Government Subsidy, Investment and Financing Constraints, and the Formation of Zombie Companies

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Zombie companies have serious adverse effects on economic development. The relationship between government subsidies and zombie companies is a focus in China's supply-side structural reform. In this paper, we classify companies into two categories: investment-constrained companies lacking investment opportunities, and financing-constrained companies with limited sources of capital. Based on data of A-share listed companies from 2007 to 2016, this paper examines the relationship between government subsidies and the zombification of companies subject to different types of constraints. We find that more government subsidies have been allotted to investment-constrained companies than financing-constrained ones; government subsidy is one of the various factors that have contributed to company zombification, but the correlation is only significant for investment-constrained companies; financing subsidy dedicated to expanding corporate financing is more effective in helping investment-constrained companies than government subsidies in general, but neither government subsidies nor financing subsidies are effective in preventing investment-constrained companies from turning into zombies. In the robustness test that controls the endogeneity problem of reverse causality, replaces proxy variables, lags subsidy variables and discusses the zombification of loss-making enterprises, the results are still valid. This paper provides a heterogeneous perspective to study the connection between government subsidies and the formation of zombie companies, and in view of subsidy mismatch, puts forward recommendations regarding the use of government subsidies.

Keywords: zombie company, government subsidy, financing subsidy, investment constraints, financing constraints

1. Introduction

Zombie companies refer to companies that have lost vitality, suffered continuous losses, and relied on support from the government or banks to survive (Shen, 2016).

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In China, a socialist economy in transition, zombie companies are a severe problem (Papava, 2010). The effects of zombie companies on the efficiency of economic resource allocation lie not only in that they absorb a huge amount of funds and use them inefficiently, but also in that their existence has a serious externality (Tan *et al*., 2017). Therefore, the issue of zombie companies must be addressed in the process of China's supply-side structural reform.

As a policy tool of government macro-control (Schwartz and Clement, 1999), government subsidies play a vital role in improving the allocation of resources and addressing market imbalances. Whether government subsidies can work depends on how we define "effectiveness" of government behavior and "moderation" of government intervention (Lin, 2017). The formation of zombie companies as a result of government subsidies (Zhang, 2016; Rao and Wan, 2018) is widely agreed among researchers to be a phenomenon brought about by inappropriate government subsidies. This paper holds that there are preconditions for the link between government subsidy and the formation of zombie companies, and the match between the way of government subsidy and the actual situation of enterprises is an important factor that affects their relationship.

Unlike existing literature that focuses on the appropriateness of the amount of government subsidies, this paper defines the appropriateness of government subsidies from the perspective of their destination, that is, whether government subsidies are directed towards the appropriate recipient enterprises. Specifically, we divide companies into two categories based on the main type of constraints they face: lack of investment opportunities (investment constraints), or lack of funds (financing constraints) (Schoder, 2013; Yu *et al.*, 2015). Investment-constrained companies refer to companies whose investment is mainly constrained by investment opportunities rather than cash flows, while financing-constrained companies refer to those whose investment is mainly constrained by cash flows rather than investment opportunities. We estimate that the mismatch between government subsidies and recipient companies may contribute to the formation of zombie companies, and that government subsidies extended to financing-constrained companies can help meet the funding needs of these companies for development and reduce their chance of turning into zombies. We then discuss the relationship between financing subsidies and the formation of zombie companies. We define special subsidies intended to make up for the financing cost of enterprises and leverage external funds, such as interest rate subsidy, as financing subsidies, including incentives or financing compensations granted by local governments to listed companies or bond issuing companies.[1] Financing subsidies can

[1] For example, the *Circular of the General Office of the Municipal Government of Dongguan on the Measures for Supporting the Listing of Enterprises* released in 2018 announces to give one-time incentives to eligible local enterprises that complete an IPO at home or abroad; the *Circular of the General Office of the Provincial Government of Sichuan on the Implementation of Fiscal Policy Encouraging Direct Financing* in 2015 pledges to grant subsidies to enterprises that successfully issue bonds based on the amount of funds raised.

attract investment into companies receiving subsidies, and may be more effective in supporting financing-constrained companies than government subsidies in general. In contrast, misallocation of financing subsidies to investment-constrained companies may cause more serious consequences than other types of subsidies.

