



Analysis of embedded non-safety regulation games in China's two types of coal mines through safety performance disparity, 1980–2014[☆]



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ABSTRACT

China has an appalling record of fatalities in its coal mining industry. Moreover, the fatalities observed in township and village coal mines (TVCMs) is much more terrible than that in state-owned coal mines (SOCMs). The safety performance of coal mines is influenced not solely by governmental safety regulation, but by their embedded non-safety regulation games with their internal and external related industries. Therefore, to better understand the safety performances disparity in SOCMs and TVCMs, an embedded non-safety regulation game analysis of the two types of mines is introduced. The paper traces China's safety records of SOCMs and TVCMs, and then analyzes their embedded non-safety regulation games respectively. The result shows that the SOCMs are mainly embedded into non-safety regulation games with the national electric power enterprises, railway sectors, and coal transportation and marketing enterprises; and the TVCMs are mainly embedded into non-safety regulation games with some local government officials and related groups (e.g. local gangdom and journalists). Moreover, in the above embedded games, the SOCMs and TVCMs are often placed in a weaker bargaining position. Besides, the SOCMs and TVCMs also play internal games on coal output and safety. Overall, the SOCMs and TVCMs are embedded into a plurality of different non-safety regulation games which, at least in part, affect their safety investment decisions differently and lead to safety performance disparity eventually.

1. Introduction

China is the largest coal producer in the world, producing an estimated 3.87 billion tonnes of coal output in 2014 (The State Administration of Coal Mine Safety, 2014). It is also the largest coal consumer in the world (Niu, 2014). According to China's *National Energy Development Strategy Plan (2014–2020)*, the coal will continue to dominate the energy strategy accounting for more than 60% of China's energy. The coal-dominated strategy is unlikely to be changed during the 13th Five-Year Plan Period (2016–2020). However, China has an appalling record of fatalities in the coal mining industry. Fatalities in Chinese coal mines account for about 70% of the global coal fatalities (Liu et al., 2015). The frequent coal mine accidents have long been considered as one of the most significant outstanding problems in China (Liu and Li, 2014). Those accidents not only led to huge loss of lives and properties damage, but also had negative influence on society. Therefore, Chinese government reformed its coal mine safety management system between 1998 and 2000 (Song and

Mu, 2013; Liu and Li, 2013). The outcome of the reform process was the new coal mine safety inspection system, namely “State inspection, Local regulation, and Enterprise responsibility” (Liu and Li, 2013). The State Administration of Coal Mine Safety (SACMS) and local regulation departments of coal mine safety share the task of administrative enforcement on coal enterprises' safety production.

Although the safety performance of coal mines has improved year after year since the reform of coal mine safety management system shown in Fig. 1, the improvement of different types of coal mines in China differ quite widely. The safety performance observed in township and village coal mines (TVCMs) is much more terrible than that in state-owned coal mines (SOCMs). For instance, according to the statistics from the State Administration of Coal Mine Safety (SACMS), in 2011, the number of fatalities and fatality rate per million tonnes in TVCMs are 1391 and 1.10 respectively. If we compare to SOCMs in the same period, we get 582 and 0.26 respectively. The comparison demonstrates that the fatality rate per million tonnes in TVCMs is 4.2 times higher than that in the SOCMs.

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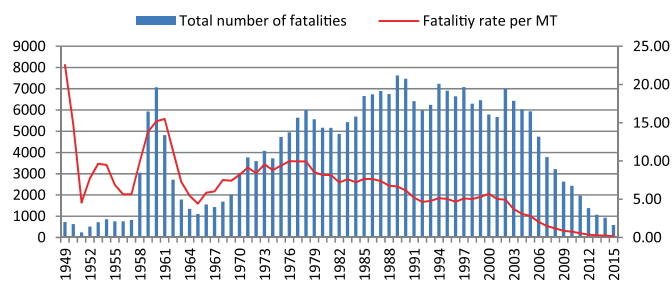


Fig. 1. China's total number of fatalities and fatality rate per million tonnes in coal mine from 1949 to 2015. Note: The People's Republic of China was established in 1949.

Source: China Coal Industry Statistical Yearbook (2013) and the website of the State Administration of Coal Mine Safety (SACMA).

