Decentralization, Collusion and Coalmine Deaths*

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Abstract

This paper investigates how collusion between regulators and firms affects workplace safety using the case of China's coalmine deaths. We argue that decentralization makes collusion more likely and that its effect is further strengthened if transaction costs of collusion are lower. These hypotheses are tested by investigating the impact of decentralization contingent on regulators' characteristics. Exploring both decentralization and centralization reforms in the coalmine

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industry, we find that decentralization is correlated with an increase in coalmine death rates. Moreover, this increase in mortality is larger for the regulators with lower transaction costs (proxied by the locality of origin).

Keywords: decentralization, collusion, workplace safety, corruption, coal

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1 Introduction

Health and safety in the workplace are essential issues in both developing and developed countries. In the real world, many examples suggest that collusion between regulators and regulated firms plays a first-order role in workplace safety problems. For instance, the explosion at the Upper Big Branch mine in southern West Virginia in 2010 is found to be due to collusion between regulators and coal companies.[1] The Fukushima nuclear power plant accident is also disclosed to be driven by "the collusion between the government, the regulators and Tepco".[2] In academic research, scholars have provided fruitful theories to understand collusion, especially on how decentralization of regulatory authority may affect collusion in organizations (Tirole 1986; Kofman and Lawarree 1993; Laffont and Martimort 1998). However, there is little empirical evidence on collusion and the theoretical link between decentralization and collusion has thus not been established empirically. In this paper, we use data on the coalmine industry and safety regulation in China to study how collusion between regulators and firms affects coalmine deaths. The findings on this particular sector may shed light on broader issues of general workplace safety. In addition, we investigate how decentralization of authority affects collusion, providing empirical evidence on the link between decentralization and collusion.

We focus on China's coalmine industry for two reasons. The coalmine sector in China provides a testing ground for the role of collusion as well as the link between decentralization and collusion in theory. Collusion between regulators and coalmine firms is so paramount that China's mass media has even coined a phrase for this phenomenon: "*guan-mei goujie*" (literally meaning "official-coal collusion"). Moreover, a unique decentralization experiment took place in the key state coalmines: in March 1998, the management of all 94 key state

[1] See the report by Barry Grey, "Miners Doomed by Collusion between Regulators and Coal Companies", available at http://www.wsws.org/en/articles/2010/04/mine-a10.html

[2] See the information disclosed in the Fukushima Nuclear Accident Independent Investigation Commission (2012).

coalmines was delegated to the provincial governments. This gave both management and safety supervision powers to the local governments and made collusion possible, or at least much easier. This decentralization experiment lasted until February 2001, when the State Administration of Work Safety was established and coalmine safety supervision was re-centralized. Hence, we have two centralization periods (1995-1997 and 2001-2005) and one decentralization period (1998-2000, when collusion became more feasible). Since the decentralization and re-centralization decisions are national policies, they are not correlated with individual province characteristics.

The second reason is that this industry is important for understanding the weak occupational health and safety protection in China's rapid industrialization process. Coal constitutes about 70% of the total energy consumption in China. In 2007, China produced 41.1% and United States produced 18.7% of all coal in the world. In the same year, at least 3,598 people died in coalmine accidents in China, compared to 34 in the United States. In fact, the death rate (i.e., the number of deaths per million tons of coal output) in China is not only much higher than that of developed countries such as the US, Japan and Germany but also more than ten times higher than that of many other developing economies such as India and African countries.[3]

To examine the impact of decentralization on death rates, we collect provincial-level panel data on key state coalmines from 1995 to 2005 and find that death rates under decentralization increased by about 0.7 deaths per million tons of coal production in an average province-year. The mean and standard deviation of death rates under decentralization are 2.8 and 4.5 respectively.[4] Thus, the magnitude of the effect is around 25% of the mean and

[3]As mentioned in Wright (2004), the head of China's safety bureaucracy admitted in 2001 that China's coalmine death rate was 11 times higher than that in Russia, and 15 times higher than that in India.

[4]Death rates measured by deaths per million tons of production are frequently used for cross-country comparisons. An alternative way of measuring death rates is to look at deaths divided by employment in coalmine industries. This does not work well for China as many

15% of the standard deviation. A competing hypothesis is that death rate is an increasing function of production, and hence, decentralization leads to higher death rates just because it is correlated with higher levels of production. When we include a flexible function of the production level in the estimation, we do not find this to be the case.

The positive correlation between decentralization and death rates is consistent with the interpretation that decentralization facilitates collusion. To further test the collusion hypothesis, we explore the variation in the transaction costs of collusion. In particular, we proxy transaction costs by exploring the information on the locality of origin for all 57 provincial safety regulators between 1995 and 2005.[5] The safety regulator in a province is the vice governor responsible for industrial-production safety, which includes coalmine safety. We focus on safety regulators rather than provincial governors because these regulators are directly in charge of coal production permits.[6] Assuming that a native of the province has lower transaction costs of collusion, we find three more deaths per million tons of coal production in provinces with native safety regulators under decentralization, around 67% of the standard deviation of death rates.[7]

Although the decentralization decision is a national policy and exogenous to individual provinces, there might still be a concern that native safety regulators are appointed to provinces with higher death rates. As 22 of the 57 safety regulators experience at least one switch of decentralization and centralization, we can explore within-regulator variations.

miners are not permanent workers. We do not have provincial-level information on the number of coalmine workers.

[5]The dominant networks in China are locality of origin, kinship, and job-related colleagues (Guo 2001, Luo 2007). We do not have kinship information. As most of the safety governors built the careers within the province, the main variation is the origin of locality.

[6]We control for characteristics of provincial governors and party secretaries in our estimations.

[7]The effect is very sizable. One might be concerned about outliers. However, as shown in Table 6, the magnitude is similar when we used logged deaths as the dependent variable.

We find that the within-regulator estimates are very close to the within-province estimates, which confirms that endogenous appointment in response to decentralization is not a serious concern.

One important concern is the misreporting of coalmine death rates. Since we find a higher death rate in decentralization with native regulators, under-reporting by the regulators is unlikely to explain our finding. As further checks, we use traffic deaths per capita and death rates in the local state coalmines to conduct two placebo tests.[8] We also conduct various other robustness checks including examining pre-trends, evaluating the impacts on deaths and output separately and comparing the impacts of decentralization and re-centralization. Additionally, we present two sets of further evidence for the collusion hypothesis, using information on media exposure and coalmine firms.

Generally, trust plays an important role in informal contract enforcement (Karlan et al., 2009). In our context, since collusion is illegal, trust is essential in the agreement of collusion. For example, Li and Wu (2010) provide qualitative evidence on the transactions between bribers and bribees in China and the Philippines. They show that personal networks play an important role in facilitating corruption, especially in a relation-based governance system such as the Chinese one. Hence, having a native safety regulator naturally decreases the collusion cost. All the findings in this study deliver the same message that both decentralization and having a native regulator decrease the collusion costs and hence increase deaths. We realize that native safety regulators can be different in other dimensions besides decreasing the transaction costs of collusion. Even though the difference in the ability to under-report deaths cannot explain our finding, native regulator can be different in their preferences and information. For these two factors to explain our finding, one needs to assume that the native regulators care less about safety of the workers or have less information about safety. Neither of hypotheses seems reasonable.[9] It is also worthwhile stressing that

[8]The key state coalmines were supervised by the central government before decentralization on whereas local state coalmines are always managed by local governments.

[9]Another potential reason is that non-native regulators are only appointed when they are

our finding holds for a given regulator while the preference of regulators is unlikely to vary with decentralization.

Our study contributes to several strands of literature. First, our study relates to a large empirical literature on the impact of decentralization.[10] One challenge in this literature is how to find exogenous variations in decentralization. The existing studies explore either cross-sectional comparison or change in one direction (from centralization to decentralization or vice versa).[11] We explore sharp regime changes in both directions, which helps relieve empirical concerns such as time trends. Our findings on the downside of decentralization share some flavor with the findings on regional protectionism in Young (2000), who argues that increased autonomy and incentives induced local governments to engage in provincial

highly qualified. But this cannot explain the effect of decentralization.

[10]Existing literature has examined the impacts of both fiscal decentralization and political decentralization. Much of the existing empirical evidence has stressed the virtues of fiscal decentralization (measured by fiscal expenditures or revenues) in terms of economic performance and government accountability. For example, Fisman and Gatti (2002) and Arikan (2004) find that fiscal decentralization in government expenditure is associated with less corruption. Bardhan and Mookherjee (2006) for a survey of existing research along this line. Within the context of China, fiscal decentralization since 1994 is often seen as one of the driving forces of China's growth miracle. For example, Jin et al. (2005) and Lin and Liu (2000) find a positive impact of decentralization on growth, despite some opposite findings in Zhang and Zou (1998). In contrast, studies on political decentralization find that political decentralization (measured by the number of administrative tiers) can lead to lower accountability. For instance, using different sources of data, Treisman (2002) and Fan et al. (2009) find that larger number of administrative or governmental tiers correlated with more corruption.

[11]For example, Galiani, Gertler and Schargordsky (2008) investigate how the change from centralization to decentralization in the schooling system in Argentina affects rich and poor municipalities differently.

protectionism. Our finding of bad outcomes due to the combination of decentralization and collusion are in line the theory in Blanchard and Shleifer (2001) and the cross-country evidence in Enikolopov and Zhuravskaya (2007), where the impact of economic decentralization depends on political institutions.

Second, it provides some empirical evidence for theories in the organizational literature that have focused on the costs and benefits of decentralization/delegation (Tirole 1986; Kofman and Lawarree 1993; Baliga and Sjostrom 1998; Laffont and Martimort 1998; Mookherjee and Tsumagari 2004; Mookherjee 2006). This literature generally argues that decentralization of authority to regulators induces collusion. As decentralization is often endogenous and collusion is often covert, there is little clean evidence.[12] We explore a national decentralization policy and further exploit the heterogeneous effect of decentralization contingent on the characteristics of supervisors.