Based on data of A-share listed companies from 2007 to 2016, we conduct empirical tests on the relationship between government subsidies and the zombification of companies under different types of constraints. The sample-wide regression results show that government subsidies have contributed to the formation of zombie companies, which is a conclusion in line with previous studies (Zhang *et al.*, 2016; Rao and Wan, 2018), but such relationship is only valid for investment-constrained companies, and not significant for financing-constrained companies; and compared with government subsidies, financing subsidies have a more significant negative effect on investment-constrained companies. The above results are all economically significant. Contrary to expectations, neither financing subsidy nor government subsidy can lower the possibility of zombification for financing-constrained enterprises. The main results remain valid in the robustness test, in which we take non-zombie loss-making enterprises as a sample to observe whether government subsidies prompt the zombification of loss-making enterprises, conduct a PSM-DID test to mitigate the endogeneity of reverse causality, use alternative measures of government subsidies and financing subsidies to control measurement errors, and lag the subsidy variable. Descriptive statistics show that government subsidies extended to financing-constrained companies are significantly less than those granted to investment-constrained companies. In combination with the empirical results, this confirms subsidy mismatch in certain cases, and highlights the importance of this paper's conclusions and policy implications.

The contributions of this paper lie in the three aspects. First, it examines the effects of government subsidies on the zombification of companies under different types of constraints, reveals the economic impacts of a subsidy mismatch, expands the scope of research on the economic impacts of government subsidies, and deepens existing research on the relationship between government subsidies and the formation of zombie companies. Second, although research on specific types of government subsidies and particular economic consequences presents a clearer logical relationship, and the empirical evidence is more reliable, there are few in-depth studies on the role of specific types of government subsidies. Based on data of financing subsidies aimed at alleviating the financial constraints on enterprises, this paper discusses, in a creative manner, the efficiency of government subsidies, and provides new inspirations for research on the economic impacts of government subsidies. Third, this paper provides an analytical perspective for the government to reduce subsidy mismatch according to the types of constraints faced by enterprises, and emphasizes the necessity of and puts forward suggestions on the improvement of the efficiency of government subsidies, especially financing subsidies. It is of great practical significance for resolving the

dilemma of zombie companies and improving the efficiency of government subsidy.

The structure of this paper is as follows. The "Literature Review and Hypotheses" section reviews literature on the economic impacts of government subsidies and the formation of zombie companies, sorts out the logical line of "government subsidy–investment and financing constraints–zombie companies", and presents some hypotheses. The "Design of the Study" section describes the variables, data sources, and empirical model. The "Empirical Results" section consists of descriptive statistics of main variables and empirical results of hypothesis testing. After the robustness test of the main empirical results, we draw conclusions, put forward policy recommendations, point out the limitations of this study, and offer suggestions on future research.

2. Literature Review and Hypotheses

Zombie companies suffer losses and are like leeches living off others (Zhang, 2016), and the fundamental reason for their appearance is that they go against the law of comparative advantage and lack competitiveness (Shen, 2015). There are various reasons for lack of competitiveness, which can be classified into financing constraints and investment constraints. Modigliani and Miller (1958) conclude that in a perfect market, enterprise investment is only related to investment opportunities. Market frictions, however, impose financing constraints on the investment behavior and profitability of enterprises (Fazzari *et al.*, 1988). Financing constraints cause enterprises to miss out on good investment opportunities, leading to lack of competitiveness. Investment constraints mean that the companies have no or cannot leverage the comparative advantage of resources. The paths towards zombie companies are: 1) investment-constrained companies are short of high-net-present-value investment projects, suffer continuous losses, and turn into zombie companies; and 2) financing-constrained companies lacking financing channels miss out on high-net-present-value investment opportunities, suffer continuous losses, and thus become zombie companies.

The government can set differentiated subsidy rates or introduce differentiated subsidy policies for different industries and investment projects. The flexibility of government subsidy lies in its incomparable advantage over other financial instruments (Galai and Wiener, 2003). However, it is very difficult for the government to get a good grasp on enterprises (Edgerton, 2010), or adopt suitable subsidy policies for different types of enterprises in all cases. Government subsidy is liable to be a source of "blood" for zombie companies (Giannetti and Simonov, 2013). Therefore, the role of government subsidy has two sides. Whether government subsidy contributes to the formation of zombie companies depends on whether government subsidy can address the problems faced by enterprises, or whether government intervention is appropriate.

Existing studies agree that not all government subsidies account for the formation of zombie companies, but their analyses on the appropriateness of government subsidies

focus on the amount of government subsidies (Callahan, 2012; Fu and Li, 2015; Rao and Wan, 2018). In fact, amount is the second factor to consider, while the top question is where they go. A right direction is the prerequisite. If government subsidies can meet the needs of enterprises, they can live up to expectations, and if government subsidies granted blindly and not able to help tackle the actual problems of enterprises, they can cause problems such as corporate fraud, and zombie companies.

