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Resolving China's Zombies: Tackling Debt and Raising Productivity

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I N T E R N A T I O N A L M O N E T A R Y F U N D

IMF Working Paper

Asia and Pacific Department

Resolving China's Zombies: Tackling Debt and Raising Productivity¹

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Abstract

Nonviable “zombie” firms have become a key concern in China. Using novel firm-level industrial survey data, this paper illustrates the central role of zombies and their strong linkages with state-owned enterprises (SOEs) in contributing to debt vulnerabilities and low productivity. As a group, zombie firms and SOEs account for an outsized share of corporate debt, contribute to much of the rise in debt, and face weak fundamentals. Empirical results also show that resolving these weak firms can generate significant gains of 0.7–1.2 percentage points in long-term growth per year. These results also shed light on the ongoing government strategy to tackle these issues by evaluating the effects of different restructuring options. In particular, deleveraging, reducing government subsidies, as well as operational restructuring through divestment and reducing redundancy have significant benefits in restoring corporate performance for zombie firms.

JEL Classification Numbers: G3, F3, D22, L2, L6

Keywords: China, corporate debt, state-owned enterprises, debt restructuring, and zombie firms

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I. INTRODUCTION

Nonviable “zombie” firms have become a key priority of the government in addressing corporate debt vulnerabilities and improving resource allocation in China.² Zombie firms account for an increasing share of total corporate debt, operate inefficiently with low productivity, and have crowded out non-zombie investments.

Based on firm-level industrial survey data, the study assesses the vulnerabilities of, and potential gains from resolving, these weak firms. This paper extends previous studies (Tan and others 2017; Nie and others 2016; Sekiguchi and others 2016) that primarily discuss the formation of zombies and its crowding out effects. It is one of the first studies to illustrate empirically the linkages between zombie firms and state-owned enterprises (SOEs) in contributing to corporate debt vulnerabilities and low productivity. It also analyzes the effects of different restructuring options and the potential output gains from resolving these weak firms.

The paper is organized as follows. Section II presents background on key corporate debt vulnerabilities and the misallocation of resources posed by zombie firms, and their close linkages with SOEs. Section III argues that zombie firms, along with SOEs, play a central role in China’s ongoing deleveraging efforts. Section IV provides empirical results on the determinants of zombie firms and what factors can help restore their viability. Section V estimates the potential gains from resolving these weak firms. Section VI outlines policy implications and the last section concludes.

II. BACKGROUND: CORPORATE DEBT VULNERABILITIES AND MISALLOCATION OF RESOURCES

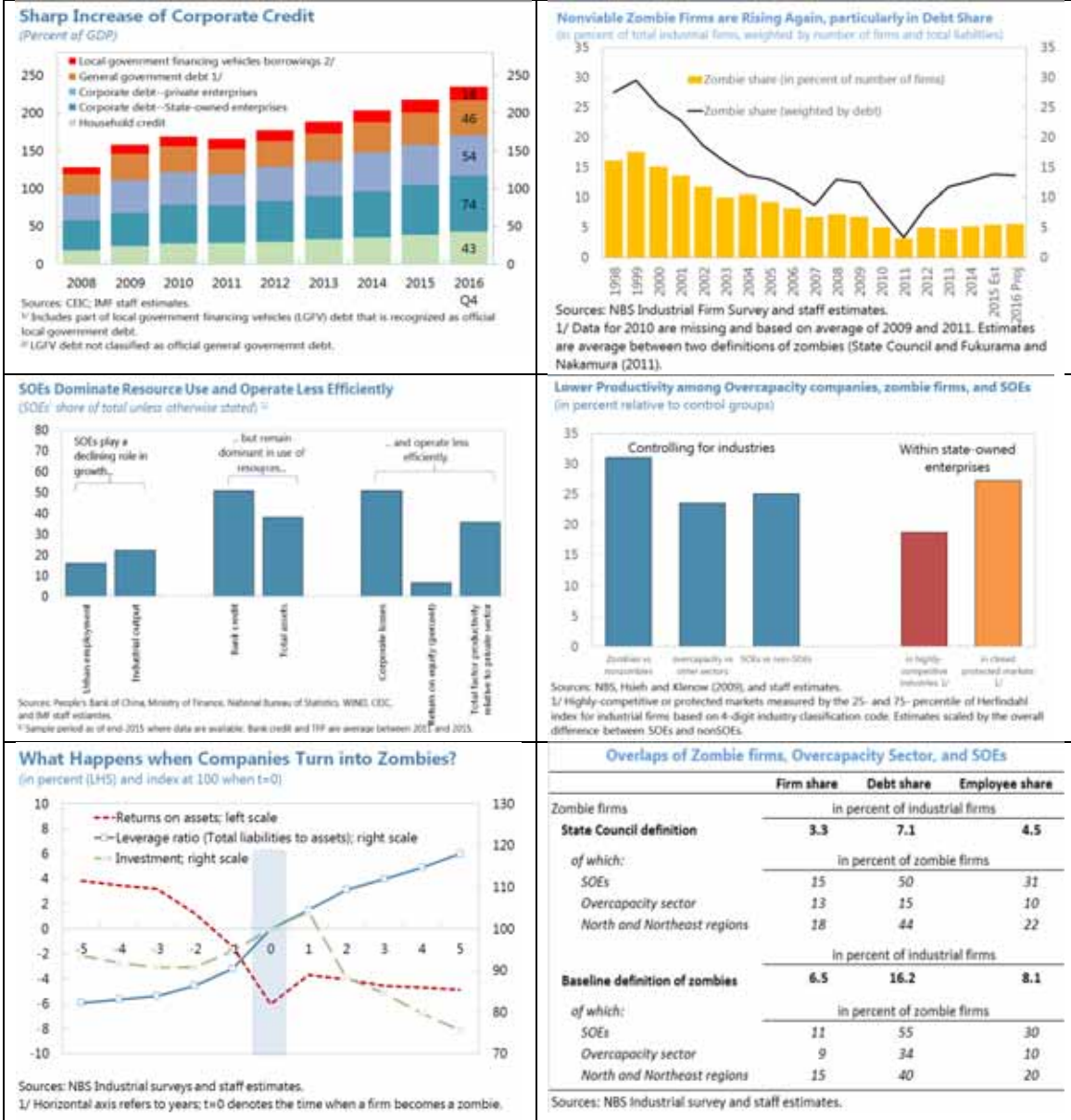
China’s nonfinancial private sector debt has increased significantly over the past decade, reaching 176 percent of GDP as of the end of March 2017 (Figure 1). Corporate debt, standing at about 135 percent of GDP, contributed most of the rising debt and has become a key vulnerability. In China overall, SOEs account for a large share of corporate debt (accounting for 57 percent of total corporate debt or 72 percent of GDP in 2016). They also contributed to almost 60 percent of the rise in total corporate debt during 2008–16 (Table 1). The share is disproportionate considering SOEs have a declining share of output and employment (from over 40 percent in the late 1990s to about 15–20 percent in 2015).

Moreover, the share of nonviable zombie firms (see section III for the definition) in total corporate debt also rose quickly to 6 percent by 2016 (or 15 percent of total industrial liabilities), the highest level since 2009 (Figure 1).³ The debt share of zombie firms has remained high despite declining employment, profitability, and fixed asset investment, suggesting rising vulnerability due to a debt overhang.

² Nonviable zombie firms are those whose liquidation value is greater than their value as a going concern, taking into account potential restructuring (see Section III for the definition).

³ There is a distinction between industrial liabilities (reported by the National Bureau of Statistics) and total corporate debt based on indicators of Total Social Financing by the People’s Bank of China (PBC). Industrial liabilities do not cover the service sector and include cross-company claims that are netted out in corporate credit (for example, intercompany loans and accounts payable).

