E-commerce, Pandemic Shock, and the Survival of Small and Medium Enterprises

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Surviving a Crisis: E-commerce, Pandemic Shock and the Survival of Small and Medium Enterprises

Zengdong Cao, *Qin Tu**, *Nichola Latoya Williams*

Abstract

This study examines the impact of e-commerce on survival rate of Small and Medium Enterprises (SMEs) during the crisis using a combined dataset of the Enterprise Survey for Innovation and Entrepreneurship in China from 2018 to 2020. We exploit the variation of e-commerce adoption across SMEs before and after the outbreak of COVID-19 pandemic to conduct a difference-in-differences estimation. The results show that e-commerce has a significant positive effect on the survival rate of SMEs during the crisis. Specifically, it improves SMEs' survival rate by 3.0 to 3.4 percentage points. E-commerce improves survival rate through expanding market scale, alleviating order decline, shortening repayment period of account receivables and improving cash flow during the pandemic. Heterogeneity analysis reveals that e-commerce has greater impacts on SMEs with a larger share of online sales and labor-intensive SMEs, and third-party e-commerce platform or website play a bigger role than self-built website and social media. This study offers novel evidence of the value of digitalization for firms during the crisis.

Key words: e-commerce, survival rate, COVID-19 pandemic, difference-in-differences
JEL codes: G30, L81, H12

I. Introduction

The COVID-19 pandemic has upended economies worldwide, leading to significant challenges for firms to survive. Business stagnation and interruptions in the supply chain has forced some firms to withdraw from the market. Small and Medium enterprises (SMEs) are more vulnerable to shocks due to their lower market competitiveness and weaker risk management capabilities. Unfortunately, smaller and informal firms were less likely to apply for and receive aid (Guerrero-Amezaga et al., 2022). According to Takeda et al. (2022), the vast majority of firms experienced declines in sales revenue and a shortage of cash in the first half of 2020. Some SMEs were even unable to resume work because of employee unavailability, disrupted supply chains, and reduced market demand (Lu et al., 2020). If a firm cannot sustain itself for a prolonged period, the entrepreneurs may choose to exit the market. Data also shows that the survival rate of SMEs has decreased by 11.81 percentage points due to the pandemic's impact (Liao et al., 2021). Given that SMEs are an integral part of the global economy, it is crucial to pay attention to improving their survival rate. These facts raise an important question: how can firms survive a global crisis?

Our study investigates the role of e-commerce in supporting SMEs' survival during the pandemic. Traditional offline sales channels have been severely hindered by the pandemic, with many offline sellers facing challenges related to a large backlog of unsold inventory. During the

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COVID-19 pandemic, the increase in firm exits is primarily due to the decrease in the expected growth rates of sales (Miyakawa et al., 2021). However, firms that adopt e-commerce can fully leverage the benefits of online sales, non-contact transactions, rapid matching of supply and demand, and efficient connections between production and sales. They use various methods such as live streaming, short videos, and e-commerce platforms to sell products and services, ensuring the smooth operation of cash flow. Using survey data of Micro, Small and Medium-sized Enterprises (MSMEs) in eight developing countries in South, Southeast, and Northeast Asia, Takeda et al. (2022) find that most MSMEs are willing to expand their e-commerce, especially those with a higher percentage of online sales. This suggests that MSMEs' entrepreneurs consider online business to be beneficial, if not profitable. In this regard, e-commerce may improve the survival rate of firms during the pandemic.

The COVID-19 pandemic struck Wuhan unexpectedly at the end of 2019 and quickly spread worldwide in 2020. This outbreak was neither predicted nor planned, and its occurrence was not influenced by the decisions, actions, or control of firms or individuals. Furthermore, the transmission of the COVID-19 virus is caused by pathogens in the natural world, rather than being a result of economic activities. Considering these facts, it is reasonable to treat the COVID-19 pandemic as an exogenous shock that provides a valuable quasi-natural experiment for this study. Meanwhile, China has the largest e-commerce market, and there are significant differences among SMEs in terms of adopting e-commerce. China's setting provides favorable conditions for studying the advantages of e-commerce for SMEs during the crisis. To investigate this, we use multiple rounds of the Enterprise Survey on Innovation and Entrepreneurship in China (ESIEC). These surveys cover SMEs from 62 Chinese cities across all sectors and span pre-pandemic to post-lockdown phases. We exploit the e-commerce adoption variation across SMEs before and after the pandemic to conduct a difference-in-differences (DID) estimation. Our results demonstrate that e-commerce adoption significantly increases the survival rate of SMEs during the crisis. E-commerce is one of the important tools for firms' risk management.

Our study contributes to the literature in three ways. Firstly, we add to the literature on the impacts of e-commerce on firm performance. Previous studies have demonstrated that e-commerce helps firms to enhance trade, explore new markets, increase profit margins and improve overall performance (Benitez et al., 2018; Fernandes et al., 2019; Wirdiyanti et al., 2023). In the context of the pandemic, the adoption and integration between the e-commerce platform and suppliers have been found to have a positive association with financial benefits and supply chain resilience (Orji et al., 2022; Qi et al., 2023). Building upon these findings, our study investigates the specific impact of e-commerce on the survival of SMEs, an area that has received limited attention. Overall, we use the COVID-19 pandemic as a quasi-natural experiment and examine the casual effect of e-commerce on the survival of SMEs during external shocks. Our study enriches the existing literature on the role of e-commerce in firms.

Secondly, we confirm the rationale of Resource-Based Theory of the firm. According to the theory, a firm's ability to develop unique capabilities enhances its sustainable competitive advantage and improves its chances of survival (Wernerfelt, 1984; Barney, 1991). Esteve-Pérez and Mañez-Castillejo (2008) confirm that advertisement, R&D, age, production capacity, and international market are crucial determinants of firm survival. Drawing from the Resource-Based Theory of the firm, we propose that e-commerce is also one of the important resources for firm survival. Our results show that e-commerce can enhance firms' ability to adapt to the changing

competitive environment and improve their survival rate under the pandemic. The fact that e-commerce has helped firms to overcome challenges posed by the pandemic is a confirmation of the predictions of this theory.

Finally, we extend the literature on firm resilience to shocks. A large body of literature has focused on the factors influencing business resilience under the impact of the COVID-19 pandemic (Ding et al., 2021; Fahlenbrach et al., 2021). Most relevant to our study, there is substantial evidence that firms that were more digitally transformed were more resilient to negative market sentiment on the pandemic (Ding et al., 2020). However, the impact channels of digitalization on firms' operations vary for each area. Unlike generalized digital transformation (Gaspar et al., 2022), technology sophistication (Comin et al., 2022), work-from-home feasibility (Bai et al., 2021), and website construction (Vo et al., 2022), our study focuses on the role of e-commerce, which are new to the literature. Moreover, existing literature mainly uses public firms as samples (Gaspar et al., 2022), but we focus on SMEs because the impact of the pandemic on SMEs is far greater than that on public firms, making our study especially relevant.