Based on this, this paper analyzes the appropriateness of government subsidies from the perspective of the match between government subsidies and the main constraints faced by enterprises. Investment constraints means companies are in lack of good investment opportunities, not cash flows. Factors such as rent-seeking behavior of enterprises to obtain government subsidies (Yang, 2017), and wrong decision-making or inefficient government decision-making processes (Wang, 2014; Mo, 2017) will further aggravate the inefficiency of investment. We believe that government subsidies extended to enterprises struggling to pay their debts and with dim prospects of development is unable to fundamentally solve the problem of a lack of comparative advantages on the part of enterprises. Instead, it will delay possible M&A or reorganization. As a result, the enterprises are beset by continuous losses, and gradually degenerate into zombie companies. Based on the above analysis, we put forward Hypothesis I as follows.

Hypothesis I: Other things being equal, government subsidies can increase the chance of zombification of investment-constrained companies.

Financing constraints mean that compared with investment demand, enterprises are struggling with insufficient financing. Enterprises under financing constraints become zombies because they do not have funds to meet their investment demand. Government subsidies can reduce financing costs and ease financing constraints (Ren and Lv, 2014) Lim *et al.*, 2018;. Moreover, the obstacle posed by financing constraints to the timely use of factors of production can also be offset by government subsidies (Ren and Lv, 2014). Ideally, government subsidies should be steered towards companies with good prospects but temporarily having limited access to financing, and can effectively alleviate the misallocation of financial resources, and help companies seize investment opportunities and reduce their chance of becoming zombies. On this basis, Hypothesis II is proposed.

Hypothesis II: Other things being equal, government subsidies can lower the chance of zombification of financing-constrained companies.

Government subsidies can serve as a direct source of funds to support corporate investment, and can also attract external funds to subsidized enterprises. Research finds that government subsidies can significantly reduce the cost of debt capital of enterprises (Lim *et al*., 2018). This paper provides two explanations for this role: 1) receiving government subsidies can proof a company's capacity for development, and therefore help them attract investment (Meuleman and Meseneire, 2012); and 2) financing subsidies help enterprises avoid the cost of external financing. In this paper, financing subsidies are defined as the government subsidy that encourages or supports

listed companies to obtain external funds by borrowing or by issuing stocks.

The relationship between financing subsidies and the zombification of enterprises under different types of constraints is clearer. Financing subsidies are suitable for enterprises with financing constraints. Financing subsidies give the government a leverage to use small amounts of funds to motivate larger funds, so as to jointly remove financing constraints. Under ideal conditions, expanding financing can help enterprises grasp investment opportunities, and the profits generated all belong to the enterprises. Therefore, financing subsidies can reduce the probability of zombification. However, financing subsidies are not suitable for investment-constrained companies. Financing subsidies provided by the government require no repayment and thus will not bring leverage risks to the enterprises. However, because they may bring more funds from other sources, and investment-constrained companies are unable to seek high-return projects for this part of the funds, the losses are to be borne by various stakeholders, including the government. The funds motivated by the financing subsidies of the government can become vampires for zombie companies. Therefore, this paper proposes and tests Hypotheses III and IV to explore the economic consequences of financing subsidies.

Hypothesis III: Other things being equal, financing subsidies can increase the chance of zombification of investment-constrained companies.

Hypothesis IV: Other things being equal, financing subsidies can reduce the chance of zombification of financing-constrained companies.

3. Design of the Study

3.1. Sample and Data

This paper chooses all non-financial A-share listed companies as sample companies. Considering the changes to government subsidy accounting standards in 2006 and 2017, to ensure data comparability, the sampling period is 2007–2016. After winsorizing all continuous variables at 1%, we finally get 14,776 company-year of data. The data on financing subsidies are obtained through text analysis of annotations to the annual reports of listed companies. All other variables come from the CSMAR database.

3.2. Variables and Basic Models

3.2.1 Definition of Zombie Company

On the basis of the criteria of the SASAC that zombie companies are those operating on a loss for three consecutive years, this paper defines zombie companies as enterprises whose net profit after deducting non-recurring gains/losses has been negative for three consecutive years (Rao and Wan, 2018) on the following grounds. First, during

2007–2016, accounting standards required that enterprises should include government subsidies in their non-operating income, so deducting recurring gains/losses can offset the influence of government subsidy per se. Second, as non-recurring gains/losses are occasional and not continuous and cannot measure the profitability of enterprises, deducting non-recurring gains/losses can better depict the characteristics of zombie companies. Third, after receiving government subsidies, the amortized costs are usually attributed to operating profit, so net profit after non-recurring gains/losses can include the influence of government subsidies on the sustainability of corporate profitability.

Therefore, the dependent variable in this paper is the dummy variable of zombie companies. If a company's net profit after deducting non-recurring gains/losses has been negative for three consecutive years (t, t+2), then *Zombie*=1; otherwise, *Zombie*=0.

