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How Natural Resources Affect Corruption in China ☆

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ABSTRACT

This study explores the effect of natural resource production on the corruption of local public officials in China. We introduce a novel, micro-level data set on the production of three major fuel resources in China—oil, natural gas, and coal (2000–2005)—and analyze alongside county-level statistics and individual-level survey data. Our analyses show that the effects of resource extraction on corruption vary substantially depending on the type of natural resources exploited. We find that coal production alone is robustly associated with corruption among local public officials in county governments. Moreover, citizens in coal-producing areas are more likely to perceive government officials as corrupt. We posit that the coal industry's regulation-heavy and labor-intensive production process along with smaller firm sizes are the primary sources of this effect. Our findings suggest effective tackling of resource-related corruption requires careful attention to the type of resources and their link to local political economy.

1. Introduction

Does the presence of natural resources induce corruption in China? Since the country implemented its recent anti-corruption campaign, two of the highest-profile cases, those of Zhou Yongkang and Ling Jihua, have been publicly discussed as representative of the tendency toward corruption embedded in natural resource production. Zhou and Ling each worked for an extended period in a resource-rich region, Sichuan and Shanxi, respectively. Zhou worked in the oil industry and the Ministry of Land and Resources, which oversees resource production and the allocation of Chinese state-owned enterprises (SOEs). While some scholars view the crackdown on these "tigers" as a struggle among political factions in China (Gao & Pearson, 2022; Shih, 2016; Zhu, 2022), both men's deep associations with the natural resource industries have been extensively documented. This paper uses new systematic data on natural resource production to examine whether the link between natural resource production in China and public officials' corruption can be generalized beyond these well-known cases.

Previous studies using cross-country data sets have posited a "resource curse" that affects various political economic outcomes such as democracy, peace, and economic growth (Fearon, 2005; Jensen & Wantchekon, 2004; Karl, 1997; Ross, 1999, 2001, 2004; Sachs & Warner, 1995; Smith, 2004; Ulfelder, 2007). A more recent stream of research has provided subnational evidence that natural resource endowment is associated with more mixed or conditional effects. On the one hand, a number of these subnational studies have identified a modest positive relationship between natural resources and political economic outcomes, including public goods provision, human capital development, and transparency in local government in countries including the United States (Michaels, 2011), Brazil (Caselli & Michaels, 2013; Monteiro & Ferraz, 2010), Indonesia (Olsson & Valsecchi, 2012), Nigeria (Fenske & Zurimendi, 2017), Iran (Mahdavi, 2015), and China (Hong & Yang, 2020). On the other hand, some studies have found adverse effects of resource extraction on the quality of subnational governance in countries including the United States (Tyburski, Egan, & Schneider, 2020) and China (Hong, 2018; Zhan, Duan, & Zeng, 2015).

In line with these subnational studies, this paper examines the effect of resource production on the corruption of local public officials using novel county-level natural resources data from China. We are not the first to look into this critical question, as rampant corruption is considered a chronic problem in China and one of the most puzzling phenomena that has accompanied the country's staggering economic growth (Ang, 2020). Using official data on corruption investigations at the province level, Zhan (2022) has shown a strong association between

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resource production and corruption. Zhan (2017) has also described the corruption-prone nature of resource production in China using case studies and interviews. We aim to build on this literature by providing evidence based on systematic data from a lower administrative layer and three different fuel industries—crude oil, natural gas, and coal—which each have a distinctive industrial structure.

To capture local officials' corruption, we employ various measures in our analyses, including anti-corruption investigations by the local commission for discipline inspection, the volume of misused public funds within each local government, and citizens' perceptions of corruption. Accurately measuring corruption is tricky because of the secretive nature of the behavior. Thus, we use multiple measures of corruption, which each have their own strengths and weaknesses. For instance, as scholars have pointed out, the extent and intensity of corruption investigations might be affected by factional competition among political elites (Gao & Pearson, 2022; Shih, 2016; Zhu, 2022).[2] Examining the volume of misused public funds as a measure of corruption relies on the assumption that corrupt behavior results in an auditable misuse of public funds, which may not always be the case. Finally, subjective corruption measures might reflect objective corruption levels which are often unobservable (Johnston, 2005; You, 2016). Yet, perceptions of corruption may reflect individual, communal, cultural, or national features beyond just corruption itself (Heywood, 2015; Kaufmann, Kraay, & Mastruzzi, 2007; Treisman, 2007). Therefore, we use the three measures as supplementary indicators of local government corruption.

We find that, among the three fossil fuel industries, coal production is particularly associated with corrupt behavior by local government officials. We find consistent results from corruption investigations and measures of misused public funds. Our analysis of individual-level survey data from the China Family Panel Studies (CFPS) demonstrates that residents of coal-producing areas perceive a higher level of corruption among their government officials than residents of other areas do. Other fuel resources (crude oil and natural gas) do not show statistically significant and consistent associations with corruption at the county level. In the Appendix, we elaborate on the case of Shanxi in detail, discussing the mechanisms and practices that connect the coal industries with corruption in local government.

Our paper contributes to the literature in several respects. First, we enhance the accuracy of natural resource data in various ways. We collect novel resource production data from raw data sources at the production site–level. These data allow us to analyze the effect of natural resources at the county level, which is a lower administrative unit than has been analyzed in most previous studies of natural resources in China (Hong, 2018; Zhan, 2022; Zhan et al., 2015). Furthermore, this study focuses on how specific natural resources affect localities differently. Instead of assuming that natural resources have the same or similar effects, we separate the sales revenues from oil, natural gas, and coal extraction and examine whether the effects of each on corruption differ. As well described in previous literature (Hong, 2018; Zhan, 2022), coal production in China is a regulation-heavy and labor-intensive industry consisting of small firms where the local governments and firms are interdependent in the local political economic system. In contrast, the oil and natural gas industries are more capital-intensive and are run by several conglomerate SOEs. Although the coal industry in China went through an intense reform beginning in the 2000s, which merged small mining companies into bigger firms in order to improve market competitiveness and workplace safety, the industry remains more locally rooted and smaller than the other two fossil fuel industries. We claim that the corruption-related findings of this study are closely related to these features of the coal production industry.

Our study suggests that greater attention be paid to grassroots-level resource-related corruption. Corruption in low-level local governments, such as county governments, directly affects the welfare of citizens, as these officials are the ones who interact with residents most frequently and make decisions that affect the residents' daily lives. Furthermore, corruption in the coal industry comes with exceptionally high costs, as coal mining in China has been identified as the deadliest occupation in the world.[3] Corruption among local officials takes the form of collusion with profit-oriented firms and neglect of regulatory duties. Deadly accidents have declined substantially due to the coal industry reforms over the last two decades. However, according to the National Mine Safety Administration, 245 coal miners died in 2022.[4] Xu, Wang, Wang, Yano, and Zou (2021) have found that provinces that experienced more intense anti-corruption campaigns saw larger decreases in coal mining deaths, indirectly indicating that corruption was a cause of these incidents or at the least, led local officials to neglect severe safety issues in China's coal industry.