Third, our study contributes to the literature evaluating political connections. This body of work has documented the benefits captured by agents with strong political connections (Fisman 2001; Faccio 2006).[13] Arguably, such private benefits are captured at the cost of public interest. Our study provides new evidence on the cost of political connections. The closest study to ours is Fisman and Wang (2013). They document that politically connected firms in China have higher mortality using firm-level data from different industries between 2008 and 2011.[14]

[12]Nie and Jiang (2011) suggest that possible collusion between local governments and coalmines is one of the reasons for coalmine accidents, but the argument is based on very rough correlations.

[13]A recent literature investigates the impact of political connections in China measured by different ways such as connections with the Center in Shih, Adolph and Liu (2012) and whether a leader advanced his career in a region in Persson and Zhuravskaya (2012). Different from the strategies in these papers, we exploit within-individual variation in this paper, which helps relieve the concern of endogenous appointments.

[14]In contrast to their study, we focus on the characteristics of regulators rather than firms.

Finally, our study is related to the literature on how potentially corrupt local bureaucrats and politicians affect the provision of public goods or bads. For example, using the case of deforestation in Indonesia, Burgess et al. (2012) document that local officials' incentives affect the environment. Our paper shows that the incentives of local bureaucrats affect workplace safety.

To explore institutional change in our identification, we only focus on key state coalmines, which are usually large mines. But our perspective also sheds possible light on the death rates in smaller coalmines. For example, Wright (2008) mentions that township and village coalmines are closely related to local governments in a nexus of "local state corporatism" (Oi 1999). Given the anecdotal evidence such as the coalmine disaster in West Virginia, the collusion logic documented in this paper may also be relevant for countries beyond China. However, the relevant characteristics of local regulators naturally depend on the specific context.

The rest of the paper is organized as follows. Section 2 describes the centralization-decentralization background and provides some qualitative evidence to understand how collusion works. Section 3 describes the data. Section 4 presents the baseline results, while Section 5 presents various robustness checks and two sets of additional evidence. Section 6 concludes the paper.

2 Institutional Background and Qualitative Evidence

In this section, we first describe the decentralization process. Then we present some qualitative evidence to illustrate how collusion works, where we also discuss why decentralization

The findings from both sides of collusion are complementary. Moreover, we explore switches of decentralization, which helps our identification and also speaks directly to the effect of decentralization. The time period in this paper is also longer, but we only focus on one particular industry.

and collusion can affect coalmine deaths even in a short period.

2.1 Decentralization of Key State Coalmines

According to their ownership, Chinese coalmines can be divided into three types: key state coalmines, local state coalmines and township and village coalmines. In 2003, the state coalmine firms produced 47.8% of the total coal extracted in China whereas the local state coalmines produced 16.9% and township and the village coalmines produced 35.3% (The State Administration of Coal Mine Safety 2004).

We focus on the management of the key state coalmines because the national policy changes we exploit concerned their management and safety supervision. Before 1998, all the key state coalmines were overseen by the Ministry of Coal Industry in the Central government. Due to many policy burdens for state-owned enterprises and the competition of small coalmines, the profits of the key state mines were negative in the 1990s. To provide more incentives for profitability, the management of the key state mines was shifted to provincial governments, through a delegation decision at China's Ninth National People's Congress in March 1998 (The State Council 1998, Document No. 22). This delegation also involved 206 enterprises affiliated with the coalmines, assets of 237.9 billion yuan ($30 billion) and 4.35 million employees. After delegation, the powers of management and safety supervision were shifted to the provincial governments. This decentralization period lasted until February 2001, when the State Administration of Work Safety (SAWS) was established and re-centralized the safety supervision powers.[15] However, the management power remains in the hands of the provincial governments. The centralization was further increased in 2003, when SAWS became part of the general offices of the State Council.

Hence, we take the period between 1998 and 2000 as the decentralized (treatment) period

[15]The official document on the establishment of SAWS is the Document No. 1 of the State Council in 2001. When SAWS exerts its regulatory and supervisory power over the coalmine industry, it is also known as the State Administration of Coal Mine Safety (SACMS).

when collusion became possible, or at least much easier, whereas 1995-1997 and 2001-2005 are centralized comparison periods. We will also examine whether the impacts of decentralization and re-centralization differ, as decentralization concerns both management and safety regulation whereas re-centralization focuses on safety regulation.

2.2 Collusion between Coalmines and Regulators

As acknowledged by Li Tieying (who was the Vice chairman of the Standing Committee of the National People's Congress) in 2005, "coal mine accidents that have already been investigated and prosecuted have revealed that corruption was behind almost every accident that caused exceptional loss of life" (China Labor Bulletin, 2008). Investigations of accidents often report the number of officials involved in the accidents, although they often do not disclose the identity of officials or collusion details. We briefly describe some qualitative evidence to illustrate how collusion works.

Zheng Maoqing, a vice governor in charge of safety in Hunan Province between 1998 and 2006, reportedly attempted suicide after being accused of corruption. The report also links his corruption to coalmine fatalities. For example, under his permission, a coal mine that should be closed resumed production. Three days later, 39 individuals died in a gas explosion.[16] As disclosed in the accident investigation report, the miners were asked to drill a much shallower depth than the safe level and no gas drainage was conducted.

Collusion happens at different levels of coal mines and officials. The collusion often does not only benefit one specific regulator but also a group of officials and the local government. For example, it is common that officials own stocks in the coalmine companies under their supervision. In 2005, the State Council issued regulations barring officials from holding stocks in coal mine companies. However, it is difficult to implement such regulations as

[16]One report can be found at: http://www.boxun.com/news/gb/china/2006/01/200601032341.shtml. Note that this information has not been confirmed by the government. Zheng was dismissed from office in 2006 and his offenses were not disclosed.

officials can easily transfer their stocks to their family members.

Li Yizhong, the Director of the State Administration of Work Safety (SAWS), has identified five types of collusion between corrupt officials and mine operators: (i) officials own coal mine shares; (ii) officials secretly operate coal mines or protect those connected with him operating illegal mines; (iii) officials flout regulations and abuse their authority to review and approve mines in exchange for bribes from mine operators; (iv) officials turn a blind eye to or help conceal illegally run mines; and (v) officials take part in or tacitly consent to accident cover-ups (China Labor Bulletin, 2008). In this paper, as we cannot directly measure these collusion types, we only focus on how collusion opportunities affect deaths.

It is worthwhile noting that most of the coalmine accidents in China are caused by "human factors", i.e., employers' or employees' neglecting the regulations. Chen et al. (2012) investigate the causes of coalmine accidents in China between 2001 and 2010 and show that intentional violation of regulations, mismanagement and defective design account for 35.43%, 55.12% and 3.54% of the causes of the accidents respectively. Intentional violation of regulations and mismanagement are usually driven by the pursuit of cutting costs to increase profits. In other words, many coalmine accidents are not caused by any systematic change in the investment of safety equipment. Instead, they are often driven by factors that can be changed in a short period, e.g., whether to allow unsafe drilling, whether to require longer hours of working etc. Under collusion, employers are more likely to neglect the safety regulation as they do not need to worry about being detected.[17] Therefore, when decentralization renders collusion easier, decentralization can have important consequences on coalmine safety. Section A1 in the appendix presents a model to formalize the role of decentralization and collusion in coalmine accidents, where we model intentional violation of regulations and mismanagement as a cheaper but more dangerous technology.

[17]This seems to be a general phenomenon that goes beyond coalmine safety. For example, when examining the pollution problem in China, van Rooij (2006) finds that some firms just stop using their environmental equipment, once they think that they will not be detected.

3 Data

We collect a panel data set on the key state coalmines, safety regulators, as well as provincial characteristics for 22 provinces across China between 1995 and 2005.[18] As already explained, we focus on the key state coalmines because they were subject to the decentralization and centralization policies. Figure 1 maps the distribution of key coalmines across China in terms of production. Among China's remaining provinces, Tianjin, Shanghai, Hainan and Tibet do not produce any coal at all, while there are no key state coalmines in Fujian, Hubei, Gungdong, Guangxi and Qinghai.

[Figure 1 about here]

3.1 Death Rates and Number of Deaths

Our main dependent variable is death rates, measured by number of deaths per million tons of coal production. The number of deaths and the yearly production of key state coalmines come from the China Coal Industry Yearbooks. As shown in Table 1, the mean of death rates is about 2.38 people per million tons of production in the whole period. In contrast, the mean is about 2.21 in the centralization periods but 2.84 in the decentralization period. As an alternative measure of safety, we also use the logged number of deaths as another dependent variable.

We have a few comments on the quality of the data. First, the death rate of key state coalmines is believed to be more reliable than that of smaller coalmines. This is another reason why we focus on key state coalmines. Second, suppose the provincial governments have incentives to under-report deaths. For this concern to matter for our finding, one has to assume that native regulators tend to over-report and that this preference varies with decentralization, which is highly unlikely. Third, we check whether the distribution of the number of deaths exhibits any bunching. In particular, we explore the classification

[18] This is no systematic data for the key state coalmines beyond this period.

of accidents that might affect the career of regulators. During 1995 and 2007, workplace accidents are classified into three levels: general accident (one or two people died), major accident (more than two people and no more than nine people died), and extraordinarily severe accident (10 or more people died).[19] Since these levels can potentially affect the punishment of regulators, we check whether the distribution of the number of deaths exhibits bunching at 2 and 9. As shown in Figure A1 in the appendix, we do not find any evidence of bunching at 2 or 9. This is not to say that the data quality on the number of deaths is perfect but at least suggests no clear evidence of bunching. Moreover, we conduct two placebo tests using deaths in traffic accidents and the local state coalmines in our robustness checks.

