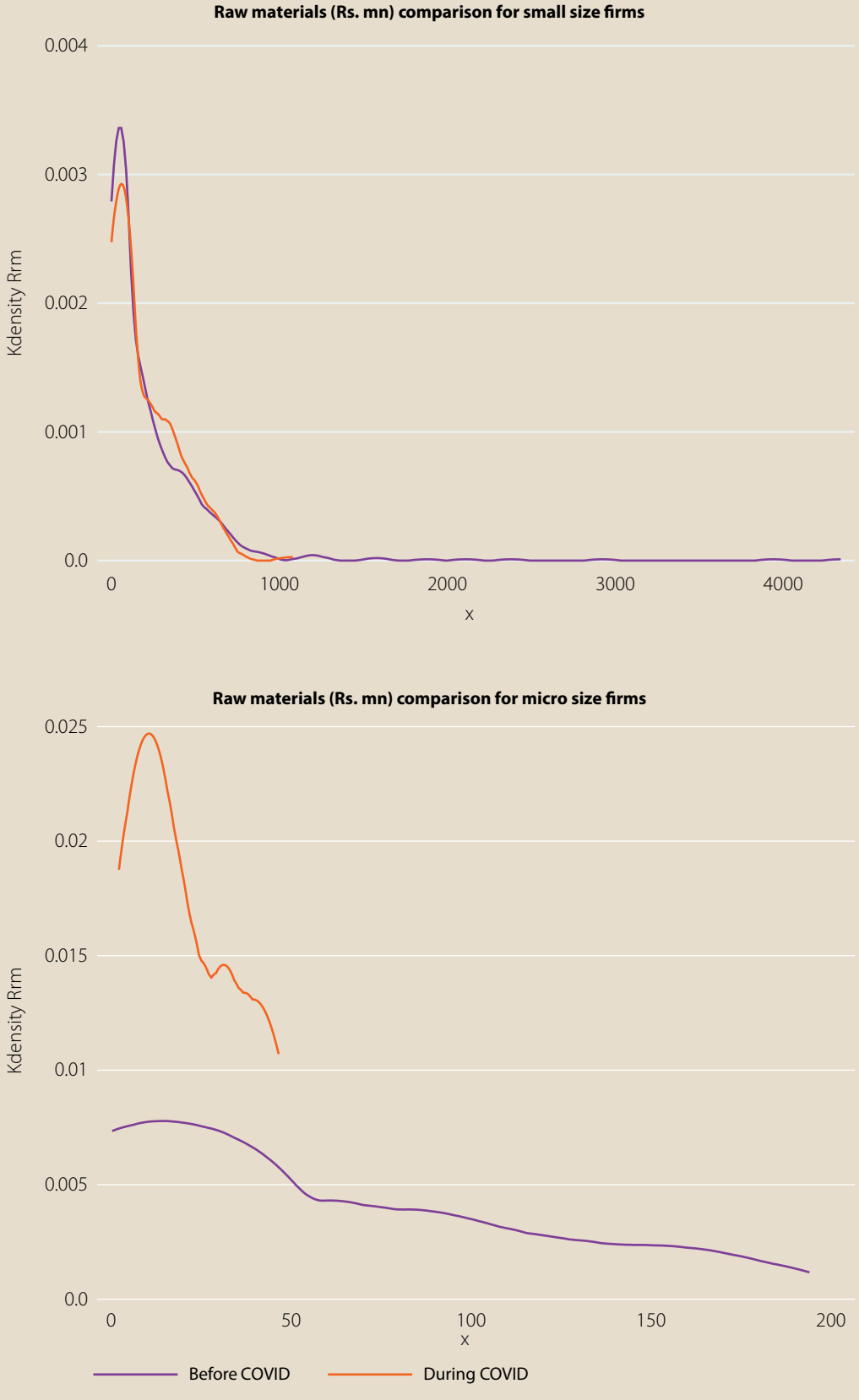