2. Literature review and theoretical discussion

Scholars have shown that countries with natural resources are more likely to suffer from corruption due to the rent-seeking behavior of public officials or pervasive patronage between the government and the private sector and political supporters (Bhattacharyya & Hodler, 2010a; Knutsen, Kotsadam, Olsen, & Wig, 2017; Kolstad & Søreide, 2009; Leite & Weidmann, 1999; Petermann, Guzmán, & Tilton, 2007). As Kolstad and Søreide (2009) states corruption is one of the primary reasons "why resource-rich countries perform badly in economic terms" (Kolstad & Søreide, 2009, p.214). Several scholars put effort into discerning the effects of diverse natural resources. Petermann et al. (2007) show that fuel resources facilitate corruption unambiguously, while non-fuel minerals increase corruption in poor countries only. Indeed, most empirical evidence on the relationship between natural resources and corruption relies on fuel minerals. Oil revenue has been most frequently investigated as the cause of corruption (Arezki & Brückner, 2011; Shaxson, 2007; Vicente, 2010). However, a few studies also focus solely on the effects of coal mining on corruption (Dong, Zhang, & Song, 2019; Kotikalapudi, 2016).

Regarding natural resources, China as a country faces the largest deficit in the world. In 2019, before COVID-19 impacted its economy, the country was importing more than 10 million barrels of oil per day. Yet China is also regarded as a major producer of natural resources. According to the United States Energy Information Administration, as of 2021, it was the world's largest coal producer, the sixth-largest producer of crude oil, and the fourth-largest producer of natural gas. This means that numerous local districts are endowed with natural resources and stand to benefit economically from resource extraction. How do these windfall gains from resource production affect corruption in localities?

Previous academic studies have well documented the general link between the resource extraction industries and the corruption of public officials in China (Zhan, 2017, 2022; Zhu & Wu, 2014). Our study conducts further empirical investigations on whether the degree of grassroots corruption is affected by natural resource extraction and whether it differs across the sub-sectors of the natural resource extraction industry in China. While we agree with the previous studies on the reasons why natural resource sectors, in general, tend to be vulnerable

[2] Our corruption investigation dataset is less likely affected by factional competition, as it contains corruption-investigated officials at the county level. Senior officials at the prefecture or provincial level are not included. Local leaders at county level or below are less likely to be influenced by factional competition among political elites which generally refer to high-rank public officials.

[3] https://canadiandimension.com/articles/view/the-worlds-most-dangerous-job (last accessed on June 22, 2023)

[4] https://www.chinamine-safety.gov.cn/zfxxgk/fdzdgknr/sgcc/sgtb/202302/t20230215_442433.shtml (last accessed on June 22, 2023)

to corruption, we discuss several critical factors why grassroots-level corruption is expected to be more prevalent in regard to the coal industry.

Firstly, the coal industry has historically been formed in a more decentralized and fragmented structure compared to the oil and natural gas industries. While the two major SOEs monopolize the oil and natural gas industries – Petro China and Sinopec, particularly after the reform in the late 1990s (Hong, 2018), the development and operation of the coal industry in China depended heavily on small-scale firms such as township- and village-enterprises (TVEs) or private firms (Huaichuan, 2005; Wright, 2004, 2012). This structural difference has led the coal industry to be more attached to the local community and subjected to grassroots bureaucracy than the industries operated by the high-level SOEs. In the case of the oil and gas industries operated by the SOEs, the operating units of the SOE often administratively rank higher than the local government. For instance, an operating unit extracting oil in a county can be a prefecture-level unit. In such a case, the county governments are unable to wield much influence (Hong & Yang, 2020). Despite the intense industrial reforms in the coal industry in recent decades to close down small mines and merge them into larger ones, the nature of coal industries remains more decentralized and locally grounded compared to the other natural resource industries.

Relatedly, and more critically for the issue of corruption, the operation and regulation of the coal industry have created a complex system of interdependence between the local government and the local business sectors. The registration and operation of the coal mining business involve many departments in the local government. The registration itself may require numerous permits from different departments and units in local government, such as "the Department of Land and Resources, Department of Coal Mine Safety, Bureau of the Coal Industry, and Administration for Industry and Commerce" in a local government in some regions (Zhan, 2017, p. 242). The time and cost barriers created by these bureaucratic and regulative systems at the local level make corrupt behavior like bribery particularly attractive for many business owners. At the same time, local governments in coal-producing counties also depend heavily on the coal business as coal production is detrimental to the local economic performance, which determines the promotion perspectives of local leaders in China, especially until 2010 (Yao & Zhang, 2015). Because coal has been a primary energy source for China's rapid industrialization amid expanding energy deficits, these local governments were also put under increasing pressure to facilitate more production with less cost and negative externalities. This interdependence at the grassroots level made it challenging to enforce regulations and oversight corruption in these localities, creating a deeply rooted and tangled "web of corruption" (Xu et al., 2021, p.459).

Finally, the industrial structure of the Chinese coal industry not only enables the business-local government interdependence but also makes large profits by pushing the negative externalities onto labor and residents. The Chinese coal-mining industry has long been plagued by notorious workplace safety hazards (Jia & Nie, 2017; Nie, Jiang, & Wang, 2013; Wright, 2004; Xu et al., 2021). Chinese coal mining industry has been a notorious cause of a large number of deaths due to unsafe work conditions. For instance, 6,995 mine workers were killed in 4344 coal mine accidents in 2002, according to official statistics published by the State Work Safety Supervision Administration.[5] Including unregistered small mines, the actual death toll is expected to be higher. Premier Wen Jiabao celebrated the 2003 Chinese New Year by eating dumplings with coal miners at 2300 ft underground, promising an improvement in mine safety. However, despite the central government's intervention to improve work conditions in coal mines, the death toll remained high for several years before it gradually decreased. The central government continued and strengthened the policy efforts to improve the workplace safety of coalmines.[6] Despite being recognized as a pressing challenge by the central government, these safety issues persist to this day, primarily because the majority of coal-mining workers in China are easily replaceable, low-skilled, and often migrant workers (Hong, 2018).

Environmental hazard has also been a source of discontent in Chinese coal-producing cities. The entire process of coal production, such as mining, processing, and loading, generates numerous forms of pollutants including polluted dust and mining wastes harming the public health of residents near the production sites. Chu, Holladay, Qiu, Tian, and Zhou (2023) use suspended mines due to coalmine accidents between 2003 and 2015 and find that suspending coal mining reduces local air pollution by 8% and respiratory mortality of vulnerable populations. This highlights the public health hazard that the coal industry imposes on workers and residents. These hazards persist or worsen due to ineffective monitoring and regulation by the local government associated with pervasive corrupt practices.

