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Monetary Policy, Financial Development and the Financing of Zombie Firms: Evidence from China

By Liping Lu, Xiaoyang Li, and Zongxin Qian[1]

Abstract

This paper examines the financing channels for zombie firms in China. We find that equity markets and suppliers provide substantial financing support for zombie firms, while banks and other financing channels are less important. We also find that the amount of investment does not increase accordingly after zombie firms obtain external financing, which indicates an inefficient use of funds by these zombie firms. Our results are robust to various definitions of zombie firms, and also to a propensity score matching method.

Keywords: Zombie firms; external financing; equity market; trade credit

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Introduction

Keynesian macroeconomics proposes that central banks should use monetary policy to smooth economic fluctuations. In particular, when there is a recession or a recession is anticipated, central banks should employ a loose monetary policy to stimulate the economy. In developing countries, government agencies also have long-term targets of ensuring economic growth and smoothing business cycles. Financial development policies such as liberalising the banking sector are often part of the policy package for enhancing economic growth.[2]

China often uses the monetary policy to smooth its business cycles and employs financial development policies to promote long-term economic growth. One dramatic example of China's counter-cyclical monetary policy is the four-trillion stimulus plan (Zheng, Wang, and Xu 2018) in anticipation of the negative spillover of the 2008 global financial crisis. The M2 growth rate reached 27.7% in 2009, which was ten percentage points higher than the level of 2008. However, by the end of 2009, the People's Bank of China (PBOC) tightened its monetary policy due to a concern about over-expansion. Besides, the China Banking and Insurance Regulatory Commission (CBIRC) and the China Securities Regulatory Commission (CBRC) set policy targets to promote the development of the specific financial sector within their supervision sovereign.

In this paper, we show that the counter-cyclical monetary policy and financial development policies have had an unintended side effect of resource misallocation in China. Specifically, these policies have made it easier for zombie firms to obtain external financing, which can diminish the financing available to other firms. Therefore, the authors recommend a scheme to limit the extent to which banks can exploit their

[2] See Levine (1997) for a review of the economic rationale.

private information. By aligning the banks' incentives with regulators' incentives, we propose a method to help prevent lending to zombie firms. Also, we investigate the impact of macro-financial policies, i.e. the monetary policy and financial development policies, on the financing of zombie firms. We show that monetary expansion and financial development targeted at macroeconomic stability and economic growth could enhance the financing of zombie firms. Therefore, for macroprudential purposes, these policies need to make a trade-off between influencing macroeconomic performance and preventing lending to zombie firms. Our paper further complements the literature by providing a broader perspective of zombie firm financing. While the literature often examines banks' lending to zombie firms, we investigate both bank loans and other external financing channels for the firms. Adrian and Shin (2009) show that leverage through nonbank financing could have a significant impact on macroeconomic fluctuations and financial stability.

Our paper is also related to the literature on the unintended effects of monetary policy and financial development. Triggered by the 2008 global financial crisis, a large body of literature has discussed the impact of monetary policy on the risk-taking behaviours of financial institutions (Borio and Zhu 2012; Jimenez et al. 2014; Bruno and Shin 2015). Our paper adds to this aspect of the literature by looking at the side effects of monetary policy and financial development from the perspective of lending to zombie firms.

Previous research has addressed several related problems. For instance, Caballero, Hoshi, and Kashyap (2008) explain that Japanese zombie firms depress both the growth of investment and employment of non-zombie firms and find that the undercapitalised banks in Japan tend to support zombie firms, who are not willing to recognise the losses

of non-performing loans. In addition, Kwon, Narita, and Narita (2015) find that lending to zombie firms in the 1990s reduced the aggregate productivity growth in Japan, which exhibited severe resource misallocation. However, very few papers investigate how to prevent lending to zombie firms. Bruche and Llobet (2014) show that banks with bad loans are better informed than regulators, and these banks can use their information advantage to maximise the amount of transfers they could receive during a regulatory intervention, and that this distortion can encourage lending to zombie firms.

This paper proceeds as follows. The first section introduces the institutional background of lending to zombie firms. Then, it discusses the identification of zombie firms. In the following three sections, we develop our hypotheses, present the methodology used and the data, and present the results. Next, we show how zombie firms use the funds obtained through external financing and then conduct robustness checks. The final section concludes the paper.

Institutional background

There are three typical tools for medium- and long-term external financing for firms listed on a stock exchange, i.e. bank loans, equity, and corporate bonds. Table 1 shows the value of external financing from 2004 to 2016. Loan financing plays a dominant role over the years. When the four trillion stimulus plan was implemented by the Chinese government in 2009, loan financing doubled and reached 9.59 trillion yuan, which accounted for 68.97% of the total financing in the real economy. Equity financing played a relatively less important role, and grew from 67 billion yuan in 2004 to 1.242 trillion yuan in 2016. Bond financing witnesses a dramatic increase during the past 13 years, i.e. bond issuance accounted for 1.64% of the total financing at the outset, while

this ratio reached 16.85% in 2016.

Table 1. Annual flow of external financing channels (in billion of RMB).

Year	AFRE	RMB loans	Foreign currency loans	Entrusted loans	Trust loans	Banker's acceptances	Corporate bonds[3]	Equity financing by non-financial firms
2004	2,863	2,267	138	312	0	-29	47	67
2005	3,001	2,354	141	196	0	2	201	34
2006	4,270	3,152	146	269	83	150	231	154
2007	5,966	3,632	386	337	170	670	229	433
2008	6,980	4,904	195	426	315	107	552	333
2009	13,911	9,594	927	678	436	461	1,237	335
2010	14,019	7,945	485	875	386	2,335	1,106	579
2011	12,829	7,472	571	1,296	203	1,027	1,366	438
2012	15,763	8,204	916	1,284	1,285	1,050	2,255	251
2013	17,317	8,892	585	2,547	1,840	776	1,811	222
2014	16,413	9,781	356	2,507	517	-129	2,382	435
2015	11,333	1,126	-643	1,591	43	-1057	2,825	760
2016	17,802	1,243	-564	2,185	859	-1953	2,999	1,242

Data source: PBOC's *Aggregate Financing to the Real Economy* from 2004 to 2016.

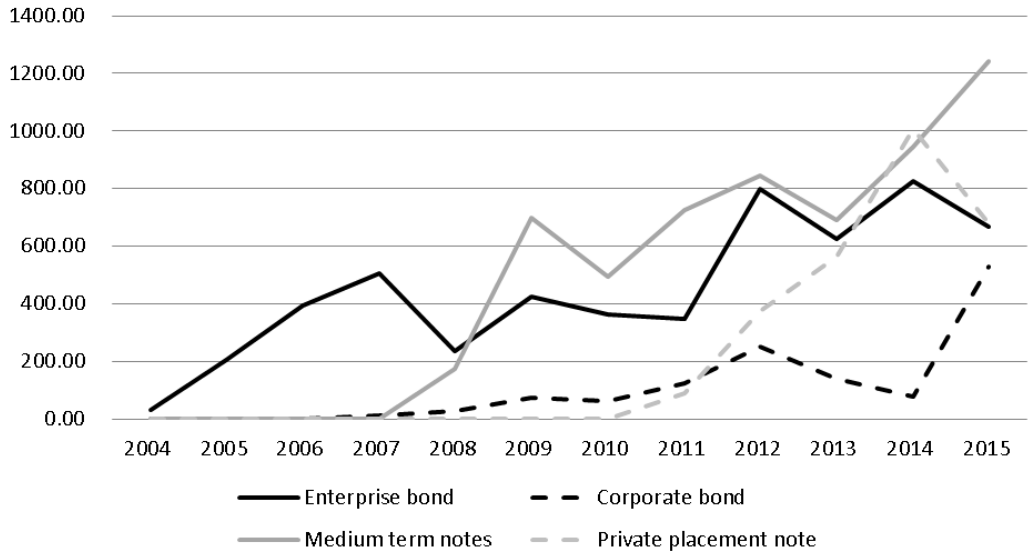

Figure 1. Bond financing by instruments (in billion of RMB).
Data sources: Data before 2014 is from *Almanac of China's Finance and Banking* by PBOC, and data in 2015 is from the Wind database.

[3] The term corporate bonds here refers to all kinds of bonds issued by firms, instead of a specific type of bond.