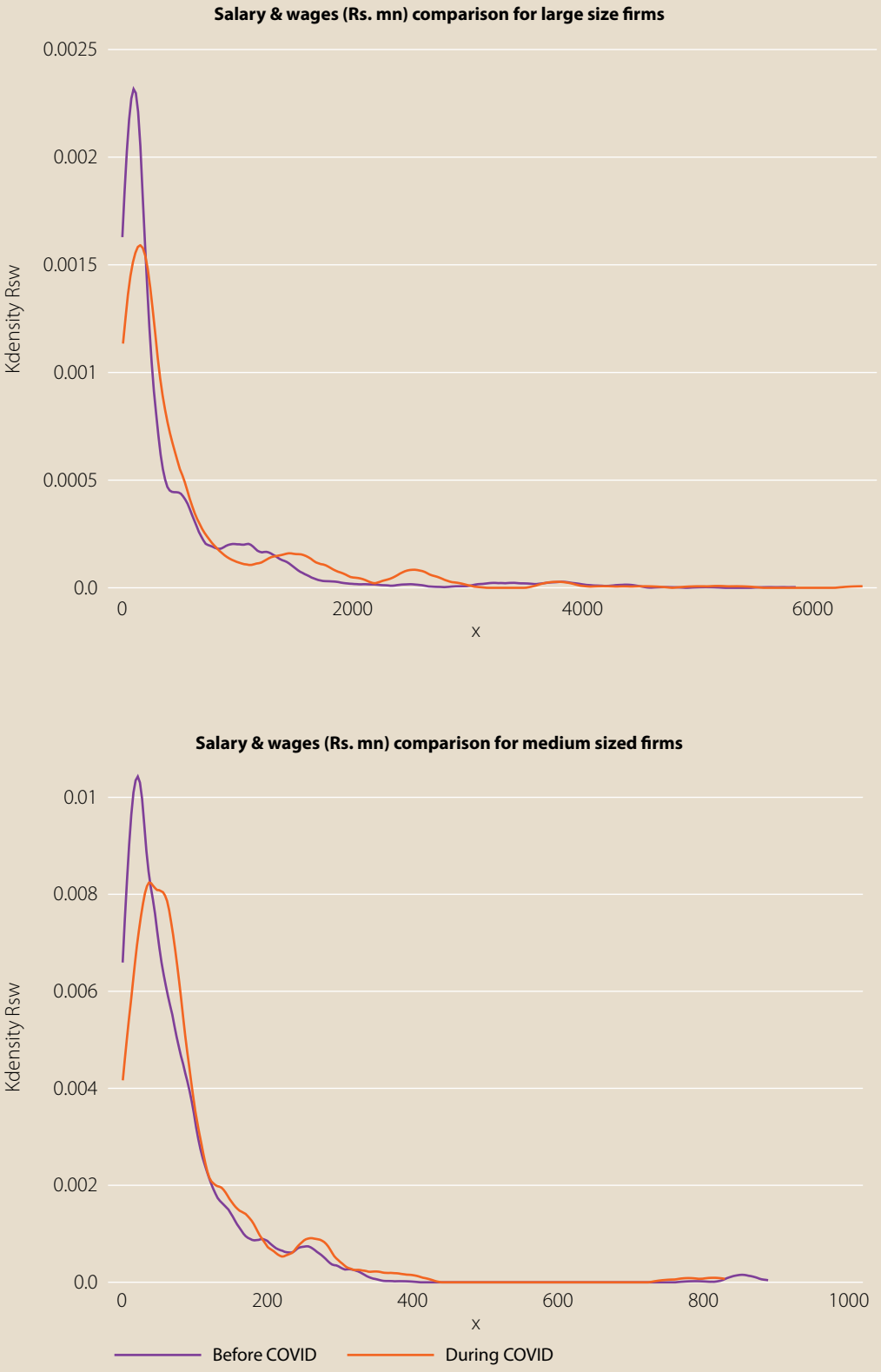