3. Data and specification

For this study, we collected novel data on natural resource production at the county level (*xianjixingzhengqu*).[7] Among the many natural resources produced in China, we focus on three major fossil fuel resources—crude oil, natural gas, and coal—which are the primary energy sources that have been fueling China's economic growth.

We first construct data on oil and gas sales revenue by collecting the annual domestic prices and production volumes for each county. The oil and gas production volumes from each county are calculated from the *China Oil and Gas Field Development Reports* (hereafter, *Development Reports*). China has 20 large oil and gas fields, and each field has published at least one *Development Report* containing detailed information on the field, including its location, development history, and proven reserves of each sub-oil/gas field and its annual production volume up to 2005. Using geographic information on each sub-oil/gas field, we match the production data to the county in which the field is located. If an oil or gas field crosses a county border, we split the production quantity equally among the relevant counties.[8] Price is the nationally representative price. For instance, for oil, we use the price trend of Daqing oil, crude oil produced by the largest oilfield in China. For natural gas prices, we use the national average price.

Second, we collect coal reserve data from the *China Coal Industry Chronicle*, which contains information about the coal reserves of each coal mine. To the best of our knowledge, nationwide coal production volume data are not available at the county level or below. Therefore, as a second-best method, we calculate the potential sales revenue for each mine using the reserves data and the annual average domestic price of coal.[9] Finally, we merge production site-level data to the county level for analysis.

Out of the 2823 counties in our dataset, approximately 32.4% (914 counties) have fossil mineral reserves. The following figures— Fig. 1, Fig. 2, and Fig. 3—illustrate the geographic distributions of the three natural resources, our independent variables.

Our dependent variables are the various measures of corruption by local government officials. As many scholars of corruption have noted, measuring corruption is challenging, as corrupt actors make efforts to hide their behavior (Heywood, 2015; Kaufmann et al., 2007). Following the conventions in the existing literature on corruption in

[5] https://www.gov.cn/xinwen/2019-12/27/content_5464574.htm (last accessed on June 22, 2023)

[6] https://english.www.gov.cn/policies/latestreleases/202309/07/content_WS64f900c8c6d0868f4e8df2d0.html (last accessed on October 20, 2023)

[7] Currently, China has 2,862 county-level divisions.

[8] We discuss the detailed data generation process using the oil reserves quantity with an actual example in Figure A.1 in Appendix.

[9] We discuss the detailed data generation process using the coal reserves quantity with an actual example in Figure A.2 in Appendix.

Fig. 1. Average Oil Sales Revenue (2000–2005).
Notes: The figure plots the average oil sales revenue in county *i* between 2000 and 2005. The unit of average oil sales revenue is 10,000 RMB.

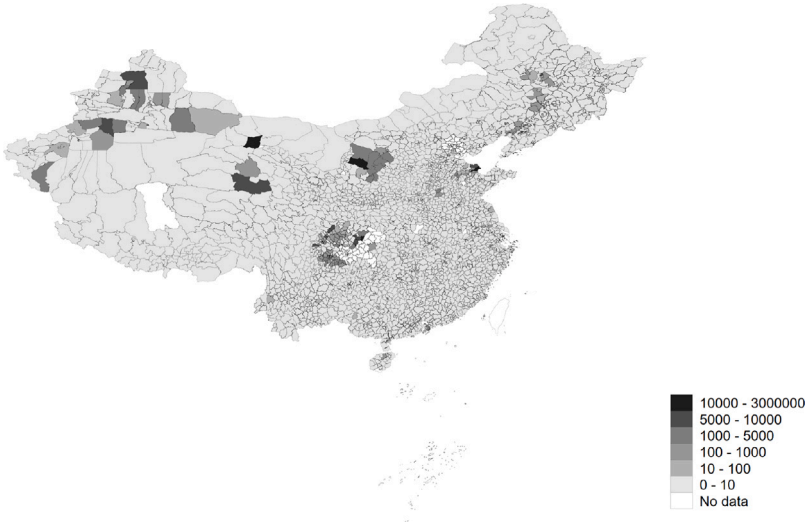

Fig. 2. Average Natural Gas Sales Revenue (2000–2005).
Notes: The figure plots the average natural gas sales revenue in county *i* between 2000 and 2005. The unit of average natural gas sales revenue is 10,000 RMB.

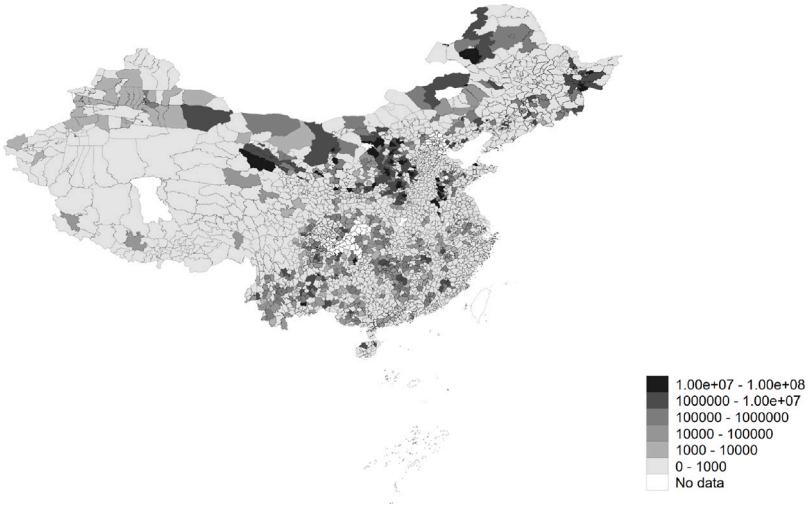

Fig. 3. Average Coal Sales Revenue (Reserve,2000–2005).
Notes: The figure plots the average coal reserve sales revenue in county *i* between 2000 and 2005. The unit of average coal reserve sales revenue is 10,000 RMB.

Fig. 4. The Number of Corruption Investigations (2012–2016). Notes: The figure plots the total number of corruption investigations between 2012 and 2016 in each county.

China and other developing countries (Bhattacharyya & Hodler, 2010b; Dong et al., 2019; Okada & Samreth, 2017; Robbins, 2000; Zhan, 2017, 2022), we first use data on corruption investigations. Specifically, we use corruption investigation data from the anti-corruption campaign launched in 2012.[10] The original data on corruption investigations comes from an information technology firm, *Tencent*. *Tencent* constructed a website in 2016 that provided individual-level information on corruption investigations at every administrative level. The information was compiled from the official websites of party disciplinary committees, courts, and procurators. However, this website became unavailable soon after its launch. Our study relies on data from *Tencent* that were collected by Wang and Dickson (2022). We use the number of corruption cases in each county and exclude all cases above the county level. The dataset contains information on 11,209 corruption investigations all at the county level.