The remainder of this paper is organized as follows. Section II constructs a theoretical model to explore the relationship between e-commerce and firms' survival rate. Section III describes the ESIEC data and the empirical strategy. Section IV analyzes the baseline empirical results and potential threats to causal identification. Section V analyzes heterogeneity in the impact of e-commerce. Section VI discusses the evidence regarding mechanisms. Section VII concludes.

II. Theoretical model

Assuming a market consisting of two firms, one adopting e-commerce (referred to as Firm 1) and the other not adopting e-commerce (referred to as Firm 2). According to Belleflamme and Peitz's (2015) extension of the Linear Hotelling Model, consumers in this market exhibit a uniform preference for X distributed within the interval [0, 1], and the two firms compete for the entire consumer base equal to 1. Firm 1 sets the price of its product as p_1 with a transaction cost of τ_1 per unit, while Firm 2 sets the price of its product as p_2 with a transaction cost of τ_2 per unit (where $p_1>0$, $p_2>0$, $\tau_1>0$, $\tau_2>0$). Consumers have a maximum willingness to pay (WTP). Therefore, for any consumer $i \in [0, 1]$, the indirect utility functions for purchasing the products of Firm 1 and Firm 2 can be defined as follows, respectively.

$$U_1 = WTP - p_1 - \tau_1 X \tag{1}$$

$$U_2 = WTP - p_2 - \tau_2 (1 - X) \tag{2}$$

For indifferent consumers, where $U_1=U_2$, the equilibrium demand functions can be derived as follows:

$$\hat{X} = \frac{p_2 - p_1 + \tau_2}{\tau_1 + \tau_2} \tag{3}$$

Assuming that the proportion of online sales is denoted by "*k*." We considered the scenario where only Firm 1 adopts e-commerce while Firm 2 does not, so Firm 1 captures a market share of k, while Firm 2 occupies a market share of $1-k$. Taking into account the relationship between demand functions and parameters, we incorporate k and $1-k$ into Equation (3). Specifically, the demand for Firm 1's product is positively correlated with the price of Firm 2's product and the share of online sales (k), and is negatively correlated with the price of Firm 1's product and the share of non-online sales ($1-k$).

The demand function for Firm 1 is set as Equation (4). When the online market share (k) increases or the price difference (p_2–p_1) increases, the demand for Firm 1's product also increases. Similarly, we express the demand function for Firm 2's product as Equation (5).

$$X_1 = \frac{k(p_2 - p_1) + \tau_2}{\tau_1 + \tau_2} \tag{4}$$

$$X_2 = \frac{(1-k)(p_1 - p_2) + \tau_2}{\tau_1 + \tau_2} \tag{5}$$

The problem of maximizing Firm 1's profit can be formulated as follows:

$$W = Max\ p_1 x_1 - c_1 x_1 \tag{6}$$

where c_1 is the marginal cost. The first-order condition for optimization yields:

$$p_1(1 + \frac{1}{\Delta_1}) = c_1 \tag{7}$$

Where Δ_1 is the price elasticity. Furthermore, the markup rate f_1 for Firm 1 can be obtained as:

$$f_1 = \frac{p_1}{c_1} = \frac{1}{1 + 1/\Delta_1} = \frac{1}{1 + [(p_2 - p_1)k + \tau_2]/\ p_1 k} = \frac{p_1 k}{p_2 k + \tau_2} \tag{8}$$

During the pandemic, consumers were restricted in their mobility. To adapt to these restrictions, consumers increasingly turned to online purchasing, especially during the initial containment period (Bounie et al., 2023; Guthrie et al., 2021). This shift results in a significant increase in online consumption. To analyze the impact of e-commerce on the markup rate of Firm 1, we take the derivative of the markup rate function *f1* with respect to the proportion of online sales k, yielding the following expression:

$$\frac{\partial f_1(k)}{\partial k} = \frac{p_1 \tau_2}{(p_2 k + \tau_2)^2} > 0 \tag{9}$$

The above analysis reveals that as the parameter k increases, the markup rate of Firm 1 also increases, as indicated by the positive partial derivative. We further assume that the survival rate of a firm is an increasing function of the markup rate f. This relationship is intuitive, considering that a higher markup rate allows firms to obtain higher gross profit relative to their costs, which can improve the overall business performance. There is evidence supporting the notion that profitability plays a crucial role in enhancing the likelihood of survival. Studies by Delmar et al. (2013) and Zhou and Park (2020) indicate that firms can improve their chances of sustained growth and long-term survival by developing and leveraging firm-specific advantages. Based on these findings, we can conclude that:

$$\frac{\partial Rate_1}{\partial k} = \frac{\partial Rate_1}{\partial f_1(k)} \frac{\partial f_1(k)}{\partial k} > 0 \tag{10}$$

The partial derivative shown above is positive, indicating that an increase in k leads to an increase in the survival rate of the Firm 1.

Similarly, we can calculate the markup rate f_2 for Firm 2 as follows:

$$f_2 = \frac{p_2}{c_2} = \frac{1}{1 + 1/\Delta_2} = \frac{1}{1 + [(1-k)(p_1 - p_2) + \tau_2)]/(1-k)p_2} = \frac{p_2 - p_2 k}{-p_1 k + p_1 + \tau_2} \tag{11}$$

To examine how e-commerce affects the markup rate of Firm 2, we take the derivative of the markup rate function f_2 with respect to the proportion of online sales k. The derivative is computed as follows:

$$\frac{\partial f_2(k)}{\partial k} = \frac{-p_2\tau_2}{(-p_1k + p_1 + \tau_2)^2} < 0 \tag{12}$$

The partial derivative shown above is negative, indicating that an increase in k leads to a decrease in the markup rate of Firm 2. Similarly, we further assume that the survival rate of a firm is an increasing function of the markup rate f. We can conclude:

$$\frac{\partial Rate_2}{\partial k} = \frac{\partial Rate_2}{\partial f_2(k)} \frac{\partial f_2(k)}{\partial k} < 0 \tag{13}$$

The partial derivative consistently yields negative values, indicating that as k increases, the survival rate of the Firm 2 decreases. By combining Equations (10) and (13), we can infer that firms that adopt e-commerce are more likely to survive compared to those that do not adopt e-commerce. This model also implies that firms with a higher e-commerce intensity benefit more, as they can capture a larger share of the online market. E-commerce serves as a crucial resource for firms, enabling them to adapt to changing environments and enhance their chances of survival. This perspective aligns with the Resource-Based Theory of the firm (Perrigot and Pénard, 2013). Therefore, we propose that e-commerce can improve the survival rate of SMEs under the impact of the pandemic, assisting them in "surviving a crisis".

III. Data and empirical strategy

1. Survey data of SMEs

The data used comes from the Enterprise Survey for Innovation and Entrepreneurship in China (ESIEC), which is conducted by the Center of Enterprise Research, Peking University. The baseline survey was completed in 2018 and 2019. The 2018 wave covered 6199 firms, and the 2019 wave covered the remaining 429 firms that missed the 2018 wave. The baseline surveys collected information on entrepreneurial history, supply chain, innovation, and other issues. The sample consists of 6628 SMEs in six provinces and centrally administered municipalities, namely Liaoning, Shanghai, Zhejiang, Henan, Guangdong, and Gansu. The ESIEC firms have good representativeness in terms of geographical regions and national economic industries (Dai et al., 2021).