Figure 1. Central Role of SOEs and Zombie Firms



Corporate fundamentals are much weaker among zombies, which often incur persistent losses. They have higher leverage, lower returns, slower growth, and lower productivity than non-zombie firms. They continue to survive despite weak fundamentals and losses. For example, about 30 percent of zombie firms remain zombies after 5 years. Moreover, zombies formed during 2008–13 are more entrenched, that is, more likely to stay as zombies than those formed in the early 2000s. Duration analysis shows that state-owned zombie firms that have higher debt burdens (in the top 10th percentile in the debt share in their industries or provinces) are more likely to stay zombies (Appendix 1). For example, an SOE zombie is 30 percent more likely to stay a zombie in the next year than a non-SOE zombie (Figure 2).

Table 1. Debt Vulnerabilities of Zombie Companies and SOEs

As of end-2016 and in percent unless otherwise stated	Debt level		Contribution to overall corporate debt (2008-16)		Corporate performance				Regional concentration ^{1/}
	Corporate Debt		Increase (in percent of GDP)	Contribution	2003-2008		2016		2015
	Share of total	in percent of GDP			Leverage ratio ^{2/}	Returns on assets	Leverage ratio ^{2/}	Returns on assets	Share of provincial total
Total	100	127	52	100					
Private enterprises	43	55	22	42	144	7.1	98	5.9	...
State-owned enterprises	57	72	30	58	125	3.2	181	2.6	37
Zombie firms^{4/}									
1) State Council definition	5	6	4	7	247	-5.3	346	-5.9	44
2) Baseline definition ^{4/}	9	11	4	8	242	-1.7	284	-1.6	40
Overcapacity sector^{3/}	16	21	4	8	156	6.1	183	3.7	43
<i>of which:</i>									
<i>Coal</i>	3	4	2	5	146	6.9	201	0.8	17
<i>Steel</i>	6	8	0	1	162	6.0	180	3.1	18

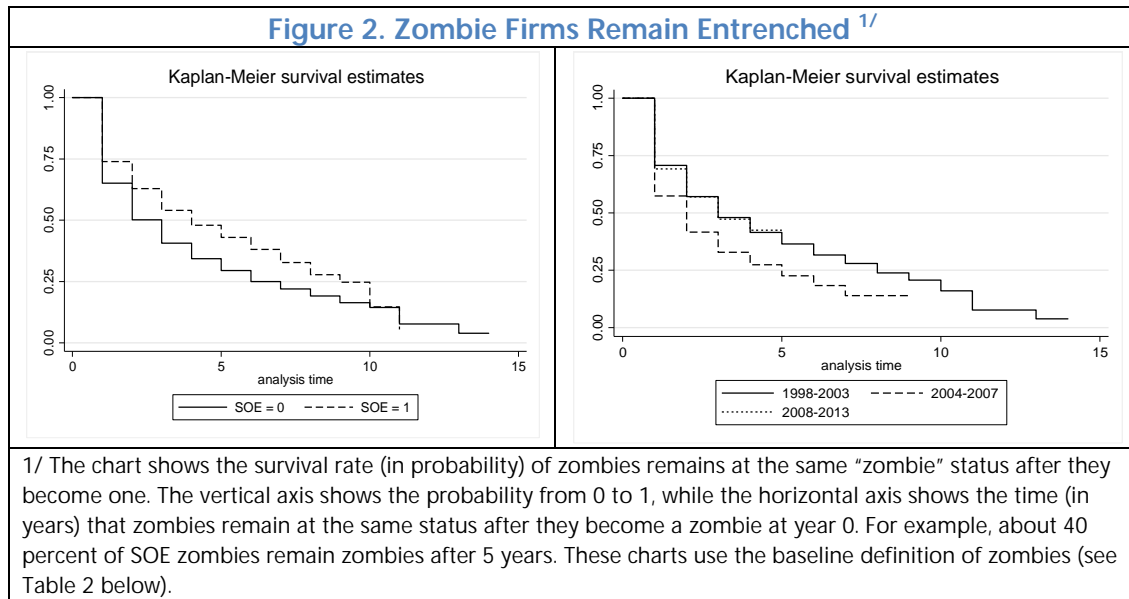
Sources: PBC, CEIC, NBS, IMF staff estimates.

1/ Regional concentration is measured by the average share of industrial liabilities relative to the provincial total among the North and Northeast regions (Heilongjiang, Jilin, Liaoning, Shanxi, Shaanxi, and Hebei provinces, and Inner Mongolia autonomous region). For example, coal firms account for an average of 17 percent of industrial liabilities in the selected provinces (highest in Shanxi at 51 percent) and steel firms account for an average of 18 percent (highest in Hebei province at 37 percent). Overall, overcapacity firms account for 21-65 percent of industrial liabilities in North and Northeast regions.

2/ Leverage ratio is measured by total liabilities to total owners' equity (in percent).

3/ Overcapacity sector includes coal, steel, plated glass, cement, aluminum, nonferrous metals.

4/ The debt share of zombie firm is based on industrial liabilities in National Bureau of Statistics industrial survey from 1998-2013, which is then scaled to total corporate debt based on the aggregate ratio. Data after 2013 are estimated based on overall increase in credit and aggregate corporate performance. See section III for the definition of zombies



Zombie firms also overlap considerably with overcapacity sectors and SOEs,⁴ which account for half of total debt and about one-third of employment in zombie firms. The strong linkages between SOEs and zombie firms are partly driven by resource misallocation arising from implicit support (Lam and Schipke 2017). Implicit guarantees and the government’s desire to support growth encourage these firms to invest excessively, which raises already-high leverage while weakening fundamentals, such as profitability and debt-service capacity. Thus, zombie firms are more common in resource-intensive regions and in industries with the protected markets that SOEs dominate.

III. WHY DO ZOMBIE FIRMS MATTER IN RESOURCE MISALLOCATION?

A. What are zombies?

Although there is no unique definition of nonviable zombie firms, this paper uses a definition similar to the literature and the one used by the government. First, the Chinese State Council (SC definition) broadly defines nonviable “zombies” as firms that incur three years of losses, cannot meet environmental and technological standards, do not align with national industrial policies, and rely heavily on government or bank support to survive.⁵ Other definitions in the literature include Fukuda

⁴ Overcapacity sectors are those that suffer from low capacity utilization rates (commonly interpreted as below 70 percent) and persistent losses. This note includes coal, steel, cement, plated glass, and aluminum industries as overcapacity sectors. Paper, solar power, chemicals, ship building, coal-fueled power, and auto manufacturing are sometimes included in other studies, such as the European Chamber of Commerce (2016) and Maliszewski and others (2016). Data for these industries are grouped into the broader manufacturing sector. Zombie firms have high regional exposure, with 40 percent of zombie debt in the North and Northeast regions such as Heilongjiang, Jilin, Liaoning, Hebei, Shanxi, and Shaanxi provinces, and Inner Mongolia autonomous region. Private sector zombie firms tend to have a higher exit rate without implicit government support.

⁵ In practice, local governments use both financial and production benchmarks to identify zombies. For example, financial benchmarks include three years of losses, liability to asset ratios exceeding 85 percent, negative operating cash flow, and debt in arrears for more than one year. Production benchmarks include capacity

(continued...)

and Nakamura (2011), which identifies zombies as firms that face persistent losses and receive subsidized credit (actual interest cost less than market prime interest rates) (FN definition), and Nie, Jiang, Zhang, and Fang (2016) that extend the FN definition to two successive years (NJZF definition).

This paper uses a baseline definition that considers zombies as firms incurring persistent losses and with estimated interest payment costs below market lending rates—a proxy for support from creditors or the government, essentially the FN definition by Fukuda and Nakamura (2011) adjusted for short-term debt due less than a year (Table 2).⁶ Different classifications of zombies provide robustness checks in the empirical results.