One advantage of this dataset is that it allows us to classify corruption investigations according to the rank of the officials who were investigated. This enables us to examine the effects of grassroots-level officials' corruption separately from those of senior officials. We define grassroots officials as those with ranks of *fuke* (vice section chief) or *zhengke* (section chief). Senior officials are those ranked *fuchu* (division chief) or above within a county. While senior-level corruption is likely to be connected to grand theft, embezzlement, or bribery related to firms or official organizations, grassroots officials' corruption is more likely to be related to petty theft or smaller bribes that may be more visible to ordinary residents. Fig. 4 illustrates the number of corruption investigations at the county level in China.

Second, we employ a measurement of misuse of government funds, which several recent scholarly works have used as a proxy for corrupt behavior in local government (Berkowitz, Lu, & Wu, 2023; Bo, Wu, & Zhong, 2020; Li, Pang, & Wu, 2019). We collect information on the misuse of government funds from the *China Audit Yearbook* from 2000 to 2005. Misuse of government funds refers to questionable uses of funds uncovered by audits, such as monies spent extravagantly, excessive collection of funds from firms, unrecorded income from business activities in financial statements, and public funds going unused because of a delay in executing financial plans (Gong, 2009).

Additionally, we employ another type of data from a nationwide survey, the CFPS, to understand how local economies' reliance on particular natural resources affects residents' perceptions of government corruption. The 2012 CFPS contains a question in which respondents are asked to evaluate the severity of bureaucratic corruption, with options ranging from 0 (not at all serious) to 10 (very serious).[11] Scholars have used this question to capture the perceived severity of government corruption in China (Wu & Xie, 2014). Descriptive statistics for all variables are provided in Table 1, and the correlation matrix is shown in Table 2. Table 2 indicates that corruption variables are highly significantly correlated with each other. Gas and oil are also correlated as some major oil fields overlap with natural gas fields. Even in a simple correlation matrix, coal sales show a significant correlation with some of the corruption measures, which regression analyses in the following section investigate further. Data sources of all variables are listed in Table A.11.

We acknowledge the mismatch in observation years of our independent variables (natural resources) and of dependent variables (corruption measures). This discrepancy is due to the data limitation as resource production data are not publicly available after 2005. Therefore, our analysis focuses on cross-sectional analysis across counties, which may obscure the dynamics between natural resources and corruption. In addition, as noted above, systematic coal production data at the county level is unavailable. Therefore, we use potential coal sales revenue constructed from coal reserves data as an alternative measurement.

Our empirical specification is as follows:

$$Y_{(i,)\,c} = \beta Resource_c + \alpha X_c + (\eta X_i) + \gamma_p + \varepsilon_{(i,)\,c}. \quad (1)$$

where Y is the outcome of interest, the severity of corruption in county c. *Resource* refers to the value of the extracted resources, for which we use the average logarithmic value of the sales revenue from oil,

[10] We acknowledge the time gap between our independent variable, which is from 2000–2005, and this dependent variable drawn from 2012–2016. The gap is inevitably generated by the unavailability of the resource data. To our best knowledge, the Development Reports from which we draw the oil and gas production information were discontinued after 2005. At the same time, systematic county-level corruption investigation was only available between 2012 and 2016, after the nationwide anti-corruption campaign began. To address the issue, we use the misuse of government funds between 2000 and 2005 as another outcome variable.

[11] The original question in the CFPS asks "What do you think of the seriousness of the problem of government integrity in our country (您认为政府廉政问题在我国的严重程度如何)?"

Table 1
Summary statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
Resource Variables (log (x+1))					
Oil sales	2728	0.690	2.587	0	15.616
Gas sales	2728	0.293	1.349	0	14.789
Coal sales (reserve)	2728	3.232	5.590	0	20.198
Corruption Variables					
Corruption investigation	2728	0.795	0.87	0	7.8
Corruption investigation (grassroots)	2728	0.697	0.782	0	6.8
Corruption investigation (senior)	2728	0.098	0.23	0	3.6
Misuse of government funds (log)	2633	7.327	1.267	0	11.268
Local Finance and Conditions					
GDP per capita	2728	0.817	1.055	0.066	38.817
Fiscal revenue per capita	2728	0.034	0.064	0.002	2.638
Population density	2728	0.001	0.002	0	0.037
Urbanization rate	2728	0.312	0.273	0.02	1
Fiscal transfer (log)	2728	7.862	1.021	0	11.691
Law enforcement	2728	0.061	0.024	0.009	0.248
Average age of party secretary	2681	53.183	2.833	43.5	58.5
Average age of mayor	2674	50.901	3.192	38.5	58.25
Party secretary from same prefecture	2681	0.06	0.2	0	1
Mayor from same prefecture	2681	0.095	0.273	0	1
Distance to prefecture (log (x+1))	2605	3.381	1.412	0	6.262
Individual-level Characteristics					
Perception of corruption	25 317	5.876	3.06	0	10
Year of schooling	25 317	6.498	4.911	0	22
Gender	25 317	0.498	0.5	0	1
CCP membership	25 317	0.023	0.15	0	1
Age	25 317	45.458	15.864	18	99
Income(log+1)	25 317	4.315	4.777	0	14.001
Urban hukou	25 317	0.416	0.493	0	1

Table 2
Correlation matrix.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Corruption investigation	1.000											
(2) Corruption investigation (Grassroots)	0.967***	1.000										
(3) Corruption investigation (Senior)	0.500***	0.264***	1.000									
(4) Misuse of government funds	0.246***	0.224***	0.169***	1.000								
(5) Oil sales	0.012	0.023	−0.032*	0.076***	1.000							
(6) Gas sales	0.030	0.032*	0.002	0.060**	0.480**	1.000						
(7) Coal sales (reserve)	0.050***	0.056***	−0.002	0.015	−0.060***	0.025	1.000					
(8) GDP per capita	0.078***	0.042**	0.151***	0.254***	0.019	0.013	−0.049**	1.000				
(9) Fiscal revenue per capita	0.056***	0.025	0.128***	0.174***	0.029	0.023	−0.037*	0.890	1.000			
(10) Population density	−0.0772***	−0.114***	0.092***	−0.0672***	−0.065***	−0.047**	−0.107***	0.090***	0.123***	1.000		
(11) Urbanization rate	−0.156***	−0.194***	0.069***	−0.177***	−0.052***	−0.042**	−0.048**	0.270***	0.274***	0.553***	1.000	
(12) Fiscal transfer	0.235***	0.210***	0.174***	0.312***	−0.028	0.025	0.055***	0.031	0.013	−0.112***	−0.289***	1.000

Notes: * p < 0.1; ** p< 0.05; *** p < 0.01.

natural gas, and coal between 2000 and 2005. X_c is a vector of control variables at the county level.

