Research on the Survival Resilience and Heterogeneity of Chinese Enterprises under the Shock of COVID-19: An Empirical Analysis based on the SRD Model

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Abstract: The outbreak of the COVID-19 epidemic in China from the end of 2019 to the beginning of 2020 has greatly impacted the survival resilience of many enterprises. Therefore, systematic research on how Chinese enterprises cope with the shock of the epidemic and how to improve their resilience is of great significance for the development planning of enterprises in the post-epidemic era. In this study, the ability to resist and defend, and the ability to grow and innovate after exogenous shocks, are taken as two aspects to measure the stability and development of enterprise survival resilience. The quarterly index data of A-share listed companies in China from 2017 to 2022 are selected, and the time point of the full outbreak of the epidemic in China, that is, the first quarter of 2020, is taken as the breakpoint. A breakpoint regression (SRD) model is used to study the impact of the epidemic shock on the survival resilience of enterprises in China, and the heterogeneity characteristics of state-owned and non-state-owned enterprises and enterprises in different national industries are analyzed. According to the test results, the shock of the epidemic has a significant impact on the survival resilience of Chinese enterprises, and there is heterogeneity among enterprises of different natures and industries. Finally, based on empirical results, this paper proposes differentiated stability maintenance strategies for enterprises in the service industry with strong dependence on offline human flow, the real economy industry with high market demand sensitivity, and the important supply industry related to the national economy and people's livelihoods.

Keywords: *epidemic shock; enterprise survival resilience; heterogeneity; SRD*

1. Introduction

As an exogenous shock, the COVID-19 pandemic has posed a major challenge to the stability and development of the global economy. On the one hand, according to a report released by the World Bank, the global GDP growth rate in 2020 was reduced by 4.3% due to the epidemic, including -3.6% in the United States and -5.3% in Japan. China's GDP growth rate in the first quarter of 2020 was also as low as -6.8%. On the other hand, from the final result of China's positive GDP growth of over 2% in 2020, the Chinese economy has shown a certain resilience in this exogenous shock, which is worthy of our in-depth study. In the process of the spread of the epidemic and

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policy containment, enterprises, as one of the important economic entities, were affected by rising prices, policy isolation, and employee absenteeism, resulting in a sharp increase in costs. A large number of enterprises suffered losses as a result, and their survival resilience deteriorated sharply in a short period of time. In this regard, enterprises of diverse natures in a variety of industries show different survival resilience. In terms of the nature of different enterprises, both state-owned and non-state-owned enterprises were deeply affected in the early stage of the outbreak, but the impact on the two kinds of enterprises varied with the passing of time. In terms of different industry categories, the annual GDP of the accommodation and catering industry fell by 16.6% year-on-year, and many real estate companies suffered serious losses. However, the digital economy, express delivery and food delivery industries were hit briefly, but later developed rapidly. The growth rate of the digital economy was 3.2 times that of GDP in the same year. The total business completed by the express delivery industry above the designated size increased by 31.2% year-on-year, and the size of the online food delivery market increased by 15% year-on-year. Therefore, assessing the impact of COVID-19 on the survival resilience of enterprises, as well as the heterogeneity of the survival resilience of enterprises in different natures and industries, and working out corresponding strategies are of great significance to the high-quality and sustainable development of the national economy in the post-COVID-19 era.

Therefore, based on the fact that China's large enterprises rarely fall into the dilemma of bankruptcy, this paper selects the data of China's Shanghai and Shenzhen A-share listed companies from 2017 to 2022, and uses the precise breakpoint regression SRD model to assess the impact of the exogenous impact of COVID-19 on the survival resilience of listed companies. At the same time, heterogeneity analysis is carried out according to the nature and industry of enterprises, so as to provide a scientific basis for improving the survival resilience of all types of enterprises in the post-epidemic era.

2. Literature Review

The novel coronavirus (COVID-19) epidemic emerged in Wuhan, Hubei Province, China, at the end of 2019, and it fully broke out in China in the first quarter of 2020, attracting great attention from scholars around the world. In fact, there have been many large-scale public health outbreaks in human history, such as the Black Death in Europe, the Spanish flu, the Ebola epidemic in Africa, and the SARS epidemic in China. These major public health emergencies often have a serious impact on a country's economy due to their unpredictability, and they are becoming increasingly frequent (Sun 2004), which has caused extensive research by scholars. Since the beginning of the 21st century, there have been two major public health emergencies in China, namely the SARS virus epidemic in 2002 and the novel coronavirus pneumonia epidemic this time. Although the death rate of COVID-19 is lower than that of SARS, it is more infectious, spreads faster, infects a wider area, and is more difficult to control (Ma and Zhang 2020; Sheng and Li 2020), so it has caused a serious impact on China's economy in a short period of time. Some scholars looked into the supply side and the demand side, and found that the COVID-19 epidemic caused adverse effects such as increased pressure on investment and financing, sharp decline in market demand, labor distortion, decline in household income, disruption of industrial chain and supply chain (Baker et al. 2020; Fang et al. 2020; Li et al. 2020), added a lot of uncertainties to the development prospects of China's economy in a short time. The uncertainty added by the epidemic will increase the vulnerability of the financial system, thus increasing the probability of the outbreak of a financial crisis (Yang et al. 2019), which will lead to a new round of economic turmoil, which needs to be paid close attention to by the relevant entities.

The main bodies dealing with the impact of the epidemic can be divided into two categories: macro government and micro enterprises. Some scholars take the macro government as the main body, and believe that as the leader of an emergency response, it needs to strengthen the capacity of its epidemic prevention system, organization and mobilization capacity, improve overall social welfare, and stabilize investment and employment as the key point of response to the epidemic (Lin et al. 2020; Zhang et al. 2021; Zhu and Peng. 2020) and take this as an overall action guide for planning the direction of economic development in the post-epidemic era. Other scholars mainly focus on microenterprises and study the impact of COVID-19 on enterprise operation and development based on changes in economic indicators of enterprises. In this regard, in view of the deterioration of the economic environment caused by the exogenous impact of similar epidemics, the ability of enterprises to resist the impact and recover development was measured (Gunderson et al. 2002; Sajko et al. 2021), the academic community put forward the category of "resilience," but the quantitative analysis of it is relatively lacking (Lu et al. 2021). Due to the impact of the epidemic, some economic indicators of Chinese enterprises show a temporary fault phenomenon. Some scholars use the breakpoint regression method to study the impact of COVID-19 on the business performance of China's forest-related listed companies (Fan et al. 2023), some analyze the significant inhibitory impact of the epidemic on China's import and export trade activities (Liang et al. 2022), and some try to evaluate the survival resilience of enterprises based on profitability and growth ability indicators (Shi and Li 2022). However, in general, there are still few studies on the measurement of enterprise survival resilience, and there is a lack of micro empirical evidence.

In view of this, this paper divides the survival resilience of enterprises into two dimensions: stability and development. By measuring the ability to resist and defend and the ability to grow and innovate respectively, this paper selects the quarterly indicator data of China's A-share listed companies from 2017 to 2022, takes the first quarter of 2020, the time point of the full outbreak in China, as the breakpoint, and adopts the precise breakpoint regression SRD model to measure the impact of COVID-19 on the survival resilience of Chinese enterprises and the heterogeneity of different natures and industries.