Zombie definition	Sources	Criteria
State Council (SC definition)	China's State Council	· Firms with three years of successive losses.
Fukuda and Nakamura (FN definition)	Fukuda and Nakamura (2011)	· Firms that have lower interest cost relative to market interest rates (as in Caballero, Hoshi, and Kashyap 2004) or a debt-to-asset ratio higher than 50 percent and increasing over the year, and earnings before interest and tax (EBIT) smaller than interest payment at market interest rate.
Nie, Jiang, Zhang, and Fang (NJZF definition)	Nie, Jiang, Zhang, and Fang (2016)	· Firms that fit the Fukuda and Nakamura definition for two successive years.
Baseline definition	Modified from Fukuda and Nakamura (2011)	· Firms that fit the Fukuda and Nakamura definition but considering only one-fourth of short-term debt due less than a year when applying the criteria (i.e., assuming half of short-term debt of six-month maturity).

B. Why do we care about zombie firms?

As illustrated in the background section, zombie firms and SOEs are the most pressing source of corporate vulnerabilities. Zombies have contributed to the rising share of corporate debt, overlap significantly with SOEs, and have particularly weak fundamentals. Implicit guarantees allow these firms to survive despite persistent losses and high leverage.

Studies find that zombie firms tend to crowd out private investment, contribute to lower productivity growth, and hinder competition (Tan and others 2017; Guo and others 2017; Ahearne and Shinada 2005; Kwon, Narita, and Narita 2009). For example, Tan and others (2017) find that zombie firms tend to crowd out non-zombie firms' investment by 2–8 percent. As a result, they may drag overall productivity and growth and pose financial stability risks by adding to nonperforming loans in the financial system.

Empirical analysis of the cost of sustaining nonviable companies is extensive. For example, Caballero, Hoshi, and Kashyap (2008) found that allowing zombies to survive tends to suppress competition in

utilization rates less than 50 percent, suspended production for six months, and unpaid taxes or electricity bills. In this paper, the State Council definition uses three years of cumulative losses as the criterion.

⁶ One-fourth of short-term minimum interest payments (such as assuming half of them were within a six-month maturity), considering part of firms' short-term debt due in less than a year.

Japan. Studies also suggest that implicit government support is a key contributing factor to the rise of zombies. For example, institutional arrangements, such as lifetime employment and banks' credit support in Japan, encouraged weak firms to survive (Hoshi 2006; Peek and Rosengren 2000). Their easier access to credit encourages the survival of zombies, even when the performance of these SOEs deteriorates (Cull and Xu 2003; Ferri and Liu 2010; Lin and Tan 1999; Jaskowski 2015).

Resolving zombie firms, by addressing the misallocation of resources, would produce significant gains. Hsieh and Klenow (2009) found that misallocation across firms within four-digit industries has reduced total factor productivity (TFP) in China and India, while addressing the misallocation can lift productivity gains. Other studies found that the misallocation amplifies business cycles and inequality in the economy (Bartelsman, Haltiwanger, and Scarpetta 2013; Caliendo, Parro, and Tsyvinski 2017; Hall and Jones 1999; Jones 2011; Restuccia and Rogerson 2008, 2013).

IV. EMPIRICAL ANALYSIS

The empirical analysis illustrates the key determinants of zombies and evaluates the effects of restructuring options in restoring viability. The government is currently tackling excessive corporate leverage of SOEs and the exit of zombie SOEs. The analysis aims to help the government's policy design in resolving debt and raising productivity gains, particularly highlighting the central role of SOEs and zombie firms.

A. Data

The paper uses firm-level data from the annual industrial surveys compiled by the National Bureau of Statistics. The dataset covers industrial firms in China between 1998 and 2013 for about one million companies in each year that have annual sales of RMB5 million or above (1998–2009) and of RMB20 million or above (2011–13). Aggregate data is obtained from the National Bureau of Statistics, the People's Bank of China, and the Ministry of Finance through CEIC, a commercial data vendor.

For consistency, we use firm-level observations with annual sales of 20 million or above and eliminate data outliers using the methodology in Feenstra, Li, and Yu (2014) and Cai and Liu (2009).

Observations are deleted if (1) key financial variables are missing or negative (such as total assets, sales revenue, gross value of industrial output, employment, and net fixed assets); (2) they do not meet the general accounting principles, that is, the value of variables in a firm's balance sheet, such as liquid assets, total fixed assets, and the net value of fixed assets exceeds the total asset value; (3) employment is 10 people or less (financial reports of small firms are generally not reliable); (4) a firm identification code is missing or non-unique; and (5) the inception date is missing or invalid. In addition, the paper classifies overcapacity sectors—such as coal, steel, cement, plated glass, aluminum, paper, solar power, chemicals, ship building, coal-fueled power—using the four-digit industry codes in the industrial surveys.

B. What are key determinants of zombie firms?

This paper considers a "probit" model to assess the determinants of zombie firms with the following specification:

$$\Pr(zombie_{it} = 1) = \beta X_{it-1} + DInd + Dyear + Dreg + \varepsilon_{it}$$

where i denotes firms, t denotes time horizon at annual frequency, $zombie_{i,t}$ is the zombie index under various definitions, $X_{i,t-1}$ includes explanatory variables in lagged terms to avoid the

endogeneity problem. Dummy variables such as industry (in two-digit code), year, and province/region are added.

Empirical results. Results suggest that zombie companies tend to underperform—that is, they have higher leverage and lower profitability. Coefficients are all statistically significant, and the magnitudes are also important in economic terms (Table 3 and Appendix Table 2.1 show the results of different specifications). For example, a one-percentage-point increase in the liabilities-to-assets ratio would raise the likelihood of being a zombie firm by about 0.15 percent on average. A reduction of aggregate demand (proxied by average growth of revenue in the industrial sector) would contribute to an increase in zombie companies. Zombie firms are also more common among SOEs and are concentrated in overcapacity industries and in the North and Northeast regions, holding other factors constant.

Table 3. Summary Results of Key Determinants of Zombie Firms				
Probit model 1/ $\Pr(zombie_{it}=1) = \beta X_{it-1} + D_{ind} + D_{year} + D_{reg} + \varepsilon_{it}$				
Indicators	Expected signs	Regression results		
		Signs	Magnitud	Stat.
Firm-level indicators				
Firm type (SOE)	+	+	3.2	***
Leverage ratio (lag)	+	+	0.14	***
Returns on assets (lag)	-	-	-0.5	***
Firm size (lag) 3/	?	+	1.0	***
Firm age 3/	?	+	0.10	***
Government subsidy (lag)	+	+	0.15	***
Industry-level indicators				
Sales growth (lag)	-	-	-3.5	***
Provincial-level indicators				
Degree of state influence	+	+	0.40	***
<i>Results controlled for yearly fixed effects</i>				
1/ Results controlled for fixed effects on year, industry, and provinces				
2/ '***' indicates statistical significance at 1 percent level.				
3/ Adjusted for logarithm terms.				

More importantly, the role of banks and local governments is also a key determinant of zombie firms. Specifically,

- *Local governments.* Greater government support (estimated using an index of the government direct intervention level across provinces by Fan and others 2011) is a decisive factor in zombie formation. The variable uses the average share of working hours that firm managers spend with provincial government officials. The estimated coefficient is positive and statistically significant at the 5 percent level. In addition, the regression has a specification that measures the level of government support. A one percentage-point increase in government subsidies to total sales would raise the likelihood of becoming a zombie by 0.15 percent, holding other factors constant.
- *Local banks.* Banks may extend or roll over credit for zombie firms because of their perceived close ties to local government or importance for the local economy. Using the share of

deposits held by major state-owned banks as a proxy of the extent of close connections, the results show that zombies are more likely in provinces where ties between banks and local governments are close (with positive and statistically significant coefficients).