We present summary statistics for the bond and equity issuance by all listed firms in China from the Wind database[4] in Table 2. Equity financing has been more frequently employed than bond financing by listed firms. Chinese listed firms do not employ bonds as a regular tool for external financing, although they can raise more funds from a single bond issuance, e.g. the average size of bond financing is 1.98 billion yuan, which is 1.3 times higher than the equity financing.

Table 2. Summary statistics of bond and equity financing (in billions of RMB).

	Total	State owned	Private
Bond			
Observations	1,014	632	382
Average Amount (million)	1,977.49	2,512.00	1093.16
Equity			
Observations	2,272	984	1,288
Average Amount (million)	1,473.40	1,940.98	1,116.19

Data source: the Wind database.

Loan financing

China has a bank-dominated financial system. Loan financing accounted for about 95% of the total financing to the real economy in 2004, while it decreased to 69.86% in 2016 with the development of the equity and bond markets. On average, ordinary loans accounted for 85.94% of the medium- and long-term loan financing during 2011-2014, syndicated loans for 12.40%, and 1.66% for trade financing, loans for mergers and acquisitions, and others (see the *Almanac of China's Finance and Banking* from 2004 to 2016). Unfortunately, there is no detailed record of bank loans to listed firms,[5] so we use increases in long-term loans as a proxy for firms' long-term loan financing.

[4] There are also records of bonds issued by non-listed or off-shore listed firms. However, our analysis focusses on the financing patterns of listed A-share firms.

[5] China Stock Market & Accounting Research releases the bank loan announcements of listed firms. However, it is not compulsory for listed firms to announce every bank loan, which results in a severe sample selection problem and cannot satisfy the criterion for our research.

Equity financing

Equity financing is not a major external financing tool in China. However, China's listed firms have a strong preference for equity financing due to the poor protection of investors. There are two ways of obtaining equity financing for listed firms, i.e. seasoned equity offering (SEO) and the allotment of shares. In our sample, SEOs were used more frequently (2,221 records), while share allotment was not commonly used (120 records).

Bond financing

The issuance volume of enterprise bonds increased about 35 times in China during 1987-1992. However, a massive default occurred afterwards (Pessarossi and Weill 2013). Also, the burgeoning of enterprise bonds squeezed out national bonds, e.g. the issuance of national bonds faced severe difficulties in 1993. Since then, China's bond market has been tightly regulated with the promulgation of a set of regulatory rules.

According to the *Securities Law of China,* a firm has to satisfy a series of requirements to be eligible to issue corporate bonds, such as meeting the criteria for firm size, issuance size, interest coverage ratio, industry, and interest rate. In addition, a firm needs to specify the intended fund usage before issuing bonds, and the funds raised through the public issuance of corporate bonds should be used for the purpose stated and cannot be used to cover deficits or non-production expenditures. The tight regulatory framework increases the cost of bond financing, which leads to the lower issuance of bonds. Furthermore, poorly performing firms at risk of delisting, such as a type of zombie firm, can barely meet these regulatory requirements (in our sample only two of them have issued bonds).

Trade credit

Apart from formal financing channels, trade credit has also become a remarkable tool for external financing, especially during the economic downturns. The delay in payment by a firm spills over to its business partners, which may trigger a triangular debt problem and increase the reliance on trade credit. Trade credit (e.g. accounts payable, bills payable and advances from customers) accounts for 34.7% of total liabilities. We identify the use of trade credit by determining whether the annual increase of the trade credit is higher than 5%.

Identification of zombie firms

Zombie firms often survive with the help from creditors or government (Kane 1987; 2000). Ahearne and Shinada (2005) define zombie firms as those companies with low productivity and high debt. However, this definition does not capture the essential characteristics of zombie firms. For example, firms in the heavy industries whose profit mainly relies on the economies of scale are often highly indebted and less productive. However, these firms can still be healthy and profitable, and thus it may be unfair to categorise them as zombie firms.

Hoshi (2006) makes an interesting analogy between zombie firms and the zombies in Hollywood films, which helps reveal the typical traits of zombie firms. Similar to human zombies who drain blood and attack humans, zombie firms rely on subsidies and hurt healthy firms. Thus, Caballero, Hoshi, and Kashyap (2008) propose the CHK criterion, which defines zombie firms as those companies receiving subsidised credit from creditors.

Subsidised zombie firms and CHK criterion

Specifically, the CHK criterion identifies firms that pay an interest expense ($R_{i,t}$) that is lower than the theoretical minimal interest expense ($R^*_{i,t}$) as zombie firms. The minimal interest expense ($R^*_{i,t}$) is calculated as follows:

$$R^*_{i,t} = rs_{t-1} * BS_{i,t-1} + \left(\frac{1}{5}\sum_{j=1}^{5} rl_{t-j}\right) * BL_{i,t-1} + rcb_{min\ over\ laset\ 5\ years,\ t} * Bonds_{i,t-1},$$

where $BS_{i,t}$, $BL_{i,t}$ and $Bonds_{i,t}$ stand for balance of short-term loans, long-term loans, and bond of firm *i* at the end of year *t*; in rs_t, rl_t and $rcb_{min\ over\ last\ 5\ years,t}$ represents the average short-term prime rate, average long-term prime rate, and the minimum observed coupon rate in year *t*.

The assumption behind the calculation of theoretical minimal interest expenses ($R^*_{i,t}$) is that firm *i* obtained all of its interest-bearing liabilities at the lowest cost available. Should the actual interest expense be less than this lower boundary, it might be due to subsidies from creditors such as debt forgiveness, interest rate concessions, debt for equity swaps, or moratoriums on interest rate payments.

We make two modifications to the CHK criterion to make it applicable to China's listed firms. On one hand, instead of using the prime rate, we use the discounted benchmark rate of the PBOC. Six-month and one-year benchmark rates are used for short-term and long-term loan rates, respectively. Financial institutions are required to set loan rates within a certain interval around the benchmark rate in China. The POBC adjusts the benchmark rate as a monetary policy tool. This unique regulatory requirement guarantees that no interest rate shall be less than the lower boundary of the interval around the benchmark, and thus it provides us with a more trustworthy estimate of the minimal interest rate. Appendix 1 lists the benchmark rate, floating range and

minimum rate during our sample period. On the other hand, disaggregated bond data is available for China's listed firms, which enables us to divide the bonds into short-term and long-term bonds, calculate their minimum coupon payments, and obtain a more accurate estimate of the firms' theoretical minimum interest expenses ($R^*_{i,t}$).

We replace $rcb_{min\ over\ last\ 5\ years,\ t} * Bonds_{i,t-1}$ with the sum of (i) $cps_{t-1} * BondS_{i,t-1}$ and (ii) $\left(\frac{1}{5}\sum_{j=1}^{5} cpl_{t-j}\right) * BondL_{i,t-1}$, where $BondS$ and $BondL$ are short-term and long-term bonds; *cps* and *cpl* are the observed minimum coupon rate for short-term and long-term bonds, respectively. Finally, we derive our estimate of the theoretical minimum interest expenses ($R^*_{i,t}$) as follows:

$$R^*_{i,t} = rs_{t-1} * BS_{i,t-1} + \left(\frac{1}{5}\sum_{j=1}^{5} rl_{t-j}\right) * BL_{i,t-1} + cps_{t-1} * BondS_{i,t-1} + \left(\frac{1}{5}\sum_{j=1}^{5} cpl_{t-j}\right) * BondL_{i,t-1}.$$

Poorly-performing zombie firms and STPT criterion

While the CHK criterion accurately depicts the type of zombie firms that rely on subsidies from creditors, it leaves out another type of zombie firms, i.e. poorly-performing zombie firms. Poorly-performing firms often face consecutive deficits, technical bankruptcy (i.e. their total liabilities exceed their total assets), and their potential risks of big losses or delisting, and so forth. Similar to the CHK zombies, these firms should have gone bankruptcy and been delisted from the stock market, but they still remain active. They consume resources and destroy healthy firms, which is harmful to the economy.

The China Securities Regulatory Commission (CSRC) publishes a special treatment list for poorly-performing firms, i.e. the 'ST' label is put in front of the stock name of firms as a warning to investors. For those firms facing an immediate risk of

delisting, the '*ST' label is put in front of the stock name (the '*ST' warning label used to be 'PT'). The 'ST' and '*ST' list enable us to identify a sample of poorly-performing firms. We thus identify poorly performing firms according to the 'ST' and '*ST' list and categorise them as STPT zombies.

