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# The Chinese zombie firm: dilemma and resolution

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## ABSTRACT

The problems of over-capacity of zombie firms in China have attracted much attention. However, little is known theoretically, and even less empirically, about the boundaries and causes of zombie enterprises. This article extends a model to identify the characteristics of zombie firms in consideration of supply-side structural reform in China. We focus on the cause of zombie firms under the background of the ‘de-capacity’ strategy in China. Using a sample of Chinese listed companies over the period 2006–2018, we find that the proportion of zombie firms in the manufacturing industry declined significantly due to expansionary fiscal policy in 2011. Moreover, the structure of ownership, operational capabilities, and debt-paying ability co-varies positively, with state-owned enterprises being most prone to becoming zombie firms. The results allow us to construct various insights into how to govern the zombie firm. These results offer a frame for dealing with zombie firms. Our results are also robust in the sensitivity test of changing the measurement of zombie firms.

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Zombie firm; corporate governance; supply-side structural reform; state-owned enterprise; financing policy—Financial Risk and Risk Management—Capital and Ownership Structure—Value of Firms—Goodwill; Bankruptcy—Liquidation; Government Policy and Regulation

## JEL CLASSIFICATION

D21; D61; M13; M21

## 1. Introduction

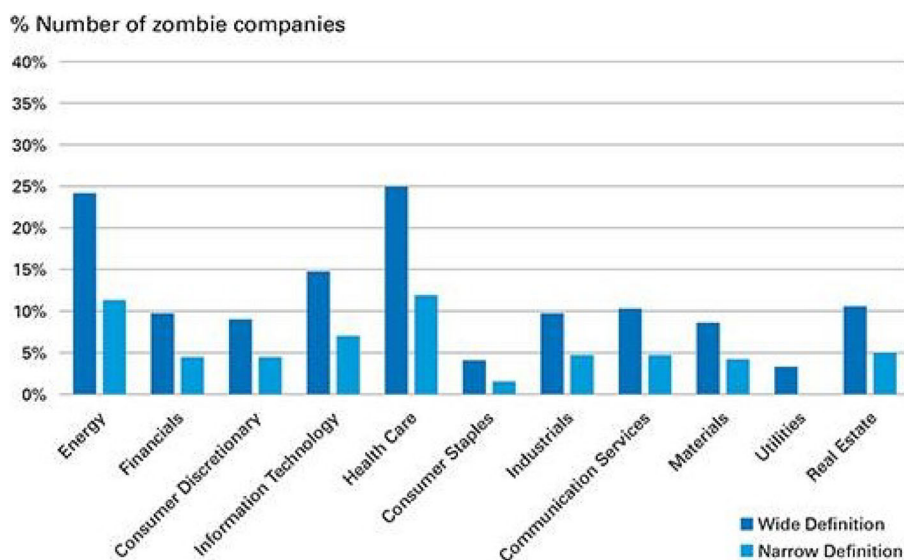
The 2019 Global Innovation Index reports released by the World Intellectual Property Organization (WIPO) ranks China 14th, which is clearly out of proportion to China’s status as second largest economy in the world. Therefore, in response to the changes of current events, it is appropriate to highlight the status of China as an important node in the global industrial chain, reflecting the transformation of China’s economy from ‘Made in China’ to ‘Quality in China’.

The rise in the number of zombie firms over the past decade has been precipitated by an unprecedented set of economic circumstances. In other words, zombie firms are pervading the real economy. The persistence of zero percent interest rates has allowed fully-fledged zombie firms to become a fixture of the US economy. The rise of zombie firms in Europe also spells trouble ahead, as shown in [Figure 1](#). The so-

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**Figure 1.** Concentration of listed zombie firms in EU sectors.

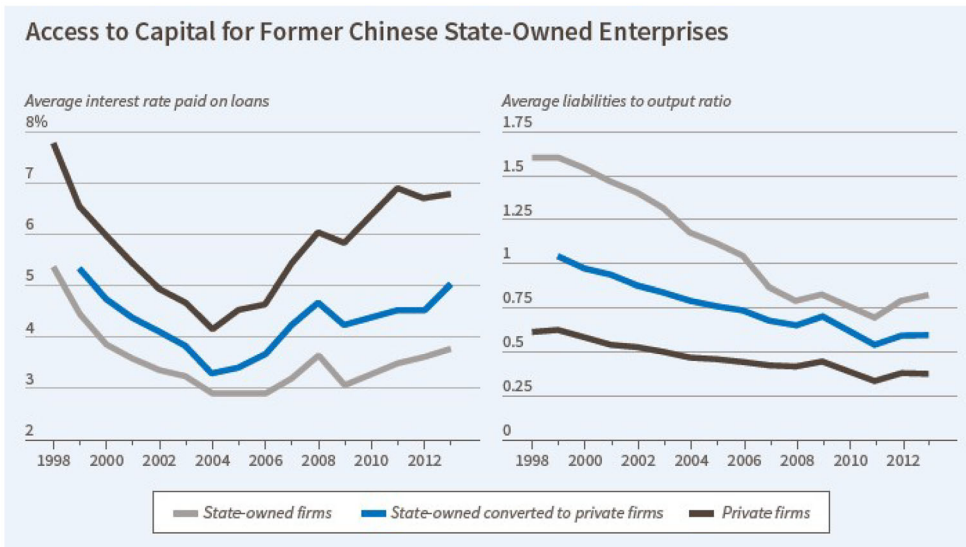
Source: Euronext, Refinitiv data and KPMG analysis

called zombie firm is generally defined as a firm under sustained financial strain because of low efficiency and profitability, but surviving with external support from the government or bank—instead of pursuing restructuring or bankruptcy (Kane, 1987; Dewenter & Malatesta, 2006). In the real economy, it seemed almost straightforward: If a central bank could lower the cost of debt and equity closer and closer to zero, then inevitably the private sector would take the bait—investing in cheap plant + equipment, technology, and innovation (Caballero et al., 2008).