These findings remain broadly valid regardless of different zombie definitions (Appendix Table 2.2 for the robustness check). Key differences include the role of markets in resource allocation across provinces, proxied by provincial indicators that capture the dominance of the government or public entities in directing activity (see appendix Table 2.2). Except for two definitions, all others are significant at the 10 percent level. The varying results are possibly due to the lesser extent to which the State Council and NJZF definitions capture interest cost relative to market rates, which are more sensitive to the market degree in a province. Overall, the empirical results across definitions support the view that zombie firms contribute to corporate debt vulnerability, have weaker corporate performance on profitability and leverage ratios, and overlap with overcapacity firms and SOEs.

C. What factors contributed to resolving zombies?

Assessing the effects of restructuring options can help guide the design of policy measures to resolve debt vulnerabilities. In that context, a probit regression is used to assess the likelihood of returning to non-zombie firm status when a zombie firm undertakes selected restructuring options. The specification is:

$$\Pr(zombie_{it} = 0 | zombie_{it-1} = 1) = \beta X_{it-1} + DInd + Dyear + \varepsilon_{it}$$

where firms in the sample in period t are those classified as zombies in the last period ($t-1$). The dependent variable is set to one if firms in period t move to the non-zombie category, and is assigned zero if otherwise. All explanatory variables are common restructuring options with a one-period lag, while controlling for industry and year fixed-effects. These variables are all expected to have positive effects on raising the chance of moving from zombies to non-zombie firms. Specifically,

- *Deleveraging.* A dummy variable of "deleveraging" is set to one when the debt-to-asset ratio is reduced by more than 5 percentage points over a year.
- *Ownership change.* Two dummy variables are included, which capture the transition of the zombie firm from state- or collectively owned to privately owned (*SOE to private*) and when the zombie firm is incorporated (*corporatization*).
- *Reduction in the labor force.* Cutting redundant labor is often an operational restructuring option to improve firm performance. The wage-payment-to-asset ratio is used as a proxy to test for this.
- *Asset sale or injection.* Restructuring also often involves the sale of noncore assets or injection of assets by parent companies. As data on firms' asset injection or sale are limited, the analysis uses the growth of fixed assets as a proxy. Dummy variables of "asset injection" and "asset sale" are introduced when the fixed asset growth is higher than ± 10 percentage points, respectively.

Empirical results. The results suggest that some important measures are correlated with firms transitioning to non-zombie status (Table 4 and Appendix Tables 2.3 and 2.4).⁷

- *Deleveraging.* Debt restructuring to reduce the debt burden and leverage would help improve repayment capacity and therefore raise the likelihood of turning into viable firms. In the process, creditors may also take an ownership stake and have common incentives to raise firm's performance for upside gains.
- *Ownership change.* As during the last SOE reform in late 1990s and early 2000s, many insolvent SOEs were privatized or corporatized under the "Grasping the Large and Letting Go of the Small" reform. The operational restructuring change in the ownership tends to improve the likelihood of transitioning into viable non-zombie firms, as evidenced by a strong statistically significant coefficient.
- *Reduction in labor costs.* The marginal effect of reducing labor cost also seems to be significant in some specifications, although the results are less robust across specification. That may be because zombies are more determined by the debt burden rather than labor redundancy in the sample.
- *Asset injection and sale.* Both dummy variables of asset "injection" and "sale" have statistically significant positive effects, suggesting a substantial unloading of noncore assets or asset injection from parents tend to help zombie firms to transit into viable firms again.

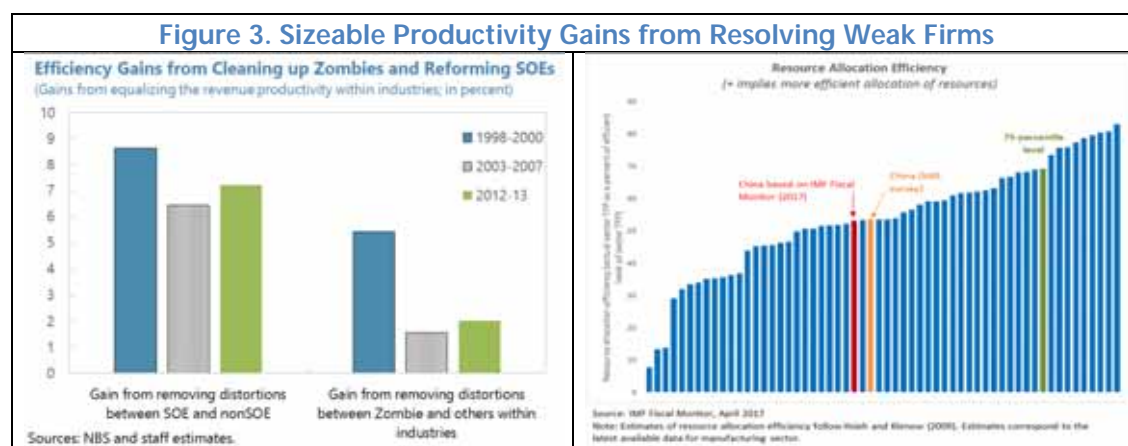
Table 4. Summary Results of Restoring Firm Viability				
$Pr(zombie_{it} = 0 zombie_{it-1} = 1) = \beta X_{it-1} + DInd + DYear + \varepsilon_{it}$				
Indicators	Expected signs	Regression results		
		Signs	Magnitude	Stat. 2/
Firm-level action in a year (t-1)...				
Deleverage by >5 ppts	+	+	0.18	***
Ownership change (from SOE to private)	+	+	0.06	***
Incorporatization (corporate governance)	+	+	0.02	***
<i>Interaction terms with time dummy after 2004</i>				
Ownership change (from SOE to private)	?	-	-0.05	***
Incorporatization	?	-	-0.01	
Reduce wage bill (relative to industry)	-	-	-0.05	*
Capital injection or withdrawal by >10 percent	?	+	0.04	***
Divestment of noncore fixed assets by >10	+	+	0.04	***
<small>1/ Deleveraging equals 1 if the decrease of a firm's leverage is larger than 5 percentage points. Ownership change (from SOE to private) and in incorporatization are measured based on firm registration type, denoting a firm turns from SOE into private enterprise or turns into corporation. Injection and sell equals 1 if a firm's capital growth is larger than 10% or lower than -10%, respectively. Reducing wage bill is measured by difference of firms' wage to sales ratio relative to the industry. For all the regressions, there's one period lead between the dependent variable and continuous independent variables. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.</small>				

⁷ Empirical results illustrate the correlation of restructuring options and the likelihood of restoring viability of zombies. They do not imply causality.

V. PRODUCTIVITY GAINS FROM RESOLVING RESOURCE MISALLOCATION

Resolving zombies is a first step to improving resource allocation and raising productivity. Efforts can extend to SOEs and other weak companies. The conceptual framework for assessing potential gains from resolving weak firms follows the literature on firm distribution and resource misallocation. The efficiency of resource allocation is an estimated variable for an industry or a country that can be constructed based on firm-level data. This paper uses the theoretical framework in Hsieh and Klenow (2009) (see Appendix 3) and estimates the efficiency using the firm-level data.

In estimating the efficiency gains, we first calculate the total gain of equalizing revenue total factor productivity (TFPR)—a measure of total factor productivity obtained from the firm-level revenue data, defined in greater detail in Appendix III—within industry and the TFP gains from equalizing TFPR within groups (zombie versus non-zombie) or ownership types (SOEs versus non-SOEs) in each industry. The difference between these two estimates would be the gains from resolving debt vulnerabilities by resource reallocation. At the same time, reducing overcapacity can imply resource reallocation across industries. For example, during 1998–2000, resolving debt vulnerabilities would respectively boost aggregate industrial TFP by 5–8 percent for zombie firms and SOEs (Figure 3). After reforms took hold in mid-2000s, further gains have narrowed until recent years. As debt vulnerabilities have risen in the past few years, the potential gains appear likewise to have risen to about 7 percent between SOEs and non-SOEs.