Subsidised and poorly-performing zombie firms and FN criterion

In 2011, Fukuda and Nakamura (FN) proposed the FN criterion based on CHK criterion; the FN criterion can be used to detect firms that rely on subsidies and perform poorly (FN zombies). Their first adjustment ensures that the FN criterion does not include firms with an EBIT higher than minimum interest expenses ($R^*_{i,t}$) as zombies, even if their actual interest payment ($R_{i,t}$) is lower than $R^*_{i,t}$. It is very useful for distinguishing low interest payments that are due to subsidies from the bargaining power. This adjustment decreases the type one error, i.e. categorising healthy firms as zombies (Fukuda and Nakamura 2011).

Also, the FN criterion further categorises firms with an EBIT lower than the minimum interest expenses ($R^*_{i,t}$) and an increasing borrowing amount as zombie firms. Banks may also support troubled firms through 'evergreen lending' other than direct subsidies. Thus, the FN criterion augments the CHK criterion, and the FN criterion also reduces the type two error (i.e. categorising zombie firms as healthy firms).

Hypotheses

Zombie firms, according to our definition, should be less profitable and more financially risky than healthy firms. As a result, lenders, shareholders and other investors are not willing to provide financing to them. Therefore, we propose our first

hypothesis:

H1: Zombie firms (CHK, STPT and FN) are less likely to obtain formal financing.

Formal financing refers to loan, bond and equity financing. Although zombie firms have limited access to formal financing in general, they are still prevalent in the market, which suggests that some financiers indeed help zombie firms survive. We will analyse various financing channels that are available to zombie firms.

As CHK zombies rely on subsidies from the government and/or creditors, they are not favoured by banks. They do not offer any advantage in equity financing either. Subsidies, as a type of non-operating income, are not sustainable and quite volatile. Thus, the stocks of CHK zombie firms are riskier and less attractive than healthy firms with similar performance.

However, CHK zombies may resort to their suppliers for trade credit, which is different from bank financing in the sense that suppliers have proprietary information about these firms (Petersen and Rajan 1997). Therefore, suppliers have a better understanding of the implicit support offered by the government to CHK zombies than banks and equity investors, so suppliers finance these firms through trade credits. As a result, CHK zombies may use trade credits from their suppliers.

STPT zombies have high default risks and perform poorly, and thus both banks and suppliers are cautious about granting credit to them. However, instead of being discriminated by creditors, these firms are often chased by investors in the stock market. Due to the high financial and regulatory costs of IPOs in the stock market, listed firms have remarkable shell values. When a listed firm performs poorly over a few consecutive years, parent firms and large shareholders often prop up the firm to avoid

delisting and keep its shell value. Apart from these insiders, other non-listed firms may seek the chance to gain a back-door listing by purchasing the stock of STPT zombies.

FN zombies are the worst type of zombie firms, and they are not attractive to either banks or suppliers; we conjecture that they have difficulty in obtaining financing from any channel. Therefore, we propose our second set of hypotheses on the financing channels that keep the three types of zombie firms afloat in China:

H2a: CHK zombies could obtain financing from suppliers (trade credits), despite being discriminated in other markets.

H2b: STPT zombies could obtain financing from the equity market despite being discriminated in other markets.

H2c: FN zombies are discriminated in all markets.

We also examine the impact of monetary policy on the choice of financing channels by zombie firms. Monetary policy influences the behaviours of households, firms and financial institutions by adjusting the interest rates and money supply; this can affect firms' access to finance in general. However, zombie lending is a structural issue (i.e. financial resources allocated to poorly performing firms), which cannot be alleviated by a loose monetary policy. Even worse, a loose monetary policy may aggravate the resource misallocation. We thus propose our third hypothesis:

H3: Zombie firms (CHK, STPT and FN) benefit more from loose monetary policy comparing to healthy firms.

Also, we investigate the role of financial developments in zombie firms' financing. Financial development may enhance resource allocation and facilitate economic growth. We will examine whether this theory still holds in an economy, like China's, that is

congested with zombie firms.

On one hand, financial development can alleviate information asymmetry between fund suppliers and users. As a result, financial resources can be allocated in a more efficient manner, e.g. with less funds allocated to zombie firms. On the other hand, financial development can also harm credit allocation efficiency via loose monetary policy. For example, an abundant supply of funds leads to lower requirements, and thus helps zombie firms obtain funds easily. We propose our fourth hypothesis as follows:

H4: Zombie firms (CHK, STPT and FN) benefit more from financial development compared to healthy firms.

We also examine the use of funds by zombie firms, which may shed light on the misallocation of funds. Zombie firms are subject to severe agency problems and cream-skimming due to conflicts of interest. We thus suspect that even if zombie firms receive external funds, they may not use them in an efficient way. In particular, we suspect that zombie firms are more likely to channel the funds away from the firm rather than investing the funds in the firm.

Besides, zombies are often more heavily indebted than healthy firms, and thus face higher burdens of debt repayment. Zombie firms may pursue external financing to repay their debts earlier, which is consistent with the concept of 'zombie lending', 'forbearance lending' or 'evergreening' (Sekine, Kobayashi, and Saita 2003; Fukuda and Nakamura 2011; Kwon, Narita, and Narita 2015).

Thus, our fifth hypothesis is as follows:

H5: Instead of increasing real investment, zombie firms (CHK, STPT and FN) spend more on debt repayment and dividend distribution than healthy firms.

Data and methodology

Our data set consists of 2,749 listed non-financial firms in China. To alleviate concern regarding the reform of non-tradable shares,[6] we limit our sample period to 2005-2015. After excluding records with missing data, we have 19,999 firm-year observations. Firm level information is retrieved from the Wind and CSMAR databases, and the macroeconomic indicators are obtained from the National Bureau of Statistics of China (NBS), CSRC and PBOC. We winsorise firm-specific variables at the 1st and 99th percentiles.

We focus on three types of formal financing, namely loan, equity, and bond financing. We use changes in long-term loans to measure the loan financing, i.e. a dummy indicating an increase of long-term loans above 5%. Furthermore, we use the SEOs or share allotment to measure the equity financing. The Wind database has a full record of the bonds issued by listed firms, and thus allows us to identify whether a firm has bond financing in a specific year or not. Firms without a financing channel are categorised as having no formal financing. In addition, we examine whether the changes to firms' trade credits are above 5% to measure the trade credit.

Table 3 shows an overview of firms' financing choices by year. Loan and equity financing are the major financing tools, while bond financing is not used very much. All three financing tools exhibit an upward trend. Also, trade credit plays an important role.

[6]The reformation initiated in 2005, which aims to improve the shareholder structure of listed firms.

Table 3. Firms' financing choice by year.

		2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Loan	Yes	365	391	405	424	591	509	618	582	775	694	747
	No	898	886	923	1015	923	1107	1330	1644	1626	1709	1783
Bond	Yes	1	3	15	18	58	35	120	201	156	167	238
	No	1276	1338	1441	1515	1571	1937	2130	2130	2250	2363	2511
Equity	Yes	3	56	162	131	133	169	190	153	249	384	597
	No	1274	1285	1294	1402	1496	1803	2060	2251	2157	2146	2152
Formal financing	Yes	382	481	620	601	676	964	1041	967	1014	1148	1426
	No	895	860	836	932	862	1008	1209	1437	1392	1382	1323
Trade credit	Yes	491	472	539	648	559	541	743	881	888	1021	1131
	No	729	766	761	756	926	1036	1171	1325	1473	1348	1361

Panels A to D of Table 4 compare the characteristics of firms that have obtained formal, loan, equity financing, and trade credits, respectively, and versus other firms without a financing tool. The variable definitions are listed in Appendix 2.

Table 4. Summary statistics of independent variables.