Besides limiting the expansion possibilities of healthy incumbent firms, market congestion generated by zombie firms can also create barriers to entry. In this sense, the zombie firm is a going concern but fundamentally broken. There is a chance that the zombie firm could restructure and save its business. Since the 2008 recession, the US government also offered a subsidy to General Motors—which helped it to survive its near bankruptcy in the 2009 recession. For instance, some banks continue to provide credit to troubled borrowers, and state-owned enterprises (SOEs), which are known as zombie firms, also occupied the middle ground with respect to government loans, which is shown in Figure 2.

As productivity has slowed down in the post-crisis era, a large number of zombie firms with over-capacity have proven unproductive, obstructing the rest of the economy through resource misallocation (Yuyan et al., 2016). In this scenario, one source of concern is that firms would normally exit the market under fiscal or monetary policies that would reduce policy-induced exit barriers, generate growth, and fulfil growth targets. However, macro-stimulus is fast-acting while structural reforms are slower in implementation. They are also probably symptomatic of structural policy weaknesses, particularly with respect to insolvency regimes.

This article discusses the following questions through both theoretical and empirical research with the background of supply-side structural reform in China. The marginal contributes to the existing literature in two ways. First, we develop the



**Figure 2.** Access to capital for former Chinese state-owned enterprises.  
Source: Researchers' calculations from the NBSC and the Dios Database

methodology to characterise zombie firms existing in China and to evaluate the scale of their assets. Using panel data of industrial firms in China, we find robust empirical evidence that zombie firms have lower performance than non-zombie (viable) firms. Second, we also provide a mechanism to analyse the causes and consequences of zombie firms. As part of this process, we prove that the identification and classification of zombie firms can be rigorous. Exploring the causes of zombie firms in the context of supply-side structural reforms based on the evidence of industrial firms in China and proposing governance strategies, we offer a comprehensive proposal to determine zombie firms by combining the three aspects of firms' behaviour, governmental activities, and bank behaviour. There are a few policy implications from the findings aiming to improve sustainable economic development in China.

The remainder of this article is organised as follows: [Section 2](#) provides a review of the previous literature; [Section 3](#) presents the methodology and hypothesis; [Section 4](#) specifies data and empirical result; [Section 5](#) provides discussion and conclusions.

## 2. Theoretical background

According to the American Savings Loan Association, a firm went into bankruptcy proceedings during the US deposit and loan crisis in the late 1980s, as a 'zombie storage organization' (Kane, 1987). This was apparently the origin of the term. After the Japanese asset bubble burst in the early 1990s, the term was further used to describe firms that could not continue to operate normally and would in normal circumstance go bankrupt but were prevented from doing so through borrowing or government funding. The American academic community believes that zombie firms have three characteristics: One is that they need help to survive; the second is that they are losing

money and are heavily in debt. Production income can only repay their debt interest and cannot repay the debt itself. Third, they are unable to attract investment to grow.

Most studies judge zombie firms from the perspective of corporate liabilities, the ability of firms to maintain normal operations and to pay debts. Hoshi (2006) pointed out that ‘zombie firms’ refers to firms that would be eliminated by the market under normal circumstances, but persist because of help from creditors. (Yinan & Wei, 2016) pointed out that zombie firms that are not competitive and profitable, inefficiently occupy resources and rely entirely on government blood transfusion and bank loans to survive, continue to lose for more than three years and do not meet structural adjustments’. Through a survey of academic discussions on zombie firms, Bing (2016) came up with a clear and unified concept, i.e., the zombie firm is a liability firm that has lost its ability to develop itself, has weak market competitiveness and is dependent on government subsidies or bank lending to survive (Bing, 2016). Its external performance shows a long-term loss and its own turnaround is hopeless. Its essence is as a firm that accepts a large amount of investment but is inefficient and occupies social resources but does not produce economic benefits.

To sum up the foregoing, little is known theoretically, and less empirically, about the boundaries and causes of zombie firms. In this article, we interpret the zombie firm as an inefficient firm that suffers long-term losses, lacks normal operational capability solvency, and depends on government subsidies and bank lending to maintain a basic level of survival. The view that zombie firms are inherently less efficient than private ones, however, remains controversial among economists.

### **2.1. Identification of zombie firm**

The identification of a zombie firm depends on its essential characteristics, in which, the CHK method and the FN method are more popular. However, the recognised standards of zombie firms in theoretical have not yet reached a unified conclusion for use in research and policy. The existing literature tends to focus on the economic environment and emphasises that the zombie firms, which rely on external ‘blood transfusion’ funding to survive, are inefficient. Although combination methods have been developed, we are further aware of the unique political and cultural climate in China, especially the deep processing of supply-side structural reform, should be taken into account. For instance, according to the regulations of the China Securities Regulatory Commission, listed companies that have suffered losses for three consecutive years will be suspended. Therefore, to investigate and prescribe the governance of zombie firms, it is critical to identify those firms that can be categorised as zombies.

The basic feature of zombie firms are credit assistance with direct bank interest rate subsidies, where interest expenses are lower than those extended to healthy firms (Caballero et al., 2008). Therefore, identifying zombie firms can be realised by calculating the firm’s interest rate gap, referred to as the ‘CHK’ strategy, which identifies the optimal interest rate and compares the optimal interest rate with the interest rate actually paid by the firms, i.e.,

$$R_{i,t}^* = rs_{t-1}BS_{i,t-1} + \left( \frac{1}{5} \sum_{j=1}^5 rl_{i-j} \right) \times BL_{i,t-1} + rcb_{\text{minoverlast5years}} \times Bonds_{i,t-1} \quad (1)$$

where *BS* and *BL* represent the short-term and long-term bank loan balance, respectively. The outstanding bond balance at the end of the year;  $rs_{t-1}$ ,  $rl_{t-j}$  and  $rcb_{\text{minoverlast5years}}$  represent the lowest short-term borrowing rate of t-1 year, the lowest long-term borrowing rate and the lowest convertible bond rate from t-5 to t-1 year, respectively.