[Table 1 about here]

3.2 Transaction Costs of Collusion

Collusion between firms and regulators involves transaction costs. To reduce transaction costs, firms often rely on personal networks to bribe regulators (Li and Wu 2010). Empirically, we gauge the transaction costs of collusion by examining the biographical information of the safety regulators. Every province has one provincial governor and four to six vice governors. The safety regulator is one of the vice governors and has a tenure of at most 10 years. Besides coalmine safety, the vice governor is also in charge of safety in other industries such as construction-site safety and road-traffic safety. We trace the careers of all the 57 safety regulators across 22 provinces between 1995 and 2005. These data come from yearly provincial government reports and CVs found on People's Daily online. The average length in office is very close for native governors and non-native governors, around four years. Com-

[19]The information is based on the document No. GB/T15236-1994 of the State Bureau of Technical Supervision. This classification was revised in 2007 and an extra threshold was added: accidents with deaths between 10 and 29 are counted as severe ones while those with deaths of 30 or more are classified as extraordinarily severe ones.

pared with the main politicians (governors and party secretaries) whose characteristics we also control for, these regulators are less motivated by the incentives of promotion. Most of these regulators move to a position of a similar rank or retire after their service.[20] Therefore, the incentives to collude for rents are more important than career concerns.

We proxy the transaction costs of collusion by whether the governor in charge of coalmine safety is a native, i.e., born in the same province as the one he supervises. Since all the governors work some years before coming to office, being native naturally implies a longer experience in a certain province. As shown in Table 1, about 40% of the safety regulators are native. The average death rate is 2.96 when the regulator is a native whereas it is 1.94 when the regulator is a non-native.

The appointment of the regulators can be influenced by provincial governments. Therefore, the main empirical concern is that native regulators may be endogenously appointed in regions with higher or lower death rates. This concern is not very serious in this context because regulators are usually switched during congress years, which is not correlated with the timing of decentralization.

Figure 2 shows the number of provinces that switched from a non-native safety regulator to a native safety regulator and vice versa by year. As it shows, there is no systematic correlation between the switches and decentralization. This is expected, because regulators are often switched along with great political reshuffling that takes place every five years (in pace with each Party congress) rather than a national policy of decentralization.

[Figure 2 about here]

Another way to examine the concern is to check whether having a native regulator is positively correlated with the past death record. Table A1 in the appendix reports the correlations between the probability of having a native regulator in year t and the death rates in year $t-1$ and year $t-2$. As it shows, there is no significant correlation between having a native regulator and the lagged death rates.

[20] In our dataset, none of the regulators got promoted to be the provincial governor.

Moreover, 22 of the 57 regulators experience at least one switch of the centralization and decentralization regimes. Therefore, we can explore within-regulator variations for identification by examining the interaction effect of decentralization and nativeness given a regulator. The concern that the characteristics of regulators are endogenous is unlikely to be critical once we explore within-regulator variations.

3.3 Control Variables

We collect additional information on the characteristics of coalmines, other characteristics of the regulators as well as a set of provincial characteristics.

Coalmine Characteristics Data on coalmines includes the production level and average yearly wages of the coalmine industry. The average yearly wage can be seen as a proxy for labor quality. These data also come from China Coal Industry Yearbook and China Statistical Yearbook, with summary statistics presented in Table 1.

Other Characteristics of the Regulators Other characteristics of the safety regulators include their age and how many years they have been in office. We use these variables to control for the career concerns and the experience of the governors. We present results using age and tenure linearly, which are robust to using dummies to indicate whether one is older or is in office longer than average. Like the proxies for transaction costs of collusion, these data come from yearly provincial government reports, with summary statistics presented in Table 1.

Provincial Characteristics Provincial characteristics include real GDP per capita, whether the main provincial governor and the secretary is a native, the distance of the provincial capital to Beijing as well as the amount of electricity consumption. GDP per capita comes from China Statistical Yearbook. The biographical information of the provincial governors

and secretaries is from China Vitae.[21] The distance of the provincial capital to Beijing is calculated with ArcGIS and works as a proxy for the supervision intensity by the Central government. In practice, we use log (1+distance to Beijing) to take account of the 0 observation for Beijing. Electricity is to capture any potential demand effect on coal production. The summary statistics for these variables are presented in Table 1.

Ideally, one would also like to know provincial-level coal prices. Given that coal prices are highly regulated by the central government during this period, we do not have coal prices by province. Figure A2 in the appendix plots the trend of national coal prices over time. The information comes from the Price Statistical Yearbook of China. One concern for our finding is whether decentralization actually reflects the rise of coal prices. This is clearly not the case, as shown in Figure A2.

To further test the reliability of death rates in the key state coalmines, we also collect information on two other types of deaths. In particular, the information on traffic deaths provides a nice placebo. Coalmine accidents and traffic accidents are under the supervision of the same safety regulator and their reporting can be influenced by the same statistical bureau. In our empirical analysis, we control for traffic death capita when we use coalmine deaths as our dependent variable. Additionally, we use the death rates in local state coalmines that are not subject to the decentralization/centralization reforms as another placebo. The information on traffic deaths comes from the China Statistical Yearbooks whereas that on the deaths in local state coalmines comes from the China Coal Industry Yearbooks.

4 Empirical Strategy and Baseline Results

Correlation between Decentralization and Death Rates To examine the correlation

[21] China Vitae is a website providing detailed career information on China's top leadership, run by a non-profit organization based in the United States: http://www.chinavitae.com/

between decentralization and death rates, we run the following specification:

$$Deathrate_{pt} = \beta D_t + \lambda_p + \lambda_p \times t + \varepsilon_{pt}, \tag{1}$$

where D_t is the decentralization dummy for the year 1998-2000. Since the decentralization policy is not staggered, we cannot control for year fixed effects when looking at the impact of decentralization. However, we can include $\lambda_p \times t$ to control for provincial specific trends.

Table 2 presents the correlation between decentralization and death rates. Column 1 and 2 are the results after including province fixed effects, with and without province-specific trends. Column 3 and 4 also include logged output as well as the quadratic term of logged output. The coefficients are stable across different specifications. Decentralization is correlated with 0.7 more deaths per million tons of coal production, which is about 25% of the mean death rate in the decentralized period (2.8). The median coal output in the province-year dataset is 12 million tons. Therefore, this finding implies that decentralization is correlated with eight more deaths in an average province-year.

[Table 2 about here]

As we cannot control for year fixed effects in the estimation and the results are significant at 10% level, this finding only provides suggestive evidence.[22] Below we explore the interaction effect of decentralization and the characteristics of regulators, which provides more cleanly identified evidence.

[22]On the other hand, with the addition of controls, the estimates are not only stable but also increase in magnitudes. As long as the index of the observed variables that determine decentralization is positively correlated with the index of the unobserved variables, the increasing pattern in magnitudes indicates that the effect of decentralization is underestimated (Altonji, Elder, and Taber 2005).

Decentralization and Collusion: Within-province Evidence To examine whether the impact of decentralization depends on the characteristics of regulators, we explore both within-province and within-governor variations. The within-province specification is as follows:

$$Deathrate_{spt} = \beta_1 N_{spt} \times D_t + \beta_N N_{spt} + \gamma' X_{spt} \times D_t + v' X_{spt} + \lambda_p + \gamma_t + \lambda_p \times t + \varepsilon_{spt}, \quad (2)$$

where N_{spt} is a binary indicator whether the safety regulator s is a native in province p and year t. Now we can also control for both province and year fixed effects (λ_p and γ_t). Naturally the D_t dummy is redundant once we have controlled for year fixed effects γ_t.

X_{spt} is a vector of controls discussed above including (i) the logs of coal output and coalmine industry wages, (ii) other characteristics of safety regulators (age and tenure), (iii) different provincial characteristics (the logs of GDP per capita, electricity consumption, distance to Beijing as well as whether the provincial governor or secretary is a native), and (iv) traffic deaths per capita.

This estimation strategy is a generalized difference-in-difference (DD) strategy, where we compare the impact of nativeness before and after decentralization across regulators. To take into account the concern of serial correlation using the DD strategy (pointed out by (Bertrand et al. 2004)) and capture the fact that there are three regimes (centralization-decentralization-centralization), we cluster the standard errors by province $*$ regime. The results are robust to clustering at the province level and the regulator level, as shown in Table A2 in the appendix.

The results are presented in Table 3A. Column 1 includes province fixed effects and column 2 includes both province and year fixed effects. Column 3 reports the results including the four sets of controls discussed in the data section and column 4 also includes the interactions of decentralization and these controls. Column 5 further controls for provincial trends. The coefficients are similar across these specifications: decentralization with a native safety

regulator increases the death rates by about three deaths per million tons of coal production, which is four times the impact of decentralization per se.

[Table 3A about here]

To save space, the coefficients of the control variables are not reported. Among these control variables, the log of output decreases death rates under decentralization. This is reasonable considering that bigger coalmines are safer. It also shows that the increase of death rates is not due to the increase in output alone. The effects of the other control variables are not significant.

Decentralization and Collusion: Within-regulator Evidence A subgroup of regulators experience both centralization and decentralization periods. For example, the safety regulator of Beijing during 1998-2002 experienced the decentralized period and the second centralized period. The safety regulator of Hebei during 1995-2001 experienced the first centralized period and the decentralized period. The safety regulator who served in Shaanxi for ten years experienced all three periods. Given this advantage of the data, we can also compare the impact of nativeness before and after decentralization within an office spell of the same regulator, by including regulator fixed effects (μ_s) in equation (2). This way, the concern that native regulators are more likely to be assigned into certain provinces is relieved.

The results are presented in Table 3B. Columns 1-3 show the results using the full sample whereas columns 4-6 limit the sample to those regulators who experience at least one switch of the centralization and decentralization regimes. In fact, the within-regulator estimates are very close to those from within-province estimations. Consistent with Figure 2, the similarity in magnitudes also suggests that endogeneity in the appointment of native regulators is not a big concern.