	No. of Obs.		Mean			Std. Dev.		Min		Median		Max	
	Yes	No	Yes	No	Diff	Yes	No	Yes	No	Yes	No	Yes	No
Panel A: Formal													
CHK	7384	9995	0.191	0.186	0.005	0.393	0.389	0	0	0	0	1	1
STPT	9410	12075	0.038	0.102	-0.0639***	0.192	0.303	0	0	0	0	1	1
FN	7297	9921	0.070	0.068	0.002	0.255	0.251	0	0	0	0	1	1
Size	9410	12075	7.596	6.954	0.0054***	1.474	1.481	2.868	2.868	7.467	6.939	11.284	11.284
Tangibility	9410	12075	0.239	0.253	-0.0137***	0.181	0.175	0.002	0.002	0.202	0.219	0.756	0.756
Age	9410	12075	8.382	8.991	-0.6094***	6.251	5.729	0	1	8	9	25	25
Panel B: Loan													
CHK	5541	11585	0.178	0.185	-0.007	0.383	0.388	0	0	0	0	1	1
STPT	6101	13789	0.047	0.095	-0.0479***	0.211	0.293	0	0	0	0	1	1
FN	5485	11505	0.081	0.064	0.0170***	0.273	0.245	0	0	0	0	1	1
Size	6101	13789	7.761	7.071	0.6900***	1.459	1.498	2.868	2.868	7.624	7.032	11.284	11.284
Tangibility	6101	13789	0.258	0.251	0.0071***	0.187	0.175	0.002	0.002	0.228	0.217	0.756	0.756
Age	6101	13789	9.974	9.107	0.8677***	5.455	5.749	1	1	10	9	25	25
Panel C: Equity													
CHK	2034	15345	0.169	0.191	-0.0220***	0.375	0.393	0	0	0	0	1	1
STPT	2227	19258	0.067	0.075	-0.0083*	0.250	0.264	0	0	0	0	1	1
FN	2013	15205	0.035	0.073	-0.0380***	0.183	0.260	0	0	0	0	1	1
Size	2227	19258	7.807	7.169	0.6380***	1.315	1.519	2.868	2.868	7.643	7.097	11.284	11.284
Tangibility	2227	19258	0.226	0.250	-0.0239***	0.169	0.179	0.002	0.002	0.189	0.215	0.756	0.756
Age	2227	19258	9.681	8.614	1.0670***	5.564	6.007	0	0	9	8	25	25

Panel D: Trade credit													
CHK	10069	6743	0.181	0.184	-0.003	0.385	0.388	0	0	0	0	1	1
STPT	11650	7901	0.054	0.108	-0.0547***	0.225	0.311	0	0	0	0	1	1
FN	9968	6688	0.059	0.086	-0.0270***	0.235	0.280	0	0	0	0	1	1
Size	11650	7901	7.428	7.137	0.2903***	1.446	1.557	2.868	2.868	7.322	7.116	11.284	11.284
Tangibility	11650	7901	0.241	0.267	-0.0264***	0.171	0.182	0.002	0.002	0.208	0.238	0.756	0.756
Age	11650	7901	8.902	10.051	-1.1486***	5.657	5.631	1	1	8	10	25	25

Generally speaking, zombie firms are less likely to raise funds from any of these financing tools. However, the mean of the FN zombies in Panel B is significantly higher than that of non-FN zombies, which may be caused by simultaneity. Insolvent firms with increasing loan financing are more likely to be classified as FN zombies. When we use the lagged FN zombies, we consistently find that zombie firms obtained less external financing.

Table 5 shows the correlation of variables. The correlation coefficient of STPT zombies and size is -0.277, while the correlation among the zombie indicators and control variables are even smaller, which alleviates concerns about multi-collinearity.

Table 5. Correlation table.

		[1]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
Loan	[1]	1								
Equity	[3]	0.095	1							
Formal	[4]	0.834	0.349	1						
Trade credit	[5]	0.080	0.064	0.089	1					
CHK	[6]	-0.007	-0.018	0.008	-0.005	1				
STPT	[7]	-0.083	-0.014	-0.111	-0.102	-0.021	1			
FN	[8]	0.029	-0.049	0.002	-0.055	0.090	0.040	1		
Size	[9]	0.205	0.136	0.172	0.096	-0.016	-0.277	-0.088	1	
Tangibility	[10]	0.025	-0.045	-0.017	-0.070	-0.092	0.040	0.059	0.100	1
Age	[11]	0.065	0.066	-0.079	-0.099	0.011	0.160	0.056	0.180	0.026

We test the hypothesis using a linear probability model (LPM). Non-linear models with a comprehensive set of fixed effects may come across incidental parameter problems and yield inconsistent estimates. The LPM is as follows:

$$Financing\ choice_{i,t} = Zombie_{i,t-1} * \beta_0 + Character_{i,t-1} * \beta_1 + Macro_{i,t} * \beta_2 + \gamma_i + \delta_t$$

Financing choice is a set of binary variables: *Formal*, *L*oan, *Equity* and *Trade credit*. Zombie includes the three zombie indicators, *CHK*, *STPT* and *FN*, whose coefficients reflect the financing patterns of different types of zombie firms. *Character* is a set of firm level control variables such as *Size*, *Tangibility* and *Age*. All firm level variables are lagged by one year to alleviate the endogeneity problem.

Macro stands for the macroeconomic indicators of the firms' location. γ and δ capture firm and year fixed effects, respectively, and *Macro* and δ will not be included in the same equation. The definitions and descriptive statistics of these variables are given in Appendix 2 and Table 4.

Results

Our baseline model includes zombie indicators, firm characteristics, macroeconomic indicators and firm fixed effects. Groups A to D use Formal loan, Equity and Trade credit as independent variables, sequentially. We use the zombie indicators of CHK, STPT and FN as different specifications.

Table 6 shows that the coefficients of the zombie indicators are negative with CHK and FN being significant at the 10% and 1% levels, which suggests that all kinds of zombie firms are less likely to obtain formal financing. The probability of formal financing for CHK zombies and FN zombie is lower than that for healthy firms by 1.98% and 8.42%, respectively. We then disaggregate the formal financing by using different tools.

Table 6. LPM for the choice of financing channels.

	(A) Formal			(B) Loan			(C) Equity			(D) Trade credit		
	CHK	STPT	FN	CHK	STPT	FN	CHK	STPT	FN	CHK	STPT	FN
	(1)	(2)	(3)	(4)	(5)	(6)	(10)	(11)	(12)	(13)	(14)	(15)
Zombie	-0.0198*	-0.0115	-0.0842***	-0.0125	-0.0261*	-0.0757***	-0.0176**	0.0284***	-0.0161	0.0512***	-0.0350*	-0.0651***
	(0.0107)	(0.0159)	(0.0165)	(0.0104)	(0.0146)	(0.0164)	(0.0072)	(0.0106)	(0.0106)	(0.0118)	(0.0181)	(0.0176)
Size	0.0363***	0.0388***	0.0345***	0.0205***	0.0206***	0.0190**	-0.0061	-0.0022	-0.0067	-0.0474***	-0.0510***	-0.0515***
	(0.0077)	(0.0069)	(0.0077)	(0.0075)	(0.0068)	(0.0075)	(0.0051)	(0.0046)	(0.0051)	(0.0083)	(0.0078)	(0.0083)
Tangibility	-0.3198***	-0.2175***	-0.3052***	-0.4303***	-0.3385***	-0.4247***	0.0972***	0.1346***	0.1048***	-0.2316***	-0.2410***	-0.2420***
	(0.0458)	(0.0413)	(0.0458)	(0.0446)	(0.0402)	(0.0443)	(0.0304)	(0.0263)	(0.0305)	(0.0500)	(0.0450)	(0.0502)
Age	0.0149***	0.0182***	0.0154***	0.0014	0.0047***	0.0014	0.0170***	0.0180***	0.0174***	-0.0038*	-0.0028	-0.0038*
	(0.0019)	(0.0017)	(0.0019)	(0.0018)	(0.0016)	(0.0018)	(0.0010)	(0.0010)	(0.0010)	(0.0020)	(0.0018)	(0.0020)
M2 growth	0.4023***	0.3454***	0.4093***	0.5773***	0.5288***	0.5718***	-0.0014	-0.0217	0.0148	0.3497***	0.3551***	0.3598***
	(0.1094)	(0.0902)	(0.1100)	(0.1105)	(0.0910)	(0.1114)	(0.0690)	(0.0555)	(0.0701)	(0.1168)	(0.0972)	(0.1180)
Stock return	0.0171**	0.0262***	0.0192***	0.0112	0.0189***	0.0101	0.0158***	0.0203***	0.0170***	0.0063	0.0081	0.0036
	(0.0072)	(0.0063)	(0.0072)	(0.0071)	(0.0062)	(0.0071)	(0.0045)	(0.0041)	(0.0046)	(0.0083)	(0.0074)	(0.0084)
Constant	0.0302	-0.0570	0.0341	0.1858***	0.1132**	0.1981***	-0.0296	-0.0794**	-0.0358	0.9663***	0.9939***	1.0133***
	(0.0582)	(0.0508)	(0.0580)	(0.0572)	(0.0501)	(0.0571)	(0.0381)	(0.0324)	(0.0379)	(0.0626)	(0.0554)	(0.0627)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	16,091	19,967	15,929	16,043	19,859	15,906	16,091	19,967	15,929	15,800	19,541	15,641
R-squared	0.0234	0.0255	0.0251	0.0114	0.0101	0.0132	0.0233	0.0279	0.0230	0.0118	0.0102	0.0120
No. of ticker	2,391	2,530	2,391	2,391	2,530	2,391	2,391	2,530	2,391	2,379	2,517	2,379

Notes: (1) Dependent variable equals 1 when a firm uses a financing channel and 0 otherwise. (2) Firm characteristics, macroeconomic indicators and firm fixed effects are controlled. (3) Dependent variables in Groups A to D are *Formal*, *Loan*, *Equity* and *Trade credit*, respectively. (4) CHK, STPT and FN are used as indicators for zombie firms. (5) All firm level variables are lagged by one period, robust standard errors in parentheses. (6) *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively.