According to the CHK standard, Fukuda and Nakamura (2011) (Bing, 2016) believe that healthy firms may be mistakenly identified as zombie firm, or non-healthy firms may be identified as healthy ones. For example, there are some healthy firms whose interest rates are lower than the main loan rates and the bank allows for interest deductions for troubled lenders. In order to avoid the identification error, they introduced additional standards for defining zombie firms, identified the misidentified healthy firms through ‘profitability standards’ and used continuous credit standards to correct them, thereby increasing the accuracy of zombie firm identification. This is referred to as the ‘FN’ method.

It has also been proposed by State Council in China that the identification standards for zombie firms and classified firms do not meet national energy consumption, environmental protection, quality, and safety requirements. These firms have continued to lose for more than three years and do not meet the structural adjustment direction, as a zombie firm. Benfei, (2016) made improvements on this basis, and defined the zombie firms as ‘a firm with negative earnings per share for three consecutive years after deducting non-recurring gains and losses’, referred to as ‘actual profit method’.

Fan & He (2016) argue that keeping zombie firms alive with government funds or bank loans prevented the entry of more efficient firms. Historically, banks have played a decisive role in this issue. Therefore, Fan and He (2016) focused on excessive borrowing, in the context of the FN method. Their measurement method identifies as zombie firms those with asset-liability ratios in the top 30%, which are unable to make normal profits and whose borrowing continues to increase. Additionally, by combining the actual profit method with the original CHK, the adjusted CHK strategy was proposed. Shao Qing & Yan (2017) considered government subsidies into the revised FN method within the institutional environment by smoothing the sum of actual profits for several consecutive years for identification (Shao Qing & Yan, 2017). In addition to the previously mentioned methods, ‘the sum of actual profits after deducting various kinds of subsidies is negative for several consecutive years’ was also used to judge zombie firms.

## 2.2. The causes of zombie firm

At present, most of the literature focuses on the role of policymaker in the formation of zombie firms. Banks are encouraged by the policymaker to continue business lending even through an economic downturn. The unreasonable allocation of bank loans

and the fact that banks provide preferential conditions to borrowers in crisis in order to avoid terrible debt losses are important factors in the formation of zombie firms. In this case, lenders are exhibiting greater creditor forbearance and banks have taken a 'wait-and-see' approach to struggling businesses within their portfolios. Since the 1990s in China, policymakers assisted a large number of firms in order to prevent them from failing, which practice should have been eliminated naturally, in order to relieve the pressure of unemployment and fiscal revenue. In addition, the incomplete reform of property rights in SOEs in the 1990s is also considered to be an important reason for the formation of zombie firms in China. Huihua et al. (2016) pointed out that in the post-financial crisis in 2008, the 4 trillion RMB investment plan initiated by the policymaker led to blind expansion, which laid potential opportunities for the emergence of zombie firms.

Inside the firm, empirical findings of low product quality, lack of technological innovation and lack of entrepreneurship are also reasons for naming a zombie firm (Fukuda & Nakamura, 2011). The absence of effective exit mechanism causes a further deterioration of the problem of zombie firms. Hoshi (2006) found that firms with high asset-liability ratios and low-profit margins are more likely to become zombie firms.

### **2.3. The consequences of zombie firm**

The existence of zombie firms will have an important impact on economic development. First, the production efficiency of zombie firms is very low, which affects the average level of social production. Zombie firms have a negative impact on performance, especially for sectors with more job creation opportunities, and the prevalence of zombie firms will greatly reduce productivity (Caballero et al., 2008; Fei & Kunru, 2017). Second, zombie firms can bring mismatches in resources and cause harm to other firms in the industry. The presence of zombie firms has a significant inhibitory effect on the fastest-growing healthy firms. Specifically, the investment in zombie firms has a significant crowding-out effect on private firms. Zombie firms may be one of the potential factors for weak private investment in recent years. The reduction of zombie firms can increase the rate of output growth and employment. Additionally, the credits of zombie firm continue to accumulate, increasing the burden on banks and possibly triggering a serious financial crisis. The increase in bank credit risk will make banks face the possibility of bankruptcy. If the bank has a large-scale bankruptcy, the economy will suffer a major blow, and more firms will be on the verge of bankruptcy, thus forming a vicious circle.

For some of the corporate attributes of zombies, it is an item of faith that SOEs must be less efficient. Lin (1998, 2008) argued that it is precisely since SOEs have undertaken a policy burden, such as solving the employment burden, which is the root cause of their policy support and soft budget constraints (Yifu et al., 1998; Yifu & Zhiyun, 2008).

Since the formation of zombie firms will be different in different countries and regions, there are also major gaps in the governance of zombie firms. Research on zombie firms in the US and Japan found that the government is forced to condone



the bank's misconduct by pressure from employment and other challenges, and that loose regulation induced the formation of zombie firms. In the last decade, Japan had a large burst of bad asset problems because of faulty governance. However, Japan has made remarkable achievements in dealing with zombie firms through developing supporting policies, setting up special institutions, improving relevant laws, establishing a hybrid policy framework and industrial regeneration institutions that have played a significant positive role in dealing with zombie firms after the collapse of Japan's economic bubble. The United States has succeeded in handling the disposal of zombie firms in the automobile industry during the international financial crisis, through the perfection of the bankruptcy laws, the development of a strict reforming process and the help of firms to initiate bankruptcy restructuring. Yujie & Daxian (2017) found that it is necessary to set up an intermediary to help manage zombie firms; and to smooth the delisting mechanism, prompting the collapse of zombie firms in Japan.