During the first half of 2020, the ESIEC team conducted two special investigations on the survival status of SMEs amidst the COVID-19 pandemic. They mainly focus on firms' reopening and operational status, as well as challenges and prospects. The first wave was conducted from February 10th to 13th, and the second wave was conducted from May 18th to 25th. The team received responses from 2513 and 2508 firms, respectively. These two surveys can be matched with the baseline survey.

We have chosen to use the survey data from May 2020 (ESIEC202005) instead of the survey data from February 2020 for two main reasons. Firstly, our study specifically focuses on the survival of SMEs, and using the business status measured by ESIEC202005 provides a more accurate assessment of SMEs' survival. In February 2020, several lock-down policies were introduced after all provincial governments in China declared first-degree state of emergency. Due to the strict restrictions on firm resumption of work imposed by governments, many firms temporarily suspended their operations rather than exiting the market. This makes it challenging to infer the survival status of firms based on data from February 2020. However, by March 2020, most firms have begun to resume work and production, and the spread of COVID-19 had been largely contained. Thus, the survey data from May 2020 is more suitable for inferring the survival

status of SMEs. Secondly, ESIEC202005 provides detailed information on SMEs' operation conditions, especially in terms of orders, cash flow, and average accounts receivable period, which is important for mechanism analysis.

In this study, we use a panel consisting of ESIEC from 2018 to 2020 for analysis. Firstly, we infer the survival status (survival or bankruptcy) of firms at the end of 2018 and 2019 based on their exit time in ESIEC202005. Secondly, the firm registration types in the data are divided into self-employed firms and incorporated firms. Since only incorporated firms are queried about e-commerce, we retain only the samples of incorporated firms. Thirdly, we merge the micro-firm data with city-level data based on address information. Moreover, all continuous variables are winsorized at the 1st and 99th percentiles. After applying these data processing steps, we obtain a balanced panel data of 1324 SMEs in 62 cities from 2018 to 2020. Additionally, the city-level controls data is sourced from China City Statistical Yearbook in 2019.

2. Identification Strategy

We study whether firms that adopt e-commerce prior to the shock have higher survival rate during the pandemic restrictions. We consider the COVID-19 pandemic as an exogenous shock and categorize firms that adopted e-commerce prior to the shock as the treatment group and those that did not adopt e-commerce prior to the shock as the control group. The difference-in-difference (DID) is employed to identify the impact of e-commerce on the survival of SMEs during the crisis. Similar to Ding et al. (2021), we formulate our baseline specification as follows:

$$Survival_{ict} = \alpha_0 + \beta E-commerce_i \times Pandemic_t + \delta X_{ic} \times Pandemic_t + \lambda_i + \theta_t + \varepsilon_{ict} \quad (14)$$

where i indicates the firm, c indicates the city a firm is located, t indexes the year. $Survival_{ict}$ represents SMEs' survival, taking a value of one if the firm survives and zero otherwise. $E\text{-}commerce_i$ denotes e-commerce adoption, taking a value of one if e-commerce is adopted before the COVID-19 pandemic and zero otherwise. $Pandemic_t$ equals one for the year 2020, and zero otherwise. X_{ic} represents a set of firm-level and city-level controls in 2018. The interaction term $X_{ic} \times Pandemic_t$ not only helps control for observable omitted variables, isolate the independent relationship between e-commerce and firm outcomes, but also avoid the issue of "bad controls" (Levine et al., 2018).[1] We also include firm fixed effects (λ_i) and year fixed effects (θ_t). Standard errors are clustered at the firm level.

Our coefficient of interest is β, the estimated effect of e-commerce on SMEs' survival rate during the pandemic. The key dependent variable is binary. We mainly use the difference-in-differences estimator by Mundlak approach to estimate the baseline regression Equation, specifically Equation (14). This choice is motivated by the fact that the two-way Mundlak (TWM) regression is easily suited for nonlinear models like logit and probit models, as highlighted by Wooldridge (2021). We also present the estimation results using the two-way fixed effects (TWFE) estimator, acknowledging its classic and widely used nature.

The dependent variable is the survival status (*Survival*). The survival of a firm is a fundamental condition for its development. Like Geroski et al. (2010), we infer the survival status of a firm based on its exit year. The May wave of ESIEC asked entrepreneurs whether they had closed their firms, and when. As such, if a firm has not been closed, we assume that it has survived.

[1]To avoid "bad controls", we do not control for time-varying firm characteristics because e-commerce may affect the outcome variable survival through these time-varying firm characteristics.

The independent variable is the interaction term between e-commerce and pandemic, referred to as "*E-commerce*×*Pandemic*" hereafter. We assign a value of one to "E-commerce" if a firm sells products and services through the internet (excluding online promotion), and zero otherwise. We assign a value of one to "*Pandemic*" if the year is 2020, and zero otherwise.

The control variables include both firm-level and city-level factors. The firm-level controls include the number of employees, entrepreneurs' education level, registered capital, firm age, and whether the firm enjoys supportive policies. These variables are highly related to the adoption of e-commerce and are associated with firms' operating conditions. The city-level controls include economic development level, internet penetration, per capita income from telecommunications services, and digital financial inclusion. Economic development is considered as a control variable because it is positively correlated with e-commerce adoption by firms and may impact firm operations by improving the business environment and market vitality. Internet popularization and per capita income from telecommunications services are used to represent the level of regional informatization development. Informatization development is a fundamental requirement for firms to adopt e-commerce, and it can also influence firms' operating conditions. Digital inclusive finance expands the coverage of financial services, enhances the convenience of financial services and reduces the cost of financial services, which is positively correlated with e-commerce adoption by firms. Meanwhile, inclusive financial services can also impact firm operations.

To verify the mechanism of e-commerce on the survival rate of SMEs under the impact of the pandemic, we specify model (15). The dependent variables used in the mechanism analysis are sourced from ESIEC202005. The dependent variables used in the mechanism analysis represent the financial conditions of firms during the pandemic. We clarify that these variables are only available in the special investigations conducted in 2020 (specifically, ESIEC202005 in our study), which limits the feasibility of implementing a Difference-in-Differences (DID) strategy. We use cross-sectional OLS estimates to perform the regression analysis for verification of mechanisms.

$$Survival_{ic} = \alpha_0 + \beta E - commerce_i + \delta X_{ic} + \lambda_j + \varepsilon_{ic} \quad (15)$$

The outcome variables considered in the mechanism analysis include order decline as main challenge, the duration of cash flow, and repayment period of account receivables. We measure order decline as main challenge (*Order*) by using the question "whether the most important reason for the firm's operating problems is the decrease in orders." Cash flow duration (*Cash flow*) is determined by the question "How long will your firm's current cash flow last?". We construct a dummy variable to indicate whether the duration of cash flow is longer than one month. The repayment period of account receivables is assessed through different categories: 1-30 days, 31-60 days, 61-90 days, and more than 90 days. Based on this, we construct dummy variables to indicate whether the average account period is less than one month (*Acount*1) and whether it is less than two months (*Acount*2). The independent variable is whether e-commerce was adopted prior to the pandemic. X_{ic} represents a set of controls, which is the same as Equation (14). We also control one-digit industry fixed effects (λ_j).