[Table 3B about here]

5 Robustness Checks and Additional Evidence

We conduct different robustness checks regarding our main results. First, an important concern is the quality of the death records. We use other types of death records to conduct two placebo tests. Second, to check whether there exist different pre-trends in our difference-in-difference analysis, we use a more flexible specification to evaluate the effect of having a native regulator year by year. Third, to ensure that the finding is robust to the way we measure death rates, we examine deaths and production separately. Finally, we look at the impact of decentralization and centralization separately.[23]

Further, we present two sets of additional results using information on media exposure and coalmine firms. Both provide further support for our hypothesis of decentralization and collusion.

5.1 Robustness Checks

Investigating Misreporting As discussed in Section 3.1, misreporting by the safety regulators is unlikely to our finding, as we find higher death rates for native regulators under decentralization. However, there can still be misreporting by certain statistical bureau or by the coalmine firms.

Misreporting by the statistical bureau is unlikely to explain our finding because those officials are not rewarded or punished by the figures on coalmine deaths. Nevertheless, we conduct a further check by exploring traffic deaths as a placebo. Traffic safety is supervised by the same regulator as coalmine safety and its reporting can be influenced by the same statistical bureau. We would expect a similar impact of decentralization and having a native regulator on traffic deaths if misreporting by the statistical bureau is the main driver of our

[23]We realize that the re-centralization in 2001 might be endogenous. However, it will not affect our main identification as long as the nativeness of regulators are not correlated with the decision.

finding. Columns 1-3 present the results using traffic deaths per capita as our dependent variable, using similar specifications to those in columns 1-3 in Table 3B. Unlike the impact on death rates in the key state coalmines, we do not find that decentralization and having a native regulator affect traffic deaths per capita.

[Table 4 about here]

Another possibility of misreporting is that coalmine firms tend to under-report death rates. Both decentralization and having a native regulator may reduce asymmetry of information between safety regulators and coalmine firms and hence lead to higher (and more accurate) reporting of deaths. If information asymmetry were the main driver of our finding, one would expect a positive correlation between having a native regulator and death rates even without decentralization. However, as shown in Table 3A, we find that having a negative regulator matters only when decentralization makes collusion with local regulators feasible.

As another placebo test, we examine whether death rates in the local state coalmines exhibit the same pattern as those in the key state coalmines under decentralization and the supervision of native regulators. The results in columns 4-6 of Table 4 show that this is not the case. Together with the placebo test on traffic deaths, misreporting is unlikely to be the driver of our main finding.

Moreover, death rates in the local state coalmines also provide a natural comparison group for a difference-in-difference-in-difference (DDD) analysis. The results are presented in Table A3 in the appendix and show that death rates in the key state coalmines are much higher under decentralization and the supervision of native regulators, compared with that in the local state coalmines.

Examining Pre-trends Our baseline estimates evaluate the average effect under decentralization. We can allow for more flexible specifications and evaluate the dynamic effects. This way, we can also test whether the concern of different pre-trends matters. The specifi-

cation is as follows:

$$Deathrate_{spt} = \sum_{\tau} \beta_{\tau} N_{sp\tau} \times year_{\tau} + \beta_N N_{spt} + \gamma' X_{spt} \times D_t + v' X_{spt} + \lambda_p + \gamma_t + \varepsilon_{spt},$$

where $\sum_{\tau} N_{sp\tau} \times year_{\tau}$ are the interactions between the dummy for being native and different year dummies and the year before decentralization (i.e., the year of 1997) is left as the comparison year.

The results are presented in Table 5. As we examine the effects year by year, we focus on the within-province estimates. Column 1 reports the OLS results without fixed effects. Column 2 reports the results after including fixed effects. Column 3 includes the controls while column 4 further includes the interactions of decentralization and the controls. These results are close to the baseline estimates and they also show that the positive effect on death rates is limited to the decentralization period. Moreover, they also show that β_{1995} and β_{1996} are not different from zero.

The results in column 4 are also visualized in Figure 3.[24] The dotted line indicates the 95% confidence interval. Every estimated effect is relative to the year of 1997, which is displayed as an effect of 0 to aid visual analysis. It can be seen clearly that there were no significant pre-trends before decentralization.

Consistent with our hypothesis, death rates increase under decentralization and decrease after re-centralization. However, there is no clear pattern regarding the differences in the impacts during 1998-2000. On the one hand, the magnitude of the coefficient is slightly larger in 1998. On the other hand, it is much less precisely estimated. The precision of the estimates is increasing during the three years of decentralization.

[24]Figure A3 in the appendix plots the average death rates by native and non-native regulators. It also shows that a clear increase in death rates under decentralization for native regulators. However, this comparison has to be taken with a grain of salt as there exist compositional changes of regulators between the two groups.

[Table 5 about here]

[Figure 3 about here]

Evaluating the Impacts on Deaths and Output In our baseline estimates, we use number of deaths per million tons of coal production as an indicator of safety. It is an intuitive measure often discussed in the media. There are two limitations of this intuitive measure. First, the number of deaths and production are both endogenous. Second, the results might be affected by a few extreme values. As a robustness check, we examine the impact on the logged number of deaths as well as the logged coal output. In the province-year dataset, only three observations are zeros for the number of deaths.

The specification is similar to equation (2) except that the dependent variable is replaced by the logged number of deaths and coal production. The controls are also the same as those in equation (2) but the logged production is naturally excluded. Column 1 of Table 6 presents the estimate for the logged number of deaths from within-province specifications and columns 2-3 report the results from the within-regulator estimation with different sets of controls. They show that deaths increase by around 80% to 100% for the provinces with native regulators. Similarly, columns 4-6 present the results for the logged coal output. Indeed, output is also increased under collusion. However, the magnitude is much smaller than that of deaths, only around one eighth of the impact on deaths.

[Table 6 about here]

Comparing the Impacts of Decentralization and Re-Centralization The decentralization policy in 1998 concerns both management and safety regulation power whereas the re-centralization policy in 2001 focuses on safety regulation power. If safety supervision plays a critical role in deterring collusion, we should see an effect both when decentralization is introduced and when it is taken away. Thus, we can estimate separate regressions for different subperiods.

We replicate the same regressions as in equation (2) but separately for two sample periods: 1995-2000 and 1998-2005. In the first subsample, 1995-1997 is the centralization period whereas 1998-2000 is the decentralization period. In the second subsample, 1998-2000 is the decentralization period where 2001-2005 is the centralization period.

The results are presented in Table 7. Columns 1-3 present the results using data between 1995 and 2000, where column 1 reports the within-province estimates and columns 2-3 report the within-regulator estimates with different sets of controls. Similarly, columns 4-6 present the results using data between 1998 and 2005.

While the effect of decentralization is generally larger, the effects of the two switches are not dramatically different. This finding suggests that separating safety regulation from interest groups rather than general management is the key to reduce collusion possibilities.[25]

[Table 7 about here]

5.2 Additional Evidence

Estimating the Impact of Media Exposure As an additional test for our hypothesis, we also investigate the effect of media exposure. In particular, we are interested in whether media exposure decreases the interaction effect of decentralization and having native regulators, i.e., the triple effect of media exposure, decentralization and native regulators.[26]

We measure media exposure using two variables: the number of newspapers as well as total circulation of newspapers per 1,000 inhabitants. The first proxy measures media pluralism in a province (emphasized in Besley and Prat (2006)) whereas the second proxy measures the extent of news received by the inhabitants. Naturally, these measures are not exogenous and are correlated with economic development. Given this limitation, we use the

[25]This logic is consistent with the reaction of accidents in a different context: to help prevent a recurrence of the Deepwater Horizon spill, an offshore safety institute was established to be separate from the lobbying organization of the American Petroleum Institute.

[26]The simple model in the appendix also formalizes the role of media exposure.

lagged numbers and always control for GDP per capita in our analysis. Our aim is not to identify an causal impact of media exposure. Instead, we attempt to provide correlations that speak to the logic of collusion.

The data is taken from China Statistical Data of Press and Publication published since 1996. Because we use the lagged number of newspapers, we have a shorter sample (from 1997 and 2005) when we examine the impact of newspapers. The number of newspapers varies from 2 to 71, with a mean of 28. The circulation of newspapers per 1,000 inhabitants varies from 0.05 to 8, with a mean of 1.5.

The estimates on the triple effects are presented in Table 8. Column 1 presents the results for the number of newspapers, exploring within-province variations. Column 2 presents the results from within-regulator analysis, which are very similar to those in column 1. Similarly, columns 3-4 report the results using the circulation of newspapers per 1,000 inhabitants to proxy media exposure. The triple effect is negative across all specifications. This finding is consistent with the interpretation that media exposure deters collusion and provides further evidence for our hypothesis.

Little is known about the role of media in a non-democracy like China. Our finding provides suggestive evidence for the role of media. The logic is similar to that in Egorov, Guriev and Sonin (2009), where dictators employ media to monitor bureaucrats. Clearly, to give a conclusive answer, one needs exogenous measures of media exposure.

[Table 8 about here]

Using Firm-Level Information Our framework predicts that local regulators and firms benefit from collusion. As we cannot observe the wealth of regulators, we focus on the impact on coalmine firms. The firm-level data comes from the Annual Surveys of Industrial Firms conducted by National Bureau of Statistics of China since 1998. We have managed to match the province-level data with the balance sheets of 90 (out of 94 in total) key state coalmine firms between 1998 and 2005. Thus, we only have the policy change in 2001 to examine.

The summary statistics are presented in Table 1.

We are interested in three sets of outcomes. First, we look at the impact on firm-level output. Using provincial-level data, we find a positive impact on coal output. The firm-level data provides a sanity check for our finding.

Second, we examine the impacts on employment and average wages, as proxies for the ex ante compensation for coalmine workers. In addition, we would also like to know ex post compensation for accidents. The exact compensation for deaths is not reported in the balance sheet. As these expenses are part of welfare expenditure, we also examine the impact on welfare expenditure. These results provide a better understanding of the consequences of decentralization and collusion.

