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Abstract

China's coalmining fatalities were 140 times higher than the U.S. in the last decade. To shed light on this issue, we form and examine a unique panel dataset of 25,387 firm-year observations for China's coalmining industry. We show that a firm's leverage significantly determines its coalmining fatality: A 10% increase in the debt ratio leads, on average, to a 3% increase in the number of death tolls. It suggests that reducing leverage in coalmining firms can be an effective way to curb employee fatalities. Our study highlights the importance of corporate finance in helping solving social and institutional problems.

JEL classification: G30, G32, J81

Keywords: Leverage, Debt, Capital Structure, Stakeholder Interest, Employee Death, Coalmining Accident

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1. Introduction

The annual coalmining fatalities in China were, on average, at 4,643 between 2000 and 2011, which were 140 times higher than that of the U.S. for the same period,[1] despite the fact that China's annual coal production was merely 2 times of the U.S.[2] At its peak, in 2003, the death rate per 100 tons of coal produced was 100 times higher than that of the U.S. and 30 times higher than South Africa.[3] It is hard to reconcile this fact with the Chinese government's continued efforts to improve the coalmining safety. For instance, in 2000, it set up a national surveillance system to keep a close eye on the safety conditions of coalmines; in 2001, it earmarked over 4 billion yuan (over $480 million) to help both the state-owned and small private coalmines to improve safety.[4]

Studies in the past decade have been trying to uncover the causes for such a high fatality rate. Wright (2004) and Tu (2007) attribute the high death rate to the hiring of low quality workers in local town-owned mines. Wang (2006) points to the lack of effective monitoring at the state level. Jia and Nie (2013) argue that collusion between local government and coalmining firms is responsible for it. Fisman and Wang (2013) show that executives' political connections significantly increase workplace fatalities.[5] While these studies shed important light on the causes of coalmining fatalities, they are confined to case, small sample, or provincial-level

[1] China's data is obtained from the State Administration of Work Safety (SAWS) website: http://www.chinasafety.gov.cn. The U.S. data is obtained from the Mine Safety and Health Administration (MSHA) website: http://www.msha.gov

[2] BP Statistics Review of World Energy 2013, http://www.bp.com/en/global/corporate/about-bp/statistical-review-of-world-energy-2013/statistical-review

[3] "Coal mining: Most deadly job in China," *China Daily*, November 13, 2004. http://www.chinadaily.com.cn/english/doc/2004-11/13/content_391242.htm

[4] *Ibid*.

[5] Fisman and Wang (2013) provide a comprehensive discussion on workplace safety oversight in China.

(rather than firm-level) studies.[6] Most of them, except Fisman and Wang (2013), are focusing mainly on the regulatory environment and industrial features, which overlooks the potentially important firm-level characteristics. Our study aims to fill this gap.

Myers (1977) argues that a firm with high leverage has incentives to pass up valuable investment opportunities. Thus, if a firm's investment in its employee is a positive NPV project, the firm is likely to underinvest in employee benefits given its high leverage, resulting in a negative relation between leverage and employee benefits (Bae, Kang, and Wang, 2011). Maksimovic and Titman (1991) show that if firms want to credibly commit themselves to providing better employee benefits, they need to have lower debt ratios than firms that do not implement employee friendly policies. Hanka (1998) finds that high leverage is associated with more frequent employment reductions, lower wages and reduced pension. Recently, Bae, Kang, and Wang (2011) find that firms that treat their employees fairly maintain low debt ratios.[7] In the spirit of above studies, we posit that a coalmining firm's leverage is likely to be related to its employee fatality.

To conduct this investigation, we hand collect coalmining accidents/deaths data from the State Administration of Work Safety (SAWS) and the State Administration of Coal Mine Safety (SACMS). We then merge it with the Chinese Industrial Enterprise Database (CIED) to obtain the firm-level data for coalmining firms. We create a unique panel dataset of 25,387 firm-year observations for 2001-2006. Our

[6] One of the main limitations of provincial-level studies is that it is unable to control for the cross-sectional variations of firm characteristics within the same province.

[7] In addition, the literature on trade unions shows that, due to bankruptcy risk, a firm can improve its bargaining power with the trade union on negotiating workers' wages when the firm chooses to use more debt in its capital structure, suggesting a negative relation between leverage and employee benefits. See, for example, Bronars and Deere (1991), Perotti and Spier (1993), and Matsa (2010).

key finding is that a firm's leverage (debt-to-asset ratio) significantly determines its coalmining fatality.

Using multiple regression analysis, we first identify a positive relation between leverage and coalmining death, which is robust to the use of alternative variables and subsample analysis. After showing that high leverage is related to high death toll, we investigate whether high leverage *causes* high fatality rather than the other way around. Since one may argue that it is the high death tolls that force the firm to borrow excessively to meet the employee compensations, government fines, and other associated costs. We show that the reverse causality is unlikely to hold for China coalmining firms.

Another concern is that some unobservable firm characteristics could be responsible for both the level of the firm's leverage and its number of fatalities. We use the two-stage least squares (2SLS) regression method to address this potential endogeneity problem. Our results hold up to this test.

One may also argue that this year's coalmining fatality could be affected by the death toll of last year. To address this issue, we control for the number of death of last year and use the system GMM (generalized method of moments) regression method which is most suitable for examining dynamic panel data. The GMM regression results are consistent with our main findings.

Although our evidence shows that leverage significantly determines coalmining fatalities, this result can still be attributed to the use of inappropriate estimation methods. Our dependent variable, the number of coalmining death, is nonnegative and takes only on relatively few values including zero, known as the count variable. It does not follow a normal distribution as that is for continuous variables that can take on a large range of values. This violates the standard distributional assumption for

liner regression. Since the nominal distribution for count data is the Poisson distribution, we run Poisson regressions to check the robustness of our results. Our key finding holds at the 1% significance level. Further, the economic meaning of the regression is straightforward: A 10% increase in the debt ratio leads, on average, to a 3% increase in the number of death tolls.