3. Descriptive statistics

Table 1 presents the descriptive statistics of major variables. According to the sample sizes of the treatment and control group, the proportion of SMEs that adopt e-commerce is approximately 30%. The overall survival rate of SMEs that adopted e-commerce is 94.6%, while the overall survival rate of SMEs that did not adopt e-commerce is 91.4%.

Table 1. Descriptive Statistics

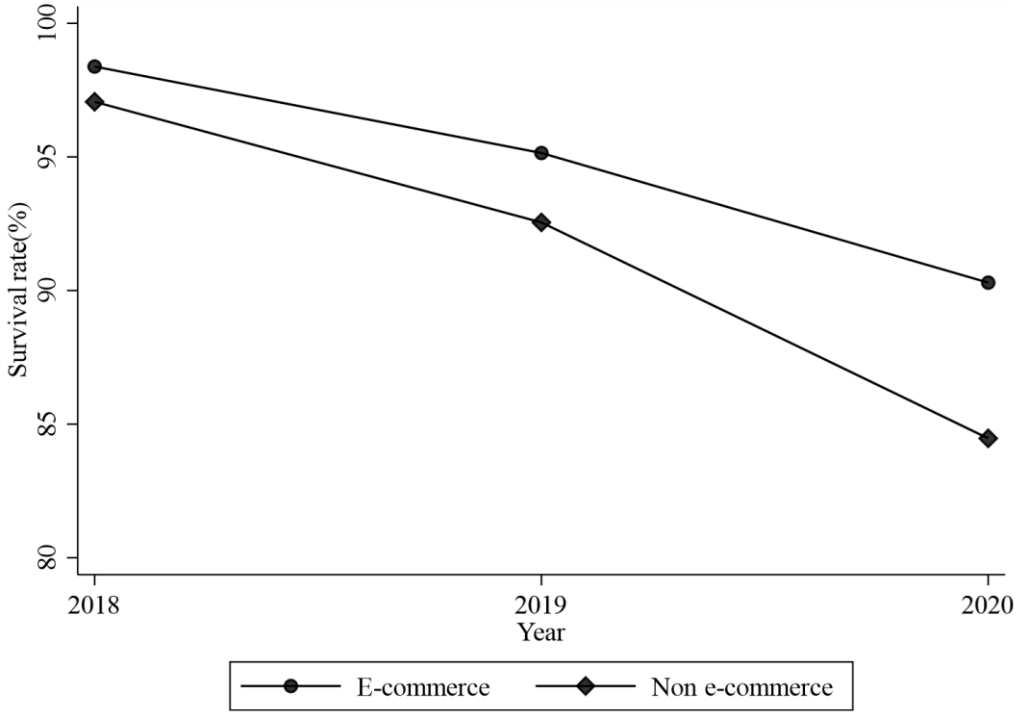
Variables	Definitions	E-commerce Group			Non E-commerce Group		
		Obs	Mean	Std. Dev	Obs	Mean	Std. Dev
Survival	Whether a firm survives	1113	0.946	0.226	2859	0.914	0.281
Pandemic	Year=2020	1113	0.333	0.472	2859	0.333	0.471
Employees	Number of employees	1113	20.429	37.930	2859	14.133	41.571
Education	Entrepreneurs' years of education[2]	1104	13.750	2.809	2850	12.494	3.512
Capital	Registered capital amount	1113	281.016	577.289	2859	307.48	683.748
Policies	Whether enjoys supportive policies	1089	0.201	0.401	2799	0.165	0.371
Age	2018 minus registration year plus one	1113	3.431	2.135	2859	3.147	2.112
Order	Order decline as main challenge	371	0.019	0.136	953	0.028	0.166
Cash flow	Cash flow>1 Month	371	0.760	0.428	953	0.720	0.449
*Acount*1	Repayment period of account receivables<1 Month	252	0.321	0.468	604	0.232	0.422
*Acount*2	Repayment period of account receivables<2 Months	252	0.575	0.495	604	0.386	0.487
PGDP	Per capita *GDP*	1113	11.153	0.666	2859	10.972	0.673
Telecommunications	Telecommunications service revenue/total population	1113	7.356	0.947	2859	7.042	0.900
Internet	Number of internet broadband access users per 100 people	1113	48.068	28.174	2859	40.865	24.231
Finance	Digital inclusive finance Index	1113	254.553	29.864	2859	245.384	29.161

Sources: Authors' calculations are based on data from ESIEC and China City Statistical Yearbook.

Figure 1 below illustrates the annual survival rate of SMEs in the treatment group and control group. In 2018, the survival rate of the treatment group and control group was 98% and 97%, respectively, with a negligible difference. In 2019, the difference between the two was 2% (95%−93% = 2%). Before the pandemic outbreak, there was no significant difference in the survival rate between the treatment group and control group, which preliminarily confirms pre-parallel trend hypothesis. In 2020, the survival rate of the treatment group and control group was 90% and 84%, respectively, with a difference of 6%. The data indicates that firms that adopt e-commerce have a greater likelihood of survival after being impacted by COVID-19 pandemic compared to those that do not adopt e-commerce. These results preliminarily confirm the inference made by theoretical model mentioned earlier.

[2]Illiterate or seminally literate = 0; primary school = 6; junior high school = 9; high school, vocational school, technical school or professional high school = 12; junior college = 15; undergraduate = 16; master's degree = 19; doctorate = 22.

Figure 1. Annual Survival Rate of Treatment Group and Control Group



Sources: Authors' calculations are based on data from ESIEC.

IV. Empirical results

1. Baseline results

Table 2 presents the empirical results analyzing the effect of e-commerce on the SMEs' survival during the pandemic. Columns (1)—(3) present the TWM estimator results, while columns (4)—(6) present the TWFE estimator results. All regressions account for firm fixed effects and year fixed effects. Both the TWM estimators and TWFE estimators indicate that the interaction term has a significant positive effect on SMEs' survival. This finding is particularly relevant in the context of the pandemic, where a substantial shift in consumption patterns from offline to online has occurred. By embracing e-commerce platforms, businesses gain access to a wider range of sales channels and a larger market size, effectively mitigating the issue of insufficient orders. Additionally, the adoption of e-commerce enables real-time online communication between firms and customers. This feature proves advantageous as it shortens the collection time of accounts receivable, ensuring the smooth operation of working capital.

Columns (3) and (6) present the results of our preferred specification, as outlined in Equation (14) above. The estimated coefficients obtained from these two estimators are largely similar. Specifically, in the face of the pandemic shock, e-commerce increases SMEs' survival rate by 3.0 to 3.4 percentage points (approximately 3.5 percent of the mean). These findings indicate that the improvement in SMEs' survival rate by e-commerce has significant economic implications.Ferguson and Olofsson (2004) conducted a comparison between Swedish science park firms with comparable off-park firms. Their findings revealed that after a 7-year period, the survival rate of the former was nearly 30% higher than that of the latter. Similarly, Wagner and Cockburn (2010) find that firms that submitted at least one patent application have a 32% higher

probability of survival relative to the baseline. In contrast to our study, these studies have a wide sample period. Furthermore, against the backdrop of the pandemic, the tax incentives and job stability policies implemented in China have increased the probability of normal business operation for SMEs by approximately 4.6 and 3.9 percentage points in 2020, respectively (Cai et al., 2021). Notably, the effect of e-commerce on survival is only slightly lower than that of these fiscal policies.