The specification is similar to the baseline, expect that we also include firm fixed effects to control for time-invariant firm characteristics:

$$Y_{fspt} = \beta_1 N_{spt} \times D_t + \beta_N N_{spt} + \gamma' X_{spt} \times D_t + v' X_{spt} + \lambda_p + \gamma_t + \mu_s + \delta_f + \varepsilon_{fspt},$$

where δ_f indicates firm fixed effects. X_{spt} is similar to those in the baseline specification, but we do not control for the logged output or wages here.

The results are presented in Table 9. Columns 1-2 show that the interaction of decentralization and nativeness of the safety regulator increase coalmine output by about 16%, which is consistent with the finding using provincial level data.

Columns 3-4 show that employment is also weakly increased. However, columns 5-6 show that average wages are not affected by decentralization and collusion, which suggests that the benefits are not shared by coalmine workers despite larger health hazards. As shown in columns 7-8, there is no evidence that welfare expenditure per worker responds to the reforms either. These findings are not surprising given the labor-supply surplus in rural China during this period.

Together, these results show that decentralization and collusion increase firm-level coal

output. However, no evidence suggests that coalmine workers benefit from the increase in output.

[Table 9 about here]

6 Conclusion

We argue that China's abysmal record on coalmine safety can be partly explained through a political-economic channel: the local regulators allow firms to choose dangerous but profitable production technologies when collusion is feasible. We explore an institutional change in the management of key state coalmines to test our hypothesis, using a provincial level panel dataset from 1995 and 2005.

Our finding that decentralization increases coalmine deaths supports the collusion channel in the theoretical literature. It also implies that public-sector decentralization can have unintended consequences. Our finding that the impact of decentralization is much larger for native safety governors provides further evidence on the collusion channel, because natives are likely to have lower transaction costs of collusion.

We might be the first to document the collusion logic in coalmine accidents with systematic empirical evidence. While our study focuses on a specific industry, the political logic may be applied to other industries and other type of safety problems.

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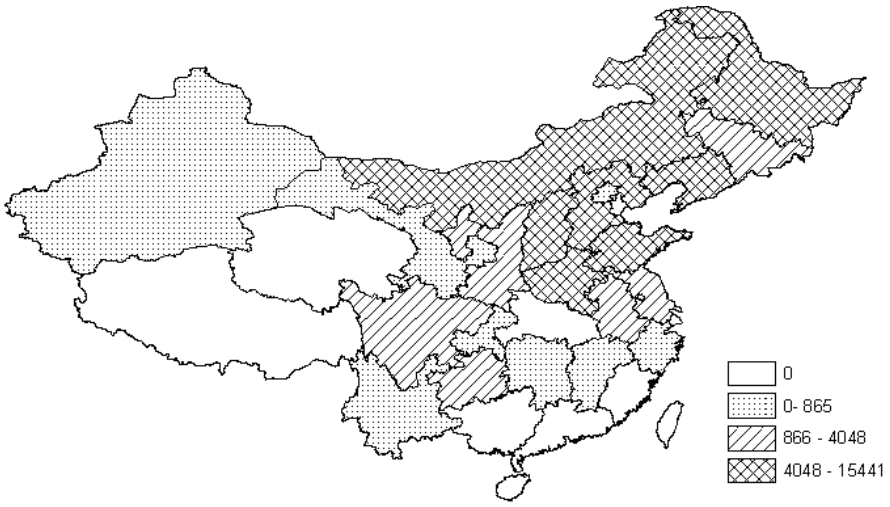
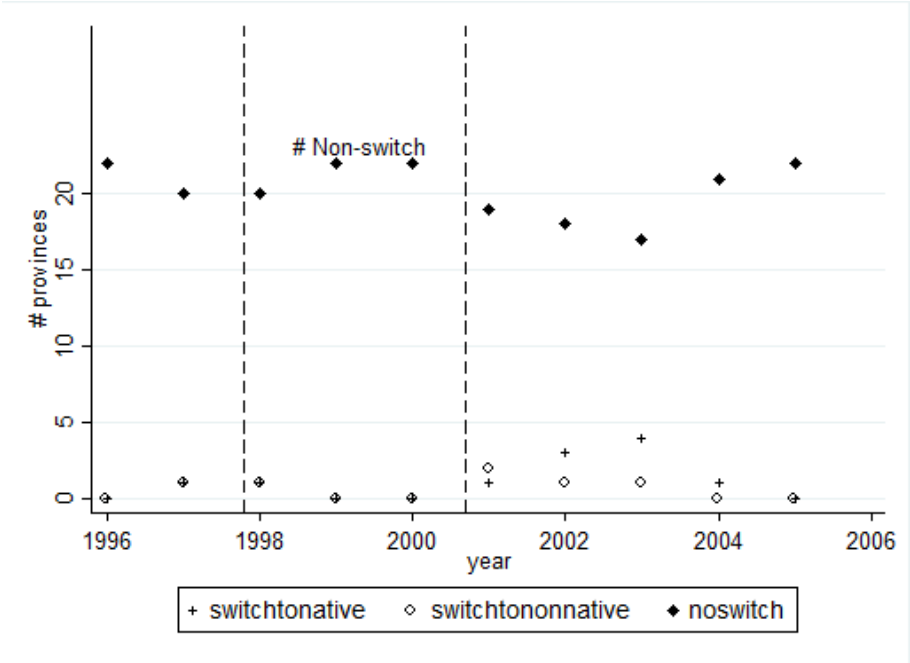
FIGURE 1. – Average Production of Key State Coalmines between 1995 and 2005



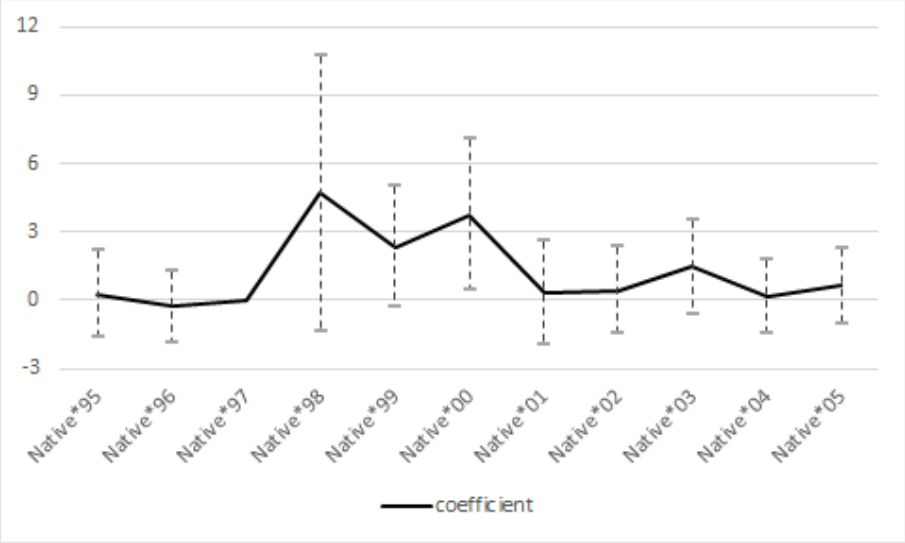
Notes: The production level is measured in millions tons. 22 out of 31 provinces in China have key state coalmines, which are the provinces in our sample.

FIGURE 2. – Switches of the Safety Regulators between 1995 and 2005



Notes: The figure shows that the number of provinces that switched from a non-native governor to a native governor and vice versa by year, which has no systematic correlation with the decentralization period (1998-2000).

FIGURE 3. – The Dynamic Impacts



Notes: The figure visualizes the results in column 4 of Table 5. It shows that the positive effect of native*year dummy is restricted to the decentralization period. The dotted line indicates the 95% confidence interval, with standard errors clustered at the province∗regime level. Every estimated effect is relative to the year of 1997, which is displayed as an "effect" of 0 to aid visual analysis.

Table 1. – Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max	Data Source
			Key State Coalmines			
Death Rate (Centralized)	169	2.20	2.47	0	15.49	1
Death Rate (Decentralized)	65	2.84	4.48	0.14	27.70	1
ln Death	231	3.28	1.02	0	6.37	1
ln Output	234	7.34	1.24	3.76	10.15	1
Decentralized	234	0.28	0.45	0	1	2
			Safety Regulator Characteristics			
Native	234	0.42	0.50	0	1	3
Tenure	234	4.65	2.33	2	11	3
Age	234	52.53	4.69	36	61	3
			Provincial Characteristics			
ln (Coalmine Wage)	234	9.15	0.43	8.39	10.16	1
ln (GDP per capita)	234	8.82	0.57	7.51	10.72	4
ln (1+ Distance to Beijing)	234	6.48	1.55	0.00	7.80	5
ln (Electricity Consumption)	234	6.05	0.61	4.53	7.69	4
Native Provincial Governor	234	0.42	0.49	0	1	6
Native Party Secretary	234	0.19	0.39	0	1	6
Traffic Deaths per 100,000	234	7.50	3.17	2.05	17.25	4
Death Rate of Local State Coalmines	222	4.82	5.12	0.00	33.71	1
Newspaper number	214	27.90	14.45	2	71	7
Newspaper published per 1,000	214	1.53	1.29	0.05	8.00	7
			Firm-level Information			
ln Output	590	13.14	1.37	8.14	16.85	8
ln Employment	590	9.73	1.02	6.80	11.94	8
ln (Average Wage)	589	9.11	0.49	6.40	10.89	8
ln (Average Welfare Exp.)	578	0.25	0.59	-3.32	2.64	8

Data Sources:

1. China Coal Industry Yearbook

2. The State Council, Document No. 22 in 1998 and Document No. 1 in 2001

3. Provincial government documents collected by the authors

4. China Statistical Yearbook

5. Calculated based on the latitudes and longitudes of provincial capitals

6. China Vitae: http://chinavitae.com

7. China Statistical Data of Press and Publication

8. Annual Surveys of Industrial Firms

Table 2. – Correlation between Decentralization and Death Rates
D.V.: Death Rates

	(1)	(2)	(3)	(4)
Decentralization	0.610	0.749*	0.768*	0.753*
	(0.378)	(0.390)	(0.411)	(0.416)
ln Output			0.123	1.445
			(0.822)	(5.868)
(ln Output)^2				-0.089
				(0.390)
Province FE	Y	Y	Y	Y
Provincial Trends		Y	Y	Y
# observations	234	234	234	234
R-Squared	0.40	0.44	0.44	0.44

Notes: This table shows that decentralization is positively associated with death rates. The dependent variable is the number of deaths per million tons of coal output. Decentralization refers to the years 1998, 1999 and 2000. * Significant at 10%, ** 5%, *** 1%.