For international comparison, the estimates of China are compared to 57 countries (IMF, 2017).⁸ The potential efficiency gains of resolving weak firms in China are sizeable. The revenue-productivity of Chinese firms is estimated to be slightly below the average across the 57 countries (Figure 6). Narrowing this productivity gap between China and the relatively efficient countries (assumed to be at the 75th-percentile distribution level) in the cross-country sample would boost output by about 16

⁸ The IMF 2017 Fiscal Monitor uses firm-level data from World Bank Enterprise Surveys (WBES) and ORBIS with industry classification at the four-digit level. Calculations are done for the manufacturing sector at the 2-digit ISIC industry level for the WBES sample, and at the 4-digit NAICS industry level for the ORBIS sample. Resource allocation efficiency was also calculated for the services sector in the case of advanced economies, but not for developing countries because of data constraints.

(continued...)

percent or raise long-term growth potential by 0.7 percentage points per year.⁹ Converging to the high-performing countries (at the 90th percentile level) would raise the output level by 28 percent or about 1.2 percentage points in long-term growth.

Resolving weak firms thus contributes to large potential gains (0.7–1.2 percentage points) in output. Scaling the efficiency gains of TFPR to total output would suggest that half of the total potential gains in output arise from resolving weak firms. In particular, SOE reforms can play a central role in the gains, accounting for over 0.4 percentage points of the increase of output in the long term. Substantial overlap in these weak firms indicates a complementarity of these reforms that could maximize the potential gains.



VI. GOVERNMENT MEASURES IN RESOLVING WEAK FIRMS

Addressing corporate debt vulnerabilities and raising firm efficiency are key priorities in the 2017 Government Work Plan and in the Five-Year Plan (2016–20).

Government strategy

On corporate debt vulnerabilities, the overarching strategy envisages a market and legal framework on debt restructuring and aims to guard against systemic or regional risks. A multipronged approach (for example, one using merger and consolidation, liquidation, debt-equity swaps, and corporate asset sales) is envisaged on a firm-by-firm basis (State Council 2016). An inter-ministerial group, led by the National Development and Reform Commission, was tasked to facilitate deleveraging. Financial regulators have renewed policy focus on controlling financial risks (CBRC 2016, 2017).

At the same time, the government has taken measures to raise SOE efficiency. The strategy of SOE reforms is to “integrate naturally” modern corporate governance and the leadership of the Communist Party so that SOEs can raise efficiency while meeting national development goals (Naughton 2016; Leutert 2016; OECD 2015; and IMF 2016). Recent measures include (1) consolidating some central SOEs,¹⁰ (2) phasing out SOE social functions; (3) transferring about ½ percent of state-owned equity to social security funds; (4) cutting central SOE losses; (5) individually incorporating the subsidiaries of central SOEs by 2017; (6) implementing pilot employee stock-ownership programs to align incentives; and (7) bringing in other investors under the mixed-ownership pilot reforms and committing to opening up sectors such as travel, medical care, electricity, and power and utilities to private and foreign investment.

⁹ The overall magnitude of the growth improvement could vary depending on changes in other macroeconomic variables in a general equilibrium setting. For example, a rise in productivity could raise the equilibrium interest rates, which would dampen investment and future output relative to the case where the interest rate is constant.

¹⁰ Other pilot programs include managing state assets better for 72 SOEs and debt restructuring and ownership changes for 40–60 local SOEs in Northeast China.

(continued...)

When the government strategy comes specifically to zombies, the government envisages a strategy to exit through a menu of options, including asset transfer, consolidation, and liquidation. About 2,000 central SOEs (with total assets of about 4 percent of GDP) and over 7,000 local SOEs have officially been identified as zombie firms. Reportedly, about 20 percent of the identified central SOE zombies have already been resolved, however, without details about the resolution method.¹¹ Regulatory amendments relevant to nonperforming loans have also been made to expedite the liquidation of zombies.

Assessment of measures

The deleveraging guidelines of the government are positive initial steps toward a comprehensive framework to resolving excessive corporate debt. However, the guidelines lack important details of loss recognition and operational restructuring of weak firms. While some cases contain elements of operational restructuring, details and time frames are not specified (at least not publicly).¹² A few debt-equity swaps appear to be equity in name but debt in essence (Table 5). And without concerted efforts to slow credit growth, there is an increasing risk of superficial financial restructuring to meet a deleveraging “target” (such as reducing firm-level liability-to-asset ratios) without tackling underlying structural problems, essentially “kicking the can down the road”.

No.	Date	Company	Firm type	Buy-back policies	A. Debt Restructuring		B. Operating Restructuring 2/				
					Take a haircut on face value and recognize losses	Extend maturity of existing loans or reduce interest cost	Corporate governance	Divestment of non-core assets	Workforce reduction	Transformation / upgrading	Change of management or board directors
Investment plans approved											
1	Oct-16	Yunnan Tin ¹	Local SOE	✓	x	✓	✓	✓	✓	✓	✓
2	Oct-16	Wuhan Steel	Central SOE	✓	x	✓	o	x	✓	o	n.a.
3	Nov-16	Shandong Energy Group	Local SOE	✓	x	✓	o	x	n.a.	o	n.a.
4	Dec-16	Sino Steel	Central SOE	n.a.	✓	✓	o	✓	✓	n.a.	n.a.
5	Feb-17	Nanjing Steel Industrial Develop Co.	Private	✓	x	✓	o	x	x	x	✓
Announcement of intents on debt-equity swaps											
	Nov 16 - 27 Apr 17	27 other central and local SOEs	Local/ Central SOEs	n.a.	n.a.	"o" 1 out of 27, no details; others n.a.	"o" 20 out of 27; no details	n.a.	n.a.	"o" 7 out of 27, no details; others n.a.	n.a.
Sources: Deutsche bank, HSBC, media reports.											
1/ Yunnan Tin restructured the debt by extending to long-term loan at a lower interest rate. The bank gained one seat in the board at the group conglomerate and two seats in the invested subsidiaries, and sought to diversify non-core assets (e.g., real estate) and to implement a layoff plan for redundant workers. Specific operating targets were set to secure its investment, otherwise the buy-back policy will be activated.											
2/ "o" indicates the announcement of the corresponded action, but lack in details on implementation plans.											

¹¹ This coincided with the greater use of bankruptcy courts in over 5,600 cases in 2016, doubling from two years previous.

¹² Some recent SOE restructuring cases included operational plans to reduce employees, better manage assets, and measures to strengthen corporate governance. For example, China ErZhong's debt restructuring indicated plans to raise efficiency through reducing redundancy, improving asset returns, and upgrading production. Sino-Steel also includes divestment of noncore assets, debt restructuring, and bringing in strategic investors. China Railway has reached a debt-restructuring agreement with creditor committees.

(continued...)

Renewed focus to allow exit of zombies is appropriate. Lack of resolution details, however, makes it difficult to assess progress. Although zombie debt is estimated to be moderating from improving profitability, resolving the zombie companies may still prove difficult as they are about 30 percent more likely to remain so if they are state-owned.

Broader SOE reform implementation has lagged other reforms and has not yet raised growth potential. For example, the transfer of SOE profits to the government budget has been well below the target 30 percent. Central SOEs still bear the cost (0.2 percent of GDP per year) of over 7,000 social entities.¹³ Preliminary classification suggests that only less than 60 percent of SOEs were considered commercially competitive—the category in which SOEs will face direct market competition—raising concerns about whether SOE reform can achieve significant productivity gains.¹⁴

VII. POLICY IMPLICATIONS

Resolving weak firms such as zombies is a first step in addressing debt vulnerabilities and raising productivity gains. While the government has taken measures, progress is complicated by the piecemeal exit of zombies and limited progress in SOE reforms. Resolving these weak firms requires a holistic, coordinated approach with time-bound actions. The focus should therefore be a government-led process that allows market forces to operate, while complementary actions should follow with operational restructuring to raise efficiency (Maliszewski and others 2016).