3. Data Explanation and Variable Selection

(1) Data Explanation

The data in this paper are all from the index data of China's Shanghai and Shenzhen A-share listed companies in the WIND Information financial terminal and the CSMAR database, and the data are processed as follows: First, individuals with abnormal data and excessive data missing are eliminated, a small number of missing values are processed by the method of adjacent value replacement, and more than 4,000 individual data are finally screened, with a large sample size. Second, considering the stationarity of the data, logarithmic processing was carried out on all the sample data in this paper. Third, the time span of the sample data is from the first quarter of 2017 to the fourth quarter of 2022. In the following, "XX year.03" represents the first quarter of XX, and 06, 09 and 12 respectively represent the second, third and fourth quarters.

(2) Variable Selection

In this paper, the survival resilience of enterprises is defined as the degree of damage to the operational ability of enterprises after exogenous shocks and the level of subsequent development

ability. The former is classified as stability, and the latter as development. In this paper, the stability and development of enterprise survival resilience are measured by the enterprise's ability to resist and defend and its ability to grow and innovate after exogenous shocks. Based on the above two dimensions, the enterprise survival resilience index system and covariate index system are constructed as in Tables 1 and 2.

Table 1. Outcome Variable — Enterprise Survival Resilience Index System

Primary Indicators	Secondary Indicators	Nature	Indicator Description
Stability (Ability to resist and defend)	Return on equity (lnroe)	Positive	According to the growth or decline of indicators to measure the enterprise's ability to resist and defend
	Return on total assets (lnroa)	Positive	
	Net profit margin on sales (lnnpm)	Positive	Measure an enterprise's ability to realize inventory assets
	Inventory turnover (lnito)	Positive	
Development (Ability to grow and innovate)	Year-on-year growth rate of operating income (lnbiyoy)	Positive	Year-on-year growth rate: (Current index value - Index value in the same period of last year)/Index value in the same period of last year *100%
	Year-on-year growth rate of net profit (lnnpyoy)	Positive	
	Number of R&D patents (lnzl)	Positive	Measure the originality of the enterprise

In terms of the selection of outcome variables, as shown in Table 1: On the one hand, in terms of stability, referring to existing literature (Shi and Li 2022; Sun and Zhai 2021), select return on equity (lnroe), return on total assets (lnroa) and Net profit margin on sales (lnnpm) as indicators to measure the degree of impairment of corporate profitability. At the same time, the inventory turnover ratio (lnito), as an important indicator to evaluate the inventory operation efficiency of each link of production and the business performance of enterprises, is also included in the index system. On the other hand, in terms of development, considering that the year-on-year growth rate can better avoid the problem of seasonal effect, the year-on-year growth rate of operating income (lnbiyoy) and the year-on-year growth rate of net profit (lnnpyoy) are selected as indicators to measure the growth and innovation ability of enterprises, and the number of R&D patents (lnzl) is added as an indicator to measure the innovation ability of enterprises.

Table 2. Covariate Indicators and Their Descriptions

Concomitant Variable	Variable Description
Enterprise attribute (lnse)	State-owned enterprises (1) and non-state-owned enterprises (0)
Total number of employees (lnhc)	Control the impact of employment level on the survival state of the enterprise
Equity multiplier (lnem)	Control the impact of debt risk on the survival state of enterprises
Total corporate assets (lnta)	Control the impact of enterprise size on the survival state of the enterprise

In terms of the selection of covariables, as shown in Table 2, this paper selects enterprise attributes (lnse), total number of employees (lnhc), equity multiplier (lnem) and total corporate assets (lnta) to control the impact of enterprise nature differences, employment level, debt risk and enterprise size on the survival resilience of enterprises, respectively. Here, because the outbreak of

the epidemic is exogenous to the covariate index, it conforms to the principle that the covariate only affects the outcome variable, which is scientifically sound.

4. Model Construction and Descriptive Statistics

In this part, in order to measure the impact of an epidemic shock on enterprise survival resilience, we choose to construct an SRD model. At the same time, on the one hand, descriptive statistics were carried out on the covariables, and a T-test and a VIF test were conducted for covariables to measure the continuity at the outbreak point and address the multicollinearity problem. On the other hand, descriptive statistics were carried out on the outcome variables. By comparing the mean difference of the outcome variables in the first quarter of 2019 and 2020, it was initially shown that there was a breakpoint effect in the first quarter of 2020.

(1) SRD Model Construction

1) Model Assumptions

The COVID-19 pandemic is an external shock that cannot be predicted or controlled, and it has had a significant impact on China's economy. So, as one of the most important economic entities, what impact does the epidemic have on the resilience of enterprises? Aiming at the above problems, this paper intends to build an SRD model and verify the following two hypotheses:

H^1: The shock of the epidemic has a significant impact on the survival resilience of Chinese enterprises.

H^2: There is heterogeneity in the impact of COVID-19 shocks on the resilience of Chinese enterprises.

2) Construct SRD Model

Taking the first quarter of 2020 as the precise breakpoint, the accurate breakpoint regression SRD model was constructed. Among them, the impact of epidemic shock on outcome variable Y is related to experimental group D. According to D, the time interval can be divided into before and after the epidemic shock, and the 11 quarters after the epidemic shock are selected as the observation interval. X_{it} as the configuration variable, represents the length of time between the corresponding time point and the breakpoint. It is assumed that the change in the survival state of

listed companies before and after the epidemic shock depends only on the COVID-19 shock itself, and the tested covariates show continuity at the time point of the epidemic shock. Using the difference of survival resilience indicators of listed companies before and after the epidemic shock to estimate the average impact of the epidemic shock on the survival resilience of listed companies:

$$w = EY_1 - EY_0 \qquad (1)$$

Since the outbreak time is a definite event, which is called the exact breakpoint, the local average processing effect (LATE) is estimated for experimental group D, the SRD model can be obtained:

$$y_{it} = \alpha + \beta D_{it} + Yf(x_{it}) + \varphi cov(\overrightarrow{z_{it}}) + Ev_i + \sigma_{it} \qquad (2)$$

$$y_{it} = \alpha_1 + \beta_1 D_{it} + Y_1 x_{it} + \varphi_1 cov(\{lnse, ln\textit{h}c, lnem, lnta\}) + E_1 v_i + \sigma_{it} \qquad (2.1)$$

$$y_{it} = \alpha_2 + \beta_2 D_{it} + Y_2 x_{it}^2 + \varphi_2 cov(\{lnse, ln\textit{h}c, lnem, lnta\}) + E_2 v_i + \sigma_{it} \qquad (2.2)$$

$$y_{it} = \alpha_3 + \beta_3 D_{it} + Y3 x_{it} + \varphi_3 cov(\{ln\textit{h}c, lnem, lnta\}) + E_3 v_i + \sigma_{it} \qquad (2.3)$$

$$D_{it} \begin{cases} 0, & n < 13 \\ 1, & n \geq 13 \end{cases} \quad (3)$$

In formula (2), Y_{it} represents the survival resilience variable of enterprise i at time point t. Using D_{it} as a processing variable, D_{it}=1(0) represents the observed value of enterprise i at time point t in the experimental group (control group). n is a grouping variable or driving variable. It represents the ranking of the season time point. As a continuous variable, n=1, 2, 3, [...], 24, where n=13 represents the breakpoint of the first quarter of 2020. β is the estimated value of the local average processing effect (LATE) at n=13. The configuration variable X_{it} =n-13, is used to aid in measuring the different effects before and after the breakpoint. $\overrightarrow{Z_{it}}$ is a set of covariables, including lnse, lnhc, lnem and lnta, representing the characteristic fixed effects of the listed company's enterprise attributes, total number of employees, equity multiplier and enterprise size. This article assumes f(X_{it}) is linear (2.1), and the robustness of the model is tested by the quadratic term 2.2, and formula 2.3, is used to measure the heterogeneity of survival resilience of state-owned and non-state-owned enterprises. Since the SRD model in this paper aims to identify the discontinuity of the result variable Y_{it} at the time break point, in order to control the factors that may affect the survival resilience of enterprises at the time level, the variable Vi is added to equation (2) to represent the fixed effect of time. Finally, the random disturbance term σ_{it} follows a normal distribution.