While debt serves as an effective disciplinary/control mechanism that reduces the agency costs of free cash flow (Jensen, 1986), our evidence suggest that high leverage is not suitable to China's coalmining industry. Our finding is, nonetheless, not inconsistent with Jensen's theory, since Jensen (1986) posits that the disciplinary benefits of debt is mostly gained by firms with activities that generate "substantial economic rents" and hence substantial amounts of free cash flow. Our data show that the coalmining firms are, on average, not the very profitable ones with a mean annual profitability rate of 6.6% (median = 6.4%), which is partly due to the tight coal price control by the central government.[8]

Overall, our study lays a micro foundation to the analysis of coalmining fatality. We show that, from a corporate finance perspective, a seemingly institutional failure could have its micro root. A more suitable capital structure strategy (a low leverage in our case) can be an effective tool in easing the number of death tolls. Our study, therefore, highlights the importance of corporate finance in helping solving social and institutional problems. Our study also paves the way for more corporate finance based analyses in workplace accidents and fatalities.

[8] Chinese coalmining firms, since 1996, had to sell a certain amount of coals to domestic power generators at a tightly regulated below-market price, since the Chinese government had tried to ensure power supply and smooth energy prices. This policy was, however, abolished by the government in 2013. http://www.chinadaily.com.cn/cndy/2012-12/26/content_16055107.htm.

The rest of the paper is organized as follows: Section 2 introduces the data and describes the sample statistics. Section 3 presents the empirical results and conducts various robustness tests. Section 4 concludes the paper.

2. Data and Descriptive Statistics

2.1. The Sample

The data on coalmining accidents and fatalities are hand collected from the State Administration of Work Safety (SAWS) and the State Administration of Coal Mine Safety (SACMS). From 2001, the SAWS and SACMS publish coalmining accidents news bulletin on their official websites,[9] which includes the date of the coalmining accident, the name of the firm involving an accident, the number of death tolls for each accident, and the total casualty numbers for each accident (the number of deaths plus the number of people injured and missing). We hand collect above information for each coalmining firm across all the provinces for the period 2001-2006. Our sample starts from 2001 because the SACMS only started to publish coalmining accidents data from July 2000 and the SAWS was officially formed on 2001. We end our sample at 2006, since SAWS and SACMS only publish data on accidents involving more than 3 casualties from 2007.

We obtain all the firm information and financial data from the Chinese Industrial Enterprise Database (CIED),[10] which is constructed by the National Bureau

[9] The State Law requires the coalmining firms to report to their provincial governments and the relevant departments of the state council immediately following the coalmining accidents. Delayed reporting or underreporting are subject to administrative penalties and criminal charges. See Article 92 of "The Production Safety Law" issued in 2002.

[10] The CIED contains 130 firm-level data items. It is also called China Annual Survey of Industrial Firms or China Annual Survey of Manufacturing Firms by some studies. For recent studies which use this database, see, for example, Hsieh and Klenow (2009).

of Statistics and is the largest database for Chinese industrial firms.[11] The CIED covers all state-owned and sizable non-state-owned enterprises,[12] which accounts for 90% of the total sales of all industrial firms in China.[13] The CIED database with its complete information is, however, only available for 1998-2007.[14] This is another reason why we end our sample at 2006. We take all the coalmining firm data from CIED and merge it with the coalmining accidents data hand collected from SAWS and SACMS. We manage to form a panel dataset of 25,387 firm-year observations which includes all state-owned and sizable non-state-owned coalmining firms for the period 2001-2006.

We also collect some provincial-level data which we believe are important to our analysis. The GDP per capita for each province is collected from China Statistical Yearbook. The measure of the level of corruption for each province is recorded in China Procuratorial Yearbook. The number of total circulation of media newspapers is obtained from China Statistical Data of Press and Publication.

Table 1 presents the annual distribution of coalmining accidents/fatalities for 2001-2006. It shows that the number of coalmining firms increased year on year. The number of firms in 2006 (6,463) was nearly 3 times higher than that of 2001 (2,549). The number of firms with coalmining accidents also increased year on year except for 2006. The number of accidents reached over 400 per year during 2003-2005 accompanied with a sharp decline in 2006 (90 accidents). The number of fatalities since 2001 doubled every year and peaked at 2003 (863 deaths); it then fell by over 10%

[11] The CIED contains over 2 million observations for the period 1998-2007. The number of firms stands at 160,000 in 1998 and increases year on year and reaches 330,000 in 2007.
[12] The sizable non-state-owned enterprise refers to firms with annual sales of no less than 5 million yuan.
[13] In the first national economic survey conducted in 2004, the total sales for all industrial firms were at 218 billion yuan, while the total sales for all CIED firms were at 196 billion yuan.
[14] Some key data items (e.g., registration ID, equity capital, subsidy） are missing from CIED after 2007 which prevents us matching the post-2007 data with the earlier observations between 2001 and 2006.

per year and dropped to 316 in 2006. The death toll per accident shows that it was around 2 deaths per accident (except for 2006) despite the variations in other indicators. Though we have seen many improvements in 2006, it was the worst year in terms of death per accident (at 3.5). This indicates that it is no easy task to deal with the fatality problem in the coalmining industry. Overall, there are 1,155 firms involved with 1,725 accidents and 3,267 deaths averaging 1.9 deaths per accident.

[Table 1]

2.2. Main Variables

We first define all the main variables used in this study which are constructed at the annual frequency.[15] The main dependent variable is the natural logarithm of (one plus) the number of coalmining deaths per firm per year. Our main variable of interest is the firm's debt ratio which is measured as the firm's total debt divided by its total asset. We observe a positive relation between debt ratio and employee death at the 1% significance level (Appendix Table A.2). We posit that a firm's leverage significantly determines the number of coalmining deaths.