Table 2. The Effect of E-commerce on Survival during the Pandemic

	(1)	(2)	(3)	(4)	(5)	(6)
		TWM			TWFE	
			Survival			
E-commerce×Pandemic	0.039***	0.032***	0.030***	0.039**	0.034**	0.034**
	(0.011)	(0.011)	(0.011)	(0.015)	(0.015)	(0.015)
Firm level controls	NO	YES	YES	NO	YES	YES
City level controls	NO	NO	YES	NO	NO	YES
Firm and Year FEs	YES	YES	YES	YES	YES	YES
Observations	3972	3876	3876	3972	3876	3876
R^2	0.719	0.723	0.723	0.679	0.682	0.682

Sources: Authors' calculations are based on data from ESIEC and China City Statistical Yearbook.

Notes: The first three columns are estimated using the two-way Mundlak (TWM) estimator, while the last three columns are estimated using the two-way fixed effects (TWFE). ***, **, and * represent significance at the 1, 5, and 10 percent levels, respectively. Robust standard errors are clustered at firm level.

2. Validity of the DID specification

Parallel trend test. An important assumption of the difference-in-differences (DID) specification is that there are similar trends in the survival rate between firms adopting e-commerce and those not adopting e-commerce prior to the pandemic. To test the parallel trend hypothesis, we set the following estimation equation:

$$Survival_{ict} = \sum_{\substack{\tau=2018 \\ \tau\neq 2019}}^{2020} \alpha_\tau E-commerce_i \times Pandemic_\tau + \delta X_{ic} \times Pandemic_t + \lambda_i + \theta_t + \varepsilon_{ict} \quad (16)$$

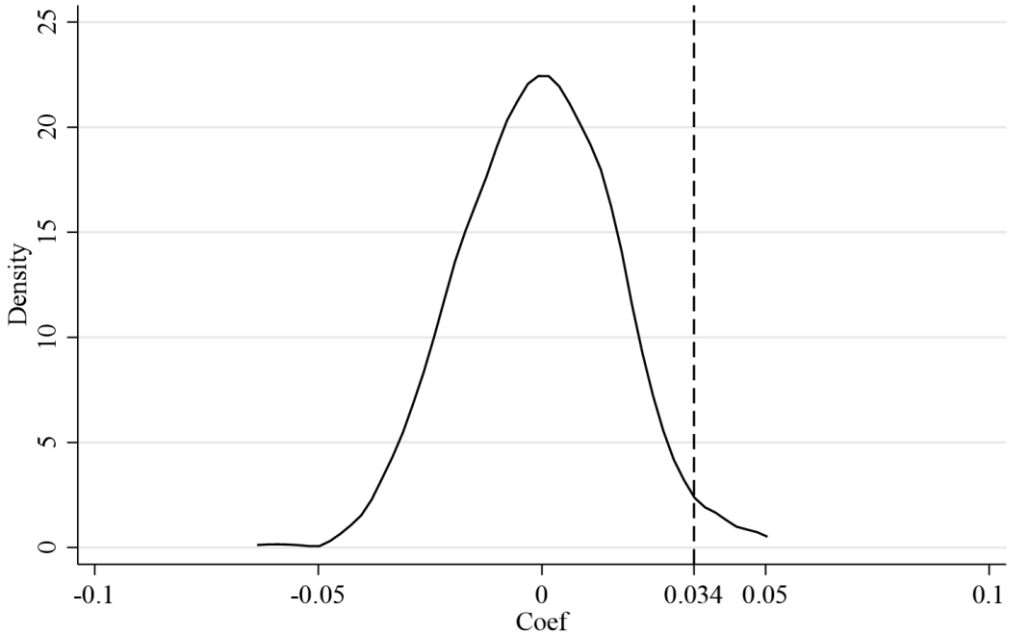
In Equation (16), the core independent variables are the interaction terms between e-commerce and the full set of year dummies. We drop the pre-treatment year of 2019 as the baseline comparison group. The definitions of other variables are the same as the baseline specification.

Table 3 column (1) reports the estimation results of Equation (16). It is evident that there is no significant difference in the survival rate of SMEs between the treatment group and control group before 2020. The above results provide evidence for the pre-parallel trend assumption. After the pandemic, the estimated coefficient of the interaction term is significantly positive, indicating that e-commerce has a positive effect on SMEs' survival under the pandemic shock.

Placebo test. Although the results for parallel trend support our identification assumption, we provide further evidence here by performing a placebo test. We randomly select 371 firms as the treatment group, which matches the actual number of firms undergoing the treatment, and re-estimate our baseline specification 500 times. If there are no differential trends in survival outcomes, the estimated coefficients of "*E-commerce×Pandemic*" should follow an approximate

normal distribution centered around 0. The results, shown in Figure 2, consistently indicate no evidence of an effect in the placebo programs, further strengthening the identification assumption.

Figure 2. Placebo Test



Sources: Authors' calculations are based on data from ESIEC.

Notes: The figure plots the placebo test results conducted with 500 permutations of the treatment and control group. All regressions use TWM estimators and control for firm and city level controls, firm fixed effects and year fixed effects.

3. Endogeneity discussion

The current estimation may suffer from endogeneity concerns. Firstly, there exists a bidirectional causal relationship between firm survival and e-commerce adoption. Stronger survival capacity may stimulate the demand for expanding market channels, thereby increasing the likelihood of e-commerce adoption. Secondly, there are unobserved factors that influence both e-commerce adoption and firms' survival, such as the ability to master digital technology. It is important to acknowledge that e-commerce adoption is endogenous. However, the COVID-19 pandemic shock is considered exogenous in this study.

To address the endogeneity issue, we select two instrumental variables (IV) for e-commerce. The first IV is the number of post offices per million people in cities in 1984. This choice is based on the notion that the development of traditional communication technology has paved the way for the emergence of internet technology, which in turn gives rise to e-commerce. As such, a correlation exists between historical post office numbers and e-commerce. Additionally, for firms, the utilization of traditional communication technology is infrequent, making it difficult to influence their operations through channels other than e-commerce. This IV satisfies exogeneity requirement.

Our second IV is the shortest spherical distance from the city where a firm is located to the cities where "Eight Verticals and Eight Horizontals" (EVEH) optical fiber backbone network nodes are situated. Information infrastructure is the basic requirement for firms engaging in e-commerce activities. The closer the distance from the firm's location to the "Eight Verticals and

Eight Horizontals" optical fiber backbone network nodes, the more likely the firm participating in e-commerce-related business, so the second IV satisfies relevance. Furthermore, the construction of the "Eight Verticals and Eight Horizontals" transmission backbone network was proposed in the 1994 "National Post and Telecommunications Ninth Five-Year Plan Outline" to address long-distance communication congestion. The selection of node cities was based more on geographical factors, rather than economic factors. Hence, the distance to "Eight Verticals and Eight Horizontals" node cities was minimally affected by endogenous economic conditions.