Regarding the process of governance of zombie firms, there are roughly two disposal strategies. First, let the zombie firms directly withdraw from the market, thus restoring market order. Second, improve the operation of the zombie firms and restore their vitality. That is, firms vigorously implement restructuring and reduce redundant investment; the government takes decisive action, injects timely capital, and accelerates financial health construction; at the same time eliminates bank concerns about non-performing loans.

### 3. Methodology and data

#### 3.1. Methodology

To investigate the performance of zombie firms, it is critical to first identify those firms that can be categorised as zombies. In this instance, a scoring scheme could be defined in order to ensure a consistent approach in the risk identification throughout the debt universe. Caballero et al. (2008), hereafter CHK, define zombies as those firms whose interest payments are lower than their hypothetical risk free interest payments (Dewenter & Malatestea, 2006). However, it is also a noisy measure of zombies, where both type one and two errors are noteworthy. To avoid these two types of errors, Fukuda and Nakamura (2011), hereafter FN, modify the CHK measure with 'profitability criterion' and 'evergreen lending criterion'. We combine the two criteria of CHK and FN to identify zombie firms (Caballero et al., 2008, Fukuda & Nakamura, 2011).

Step 1: Let any variable  $X_t$  be the value of that quantity at the end of period  $t$ . The minimum required interest payment of firm  $i$  in year  $t$ ,  $RA_{i,t}$  is defined as:

$$RA_{i,t} = rs_{t-1}BS_{i,t-1} + \left( \frac{1}{5} \sum_{j=1}^5 r_{t-j} \right) BL_{i,t-1} \quad (2)$$

where  $BS_{i,t}$  denotes short-term liabilities minus accounts payable, taxes payable, and other payable items to measure the short-term bank debt, and  $BL_{i,t}$  denotes long-



term liabilities.  $rs_t$  and  $rl_t$  are, respectively, the average short-term and long-term prime rate in year  $t$ .

It should be noted that since the liabilities of the payables are business operating liabilities and contribute to the short-term liabilities of the firms that are not required to pay interest, it should be stripped from the short-term liabilities when identifying whether the firm's value is lower than the most favourable interest rate financing in the market. Based on the availability of data, this article utilises short-term borrowing representatives to deduct short-term liabilities including accounts payable, taxes payable, employee benefits payable, and welfare payable. Secondly, according to the regulations of the People's Bank of China, during the period 1998–2011, the lower limit of the floating range of financial institutions' loan interest rates was 0.9 times the benchmark interest rate. Although there were changes in 2002, the lending rate of financial institutions is still basically within 10% of the benchmark interest rate. Therefore, the average short-term and long-term preferential interest rates of the banks represented by A and B, respectively, are 0.9 times the one-year and five-year average long-term benchmark lending rates of the bank.

Step 2: The actual interest payments made by firm  $i$  from bank deposits in year  $t$  is estimated as follows:

$$RB_{i,t} = (AT_{i,t-1} - AR_{i,t-1} - AL_{i,t-1}) \times rd_t \quad (3)$$

where  $AT_{i,t}$ ,  $AR_{i,t}$ ,  $AL_{i,t}$  are firm  $i$ 's liquid assets, accounts receivable, respectively, and inventory for year  $t$ , and  $rd_t$  is the one-year bank deposit rate.

Step 3: Comparing the actual net interest payment of firm  $i$  ( $RC_{i,t}$ ) and the minimum required net interest payment ( $RA_{i,t} - RB_{i,t}$ ). standardising it with loans in the previous period ( $B_{i,t-1} = BS_{i,t-1} + RB_{i,t-1}$ ), the interest rate gap is

$$gap_{i,t} = [RC_{i,t} - (RA_{i,t} - RB_{i,t})]/B_{i,t-1} \quad (4)$$

It should be noted that due to the availability of data, this article replaces the net interest expense ( $FE_{i,t}$ ) with the firm's financial expenses ( $RC_{i,t}$ ). This approach will not miss the zombie firms, but there may be a risk of misclassifying a non-zombie firm as a zombie firm.

Following CHK (2008) (Dewenter & Malatestea, 2006), if  $gap_{i,t} < 0$ , firm  $i$  will receive a subsidy, and its zombie index is 1; otherwise, its zombie index is 0.

Step 4: We might misclassify the non-zombies by their good performance and low-interest cost, because our firm debt information is not very specific. Therefore, we follow Fukuda and Nakamura (2011) (Bing, 2016). Further adjust firms' zombie index based on their profitability: firm  $i$  will be re-classified as a non-zombie if firm  $i$ 's profit is greater than the gap between the minimum required net interest ( $gap_{i,t}^{adj} > 0$ ) and actual net interest payment ( $profit_{i,t} + RC_{i,t} > RA_{i,t} - RB_{i,t}$ ),

$$gap_{i,t}^{adj} = [NAGL_{i,t} - (RA_{i,t} - RB_{i,t})]/B_{i,t-1} \quad (5)$$

**Table 1.** Descriptive statistics.

variable	Obs.	Mean	SD	Min	Max
<i>zombie</i>	3300	0.6312	0.4826	0	1
<i>inventory</i>	3300	12.9286	46.4152	−97	884.6723
<i>accounts</i>	3300	4.6947	23.7780	−97	502.5799
<i>current</i>	3300	169.3132	179.0228	7.4699	2629.9510
<i>cash</i>	3300	24.1429	42.7584	−89.0519	750.1235
<i>soe</i>	3300	0.7285	0.4449	0	1
<i>size</i>	3300	22.2460	1.2514	19.1781	28.0356
<i>Shgle</i>	3300	4.4970	56.9678	0	42.6818

Source: Authors' elaborations.