Other firm-level explanatory variables are classified into three groups. The first group, in addition to the debt ratio, contains other financial indicators (i.e., burdens and benefits). The tax rate is the total amount of taxes actually paid by a firm divided by its total sales. The subsidy rate is the total amount of government subsidies received divided by the total sales. The second group controls for firm-specific characteristics. Size is defined as the natural logarithm of total asset. Age is the natural logarithm of the number of years starting from the formation of the firm. Profitability rate is measured as the operating profit divided by the total sales. Investment in fixed asset is defined as the total investment in fixed asset divided by

[15] Definitions for all the variables used in this study are provided in Appendix Table A.1.

the total asset, which captures firm's investment in advanced technology, equipment, and infrastructure.[16] The third group controls for the equity ownership. State ownership is the percentage equity ownership by the state. Individual ownership is the total equity ownership by the collective individual investors.

In addition to the firm-level measures, we also construct three provincial-level variables to control for the variations across different provinces. GDP per capita is the natural logarithm of average GDP per capita for each province. Corruption is measured as the corruption cases filed per 10,000 government officials in that province, similar to Fisman and Gatti (2002), Adsera, Boix, and Payne (2003), and Glaeser and Saks (2006). Media exposure is the per capita print of newspapers, as in Besley and Burgess (2002), Nie, Jiang, and Wang (2013). Large circulation of newspapers facilitates the flow of information especially the bad ones like coalmining death. Egorov, Guriev, and Sonin (2009) argue that media can play a significant role even in an authoritarian system since it helps the government to monitor the behaviour of bureaucratic officials. Finally, we adjust all the relevant variables at the 2001 price by using various price indices obtained from China Statistical Yearbook.

Table 2 presents the descriptive statistics for above variables. The average debt ratio is 53.4% (median = 51.9%) with a standard deviation of 0.36. The debt ratio is 28.2% for the 25th percentile while it reaches 75.0% for the 75th percentile.[17] The average effective tax rate is 9.4% with a standard deviation of 0.06, which suggests

[16] According to the National Bureau of Statistics, "Investment in fixed assets is the essential means for social reproduction of fixed assets. By means of construction and purchase of fixed assets, more advanced technologies and equipment are adopted in the national economy, and new sectors are established, which promote the adjustment of economic structure and the regional distribution of productive forces and enhance the economic strengths so as to provide the material conditions for improving people's livelihood."

[17] There are in total 548 observations (2.16% of the sample) have zero leverage.

that coalmining firms are not in fact heavily burdened by taxes.[18] The average subsidy received from the government is rather low at 0.7% of its total sales (standard deviation = 0.07). Even this figure is driven by relatively few firms with very large subsidy rates since the rate at the 75th percentile is still at 0%. We take a closer look at the data and find that large state-owned coalmining firms receive most of the subsidies. Thus, subsidy rate could potentially capture a firm's degree of connection with the government.

[Table 2]

The average size of coalmining firm is 159 million yuan (20 million U.S. dollars), which is larger than the average size of 85 million yuan for all the industrial firms recorded by CIED for the same period.[19] The average firm is 15 years old with the oldest one at 58 years and youngest at 1 year old. Coalmining firms are, on average, not very profitable with an average operating profit to total sales at 6.6% (median = 6.4%). Investment in fixed assets is, on average, at 45.3% (median = 44.4%). In terms of equity ownership, individual investors, on average, collectively own 34.7% of the firm compared to the 20.2% of state ownership. This is mainly because 80% of the sample firms are classified as non-state-owned firms by CIED.

The provincial-level data shows that the average GDP per capita is 13,461 yuan, while a large disparity exists: the minimum is just 3,000 yuan and the maximum is 58,837 yuan. The degree of corruption for each province is similar. There are, on average, 4.4 corruption cases filed for every 10,000 government officials, which reflect the prevalence of corruption in China. The level of media exposure (i.e., per

[18] Although the nominal tax rate in China is reasonably high, e.g., 25% for corporate income tax and 17% for value added tax (VAT), the effective tax rate is rather low thanks to many different kinds of tax rebate and weak enforcement on taxation.

[19] The exchange rate between the U.S. dollar and the Chinese yuan (RMB) was around 1 dollar to 8 yuan for our sample period (2001-2006).

capita print of newspapers in a year) is not even with a mean of 22.7 and a standard deviate of 19.2.

Appendix Table A.2 presents the correlation matrix for the firm-level variables. As can be seen, leverage (our main variable of interest) is positively correlated with subsidy rate, firm size, age, and state ownership, while negatively correlated with profitability, investment in fixed assets, and individual ownership. It suggests that if a firm is large, old, receiving more subsidies from the government, or largely owned by the state, it is more likely to have a high leverage; while high leverage is likely to be associated with low profitability, low investment in fixed assets.

Coalmining fatality (the dependent variable of our study) is significantly related to most of the explanatory variables. Specifically, it is positively related to leverage, subsidy rate, firm size, age, investment in fixed assets, and state ownership, while negatively correlated with tax rate and individual ownership. It would be interesting to see how many of these relations are still held in a multiple regression analysis, which is the focus for the rest of the study.

3. Empirical Results

In this section we perform multiple regression analyses in an attempt to establish the determinants of coalmining deaths. All regression estimates use robust standard errors clustered at the provincial level, which account for possible heteroskedasticity and within-province serial correlation of the idiosyncratic error terms.

3.1. Baseline Regressions

In Table 3, we report the results from our baseline regressions, which control for leverage and all the other explanatory variables discussed in the last section. The

dependent variable is the natural logarithm of (one plus) the number of coalmining deaths per firm per year. Specification 1 runs simple OLS regression with leverage as the only explanatory variable. The coefficient estimate of debt ratio is 0.030 and is statistically significant at the 1% level test, suggesting a positive relation between leverage and coalmining fatalities. This simple result survives after controlling for all the important explanatory variables and is robust to various regression techniques.