Building on recent efforts, steadfast implementation to resolving weak firms is critical. Banks should initiate a targeted asset quality review to assess firm viability. Supportive policies will also include reinforcing accounting and audit rules to provide timely and accurate financial information, raising the standards of appraisers for asset valuation, and developing efficient credit registers. Regulators should strengthen reviews of regulatory policies such as loan classification, bank capital, collateral valuation, and prudential reporting to foster banks' proactive NPL resolution.¹⁵

Operational restructuring plans should be quickly developed for weak firms. Empirical results strongly support the view that corporate governance reforms (possibly divestment and a change of management), deleveraging, and tighter budget constraints will help distressed firms return to viability. The state should neither “window-dress” by merging them with sound SOEs nor encourage creditors to refinance, even if that means immediate loss recognition and a mild growth slowdown.

The government should harden budget constraints for zombies and SOEs in general by suspending implicit support on credit access and allowing greater corporate defaults. This will not only address existing debt overhang, but also improve the efficiency of new credit. In that context, nonviable zombies should be publicly identified and subject to greater use of liquidation. This should be complemented with a clear timetable to resolve all identified zombies within 1–2 years.

¹³ Quoted in a speech provided by SASAC officials.

¹⁴ In the sample of 10–15 city or provincial State-Owned Asset and Supervision Commissions, about 56 percent of SOEs were classified as commercial competitive, 36 percent as commercial strategic, and 8 percent as social function SOEs. However, no detailed information by sector, size, and debt or ownership profiles is available.

¹⁵ Newly-established creditor committees should align with international best practices (for example, the insolvency principles for multi-creditor workouts INSOLs), which allow a sufficient standstill period and information sharing between debtors and creditors.

Advancing SOE reforms can also help improve resource allocation and raise efficiency. First, reducing entry barriers and phasing out restrictions that give SOEs a privileged role will level the playing field and make markets more contestable. Implementing the commitment to open up protected markets in the state-dominated services sector, such as logistics, finance, and telecommunications, and breaking up administrative monopolies would foster competition and promote growth.

Resolving weak firms also involves significant social welfare costs, such as layoffs and bankruptcy. Targeted social policies through the budget can complement local social security to mitigate the substantial welfare cost of layoffs (estimated to be about 2.5–2.8 million workers). Moreover, ensuring sufficient resources for bankruptcy courts and professionals on valuation and overcoming remaining hurdles in the insolvency framework will be critical.

VIII. CONCLUSIONS

Zombie firms as well as SOEs have contributed significantly to China's high and rising corporate debt and low productivity. These companies account for an outsized share of corporate debt and have contributed to much of its rise. Implicit guarantees and the government's desire to support growth encourage these firms to invest excessively, raising already-high leverage while weakening performance on profitability and debt service capacity.

Using firm-level industrial survey data, this paper shows strong linkages between zombie firms and SOEs in contributing to corporate debt vulnerabilities and low productivity. For example, nearly half of zombie firms' debt is related to SOEs. At the same time, we find that zombie firms that are also SOEs remain zombies for a longer period and are less likely to become viable again.

Empirical results also demonstrate the effects of different restructuring options. Measures that include addressing the issue of redundant workers, reducing debt burden, scaling down state subsidies, and divesting noncore business activities have the largest positive impact in restoring the viability of weak firms. Reforms to resolve these weak firms will be critical in reducing debt vulnerabilities and raising productivity and long-term growth potential. Indeed, the gains are estimated to be around 0.7–1.2 percentage points per year.

While the government has introduced various reforms to facilitate deleveraging and resolve weak companies, progress has been limited. The empirical results in this paper would support the arguments that accelerating that progress requires a more holistic and coordinated strategy, which should include debt restructuring to recognize losses, fostering operational restructuring, reducing implicit support, and liquidating zombies.

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APPENDIX 1. DURATION ANALYSIS OF ZOMBIE FIRMS

Understanding the transition from zombies to non-zombies can help guide policies in restructuring (or liquidating) these companies. Although zombies, in principle, should have exited the markets, our definitions could allow the possibility of recovering viable companies.

Estimation of hazard functions. The duration and survival analysis in statistics can help assess the transition. A firm classified as zombie this year can transit into one of the three states: staying zombie, recovering into a viable company, or exiting the sample (such as liquidation). Some zombies in the sample could experience multiple transitions, which are treated as independent observations. To avoid estimation bias, a left-censored treatment on observations excludes firms that are classified as zombies in the first year of the dataset.

The survival and hazard functions assume n independent observations denoted (t_j, C_j) , where $j=1, 2, \dots, n$, where t_j is the "survival" time (zombie duration) and C_j is the event indicator variable C of observation j . C_j takes on a value of 1 if "failure event" (zombies recover into non-zombies) occurred and 0 otherwise. Assume there are $m \leq n$ recorded times of zombie recovery. Denote the rank-ordered zombie duration times as $t_1 < t_2 < \dots < t_m$. Let n_j denote the number of subjects at t_j and let d_j denote the number of observed zombie recovery. The Kaplan-Meier estimator at time t is given by

$$\hat{S}(t) = \prod_{j|t_j \leq t} \left(\frac{n_j - d_j}{n_j} \right)$$

which is a nonparametric estimate of the survivor function. It shows the probability of not turning into a non-zombie in time period t , and is robust to data censoring.

Appendix Table 1. Baseline Results on the Duration Analysis of Nonviable Zombie Firms				
Hazard function: $\ln h_j(t) = \ln h_0(t) + x_j \beta$				
Specifications	(1)	(2)	(3)	(4)
State-owned enterprises (dummy variable)	-0.290*** (0.018)	-0.290*** (0.018)	-0.290*** (0.018)	-0.320*** (0.018)
Firms that have debt accounting for top 10 percent in the province or sector (dummy)	-0.081*** (0.016)	-0.081*** (0.016)	-0.081*** (0.016)	-0.088*** (0.016)
Firms in the North/Northeastern region (dummy)		0.002 (0.014)		
Firms in overcapacity industry (dummy)			0.020 (0.026)	0.102*** (0.032)
Firms that became zombie after 2008 (dummy)				-0.196*** (0.011)
Interacting terms: overcapacity dummy x after 2008				-0.176*** (0.053)
Observations	95,980	95,980	95,980	95,980
1/ Standard errors are reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.				
2/ The estimation is the Kaplan-Meier estimates on the duration of the zombie firms based on firm characteristics using the Cox-proportional hazard model with a multivariable regression in a logarithm specification.				

The Kaplan-Meier estimates on the duration of the zombie firms are based on the Cox-proportional hazard model with a multivariate regression analysis. The Cox regression does not directly model the survival time (the duration of zombie status) but rather the natural logarithm of the hazard rate function. Specifically, the model is $h_j(t) = h_0(t) \exp(x_j \beta)$. The hazard function $h_j(t)$ is the probability of a

zombie firm turning into a non-zombie firm, conditional on the observation j that has been a zombie for t years. $h_0(t)$ denotes the underlying baseline hazard function not to be specified for the parameter estimation, while x_j includes all independent explanatory variables. Taking logarithm will arrive at a linear regression model as $\ln h_j(t) = \ln h_0(t) + x_j\beta$.

Results show that (1) zombies that are SOEs are more difficult to recover because of soft budget constraints and implicit support; (2) zombies that have higher debt burden are less likely to recover; and (3) zombies in overcapacity industries and/or in the North and Northeast regions are more entrenched.