When exploring the underlying causes of China's appalling record of coal mine fatalities, the complicated geological condition, the backward technology and equipment, the insufficient skills of miners, the inadequate safety investment and poor safety management are all the factors that contribute to the frequency and catastrophic nature of China's fatal coal mining accidents (Wright, 2004; Wang, 2006; Liu et al., 2016). Furthermore, it suggests that problems with governmental coal mine safety regulatory regime might be contributing to China's bad safety performance (W. Homer, 2009; Liu and Li, 2013; Liu et al., 2015). Scholars from China and elsewhere have studied the existing problems of China's poor coal mine safety performance from the perspective of governmental safety regulation to explain the high incidence of accidents. Some scholars argued that coal mine safety performance, such as accident frequency and extent of injury in work place, possess obvious correlation with the strength of governmental safety regulation and that the government should strengthen the safety regulation on coal mines (Lewis-Beck and Alford, 1980; Gray and Scholz, 1993; William, 2001; Gray and Mendeloff, 2005; Lu and Shang, 2005; Xiao et al., 2008; Liu and Li, 2013; Qin, 2013). However, some other scholars put forward objections and argued that the governmental safety regulation is ineffective and even hinder the development of the coal industry (Viscusi, 1979; Baggs et al., 2003; Wright, 2004). In the existing literatures, many researches have focused on the study of high incidence of accidents from the perspective of governmental safety regulation games with the government regulators, such as American's Mine Safety and Health Administration (MSHA), China's State Administration of Coal Mine Safety (SACMS) whose predecessor is the Ministry of Coal Industry (MCI), etc. (Keise, 1980; Scholz, 1991; Fu and Liu, 2007; Hu and Liu, 2008; Shen and Mei, 2010; Feng and Ma, 2011; Song and Guo, 2011; Liu and Li, 2013; Liu et al., 2015). These studies provide a promising foundation to explain the high incidence of coal accidents. However, the safety performance of coal mines is influenced not solely by the governmental safety regulation, but, to some extent, by their embedded non-safety regulation games with their internal and external related industries. The non-safety regulation game is relative to safety regulation game. It is the games between coal mine and coal mines' internal and external related industries, such as the national electric power enterprises, railway sectors, etc. not the government regulators.

The embedded non-safety regulation games of TVCMs and SOCMs differ quite widely due to their different mine ownership, mine objectives, and coal pricing. Research is also needed to explain the above large disparity in terms of safety performance in the TVCMs and SOCMs. Therefore, to help address the gaps in the research, this paper describes the analysis of embedded non-safety regulation games in China's two types of coal mines through safety performance disparity (1980–2014). The remainder of this research is organized as follows. In Section 2, we trace China's two types of coal mines and their safety records from 1980 to 2014. In Section 3 and Section 4, we analyze the characteristics of TVCMs and SOCMs, and then explore their embedded non-safety regulation games respectively. In Section 5, we

analyze the non-safety regulation games between SOCMs and TVCMs. Finally, we conclude this work in Section 6.

2. China's two types of coal mines and their safety records disparity

Reports from the State Administration of Coal Mine Safety (SACMS) reveal that within the 26 provinces, autonomous regions, and municipalities that produce coal, 15071 and 12722 coal mines were in operation in 2007 and 2008 respectively (SACMS, 2008, 2009). Although the number of mines has declined due to the closure or consolidation of some small mines, these numbers are perhaps the largest among the main coal producers in the world (Wang et al., 2014).

Coal mines in China have been historically classified into SOCMs (state-owned coal mines) and TVCMs (township and village coal mines) based on their ownership, subordination, and product distribution. The SOCMs are run or managed by the state, which played a key role in China's energy supply. They have the responsibility of earning social benefits and multiple objectives from all facets of public needs and political pressures. Moreover, the state has the complete right to dominate the SOCMs and assigned an output quota (allocated coal) to the SOCMs which filled the quota and sold to the state at the fixed price (Shen et al., 2012). The output, which beyond the allocated coal output, could be sold at free market price in the open market. Differently, the TVCMs were owned and controlled by a variety of private companies and agencies or local township and village governments. They usually have small size on coal output, but also have played a significant role in China's energy supply. Furthermore, they mostly distribute and locate in remote areas with low degree of mechanization and automation, which provide a basis for the local employment and economy development. A summary of safety production statistics for SOCMs and TVCMs are shown in Table 1.

First, according to Table 1, the Fig. 2 below demonstrates the trends of coal outputs in SOCMs and TVCMs during the period 1980–2014. It can be clearly seen that the coal outputs in SOCMs and TVCMs followed the same trend. In 1980, the figures stood at 515 in SOCMs and 105 in TVCMs, and moderately increased to 759 and 615 million respectively in 1996, before falling to 683 in SOCMs in 1999 and 246 in TVCMs in 2001. But after 2001, the figures began to grow markedly and continued on this upward trend. Furthermore, the coal outputs in SOCMs and TVCMs stood at 2728 and 1142 in 2014 respectively.

Second, the Fig. 3 below demonstrates changes in the number of fatalities in SOCMs and TVCMs from 1980 to 2014. It is clear that the number of fatalities in SOCMs experienced a downward trend with slight fluctuation, but the figure in TVCMs fluctuated dramatically. During the period 1980–1982, the number of fatalities in TVCMs remained steady at around 1750, follow by a sharply rose to the peak of 5191 in 1990. The figure then fluctuated during the period 1991–2002 and reached the peak again in 2002, and then fell sharply over the following years. What's more, it is found that the annual number of fatalities in TVCMs is more than twice as many as that in TVCMs in the recent thirty years.

Third, if the fatalities are considered as a function of production, namely fatality rate per million tonnes, then the changes of fatality rate per million tonnes in SOCMs and TVCMs can be shown in Fig. 4 below. During the period 1980–2014, there was a sustained decline of fatality rate per million tonnes in SOCMs from 6.59 in 1980 to 0.16 in 2014. By contrast, the figures in TVCMs fluctuated sharply. Especially in 2001, the figure peaked at 14.82, whereas that number is 2.12 in SOCMs, namely 7 times as many as that of SOCMs.

Overall, the safety performance observed in TVCMs is much more terrible than that in SOCMs. Specifically, the TVCMs, which account for approximately one third of the total production, are responsible for over 70% of the death toll before 2013. The large disparity is impacted by various factors, such as the strength of government regulation, the

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