CHK zombies, i.e. firms with subsidies from creditors, are not favoured by banks or equity investors. However, the significantly positive coefficient in specification (13) suggests that they have a 5.12% higher chance of receiving in formal financing (trade credit). This result corroborates our hypothesis that suppliers, with their closer ties to CHK zombies, have more information about their implicit governmental support, and thus are more willing to finance these zombie firms through trade credit.

STPT zombies, i.e. firms with poor financial performance, are difficult to obtain external financing except in the equity market. In fact, these firms seem to be preferred by equity investors. Once a listed firm performs poorly and faces the risk of delisting, insiders (parent firms and large shareholders) have incentives to prop up the firm in order to prevent delisting, and outsiders also have incentives to buy these stocks for the sake of the firm's shell value (i.e. the value created by being listed on the stock exchange). Consequently, the chances of equity financing for STPT zombies are higher than healthy firms by 2.84%.

The FN zombie firms, i.e. firms receiving subsidies and also performing poorly, is the worst type of zombie firm. These firms have difficulty accessing financing from all types of financing channels.

Influence of monetary policy

In the context of loose monetary policy, interest rate often goes down. We construct the variable, *Rate*, which equals 1 if the ten-year benchmark loan rate set by the PBOC is lower than the previous year, and 0 otherwise. In the same vein, we use another variable, *Reserve*, which equals to 1 if the year-end reserve rate is lower than that of the previous year, to capture the changes in monetary policy. We add their interaction terms to the zombie indicators to reveal the impact of monetary policy on zombie firms' financing patterns in the different panels.

Table 7. LPM for the choice of financing tools.

Panel A	(A) Formal			(B) Loan			(C) Equity			(D) Trade credit		
	CHK	STPT	FN	CHK	STPT	FN	CHK	STPT	FN	CHK	STPT	FN
	(1)	(2)	(3)	(4)	(5)	(6)	(10)	(11)	(12)	(13)	(14)	(15)
Zombie	-0.0137	-0.0195	-0.1050***	-0.0153	-0.0310*	-0.0942***	-0.0066	0.0055	-0.0357***	0.0212	-0.0386*	-0.0992***
	(0.0144)	(0.0192)	(0.0240)	(0.0144)	(0.0180)	(0.0238)	(0.0085)	(0.0115)	(0.0109)	(0.0153)	(0.0222)	(0.0264)
Rate*Zombie	-0.0143	0.0285	0.0343	-0.0008	0.0138	0.0272	-0.0185	0.0718***	0.0402**	0.0523**	0.0028	0.0553
	(0.0205)	(0.0247)	(0.0312)	(0.0199)	(0.0231)	(0.0308)	(0.0132)	(0.0176)	(0.0191)	(0.0220)	(0.0296)	(0.0346)
Size	0.0378***	0.0404***	0.0366***	0.0208***	0.0212***	0.0197***	-0.0023	0.0017	-0.0023	-0.0474***	-0.0496***	-0.0506***
	(0.0077)	(0.0070)	(0.0077)	(0.0075)	(0.0068)	(0.0075)	(0.0051)	(0.0046)	(0.0051)	(0.0084)	(0.0078)	(0.0084)
Tangibility	-0.3365***	-0.2384***	-0.3238***	-0.4346***	-0.3465***	-0.4301***	0.0662**	0.1022***	0.0726**	-0.2090***	-0.2243***	-0.2237***
	(0.0461)	(0.0416)	(0.0461)	(0.0447)	(0.0405)	(0.0445)	(0.0304)	(0.0264)	(0.0305)	(0.0502)	(0.0454)	(0.0505)
Age issue	0.0155***	0.0187***	0.0152***	-0.0022	0.0014	-0.0022	0.0236***	0.0239***	0.0230***	-0.0087***	-0.0066***	-0.0082***
	(0.0020)	(0.0018)	(0.0020)	(0.0020)	(0.0018)	(0.0020)	(0.0011)	(0.0010)	(0.0011)	(0.0022)	(0.0020)	(0.0022)
Constant	0.0907*	0.0056	0.1023*	0.3026***	0.2252***	0.3126***	-0.0886***	-0.1244***	-0.0863**	1.0366***	1.0460***	1.0730***
	(0.0546)	(0.0478)	(0.0541)	(0.0532)	(0.0471)	(0.0529)	(0.0340)	(0.0291)	(0.0337)	(0.0598)	(0.0537)	(0.0595)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	16,091	19,967	15,929	16,043	19,859	15,906	16,091	19,967	15,929	15,800	19,541	15,641
R-squared	0.0259	0.0279	0.0280	0.0144	0.0121	0.0164	0.0377	0.0438	0.0376	0.0165	0.0139	0.0166
Number of ticker	2,391	2,530	2,391	2,391	2,530	2,391	2,391	2,530	2,391	2,379	2,517	2,379

Panel B	(A) Formal			(B) Loan			(C) Equity			(D) Trade credit		
	CHK	STPT	FN	CHK	STPT	FN	CHK	STPT	FN	CHK	STPT	FN
	(1)	(2)	(3)	(4)	(5)	(6)	(10)	(11)	(12)	(13)	(14)	(15)
Zombie	-0.0204	-0.0152	-0.0971***	-0.0205	-0.0239	-0.0788***	-0.0117	0.0042	-0.0485***	0.0180	-0.0379	-0.0813***
	(0.0153)	(0.0198)	(0.0259)	(0.0151)	(0.0185)	(0.0255)	(0.0100)	(0.0128)	(0.0128)	(0.0167)	(0.0236)	(0.0302)
Reserve*Zombie	-0.0002	0.0153	0.0173	0.0083	-0.0019	-0.0002	-0.0065	0.0612***	0.0542***	0.0489**	0.0010	0.0202
	(0.0197)	(0.0228)	(0.0303)	(0.0191)	(0.0210)	(0.0296)	(0.0129)	(0.0163)	(0.0182)	(0.0219)	(0.0284)	(0.0360)
Size	0.0378***	0.0402***	0.0362***	0.0207***	0.0212***	0.0193**	-0.0024	0.0013	-0.0025	-0.0473***	-0.0497***	-0.0514***
	(0.0077)	(0.0070)	(0.0077)	(0.0075)	(0.0069)	(0.0075)	(0.0051)	(0.0045)	(0.0050)	(0.0084)	(0.0078)	(0.0084)
Tangibility	-0.3356***	-0.2396***	-0.3228***	-0.4343***	-0.3475***	-0.4290***	0.0672**	0.1002***	0.0729**	-0.2104***	-0.2244***	-0.2220***
	(0.0461)	(0.0415)	(0.0461)	(0.0447)	(0.0404)	(0.0445)	(0.0304)	(0.0263)	(0.0305)	(0.0502)	(0.0454)	(0.0504)
Age issue	0.0153***	0.0190***	0.0156***	-0.0021	0.0015	-0.0020	0.0232***	0.0247***	0.0234***	-0.0074***	-0.0065***	-0.0077***
	(0.0020)	(0.0018)	(0.0020)	(0.0019)	(0.0018)	(0.0019)	(0.0011)	(0.0010)	(0.0011)	(0.0021)	(0.0020)	(0.0021)
Constant	0.0937*	0.0039	0.1009*	0.3017***	0.2250***	0.3124***	-0.0839**	-0.1302***	-0.0902***	1.0198***	1.0459***	1.0716***
	(0.0544)	(0.0480)	(0.0542)	(0.0530)	(0.0472)	(0.0530)	(0.0340)	(0.0294)	(0.0337)	(0.0594)	(0.0540)	(0.0595)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	16,091	19,967	15,929	16,043	19,859	15,906	16,091	19,967	15,929	15,800	19,541	15,641
R-squared	0.0258	0.0278	0.0279	0.0144	0.0121	0.0163	0.0376	0.0435	0.0378	0.0164	0.0139	0.0164
Number of ticker	2,391	2,530	2,391	2,391	2,530	2,391	2,391	2,530	2,391	2,379	2,517	2,379

Notes: (1) Dependent variable equals 1 when a firm uses a financing tool and 0 otherwise. (2) Firm characteristics, macroeconomic indicators and firm fixed effects are controlled. (3) Dependent variables in Groups A to D are *Formal*, *Loan*, *Equity* and *Trade credit* respectively. (4) CHK, STPT and FN are used as indicators for zombie firms. (5) All firm level variables are lagged by one period, robust standard errors in parentheses. (6) *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively.