[Table 3]

In specification 2, we add all the firm-level explanatory variables into the regression as well as control for year and firm fixed effects. The coefficient estimate of debt ratio is positive and significant at the 5% level test. In addition, profitability rate is significantly positive at the 5% level, suggesting a rather unpleasant relation between profitability and coalmining fatality. The coefficient estimate of size is weakly significant.[20] It is intuitive that the larger the firm the more workers it may employ and the more death tolls it may have. It contradicts, however, to the commonly held belief that coalmining deaths are mainly constrained to small firms where the safety standard has been kept to a sheer minimum.[21] It also seems to suggest that the government's efforts to increase the size of coalmining firms via merger and nationalization have yet to achieve its objective of reducing fatalities.

Specification 3 adds further the provincial-level explanatory variables into the regression, the results mirror that of specification 2 that leverage, size and profitability significantly relates to the number of coalmining deaths.

[20] However, as can be seen from the rest of the tests, the size pattern is unstable across various tests, suggesting, at best, a loose relation between size and the number of employee death.

[21] One potential reason for the significant positive relation between firm size and employee death is that we include only sizable coalmining firms in our sample: either state-owned firms or non-state-owned firms with annual sales of no less than 5 million yuan. Statistics show that small (non-sizable) coalmining firms typically owned by villages, however, have the highest employee death rate in China. http://news.163.com/41214/4/17IPC77C0001124T.html

3.2. Sub-sample regressions

Table 4 specification 1 is the same as specification 3 in the last table apart from adding an interaction variable (debt ratio * key state firm). Key state firm refers to the 94 largest state-owned coalmining firms named by the central government. We construct a dummy variable which equals one if the firm is a key state firm and zero otherwise. We find similar results as in the Table 3, while the interaction variable is statistically insignificant.

In specification 2, instead of using the debt ratio as the explanatory variable, we set a dummy variable that equals one if a firm's debt ratio is above the sample average and zero otherwise. We find that the coefficient estimate of high debt dummy is positive and statistically significant at the 5% level test.

[Table 4]

In specifications 3 and 4, we divide the sample into two subsamples based on whether the coalmining firm is a key state firm or not. Specification 3 shows the regression results for the key firm subsample. Since very limited firms are classified as the key state firm, we only have 478 firm-year observations for this regression. We find that none of the previous results hold for the key state firms but some interesting patterns emerge however.

The coefficient estimate of subsidy rate is significantly positive at the 1% level test. The positive relation between subsidy and coalmining death is a challenge to the government which begs for a rethink on its subsidy policy to the key state firms. In unreported results, we find that the average subsidy rate for key state firms is 6.73%, while it is merely 0.55% for non-key firms. In addition, the coefficient estimate of corruption is significantly positive for key state firms while insignificant for non-key firms. Corruption seems to be a problem for coalmining death in key state firms.

In unreported results, we run tests for publicly listed firms. Since there are only 24 coalmining firms listed on the stock market, it limits us to do any large scale tests on public coalmining firms in this study. Interestingly, 23 out of the 24 public firms are key state firms. Thus, the public sample is simply a subsample of key state firms. Again, it shows that key state firms enjoy an overwhelming advantage in listing in China's tightly regulated IPO market. We run a same regression as specification 3 for the 24 public firms (146 firm-year observations). With little surprise, the key result is similar to that of specification 3 that leverage of public firms does not have a significant effect on the death toll.

In specification 4, we run the same regression for the non-key firms. Since the sample observations are just slightly less than the full sample, the results mirror our main findings reported for the full sample, which suggests that the leverage effect is pronounced only for the non-key firms.

Specifications 5 and 6 divide the sample into two subsamples based on whether a firm's debt ratio is below or above the sample average. We obtain two subsamples with roughly equal number of observations. It shows that the leverage effect holds only for the high-debt subsample. Overall, specifications 2 and 5 suggest that high leverage is a significant issue for high coalmining fatality.

3.3. Alternative variables

We next use alternative explanatory and dependent variables to test the main results. Specifically, we have found in previous regressions that in addition to leverage, firm size and profitability significantly relates to coalmining fatalities. We thus use alternative measures of size and profitability to test the robustness of our results. For

the dependent variable, we use an alternative measure of employee death to test whether the leverage effect is robust to this change.

In Table 5 specification 1, we use total sales, instead of the total assets, to proxy for firm size and use return on asset (ROA) to measure the profitability rate. In this new regression, our main variable debt ratio is the only significant variable though at a weaker significance level (P value = 0.071).[22]

[Table 5]

In the next two specifications, we use an alternative measure for employee fatality. According to the Chinese government, the severity levels for workplace accidents are classified as follows: accident with a fatality of 3 or less is defined as "general", 3-9 as "relatively serious", 10-29 as "very serious", and 30+ as "extremely serious". Based on this, we set a dummy variable 'Death3' as our new dependent variable, which equals one if an accident involving 3 or more deaths (i.e., relatively serious or more severe) and zero otherwise.[23] Specification 2 use the original set of explanatory variables and specification 3 use the same set of variables as in specification 1. It shows that leverage is statistically significant at the 5% level test for both specifications.[24]

3.4. Reverse causality

We have so far established a significant relation between firm's debt ratio and the number of employee death. This seems to suggest that high debt burden leads to high

[22] In results unreported here, we use the total number of employees of a firm as an alternative proxy for firm size. While this new proxy for firm size is insignificant, our main variable debt ratio is still statistically significant (P value = 0.062).
[23] Table 2 shows that the average death toll per accident for the full sample is about 2 people.
[24] In results unreported here, instead of using the natural logarithm of the number of deaths, we use the natural logarithm of the death rate where death rate is defined as the number of death per firm per year divided by the firm's total number of employees, and then times 1,000. We find that leverage significantly affects the death rate, though at a 10% significance level.

coalmining fatalities. However, endogeneity issues prevent us from drawing a conclusion that high debt ratio causes the high death toll. One form of the endogeneity problem is reverse causality. One may argue that it is the high death tolls that force the firm to borrow excessively to meet the employee compensations, government fines, and other associated costs. This can be true for many developed countries as compensation for employee's life can be extremely high,[25] while it is not the case for China.