APPENDIX II. EMPIRICAL RESULTS

Appendix Table 2.1. Determinants of Nonviable Zombie Firms—Different Specifications under Baseline Definition

Specifications	Probit specification: $Pr(zombie_{it} = 1) = \beta X_{it-1} + DInd + Dyear + Dreg + \varepsilon_{it}$						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Provincial index on market degree 2/						-0.004** (0.002)	-0.004** (0.002)
Provincial government dominance in Fan et al (2011) (in lag)			0.017* (0.010)				
Deposit share of state-owned banks (in lag)				0.054** (0.022)			
Market discipline in Fan et al (2011) (in lag)					-0.015 (0.026)		
Subsidy received by firm (in lag) 3/		0.147*** (0.048)					0.145*** (0.048)
North & Northeast regions	0.017*** (0.006)						
Overcapacity industries (dummy)	0.022* (0.013)						
State-owned enterprises (dummy variable)	0.040*** (0.002)	0.032*** (0.003)	0.033*** (0.003)	0.033*** (0.003)	0.033*** (0.003)	0.033*** (0.003)	0.032*** (0.003)
Firm leverage (in lag) 4/	0.138*** (0.020)	0.141*** (0.007)	0.141*** (0.007)	0.141*** (0.007)	0.141*** (0.007)	0.141*** (0.007)	0.141*** (0.007)
Firm's return on assets (in lag)	-0.534*** (0.047)	-0.512*** (0.010)	-0.512*** (0.010)	-0.511*** (0.010)	-0.512*** (0.011)	-0.511*** (0.010)	-0.511*** (0.010)
Firm size (in logarithm and in lag) 4/	0.002*** (0.000)	0.001*** (0.000)	0.002*** (0.000)	0.002*** (0.000)	0.002*** (0.000)	0.002*** (0.000)	0.001*** (0.000)
Firm age (in years and in lag)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	0.000*** (0.000)
Sectoral sales growth (in lag)	-0.028* (0.015)	-0.034*** (0.007)	-0.035*** (0.007)	-0.035*** (0.006)	-0.035*** (0.007)	-0.036*** (0.006)	-0.035*** (0.006)
Fixed effects							
Year	YES	YES	YES	YES	YES	YES	YES
Industry	YES	YES	YES	YES	YES	YES	YES
Province	NO	YES	YES	YES	YES	YES	YES
Observations	2,377,183	2,377,183	2,376,491	2,377,142	2,376,491	2,376,491	2,376,491
Pseudo R-squared	0.223	0.234	0.234	0.234	0.234	0.234	0.234

1/ Standard errors are reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

2/ Provincial index on market degree is measured by the principal component of three correlated indices on the government dominant index, state-owned bank dominant index, and the market discipline index as in Fan et al. (2011). The larger the index is, the higher the degree of marketization is.

3/ Firm-level subsidy received from the government in percent of sales revenue. Firms that do not receive subsidy have entries of zero.

4/ Firm leverage is measured by total liabilities to total assets and firm size refers to total assets.

Appendix Table 2.2. Determinants of Zombie Firms Based on Alternative Definitions

Probit specification:		$Pr(zombie_{it} = 1) = \beta X_{it-1} + DInd + Dyear + Dreg + \varepsilon_{it}$							
Specifications	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
Variables	Baseline definition		State Council (SC) definition		Fukuda and Nakamura (FN) definition		Nie-Jiang-Zhang-Fang (NJZF) definition		
Provincial index on market degree 2/	-0.004** (0.002)	-0.004** (0.002)	-0.001 (0.001)	-0.001 (0.001)	-0.005** (0.003)	-0.005** (0.003)	-0.001 (0.001)	-0.001 (0.001)	
Subsidy received by firm (in lag) 3/		0.145*** (0.048)		0.053 (0.043)		0.178*** (0.063)		0.056*** (0.021)	
State-owned enterprises (dummy variable)	0.033*** (0.003)	0.032*** (0.003)	0.012*** (0.001)	0.012*** (0.001)	0.041*** (0.003)	0.041*** (0.003)	0.018*** (0.002)	0.018*** (0.002)	
Firm leverage (in lag) 4/	0.141*** (0.007)	0.141*** (0.007)	-0.005** (0.003)	-0.005** (0.003)	0.188*** (0.008)	0.188*** (0.008)	0.060*** (0.005)	0.060*** (0.005)	
Firm's return on assets (in lag)	-0.511*** (0.010)	-0.511*** (0.010)			-0.659*** (0.012)	-0.659*** (0.012)	-0.290*** (0.014)	-0.290*** (0.014)	
Firm size (in logarithm and in lag) 4/	0.002*** (0.000)	0.001*** (0.000)	0.003*** (0.000)	0.003*** (0.000)	0.003*** (0.000)	0.003*** (0.000)	0.001*** (0.000)	0.001*** (0.000)	
Firm age (in years and in lag)	0.000*** (0.000)	0.000*** (0.000)	0.000** (0.000)	0.000* (0.000)	0.001*** (0.000)	0.001*** (0.000)	0.000*** (0.000)	0.000*** (0.000)	
Sectoral sales growth (in lag)	-0.036*** (0.006)	-0.035*** (0.006)	-0.048*** (0.005)	-0.048*** (0.005)	-0.051*** (0.009)	-0.050*** (0.009)	-0.021*** (0.005)	-0.020*** (0.005)	
Fixed effects									
Year	YES	YES	Yes	Yes	Yes	Yes	Yes	Yes	
Industry	YES	YES	Yes	Yes	Yes	Yes	Yes	Yes	
Province	YES	YES	Yes	Yes	Yes	Yes	Yes	Yes	
Observations	2,376,491	2,376,491	1,275,249	1,275,249	2,376,491	2,376,491	1,710,763	1,710,763	
Pseudo R-squared	0.234	0.234	0.0520	0.0521	0.244	0.245	0.250	0.250	

1/ Standard errors are reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

2/ Provincial index on market degree is measured by the principal component of three correlated indices on the government dominant index, state-owned bank dominant index, and the market discipline index as in Fan et. al. (2011). The larger the index is, the higher the degree of marketization is.

3/ Firm-level subsidy received from the government in percent of sales revenue. Firms that do not receive subsidy have entries of zero.

4/ Firm leverage is measured by total liabilities to total assets and firm size refers to total assets.

Appendix Table 2.3. Baseline Results on the Effects of Restructuring on Zombie Recovery

Probit model:		$Pr(zombie_{it} = 0 zombie_{i,t-1} = 1) = \beta X_{i,t-1} + DInd + Dyear + \varepsilon_{it}$							
Specifications	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
deleveraging	-0.452*** (0.012)								
Firms that deleverage by >5 pts in t-1 (dummy)		0.187*** (0.005)						0.182*** (0.005)	
Firms that convert from SOE to private firms at t-1 (dummy)			0.070*** (0.010)	0.095*** (0.016)				0.060*** (0.010)	
Firms that incorporated (strengthening governance) at t-1 (dummy)			0.033*** (0.009)	0.033** (0.013)				0.022** (0.009)	
Firms that convert from SOE to private firms at t-1 interacted with dummy variable after 2004				-0.055** (0.021)					
Firms that incorporated (strengthening governance) at t-1 interacted with dummy variable after 2004				-0.000 (0.019)					
Difference in wage to sales ratio relative to industry						-0.049* (0.027)		-0.048 (0.030)	
Fixed asset growth							0.004* (0.002)		
Capital injection by more than 10 percent in a year (dummy).							0.059*** (0.004)	0.038*** (0.004)	
Capital decline by more than 10 percent in a year (dummy).							0.051*** (0.006)	0.039*** (0.006)	
Observations	228,581	228,581	228,581	228,581	228,581	228,581	228,581	228,581	
Pseudo R-squared	0.0683	0.0717	0.0557	0.0557	0.0554	0.0554	0.0573	0.0728	

1/ Standard errors are reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

2/ Explanatory variables on deleveraging refers to firms that decreased their liabilities to asset ratios by more than 5 percentage points in a year.

The dummy variables on ownership change from SOE to private and the corporatization is measured based on firm registration type.