In Panel A of Table 7, we focus on the changes in the benchmark rate. Group A examines the effect of monetary policy on formal financing. None of the interaction terms are significant, which suggests that monetary policy may not change the accessibility of formal financing for these zombie firms. Groups B to D of Table 7 show that a loose monetary policy gives CHK zombies an additional 5.23% chance of receiving informal financing. The STPT zombies' probability of receiving equity financing also increases by 7.18% compared to healthy firms. FN zombies also benefit from a monetary easing in the sense that the availability of equity financing increases more than it does in healthy firms. In Panel B, we replace the variable *Rate* with *Reserve*, and investigate the impact of changes in the reserve rate on the financing pattern of zombie firms. The results are very similar to those in Panel A.

Influence of financial development

We use two measurements for financial development at the province level (He, Xue, and Zhu 2016). One indicator is the loan to GDP ratio, and the other is the capitalisation to GDP ratio (total capitalisation of listed firms to GDP). We sort the financial development indicators by year. The top half is categorised as the high financial development group, while the bottom half is the low financial development group. We split the full sample into two subsamples, accordingly.

Table 8 reports the results of the baseline regressions using different subsamples. Panel A shows that the CHK zombies are less likely to obtain formal financing only in provinces with low financial development. Also, the FN zombies are discriminated more in regions where loan amount to GDP is lower. While FN zombies have difficulty accessing formal financing regardless of the development of stock market, this effect is more pronounced in provinces with lower stock capitalisation to GDP ratios.

Table 8. LPM for the choice of financing channel.

Panel A: Formal	Loan to GDP						Capitalisation to GDP					
	CHK		STPT		FN		CHK		STPT		FN	
	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Zombie	-0.0048	-0.0322**	0.0281	-0.0173	-0.0662**	-0.1006***	-0.0171	-0.0310**	0.0226	-0.0323	-0.0844***	-0.0868***
	(0.0156)	(0.0154)	(0.0242)	(0.0208)	(0.0261)	(0.0216)	(0.0160)	(0.0150)	(0.0242)	(0.0213)	(0.0249)	(0.0225)
Size	0.0285***	0.0437***	0.0330***	0.0479***	0.0283**	0.0419***	0.0168	0.0435***	0.0233**	0.0436***	0.0154	0.0412***
	(0.0109)	(0.0111)	(0.0100)	(0.0100)	(0.0111)	(0.0111)	(0.0116)	(0.0117)	(0.0106)	(0.0105)	(0.0117)	(0.0116)
Tangibility	-0.3073***	-0.3522***	-0.2055***	-0.2737***	-0.2920***	-0.3380***	-0.2708***	-0.3813***	-0.1533**	-0.2786***	-0.2526***	-0.3729***
	(0.0703)	(0.0641)	(0.0623)	(0.0576)	(0.0705)	(0.0640)	(0.0723)	(0.0655)	(0.0648)	(0.0572)	(0.0727)	(0.0656)
Age	0.0195***	0.0118***	0.0234***	0.0147***	0.0194***	0.0121***	0.0218***	0.0121***	0.0263***	0.0161***	0.0221***	0.0125***
	(0.0028)	(0.0029)	(0.0026)	(0.0027)	(0.0028)	(0.0029)	(0.0030)	(0.0029)	(0.0028)	(0.0027)	(0.0030)	(0.0029)
Constant	0.0902	0.1043	-0.0123	0.0117	0.0931	0.1133	0.1649**	0.0971	0.0341	0.0174	0.1709**	0.1081
	(0.0776)	(0.0777)	(0.0681)	(0.0689)	(0.0781)	(0.0772)	(0.0818)	(0.0811)	(0.0721)	(0.0718)	(0.0818)	(0.0807)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	7,826	8,265	9,917	10,050	7,732	8,197	7,934	8,157	9,937	10,030	7,836	8,093
R-squared	0.0291	0.0245	0.0321	0.0259	0.0307	0.0268	0.0267	0.0232	0.0307	0.0249	0.0292	0.0249
No. of ticker	1,413	1,382	1,535	1,464	1,411	1,381	1,462	1,397	1,563	1,494	1,461	1,396

Panel B: Loan	Loan to GDP						Capitalisation to GDP					
	CHK		STPT		FN		CHK		STPT		FN	
	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Zombie	-0.0097	-0.0194	0.0072	-0.0391**	-0.0580**	-0.1006***	-0.0146	-0.0193	0.0122	-0.0544***	-0.0663***	-0.0915***
	(0.0151)	(0.0154)	(0.0227)	(0.0193)	(0.0264)	(0.0210)	(0.0157)	(0.0149)	(0.0222)	(0.0198)	(0.0250)	(0.0221)
Size	0.0215**	0.0215*	0.0232**	0.0231**	0.0213**	0.0196*	0.0114	0.0193*	0.0141	0.0195*	0.0112	0.0163
	(0.0103)	(0.0110)	(0.0094)	(0.0100)	(0.0104)	(0.0110)	(0.0107)	(0.0116)	(0.0101)	(0.0103)	(0.0108)	(0.0116)
Tangibility	-0.4129***	-0.4591***	-0.3177***	-0.3869***	-0.4004***	-0.4557***	-0.3729***	-0.4966***	-0.2722***	-0.3920***	-0.3602***	-0.4976***
	(0.0706)	(0.0613)	(0.0603)	(0.0567)	(0.0708)	(0.0604)	(0.0724)	(0.0623)	(0.0629)	(0.0563)	(0.0725)	(0.0617)
Age	0.0008	-0.0046	0.0045*	-0.0012	0.0009	-0.0044	0.0025	-0.0039	0.0070***	0.0000	0.0027	-0.0035
	(0.0028)	(0.0028)	(0.0026)	(0.0026)	(0.0028)	(0.0028)	(0.0029)	(0.0028)	(0.0027)	(0.0025)	(0.0029)	(0.0028)
Constant	0.2436***	0.3447***	0.1552**	0.2670***	0.2422***	0.3608***	0.3027***	0.3544***	0.1963***	0.2709***	0.2990***	0.3746***
	(0.0746)	(0.0768)	(0.0656)	(0.0681)	(0.0749)	(0.0765)	(0.0772)	(0.0811)	(0.0692)	(0.0706)	(0.0774)	(0.0808)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	7,794	8,249	9,851	10,008	7,716	8,190	7,904	8,139	9,868	9,991	7,821	8,085
R-squared	0.0156	0.0164	0.0136	0.0146	0.0169	0.0194	0.0136	0.0172	0.0116	0.0152	0.0150	0.0200
No. of ticker	1,413	1,381	1,535	1,464	1,411	1,381	1,462	1,397	1,563	1,494	1,461	1,396