### 3.2. Variables and data

#### 3.2.1. Description analysis

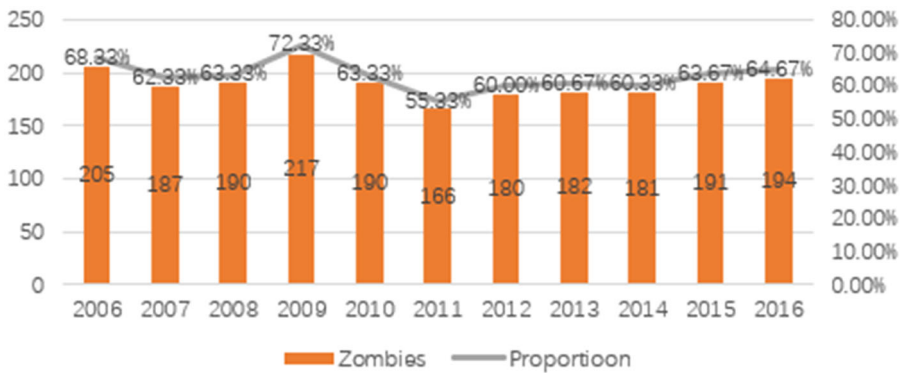
This article investigates the zombie firms of the manufacturing industry over the period 2005–2016 under the background of the ‘de-capacity’ strategy in China. Considering that internal control of firms may have an impact on the formation of zombie firms (Tagesson et al., 2009, Han, 2017), the proportion of shares held by the board of directors is also introduced as a control variable. The definition of the variables and the description of the values are shown below.

- $zombie_{i,t}$ , the dependent variable, represents the existence of a zombie firm, which is identified in the corresponding year of the zombie firms. If the firm  $i$  is identified as a zombie firm in the  $t$ -year, then  $zombie_{i,t}$  takes 1; otherwise, it takes 0.
- The operating capacity of the firms consists of inventory (the ratio of inventory turnover) and accounts (accounts receivable turnover period = 365 days/accounts receivable turnover)
- The solvency of the firms consists of  $current_{i,t}$  (Current ratio = Current assets/current liabilities) and (cash flow ratio = Cash flow/current liabilities from operating activities).
- $size_{i,t}$  is the Logarithm of total assets of a firm  $i$  at the end of the fiscal year.
- $soe_{i,t}$  is a dummy variable taken value 1 for SOEs and 0 for non-SOEs in year  $t$ .
- $Shgle$  represents the board holding ratio which calculated by the proportion of shares held by board members at the end of the year as a percentage of the firm's total shares.

#### 3.2.2. Data and sample

This article covers the listed manufacturing firms in China. The panel data of the sample are obtained from the CCER Economic and Financial database. After removing the missing observations, we obtain 3300 firm-year observations. Following prior literature, all independent variables (except *zombie*) are lagged by one year (Han et al., 2019).

A descriptive analysis for the sample was performed (see Table 1). The average sample firm is 0.63 on the *zombie* dimension, which is basically consistent with the recognition results of the zombie firms in this article. The mean value of inventory is about 12.9, indicating that the operating capacity of listed industrial firms in China is still quite different. The mean values of shareholding ratio are also relatively deconcentrated. According to the mean values of dummy variables such as *zombie* and *soe*,



**Figure 3.** Statistics zombie firm by year.

Source: Authors' elaborations.

Table 1 also shows that 63% of the sample is zombie firms, and 72% of them are effectively controlled by the government.

### 3.3 Preliminary analysis

Adopting the combination identification method, the number of zombie firm is calculated, in which industrial firms represented by mining, manufacturing, electric power, thermal power, gas and water production, and supply industries in the CCER database over the period 2006–2018, as shown in Table 1. Moreover, we also show the proportion of zombie firms by time, industry category, ownership, and region, respectively, in Figure 3.

#### 3.3.1. Time dimension inspection

Since 2004, the state-owned economy has undergone a strategic adjustment, and the reform of SOEs has come to an end. Therefore, this article selects the 2005–2016 data to identify the zombie firms in 2006–2018.

During the period 2006–2011, there was a downward trend in volatility. Table 2 shows that there were 205 zombie firms in 2006, accounting for 68.33% of all sample. In 2007–2008, due to the huge rise in the secondary market, the listed enterprise experienced a wave of large-scale asset restructuring, and the proportion of zombie firms declined significantly. As a result, the performance of a listed enterprise after removing government subsidies has increased significantly. However, due to the impact of the global financial crisis in 2008, the proportion of zombie firms increased significantly in 2009. To protect the steady growth of the macroeconomy, the government has issued a large number of financial subsidies. With the implementation of a 4 trillion RMB economic stimulus plan, the proportion of zombie firms has dropped. However, with the reduction of policy intensity and the slowdown of economic growth in China, the number and proportion of zombie firms have increased again in 2012–2016. The gradient of regional economic development is embodied in the active adjustment of the industrial structure in the developed eastern regions, while the underdeveloped central and western regions continue to invest in surplus industries. The uncoordinated development makes the increased capacity greater than the

**Table 2.** Proportion of zombie firms by year.

Year	Total	Zombies	Proportion (%)
2006	300	205	68.33%
2007	300	187	62.33%
2008	300	190	63.33%
2009	300	217	72.33%
2010	300	190	63.33%
2011	300	166	55.33%
2012	300	180	60.00%
2013	300	182	60.67%
2014	300	181	60.33%
2015	300	191	63.67%
2016	300	194	64.67%
2017	300	181	60.47%
2018	300	180	60.03%
AVE	300		62.68%

Source: Authors' elaborations.