3.2.2. Government Subsidy and Financing Subsidy

The independent variables in this paper include government subsidy (*Subsidy*) and financing subsidy (*Fsubsidy*). Government subsidy is defined as the natural logarithm of total government subsidy in the notes[1] to "non-operating income" in the annual report of listed companies plus one (Luo *et al.*, 2014).

The variable of financing subsidy is obtained through text analysis. Specifically, we first acquire the detailed information on government subsidy in the notes to "non-operating income" in the annual report of listed companies, and determine whether the subsidy is intended to help enterprises expand financing. If the explanatory notes about a subsidy mention any of the words — "fund-raising, financing, interests, borrowing, loans, issuance, stocks, bonds, additional issuance, interest subsidies, and finance", then the subsidy is classified as financing subsidy. We then aggregate the amount of financing subsidies extended to listed companies in one year, and conduct a logarithm analysis to get the variable of financing subsidy (*Fsubsidy*). When calculating financing subsidies, we also sift through the data manually after aggregation to ensure reliability.

3.2.3. Constraint Types

Schoder (2013) constructs a model to determine financing constraints and investment constraints. The basic idea is to compare the sensitivity (β_1) of an enterprise's investment demand to the marginal return on investment, and the sensitivity (β_2) of investment supply to the marginal cost of investment. The smaller β_1, the less investment demand corresponding to per-unit marginal return, indicating that the enterprise has no good investment opportunities and faces greater investment constraints. The smaller the

[1] Given that enterprises rarely pay back government subsidies, relevant non-operating expenses are not taken into account.

β_2, the less investment supply corresponding to per-unit marginal cost, indicating that the enterprise lacks funds for investment and is subject to greater financing constraints. When enterprise investment reaches an equilibrium, if $\beta_1<\beta_2$, it means that the enterprise is mainly under investment constraints; if $\beta_1>\beta_2$, the enterprise mainly faces financing constraints. Based on the Schoder model, Yu *et al.* (2015) constructs an econometric model to determine the type of constraints, in which *Tobin Q* represents investment supply, and *CF* (cash flow) represents investment demand. A lot of sample regression analyses are conducted on enterprise investment using this model, and the two coefficients are compared to determine the type of constraints faced by the samples on average. Based on the ideas of Schoder (2013) and Yu *et al.* (2015), we conduct the following regression for each enterprise during the sample period, and determine the type of constraints faced by them by comparing β_q and β_{CF}, the coefficient of *q* and *CF,* respectively. If $\beta_q>\beta_{CF}$ it means that the company is mainly subject to investment constraints (*IC*); otherwise, it is mainly under financing constraints (*FC*).

$$I = \beta_q + \beta_{CF} + \varepsilon \tag{1}$$

where *I* represents corporate investment. Based on the research of Zheng *et al.* (2001), we use corporate investment to measure the ratio of total cash flow expenditures for the purchase of fixed assets, intangible assets and other long-term assets in the year to total assets. *q* represents investment supply and is the value of *Tobin Q*; *CF* represents the change of investment demand and is the ratio of net cash flow to shareholders' equities; and ε is disturbance term.

3.2.4. Control Variables

On the basis of the existing studies, we add the following control variables in this paper: industry profitability (*Profit_Ind)* (Xiong, 2016), company size (*Size)* (Rao and Wan, 2018), type of ownership (*SOE*) (Nie, 2016), age as listed companies (*Age*) (Nie, 2016), leverage ratio (*Lev*) (Huang and Chen, 2017), management expense ratio (*Expense*) (Rao and Wan, 2018), measures of corporate governance including ownership concentration (*Holding*) and proportion of independent directors (*Director*) (Han & Tian, 2018), year dummy (*Year*), and industry dummy (*Industry*). All variables and their definitions are shown in Table 1.

Table 1. Notation

Panel A Determine constraint types		
Variable	Name	Definition
I	Enterprise investment	Cash flow expenditures for purchase of fixed assets, intangible assets and other long-term assets / total assets