(2) Descriptive Statistics of the Variable

Table 3. Descriptive Statistics of Covariables

Variables Mean	2019.03		2020.03	
	[-2, -1]	[0, 1]	[-2, -1]	[0, 1]
lnse	0.2023	0.2023	0.2023	0.2023
	(0.0034)	(0.0034)	(0.0034)	(0.0034)
N	8,698	8,698	8,698	8,698
lnhc	1.1535	1.1680	1.1779	1.1878
	(0.0095)	(0.0096)	(0.0096)	(0.0096)
N	8,698	8,698	8,698	8,698
lnem	1.0740	1.0618	1.0647	1.0678
	(0.0043)	(0.0047)	(0.0046)	(0.0044)
N	8,698	8,698	8,698	8,698
lnta	1.6598	1.6896	1.7275	1.7597
	(0.0140)	(0.0141)	(0.0141)	(0.0142)
N	8,698	8,698	8,698	8,698

Note: Data in ( ) represent the standard errors of the corresponding indicators, N represents the number of samples, the following is the same.

As can be seen from the descriptive statistics of covariates in Table 3, there is no significant fault difference between the mean value and standard error of covariates in the two quarters before and after the first quarter of 2019 and 2020.

Table 4. Results of T-test and Multicollinearity Test for Covariates

Variables Test	T-test 2020.03		VIF 2017.03-2022.12	1/VIF 2017.03-2022.12
	T-value	P-value		
lnse	0.0000	1.0000	1.18	0.8463
N	17,396	17,396	104,376	104,376
lnhc	-0.7275	0.4670	2.61	0.3827
N	17,396	17,396	104,376	104,376
lnem	-0.4775	0.6330	1.27	0.7905
N	17,396	17,396	104,376	104,376
lnta	-1.6090	0.1076	3.21	0.3116
N	17,396	17,396	104,376	104,376

First of all, the T-values and P-values shown by the T-test results in Table 4 can be obtained: If the null hypothesis is that there is no significant difference between the two independent samples constituted by two quarters before and after the breakpoint, then at the significance level of 1%, the p-value of the T-test is greater than 0.1, which means that the test results of all covariables show that the null hypothesis cannot be rejected. Secondly, according to the multicollinearity test of the covariables in Table 4, the maximum VIF value is 3.21, and the mean value is 2.07, which is far less than 10, so there is no multicollinearity problem. Finally, combined with the results of Table 3 and Table 4, it can be seen that before and after the breakpoint of the sample data in the first quarter of 2020, the covariables lnse, lnhc, lnem and lnta are all continuous, and there is no significant difference or multicollinearity problem, which ensures the reliability of the research results.

Table 5. Descriptive Statistics of Outcome Variables

	2019.03			2020.03			Diff
Variables Mean value	[-2, -1]	[0, 1]	Diff	[-2, 1]	[0, 1]	Diff	between Diff
lnroe	1.8033 (0.0168)	1.2004 (0.0145)	0.6029	1.7269 (0.0174)	0.8451 (0.0149)	0.8818	0.2789
N	8,698	8,698		8,698	8,698		
lnroa	1.5997 (0.0137)	1.1462 (0.0107)	0.4535	1.5335 (0.0139)	0.8314 (0.0119)	0.7021	0.2486
N	8,698	8,698		8,698	8,698		
lnnpm	1.8831 (0.0179)	1.7909 (0.0187)	0.0922	1.8185 (0.0190)	1.2431 (0.0244)	0.5754	0.4832
N	8,698	8,698		8,698	8,698		
lnito	1.6045 (0.0119)	1.2593 (0.0113)	0.3452	1.5898 (0.0119)	1.0069 (0.0106)	0.5829	0.2377
N	8,460	8,460		8,460	8,460		
lnbiyoy	1.8242 (0.0259)	1.2948 (0.0289)	0.5294	1.1620 (0.0277)	-0.6264 (0.0323)	1.7884	1.2590
N	8,698	8,698		8,698	8,698		
lnnpyoy	0.9166 (0.0396)	0.8931 (0.0397)	0.0235	0.8419 (0.0396)	-0.5567 (0.0431)	1.3986	1.3751
N	8,698	8,698		8,698	8,698		
lnzl	3.3126 (0.0184)	2.8903 (0.0163)	0.4223	3.4712 (0.0186)	2.6969 (0.0164)	0.7743	0.3520
N	8,168	8,168		8,168	8,168		

According to the statistical description results of the outcome variables in Table 5, the mean difference before and after the first quarter of 2020 is larger than that in the first quarter of 2019, and the mean difference of indicators of growth and innovation ability is larger than that of resilience and prevention ability on the whole. On the one hand, in terms of the ability to resist and defend, the change of net profit rate on sales before and after 2019.03 and 2020.03 is the largest, reaching 0.4832, while the others, return on equity, return on total assets, and inventory turnover have smaller differences, which are 0.2789, 0.2486 and 0.2377, respectively. On the other hand, in terms of growth and innovation ability, the difference between the year-on-year growth rate of net profit before and after the two quarters is the most significant, reaching 1.3751, followed by the year-on-year growth rate of operating income reaching 1.2590, and the average value of the two changes from positive to negative around the first quarter of 2020, indicating that the net profit and operating income of enterprises have declined seriously. The number of R&D patents also showed a decline of 0.3520. The above results preliminarily show that the shock of the COVID-19 epidemic has had a relatively significant impact on the survival resilience of Chinese enterprises.

5. Empirical Analysis of the Impact of COVID-19 Shock on the Survival Resilience of Chinese Enterprises

In this part, first, regression analysis based on the SRD model tests the hypothesis (H^1) and measures the change in survival resilience of A-share listed companies under the shock of the epidemic. Second, the robustness of the model is tested by transforming the configuration variables from linear to quadratic and using different bandwidths.

(1) Enterprise Survival Resilience Measurement Based on SRD Model

$$y_{it} = \alpha_1 + \beta_1 D_{it} + Y_1 x_{it} + \varphi_1 \mathrm{cov}(\{\mathrm{lnse}, \ln hc, \mathrm{lnem}, \mathrm{lnta}\}) + E_1 v_i + \sigma_{it} \quad (2.1)$$