Prior to 2005, the compensation for each coalmining death in China was between 30,000 and 50,000 yuan, with a maximum compensation of 80,000 yuan (9,756 US dollars in 2005 exchange rate)[26] and a maximum total fine of 150,000 yuan. In 2005, started from Shanxi province (the epicentre of coalmining accidents) and gradually followed by other provinces, the compensation level has been raised to 200,000 yuan plus one million yuan fines for each coalmining death.

Using 2005 data from China's official Xinhua News Agency,[27] the death toll per million ton of coals was at about 5 people and the raw profit for one million ton of coals produced was about 100 million yuan. Thus, the total compensation and fine for the 5 deaths was at 6 million yuan that was merely 6% of the raw profit. Between 2001-2004, the majority period of our sample, using the maximum compensation of 80,000 yuan and a total fine of 150,000 yuan per death, 5 deaths would cost the

[25] Take the U.S. for example. In April 5, 2010, a massive explosion happened at the Upper Big Branch coal mine in West Virginia which led to 29 miner deaths. Each family of the victims was offered case settlements for $3 million. The families were also entitled to receive other benefits including health insurance coverage, life insurance (five times the annual salary of the mineworker), college tuition, and ongoing weekly paychecks (until widows remarry). http://www.npr.org/templates/story/story.php?storyId=126397976.
In terms of fines made by the government, a Massey Energy subsidiary was fined $2.5 million by a U.S. District Judge for a fire that killed two West Virginia coal miners on Jan. 19, 2006. http://www.insurancejournal.com/news/southeast/2009/04/17/99728.htm.

[26] The average exchange rate between U.S. dollar and Chinese yuan in 2005 was 1 dollar to 8.2 yuan.

[27] The Xinhua News Agency is the official press agency of China. It is subordinate to the State Council and reports to the Communist party's Propaganda and Public Information Departments. Xinhua's website is:http://www.news.cn/english/

coalmining firm just over half million yuan, which is less than 1% of its raw profit. Thus, for Chinese coalmining firms, the reverse causality scenario mentioned above is less likely.

3.5. Other endogeneity problems

The other form of the endogeneity problem is an omitted variable bias. The concern is that some unobservable firm characteristics could be responsible for both the level of leverage in a firm and the number of fatalities. Next, we use the two-stage least squares (2SLS) regression method to address this potential problem. We use the value-weighted debt ratio for all firms in a province as the instrumental variable (IV) for a firm's debt ratio in that province.[28] Our choice of the instrumental variable is based on two reasons: First, if a province has an average high level of leverage for its coalmining industry, it is likely that this overall high leverage will affect the leverage decisions of individual firms.[29] Second, it is exogenous to the coalmining death for any particular firm.[30]

Table 6 specifications 1 and 2 report the two-stage least square (2SLS) regression results. The first stage results indicate that the provincial-level average debt ratio significantly affects the individual firm's leverage, which is consistent with our earlier argument. The second stage results show that, consistent with the main evidence, the coefficient estimates of the debt ratio is positive and statistically significant though at the 10% significance level.

[28] In economic literature, it is common to use an average indicator of an area as the instrumental variable (IV) for firms in the area. For example, Dunifon, Hansen, Nicholson, Nielsen (2013) use local unemployment rate as the instrumental variable (IV) for mother's unemployment in each family.

[29] Note that this does not necessarily mean that if the average debt level in a province is high, then an individual coalmining firm in this province would have a high death level unless it affects the firm to adopt a high debt ratio which results in high fatalities.

[30] The average debt ratio in a province does not directly affect a firm's coalmining accident/death, while it may affect the firm's leverage choice and hence indirectly affect the death toll.

[Table 6]

Another concern is that this year's coalmining fatality could be affected by the death toll of last year. To address this problem, we control for the number of death of last year and use the system GMM (generalized method of moments) regression method which is regarded as most suitable for examining dynamic panel data. The GMM strategy uses only internal instruments to cope with potential endogeneity of the debt ratio (Arellano and Bond, 1991 and Blundell and Bond, 1998). [31] Specification 3 shows the GMM regression results. Similar to other tests, the coefficient estimate of the debt ratio is positive and significant at the 5% level test.

3.6. Poisson regression for count variable

Our dependent variable, the number of coalmining death, is the annual total number of death for a coalmining firm. This variable is nonnegative and takes on relatively few values including zero, which is also known as the count variable. In our case, nearly 99% of the observations take the values of zero, one, and two.

Wooldridge (2013) argue that a count variable will not have a normal distribution, since the normal distribution is for continuous variables that can take on a large range of values. Its distribution can be very different from normal if the variable takes on very few values. Given normality is the standard distributional assumption for liner regression, a linear model might, therefore, not be the best approach for our study.[32] Since the nominal distribution for count data is the Poisson distribution, a Poisson regression model is probably more appropriate than a liner

[31] If we assume the debt ratio is endogenous and is correlated with the contemporaneous error term, we can use the second and further lagged debt ratios as instruments for the first-differenced equation, and use the lagged first-differenced debt ratios as instruments for the level equation.

[32] Wooldridge (2013) argue that although a liner model for count data might not provide the best fit over all values of the explanatory variables, it is, nevertheless, always informative to start with a liner model.

model. In addition, the economic interpretation is straightforward under the Poisson regression, which helps us to assess the economic significance of our study.

In Table 7 specification 1, we perform the Poisson regression under the original set of variable. In specification 2, we run similar regression but use total sales as a proxy for size and ROA as a proxy for profitability. In both regressions, we control only for the year fixed effects, since controlling for firm fixed effects in Poisson regression can cause the losses of a large majority of observations in an unbalanced panel dataset such as ours. Results are statistically significant at the 1% level test for both regressions. The economic meaning is also straightforward. Specification 1, for example, suggests that a 10% increase in the debt ratio leads, on average, to a 3% increase in the number of death tolls.[33]

4. Conclusion

China's coalmining fatalities were 140 times higher than the U.S. in the last decade. Studies in the past shed important light on the causes of such a high fatality rate, especially in the areas of regulatory environment and industrial characteristics. These studies, however, overlook the potentially important characteristics embedded within the coalmining firms, due largely to the unavailability of such a firm-level database.