Table 3A. – Decentralization and Collusion: Within-Province Evidence
D.V.: Death Rates

	(1)	(2)	(3)	(4)	(5)
Decentralization * Native	2.617**	3.105**	3.122**	3.081***	3.235***
	(1.230)	(1.313)	(1.336)	(0.945)	(0.933)
Native	0.339	0.246	0.200	0.420	0.073
	(0.339)	(0.407)	(0.391)	(0.362)	(0.607)
Province FE	Y	Y	Y	Y	Y
Year FE		Y	Y	Y	Y
Controls			Y	Y	Y
Decentralization * Controls				Y	Y
Provincial Trends					Y
# observations	234	234	234	234	234
R-Squared	0.44	0.47	0.49	0.55	0.58

Notes: This table shows that the impact of decentralization on death rates is much higher for native regulators, using within-province but cross-regulator estimations.

Controls include (i) the logs of coal output and coalmine industry wages, (ii) other characteristics of safety regulators (age and tenure), (iii) different provincial characteristics (the logs of GDP per capita, electricity consumption, distance to Beijing as well as whether the provincial governor or secretary is a native), and (iv) traffic deaths per capita.

Standard errors reported in parentheses are clustered at the province∗regime level. * Significant at 10%, ** 5%, *** 1%.

Table 3B. – Decentralization and Collusion: Within-Regulator Evidence
D.V.: Death Rates

	(1) All	(2) All	(3) All	(4) Switchers	(5) Switchers	(6) Switchers
Decentralization * Native	3.444**	3.553**	2.888***	3.351**	3.471**	2.814**
	(1.713)	(1.635)	(1.034)	(1.664)	(1.653)	(1.116)
Province FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Regulator FE	Y	Y	Y	Y	Y	Y
Controls		Y	Y		Y	Y
Decentralization * Controls			Y			Y
# observations	234	234	234	134	134	134
R-Squared	0.52	0.54	0.58	0.50	0.53	0.59

Notes: This table shows that the impact of decentralization on death rates is much higher for native regulators, using within-regulator estimations. Columns 1-3 use the full sample and columns 4-6 limit the sample to the 22 regulators who experience at least one switch of the centralization and decentralization regimes.

Controls include (i) the logs of coal output and coalmine industry wages, (ii) other characteristics of safety regulators (age and tenure), (iii) different provincial characteristics (the logs of GDP per capita, electricity consumption, distance to Beijing as well as whether the provincial governor or secretary is a native), and (iv) traffic deaths per capita.

Standard errors reported in parentheses are clustered at the province∗regime level. * Significant at 10%, ** 5%, *** 1%.

Table 4. – Checking the Quality of the Death Rates with Two Placebo Tests

	(1) Traffic	(2) Traffic	(3) Traffic	(4) Local Mine	(5) Local Mine	(6) Local Mine
Decentralization * Native	0.022	-0.015	0.147	-1.823	-2.124	-2.359*
	(0.303)	(0.401)	(0.326)	(1.183)	(1.335)	(1.186)
Province FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Regulator FE	Y	Y	Y	Y	Y	Y
Controls		Y	Y		Y	Y
Decentralization * Controls			Y			Y
# observations	234	234	234	222	222	222
R-Squared	0.95	0.95	0.96	0.70	0.71	0.72

Notes: This table shows that decentralization and having a native regulator has no similar impact on the death rates of traffic accidents or in the local state coalmines as that on death rates in the key state coalmines.

Controls include (i) the logs of coal output and coalmine industry wages, (ii) other characteristics of safety regulators (age and tenure), (iii) different provincial characteristics (the logs of GDP per capita, electricity consumption, distance to Beijing as well as whether the provincial governor or secretary is a native).

Standard errors reported in parentheses are clustered at the province∗regime level. * Significant at 10%, ** 5%, *** 1%.

Table 5. – Examining Pre-trends: the Dynamic Impacts
Dependent Var.: Death Rate

	(1)	(2)	(3)	(4)
Native * Year 1995	0.075	-0.400	-0.540	0.275
	(0.714)	(0.958)	(1.090)	(0.946)
Native * Year 1996	-0.279	-0.888	-1.049	-0.288
	(0.601)	(0.920)	(0.958)	(0.771)
Native * Year 1998	3.798	4.174	4.205	4.711
	(3.565)	(3.198)	(3.205)	(3.033)
Native * Year 1999	2.081	2.153	2.196	2.346*
	(1.604)	(1.387)	(1.356)	(1.325)
Native * Year 2000	3.673*	3.509**	3.518**	3.751**
	(2.098)	(1.665)	(1.706)	(1.669)
Native * Year 2001	0.721	-0.155	-0.147	0.334
	(1.423)	(1.156)	(1.182)	(1.144)
Native * Year 2002	1.348	0.285	0.005	0.424
	(1.180)	(0.805)	(0.888)	(0.956)
Native * Year 2003	1.154	1.675	1.692	1.468
	(1.435)	(1.133)	(1.067)	(1.037)
Native * Year 2004	-0.494	0.412	0.425	0.154
	(0.439)	(0.787)	(0.838)	(0.794)
Native * Year 2005	-0.119	0.955	1.006	0.626
	(0.562)	(0.896)	(0.860)	(0.822)
Province FE		Y	Y	Y
Year FE		Y	Y	Y
Controls			Y	Y
Decentralization * Controls				Y
# observations	234	234	234	234
R-Squared	0.10	0.48	0.50	0.55

Notes: This table reports the year-to-year impact of having a regulator and the positive impact restricts to the decentralization period.
Controls include (i) the logs of coal output and coalmine industry wages, (ii) other characteristics of safety regulators (age and tenure), (iii) different provincial characteristics (the logs of GDP per capita, electricity consumption, distance to Beijing as well as whether the provincial governor or secretary is a native), and (iv) traffic deaths per capita.
Standard errors reported in parentheses are clustered at the province∗regime level. * Significant at 10%, ** 5%, *** 1%.

Table 6. – Evaluating the Impacts on Death & Output

	(1) ln Death	(2) ln Death	(3) ln Death	(4) ln Output	(5) ln Output	(6) ln Output
Decentralization * Native	0.831***	1.125***	1.032***	0.102*	0.095*	0.102**
	(0.230)	(0.329)	(0.380)	(0.052)	(0.052)	(0.048)
Native	-0.093			0.016		
	(0.150)			(0.043)		
Province FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Provincial trends	Y	Y	Y	Y	Y	Y
Regulator FE		Y	Y		Y	Y
Controls		Y	Y		Y	Y
Decentralization * Controls			Y			Y
# observations	231	231	231	234	234	234
R-Squared	0.73	0.80	0.80	0.99	0.99	0.99

Notes: This table shows that decentralization * native increases both deaths and output but the impact on deaths in much larger. Columns 1-4 present the impacts on the log of deaths and columns 5-8 present the impacts on the log of coal output.

Controls include (i) the log of coalmine industry wages, (ii) other characteristics of safety regulators (age and tenure) and (iii) different provincial characteristics (the logs of GDP per capita, electricity consumption, distance to Beijing as well as whether the provincial governor or secretary is a native).

Standard errors reported in parentheses are clustered at the province∗regime level. * Significant at 10%, ** 5%, *** 1%.

Table 7. – Comparing the Impacts of Decentralization and Centralization
Dependent Var.: Death Rate

	(1) 95-00	(2) 95-00	(3) 95-00	(4) 98-05	(5) 98-05	(6) 98-05
Decentralization * Native	3.820**	3.988*	2.353**	2.676**	3.026	3.595***
	(1.456)	(2.153)	(0.976)	(1.231)	(2.164)	(1.031)
Province FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Regulator FE		Y	Y		Y	Y
Controls		Y	Y		Y	Y
Decentralization * Controls			Y			Y
# observations	126	126	126	173	173	173
R-Squared	0.49	0.55	0.58	0.53	0.59	0.60

Notes: This table presents the impact of decentralization in 1998 and that of re-centralization in 2001 respectively. Columns 1-4 present the results using data between 1995 and 2000. Columns 5-8 present results using data between 1998 and 2005.

Controls include (i) the logs of coal output and coalmine industry wages, (ii) other characteristics of safety regulators (age and tenure) and (iii) different provincial characteristics (the logs of GDP per capita, electricity consumption, distance to Beijing as well as whether the provincial governor or secretary is a native), and (iv) traffic deaths per capita.

Standard errors reported in parentheses are clustered at the province∗regime level. * Significant at 10%, ** 5%, *** 1%.