Panel A Determine constraint types		
Variable	Name	Definition
Q	Tobin Q	Market value / (total assets - net goodwill - net intangible assets)
CF	Cash flow	Net cash flow/shareholders' equity
Ctype	Constraint type	If a company is mainly under investment constraints (*IC*), *Ctype*=1; otherwise, *Ctype*=0.
Panel B Government subsidy and zombie companies		
Zombie	Zombie company	When net profit after deducting non-recurring profits/losses has been negative for three consecutive years, *Zombie*=1; otherwise, *Zombie=0.*
Subsidy	Government subsidy	Natural logarithm of the amount of government subsidy + 1
Fsubsidy	Financing subsidy	Natural logarithm of the amount of financing subsidy + 1; data on financing subsidy are obtained through text analysis of the notes to "non-operating income" in the annul report of listed companies
Profit_Ind	Industry profitability	Average operating profit margin of the industry * 100
Size	Company size	Natural logarithm of total assets
Lev	Leverage ratio	Total liabilities/total assets
SOE	Type of ownership	For state-owned enterprises, *SOE*=1; for private enterprises, *SOE*=0
Age	Age as listed companies	Current year - the year getting listed
Expense	Management expense ratio	The difference between management expense ratio (expense/revenue) and the industry average
Holding	Ownership concentration	Herfindahl-Hirschman index of the share of top ten shareholders
Director	Share of independent directors	Share of independent directors in all directors
Ind	Industry dummy	Divided at tier-1 according to the 2012 industry classification standard of the CSRC, tier-2 for the manufacturing sector
Year	Year dummy	
Robustness test		
NPZ1	Enterprises that lose money for the first time become zombies	(Loss-making enterprises that did not lose money in the previous year) If they suffer losses in the following two years, *NPZ1=1*; otherwise, *NPZ1*= 0
NPZ2	Enterprises that have suffered losses for two consecutive years become zombies	(Loss-making enterprises that did not lose money two years ago but in the previous year and current year) In the case of losses in the next year, *NPZ2*=1; otherwise, *NPZ2*=0

3.2.5. Fundamental Model

The fundamental model of this study is Model (2). We run Logistic regression to verify the relationship between government subsidies and zombie companies. The explained variable of Model (2) is a dummy variable (*Zombie*), and the explanatory variable is government subsidy (*Subsidy*). According to Hypotheses I and II, we run Model (2) in the sample of financing-constrained companies, expecting β_1 to be significantly negative; and

then run Model (2) in the sample of investment-constrained companies, expecting β_1 to be significantly positive.

$$Zombie = \beta_1 Subsidy + \sum \beta_n Controls + \mu \quad (2)$$

We then replace government subsidy (*Subsidy*) with financing subsidy (*Fsubsidy*) to verify Hypotheses III and IV with Model (2). We run Model (2) in the sample of financing-constrained companies, expecting β_1 to be significantly negative; and then run Model (2) in the sample of investment-constrained companies, expecting β_1 to be significantly positive.

4. Empirical Results

4.1. Descriptive Statistics

During the sample period, the sample size of zombie companies is 821, accounting for 5.89%, and that of non-zombie companies is 13955. The mean of *Subsidy* is 13.85, equivalent to an annual subsidy of more than RMB1.03 million per company, with a quartile of 14.18. A majority of listed companies received government subsidy, of which the distribution has a peak and thin tails. The mean of *Fsubsidy* is 3.62; during the sample period, about 26.3% of enterprises received financing subsidy, and the mean of *Fsubsidy* for these companies is 10.03, equivalent to an annual financing subsidy of over RMB950,000 per company. The mean of *Ctype* is 0.529, and the number of companies under investment constraints is slightly higher than those under financing constraints. The ratio of listed companies receiving government subsidy or financing subsidy differs greatly from the mean of *Ctype*, indicating that the mismatch of government subsidy may be serious. The basic statistics of each variable are within the expected range, and the relationship between standard deviation and mean suggest notable variation of each variable. The results of descriptive statistics of the main variables are shown in Table 2.

Table 2. Descriptive Statistics

Variable	Mean	Standard deviation	Minimum	p25	Median	p75	Maximum	N
Zombie	0.06	0.23	0	0	0	0	1	14776
Subsidy	13.85	5.75	0	14.18	15.76	16.93	25.16	14776
Fsubsidy	3.62	6.12	0	0	0	11.00	20.89	14776
Profit_Ind	1.96	1.26	0.426	1.05	2.09	2.57	9.19	14776
Size	22.01	1.41	19.24	21.03	21.79	22.73	27.12	14776
Lev	0.49	1.02	0.01	0.29	0.47	0.63	0.99	14776
SOE	0.44	0.50	0	0	0	1	1	14776

Variable	Mean	Standard deviation	Minimum	p25	Median	p75	Maximum	N
Age	9.51	6.28	0	4	9	15	26	14776
Expense	–0.12	0.20	–0.535	–0.13	–0.05	–0.01	0.34	14776
Holding	0.17	0.12	0.014	0.08	0.143	0.24	0.58	14776
Director	0.37	0.05	0.3	0.33	0.33	0.4	0.57	14776
Ctype	0.53	0.50	0	0	1	1	1	14776