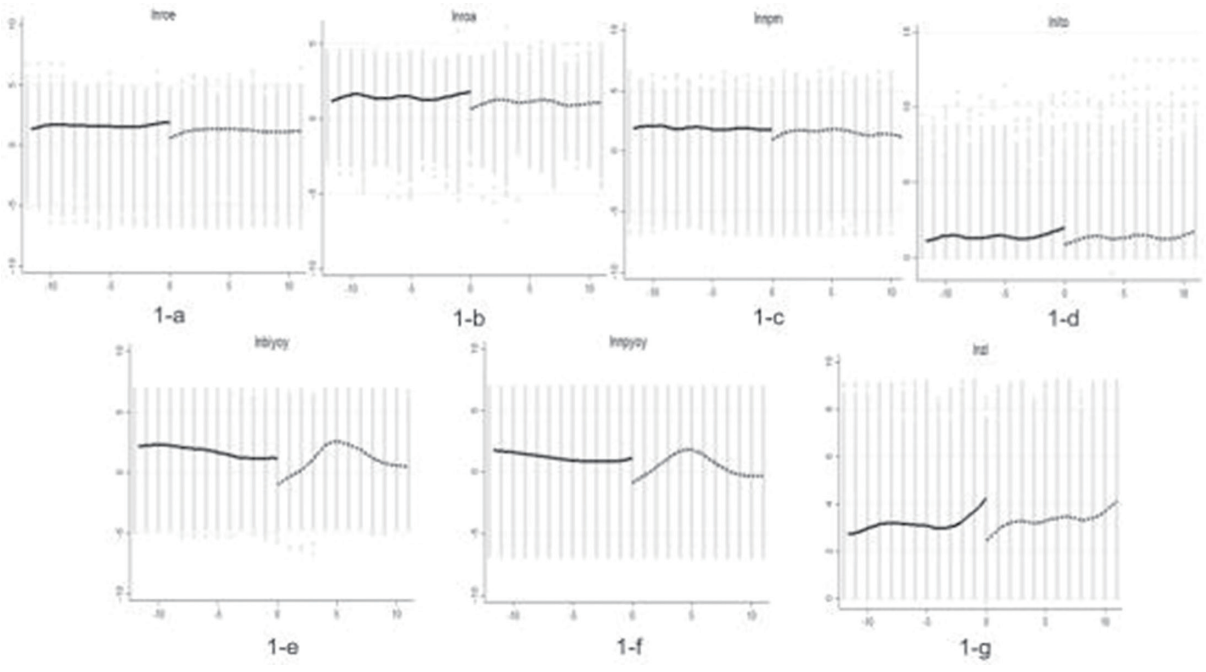

Figure 1. Linear Graph of Enterprise Survival Resilience Index

Table 6. SRD Model Results of Enterprise Survival Resilience

Variables	Coefficient	se	Z	P>|z|	95% Confidence Interval	N	cov
lnroe	-1.3216	0.0491	-26.94	0.000***	[-1.4177, -1.2254]	104,376	Yes
lnroa	-1.1801	0.0493	-23.96	0.000***	[-1.2767,-1.0836]	104,376	Yes
lnnpm	-0.8133	0.0461	-17.62	0.000***	[-0.9038,-0.7229]	104,376	Yes
lnito	-1.1615	0.0398	-29.19	0.000***	[-1.2395,-1.0836]	101,520	Yes
lnbiyoy	-2.1569	0.0593	-36.40	0.000***	[-2.2730,-2.0408]	104,376	Yes
lnnpyoy	-2.0227	0.1374	-14.72	0.000***	[-2.2920,-1.7534]	104,376	Yes
lnzl	-1.9131	0.0462	-41.37	0.000***	[-2.0037,-1.8224]	98,016	Yes

Note: ***, ** and * represent a significance level of 1%, 5% and 10% respectively, "cov" represents the covariate, the same as below.

Based on equation (2.1), when the configuration variable is linear and takes one quarter as the bandwidth, it can be intuitively seen in Figure 1 that there is a certain degree of fault effect in the indicator data of each outcome variable at the breakpoint. The SRD model results in Table 6 clearly show that: at the significance level of 1%, the epidemic shock has a significant impact on the survival resilience of Chinese listed enterprises. Corresponding to Figure 1 and Table 6, it can be seen that, taking the first quarter of 2020 as the breakpoint, the coefficients of relevant indicators measuring the resilience of enterprises have different degrees of breakpoint effect, and the degree of damage of development indicators is significantly greater than the stability, which is basically consistent with the inferences drawn in the descriptive statistics above.

On the one hand, in terms of the ability to resist and defend, return on equity, return on total assets and inventory turnover decreased by more than one relative unit, to 1.3216, 1.1801 and 1.1615, respectively, while the degree of decline of the net profit rate on sales was lower, at 0.8133. The reason is that in the first quarter of 2020, the COVID-19 epidemic broke out in China, the rapid spread of the virus, the introduction of epidemic surveillance and control measures in various places, and even the lockdown strategy in the severely affected region of Wuhan affected the normal operation of enterprises in many ways. First of all, in the production and sales link, for offline business channels, the purchase of many raw materials and the circulation and sales of commodities have been seriously hindered by the epidemic controls, and brick-and-mortar stores have suspended business. As for online business channels, since the novel coronavirus can be spread through goods, and many couriers were on leave due to the virus, the online sales channels also fell into a slump in the early stage of the epidemic. Secondly, at the management level, a large number of employees of enterprises were quarantined due to their own infection, or people near their homes were quarantined at home, or some employees of enterprises were infected and other employees could not return to work, and companies whose employees had not been vaccinated were not allowed to resume work, which had a great negative impact on the management cost of enterprises. Finally, the existence of long-term lease contracts makes it difficult for enterprises to avoid major expenses during the epidemic, such as payment for leased workshop space for production or office space for management, without the intervention of local governments. To sum up, at the time of the outbreak of the epidemic, the obstruction of online and offline operations directly affected the realization ability of the inventory assets of enterprises, and the inventory turnover rate was subsequently reduced. While the income declined, the production, sales and management costs increased significantly, which led to the decline of the return on equity, return on total assets and net profit rate on sales.

On the other hand, in terms of growth and innovation ability, the year-on-year growth rate

of operating income and net profit decreased by more than two relative units, to 2.1569 and 2.0277, respectively, and the degree of decline in the number of R&D patents also reached 1.9131. The sharp decline of the above index coefficients is closely related to the shock of the novel coronavirus epidemic. Firstly, the spread of the virus and the introduction of control policies have hindered enterprises' production and employees' return to work, which directly led to a sharp decline in operating revenue and a corresponding decline in net profit. Based on this, the growth rate of operating revenue and net profit of enterprises has dropped significantly compared with the corresponding indicators before the shock of the epidemic. Secondly, the inconvenience caused by illness and isolation due to the novel coronavirus epidemic has become one of the important reasons for the decline in the number of R&D patents applied for by enterprises. Finally, due to the declining revenue capacity of enterprises, fixed costs are difficult to reduce. Coupled with the premium of raw materials, the increase in shutdown costs, and the cost of new epidemic prevention and control measures, many enterprises face a tight cash flow. In addition, the outbreak of the epidemic was at the beginning of 2020, which is more likely to affect the planning of the entire year's funding budget, a larger share of the funding plan for stable production and operation, and appropriate reduction of research and development funds, which will greatly affect the innovation ability of enterprises, and the number of new research and development patents will decline. To sum up, due to the adverse impact of the COVID-19 epidemic, the year-on-year growth rate of business revenue and net profit of enterprises have declined significantly, while the attendance of enterprise R&D personnel has been hindered, and the annual funding budget has been tilted to other aspects compared with previous years, resulting in a large decline in R&D capabilities. All of these jointly hinder the development of enterprises' growth and innovation capabilities.