We control several variables to mitigate potential endogeneity issues. We first control for variables related to local economic development because natural resources may affect local corruption by affecting local economic development (Ang, 2020; Gylfason, 2001), and economic development is closely linked to corruption (Méon & Weill, 2010). Therefore, we control for GDP per capita and the urban proportion of the population to capture economic development. Natural resource production tends to provide more employment opportunities (Hong & Yang, 2020) and increase local population density, while the population increase may raise the probability of corruption (Goel & Nelson, 2011). Population density is thus controlled. We also control fiscal revenue per capita in each county, as fiscal corruption is more serious in developing countries (Fjeldstad & Tungodden, 2003) and the exploitation of natural resources contributes to local fiscal revenue (Hong, 2018). Furthermore, we control for fiscal transfers from the upper-level government (log), particularly because our study period overlaps with the West Development Campaign launched in 2000 (Gilley, 2001; Goodman, 2004; Liu, Wang, Tao, & Murphy, 2009).[12] Fiscal transfer from above may also fuel local corruption (Brollo, Nannicini, Perotti, & Tabellini, 2013). In addition, to address the idiosyncrasies of each prefecture, we also include prefecture fixed effects to capture time-invariant prefecture-specific factors. Therefore, our results reflect the variation across counties within a prefecture. Finally, robust standard errors are clustered at the county level.

In individual-level analyses using the CFPS data, we additionally employ a set of individual-level controls (X_i), including years of schooling, gender, age, income (log), urban hukou,[13] and the Chinese Communist Party membership. An Individual's educational attainment, gender, and political ideology may affect the probability of an individual's experience of corruption and beliefs on it (Olken, 2009). At the same time, we control county-level covariates such as GDP per capita, fiscal

[12] Since the launch of this campaign, the central government has made a large volume of fiscal transfers to western regions, many of which are endowed with natural resources in the name of poverty reduction, infrastructure investment, and, ultimately, economic development.

[13] *hukou* is a household registration system in China which have controlled the population movement and limited rural population's access to advanced public services in urban districts (Liu, 2005).

revenue per capita, population density, urbanization rate, and fiscal transfers.

4. Empirical findings

4.1. Main results

The results of the analysis using corruption investigations are presented in Table 3. They reveal that coal is the only type of natural resource associated with greater corruption at the county level. Although the other resource variables—crude oil and natural gas sales revenue—show positive associations with corruption investigations, these are not statistically significant. The estimation from the full model (Column (3)) indicates that if the sales value of the coal produced in a county increases by one standard deviation (5.59), the average number of investigations in the county increases by approximately 0.034. Controlling for county characteristics and/or prefecture fixed effects does not affect the result.[14]

Next, we turn to a subgroup analysis of the ranks of officials investigated for corruption. We divide the corruption dataset into two subgroups: corruption investigations of senior officials and those of grassroots officials. While the corruption of senior officials may involve large-scale cases connected with large firms, the corruption of lower-level officials is more likely to be related to small firms or individuals who need access to the local authority. Therefore, ordinary residents are more likely to be involved in, observe, or hear about the corruption of lower-ranking cadres. Given the smaller size of coal production sites relative to those of the other fuel resource industries, it is expected that lower-level officials in coal-producing counties would be more likely to engage in corruption than their counterparts in counties with oil or gas.

As we see in Table 3, coal is associated with corruption among grassroots-level officials. The results are consistent regardless of specification (Columns (4) to (6)). The estimation for the corruption of senior officials is significant only in the full model with the control variables and prefecture fixed effects, and the size of the effect is also much smaller (Column (9)). This indicates that the effects found in the pooled data (Columns (1) to (3)) are largely driven by corruption investigations of grassroots officials in coal-producing counties. If the sales value of the coal produced by a county increases by one standard deviation (5.59), the number of corruption investigations of grassroots officials in the county increases by approximately 0.03. Other fuel resources are not correlated with any type of corruption. One may be concerned that the OLS model may result in biased estimated results, as our dependent variable, the number of corruption investigations, is a positive and discrete variable. As a robustness check, we use the Poisson regression to replicate the main results in columns (1) to (3). As shown in Table A.5, the results are consistent using an alternative specification.

We then turn to our second dependent variable, the amount of misused government funds. The results are presented in Table 4. In the specification without control variables and prefecture fixed effects, oil sales value seems to correlate most prominently with the misuse of government funds (Column (1)). However, when we employ a more stringent model, only coal sales value is associated with greater misuse of public funds by the local government (Columns (2) and (3)). The results indicate that A 10 percent increase in the coal sales value leads to a 0.06 percent increase in the amount of government funds misused (Column (3)).[15]

Finally, we use the CFPS data to examine how citizens perceive corruption based on the type of resource production in their counties. Columns (4)–(6) in Table 4 show that respondents in coal-producing counties perceive greater corruption regardless of the inclusion of individual- or county-level controls. Other resources do not appear to affect county residents' perceptions of corruption. This finding indicates that the respondents in coal-producing counties are more likely to believe that the corruption problem in the government is serious. If the sales value of the coal produced by a county increases by one standard deviation (5.66), perceptions of the severity of corruption increase by approximately 0.172.

4.2. Additional analyses

We conduct various additional analyses to explore the mechanisms to explain why coal production leads to greater grassroots corruption. We also implement several robustness checks to confirm that our results are not driven by our choice of specific measurements.

4.2.1. Heterogeneity analysis

In the theory section, we claim that because the coal industry is operated by smaller firms, it is more susceptible to local corruption. To explore this mechanism, we test the share of the coal firms owned by the state affects the local government corruption in coal-producing counties.

Firm-level coal production data are not publicly available, to our best knowledge. Therefore, we use the firm information provided by the Chinese Industrial Enterprises Database to measure the share of the SOEs in the coal industry of each county. This database contains company information of all industrial firms with annual sales of over 5 million RMB yuan (approximately 700,000 USD). The 2005 data contains information on 5,440 firms in the coal industry. We then construct a variable measuring the proportion of SOEs out of all coal-producing firms in each county and divide our county sample into two groups: The first group is the counties where the majority of the coal firms are SOEs (SOE dominant counties). The other is the counties the majority of coal-producing firms are not SOEs (SOE weak counties). Table 5 shows the results. We find that the positive impact of coal sales on corruption appears significant only in counties with weak SOE dominance. Although the effects are significant in a 90% confidence interval, the results suggest that corruption is more likely prevalent in counties where the coalmines are mostly operated by smaller non-SOE firms.

Including the well-known cases of oil in Xinjiang and natural gas and coal in Inner Mongolia, many natural resources are endowed in ethnic minority autonomous areas in China. To understand if the dynamics of local corruption, especially related to coal are different in ethnic minority autonomous localities, we run another heterogeneity analysis. Table A.3 shows the results from ethnic minority autonomous counties, which are either an ethnic minority autonomous county or located in an ethnic minority autonomous province or prefecture and those from the rest. We find the effects of coal on corruption are mostly driven by the areas that are not ethnic minority counties.