Panel C: Equity	Loan to GDP						Capitalisation to GDP					
	CHK		STPT		FN		CHK		STPT		FN	
	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Zombie	-0.0090	-0.0245**	0.0512***	0.0353**	-0.0019	-0.0183	-0.0098	-0.0290***	0.0543***	0.0219	-0.0120	-0.0112
	(0.0104)	(0.0101)	(0.0169)	(0.0143)	(0.0169)	(0.0135)	(0.0104)	(0.0104)	(0.0164)	(0.0136)	(0.0163)	(0.0145)
Size	-0.0151**	0.0055	-0.0115*	0.0103	-0.0155**	0.0056	-0.0199**	0.0031	-0.0091	0.0019	-0.0208**	0.0031
	(0.0075)	(0.0068)	(0.0065)	(0.0062)	(0.0076)	(0.0068)	(0.0085)	(0.0071)	(0.0072)	(0.0066)	(0.0084)	(0.0072)
Tangibility	0.0435	0.0999**	0.0684	0.1330***	0.0529	0.1063***	0.0450	0.0895**	0.0879**	0.1123***	0.0504	0.0974**
	(0.0480)	(0.0404)	(0.0418)	(0.0346)	(0.0482)	(0.0408)	(0.0510)	(0.0422)	(0.0438)	(0.0365)	(0.0512)	(0.0428)
Age	0.0238***	0.0231***	0.0256***	0.0239***	0.0240***	0.0232***	0.0257***	0.0214***	0.0266***	0.0233***	0.0259***	0.0215***
	(0.0016)	(0.0015)	(0.0015)	(0.0014)	(0.0016)	(0.0015)	(0.0017)	(0.0015)	(0.0016)	(0.0015)	(0.0017)	(0.0015)
Constant	0.0046	-0.1489***	-0.0399	-0.1949***	0.0013	-0.1546***	0.0351	-0.1204**	-0.0575	-0.1319***	0.0385	-0.1281***
	(0.0511)	(0.0453)	(0.0426)	(0.0402)	(0.0510)	(0.0452)	(0.0573)	(0.0467)	(0.0468)	(0.0418)	(0.0567)	(0.0465)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	7,826	8,265	9,917	10,050	7,732	8,197	7,934	8,157	9,937	10,030	7,836	8,093
R-squared	0.0354	0.0403	0.0408	0.0455	0.0352	0.0398	0.0410	0.0334	0.0466	0.0378	0.0412	0.0325
No. of ticker	1,413	1,382	1,535	1,464	1,411	1,381	1,462	1,397	1,563	1,494	1,461	1,396

Panel D: Trade credit	Loan to GDP						Capitalisation to GDP					
	CHK		STPT		FN		CHK		STPT		FN	
	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Zombie	0.0494***	0.0431**	-0.0368	-0.0295	-0.0112	-0.1071***	0.0543***	0.0313*	-0.0242	-0.0397	-0.0290	-0.0914***
	(0.0164)	(0.0178)	(0.0260)	(0.0257)	(0.0254)	(0.0237)	(0.0167)	(0.0180)	(0.0267)	(0.0260)	(0.0257)	(0.0234)
Size	-0.0567***	-0.0376***	-0.0556***	-0.0457***	-0.0589***	-0.0430***	-0.0736***	-0.0435***	-0.0730***	-0.0471***	-0.0774***	-0.0492***
	(0.0127)	(0.0114)	(0.0121)	(0.0103)	(0.0126)	(0.0116)	(0.0125)	(0.0124)	(0.0120)	(0.0117)	(0.0125)	(0.0125)
Tangibility	-0.1857**	-0.2274***	-0.1794***	-0.2669***	-0.2000***	-0.2353***	-0.1591**	-0.2733***	-0.1513**	-0.2903***	-0.1673**	-0.2839***
	(0.0763)	(0.0689)	(0.0692)	(0.0618)	(0.0770)	(0.0690)	(0.0779)	(0.0698)	(0.0721)	(0.0615)	(0.0785)	(0.0700)
Age	-0.0034	-0.0110***	-0.0036	-0.0091***	-0.0042	-0.0105***	0.0037	-0.0159***	0.0038	-0.0130***	0.0030	-0.0151***
	(0.0032)	(0.0031)	(0.0029)	(0.0029)	(0.0031)	(0.0031)	(0.0032)	(0.0031)	(0.0030)	(0.0029)	(0.0032)	(0.0031)
Constant	1.0455***	0.9887***	1.0534***	1.0476***	1.0840***	1.0406***	1.0977***	1.0954***	1.1079***	1.0965***	1.1490***	1.1429***
	(0.0902)	(0.0809)	(0.0832)	(0.0706)	(0.0902)	(0.0810)	(0.0897)	(0.0862)	(0.0833)	(0.0783)	(0.0892)	(0.0863)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	7,667	8,133	9,686	9,855	7,575	8,066	7,772	8,028	9,700	9,841	7,675	7,966
R-squared	0.0183	0.0176	0.0154	0.0156	0.0172	0.0205	0.0173	0.0227	0.0145	0.0196	0.0159	0.0253
No. of ticker	1,400	1,375	1,520	1,456	1,398	1,374	1,449	1,390	1,549	1,487	1,448	1,389

Notes: (1) Dependent variable equals 1 when a firm uses a financing channel and 0 otherwise. (2) Firm characteristics, macroeconomic indicators and firm fixed effects are controlled. (3) Dependent variables in Panels A to D are *Formal*, *Loan*, *Equity* and *Trade credit* respectively. (4) CHK, STPT and FN are used as indicators for zombie firms. (5) Specifications of odd numbers use sub sample of high financial development group while even numbers use sub sample of low financial development group. (6) All firm level variables are lagged by one period, robust standard errors in parentheses. (7) *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively.

firms alive (equity financing supports CHK zombies and trade credits help STPT zombies), while loans and the bond market are relative more efficient. This result contradicts a typical claim that the misallocation of bank credit supports China's zombie firms; it is often quite misleading as firms with poor performance usually have high leverage (e.g. Table 5 shows a positive correlation between leverage and STPT/FN zombie firms).

We argue that these seemly inconsistent results reflect the difference between the balance of liability and the changes of liability. While our earlier analysis focussed on the changes, Table 9 uses the debt to asset ratio (liability/asset, stock value) as the dependent variables and captures the effect of the balance of leverage.

Table 9. Zombie firm and the debt to asset ratio.

	CHK	STPT	FN
	(1)	(2)	(3)
Zombie	-0.0261***	0.0549***	0.0686***
	(0.0041)	(0.0099)	(0.0064)
Size	0.0017	0.0112**	0.0043
	(0.0058)	(0.0054)	(0.0058)
Tangibility	0.0944***	0.1286***	0.0911***
	(0.0277)	(0.0259)	(0.0276)
Age	-0.0015	-0.0003	-0.0016*
	(0.0010)	(0.0009)	(0.0009)
Constant	0.4889***	0.3690***	0.4608***
	(0.0380)	(0.0346)	(0.0376)
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Obs	16,090	19,966	15,928
R-squared	0.0116	0.0184	0.0218
No. of ticker	2,391	2,530	2,391

Notes: (1) Dependent variable is the debt to asset ratio (total liabilities / total assets). (2) Firm characteristics, macroeconomic indicators and firm fixed effects are controlled. (3) CHK, STPT and FN are used as indicators for zombie firms. (4) All firms level data is lagged by one period, robust standard errors in parentheses. (5) *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively

Columns (2) and (3) of Table 9 show that the debt to asset ratio of firms with poor performance (STPT and FN zombies) is indeed significantly higher. Poorly performing zombie firms often have high debt levels; while they have experienced a deleveraging process, as our baseline models show, they are less likely to receive new debt financing. Firms relying on subsidies (CHK zombies) have a lower balance of leverage in general.

Ex-post use of funds

In order to gain a better understanding of the misallocation of funds, we examine how zombie firms make use of the funds they obtain. We only focuse on formal financing as a whole (loan, bond and equity financing) and informal financing (trade credit). The real investment ratio is the amount of expenditures on fixed asset minus cash inflows from disposal of fixed asset scaled by total asset[7] (see Wu, Gyourko, and Deng 2015). The positive coefficients of external financing indicate that firms tend to increase their real investment after receiving external funds. More importantly, the negative interaction term indicates that CHK zombies' capital formation is less efficient than that by healthy firms.

[7] We also use capital expenditure as a proxy for real investment; the results are very similar. However, missing data about capital expenditures is very common before 2005. Therefore, we do not report this set of results.

Table 10. Investment behaviours ex post obtaining external financing.

