The Extractive Industries and Society 2 (2015) 683–693

Contents lists available at ScienceDirect

The Extractive Industries and Society

journal homepage: www.elsevier.com/locate/exis

Original article

Coal mining in Odisha: An analysis of impacts on agricultural production and human health

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ARTICLE INFO

Article history:
Received 3 January 2015
Received in revised form 23 August 2015
Available online 7 September 2015

Keywords:
Coal mining
Agriculture
Health
Odisha
India

ABSTRACT

This study assesses the cost of coal mining on agriculture and human health in one of the prominent mining regions in the Indian state of Odisha. The study is based on household-level data collected from four mining (polluted) villages and two control (non-polluted) villages in the Ib Valley region of western Odisha. An “effects-on-production” approach has been used to analyze the effects of pollution on agriculture, whereas a “human-capital” approach and a probit model have been applied to derive estimates about the effects of mining on human health. The results reveal that the quantity of fertilizers used influences the average paddy yield positively, whereas the location of villages influences negatively the same yield, implying that average yield per acre in the mining villages is significantly lower than that of the control villages. Respiratory illness is the most prevalent and costly health problem among individuals residing in the area. Females are more likely to suffer from respiratory illness than males. Further, families housing greater numbers of literate persons have fewer incidence of respiratory disease. Inhabitants of the mining villages show higher exposure to respiratory diseases, than do inhabitants of the control villages.

1. Introduction

Mineral resources play a critical role in fostering economic development, especially in developing countries such as India. These resources provide raw materials for rapid industrialization and generate a sizable amount of employment opportunities for local people (Mishra, 2009). The extraction of mineral resources also brings other benefits to nearby communities, including schools, hospitals, construction, and improved transportation and communication facilities. In India, the state government receives revenues from the extraction of minerals, thus enabling investment in various welfare schemes for the enhancement of the overall socioeconomic status of the citizenry. However, even though mining activities provide an impetus for economic growth and development, they are also responsible for a host of adverse impacts, foremost degradation of the environment and natural resources (Mishra, 2009; Li et al., 2011). Because mineral resources are non-renewable, their extraction has important implications for intergenerational equity. Negative externalities from extraction, such as environmental and natural resource degradation and depletion, are significant, which can offset the benefits from the mining (Hilson, 2002). These adverse effects on agricultural activities (Mishra and Pujari, 2008; Li et al., 2011; Aragon and Rud, 2013), human health (Hendryx and Ahern, 2008; Mishra, 2010; Saha et al., 2011; Schatlez and Stewart, 2012), and ecosystems (Sinha et al., 2007; Li et al., 2011) are mostly borne by local people.

Open-pit operations, especially coal mines, emit a substantial amount of dust and other particles into the atmosphere that affect other economic activities in the region, as well as human health. They increase the concentration of local pollutants in the atmosphere, such as suspended particulate matter (SPM), respirable suspended particulate matter (RSPM), ozone, sulfur oxides, and nitrogen oxides, which have serious implications on the health of the people living around the mining regions. The economic effects of extractive industries have often been discussed in the context of “Dutch Disease,” the crowding-out effects that natural resource abundance has on other industries, specifically increased wages, the rise in the exchange rate, and/or decreased investment flows (Sach and Warner, 2001; Atkinson and Hamilton, 2003). However, less prominent in academic and policy debates are the other adverse effects of mining, such as economic losses caused by environmental degradation at the local level. In particular, the crowding-out effects of extractive industries on agricultural production and human health through environmental

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http://dx.doi.org/10.1016/j.exis.2015.08.007
2214-790X/

degradation have yet to receive much coverage in the economic literature. Given that developing countries often have in place subpar environmental regulations and/or enforcement, pollution from mining can cause heavy economic losses to the proximate population (Saha et al., 2011). The present study attempts to address this gap by assessing the effects of pollution from mining activities on rural communities, in general, and on agricultural production and human health, in particular, in the Indian state of Odisha.

Although Odisha is one of the richest Indian states in terms of mineral deposits and the mining sector contributing significantly to the state GDP, about 60% of its population continues to depend on agriculture and ancillary sectors. Recently, the Government of Odisha undertook various steps to promote industrialization, especially mining-based industries, which have facilitated phenomenal economic growth through increased foreign investments. The average contribution of mining and quarrying to Odisha's GDP was about 7.2% from 2004–05 to 2013–14 (Government of Odisha, 2014). Growth in employment, however, has not as been consistent, although during the last decade, the state has had an increase in employment in the mining sector (Government of Odisha, 2014).