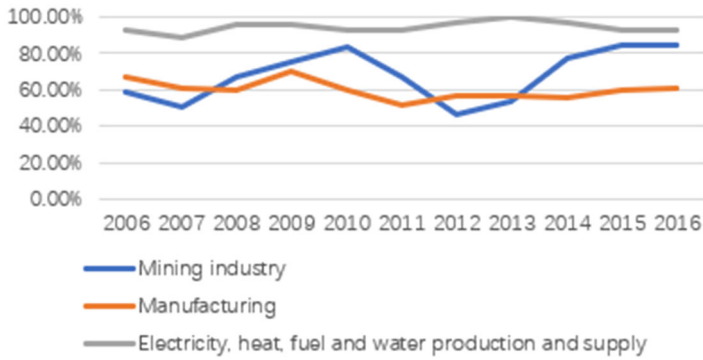
eliminated capacity. After the implementation of supply-side structural reforms in 2015, the proportion of zombie firms increased instead of decreasing significantly.

Although the trend of the proportion of zombie firms identified in this article is consistent with Fei and Kunru, (2017) results, due to the difference in sample data the proportion of zombie firms is quite different from the results she recognises. However, the CHK-FN identification method is based on whether or not a credit subsidy is used to determine whether a firm is a zombie firm. Although this method is not suitable for direct application to Chinese firms, it is helpful to predict the number and proportion of firms that have received credit subsidies. Figure 3 shows that 60% of industrial firms in China can receive credit subsidies. This also reflects the general distortion of credit resource allocation price in one area. According to the statistics of the zombie firms according to the year, it is not difficult to see that the formation trend of zombie firms is closely related to the macroeconomic environment, and the governance needs of zombie firms should be coordinated with the direction of economic development.

### 3.3.2. Industry dimension inspection

The sample in this article is also divided into manufacturing, power, heat, gas, water production and supply industries according to the industry classification of listed firms of the China Securities Regulatory Commission in 2012. Figure 4 shows the proportion of zombie firms in the industrial sector during the 2006–2016 in China.

As the public utility industry is regulated by the government, zombie firms in tap water, heat, gas, water production, and supply account for the largest proportion of the industry. After the end of the short-term stimulus policy, with the second bottom of the macroeconomic situation until 2012, the proportion of zombie firms in the mining industry moved to a higher level again, reflecting the trend of the macroeconomic situation in China. It should be noted that when exploring zombie firms in different industries, special types of firms should also be considered. For example, due to the different effects of public welfare firms and operating firms on social and economic development, different disposal methods should be adopted.



**Figure 4.** Zombie enterprises by industry.

Source: Authors' elaborations

**Table 3.** Statistics of zombie firms by size.

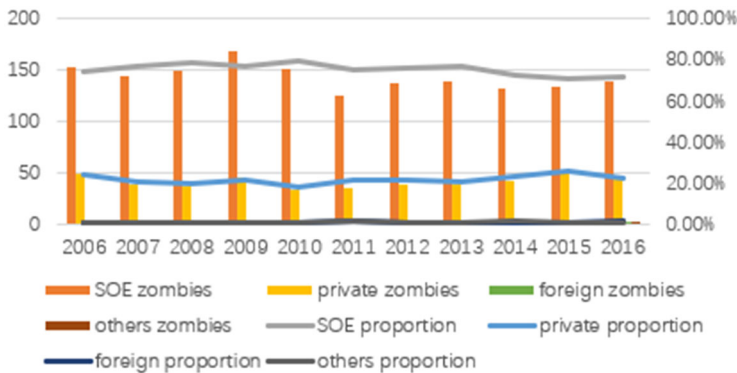
Year	Large industrial firm		Medium-small industrial firm	
	Zombies	Proportion	Zombies	Proportion
2006	205	100.00%	0	0.00%
2007	187	100.00%	0	0.00%
2008	190	100.00%	0	0.00%
2009	217	100.00%	0	0.00%
2010	190	100.00%	0	0.00%
2011	166	100.00%	0	0.00%
2012	178	98.89%	2	1.11%
2013	182	100.00%	0	0.00%
2014	181	100.00%	0	0.00%
2015	191	100.00%	0	0.00%
2016	193	99.48%	1	0.52%

Source: Authors' elaborations.

### 3.3.3. Scale dimension inspection

According to the method of dividing firms into large, medium and small micro-firms issued by the National Bureau of Statistics of China in 2003 and 2011, respectively, the sample industrial firms are classified into following two categories: a large firm with operating income greater than 40 million RMB, otherwise, the firm belongs to small and medium ones. The situation of its zombie firms is shown in Table 3.

It is readily demonstrable that among all the zombie firms that have been identified, the proportion of zombie firms in large firms is the highest since it is generally more difficult for large firms to change their original business directions and their routes. Secondly, large industrial firms provide many jobs. Local governments are more inclined to provide subsidies to large firms aiming for the development of local industrial chains, employment rates and social security and stability. Local governments even put pressure on banks to provide concessional loans for large firms. Additionally, it should be noted that these sample firms are listed industrial firms in China, and the proportion of large firms is larger than originally. Therefore, the probability of zombie firms is higher than that of small and medium-sized firms. It can be seen statistically that large industrial firms are more likely to become zombie firms. We give the following hypothesis:



**Figure 5.** Statistics of Zombie firms by ownership.

Source: Authors' elaborations

H1: The firm size is positively related to the likelihood that the firm will become a zombie firm.

### 3.3.4. Ownership dimension inspection

According to the type of ultimate controller of the firms, the zombie firm identified in the sample is divided into four types: SOEs, private firms, foreign-funded firms and others (including collective holdings, social group holdings, employee stock holdings, and firms that are not recognised by the ultimate controller). Through our observation, it can be found that the proportion of zombie firms in SOEs is the highest, while the proportion of zombie firms in foreign-funded firms and other firms is similar, much lower than the proportion of zombie of state-owned as [Figure 5](#).