(2) Robustness Test

1) Configuration Variables are Converted from Linear to Quadratic Terms

$$y_{it} = \alpha_2 + \beta_2 D_{it} + Y_2 x_{it}^2 + \varphi_2 \mathrm{cov}(\{\mathrm{lnse}, \ln hc, \mathrm{lnem}, \mathrm{lnta}\}) + E_2 v_i + \sigma_{it} \quad (2.2)$$

Table 7. SRD Model Results with Quadratic Terms as Configuration Variables

Variables	Coefficient	se	Z	P>|z|	95% Confidence Interval	N	cov
lnroe	-1.1180	0.0405	-27.60	0.000***	[-1.1974, -1.0386]	104,376	Yes
lnroa	-0.9883	0.0326	-30.34	0.000***	[-1.0521,-0.9244]	104,376	Yes
lnnpm	-0.6177	0.0484	-12.75	0.000***	[-0.7126,-0.5228]	104,376	Yes
lnito	-0.8895	0.0225	-39.56	0.000***	[-0.9336,-0.8454]	101,520	Yes
lnbiyoy	-2.0196	0.0644	-31.38	0.000***	[-2.1458,-1.8934]	104,376	Yes
lnnpyoy	-1.8296	0.0935	-19.56	0.000***	[-2.0130,-1.6463]	104,376	Yes
lnzl	-1.4609	0.0304	-48.06	0.000***	[-1.5205,-1.4013]	98,016	Yes

Note: ***, ** and * represent a significance level of 1%, 5% and 10% respectively, "cov" represents the covariate, the same as below.

As shown in formula (2.2), after the configuration variable is transformed from linear to quadratic, it can be seen from Table 7 that the coefficients of each variable are still significant at the significance level of 1%. First, compared with the linear coefficient, the absolute value of the quadratic coefficient of the number of R&D patents was reduced by 0.4522, indicating that when the configuration variable was quadratic, the decline in the number of R&D patents at the breakpoint

was relatively small. Second, the coefficients of return on equity, return on total assets, inventory turnover, net profit on sales and the year-on-year growth rate of net profit show that when the configuration variable is quadratic, the absolute value of the shock of the epidemic decreases by about 0.2. Finally, for the year-on-year growth rate of operating income, the coefficient difference between the linear and the quadratic terms is small. In summary, the SRD results of the quadratic terms are still significant, and the differences between the two forms of the configuration variables are no more than 0.5, indicating that the SRD model results are generally stable.

2) Bandwidth Sensitivity Test

Table 8. SRD Results for Different Bandwidths

BW	*lnroe*	*lnroa*	*lnnpm*	*lnito*	*lnbiyoy*	*lnnpyoy*	*lnzl*
0.5	-1.2227***	-0.9804***	-0.6264***	-0.8893***	-2.1278***	-1.8441***	-1.7981***
	(0.0334)	(0.0272)	(0.0705)	(0.0225)	(0.0951)	(0.0825)	(0.0541)
1	**-1.3216*****	**-1.1801*****	**-0.8133*****	**-1.1615*****	**-2.1569*****	**-2.0227*****	**-1.9131*****
	(0.0491)	(0.0493)	(0.0461)	(0.0398)	(0.0593)	(0.1374)	(0.0462)
2	-0.9309***	-1.1066***	-0.6267***	-0.7804***	-2.1170***	-1.8552***	-1.3905***
	(0.0305)	(0.0348)	(0.0549)	(0.0220)	(0.0722)	(0.0796)	(0.0269)
3	-0.6582***	-0.8264***	-0.6500***	-0.5523***	-2.1038***	-1.3794***	-0.9054***
	(0.0237)	(0.0259)	(0.0420)	(0.0173)	(0.0548)	(0.0635)	(0.0219)
4	-0.5155***	-0.6554***	-0.5604***	-0.3989***	-1.8278***	-0.7437***	-0.5800***
	(0.0203)	(0.0212)	(0.0353)	(0.0149)	(0.0466)	(0.0550)	(0.0189)
5	-0.4992***	-0.5275***	-0.4680***	-0.3940***	-1.4330***	-0.3978***	-0.5482***
	(0.0196)	(0.0184)	(0.0311)	(0.0139)	(0.0416)	(0.0504)	(0.0172)

Note: ***, ** and * represent a significance level of 1%, 5% and 10% respectively, “cov” represents the covariate, the same as below.

The SRD model results with bandwidths of 0.5, 1, 2, 3, 4 and 5 quarters are shown in Table 8. As shown in the table: First, at the significance level of 1%, the variable coefficients are still significant, which confirms the robustness of the model results. Second, each outcome variable showed the largest fault effect when the bandwidth was one quarter; that is, the negative impact of the epidemic on enterprises reached its peak in the first quarter, resulting in a U-shaped relationship between the coefficient and the bandwidth. When the bandwidth is less than 1 quarter, the coefficient increases with the decrease in bandwidth. If the bandwidth is higher than 1 quarter, the coefficient increases with the increase in bandwidth. Finally, when the bandwidth was increased to 5 quarters, except for the net profit on sales and year-on-year growth rate of operating income, the remaining outcome variables were all reduced by more than 50% due to the negative impact of the epidemic, among which the year-on-year growth rate of net profit and the number of R&D patents were reduced the most, reaching more than 70%.

6. Heterogeneity Analysis of the Survival Resilience of Chinese Enterprises

In this part, we test the hypothesis (H^2) by constructing an SRD model several times. On the one hand, we measure the difference in survival resilience between state-owned enterprises and

non-state-owned enterprises. On the other hand, according to the industry to which the enterprises belong, the industry heterogeneity of the survival resilience of enterprises under the shock of the novel coronavirus epidemic is measured.

(1) The Heterogeneity Analysis of Survival Resilience Between State-Owned Enterprises and Non-State-Owned Enterprises

$$y_{it} = \alpha_3 + \beta_3 D_{it} + Y_3 x_{it} + \varphi_3 cov(\{\ln hc, lnem, lnta\}) + E_3 v_i + \sigma_{it} \quad (2.3)$$

By taking lnse, the covariate in equation (2), as the grouping variable of the sample, equation (2.3) is formed to measure the difference in survival resilience between state-owned enterprises and non-state-owned enterprises.

Table 9. SRD Results of Soes and non-Soes

Variables	SOE				non-SOE			
	coefficient	se	N	cov	coefficient	se	N	cov
SRD Model Results with Bandwidth for 1 Quarter								
lnroe	-1.4740***	0.1036	30,456	Yes	-1.1779***	0.0406	73,920	Yes
lnroa	-1.3649***	0.0779	30,456	Yes	-1.1010***	0.0610	73,920	Yes
lnnpm	-0.9526***	0.1265	30,456	Yes	-0.7051***	0.0546	73,920	Yes
lnito	-1.2783***	0.0841	28,944	Yes	-0.8391***	0.0253	72,576	Yes
lnbiyoy	-2.4592***	0.1790	30,456	Yes	-2.0642***	0.1139	73,920	Yes
lnnpyoy	-2.3133***	0.2210	30,456	Yes	-1.8899***	0.1641	73,920	Yes
lnzl	-2.1868***	0.1117	27,072	Yes	-1.8190***	0.0474	70,944	Yes
SRD Model Results for 5 Quarters of Bandwidth								
lnroe	-0.6355***	0.0372	30,456	Yes	-0.7271***	0.0314	73,920	Yes
lnroa	-0.5495***	0.0264	30,456	Yes	-0.4534***	0.0222	73,920	Yes
lnnpm	-0.5814***	0.0518	30,456	Yes	-0.5990***	0.0448	73,920	Yes
lnito	-0.4507***	0.0308	28,944	Yes	-0.5787***	0.0214	72,576	Yes
lnbiyoy	-1.3105***	0.0721	30,456	Yes	-1.3548***	0.0458	73,920	Yes
lnnpyoy	-0.4380***	0.0929	30,456	Yes	-0.8503***	0.0682	73,920	Yes
lnzl	-0.5549***	0.0394	27,072	Yes	-0.5600***	0.0194	70,944	Yes

Note: ***, ** and * represent a significance level of 1%, 5% and 10% respectively, “cov” represents the covariate, the same as below.