**FIGURE B3**

## SIZE-WISE SPENDING (RS. MILLION) ON S&W DURING AND PRE-COVID-19 FOR THE FPI.

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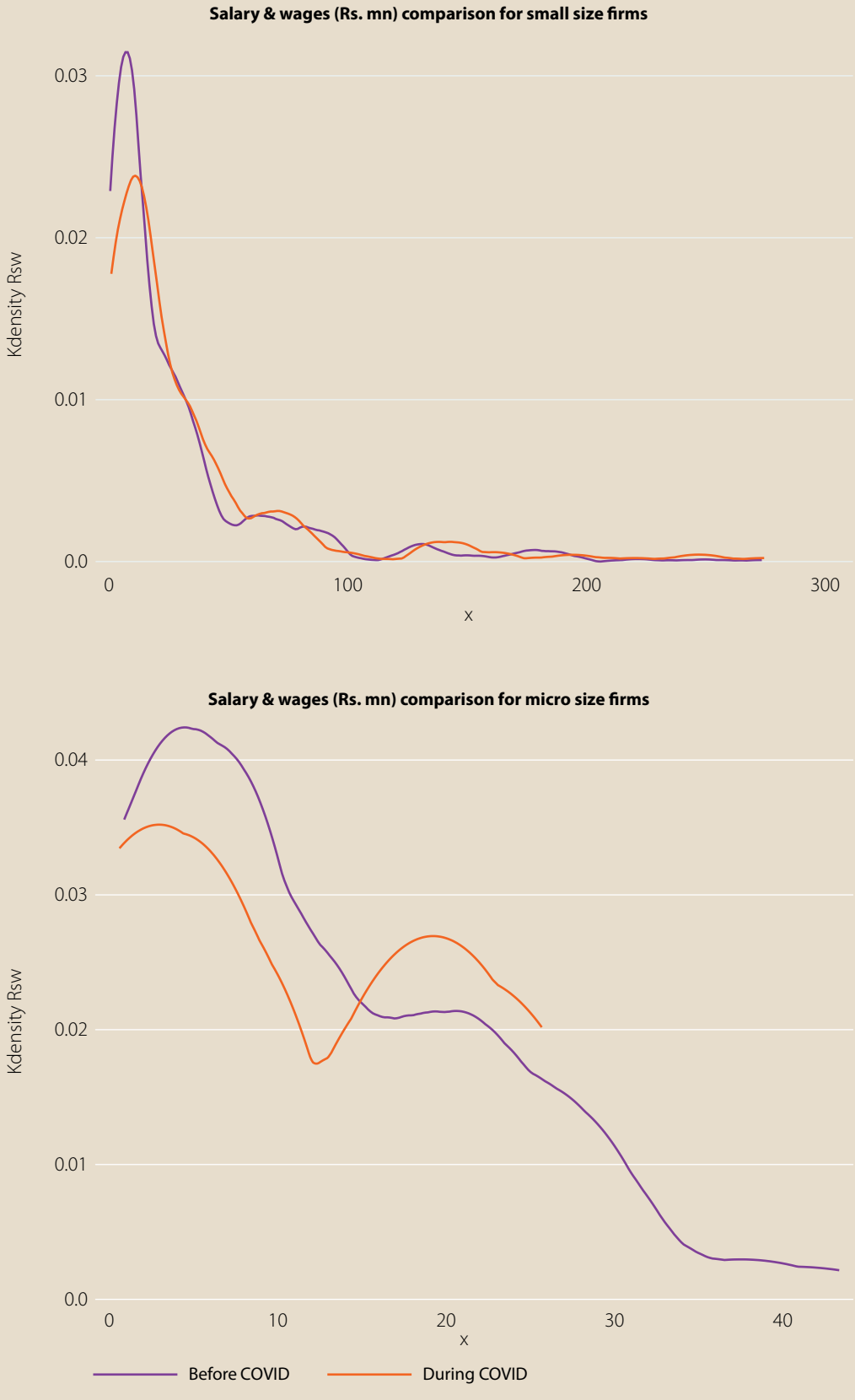

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RESULTS



APPENDIX B

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