Obviously, SOEs are more likely to become zombie firms. First, they are more likely to obtain bank loan subsidies. Second, the existence of deep-seated monopoly and institutional mechanisms in SOEs also make it easy to face low operating efficiency. The reform of SOEs has roughly undergone five stages from 1978 to 2015 in China. The decline in the number of SOEs and their proportion in the national economy have represented certain achievements in the reform of SOEs. However, from the statistics of sub-ownership zombie firms, they have shown a downward trend with the development of state-owned firm reform. The effect is still not remarkable, and the problem of state-owned zombie firm has not been effectively resolved. Given the above comparisons, we can now state the following hypothesis:

H2: The nature of ownership is related to the possibility of a firm forming zombie, and it is more likely that a SOE will become a zombie firm.

## 4. Empirical evidence

### 4.1. Estimation method

The formation of zombie firms may be affected by their own nature and financial status. Combined with the assumptions put forward in the previous sections and the financial status of the firm, this article makes some modifications based on the models of Yinan and Wei, (2016). According to the principle that the zombie firms are

**Table 4.** Pearson's correlation coefficient.

	<i>zombie</i>	<i>inventory</i>	<i>accounts</i>	<i>current</i>	<i>cash</i>	<i>soe</i>	<i>size</i>	<i>shgle</i>
<i>zombie</i>	1.0000							
<i>inventory</i>	-0.0113	1.0000						
<i>accounts</i>	0.0430	0.6037	1.0000					
<i>current</i>	-0.3611	0.0081	-0.0270	1.0000				
<i>cash</i>	-0.1657	-0.0145	-0.0368	0.6802	1.0000			
<i>soe</i>	0.0841	0.0083	-0.0157	-0.0259	-0.0212	1.0000		
<i>Size</i>	0.1111	-0.1506	-0.1482	-0.2375	-0.0499	-0.0110	1.0000	
<i>shgle</i>	-0.0449	0.0053	0.0308	0.2122	0.1842	-0.1270	-0.1309	1.0000

Source: Authors' elaborations.

**Table 5.** Regression results.

Estimate dimension	Variable	Mixed effect model	Fixed effect model	Random effect model
Operational capability	<i>inventory</i>	-0.0019**	-0.0026*	-0.0030*
	<i>accounts</i>	0.0053***	0.0060**	0.0075***
Ability to pay debts	<i>current ratio (%)</i>	-0.0110***	-0.0039***	-0.0072***
	<i>cash flow ratio (%)</i>	0.0040***	0.0039*	0.0050***
firms characteristics	<i>size</i>	0.3347***	0.6554**	0.7628***
	<i>soe</i>	-0.0776***	-0.1813*	-0.0098
	<i>shgle</i>	0.0030	-0.0971***	-0.0634***

Note: \*\*\*, \*\*, and \* indicate significant levels at the 5%, 10%, and 15%, respectively.

Source: Authors' elaborations.

affected by the operation ability, including the solvency and the nature of the firms, the dependent variable is determined. We estimate the following model in order to identify the zombie firms after controlling for other factors.

$$\text{Logit}(zombie_{i,t}) = \alpha_0 + \beta_{i1}X_{it} + \beta_2 Y_{it} + \varepsilon_{it} \quad (6)$$

where  $zombie_{i,t}$  represents the state of zombie firms identification, and  $X_{it}$  is the vector of financial indicators in the independent variables, which are taken from the operational capability and solvency of the firms. Since zombie firms are mostly loss-making firms, this article does not select financial indicators related to profits. Following the prior literature (Han et al., 2019; Tagesson et al., 2009), the following control variables are included in the vector of information  $Y_{it}$ . Specifically, *Shgle* means the proportion of board shareholding,  $soe_{i,t}$  is a dummy variable taken value 1 for SOEs and 0 for non-SOEs in year t. Logarithm of total assets of a firm at the end of the fiscal year.

## 4.2. Results analysis

In this article, the Pearson correlation test is carried out on the main variables of the model (Table 4), and the relations between the variables are preliminarily determined, as shown in Table 5. Through inspection, it can be found that the dummy variable *zombie* is negatively correlated with *inventory*, *current*, *cash*, and *Shgle*, while it is positively correlated with *soe* and *size*. The preliminarily results show that the more excellent the operational capacity and solvency, the less probability of forming zombie firms. Moreover, the ownership and firm scale increase the possibility of zombie firms. From the correlation analysis of other variables, the correlation coefficient is low, and there is no serious multi-collinearity between the variables.



We estimate the results of zombie firm identification and related indicators from 2006 to 2016. The analysis in this article is based on random effect estimation according to the Hausman test. In [Table 5](#), we provide the results of the fixed-effect model and the mixed effect model as a comparison.

According to the results of the Logit model, we find that the formation of zombie firms is related to the following factors: First of all, the operational capability of firms is significantly related to whether firms are more likely to form zombie firms, which is different from the empirical conclusions of Yinan and Wei, (2016). This could be due to conflicts in the indicators used to measure the operational capability of the industry and data resources. However, there is a relatively minor difference in the index of operational capability between industries, since the database in our article is listed industrial firms. Therefore, the difference in operating capacity will affect the possibility of zombie firms, which is negatively correlated with accounts receivable.

This indicates that the longer the turnover period of accounts receivable is, the more likely the firm will become a zombie firm.

Second, the solvency of a firm is significantly correlated with the probability of a firm becoming a zombie firm. The current ratio is significantly negatively correlated with the probability of becoming a zombie firm. Therefore, the stronger the liquidity of corporate assets, the stronger the short-term solvency, and the more likely a firm can suppress the transformation to zombie status. This shows that whether a firm will become a zombie firm is closely related to its own development. It is widely recognised that the worse the solvency, the more conducive is the environment for nurturing firms (Fukuda & Nakamura, 2011; McGowan et al., 2017). Although the CHK-FN method is used to identify the zombie firms, the data indicators selected for it are corporate profits and interest expense. However, the financial data selected in this article when exploring the operational capacity, solvency of firms, debt-paying ability, and the causes of zombie firms are inventory and current ratio. There is no endogeneity problem between the identification results and cause analysis of zombie firms.