To preliminarily compare the impact of constraints on corporate zombification and government subsidies, we run a *t*-test of inter-group mean differences, and the results are shown in Panel A of Table 3. Comparisons show that the proportion of zombie companies among financing-constrained companies is significantly higher than that among investment-constrained companies (the ratio difference is 1.8%, while the proportion of zombie companies in the whole sample is about 5.9%). In contrast, the proportion of investment-constrained companies receiving government subsidies is significantly higher than that of financing-constrained companies. While financing constraints are more severe, more government subsidies have gone to areas lacking investment opportunities, implying a possible mismatch of subsidies and needs. Financing subsidies extended to enterprises under financing-constraints is significantly higher than those to enterprises under investment constraints. This runs counter to the situation of government subsidies, indicating that the government takes into account the specific conditions of enterprises when granting financing subsidies. Indeed, more financing subsidies are directed towards financing-constrained companies rather than investment-constrained companies, but the effect still needs to be verified with Hypothesis II. According to data of government subsidies received by zombie companies and non-zombie companies listed in Panel B of Table 3, more government subsidies have gone to zombie companies; zombie companies also receive significantly more financing subsidies than non-zombie companies, which is consistent with the results for government subsidies.

Table 3. Mean T-Test by Panel

Panel A Grouped by constraint type				
Variable	Investment constraints	Financing constraints	Difference	T value
Zombie	0.047	0.065	–0.018	–4.787***
Subsidy	14.851	14.406	0.447	6.489***
Fsubsidy	3.479	3.785	–0.306	–3.418***
Panel B Grouped by whether a zombie company or not				
Variable	Zombie	Non–zombie	Difference	T value
Subsidy	14.563	14.321	0.242	1.336*
Fsubsidy	4.920	3.452	1.468	5.633***

Note: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

4.2. Empirical Results

4.2.1. Government Subsidy, Investment and Financing Constraints, and Corporate Zombification

The empirical results concerning government subsidies and the formation of zombie companies are shown in Table 4. Generally, receiving government subsidies can increase the chance of zombification, which is in line with the findings of existing studies (Zhang, 2016; Rao and Wan, 2018). This conclusion, however, is valid only for investment-constrained companies, and the coefficient is higher than that of sample-wide regression. At the mean level of *Subsidy*, a one-unit increase in *Subsidy* will raise the possibility of zombification of investment-constrained companies by 0.25%,[1] compared with the 4.7% mean of zombie companies; the effect of government subsidies on the zombification of investment-constrained companies is economically significant. These results confirm Hypothesis I.

Table 4. Government Subsidies and Corporate Zombification

	Dependent variable (Zombie)		
	(1) Total	(2) IC	(3) FC
Subsidy	0.048***	0.088**	0.029
	(0.017)	(0.039)	(0.019)
Profit_Ind	−1.134***	−1.045***	−1.125***
	(0.265)	(0.397)	(0.328)
Size	−0.231***	−0.270**	−0.217**
	(0.071)	(0.133)	(0.087)
Lev	0.692*	0.908	0.565
	(0.408)	(1.095)	(0.359)
SOE	0.722***	0.969***	0.555***
	(0.131)	(0.203)	(0.167)
Age	0.0869***	0.092***	0.075***
	(0.0126)	(0.019)	(0.017)
Expense	3.562***	4.265***	2.849***
	(0.767)	(1.511)	(0.833)
Holding	−2.458***	−2.078*	−2.724***
	(0.653)	(1.069)	(0.825)
Director	−0.971	−2.103	0.053
	(1.163)	(1.757)	(1.576)
Constant	3.529**	3.652	3.399*
	(1.521)	(2.591)	(1.965)
Year	Control	Control	Control
Ind	Control	Control	Control
N	14,297	7,725	6,336
Pseudo R^2	0.143	0.177	0.122

Notes: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; numbers in brackets are robust standard errors.

[1] Obtained by using the Margins command in Stata for marginal effect analysis.

Different from Hypothesis II, in the sample of financing-constrained companies, the coefficient of *Subsidy* is smaller than that in the sample-wide regression result, and is not significant. Government subsidies are not likely to prompt the zombification of financing-constrained companies, but neither can it help get them out of the difficult situation. This conclusion is consistent with those of other relevant studies (Huang and Zhao, 2011).