In this paper, we bridge this gap by hand-collecting and constructing a unique dataset for China's coalmining firms and examining the firm's internal characteristics that may contribute to the high death rate. We find that firm's leverage, a neglected factor in the coalmining safety studies but a fundamental element in corporate finance, significantly determines the coalmining fatalities. We argue that, from a firm level

[33] In results unreported here, we run Poisson regression by controlling for both the year and firm fixed effects where, as a result, we lose 88% of the observations (we are left with only 2988 out of 25,381 observations). Nonetheless, the coefficient estimate of debt ratio remains statistically significant at the 1% level test.

perspective, reducing leverage is a potentially effective tool in easing the number of coalmining accidents/deaths. Our study, therefore, highlights the importance of corporate finance in helping solving social and institutional problems.

While we focus on China's coalmining industry in this study, our intuition can be applied to the wide industries and perhaps other developing countries where the workplace safety is a top concern. Our study, thus, paves the way for more corporate finance based analyses in workplace accidents and fatalities.

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Table 1: Coalmining accidents and employee fatalities

This table presents the statistics on the annual distribution of China's coalmining accidents and employee fatalities for the period 2001-2006. The data on coalmining accidents and fatalities are hand collected from the State Administration of Work Safety (SAWS) and the State Administration of Coal Mine Safety (SACMS). The SAWS and SACMS publish information on the date of the coalmining accident, the name of the firm involving an accident, and the number of death tolls for each accident.

Year	No. of firms	No. of firms with accident	No. of accidents	No. of deaths	Deaths per accident
2001	2,549	83	117	265	2.3
2002	2,686	180	290	484	1.7
2003	3,058	245	407	863	2.1
2004	5,157	275	416	714	1.7
2005	5,606	290	405	625	1.5
2006	6,463	82	90	316	3.5
All	25,519	1,155	1,725	3,267	1.9

Table 2: Descriptive statistics

This table provides the coalmining firm-level and provincial-level data for the period 2001-2006. The firm-level data are obtained from the Chinese Industrial Enterprise Database (CIED), which is constructed by the National Bureau of Statistics and is the largest database for Chinese industrial firms. The CIED covers all state-owned and sizable non-state-owned enterprises, which accounts for 90% of the total sales of all industrial firms in China. For the provincial-level data: The GDP per capita for each province is collected from China Statistical Yearbook; the measure for the level of corruption for each province is recorded in China Procuratorial Yearbook; the number of total circulation of media newspapers is obtained from China Statistical Data of Press and Publication. All variables are defined in Appendix Table A.1.

Variables	Obs.	Mean	Stand deviation	Min	25%	Median	75%	Max
Panel A: Firm-level variables:								
Debt ratio	25,387	0.534	0.362	0	0.282	0.519	0.750	10.282
Tax rate	25,387	0.095	0.060	0	0.054	0.090	0.126	0.862
Subsidy rate	25,387	0.007	0.072	0	0	0	0	6.324
Size (mil)	25,387	159.0	1,224	0.024	5.8	12	30.7	49,600
Age	25,387	15.48	13.88	1	5	10	22	58
Profitability rate	25,387	0.066	0.804	-102.5	0.007	0.064	0.154	0.884
Investment in fixed asset	25,387	0.453	0.244	0	0.265	0.444	0.627	1
State ownership	25,387	0.202	0.391	0	0	0	0	1
Individual ownership	25,387	0.347	0.458	0	0	0	1	1
Panel B: Provincial-level variables:								
GDP per capita (Yuan)	186	13,460	9,979	3,000	7,216	10,083	15,000	58,837
Corruption	186	4.42	1.43	1.31	3.17	4.40	5.43	10.18
Media exposure	186	22.70	19.22	4.65	10.95	15.70	23.99	92.25

Table 3: The determinants of coalmining fatality: Baseline regression analysis

This table presents the OLS regression results on the determinants of coalmining fatality. The sample consists of 25,381 firm-year observations for the period 2001-2006. The dependent variable is the natural logarithm of (one plus) the number of coalmining deaths per firm per year. All explanatory variables are defined in Appendix Table A.1. Robust standard errors are clustered at the provincial level. P-values are reported in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% level, respectively.

Independent variables	(1)	(2)	(3)
Burdens and benefits:			
Debt ratio	0.030***	0.016**	0.016**
	(0.010)	(0.047)	(0.040)
Tax rate		-0.050	-0.049
		(0.168)	(0.176)
Subsidy rate		0.012	0.013
		(0.760)	(0.744)
Firm characteristics:			
Size (log)		0.006*	0.006*
		(0.085)	(0.068)
Age (log)		0.003	0.004
		(0.615)	(0.610)
Profitability rate		0.004**	0.004**
		(0.012)	(0.016)
Investment in fixed asset		0.009	0.009
		(0.353)	(0.353)
Equity ownership:			
State ownership		0.017	0.017
		(0.334)	(0.322)
Individual ownership		0.006	0.006
		(0.507)	(0.527)
Provincial control variables:			
GDP per capita (log)			0.025
			(0.799)
Corruption			0.006
			(0.481)
Media exposure			-0.0002
			(0.888)
Intercept	0.033***	-0.059	-0.302
	(0.003)	(0.105)	(0.731)
Year fixed effects	No	Yes	Yes
Firm fixed effects	No	Yes	Yes
No. of obs.	25,387	25,381	25,381
Adjusted-R^2	0.002	0.012	0.012

Table 4: The determinants of coalmining fatality: Subsample regressions

This table presents the OLS regression results on the determinants of coalmining fatality for subsamples formed on whether a coalmining firm is a key-state firm or whether it has high than median debt ratio. The full sample consists of 25,381 firm-year observations for the period 2001-2006. The dependent variable is the natural logarithm of (one plus) the number of coalmining deaths per firm per year. All explanatory variables are defined in Appendix Table A.1. Robust standard errors are clustered at the provincial level. P-values are reported in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% level, respectively.