Thirdly, it is widely identified that enterprise ownership matters significantly relate to becoming a zombie firm, which is mainly prominent in SOEs in China. Per our model's depiction, the owner has a significant impact on whether or not a zombie firm will form, and the SOEs are more likely to become zombie firms, confirming hypothesis 2 in the previous section. It shows that in the process of pre-judgment and governance of zombie firms, it is more important to focus on SOEs.

The result also shows that the scale of the firms has no significant effect on the formation of a zombie firm, which is inconsistent with hypothesis 1. Compared with non-listed firms, listed firms are larger and more standardised. However, listed firms are often the target of local government support, and these firms find it easier to obtain subsidies and loans.

### **4.3. Robustness checks**

In order to improve the robustness of the analysis results in this article, we also try to utilise the operational capability and solvency substitution variables to return to the [Equation \(6\)](#). According to the availability of data, this article uses the ROA and

**Table 6.** Robustness checks of fixed effect.

Content evaluation	Variable	Fixed effect model
Operational capability	<i>inventory</i>	0.004*
	<i>accounts</i>	0.000
Ability to pay debts	<i>current ratio (%)</i>	0.003
	<i>cash flow ratio (%)</i>	−0.007***
Firms characteristics	<i>size</i>	−0.015*
	<i>soe</i>	0.962***
	<i>shgle</i>	−0.063***

Note: \*\*\*, \*\*, and \* indicate significant levels at the 5%, 10%, and 15%, respectively.

Source: Authors' elaborations.

the gearing ratio *C* to replace the inventory turnover period (inventory) and the cash flow ratio (cash), respectively, to measure the operational capacity and solvency of the firms. Estimates were made to use fixed effects, random effects, and mixed effects, respectively. The fixed-effects model is used in the article, as shown in Table 6 according to the result of the F-test and Hausman test.

## 5. Discussion

By comparing the regression results of the robustness test with the previous benchmark model, it can be determined that even if the indicators are replaced, the ownership nature (% of State ownership) of the firms is highly correlated with whether the firm is likely to become a zombie firm. Accounts receivable turnover and cash flow ratios remain significantly associated with the likelihood of a firm becoming a zombie firm. This is consistent with previous results, indicating that the model can pass the robustness test.

This article analyzes the causes of zombie firms in the context of supply-side structural reforms. The identification of zombie firms in China's industrial firms is carried out, with the improved CHK-FN strategy, from the dimensions of firm scale, industry attributes, ownership structure and the structural reforms of the supply side.

Furthermore, through the construction of the Logit model, we carry out a systematic analysis of the causes of the formation of zombies. The following achievements are reached: (1) The number and proportion of zombie firms are related to the business cycle of macroeconomic. The number of zombie firms in the period 2006–2018 showed a downtrend first and then an upward trend. Among them, the proportion of zombie firms in listed firms' industrial firms was significantly affected by external shock factors. The more single the industrial chain, the easier it is to be influenced by the external environment and become a zombie firm. (2) Industrial firms with high proportions of state ownership are more likely to become zombie firms. (3) The number of zombie firms and the size of assets in SOEs are always the highest, and they are more likely to become zombie firms. SOEs have to undertake part of the policy burden. On the other hand, SOEs cannot completely separate ownership, and management rights, and the residual claims are not clear. The production efficiency is lower than that of private and foreign-funded firms. (4) The possibility of zombie firm formation is significantly positively related to operational capabilities and solvency.

The proper disposal of zombies requires comprehensive efforts of the reform, which reflects the complexity and arduous task of the supply-side structural reform.

Accordingly, it is essential to deal with zombie firms, apart from the improving their management and enhancing their competitiveness. The goal should be to prevent the continuous depletion of production resources and the deterioration of zombie firms' economic efficiency. We also suggest taking different disposal measures for zombie firms. Following the identification process, zombie firms, should enter bankruptcy proceedings or transfer residual control rights to creditors. Otherwise, they have to be transformed into healthy businesses by improving corporate governance, restructuring managers, or restructuring assets.

## 6. Conclusion

Regarding the causes and governance of zombie firms in China, whether it involves government subsidies or industrial policies, the target of policymaker is to increase production efficiency rather than to distort resource allocation. In fact, a zombie firm is an insolvent firm that continues to operate because of continued access to financing. Low-efficiency SOEs exist in large numbers, and it is easy to obtain support from industrial policies or obtain financial subsidies, which has a positive income effect. Therefore, we must take positive actions to further deepen the partial ownership reform, especially the classification reform of SOEs (Claessens & Yurtoglu, 2013). With the continuous deepening of supply-side structural reforms, SOEs' reforms are also looking for a new milestone. For the large state-owned zombie firms, it is necessary to improve the means of assessment and speed up the elimination of backward production capacity. Profitability is not the only indicator to evaluate. We should focus our resources on the direction that can enhance the development of advanced productive forces, arouse the vitality of SOEs. For small and medium-sized state-owned zombie firms, we should reorganise and merge as soon as possible, and accelerate the improvement of social security mechanisms to ensure that workers are properly placed.

We are aware from experience that the radicalisation of SOEs, at the level of system and mechanism, can make the SOEs that are at a disadvantage in the competitive market, run smoothly. Therefore, it is an efficient way to eliminate the root causes of state-owned zombie firms by constructing a dynamic mechanism of self-adjustment of capital and firm. Meanwhile, the conclusions are meaningful for corporate, and investors to make better decisions to the uncertainty of policy. From the perspective of internal governance, accelerating the reform of SOEs' internal decision-making and operation mechanism is conducive to reducing production costs, improving corporate profits, stimulating vitality, improving adaptability to the market, promoting healthy economic development, and ensuring the success of supply-side structural reforms.

## Disclosure statement

No conflict of interest has been included in this paper.

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