According to the regression results of control variables, *Profit_Ind* is negative, indicating a lower chance of becoming zombies for companies in prosperous industries; *Size* is significantly negative, indicating that the larger an enterprise, the lower its chance of becoming a zombie; *Lev* is positive, which means that the greater the financial risk, the higher the possibility of zombification; *SOE* is positive, indicating that state-owned enterprises are more likely to turn into zombies than private enterprises; *Age* is positive, implying that the more mature, the higher likelihood of zombification, which is consistent with the view (Song, 2019) that regards zombification as a natural stage of the later life cycle of enterprises; *Expense* is positive, suggesting that enterprises with lower operating efficiency are more likely to become zombies; *Holding* is negative, which indicates that the more concentrated a company's equity is, the less likely it will be to become a zombie; and the variable of *Director* is not significant. To control potential problems in relation to heteroscedasticity and sequence correlation, the standard errors of all regression coefficients in this paper are clustered at the company level.

4.1.2. Financing Subsidies, Investment and Financing Constraints, and Corporate Zombification

Table 5 provides the regression results of financing subsidies and corporate zombification. Financing subsidies can contribute to the zombification of investment-constrained companies. The significance of the regression coefficient of financing subsidy is higher than that of government subsidy, implying that the negative consequences of financing subsidy mismatch may be more serious. A one-unit increase in *Fsubsidy* to investment-constrained companies will raise the possibility of zombification by 2.76%[1], compared with the 4.7% mean of investment-constrained zombie companies; the effect of financing subsidy on investment-constrained companies is economically significant. The above results confirm Hypothesis III. Contrary to Hypothesis IV, financing subsidies cannot lower the possibility of zombification for financing-constrained companies. The possible reasons are: First, benefit inflow after solving subsidy mismatch has a time lag, and cash inflow from corporate investment in high-yield projects occurs some perieds after that. Second, financing subsidies fail to mitigate the shortage of funds, i.e. fail to bring external funds to the enterprises concerned as expected.

[1] Obtained by using the Margins command in Stata for marginal effect analysis.

Table 5. Financing Subsidies and Corporate Zombification

	Zombie		
	(1) Total	(2) IC	(3) FC
Fsubsidy	0.034***	0.052***	0.016
	(0.009)	(0.012)	(0.012)
Control variable	Control	Control	Control
N	14,292	7,721	6,335
Pseudo R^2	0.145	0.181	0.120

Notes: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; numbers in brackets are robust standard errors.

5. Robustness Test

5.1. Government Subsidies and Zombification of Loss-Making Enterprises

One purpose of government subsidies is to maintain social stability and reduce unemployment, so it is natural that government subsidies flow to enterprises in financial distress (Carlsson, 1983; Pan *et al.*, 2009). The empirical results partly explain the reasons for the formation of zombie companies. In the robustness test, we examine from the perspective of independent variables whether government subsidy inflow into loss-making enterprises can reverse the losing trend, that is, whether government subsidies can achieve their desired purpose.

We replace the dependent variable *Zombie* in Model (2) in the following two panels, and run regression: (1) replace companies reporting a loss for the first time with those becoming zombies after suffering losses for two consecutive years (*NPZ1*); and (2) replace companies suffering two consecutive years of loss for the first time with those becoming zombies after one more year of losses (*NPZ2*). As can be seen from the regression results provided in Table 6, except that the coefficient of government subsidies for investment-constrained companies is insignificant, the results are consistent with the empirical results of tests for the hypotheses: Neither financial subsidies nor government subsidies are effective in preventing financing-constrained companies from turning into zombies. The symbols of financing subsidies are consistent with those of government subsidies as explanatory variables in each column, but the significance of the two coefficients in columns (1), (2) and (5) varies, which again testifies the negative effects of financing subsidy mismatch.

Table 6. Government Subsidy and Zombification of Loss-making Companies

Panel A Government subsidy						
	NPZ1			*NPZ2*		
	(1) Total	(2) IC	(3) FC	(4) Total	(5) IC	(6) FC
Subsidy	0.015	0.035	0.011	0.044**	0.062*	0.042
	(0.016)	(0.032)	(0.018)	(0.020)	(0.037)	(0.026)

Panel A Government subsidy						
		NPZ1			*NPZ2*	
	(1) Total	(2) IC	(3) FC	(4) Total	(5) IC	(6) FC
Control variable	Control	Control	Control	Control	Control	Control
N	1,134	527	581	568	267	297
Pseudo R2	0.091	0.137	0.084	0.074	0.158	0.103
Panel B Financing subsidy						
		NPZ1			*NPZ2*	
	(1) Total	(2) IC	(3) FC	(4) Total	(5) IC	(6) FC
Fsubsidy	0.029**	0.037**	0.022	0.024**	0.032**	0.014
	(0.012)	(0.018)	(0.016)	(0.010)	(0.015)	(0.015)
Control Variable	Control	Control	Control	Control	Control	Control
N	1,133	526	581	568	267	297
Pseudo R^2	0.087	0.134	0.081	0.063	0.081	0.082

Notes: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; numbers in brackets are robust standard errors.