Independent variables	All	All	Key	Non-key	High-debt	Low-debt
	(1)	(2)	(3)	(4)	(5)	(6)
Burdens and benefits:						
Debt ratio	0.016**		0.049	0.016**	0.027**	-0.002
	(0.023)		(0.749)	(0.028)	(0.033)	(0.931)
Debt ratio * key state firm	0.007					
	(0.977)					
High debt ratio		0.010**				
		(0.047)				
Tax rate	-0.049	-0.049	-0.331	-0.042	-0.123*	0.031
	(0.176)	(0.180)	(0.820)	(0.249)	(0.058)	(0.528)
Subsidy rate	0.013	0.013	1.520***	-0.029	0.061	-0.074
	(0.739)	(0.742)	(0.001)	(0.173)	(0.498)	(0.133)
Firm characteristics:						
Size (log)	0.006*	0.005	-0.077	0.006*	0.008	0.004
	(0.065)	(0.118)	(0.489)	(0.096)	(0.275)	(0.421)
Age (log)	0.004	0.004	-0.030	0.004	0.012	0.002
	(0.609)	(0.603)	(0.469)	(0.543)	(0.256)	(0.797)
Profitability rate	0.004**	0.004**	-0.213	0.004***	0.010**	-0.0005
	(0.016)	(0.019)	(0.405)	(0.006)	(0.030)	(0.563)
Investment in fixed assets	0.009	0.009	-0.019	0.008	0.018	0.001
	(0.353)	(0.364)	(0.958)	(0.424)	(0.336)	(0.945)
Equity ownership:						
State ownership	0.016	0.017	0.087	0.012	0.015	0.009
	(0.320)	(0.322)	(0.331)	(0.449)	(0.455)	(0.671)
Individual ownership	0.006	0.005	0.362	0.006	-0.003	0.009
	(0.527)	(0.535)	(0.720)	(0.516)	(0.784)	(0.480)
Provincial control variables:						
GDP per capita (log)	0.025	0.022	0.802	0.035	-0.095	0.097
	(0.797)	(0.823)	(0.265)	(0.743)	(0.531)	(0.583)
Corruption	0.006	0.006	0.104*	0.001	0.006	0.001
	(0.481)	(0.485)	(0.055)	(0.843)	(0.625)	(0.860)
Media exposure	-0.0002	-0.0001	0.004	-0.0003	0.00002	-0.001
	(0.888)	(0.913)	(0.524)	(0.763)	(0.990)	(0.502)
Intercept	-0.303	-0.268	-6.275	-0.358	0.702	-0.875
	(0.728)	(0.762)	(0.295)	(0.703)	(0.607)	(0.562)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	25,381	25,381	478	24,903	12,279	13,102
Adjusted-R^2	0.012	0.012	0.161	0.010	0.014	0.012

Table 5: The determinants of coalmining fatality: Alternative variables

This table presents the OLS regression results on the robustness of the determinants of coalmining fatality by using alternative explanatory and dependent variables. The sample consists of 25,381 firm-year observations for the period 2001-2006. The dependent variable for specifications 1 and 2 is the natural logarithm of (one plus) the number of coalmining deaths per firm per year. The dependent variables for specifications 3 to 5 is a dummy variable 'Death3' which equals one if a coalmining accident involving three or more deaths and zero otherwise. All explanatory variables are defined in Appendix Table A.1. Robust standard errors are clustered at the provincial level. P-values are reported in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% level, respectively.

Independent variables	Dependent variables		
	Death (log)	Death3	Death3
	(1)	(2)	(3)
Burdens and benefits:			
Debt ratio	0.015*	0.007**	0.006**
	(0.071)	(0.031)	(0.046)
Tax rate	-0.042	-0.029**	-0.026*
	(0.265)	(0.043)	(0.086)
Subsidy rate	0.011	0.025	0.024
	(0.792)	(0.282)	(0.313)
Firm characteristics:			
Size – total asset (log)		0.002	
		(0.134)	
Size – total sales (log)	-0.001		-0.001
	(0.667)		(0.697)
Age (log)	0.004	-6.40e-06	0.0001
	(0.584)	(0.998)	(0.978)
Profitability rate		0.002**	
		(0.030)	
Return on asset (ROA)	-0.002		-0.001**
	(0.526)		(0.331)
Investment in fixed asset	0.005	0.002	0.0004
	(0.567)	(0.697)	(0.912)
Equity ownership:			
State ownership	0.018	-0.0004	-0.0001
	(0.301)	(0.961)	(0.991)
Individual ownership	0.006	0.004	0.004
	(0.528)	(0.119)	(0.121)
Provincial control variables:			
GDP per capita (log)	0.038	0.002	0.006
	(0.706)	(0.964)	(0.876)
Corruption	0.006	-0.0002	-0.0002
	(0.484)	(0.934)	(0.954)
Media exposure	-0.0001	0.0004	0.0004
	(0.907)	(0.451)	(0.432)
Intercept	-0.346	-0.036	-0.053
	(0.695)	(0.918)	(0.881)
Year fixed effects	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes
Number of obs.	25,381	25,381	25,381
Adjusted-R^2	0.012	0.004	0.004

Table 6: The determinants of coalmining fatality: Robustness on endogeneity

This table presents the regression results on the robustness of the determinants of coalmining fatality by performing the two-stage least square (2SLS) and the generalized method of moments(GMM) regressions to control for endogeneity. The sample consists of 25,381 firm-year observations for the period 2001-2006. The dependent variable is the natural logarithm of (one plus) the number of coalmining deaths per firm per year. All explanatory variables are defined in Appendix Table A.1. P-values are reported in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% level, respectively.