We also examine whether the level of regional development is associated with a difference in resource-driven corruption. We divide the counties into those in developed coastal provinces and those in less developed inland regions in China. The results in Table A.2 suggest that the effects are driven by the counties in inland provinces. Furthermore, we divide counties into two groups based on whether a county's GDP

[14] There might be a multicollinearity concern, particularly between population density and the urban population share. To test multicollinearity, we use the results of Column (2) in Table 3 to estimate the variance inflation factor (VIF) (Wooldridge, 2020, p.92). The VIF value of the urbanization rate is 1.70, and the VIF value of population density is 1.48. The results indicate that both variables have a moderate correlation with other explanatory variables in the model.

[15] In our dataset, the average amount of misused government funds is 30.08 million RMB (about 4.11 million USD). The 0.06 percent increase in the misuse of government funds is, therefore, approximately 18,000 RMB (2,460 USD).

Table 3
Effects of Natural Resources on Corruption Investigations.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Corruption Investigation All			Corruption Investigation Grassroots Officials			Corruption Investigation Senior Officials		
Oil sales (log)	0.001	0.001	0.007	0.005	0.004	0.008	−0.004***	−0.002*	−0.001
	(0.009)	(0.009)	(0.007)	(0.009)	(0.009)	(0.006)	(0.001)	(0.001)	(0.002)
Gas sales (log)	0.018	0.011	0.001	0.014	0.008	0.001	0.004	0.003	−0.000
	(0.018)	(0.017)	(0.017)	(0.016)	(0.016)	(0.014)	(0.004)	(0.003)	(0.005)
Coal sales (reserve, log)	0.008**	0.006**	0.006**	0.008***	0.006**	0.005**	−0.000	0.000	0.001
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.001)	(0.001)	(0.001)
GDP per capita		0.121***	0.060		0.082***	0.061*		0.039**	−0.001
		(0.034)	(0.045)		(0.029)	(0.034)		(0.016)	(0.020)
Fiscal revenue per capita		−0.561	−1.203*		−0.355	−0.731		−0.205	−0.472
		(1.002)	(0.711)		(0.724)	(0.502)		(0.348)	(0.304)
Population density		13.024*	−7.724		2.533	−6.515		10.491*	−1.210
		(7.756)	(8.580)		(4.598)	(6.353)		(6.237)	(4.430)
Urbanization rate		−0.429***	−0.214**		−0.459***	−0.261***		0.030	0.047
		(0.086)	(0.084)		(0.068)	(0.070)		(0.033)	(0.031)
Fiscal transfer (log)		0.162***	0.153***		0.120***	0.138***		0.043***	0.015**
		(0.023)	(0.025)		(0.019)	(0.022)		(0.007)	(0.007)
Prefecture FE			Y			Y			Y
N	2823	2728	2728	2823	2728	2728	2823	2728	2728
R^2	0.003	0.073	0.495	0.004	0.067	0.503	0.001	0.070	0.416

Notes: Robust standard errors are clustered at the county level. Corruption investigation refers to the average number of officials investigated between 2012 and 2016. Grassroots officials refer to those ranked *fuke* (vice section chief) and *zhengke* (section chief). Senior officials refer to those ranked *fuchu* (division chief) and above. Oil sales, gas sales, and coal sales are average county-level sales values between 2000 and 2005. All control variables are average values between 2000 and 2005. * p < 0.1; ** p< 0.05; *** p < 0.01.

per capita is below or above the national average. Table A.3 shows that the effect of coal sales on corruption is insignificant in both regions. Gas sales are more likely to increase misuse of government funds in less developed regions, while decreasing the misuse of government funds in more developed regions. In addition, we explore whether the influence of resources on corruption is conditional on government size. Large government size may facilitate corruption in nondemocracies (Kotera, Okada, & Samreth, 2012). We use the share of government employees in the total population to capture the size of local government. Small government size indicates that a county's government employee share is below the national average, and large government size refers to counties whose government employee share is above the national average. Table A.4 indicates that coal sales significantly increase the probability of corruption investigation in counties with large government size, while it has no evident impact on corruption in areas with small government size.

4.2.2. Exclusion of potential outliers

One concern may be that the effects we find are largely driven by a particularly corrupt place like Shanxi we mentioned in the introduction. To ensure that the results are not driven by a few conspicuous cases such as Shanxi, the largest coal-producing province, or Inner Mongolia, another resource-rich province that experienced an intense anti-corruption campaign in the recent period. Table A.6 shows the results excluding Shanxi and those excluding Inner Mongolia from the analysis. Both sets of results highlight that our findings on the link between coal and local corruption are not driven by any of these resource-rich provinces under intense scrutiny regarding local corruption in recent years.

4.2.3. Alternative measures for resource production and corruption perception

One potential concern with our resource revenue measure is that the coal sales revenue depends on the reserves, whereas oil and coal sales revenues use the production amounts. Scholars have claimed that although the location of resource endowment is exogenous, the production quantity of such resources is not exogenous to political economic factors (Cotet & Tsui, 2013a, 2013b; Haber & Menaldo, 2011). To address the concern that the level of corruption may affect production quantities and thus invite endogeneity into the analysis, we also collect oil and gas reserves information from the same data source, *China Oil and Gas Field Development Reports* (*zhongguo youqitian kaifazhi*) and use it as an alternative measure. This alternative measure also address any bias stemming from inconsistent measures across resources. Table A.7 presents the results using potential sales values calculated from the reserve quantities. The results for coal remain consistent with the main findings. Additionally, analysis using reserve data suggests that oil endowment may also be positively correlated with corruption investigations (at a 10% significance level).

Furthermore, one may be concerned that the CFPS survey question on corruption may read as a general question, rather than a question addressing the local government corruption. Alternatively, we use the 2015 China General Social Survey (CGSS) data, which includes a question asking the respondents regarding the perception of the integrity of local officials (*bendi guojia ganbu qinglian chengdu*). We recode this variable into a measure of the perceived corruption of local officials (from 1 to 5). Because local identification is only available at the prefecture level in the 2015 CGSS, we aggregate our resource production data into the average prefecture-level resource production between 2000 and 2005 and match it to the individual-level 2015 CGSS data. Table A.8 shows the results, which are consistent with the previous findings using the CFPS data.[16]

[16] We keep the results from the CFPS as the main results and report the CGSS analysis as a robustness check due to the limitations of the 2015 CGSS data. While the full sample of CGSS consists of around 8,000 respondents, the corruption-related question was answered by only around 3,000 respondents. Also, the identification of locality was possible only at the prefecture level with the CGSS data.

Table 4
Natural Resources and the Misuse of Government Funds and Corruption Perception.