5.2. The Endogeneity of Controlling Adverse Selection

Zombie lending may arise as a deliberate strategy on the part of the government, which is one of the main reasons for the survival of zombie companies (Jaskowski, 2015). Therefore, we use a propensity score matching difference-in-difference (PSM-DID) model to weaken the impact of possible reverse causality between zombification and financing subsidy on the empirical results. Specifically, the PSM method is first used to match sample companies having received financing subsidy (treatment group) with those not (control group), whose basic characteristics are similar except their access to subsidy. Then, the DID method is used to test whether there is a significant difference in the chance of zombification of the two groups before and after the treatment group first received financing subsidy. The variables selected in matching include: whether they belong to high-tech industries, nature of ownership, company size, leverage ratio, age as listed companies, executive compensation (the average of the top three), number of patents, price-earnings ratio, industry dummy, and year dummy. The difference-in-differences model is as follows:

$$Zombie = \gamma_1 post \times treat + \gamma_2 treat + \sum \gamma_n Controls + \eta \quad (3)$$

In Model (3), "*treat*" is a group dummy variable. When the sample belongs to the treatment group, *treat*=1; otherwise, *treat*=0; "*post*" is event dummy variable. When the year is not less than the first year to obtain financing subsidy, *post*=1; otherwise, *post*=0. The control variable is the same as in Model (2). If the *treat* × *post* coefficient is positive, it indicates a significant difference in the change of zombification in the

treatment group before and after receiving financing subsidy, and such difference is not caused by the inherent factors affecting the tendency of enterprises to obtain financing subsidy. The results of the PSM-DID test are shown in Table 7. Column (1) and column (2) are the regression results in the sample of investment-constrained companies and financing-constrained companies, respectively. The *treat* × *post* coefficient is not significant in the sample of financing-constrained companies, while investment constraints are positive at the significance level of less than 0.01. This shows that Hypotheses III and IV are still valid after controlling the endogenous explanation of reverse causality.

5.3. Control of Measurement Error

In this paper, government subsidy is redefined as the share of government subsidies in total assets and as the government subsidy dummy variable, respectively, and the results are basically consistent.

Table 7. Robustness Test: PSM-DID Model

	Zombie	
	Investment constraints	Financing constraints
	(1)	(2)
Post × *treat*	0.530**	0.398
	(0.264)	(0.294)
Control variable	Control	Control
N	5,056	3,800
Pseudo R^2	0.143	0.122

Notes: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; numbers in brackets are robust standard errors.

5.4. Lagged Government Subsidy Variable

To reduce the influence of the alternative explanation that the government is more inclined to subsidize loss-making enterprises, this paper tests the correlation between first-order lagged subsidy and zombie companies, and the results are basically consistent.[1]

6. Conclusions

We find that the role of government subsidies varies greatly in the process of zombification of companies subject to different constraints. The conclusion that

[1] The results of robustness test of alternative variable and lagged subsidy variable are not included in this paper due to length limits, but are available upon request.

government subsidies can result in zombification is only valid for investment-constrained companies; subsidy mismatch causes a significantly positive correlation between financing subsidies and the possibility of zombification, and the results are economically significant; government subsidies and financing subsidies both speed up the zombification of loss-making companies under investment constraints; government subsidies and financing subsidies cannot reduce the possibility of zombification of financing-constrained companies, nor can they reverse the losing trend of loss-making companies under financing constrained. The statistical results of subsidy allocation show that more government subsidies have gone to investment-constrained companies than financing-constrained companies, while more financing subsidies are steered towards financing-constrained companies.

Based on our findings, we put forward the following suggestions concerning the use of government subsidies. (1) Reduce the mismatch between government subsidy provision and the actual needs of enterprises, and the main type of constraints faced by enterprises is key to matching the two. (2) The government should be cautious about using financial subsidies like fiscal interest discounts, and must fully consider the risks to be borne by stakeholders after the expansion of financing. (3) Improve the subsidy supervision mechanism, and establish a subsidy redemption system to reduce the dependence of enterprises on government subsidies, and increase the efficiency of government subsidies, especially financing subsidies. (4) Improve the disclosure of information in relation to the government and enterprises in the whole process of using subsidy tools. In fact, inadequate information disclosure is also a key factor that restricts the reliability and applicability of relevant research and raises public doubt about government subsidies.

Future research can be designed to tackle the limitations of this paper. First, there may still be an unidentified mechanism that affects the relationship between government subsidies and the formation of zombie companies, and this paper only tries to control possible influence through statistical means. Second, zombie companies may face both investment and financing constraints. The two viable options for future research may be case study, and alternative methods of classification of constraints.

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