Since the two instrumental variables we have selected are cross-sectional variables that do not vary over time, we interact them with a pandemic dummy variable. Specifically, we create the interaction terms between the number of post offices per million people in 1984 and the pandemic, as well as between the shortest distance to the node cities and the pandemic. These interaction terms serve as instrumental variables for the variable "*E-commerce* × *Pandemic*".

Columns (2) and (3) of tables 3 report the results of the 2SLS estimation. The first-stage regression results reveal that the interaction term between "the shortest distance to the node cities" and the pandemic is negatively correlated with the core independent variable, while the interaction term between "the number of post offices per million people in 1984" and the pandemic is positively correlated with independent variable. These results align with our expectations. In the second-stage regression, the coefficient of the interaction term between e-commerce and the pandemic remains significantly positive, indicating that our conclusion remains reliable even after accounting for endogeneity concerns. Moreover, the aforementioned regression has passed statistical tests for insufficient identification, over-identification, and weak IV, confirming the validity of our chosen instrumental variables.

Table 3. Results of Parallel Trend Test and Endogeneity Discussion

	(1) TWM	(2) TWFE	(3) 2SLS	(4) 2SLS
	Parallel trend		IV estimation	
	Survival	*Survival*	*E-commerce* ×*Pandemic*	*Survival*
E-commerce×*Year*2018	–0.012	–0.012		
	(0.008)	(0.012)		
E-commerce×*Year*2020	0.024**	0.028*		
	(0.011)	(0.014)		
E-commerce×*Pandemic*				0.199*
				(0.113)
lnShortest distance to the node cities			–0.145**	
×*Pandemic*			(0.061)	
lnPost offices per million people in 1984			0.005***	
×*Pandemic*			(0.001)	
Firm and city level controls	YES	YES	YES	YES
Firm and Year FEs	YES	YES	YES	YES
Observations	3876	3876	3252	3252
R^2	0.743	0.682	0.514	0.020
Underidentification test				26.002 [0.000]
Cragg-Donald Wald F				38.161
Kleibergen-Paap rk Wald F				22.498

Overrecognition test	1.809 [0.179]

Sources: Authors' calculations are based on data from ESIEC and China City Statistical Yearbook.

Notes: Columns (1) and (2) show the estimated results of Equation (16). Columns (3) and (4) show the IV estimation results. In square brackets is the p-value of the tests. ***, **, and * represent significance at the 1, 5, and 10 percent levels, respectively. Robust standard errors are clustered at firm level.

4. Selection bias

The causal effect of e-commerce on the survival rate of SMEs during the COVID-19 pandemic can be quantified by calculating the difference in survival rate between the treatment group and the control group after the pandemic and subtracting this from the difference in survival rate before the pandemic. The causal effect can be expressed mathematically as follows:

$$\begin{aligned}\beta_{ATT} = &\left\{E[Y_{it} \mid Ecommerce_i = 1, Pandemic_t = 1] - E[Y_{it} \mid Ecommerce_i = 0, Pandemic_t = 1]\right\} \\ &-\left\{E[Y_{it} \mid Ecommerce_i = 1, Pandemic_t = 0] - E[Y_{it} \mid Ecommerce_i = 0, Pandemic_t = 0]\right\}\end{aligned} \tag{17}$$

There are two potential reasons for firms that are not successfully tracked: either they survive but do not respond to the second survey, or they have closed and their contact information is no longer valid. Therefore, the firms that are not tracked likely have a higher mortality rate than those that are tracked. As a result, our study is subject to survivorship bias, as it only includes the samples that are successfully tracked. This means that the observed survival rate in our study may be higher than the actual value.

We assert that the findings of our study are not undermined by selection bias.. Firms that adopt e-commerce tend to have more social interactions and closer social connections, making them easier to track. The results in Table 4 confirm this hypothesis. As a result, the observed survival rate and the actual survival rate for firms that adopt e-commerce are only minimally divergent, with a small survivorship bias, which means that $E[Y_{it} \mid Ecommerce_i = 1, Pandemic_t = 1]$ may be slightly overestimated. Conversely, firms that do not adopt e-commerce are more challenging to track, and the actual survival rate for this group is likely significantly lower than the observed survival rate (with a larger survivorship bias), which means that $E[Y_{it} \mid Ecommerce_i = 0, Pandemic_t = 1]$ may be overestimated to a greater extent. Obviously, the causal effect in this study is underestimated, and the conclusion drawn from our study remains robust.

Table 4. The Effect of E-commerce on the Tracking Rate

	(1) Being successfully tracked in May 2020	(2) Being successfully tracked in May 2020	(3) Being successfully tracked in May 2020
E-commerce	0.023*	0.029**	0.025*
	(0.014)	(0.015)	(0.015)
Firm and city level controls	NO	NO	YES
Industry FEs	NO	YES	YES
Observations	4330	4330	4163
R^2	0.001	0.005	0.014

Sources: Authors' calculations are based on data from ESIEC.

Notes: The sample consists of 4,330 incorporated firms from the baseline survey. The tracking rate in May 2020 is 30.6%. ***, **, and * represent significance at the 1, 5, and 10 percent levels, respectively. Robust standard

errors are clustered at firm level.

V. Heterogeneity

1. Heterogeneity of e-commerce intensity

Among firms adopting e-commerce, there exists variation in the extent to which they embrace e-commerce. If e-commerce can improve the survival rate of firms during the pandemic, the positive impact should be even more prominent for firms that rely more on internet platforms for their products and services sales. We define e-commerce intensity as the continuous ratio of online sales to total sales. Following Zhang et al. (2023), we employ a generalized Difference-in-Differences (DID) analysis to examine the impact of e-commerce intensity on survival, as shown in Equation (18).

$$Y_{ict} = \alpha_0 + \beta Ecom\_inten_i \times Pandemic_t + \delta X_{ic} \times Pandemic_t + \lambda_i + \theta_t + \varepsilon_{ict} \quad (18)$$

where $Ecom\_inten_i$ represents the ratio of online sales to total sales prior to the pandemic. The definitions of other variables remain the same as in Equation (14).

Table 5, Column 1 presents the estimation results of Equation (18), showing that as the share of online sales increases, the probability of firm survival also increases, and this effect is significant at the 1% level. Specifically, under the impact of the pandemic, for every 10% increase in the proportion of online sales to total sales, the survival rate increases by 0.7 percentage points. Firms with a larger share of online sales have a competitive advantage in the market. The growth of e-commerce has provided firms with opportunities to reach a wider customer base and expand their market presence, especially during times of crisis such as the COVID-19 pandemic. In summary, the positive impact of e-commerce on firm survival is more pronounced for firms that have a larger share of online sales.

2. Heterogeneity of e-commerce platforms

When examining platforms involved in e-commerce, we categorize them into third-party e-commerce platforms or websites, self-built websites and social media. Since different platforms have varying thresholds and management skills, the impact of e-commerce on the survival of SMEs during the pandemic may exhibit heterogeneity across different platforms.