	(1)	(2)	(3)	(4)	(5)	(6)
	DV: Misuse of Government Funds (log)			DV: Corruption Perception (0–10)		
Oil sales (log)	0.031***	0.011	−0.010	−0.042	−0.032	−0.014
	(0.010)	(0.010)	(0.010)	(0.027)	(0.028)	(0.029)
Gas sales (log)	0.028	0.020	0.012	0.080	0.025	0.003
	(0.019)	(0.017)	(0.015)	(0.066)	(0.066)	(0.071)
Coal sales (reserve, log)	0.004	0.014***	0.006*	0.022*	0.027**	0.030**
	(0.004)	(0.004)	(0.003)	(0.014)	(0.013)	(0.012)
GDP per capita (log)			0.250***			−0.304***
			(0.055)			(0.111)
Fiscal revenue per capita (log)			1.890			8.361***
			(1.228)			(2.750)
Population density			−2.789			−12.881
			(12.433)			(32.099)
Urbanization rate			−0.991***			0.758***
			(0.138)			(0.266)
Fiscal transfer (log)			0.387***			0.005
			(0.049)			(0.062)
Year of schooling					0.060***	0.052***
					(0.007)	(0.007)
Gender					0.224***	0.254***
					(0.044)	(0.043)
CCP membership					−0.234*	−0.228*
					(0.129)	(0.129)
Age					−0.014***	−0.016***
					(0.002)	(0.002)
Income (log)					0.019***	0.012**
					(0.006)	(0.006)
Urban hukou					0.397***	0.274***
					(0.098)	(0.093)
Prefecture FE		Y	Y			
Province FE					Y	Y
N	2719	2719	2633	25 715	25 547	25 317
R^2	0.007	0.515	0.617	0.017	0.049	0.055

Notes: Robust standard errors are clustered at the county level. Misuse of government funds refers to the average misuse of funds between 2000 and 2005. Oil sales, gas sales, and coal sales are average county-level sales values between 2000 and 2005. All county controls are average values between 2000 and 2005. Income refers to log(income+1).* p < 0.1; ** p< 0.05; *** p < 0.01.

Another potential concern is that our measurements of corruption rely on domestic sources and may have biases. To address the concern, we use the national-level analysis using an international measure of corruption. This analysis uses the national production quantity of three fuel resources and the Corruption Perception Index, the most widely used corruption index in academic research. Table A.9 shows that the results from the national-level analysis are consistent with the subnational analysis: Greater production of coal is correlated with more corruption in China.

4.2.4. Additional control variables

We add a few more critical possible confounders as additional control variables and rerun our analysis. First, we add two county characteristics as additional variables: the strength of law enforcement and the distance from the prefecture center. Zhan (2017) emphasize that the local law enforcement capacity is critically associated with the procuratorate's decision to investigate reported corruption cases. Following Zhan (2017), we use the average proportion of public security expenditure in total fiscal expenditure at a county government as a measure of law enforcement strength. The distance from the county to the upper-level government (prefecture government) may explain how the county government and its officials behave (Li et al., 2019). To address this feature, we control for the distance from the county's administrative center to the prefecture's administrative center.

In addition, we control for two key features of prefecture leaders, who are the supervisors of the county government and authorized to enforce corruption investigations at the county level. Prefecture leaders' competence and tolerance of corruption are possible confounders. As local leaders' age can be an indicator of their competence (Li & Yu, 2023), we use prefecture party secretaries' and mayors' average age between 2000 and 2005 as a proxy of their competence. Furthermore, if city leaders' hometowns overlap with the prefectures they are working in, they may tolerate more local corruption (Chu, Fisman, Tan, & Wang, 2021) or they may be more effective in identifying corrupt officials due to their dense local networks. We use whether local leaders were born in the same prefecture they are working in to measure their social ties and potential tolerance of corruption.[17] Local leaders' data is from the Chinese Political Elite Database (CPED) constructed by Jiang (2018).

Table A.10 in the Appendix shows the results. While our main findings remain significant, we find that law enforcement and the prefecture party secretary's competence are significantly correlated to local

[17] As local leaders have changed in the period, we use the average value between 2000 and 2005.

Table 5
The Share of SOEs in Coal Industry and Corruption Indicators.

	(1)	(2)	(3)	(4)
	Corruption Investigation			Misuse of
	All	Grassroots Officials	Senior Officials	Government Funds
	SOE Dominant Counties			
Coal sales	0.002	0.000	0.002	0.013
	(0.010)	(0.009)	(0.002)	(0.011)
Controls	Y	Y	Y	Y
Prefecture FE	Y	Y	Y	Y
N	341	341	341	336
R^2	0.680	0.684	0.557	0.817
	SOE Weak Counties			
Coal sales	0.006*	0.006*	0.001	0.008*
	(0.004)	(0.003)	(0.001)	(0.004)
Controls	Y	Y	Y	Y
Prefecture FE	Y	Y	Y	Y
N	2387	2387	2387	2297
R^2	0.518	0.529	0.436	0.620

Notes: Robust standard errors are clustered at the county level. Corruption investigation refers to the average number of officials investigated between 2012 and 2016. Grassroots officials refer to those ranked *fuke* (vice section chief) and *zhengke* (section chief). Senior officials refer to those ranked *fuchu* (division chief) and above. Oil sales, gas sales, and coal sales are average county-level sales values between 2000 and 2005. Control variables include GDP per capita, fiscal revenue per capita, population density, urbanization rate, and fiscal transfer. All controls are average values between 2000 and 2005. * p < 0.1; ** p< 0.05; *** p < 0.01.

corruption investigations. In contrast, the party secretary's hometown connection to the prefecture enables them to identify more corrupt officials.

4.3. Case study: Shanxi province

As a vivid example, we discuss the case of Shanxi, the largest coal-producing province and the most heavily investigated region during the anti-corruption campaign, to elaborate on the link between coal production and corruption in local governments. Shanxi supplied around 24% of China's total coal production in 2005 (National Coal Mine Safety Administration, 2006). Coal-mining industries account for two-thirds of Shanxi's economy and are the main source of fiscal revenue for 80% of counties in Shanxi.[18]

During the anti-corruption campaign, grassroots officials in Shanxi were most widely investigated and punished. Between 2013 and 2015, Shanxi punished 49,601 party and government officials for violating party disciplines or laws.[19] The number of punished officials accounts for about 8.32% of all public officials in Shanxi.[20] Wang Rulin, the party secretary of Shanxi from 2014 to 2016, acknowledged the severity of corruption in Shanxi in a press conference for the National People's Congress in 2015. He also stated that prevalent corruption in Shanxi was attributed to the practice that the local government is frequently involved in the production process of coal. Such an environment provided local government officials with opportunities to collude with businessmen and to engage in and benefit from numerous transactions in the coal industries.[21]

This corruption-prone environment in Shanxi was, to a large extent, created by the government. In the 2000s, the Chinese government launched nationwide reform to merge small- or medium-sized coal mines, many of which were township-and-village-owned enterprises (TVEs), into large state-owned enterprises (SOEs) in order to reduce coal mine accidents and upgrade the industry for the global market competition. As Shanxi took the largest share in terms of the number of accidents and death toll, Shanxi was the first place to execute the reform. During the reform, the local government came to have great discretionary power in identifying and authorizing qualified mergers and deciding whether and which small local mines to be merged (Xue & Zhao, 2020). This indicates that local coal mine owners and shareholders had even stronger incentives to bribe grassroots officials to avoid any loss of their assets and profits. As Zhan (2022, p.121) puts it, "the Chinese state's monopoly on the ownership of resource and allocation of mining rights creates an avenue for corruption."