Odisha has the second largest coal deposits in India. The state, therefore, has focused largely on activities emphasizing the extraction of this coal and its use in electricity generation by through the construction of thermal power plants. The state is the main supplier of coal to the various thermal power stations situated in the southern part of India. However, most of the coal deposits are located in deep-forested areas that house a variety of tropical biodiversity and indigenous tribal populations (CSE, 2008; Mishra and Reddy, 2009). In fact, overall, the extraction of minerals, associated activities, and rapid industrialization have caused serious environmental problems, including air and water pollution, degradation of cultivable land, deforestation and loss of biodiversity. Large tracts of forests are razed, waterways are polluted and clogged, farmlands have been transformed into waste tracts, and dust hangs heavily in the air (CSE, 2008). The objective of the present study is to assess the cost of this mining-induced pollution on agricultural production and human health. This is accomplished using household data collected from an intensive study of four mining villages and two control (non-mining) villages located in the Ib Valley coalfield of Odisha.

The paper is divided into five sections. Section 2 presents a detailed literature review concerning the effects of pollution on agricultural production and human health. The conceptual framework for the study is then presented. A description of the study area, sampling method, data collection and specification of econometric models are discussed in Section 4. Section 5 presents the results and discussion. Section 6 concludes with a discussion of related policy implications.

2. Literature review

2.1. Mining and agriculture

Environmental quality can be a non-market production input: damage to the environment reduces the supply of input and thus production falls. Conversely, improvement in environmental quality can benefit ecologically-sensitive crops. This aspect is important for the developing regions of the world, such as South Asia, where agriculture accounts for a larger share of GDP than it does in higher-income regions. Most countries in South Asia are experiencing declines in the amount of forestland, as well as desertification and rising pollution levels. The ambient air and water pollution in South Asia on average is much higher than in most other areas of the world. A study by the World Bank (2013) has estimated that in India, every year, environmental degradation, largely caused by the burning of fossil fuels, as well as a lack of access to clean water supply, sanitation, and hygiene, are costing around 5.7% of India's GDP. In a similar study by the World Bank (2007), it was estimated that the total cost of air and water pollution in China is about 5.8% of that nation's GDP.

Air pollution affects agriculture in numerous ways. It has the potential to reduce both the yield and the nutritional quality of crop plants. It adversely affects plants by either reducing yields or degrading the quality of agricultural product (Spash, 1997). Therefore, agricultural production would fall even if there were no change in the quantity of other inputs used. The resulting economic losses from air pollution have become an issue of political and scientific concern in many areas worldwide. The air pollutants that are most damaging to agriculture are gaseous sulfur and nitrogen compounds, photochemical oxidants, ozone, and SPM. Ambient air pollution has been shown to reduce the growth and economic yield of a wide range of major crop species in North America and Europe (Holland et al., 2006). Such effects are currently attributed largely to the secondary photo-oxidant ozone (O_3), which is widespread in many rural areas. The formation of ozone is influenced by major emissions of its precursors, nitrogen oxides (NO) and hydrocarbons, for which, the motor vehicle is the greatest source. However, in some areas, nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and other air pollutants are also important in terms of crop yield (Skinner et al., 1997). The synergistic effects of ozone and SO_2 make air pollution even more threatening to agriculture (Chen et al., 1996 cited in Wei et al., 2014).

There have been a number of empirical studies on agriculture-related environmental problems such as soil degradation and wind and water erosion (Lin et al., 2013; Merten and Minella, 2013; El Azab et al., 2015), but only a few studies have been focused on environmental problems in the agricultural sector caused by mining pollution. Through the estimation of an agricultural production function using household-level data, Aragon and Rud (2013) found that nitrogen dioxide pollution from gold mining in Ghana has reduced agricultural productivity by 40%, between 1998 and 2005 and further, that the negative effects decline with distance and extend to areas within 20 km from mine sites. In mining regions, the presence of high levels of suspended particulate matter is a major problem for agriculture. It is observed that when coal dust falls onto the plants it affects their nutrients, photosynthesis and production (Li et al., 2011). Using the Fisher and Tornqvist indices of Total Factor Productivity, Mishra and Pujari (2008) have shown that villages located near coal mines have suffered from a loss of productivity in rice cultivation because of the high presence of coal dust. Sulfur in coal dust affects the respiration of crops. If it reacts with dew and rainwater, it produces an acidic compound that burns crop lamina and reduces crop outputs (Li et al., 2011). Wei et al. (2014) attempted to estimate the effect of sulfur dioxide (SO_2) pollution on agricultural development, carrying out their study in 899 heavily polluted Chinese counties. The cost of agricultural losses resulting from SO_2 emissions was estimated at 0.66% of the total agricultural value added in those regions. In addition to a loss in productivity, pollution makes the products unsalable or salable at a lower rate (Behera and Reddy, 2002; Reddy and Behera, 2006).

2.2. Mining and human health

Health can be defined as a state of complete physical, mental, and social well-being of an individual, and not merely the absence of diseases (WHO, 2009). Environmental pollution affects human well-being in various ways. Although a clean environment is