To verify the heterogeneity of e-commerce platforms, we construct the interaction terms between three types of e-commerce platforms and the pandemic as the core independent variables. Specifically, we estimate:

$$\begin{aligned} Y_{ict} = {} & \alpha_0 + \beta_1 Platform_i \times Pandemic_t + \beta_2 Self\_web_i \times Pandemic_t \\ & + \beta_3 Soc\_media_i \times Pandemic_t + \delta X_{ic} \times Pandemic_t + \lambda_i + \theta_t + \varepsilon_{ict} \end{aligned} \quad (19)$$

where $Platform_i$, Own_web_i, Soc_media_i respectively represent whether a firm uses third-party e-commerce platforms or websites, self-built websites, and social media to sell products or services prior to the pandemic. The definitions of other variables remain the same as in Equation (14).

The regression results are shown in column (2) of Table 5. The results indicate that using third-party e-commerce platforms or websites to sell products and services can significantly improve the survival rate of SMEs by approximately 4 percentage points.

However, the coefficient of interaction between self-built websites and the pandemic is not statistically significant, which could potentially be attributed to the relatively smaller customer

base and limited market space of social media platforms.

Furthermore, self-built websites also do not exhibit a significant effect. Self-built website operations necessitate the presence of skilled personnel, including software development and e-commerce operation personnel. Additionally, maintaining the stable functioning of self-built websites requires substantial capital investment, leading to significantly increased costs for firms. Considering these factors, there is doubt as to whether the additional income generated from selling products on self-built websites will sufficiently offset the associated costs.

3. Heterogeneity of industries

To curb the spread of COVID-19, the Chinese government implemented strict prevention measures, including movement restrictions, job rotation and separate meals. These policies mainly targeted people, indicating that firms affected by the pandemic are predominantly labor-intensive. In contrast to offline sales, e-commerce can reduce the demand for labor and enable employees to work from home. We argue that the primary beneficiaries of e-commerce during the pandemic are firms in labor-intensive industries.

To classify industries as either labor-intensive or capital-intensive, we adopt the approach proposed by Wan and Zhang (2023). This approach involves calculating the labor-capital ratio at the industry level, which is obtained by dividing the total amount of labor in a given industry by the total amount of capital. Industries with labor-capital ratio above (below) the median of all industries are categorized as labor-intensive (capital-intensive) industries.

The estimated results of the heterogeneous effects across industries are shown in columns (3) and (4) of Table 5, where the specification follows Equation (14). Column (3) uses firm samples in labor-intensive industries, while column (4) uses firm samples in capital-intensive industries. We can see that for firms in labor-intensive industries, the coefficient of independent variable is larger and more statistically significant. The survival rate of SMEs in labor (capital) intensive industries is increased by 4.3 (2.1) percentage points by e-commerce.

4. Heterogeneity of regional pandemic severity

The preceding sections mainly discuss the internal characteristics of firms and their heterogeneity.. We then examine the heterogeneity effects associated with the severity of the regional pandemic. In regions where the pandemic is more severe, the advantages of e-commerce may become more pronounced. We measure the severity of the regional pandemic by the number of confirmed cases (referred to as "*Cases*"). In practice, we use the cumulative number of confirmed cases as of April 30, 2020, as a proxy for severity, since we use May wave of ESIEC. To verify the heterogeneity of regional pandemic severity, we estimate:

$$\begin{aligned} Y_{ict} = {} & \alpha_0 + \gamma E-commerce_i \times Pandemic_t \times Cases_c + \beta_1 E-commerce_i \times Pandemic_t \\ & + \beta_2 Cases_c \times Pandemic_t + \delta X_{ic} \times Pandemic_t + \lambda_i + \theta_t + \varepsilon_{ict} \end{aligned} \tag{20}$$

The estimated results are shown in column (5) of Table 5. The coefficient of *Cases*×*Pandemic* is significantly negative at the 1% level, indicating that as the pandemic becomes more severe, the likelihood of SME survival decreases. The interaction term between confirmed cases and the independent variable is the main focus in this section. The variable *Cases*×*E-commerce*×*Pandemic* is not statistically significant, indicating that the positive effect of e-commerce on the survival does not exhibit the heterogeneity on regional pandemic severity. There could be several reasons for this. Firstly, in regions with severe pandemic, governments

may provide increased financial support and tax incentives to firms. These aids mitigate the effect of firms' internal advantages on the survival rate. Secondly, in some areas, the spread of the pandemic may not be as serious as in other regions, but strict prevention and control policies hinder the resumption of offline production. In such case, e-commerce can still play a significant role in improving survival rate, leading to an underestimation of the interaction between confirmed cases and the core independent variable.

Table 5. Heterogeneity Analysis Results

	(1)	(2)	(3)	(4)	(5)
			Survival		
E-commerce intensity	0.071***				
×Pandemic	(0.026)				
Platform×Pandemic		0.041**			
		(0.016)			
Self_web×Pandemic		–0.025			
		(0.037)			
Soc_media×Pandemic		0.058			
		(0.047)			
E-commerce×Pandemic			0.043**	0.021	0.026
			(0.021)	(0.022)	(0.017)
Cases×E-commerce×Pandemic					0.002
					(0.006)
Cases×Pandemic					–0.011***
					(0.004)
Firm and city level controls	YES	YES	YES	YES	YES
Firm and Year FEs	YES	YES	YES	YES	YES
Observations	3528	3825	2163	1713	3876
R^2	0.690	0.684	0.692	0.674	0.684

Sources: Authors' calculations are based on data from ESIEC and China City Statistical Yearbook.

Notes: Column (1) reports the heterogeneity results of e-commerce intensity, column (2) reports the heterogeneity results of e-commerce platforms, columns (3) and (4) report the heterogeneity results of industries, and column (5) reports the heterogeneity results of regional pandemic severity. The unit of confirmed cases is 100 persons. ***, **, and * represent significance at the 1, 5, and 10 percent levels, respectively. Robust standard errors are clustered at firm level.

VI. Mechanism

This section aims to explore the mechanisms through which e-commerce improves the survival rate of SMEs during a crisis. We propose two potential mechanisms. Firstly, e-commerce can expand market scale and alleviate decline in orders experienced during the pandemic. Secondly, e-commerce can shorten the repayment period of account receivables, thus improving cash flow. The specification for mechanism analysis follows Equation (15).

1. Expand market scale and alleviate order decline

Compared to the offline sales, e-commerce offers numerous advantages. It effectively reduces search and matching costs, caters to diverse consumer needs, and has the potential to expand market scale and alleviate order decline. Firstly, e-commerce reduces the search and matching costs for both buyers and sellers, thereby enhancing market transaction efficiency. Additionally, it provides a platform for firms to showcase their products to a broader audience and extend their sales potential beyond their local regions, and even globally. Firms can also leverage big data analytics to capture, forecast, and stimulate consumer demand, thereby creating new growth opportunities. Secondly, as the trend of consumption upgrading continues, there is a growing prevalence of personalized, diversified, and high-quality consumer demands. E-commerce breaks through the standardization often found in offline retail and meet the diverse and high-quality needs of consumers. This enables firms to further explore the market.