As shown in Table 9, at a significance level of 1%, there is a difference in the index coefficient between state-owned enterprises and non-state-owned enterprises, indicating heterogeneity in the survival resilience of enterprises of different natures.

In the short term, with 1 quarter as the bandwidth, the survival resilience of state-owned enterprises is lower than that of non-state-owned enterprises. There are two main reasons for this: first, the business strategy of state-owned enterprises needs to consider multiple external factors, and many state-owned enterprises, due to the special nature of their industries and considerations for maintaining national economic stability, will abandon decisions that are most beneficial to their economic interests; Second, as the non-profit nature of state-owned enterprises does not allow

the price of their products to fluctuate too much, we need to take into account the responsibility of price stability. Therefore, at the initial stage of the epidemic shock, as shown in Table 9, state-owned enterprises faced more serious challenges than non-state-owned enterprises, both in terms of resistance and prevention, and in terms of growth and innovation.

In the long-term bandwidth of 5 quarters, the survival resilience of state-owned enterprises is generally higher than that of non-state-owned enterprises. With the change in the epidemic, when the bandwidth increased to 5 quarters, as shown in Table 9, due to the shock of the epidemic, the absolute value of the survival resilience index coefficient of state-owned enterprises, except for the return on total assets, was lower than that of non-state-owned enterprises. Especially in the year-on-year growth rate of net profit, the absolute value of the coefficient of state-owned enterprises was 0.4123 lower than that of non-state-owned enterprises.

On the one hand, from the perspective of internal reasons: First, regarding enterprise scale and financial strength, state-owned enterprises are generally large in scale, and relatively abundant in funds which the government guarantees; Non-state-owned enterprises are smaller, more exposed to market fluctuations and have less stable sources of capital. Second, regarding the industry position of the enterprise, state-owned enterprises are generally in the upper reaches of the industry, while non-state-owned enterprises are mostly in the lower reaches of the industry which have been more affected by fluctuations in market demand in the middle and later stages of the epidemic.

On the other hand, from the external reasons: First, regarding the difference in the efficiency of government support, the government has issued corresponding policies to increase support for enterprises, which has eased the difficulties they face, but on the whole, government support for state-owned enterprises is more direct and efficient than that for non-state-owned enterprises. Second, the chain reaction caused by the shock of the epidemic has made it difficult for market demand to recover, and because non-state-owned enterprises are more dependent on market demand, this has made it more difficult for them to reverse their losses.

(2) Industry Heterogeneity Analysis of Enterprise Survival Resilience

Table 10. Heterogeneity Results of Different Industries Based on SRD Model

lnroe	*lnroa*	*lnnpm*	*lnito*	*lnbiyoy*	*lnnpyoy*	*lnzl*
(Number of enterprises =124) **A. Electricity, Heat, Gas and Fisheries and Supply Industries**						
-1.1592***	-1.3248***	-0.1394	-1.4218***	-2.1139***	-2.0496***	-1.6017***
(0.2974)	(0.2089)	(0.2638)	(0.2830)	(0.3775)	(0.5037)	(0.3142)
(Number of enterprises =104) **B. Real Estate**						
-1.9794***	-1.4963***	-1.4477***	-0.3680**	-2.5073***	-1.8447***	-0.5476**
(0.2973)	(0.0864)	(0.3414)	(0.1576)	(0.4171)	(0.5204)	(0.2705)
(Number of businesses =103) **C. Construction**						
-1.3959***	-1.1042***	-0.6860**	-1.1355***	-2.6097***	-2.3054**	-2.3328***
(0.3225)	(0.2460)	(0.2684)	(0.1715)	(0.4262)	(0.5416)	(0.2561)
(Number of businesses =100) **D. Transportation, Warehousing, and Postal Services**						
-1.9569***	-1.6601***	-1.7659***	-1.5222**	-2.6675***	-2.8233***	-1.3343***
(0.2528)	(0.2038)	(0.3247)	(0.3776)	(0.3997)	(0.5731)	(0.3439)
(Number of enterprises =113) **E. Financial Industry**						
-1.0930***	-0.4775***	0.0321	-0.1692	-2.1131***	-2.5196***	-0.2986
(0.1451)	(0.1669)	(0.2243)	(0.2328)	(0.3625)	(0.6643)	(0.3288)

(Number of enterprises =47) **F. Agriculture, Forestry, Animal Husbandry, Fishery**						
-0.7016	-0.6559	0.0789	-0.9525***	-1.4676**	-1.1166	-1.4287***
(0.6587)	(0.4169)	(0.5975)	(0.1509)	(0.5939)	(1.0604)	(0.4039)
(Number of businesses =172) **G. Wholesale and Retail**						
-1.2812***	-1.2661***	-0.5676**	-1.3916***	-2.1726***	-2.2445***	-0.9481***
(0.2546)	(0.2149)	(0.2233)	(0.1439)	(0.5011)	(0.4466)	(0.3125)
(Number of enterprises =85) **H. Water Conservancy Environment and Public Facilities Management**						
-1.9336***	-1.5408***	-2.1018***	-1.1052***	-2.3494***	-1.8939***	-1.4819***
(0.3317)	(0.2557)	(0.4283)	(0.2512)	(0.4473)	(0.5817)	(0.3243)
(Number of enterprises =12) **I. Health and Social Work**						
-0.2790	-0.1135	-0.2217	-1.5385***	-2.3761**	-2.6651	-1.0059*
(0.9457)	(0.8964)	(1.1329)	(0.3722)	(1.1513)	(1.7239)	(0.6116)
(Number of businesses =58) **J. Culture, Sports and Entertainment**						
-1.1422***	-0.5391	-1.3198***	-1.3904***	-2.1729***	-2.8101***	-1.6976***
(0.4025)	(0.5657)	(0.5121)	(0.3478)	(0.5327)	(0.6933)	(0.4366)
(Number of firms =344) **K. Information Transmission, Software and Information Technology Services**						
-1.1473***	-1.2318***	-1.3563***	-1.3569***	-2.2686***	-2.3453***	-2.0259***
(0.2028)	(0.1972)	(0.2802)	(0.2098)	(0.3458)	(0.3974)	(0.1125)
(Number of firms =2843) **L. Manufacturing**						
-1.4515***	-1.3071***	-0.8432***	-1.3119***	-2.1283***	-1.8140***	-1.9536***
(0.0402)	(0.0604)	(0.0531)	(0.0275)	(0.1164)	(0.1707)	(0.0429)
(Number of businesses =8) **M. Accommodation and Catering**						
-2.1537***	-2.0313**	-2.7814***	-0.5329	-2.7147***	-2.7303**	-0.4259*
(0.4506)	(0.3799)	(0.6530)	(0.6658)	(1.0251)	(1.3383)	(0.2201)
(Number of businesses =61) **N. Leasing and Business Services**						
-1.5189***	-1.5206***	-0.8107*	-1.2851**	-1.6359***	-3.8158***	-1.4867***
(0.3954)	(0.3511)	(0.4437)	(0.5476)	(0.5526)	(0.8235)	(0.4215)

Note: ***, ** and * represent a significance level of 1%, 5% and 10% respectively, “cov” represents the covariate, the same as below.