Table 8. – Investigating the Impact of Media Exposure
Dependent Var.: Death Rates

	(1)	(2)	(3)	(4)
#Newspaper(t-1) * Decentralization * Native	-0.190**	-0.199*		
	(0.090)	(0.104)		
#Newspaper(t-1) * Native	0.030	0.073		
	(0.042)	(0.064)		
#Newspaper(t-1) * Decentralization	-0.039	-0.059		
	(0.053)	(0.070)		
#Newspaper(t-1)	-0.040	-0.069		
	(0.039)	(0.059)		
#Circulation per 1,000(t-1) * Decentralization * Native			-3.211*	-4.336**
			(1.653)	(2.127)
#Circulation per 1,000(t-1) * Native			-0.001	1.966*
			(0.545)	(1.119)
#Circulation per 1,000(t-1) * Decentralization			-1.048	-0.470
			(0.731)	(0.994)
#Circulation per 1,000(t-1)			-0.319	-1.955*
			(0.463)	(1.035)
Decentralization * Native	7.939***	8.302**	5.975***	7.060***
	(2.708)	(3.134)	(2.204)	(2.610)
Native	-0.303		0.702	
	(1.303)		(0.907)	
Province FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Controls	Y	Y	Y	Y
Decentralization * Controls	Y	Y	Y	Y
Regulator FE		Y		Y
# observations	194	194	194	194
R-Squared	0.62	0.67	0.62	0.67

Notes: This table shows that media exposure has a deterrent effect on collusion. The data on newspapers is available since 1996. Since we used lagged variables, the sample is limited between 1997 and 2005. Controls include (i) the logs of coal output and coalmine industry wages, (ii) other characteristics of safety regulators (age and tenure), (iii) different provincial characteristics (the logs of GDP per capita, electricity consumption, distance to Beijing as well as whether the provincial governor or secretary is a native), and (iv) traffic deaths per capita.
Standard errors reported in parentheses are clustered at the province∗regime level. * Significant at 10%, ** 5%, *** 1%.

Table 9. – Using Information on the Key State Coalmine Firms

	(1) ln Output	(2) ln Output	(3) ln Employment	(4) ln Employment	(5) ln Wage	(6) ln Wage	(7) ln Welfare	(8) ln Welfare
Decentralization * Native	0.131**	0.161**	0.131	0.092*	-0.011	-0.010	0.086	0.094
	(0.055)	(0.065)	(0.087)	(0.051)	(0.078)	(0.048)	(0.108)	(0.090)
Province and Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Regulator FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y
Controls		Y		Y		Y		Y
Decentralization * Controls		Y		Y		Y		Y
# observations	590	590	590	590	589	589	578	578
R-Squared	0.96	0.96	0.97	0.97	0.77	0.78	0.65	0.66

Notes: This table shows that decentralization and collusion increase firm output but have no significant impact on average wages.

Controls include other characteristics of safety regulators (age and tenure), different provincial characteristics (the logs of GDP per capita, electricity consumption, distance to Beijing as well as whether the provincial governor or secretary is a native).

Standard errors reported in parentheses are clustered the province∗regime level. * Significant at 10%, ** 5%, *** 1%.

A Appendix

A.1 A Simple Model

Given the qualitative evidence on collusion in Section 2.2, we formalize the impact of decentralization as well as its impacts contingent on the regulators.

Preferences Similar to the three-tier principal-supervisor-agent (PSA) framework in Tirole (1986), there are three players in the economy where the Central government (C) is the principal, the Safety regulator (S) serves as the supervisor and the Firm (F) is the agent. We assume that they act independently.

C cares about output (y) and safety (or dislikes accidents that cost life values V). The central government cares about output, as China has relied to a very large extent on domestic coal production to power its sustained and high levels of economic growth over the few decades. Meanwhile, the central government dislikes deaths that may affect social stability.

S cares about his own payoff that includes his wages (w) and potential transfers from the Firm (T^S). In this context, the wage of S is not varied with decentralization. We assume it to be a constant w. It is possible that S might also care about safety to some extent. As long as this concern is not too strong, all the results below will go through.

F cares about his own profits. One might wonder if state-owned enterprises care about profits. Since the early 1990s, state-owned enterprises can retain profits after submitting a certain share to the central government. Therefore, it is reasonable to assume F maximizing its profits. For example, Groves et al. (1994) have documented managers of Chinese state-owned enterprises strengthened workers' incentives when firms were allowed to retain more of their profits.

Technology To produce y units of coal, F can use a *good* technology or a *bad* technology. The good way costs $\frac{1}{2}\overline{c}y^2$ and avoids any accident. The bad way costs $\frac{1}{2}\underline{c}y^2$ and an accident

A happens with probability p.[27] Parameters $\underline{c}$ and $\overline{c}$ are known to F and S but cannot be observed by C. To employ a *bad* technology, F needs to bribe S to get permission. In the real world, besides coalmine accidents, *bad* technology often has other externalities such as environmental pollution, which are not easy to observe and verify. Hence, F and S do not take these externalities into consideration. For simplicity, we assume that F cannot bribe C to get permission. This assumption can be relaxed by assuming that it is more difficult for F cannot bribe C.[28] Under this assumption, F cannot use the bad technology in centralization and have the possibility of using it in decentralization.

To use the cheap and bad technology, F and S can collude by signing a side contract.[29] In collusion, F pays S a share of the difference in production costs T^F. However, they face some transaction costs to agree with this arrangement. For simplicity, we assume that S can get part of the transfer $T^S = t\ T^F$ where $t \in (0, 1)$.

When an accident happens and is detected, S loses his wage w. The probability of being punished is mp, where m denotes the detection probability, which is positively correlated

[27]This assumption can be thought of more generally as the accident probability higher when the bad technology is employed. As discussed in the background, the assumption on bad technology is to capture the fact that firms violate regulations to cut costs. It does not necessarily reflect any systematic change in safety equipment.

[28]At least two channels can contribute to the reason why officials in the local governments are more corruptible: (i) corruption needs networks and it is easier to reach and capture local officials, and (ii) the central government may feel obliged to use some common figure for the value of a life in all of its policies, but those who work in mines may be poor enough that they'd prefer to get extra pay rather than extra safety, a fact recognized by the local governments. We thank Roger Gordon for pointing out (ii). More generally, Bardhan and Mookherjee (2000) present a model on the determinants of relative capture at local and national levels of government.

[29]In collusion, F chooses $\underline{c}$. Note that we assume away the case that F chooses $\underline{c}$ and there is no collusion. This is because the information is symmetric between F and S.

with media exposure. F can also be punished and get fined. As this effect works toward the same direction as the punishment of S, we do not introduce this extra variable for simplicity.

Solution Given Centralization/Decentralization We first solve for the solution given the centralization or decentralization regime. Then, we discuss the optimal choice of decentralization.

Under centralization, F uses the good technology. His problem is as follows:

$$\max_y y - \frac{1}{2}\bar{c}y^2, \tag{3}$$

where the price of coal is normalized to be 1.[30] Thus, $y^C = \frac{1}{\bar{c}}$, $\pi^C = \frac{1}{2\bar{c}}$.

Under decentralization, if F uses the good technology, the solution is the same as above: $y^{Dg} = \frac{1}{\bar{c}}$, $\pi^{Dg} = \frac{1}{2\bar{c}}$. Instead, if he uses the bad technology, his problem becomes as follows:

$$\max_y y - \frac{1}{2}\underline{c}y^2 - T^F, \tag{4}$$

subject to the participation constraint of S:

$$tT^F \geq mpw. \tag{5}$$

Thus, $y^{Db} = \frac{1}{\underline{c}}$, $\pi^{Db} = \frac{1}{2\underline{c}} - \frac{mpw}{t}$.

Comparing the two profits gives the condition when F would like to propose a collusion contract with S.

$$\frac{1}{\underline{c}} - \frac{1}{\bar{c}} \geq \frac{2mpw}{t}. \tag{6}$$

[30] Coal prices are highly regulated by the central government during this period. Hence, we do not explore variations in provincial-level prices.

Empirical Predictions This simple framework generates the main hypothesis regarding decentralization-collusion:

(i) *Collusion is more likely to happen under decentralization and hence death rates are higher in decentralization.*

In the current framework, this prediction follows automatically because collusion is not feasible under centralization. More generally, we can think about the cost of colluding with the central government as being much higher than colluding with local regulators, i.e., the transfer to bribe the regulator in the center is much larger than $\frac{2mpw}{t}$. This can be because the central government is more difficult to reach or because the central government cares more about safety. We also have a second prediction:

(ii) *Under decentralization, collusion is more likely for higher t and thus death rates are higher for higher t.*

This can be seen from equation (6), as the right-hand side is decreasing in t.

To examine (i) empirically, we look at the impact of decentralization on death rates. To test (ii), we explore characteristics of S as a source of variation in t and examine the interaction effect of decentralization and t. In particular, we compare native safety regulators with nonnative ones and argue that a common background and a long period of interaction facilitates trust-based collusion.

This framework also delivers auxiliary predictions. For example, collusion is less likely for higher m and this effect is more relevant under decentralization. Because the measure of media exposure we use could be endogenous, we present these results as additional evidence.

Understanding the Choice of Decentralization This simple framework can also help us rationalize the decisions of the center whether to decentralize or centralize. It is straightforward to see the condition when decentralization is better for the Central government:

$$\frac{1}{\underline{c}} - \frac{1}{\bar{c}} \geq \lambda V(collusion), \tag{7}$$

where λ is the weight on safety relative to output and $V(collusion)$ is the cost of collusion related to the lost life values. When $\frac{1}{\underline{c}} - \frac{1}{\bar{c}} \geq \max\{\lambda V, \frac{2mpw}{t}\}$, it is optimal for the Central government to allow for decentralization and collusion. The cost of collusion can be taken as an increasing and convex function of the number of deaths, which is positively associated with collusion.

Related to the institutional background discussion, the decision of decentralization in 1998 implies that the condition in equation (7) was set at holding at that time. The decision of re-centralization in 2001 can be interpreted as evidence that this condition does not hold anymore when λV increases dramatically. We allow for this concern in our empirical tests.

A.2 Additional Figures and Tables

The Distribution of the Number of Deaths Figure A1 plots the distribution of the number of deaths. It shows that there is no clear evidence of bunching at the accident classification thresholds (2 and 9).

The Prices of Coal Figure A2 plots the national coal prices between 1995 and 2005. It shows no increase of coal price in the decentralization period. Therefore, our main finding is unlikely to be driven by the rise of coal prices under decentralization.