Thirdly, the COVID-19 pandemic has significantly impacted consumption patterns. There has been a shift in demand from offline to online channels, leading to a surge in online consumption. Research based on data from Taiwan's largest agri-food e-commerce platform revealed that each additional confirmed case of COVID-19 led to a 5.7% increase in sales and a 4.9% increase in the number of customers, indicating a rising trend in online transactions (Chang and Meyerhoefer, 2021). In response to these changes in consumer behavior, firms that adopt e-commerce can swiftly adapt, capture a larger market share, and improve their operation conditions.

Figure 3. Year-on-year Growth Rate of Total Retail Sales and Online Retail Sales in 2020

Sources: Authors' calculations are based on data from National Bureau of Statistics. Data for total retail sales of consumer goods from March to December and data for online retail sales from February to December are available.

As shown in Figure 3, the year-on-year growth rate of total retail sales of consumer goods from March to August 2020 was negative. Since the outbreak of COVID-19, total retail sales of consumer goods have decreased significantly compared to the same period in 2019. However, online retail sales witnessed an increase compared to the corresponding period in 2019. Specifically, online retail sales in February 2020 were similar to those in February 2019. From March to December 2020, online retail sales were higher than those form the same period in 2019,

with a year-on-year growth rate exceeding 10% in most months. It can be concluded that the pandemic has propelled the growth of online retail sales while causing a decline in offline sales and total sales. Notably, firms that adopt e-commerce enjoy a larger target market.

One of the primary reasons for firms withdrawing from the market is the decline in orders, making it challenging for them to sustain their operations. In our analysis, we argue that the expansion of online market size may alleviate the decline in orders. The regression results in column (1) of Table 6 illustrate the relationship between e-commerce adoption and order decline. The estimated coefficient of e-commerce is negative, indicating that firms that adopt e-commerce are less likely to face order decline than those that do not adopt e-commerce. However, the estimated coefficient is not statistically significant, which could be attributed to the fact that firms' orders come from diverse sources, such as operators' networks, customers developed by sales personnel, commodity fairs, wholesalers, downstream firms, retail stores, and so on. While e-commerce can increase the orders through online retail outlets, some firms do not rely on retail stores as their primary order channels. Consequently, the effect of e-commerce on order decline is not statistically significant. Generally, for firms with stable large customers, the impact of e-commerce on increasing orders is relatively limited. To verify the possible explanations above, we excluded this sample and re-evaluated the regression results in column (2). The results indicate that for firms without stable large customers, e-commerce significantly alleviates the problem of order decline, thus substantiating our explanations to some extent. In conclusion, e-commerce has played a role in mitigating the problem of order decline.

2. Shorten repayment period of account receivables and improve cash flow

The disruption of the capital chain stands a major factor leading to bankruptcy and closure for many firms. The prompt collection of funds is crucial for enhancing liquidity and securing sufficient operating capital for a firm's development. E-commerce can shorten the repayment period of account receivables and improve cash flow.

Firstly, e-commerce eliminates the need for multiple intermediate transaction links, such as those involved in the traditional distribution chain from firms to distributors to physical stores. Instead, it directly connects supply and demand, resulting in improved transaction efficiency. In addition, Chinese e-commerce platforms often integrate digital payment systems, effectively addressing the issue of delayed payments by ensuring prompt payment. Once customers confirm receipt of the goods, the firm can receive payment immediately, greatly reducing the time required to collect account receivables.

Secondly, the advent of a new digital credit system within online platforms has addressed concerns regarding trust in online transactions. Additionally, the governments have implemented targeted laws to regulate the consumption behavior of platforms and users, providing good guarantees for each transaction. The accelerated speed of fund collection resulting from these measures increases the turnover rate of firm funds, improves cash flow tightness, and ensures the smooth operation of firms in the future.

We analyze the impact of e-commerce on the repayment period of account receivables and its subsequent effect on cash flow. Columns (3) to (5) in Table 6 examine the impact of e-commerce on financial conditions of firms. Column (3) shows that the probability of firms having an average repayment period of less than one month increases by nearly 9 percentage points due to e-commerce adoption. This causal effect is noteworthy, given that only 25.8% of the samples have

such a short repayment period. Similarly, the results in column (4) show that firms adopting e-commerce are more likely to have an average repayment period of less than two months compared to those not adopting. Additionally, we explore whether e-commerce can alleviate the cash flow crunch caused by the COVID-19 pandemic. Column (5) reveals that e-commerce indeed has a positive impact on the duration of cash flow. Specifically, firms that adopt e-commerce are 4.5 percentage points more likely to maintain their cash flow for more than one month, as compared to those that do not. This result suggests that e-commerce assists firms in coping with the challenges posed by the pandemic and improving their overall financial stability.

Table 6. Mechanism Analysis results

	(1)	(2)	(3)	(4)	(5)
	Order decline as main challenge	Order decline as main challenge	Repayment period <1 Month	Repayment period<2 Months	Cash flow>1 Month
E-commerce	–0.008	–0.020*	0.094***	0.174***	0.045*
	(0.010)	(0.010)	(0.035)	(0.039)	(0.028)
Firm and city level controls	YES	YES	YES	YES	YES
Industry FEs	YES	YES	YES	YES	YES
Observations	1292	752	837	836	1292
R^2	0.115	0.207	0.073	0.083	0.039

Sources: Authors' calculations are based on data from ESIEC and China City Statistical Yearbook.

Note: Only samples of firms without stable large customers are utilized in column (2), whereas full samples are utilized for the other columns. ***, **, and * represent significance at the 1, 5, and 10 percent levels, respectively. Robust standard errors are clustered at firm level.

VII. Conclusion

This study examines the impact of e-commerce on the survival rate of SMEs during the crisis by leveraging the variations in e-commerce adoption across SMEs before and after the pandemic. We find that e-commerce significantly improves the survival rate of SMEs during the pandemic. We identify two key channels through which e-commerce influences survival. Firstly, e-commerce expands market scale and alleviates order decline. Secondly, e-commerce shortens the repayment period of account receivables and alleviates cash flow difficulties that SMEs commonly face. shortening the repayment period of account receivables to alleviate cash flow difficulties. Our study also highlights that during the pandemic, firms with a larger share of online sales and firms in labor-intensive industries are the main beneficiaries of e-commerce. In terms of e-commerce platforms, using third-party e-commerce platforms or websites to sell products and services is found to improve the survival rate of firms, but selling through self-built websites and social media does not exhibit a significant effect. Furthermore, the positive effect of e-commerce on survival remains consistent regardless of the severity of regional pandemic.

Our findings have several practical implications for improving survival rate of SMEs both in China and other developing countries where e-commerce is booming. It highlights the effectiveness of e-commerce as a risk management tool for SMEs. Governments should take proactive measures to support firms in their digital transformation journey. This includes reducing the barriers associated with internet usage and promoting the deeper application of network technology, such as e-commerce, to enhance firms' resilience against shocks. Additionally, laws

and regulations related to internet transactions should be improved to ensure the safety and standardization of business activities. Firms themselves should actively drive digital transformation and explore opportunities to leverage internet scenarios. Moreover, there should be a strong focus on fostering talent in the field of e-commerce to expand market reach, increase order volumes, improve capital turnover rates, and enhance survival capacity.

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