According to the industry classification of China’s national economy, this paper conducted an SRD model regression for 14 industries respectively, and the results are shown in Table 10: the significance indicators and the significance level of the indicators are different in different industries. In other words, the impact of the epidemic shock on the survival resilience of Chinese enterprises has industry heterogeneity. Among them, the coefficients of individual indicators of the agriculture, forestry, animal husbandry, and fisheries industry (F) and financial industry (E) are even positive, indicating that the survival resilience of enterprises in these two industries is relatively lightly affected by the epidemic. Table 11 shows this conclusion more directly by ranking the impact of the survival resilience indicators of different industries.

Table 11. Ranking of the Impact of the Survival Resilience Indicators

Industries	Stability (Ability to Resist and Defend)				Development (Ability to Grow and Innovate)		
	lnroe	*lnroa*	*lnnpm*	*lnito*	*lnbiyoy*	*lnnpyoy*	*lnzl*
First Level: Heaviest Impact							
D	3	2	3	2	2	2	9
M	1	1	1	12	1	4	13
H	4	3	2	10	6	11	7
N	5	4	8	8	13	1	6
Second Level: Heavier Impact							
K	10	9	5	6	7	7	2
C	7	10	9	9	3	8	1
J	11	12	6	5	8	3	4
B	2	5	4	13	4	12	12
L	6	7	7	7	10	13	3
Third Level: Lighter Impact							
A	9	6	12	3	11	10	5
G	8	8	10	4	9	9	11
I	14	14	11	1	5	5	10
Fourth Level: Lightest Impact							
E	12	13	13	14	12	6	14
F	13	11	14	11	14	14	8

In Table 11, the higher the serial number, the greater the adverse impact of the epidemic on a particular indicator in the industry, and vice versa. However, it should be noted that the lower ranking of the industry does not mean that the industry is not affected by the epidemic. The ranking of the survival resilience of the 14 industries is only conducive to the classification and comparative analysis of different industries. According to the average ranking of the index coefficients of each industry, the impact of the survival resilience of enterprises in each industry can be classified into four levels: the heaviest impact, the heavier impact, the lighter impact and the lightest impact.

1) Industries that have been Relatively the Most Heavily Impacted by the Epidemic

The survival resilience of enterprises in transportation, warehousing and postal services (D), the accommodation and catering industries (M), water, environment and public facilities management (H), and leasing and business services (N) were the most heavily affected by the epidemic. What these sectors have in common is their heavy reliance on offline human traffic. Therefore, after the outbreak of the epidemic, due to the transmission of virus infection and regional epidemic prevention and control, it directly led to a sharp decline in the offline human flow of transportation, goods transportation, accommodation, store operation, scenic spots' tourism, etc., and the stability and development indicators of enterprises were generally greatly affected, causing the survival resilience of enterprises in these industries to be severely hit. Among them, for the water, environment and public facilities management industry, many scenic spots stopped business when the epidemic was severe, and the passenger flow once hit a record low. In addition, other branches of the industry are often non-profit, and originally have a low revenue base and weak ability to resist and prevent the shock of the epidemic, so their survival resilience was seriously affected by the epidemic.

2) Industries that have been Relatively Heavily Impacted by the Epidemic

The survival resilience of enterprises in the information transmission, software and information technology services industries (K), the construction industry (C), culture, sports and entertainment (J), real estate (B), and manufacturing (L) were heavily impacted by the epidemic. Among them, the construction industry, culture, sports and entertainment industry, real estate industry and manufacturing industry are more sensitive to market demand. In the first quarter of 2020, China's GDP once recorded negative growth, which confirmed the sluggish market demand in China at that time. First of all, due to the impact of the novel coronavirus epidemic, the normal operating hours of companies have been shortened, and the attendance rate of residents has declined, resulting in a decline in residents' income and the uncertainty of their future income. Coupled with the great restriction on people's offline activities, this will largely curb residents' demand for culture, sports, entertainment and house purchase. The real estate industry has been greatly affected by the decline in residents' demand for house purchase. The breakpoint effect strength of the index coefficients of return on equity, return on total assets and net profit rate on sales ranks among the top five in the industry, indicating that the stability of the survival resilience of real estate enterprises is weak. Secondly, the construction industry is closely related to the real estate industry. Influenced by the transmission of the latter, the operating income growth rate of the construction industry has decreased significantly. At the same time, the number of research and development patents has declined significantly, indicating that the growth and innovation ability of the construction industry has also been greatly affected by the epidemic. Third, the epidemic led to a brief recession of the global economy, production disruption, and supply chain disruption, and the downstream market demand was significantly reduced, leading directly to a serious adverse impact on the development of the manufacturing industry, while its research and development capacity is also significantly limited. Finally, the impact of the epidemic on the software and information service industry is more like a double-edged sword. Although the model results show that the epidemic has impacted its stability and development in a short period of time, especially its research and development capacity has been greatly challenged, it has maintained a positive development trend in the post-epidemic era and has continuously expanded its market area by combining with other industries.

3) Industries that have been Relatively Lightly Impacted by the Epidemic

The survival resilience of enterprises in the electricity, heat, gas and fisheries and supply industries (A), wholesale and retail industries (G), and health and social work (I) were less affected by the pandemic. First of all, although the epidemic has affected the demand of energy markets such as electricity, heat, gas and water services, it is related to the national economy and people's livelihood, with the basic minimum demand, coupled with the supporting role of many state-owned enterprises in the industry, so that although the inventory turnover rate is greatly affected in a short period of time, the overall impact of the epidemic is relatively light. Secondly, for the wholesale and retail industry, although the model results show that the listed companies in the industry are generally less affected by the epidemic, the inventory turnover rate has been severely impacted by the epidemic, which could be a fatal blow to small wholesalers and retailers. Finally, during the epidemic period, the demand for the health and social work industry increased significantly, especially for the relevant drugs and supplies for epidemic protection, so the overall impact of the epidemic was light. But in the early stage of the outbreak, in the face of surging demand, the supply capacity was temporarily insufficient, resulting in a sharp decline in inventory turnover, which impacted the stability of the industry in a short period of time.

4) Industries that have been Relatively the Most Lightly Impacted by the Epidemic

The financial industry (E), and the agriculture, forestry, animal husbandry and fishery industries (F) were the least affected by the pandemic. On the one hand, from the perspective of model data, the return on equity, return on total assets, year-on-year growth rate of operating income and net profit of the financial industry have been significantly affected due to the epidemic, but the development of online business and the joint development of online and offline services make the financial industry less affected by the epidemic in the short term than most other real industries. On the other hand, agriculture, forestry, animal husbandry and fishery are important supply industries for people's daily necessities. Even if people's purchasing power is reduced due to various factors of the epidemic, the demand for these industries is unlikely to change very much. In addition, in order to maintain social stability and improve residents' confidence in fighting the epidemic, the government will try its best to ensure the normal operation of this industry. Therefore, this industry is the least affected by the epidemic compared with all other industries.