Appendix Table 2.4. Restructuring Effects across Alternative Definitions of Zombie Firms

Probit model: $\Pr(zombie_{it} = 0 zombie_{it-1} = 1) = \beta X_{it-1} + DInd + Dyear + \varepsilon_{it}$								
Specifications	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
variables	Baseline definition		State Council (SC) definition		Fukuda and Nakamura (FN) definition		Nie-Jiang-Zhang-Fang (NJZF) definition	
Firms that deleverage by >5 ppts in t-1 (dummy)		0.182*** (0.005)		0.057*** (0.009)		0.190*** (0.004)		0.177*** (0.006)
Firms that convert from SOE to private firms at t-1 (dummy)	0.095*** (0.016)	0.060*** (0.010)	0.023 (0.038)	0.034 (0.033)	0.095*** (0.017)	0.059*** (0.008)	0.101*** (0.013)	0.072*** (0.015)
Firms that incorporated (strengthening governance) at t-1 (dummy)	0.033** (0.013)	0.022** (0.009)	0.023 (0.033)	0.007 (0.018)	0.019* (0.011)	0.011 (0.008)	0.023 (0.018)	0.005 (0.010)
Firms that convert from SOE to private firms at t-1 interacted with dummy variable after 2004	-0.055** (0.021)		0.041 (0.054)		-0.054** (0.024)		-0.041 (0.028)	
Firms that incorporated (strengthening governance) at t-1 interacted with dummy variable after 2004	-0.000 (0.019)		-0.022 (0.043)		0.006 (0.015)		-0.011 (0.020)	
Difference in wage to sales ratio relative to industry		-0.048 (0.030)		-0.650*** (0.068)		-0.062** (0.030)		-0.172*** (0.051)
Capital injection by more than 10 percent in a year (dummy).		0.038*** (0.004)		0.056*** (0.006)		0.035*** (0.004)		0.031*** (0.005)
Capital decline by more than 10 percent in a year (dummy).		0.039*** (0.006)		-0.040*** (0.004)		0.036*** (0.005)		0.028*** (0.005)
Observations	228,581	228,581	42,704	42,704	282,413	282,413	114,205	114,205
Pseudo R-squared	0.0557	0.0728	0.0125	0.0228	0.0584	0.0773	0.0648	0.0826

1/ Standard errors are reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

2/ Explanatory variables on deleveraging refers to firms that decreased their liabilities to asset ratios by more than 5 percentage points in a year. The dummy variables on ownership change from SOE to private and the corporatization is measured based on firm registration type.

Appendix 3: Theoretical Framework in Estimating the Gains from Resolving Weak Firms

Resource misallocation leads to a wide dispersion of revenue productivity levels across firms, which contributes to cross-country differences in total factor productivity (TFP) (Restuccia and Rogerson 2008; Hsieh and Klenow 2009). As a result, reallocating resources from firms with low productivity to those with high productivity would increase aggregate output and raise productivity, essentially using the same amount of resources more efficiently. Using the framework in Hsieh and Klenow (2009), a standard monopolistic competition model with heterogeneous firms can be used to derive the potential gains from reallocation of resources when resolving debt vulnerabilities. Specifically, the Cobb-Douglas production function with final output Y can be represented as:

$$Y = \prod_{s=1}^S Y_s^{\theta_s} \quad \text{with} \quad \sum_{s=1}^S \theta_s = 1$$

where θ_s is the value-added share of industry s . Industry output Y_s is a constant elasticity of substitution (CES) aggregate of M_s differentiated products produced by monopolistic competitive firms:

$$Y_s = \left(\sum_{i=1}^{M_s} Y_{si}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}$$

where $Y_{s,i}$ denotes firm i 's output, and σ denotes the elasticity of substitution between output variety i . Each firm's output is given by a Cobb-Douglas function of physical productivity, capital and labor:

$$Y_{si} = A_{si} K_{si}^{\alpha_s} L_{si}^{1-\alpha_s}$$

Firms potentially face different distortions that either affect both capital and labor (placing a wedge in the marginal products of capital and labor) or affect capital labor ratio, which respectively denoted by output distortion τ^Y and capital distortion τ^K . Firms maximize profits by choosing capital and labor:

$$\pi_{si} = (1 - \tau_{si}^Y) P_{si} Y_{si} - \omega L_{si} - (1 + \tau_{si}^K) R K_{si}$$

where $P_{s,i}$ is firm-specific output price, ω and R denote the common wage rate and the rental cost of capital. The first order conditions imply that marginal products of labor and capital as:

$$MRPL_{si} = \frac{\omega}{1 - \tau_{si}^Y} \quad \text{and} \quad MRPK_{si} = \frac{R(1 + \tau_{si}^K)}{1 - \tau_{si}^Y}$$

Building on Foster and others (2008) and Hsieh and Klenow (2009), this paper also distinguishes between "revenue productivity" and "physical productivity"

$$TFPR_{si} = P_{si} A_{si} = \frac{P_{si} Y_{si}}{L_{si}^{1-\alpha_s} K_{si}^{\alpha_s}} \quad \text{and} \quad TFPQ_{si} = A_{si} = \frac{Y_{si}}{L_{si}^{1-\alpha_s} K_{si}^{\alpha_s}}$$

whereas firm-specific distortions can be reflected in revenue productivity:

$$TFPR_{si} = \frac{\sigma}{\sigma-1} \left(\frac{R}{\alpha_s} \right)^{\alpha_s} \left(\frac{\omega}{1-\alpha_s} \right)^{1-\alpha_s} \frac{(1 + \tau_{si}^K)^{\alpha_s}}{1 - \tau_{si}^Y}$$

A higher level of revenue productivity shows higher marginal products of labor and capital, and it is negatively correlated with implicit support the firm receives. Aggregating the firm-level TFPR would arrive at industry TFP as:

$$TFP_s = \left[\sum_{i=1}^{M_s} \left(A_{si} \frac{\overline{TFPR}_s}{TFPR_{si}} \right)^{\sigma-1} \right]^{\frac{1}{\sigma-1}}$$

where \overline{TFPR}_s is a geometric mean of the average marginal revenue product of capital and labor.

When marginal products are equalized across firms, $TFP_s = \overline{A}_s = \left(\sum_{i=1}^{M_s} A_{si}^{\sigma-1} \right)^{\frac{1}{\sigma-1}}$ and is larger than TFP level in the presence of distortions. For each industry, we calculate the ratio of actual TFP to the efficient level of TFP. Aggregating up yields the measure of resource reallocation gain:

$$\frac{Y}{Y_{efficient}} = \prod_{s=1}^S \left[\sum_{i=1}^{M_s} \left(\frac{A_{si} \overline{TFPR}_s}{\overline{A}_s TFPR_{si}} \right)^{\sigma-1} \right]^{\theta_s / (\sigma-1)}$$

Resolving debt vulnerabilities from SOE reforms, cutting overcapacity, and cleaning up zombies is equivalent to equalizing TFPR across firms. Hence, the output gains can be expressed as total gain when equalizing the TFPR within industries and net of the gain when equalizing TFPR only within ownership (SOE and non-SOE) or firm status (zombie and non-zombie). Reducing overcapacity suggest that resources would also be redistributed across industries. The output gain given the industrial TFP level (\overline{A}_s) can be expressed as:

$$\frac{Y_{efficient*}}{Y} = \frac{\prod_{s=1}^S (\overline{A}_s K_s^{\alpha_s} L_s^{(1-\alpha_s)})^{\theta_s}}{\prod_{s=1}^S (\overline{A}_s K_s^{\alpha_s} L_s^{(1-\alpha_s)})^{\theta_s}} = \prod_{s=1}^S \frac{\overline{A}_s^{\theta_s}}{\overline{A}_s^{\theta_s}} \times \prod_{s=1}^S \frac{(K_s^{\alpha_s} L_s^{(1-\alpha_s)})^{\theta_s}}{(K_s^{\alpha_s} L_s^{(1-\alpha_s)})^{\theta_s}}$$

Output gain

TFP gain from

Gain from inputs