Average Death Rates Over Time Figure A3 presents the average death rates between 1995 and 2005 for native and non-native regulators respectively. It suggests that there is a clear increase in death rates under decentralization and the supervision of native regulators. However, as there exist compositional changes of regulators between the two groups, this interpretation has to be taken with caution.

Past Death Records and Native Regulators Table A1 presents the correlation between the probability of having a native regulator and lagged death rates. Columns 1 and 2 only include the death rates in year t-1 whereas column 3 includes the death rates in both year t-1 and year t-2. There is no significant correlation between the probability of having a native regulator and lagged death rates.

Standard Errors Clustered at Different Levels Table A2 reports the results after clustering standard errors at the province level and at the regulator level. The specifications are the same as those in Table 3A.

Results from DDD Analysis Table A3 reports the results from DDD analysis, comparing the key state coalmines with the local state coalmines under decentralization and the supervision of native regulators. Column 1 explores with-province variations. Columns 2-4 explore within-regulator variations by adding controls. They show that the death rates in the key state coalmines are much higher under decentralization and the supervision of native regulators, compared with that in the local state coalmines. This finding is also consistent with our main hypothesis.

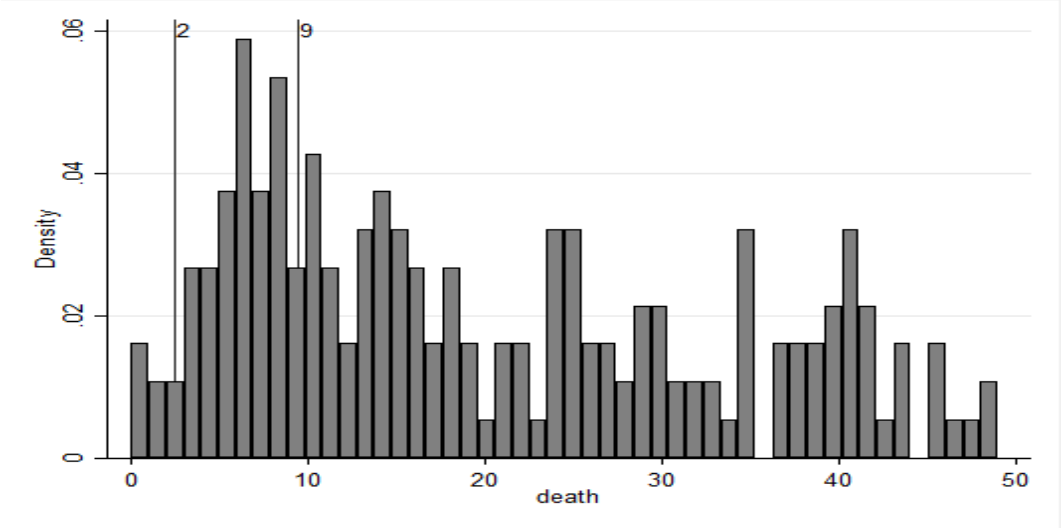
References

[1] Bardhan, Pranab, and Dilip Mookherjee, "Capture and Governance at Local and National Levels", *American Economic Review*, 90:2 (2000), 135-139.

[2] Groves, Theodore, Yongmiao Hong, John McMillan, and Barry Naughton (1994), "Autonomy and Incentives in Chinese State Enterprises", *Quarterly Journal of Economics*, 109:1 (1994), 183-209.

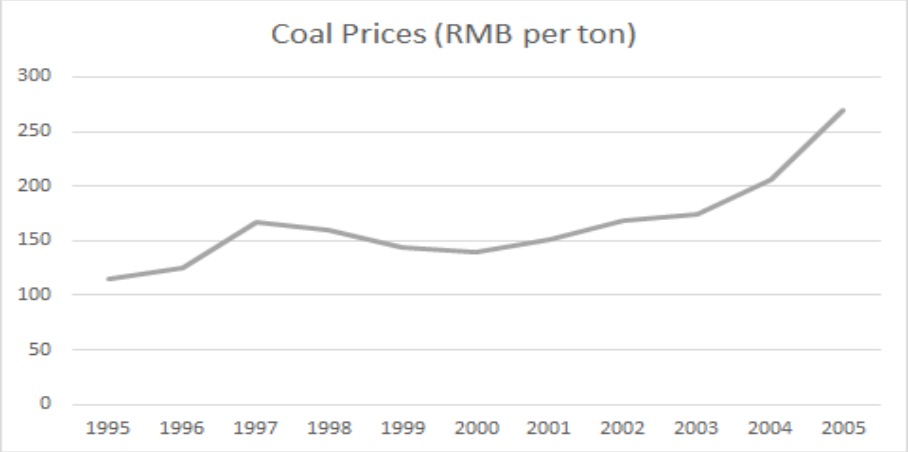
[3] Tirole, Jean, "Hierarchies and Bureaucracies: On the Role of Collusion in Organizations", *Journal of Law, Economics, and Organization*, 2:2 (1986), 181-214.

FIGURE A1. – The Distribution of the Number of Deaths



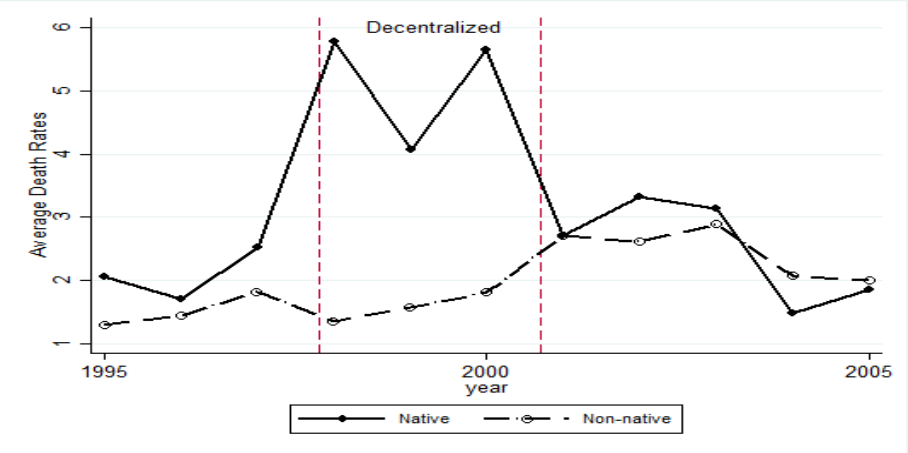
Notes: This figure checks whether the distribution the number of deaths exhibits bunching at the thresholds of different levels of accidents (2 and 9). To facilitate the reading, those above 50 are not displayed here. We include all the data in our analysis.

FIGURE A2. – Coal Prices: 1995-2005



Notes: This figure shows the trend of national coal prices between 1995 and 2005. We see no increase of coal price in the decentralization period (1998-2000).

FIGURE A3. – The Average Death Rates: 1995-2005



Notes: This figure plots the average death rates between 1995 and 2005 for native and non-native regulators respectively. Note that there exist compositional changes of regulators between the two groups.

Table A1. – Lagged Death Rates and the Prob. of Having a Native Regulator
D.V.: Native = 0/1

	(1)	(2)	(3)
Death Rate (t-1)	0.008	0.008	0.012
	(0.010)	(0.010)	(0.011)
Death Rate (t-2)			0.016
			(0.010)
Province FE	Y	Y	Y
Year FE		Y	Y
# observations	209	209	185
R-Squared	0.50	0.55	0.57

Notes: This table shows that there is no significant correlation between the lagged death rates and the probability of having a native regulator.

Table A2. – Clustering Standard Errors at the Province and Regulator Levels
D.V.: Death Rates

	(1)	(2)	(3)	(4)	(5)
Decentralization * Native	2.617*	3.105*	3.122*	3.081***	3.235***
	(1.525)	(1.669)	(1.750)	(1.087)	(1.170)
	[1.628]	[1.701]	[1.752]	[1.099]	[1.236]
Native	0.339	0.246	0.200	0.420	0.073
	(0.326)	(0.431)	(0.459)	(0.352)	(0.713)
	[0.312]	[0.371]	[0.357]	[0.336]	[0.661]
Province FE	Y	Y	Y	Y	Y
Year FE		Y	Y	Y	Y
Controls			Y	Y	Y
Decentralization * Controls				Y	Y
Provincial Trends					Y
# observations	234	234	234	234	234
R-Squared	0.44	0.47	0.49	0.55	0.58

Notes: Standard errors reported in parentheses are clustered at the regulator level and those in squared brackets are clustered at the province level. The significance levels are marked based on the results clustering at the regulator level. * Significant at 10%, ** 5%, *** 1%.

Table A3. – Results from Difference-in-Difference-in-Difference Analysis
D.V.: Death Rates

	(1)	(2)	(3)	(4)
Decentralization * Native * Key State	6.257***	6.364**	6.111***	6.034***
	(2.304)	(2.430)	(2.160)	(2.179)
Decentralization * Native	-3.061**	-2.537**	-2.487**	-2.833**
	(1.194)	(1.130)	(1.006)	(1.080)
Decentralization * Key State	0.467	0.517	0.620	0.627
	(0.709)	(0.738)	(0.814)	(0.839)
Native * Key State	-2.601**	-2.562**	-2.523**	-2.515**
	(1.166)	(1.202)	(1.194)	(1.206)
Key State	-2.133***	-2.145***	-2.323***	-2.327***
	(0.581)	(0.609)	(0.622)	(0.632)
Native	2.102**			
	(0.992)			
Province FE	Y	Y	Y	Y
Year FE	Y	Y	Y	Y
Regulator FE		Y	Y	Y
Controls			Y	Y
Decentralization * Controls				Y
# observations	456	456	456	456
R-Squared	0.45	0.51	0.52	0.53

Notes: Using Difference-in-Difference-in-Difference, the table shows that the death rates in the key state coalmines are much higher under decentralization and the supervision of native regulators, compared with that in the local state coalmines.

Standard errors reported in parentheses are clustered at the province∗regime level. * Significant at 10%, ** 5%, *** 1%.