Table 6 lists all county leaders in Shanxi investigated between 2012 and 2015 according to our data. During the anti-corruption campaign, 20 county party secretaries or county heads were investigated. Nearly all of them were accused of accepting bribes. They came from 19 out of 119 county-level districts in Shanxi. All these counties heavily rely on coal-mining industries. These local leaders had decision-making power or could have a substantial influence over administrative and regulatory decisions related to coal production and processing. In one corruption case in Lüliang city, a businessman in coal mining spent $150,000 a year on bribes for grassroots officials, and local cadres then used the bribes to purchase higher-ranking positions in the government.[22] Relying on the cases in Shanxi, more specifically the case of Lü liang reported on media, we illustrate the interdependent connections between local leaders and businessmen in the coal industry in Figure A.3 in the appendix.

To confirm that similar dynamics exist in other coal-producing regions, we additionally examine the case of Inner Mongolia, which is the second-largest coal-producing province in China. Table A.12 in the appendix lists all county leaders investigated in recent years in Inner

[18] www.npc.gov.cn/zgrdw/npc/xinwen/2015-03/07/content_1914082.htm (Last accessed on June 22, 2023)

[19] The source of data for 2013 and 2014 is www.gov.cn/xinwen/2015-02/10/content_2817423.htm (Last accessed on June 22, 2023). The source of data for 2015 is www.gov.cn/xinwen/2016-01/25/content_5036083.htm (Last accessed on June 22, 2023).

[20] The calculation is based on a broad definition of public officials. According to the *China Statistical Yearbook* published in 2013, 596,000 people worked in the public management and social organization sector in Shanxi.

[21] news.sohu.com/20150307/n409441691.shtml (Last accessed on June 22, 2023)

[22] https://www.economist.com/china/2015/11/28/king-coals-misrule (Last accessed on June 22, 2023)

Table 6
County Leaders Investigated Between 2012 and 2015 in Shanxi Province.

Prefecture	County/District	Name	Position	Year of Investigation
Taiyuan	Yangqu	Lü Rong	Party secretary	2015
Datong	Yanggao	Xie Xianwen	Party secretary	2014
Datong	Zuoyun	Xu Shanghong	Party secretary	2014
Datong	Guyangling	Li Liping	County head	2014
Datong	Hunyuan	Zhao Yaxiong	County head	2015
Yangquan	Pingding	Wang Yinwang	Party secretary	2014
Yangquan	Jiaoqu	Wang Yongzhen	Party secretary	2013
Yangquan	Chengqu	Kang Xiaojian	Party secretary	2014
Yangquan	Kuangqu	Liu Deyue	Party secretary	2014
Changzhi	Xiangyuan	Tian Zhiming	Party secretary	2015
Jincheng	Zezhou	Qin Jianxiao	Party secretary	2014
Jincheng	Zezhou	Chang Guangzhi	County head	2014
Jincheng	Gaoping	Yang Xiaobo	Mayor	2014
Yuncheng	Xiaxian	Ge Zuoming	Party secretary	2015
Xinzhou	Jingle	Yang Cunhu	Party secretary	2012
Xinzhou	Daixian	Guo Furong	Party secretary	2014
Lüliang	Liulin	Wang Ning	Party secretary	2014
Lüliang	Lishi	Yan Gangping	Party secretary	2014
Lüliang	Shilou	Chen Xiaochun	County head	2014
Lüliang	Xiaoyi	Wang Jianguo	Mayor	2014

Mongolia. For instance, several leaders under corruption investigation worked in Erdos, the largest coal production city in Inner Mongolia. Our corruption investigation data between 2012 and 2016 may underestimate coal-related corruption in the region. Starting in 2020, Inner Mongolia initiated massive corruption investigations on coal-related corruption in the past two decades, and 1,163 government officials have been investigated since then.[23]

5. Conclusion

The empirical analyses in this study show how coal production promotes corruption and diminishes the quality of local governance in China. The statistical analyses rely on original resource rent data at the county level for three major fuel resources—crude oil, natural gas, and coal—along with various measures of corruption in local governments, including the number of corruption investigations, the volume of misused public funds, and the perceived level of corruption. The findings consistently point to the coal mining industry as the most prominent facilitator of corruption in county governments. Oil and natural gas extraction are not significantly correlated with county government officials' corruption.

It is possible that oil and natural gas rents correlate with corruption in higher levels of government, such as prefectures, provinces, or central governments. We leave this possibility to future research to explore. However, the clear tendency toward corruption in coal-producing counties in China has caught the attention of the public and the top leadership. The consistent association also points to possible structural obstacles to the eradication of corruption related to the coal industry in China as long as local government officials can exploit for personal gain their ability to approve, tax, regulate, license, merge, or even close production sites. As the local corruption in coal-producing areas is due to the system made by the government's industrial set-up and reform, policy responses to address the issue seem required. Given the potentially deadly human cost implied by corruption in the coal industry (Xu et al., 2021) and harmful economic effects for further development (Cruz, Jha, Kırşanlı, & Sedai, 2023), corruption in coal-producing localities deserve continuous anti-corruption efforts like those implemented in Shanxi in 2014. Eradication of grassroots-level corruption may need a multi-faceted approach encompassing the participation of both the upper-level or central government and citizens. The upper government should ensure that external third-party auditors evaluate coal-related transactions in compliance with regulations. At the same time, encouraging monitoring by civil groups and community members and protecting whistleblowers can complement the limited monitoring capacity of upper-level government for grassroots-level corruption.

Finally, this research focuses specifically on the implications of traditional energy resources for corruption. Recently, China has seen a surge in the adoption of renewable energy sources, such as wind and solar power, which now constitute an increasingly significant share of the nation's total energy consumption. Given how the role of local governments has been instrumental in the expansion of the renewable energy industry in China (Lo, 2014; Shen, 2017), it is plausible that the renewable energy industry and the construction of the infrastructure may also serve as a source of local corruption. Future scholarly work may benefit from exploring the relationship between renewable energy utilization and local corruption dynamics.

This study is not without limitations. In particular, we acknowledge that our results mainly highlight the correlation between natural resources and corruption. More work needs to be done to establish the causal link between natural resources and corruption in China. As scholars point out, corruption may grease the wheel of growth in weak institutional environments (Ang, 2020; Méon & Weill, 2010), and it is possible that corruption may increase the production of natural resources. In addition, omitted variables such as unobserved cultural factors may affect the results. We leave these questions to future research.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

We have shared the data and code as part of supplementary material.

[23] https://www.ccdi.gov.cn/yaowenn/202209/t20220922_219434.html?eqid=fc9b1170000116dc000000036461e72d (last accessed on June 22, 2023)

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Appendix A. Suplementary material

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.worlddev.2023.106471.

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