Panel A: Real investment	Formal			Trade credit		
	CHK	STPT	FN	CHK	STPT	FN
	(1)	(2)	(3)	(13)	(14)	(15)
Zombie	0.0042**	-0.0012	-0.0199***	0.0034**	-0.0041	-0.0177***
	(0.0017)	(0.0029)	(0.0024)	(0.0016)	(0.0029)	(0.0023)
Amount	0.0790***	0.0643***	0.0674***	0.0575***	0.0457***	0.0498***
	(0.0085)	(0.0075)	(0.0081)	(0.0095)	(0.0079)	(0.0084)
Amount *	-0.0404**	-0.0035	0.0207	-0.0415**	0.0127	-0.0244
Zombie	(0.0168)	(0.0186)	(0.0396)	(0.0169)	(0.0205)	(0.0301)
Constant	0.0691***	0.0699***	0.0716***	0.0689***	0.0696***	0.0711***
	(0.0022)	(0.0022)	(0.0022)	(0.0022)	(0.0022)	(0.0022)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs	15,565	18,176	15,429	15,249	17,820	15,094
R-squared	0.0437	0.0346	0.0489	0.0378	0.0314	0.0431
No. of ticker	2,352	2,406	2,352	2,338	2,391	2,338

Panel B: Financial investment	Formal			Trade credit		
	CHK	STPT	FN	CHK	STPT	FN
	(1)	(2)	(3)	(13)	(14)	(15)
Zombie	0.0013	0.0012	-0.0017	0.0017	0.0010	-0.0018
	(0.0013)	(0.0019)	(0.0017)	(0.0013)	(0.0018)	(0.0016)
Amount	0.0116*	0.0090*	0.0120**	0.0048	-0.0001	0.0015
	(0.0059)	(0.0051)	(0.0054)	(0.0077)	(0.0064)	(0.0071)
Amount *	-0.0003	0.0104	-0.0134	-0.0098	0.0001	0.0158
Zombie	(0.0120)	(0.0159)	(0.0196)	(0.0137)	(0.0153)	(0.0215)
Constant	0.0030*	0.0029	0.0036**	0.0025	0.0030	0.0032*
	(0.0018)	(0.0018)	(0.0018)	(0.0019)	(0.0018)	(0.0018)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs	14,604	17,160	14,486	14,320	16,823	14,184
R-squared	0.0076	0.0073	0.0076	0.0075	0.0072	0.0073
No. of ticker	2,351	2,406	2,351	2,338	2,391	2,338

Financial investment is the cash payment for financial investment less cash received from reclaiming financial investment scaled by total asset. Panel B shows that while firms increase their financial investments after obtaining formal financing, they do not adjust their financial investment position after receiving trade credits. Also, zombie firms do not behave differently compared to healthy firms.

Panels C and D show firms' distributions (dividends, profit distributed or interest paid) and debt repayment behaviours after raising money. Compared to healthy firms, both the STPT and FN zombies distribute more funds after receiving external financing, which indicates a lack of investment opportunity or cream skimming. Also, both the CHK and STPT zombies spend more to repay their debt earlier, which suggests that these zombies are struggling to roll over their debts.

Robustness check

Whether a firm is zombie or not is affected by a series of factors, and the financing pattern alone is not sufficient to determine whether the firm stays healthy or becomes a zombie. Thus, the endogeneity concern is not severe in our model. Still, we address this issue by using propensity score matching (PSM) to test the treatment effect, following Rosenbaum and Rubin (1983).

We conduct the PSM in two stages. First, we predict the probability of each firm receiving treatment (i.e. becoming a zombie firm) for each firm-year observation based on the firm's characteristics using the Probit model. Next, we match observations with similar propensity scores within the same year-industry group and test the average treatment effect for the treated (ATT).

Hoshi (2008) shows that major determinants of zombie firms are firm size, leverage, profitability, and whether a firm is in a metropolitan area or not.[8] We include these variables in the first stage regression analysis. Also, we introduce a dummy for state ownership, the GDP per capita, and the GDP growth of the province to control for regional factors. We also include industry, year and province fixed effects.

[8] It is generally believed that Beijing, Shanghai, Guangzhou and Shenzhen are China's four major metropolitan areas (also known as the first-tier cities). So we construct a dummy variable equals to 1 if a firm is registered in the four cities, and 0 otherwise, and use it in the first stage regression analysis.

In the second stage regression analysis, every zombie firm ('treated') is paired with a set of non-zombie firms ('control') with a similar likelihood of becoming a zombie firm. We adopt three different matching methods, namely one-to-one matching, one-to-one matching with 0.1 caliper and 5-nearest neighbour matching. The balancing test results are shown in Appendix 3. The T-test shows that the mean difference between the treated and control groups for each variable in the first stage regression is not significant, which indicates that the matching process is appropriate.

This process serves as a quasi-natural experiment which compares zombie firms to non-zombie firms that have same probabilities of becoming zombies. The difference between the treated and control groups is only caused by whether a firm is a zombie or not. Table 11 shows that the propensity score matching results support our earlier findings. Specifically, zombie firms obtain less external financing. More importantly, CHK and STPT zombies still receive support from trade credit and equity financing, respectively. In contrast, it is difficult for FN zombies to obtain funds through any of the financing channels

Table 11. Propensity score matching.

		CHK				STPT				FN			
Matching algorithm	Outcome	Treated	Controls	Difference	T-stat	Treated	Controls	Difference	T-stat	Treated	Controls	Difference	T-stat
one to one matching	Formal	0.4421	0.4442	-0.0020	-0.15	0.3129	0.3424	-0.0295	-1.59	0.3319	0.4485	-0.1167***	-5.59
	Loan	0.3635	0.3490	0.0145	1.12	0.2440	0.2872	-0.0432**	-2.49	0.2530	0.3563	-0.1033***	-5.30
	Bond	0.0584	0.0584	-0.0024	-0.38	0.0024	0.0266	-0.0242***	-4.16	0.0252	0.0771	-0.0519***	-6.26
	Equity	0.0986	0.1263	-0.0277***	-3.12	0.1290	0.0738	0.0552***	4.23	0.1084	0.1008	0.0076	0.54
	Trade credit	0.6192	0.5869	0.0324**	2.39	0.5098	0.5691	-0.0593***	-3.03	0.5011	0.5692	-0.0680***	-3.12
one to one matching with 0.1 caliper	Formal	0.4420	0.4447	-0.0027	-0.20	0.3187	0.3453	-0.0266	-1.43	0.3341	0.4506	-0.1165***	-5.54
	Loan	0.3639	0.3493	0.0146	1.13	0.2477	0.2894	-0.0417**	-2.40	0.2534	0.3572	-0.1038***	-5.29
	Bond	0.0555	0.0586	-0.0031	-0.49	0.0025	0.0269	-0.0244***	-4.27	0.0250	0.0778	-0.0528***	-6.35
	Equity	0.0989	0.1267	-0.0278***	-3.12	0.1336	0.0761	0.0575***	4.37	0.1125	0.1035	0.0090	0.63
	Trade credit	0.6190	0.5873	0.0317**	2.35	0.5102	0.5702	-0.0600***	-3.05	0.5041	0.5677	-0.0637***	-2.90
5-nearest neighbour matching	Formal	0.4421	0.4509	-0.0087	-0.72	0.3129	0.3540	-0.0411***	-2.61	0.3319	0.4512	-0.1193***	-6.53
	Loan	0.3635	0.3577	0.0059	0.50	0.2440	0.2939	-0.0499***	-3.40	0.2530	0.3602	-0.1072***	-6.29
	Bond	0.0560	0.0637	-0.0077	-1.35	0.0024	0.0309	-0.0285***	-7.20	0.0252	0.0726	-0.0474***	-6.79
	Equity	0.0986	0.1253	-0.0267***	-3.46	0.1290	0.0817	0.0473***	4.26	0.1084	0.1018	0.0066	0.54
	Trade credit	0.6192	0.5936	0.0256**	2.14	0.5098	0.5688	-0.0590***	-3.46	0.5011	0.5602	-0.0590***	-3.06

Notes: Every zombie firm is match to a non-zombie firm with the same likelihood of becoming a zombie within the same industry and year.

Conclusion

In this paper, we examine the financing patterns of China's zombie firms. We find that different types of zombie firms rely on different financing channels to survive. On the microeconomic level, we show that it is the equity market and informal financing (i.e. trade credits) that support China's zombie firms. Loan financing, on the contrary, is more efficient in allocating financial resources. Specifically, zombie firms supported by subsidies (i.e. CHK zombies) rely on trade credits, and the poorly-performing firms (i.e. STPT zombies) resort to equity financing to stay alive.

On the macroeconomic level, the evidence shows that the stimulus plan and financial development harm the allocation of funds by increasing accessibility to external financing for zombie firms. This not only reveals the undesirable consequences of governmental support, but also indicates that the structural deficiency cannot be solved by policies targeted at the aggregated level. Also, our study proposes a warning for Chinese economy that financial development can be harmful if the distortions, which may lead to a misallocation of financial resources, are not eliminated first.

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