7. Conclusion and Suggestions

By constructing the index system of survival resilience of enterprise, this paper selects the sample data of China's A-share listed companies from the first quarter of 2017 to the fourth quarter of 2022, takes the first quarter of 2020 as an accurate breakpoint, and constructs an accurate breakpoint regression (SRD) model to measure the impact of the epidemic shock on the survival resilience of Chinese enterprises and the heterogeneity of industries and enterprises of different natures. The model results show that the COVID-19 shock has a significant impact on the survival resilience of Chinese enterprises, and there is heterogeneity among different natures of enterprises and different industries. Among them, for enterprises of different natures, the survival resilience of state-owned enterprises is weaker than that of non-state-owned enterprises in the short term, but the survival resilience of state-owned enterprises is stronger than non-state-owned enterprises in the long term. For enterprises in different industries, according to the impact of the epidemic, this paper divides different industries into four levels: the heaviest impacted, the heavier impacted, the lighter impacted and the lightest impacted. Among them, transportation, warehousing and postal services are the worst hit by the outbreak, while agriculture, forestry, animal husbandry and fisheries are impacted by the outbreak the least. Based on the above results, this paper proposes the following suggestions: Firstly, while safeguarding the overall interests of the national economy, state-owned enterprises can further enhance their ability and efficiency in handling public health emergencies in the short term by strengthening the linkage between the government and enterprises, improving digitalization, and establishing mixed ownership enterprises. Secondly, private enterprises can further increase their asset size and the stability of their funding sources through strategic investments and effective financing. At the same time, it is necessary to enhance information sharing between industrial chains. Upstream enterprises should transmit their business status, inventory turnover, and other information to their downstream enterprises in a timely fashion, while downstream enterprises should promptly provide feedback to their upstream enterprises on market supply and demand changes and whether there are new consumption hotspots, ensuring the smooth operation of the entire industrial chain. Thirdly, it is necessary to improve the cost-controllability of transportation, warehousing, postal services, accommodation, catering and other industries that have been seriously impacted by COVID-19. For example, by building a shared employee platform, the flexibility of enterprise employment can be improved, thereby reducing employee costs; the catering industry can flexibly provide food delivery services based on government control measures

and sign additional leasing agreements applicable to "special periods" such as during the impact of the epidemic, when leasing long-term contracts for storefronts, in order to regulate excessive rents.

Finally, the research samples in this paper are A-share listed companies in Shanghai and Shenzhen, and there is a lack of data samples from small and medium-sized enterprises. Due to the differences in individual characteristics between large, listed companies and small and medium-sized enterprises, the measurement of the survival resilience of small and medium-sized enterprises needs to be further studied.

References

Baker, S. R., R. A. Farrokhnia, S. Meyer, M. Pagel, and C. Yannelis. 2020. Income, Liquidity, and the Consumption Response to the 2020 Economic Stimulus Payments. *National Bureau of Economic Research*, No. 27097.

Fan, Zhuoni, Changyan Liu, and Weijia You. 2023. 新冠肺炎疫情对我国涉林上市公司经营绩效的影响研究－基于断点回归和文本挖掘的实证分析 (The Impact of the Novel Coronavirus Epidemic on the Business Performance of China's Forest-related Listed Companies: An Empirical Analysis Based on Breakpoint Regression and Text Mining). *Journal of Beijing Forestry University (Social Science Edition)*, 1–8. (in Chinese)

Fang, H., L. Wang, and Y. Yang. 2020. Human Mobility Restrictions and the Spread of the Novel Coronavirus (2019-nCoV) in China. *Journal of Public Economics*, 191, 104272.

Gunderson, L. H., L. Pritchard, C. S. Holling, C. Folke, and G. Peterson. 2002. A Summary and Synthesis of Resilience in Large-Scale Systems. *Scope: Scientific Committee on Problems of the Environment International Council of Scientific Unions*, (60), 249–266.

Li, Yizhen, Minzhi Liu, and Yaxin Liu. 2020. 重大突发公共卫生事件对宏观经济的冲击影响研究——基于供给侧和需求侧的实证分析 (Major Public Health Emergencies of Macro Economic Impact Study, Based on an Empirical Analysis on the Supply Side and Demand Side). *China Statistical Education Society*, 27. (in Chinese)

Liang, Xiangdong, Zhong Ming Jing, and Ferlin Chen. 2022. 制度异质性、外生冲击与对外贸易结构——基于断点回归的短期与长期判断 (Institutional Heterogeneity, Exogenous Impact and Foreign Trade Structure: Short-term and Long-term Judgment Based on Breakpoint Regression). *The Theory and Practice of Finance and Economics*, 43(02), 58–66. (in Chinese)

Lin, Yifu, Yan Shen, and Ang Sun. 2020. 中国政府消费券政策的经济效应 (The Economic Effect of the Chinese Government's Consumption Voucher Policy). *Beijing: Economic Research Journal*, (7), 4–20. (in Chinese)

Lu, Rong, Longbing Xu, Qianqian Ye, and Tingting Hai. 2021. 中国民营企业韧性测度与影响因素研究 (Study on Resilience Measurement and Influencing Factors of Chinese Private Enterprises). *Beijing: Business Management Journal*, (8), 56–73. (in Chinese)

Ma, Jinhua and Jiyun Zhang. 2020. 重大突发公共卫生事件冲击下我国口罩资源应急配置问题研究——以"新冠肺炎"疫情防控为例 (Research on Emergency Allocation of Mask Resources in China under the Impact of Major Public Health Emergencies: A Case Study of COVID-19 Prevention and Control). *Journal of Shandong University of Finance and Economics*, 32(03), 67–80. (in Chinese)

Sajko, M., C. Boone and T. Buyl. 2021. CEO Greed, Corporate Social Responsibility, and Organizational Resilience to Systemic Shocks. *Journal of Management*, 47(4), 957–992.

Sheng, Fangfu and Zhimeng Li. 2020. 重大突发公共卫生事件对经济的冲击、传导及其应对——以新冠肺炎疫情为例 (Impact, Transmission and Response of Major Public Health Emergencies on Economy: A Case Study of COVID-19). *Enterprise Economy*, (03), 12–20. (in Chinese)

Shi, Dan and Shaolin Li. 2022. 新冠肺炎疫情冲击下企业生存韧性研究——来自中国上市公司的证据 (Study on the Survival Resilience of Enterprises under the Impact of COVID-19: Evidence from Chinese Listed Companies). *Business Management Journal*, 44(01), 5-26. (in Chinese)

Sun, Guanlong. 2004. 中国历史大疫的时空分布及其规律研究 (Study on Spatial and Temporal Distribution and Regularity of Historical Epidemics in China). *Areal Research and Development*, (06), 123–128. (in Chinese)

Sun, Xiaohua and Yu Zhai. 2021. 盈利能力影响企业研发决策吗？——来自中国制造业上市公司的经验证据 (Does Profitability Influence Enterprises' R&D Decisions? Empirical Evidence from Listed Manufacturing Companies in China). *Management Review*, 33(07), 68–80. (in Chinese)

Yang, Zihui, Yutian Chen, and Pingmiao Zhang. 2019. 重大突发公共事件下的宏观经济冲击、金融风险传导与治理应对 (Macroeconomic Impact, Financial Risk Transmission and Governance Response under Major Public Emergencies). *Management World*, 36(05), 13–35+7. (in Chinese)

Zhang, Youguo, Bowen Sun, and Rui Xie. 2021. 新冠肺炎疫情的经济影响分解与对策研究 (Analysis of the Economic Impact of COVID-19 and Countermeasures). *Beijing: Statistical Research*, (8), 68–82. (in Chinese)

Zhu, Zhe and Zongchao Peng. 2020. 突发公共卫生事件中的政府角色厘定：挑战和对策 (Study of the Government's Role in Public Health Emergencies: Challenges and Countermeasures). *Southeast Academic Research*, (02), 11–17. (in Chinese)