Independent variables	2SLS		GMM
	First stage	Second stage	
Burdens and benefits:			
Province average debt ratio	0.321***		
	(<0.001)		
No. of death last year (log)			0.031***
			(<0.001)
Debt ratio		0.264*	0.017**
		(0.090)	(0.032)
Tax rate	-0.163***	-0.010	-0.027
	(<0.001)	(0.850)	(0.352)
Subsidy rate	0.045	0. 0004	0.059
	(0.172)	(0.992)	(0.047)
Firm characteristics:			
Size (log)	-0.040***	0.016**	-0.001
	(<0.001)	(0.039)	(0.617)
Age (log)	0.012***	0.001	0.002
	(0.005)	(0.891)	(0.641)
Profitability rate	-0.004*	0.005*	0.0003
	(0.086)	(0.061)	(0.358)
Investment in fixed asset	-0.111***	0.037*	0.014
	(<0.001)	(0.085)	(0.128)
Equity ownership:			
State ownership	0.023*	0.011	0.060***
	(0.051)	(0.390)	(<0.001)
Individual ownership	-0.014**	0.009	0.011***
	(0.046)	(0.241)	(0.004)
Provincial control variables:			
GDP per capita (log)	-0.275***	0.104	0.024
	(<0.001)	(0.290)	(0.031)
Corruption	-0.001	0.007*	0.009***
	(0.679)	(0.066)	(<0.001)
Media exposure	0.0002	-0.0002	-0.002***
	(0.761)	(0.803)	(0.004)
Intercept	3.131***	-1.217	-0.215**
	(<0.001)	(0.190)	(0.018)
Year fixed effects	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes
Number of obs.	25,381	25,381	15,020
Adjusted-R^2	0.021	0.010	
AR(2)			0.504

Table 7: The determinants of coalmining fatality: Robustness on Poisson regression

This table presents the Poisson regression results on the robustness of the determinants of coalmining fatality. The sample consists of 25,381 firm-year observations for the period 2001-2006. The dependent variable is the natural logarithm of (one plus) the number of coalmining deaths per firm per year. All explanatory variables are defined in Appendix Table A.1. P-values are reported in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% level, respectively.

Independent variable	Poisson (1)	Poisson (2)
Burdens and benefits:		
Debt ratio	0.301***	0.226***
	(0.005)	(0.005)
Tax rate	-4.807***	-3.948***
	(0.002)	(0.008)
Subsidy rate	0.348	0.465***
	(0.064)	(0.004)
Firm characteristics:		
Size (log)	0.340***	
	(<0.001)	
Sales (log)		0.360***
		(<0.001)
Age (log)	0.375***	0.403***
	(<0.001)	(<0.001)
Profitability rate	-0.009	
	(0.422)	
Return on asset (ROA)		-0.436
		(0.121)
Investment in fixed asset	0.540***	0.557***
	(0.001)	(0.001)
Equity ownership:		
State ownership	0.632***	0.869***
	(0.007)	(<0.001)
Individual ownership	0.399**	0.346*
	(0.044)	(0.084)
Provincial control variables:		
GDP per capita (log)	-0.192	-0.210
	(0.742)	(0.717)
Corruption	0.122	0.085
	(0.429)	(0.579)
Media exposure	-0.002	-0.003
	(0.943)	(0.897)
Intercept	-6.508	-6.136
	(0.190)	(0.222)
Year fixed effects	Yes	Yes
No. of obs.	25,381	25,381
Log pseudo likelihood	-11170.581	-11258.239

Appendix Table A.1: Variable Definitions

Variable	Definition
Coalmining death	The natural logarithm of (one plus) the number of coalmining deaths per firm per year.
Death3	A dummy variable equals one if a coalmining accident involving three or more deaths and zero otherwise.
Debt ratio	A firm's total debt divided by its total asset.
Tax rate	The annual total amount of taxes paid by a firm divided by its total sales.
Subsidy rate	The annual total amount of government subsidies received by a firm divided by its total sales.
Size (log)	The natural logarithm of a firm's total asset.
Sales (log)	The natural logarithm of a firm's total sales.
Age (log)	The natural logarithm of the number of years since the formation of the firm.
Profitability rate	A firm's operating profit divided by its total sales.
Return on asset (ROA)	A firm's operating profits divided by its total assets.
Investment in fixed asset	A firm's total investment in fixed asset divided by its total asset.
State ownership	The percentage equity ownership by the state.
Individual ownership	The percentage total equity ownership by the collective individual investors.
GDP per capita (log)	The natural logarithm of average GDP per capita for each province.
Corruption	It is measured as the corruption cases filed per 10,000 government officials for each province.
Media exposure	It is measured as the per capita print of newspapers in a year for each province.

Appendix Table A.2: Pearson correlation matrix

This table presents the pair-wise correlations for the key variables. P-values are reported in the parenthesis. ***, **, * denote significance at the 1%, 5%, and 10% level, respectively. All variables are defined in Appendix Table A.1.

	Death	Debt ratio	Tax rate	Subsidy rate	Size	Age	Profit rate	Inv. in fixed asset	State ownership
Debt ratio	0.027***								
	(<0.001)								
Tax rate	-0.013**	-0.008							
	(0.040)	(0.236)							
Subsidy rate	0.041***	0.071***	-0.024***						
	(<0.001)	(<0.001)	(<0.001)						
Size	0.131***	0.023***	0.019***	0.015**					
	(<0.001)	(<0.001)	(0.002)	(0.016)					
Age	0.098***	0.166***	0.087***	0.126***	0.153***				
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)				
Profitability rate	-0.010	-0.057***	0.077***	-0.120***	-0.001	-0.045***			
	(0.119)	(<0.001)	(<0.001)	(<0.001)	(0.861)	(<0.001)			
Investment in	0.013**	-0.202***	-0.119***	0.009***	-0.016***	-0.052***	-0.017***		
fixed asset	(0.037)	(<0.001)	(<0.001)	(<0.001)	(0.009)	(<0.001)	(0.006)		
State ownership	0.089***	0.204***	0.041***	0.135***	0.164***	0.476***	-0.071***	-0.010*	
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(0.100)	
Individual	-0.031***	-0.134***	-0.097***	-0.054***	-0.082***	-0.299***	0.016***	0.048***	-0.374***
ownership	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(0.009)	(<0.001)	(<0.001)