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Rural electrification and groundwater pumps in India: Evidence from the 1982–1999 period☆

Michael Graham Smith, Johannes Urpelainen*

Columbia University, United States

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ABSTRACT

India's groundwater extraction is heavily dependent on diesel pumps, and one reason is the lack of reliable power supply. The widespread use of diesel pumps is an economic problem due to the inefficiency and high cost of said pumps. Could rural electrification improve the situation? We estimate the relationship between village electrification and the counts of electric and diesel pumps in India, 1982–1999. We find that, in addition to increasing the number of electric pumps, rural electrification also greatly increases the number of diesel pumps. While initially surprising, these results make sense in an environment characterized by frequent power outages and constant quality problems. If rural electrification increases the number of electric pumps and promotes irrigated agriculture, the demand for diesel pumps also grows because many farmers need a reliable pump that does not depend on electricity. Without improvements in the supply of electricity through rational power sector reforms, India cannot stop the spread of diesel pumps through rural electrification. For energy and development economists, the results are novel because previous econometric work has largely focused on industrial uses of power.

1. Introduction

The governance of India's groundwater economy can be described as "anarchic" (Shah, 2009). In the agricultural centers of India, such as Punjab, decades of overexploitation have brought groundwater tables to alarmingly low levels (Shah, 2009). In other areas of India, such as Bihar and Uttar Pradesh, abundant water resources remain underused, at a high cost to the agricultural sector (Kishore, 2004). Policies governing the management of the water resource and the power sector, which supplies energy to electric pumpsets, have failed to promote effective and sustainable groundwater exploitation for enhanced agricultural productivity and poverty alleviation.

One major issue facing India is the prevalence of diesel pumps for water extraction. Both diesel and electric pumps serve the same purpose, and the only difference between them is the mode of energy generation. As we document below, diesel pumps are, with the sole exception of their reliability and lack of dependence on the electric grid, a more expensive and less efficient technology. Their use in the Indian agricultural sector results from a lack of infrastructure in the power sector. Farmers choose between diesel and electric pumps only based on the reliability and the capital and variable costs of

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* Corresponding author at: 420 West 118th Street, 712 International Affairs Building, New York, NY 10027, USA. Tel.: +1 734 757 0161; fax: +1 212 854 5670.
E-mail address: ju2178@columbia.edu (J. Urpelainen).

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irrigation. According to the fourth Minor Irrigation Census of India of 2006–2007, there were more than six million diesel pumps in India.[1] Given that diesel generators are much less efficient than electric power plants, these systems amount to a major inefficiency in the Indian agricultural sector. To illustrate, Shah (2007: 4003) shows that in the village of Akataha, Eastern Uttar Pradesh, the market rate for irrigating one acre of sucarcane was 3780 rupees for households who could only rent a diesel pump, while those who were close enough to an electric pump to rent it for their use only paid 1080 rupees. Between 2002 and 2007, diesel prices in India have increased by 70 percent despite government subsidies (Shah, 2007: 4002).

India's diesel subsidy and the difficulty of regulating the use of diesel generators due to their decentralized nature further underscore the problems that diesel pumps cause. When international oil prices are high and a farmer in Akataha or elsewhere uses a diesel pump, the state and national oil companies incur a cost. When farmers use diesel pumps, the government's ability to control the extraction of groundwater is limited and the diesel consumed creates a fiscal deficit. According to Anand (2012: 9–10), the monetary loss to Indian oil companies from underpriced diesel in India amounted to INR 871 billion (∼USD 16 billion, March 2012 exchange rates), and diesel pumpsets are part of this problem.

One simple solution to the problem of diesel pumps is improved rural electrification. If farmers had access to reliable electricity for groundwater pumping, any given amount of water could be extracted at a much lower cost. Moreover, it would be easier for the government to regulate the use of water and avoid a "tragedy of the commons" in regard to groundwater use. As Shah et al. (2008: 1241) show, for example, the state of Gujarat, where electricity supply is generally reliable, "effective rationing of power supply can indeed act as a powerful tool for groundwater demand management." By controlling the supply of power, the government of Gujarat has managed to conserve strained water resources and move the state's rural areas on a more sustainable trajectory of agricultural development.

This article presents the first systematic econometric analysis of the relationship between rural electrification and diesel pump ownership in India. We exploit the 1982 and 1999 rounds of the Rural Economic and Demographic Survey of India, wherein households in a broadly representative sample of villages from 17 major Indian states are surveyed.[2] For every village in the sample, we have data on rural electrification and the number of electric and diesel pumps in use. We first demonstrate that rural electrification is not associated with key covariates that could predict the growth in the number of pumps. Then, we examine the panel data to see how rural electrification shapes the number of different types of pumps. Based on the existing literature and the argument concerning rural electrification, we would expect the number of electric pumps to increase and the number of diesel pumps to decrease with rural electrification. While we do not have an experimental or quasi-experimental research design, changes over a long period of time are new and shed light on the dynamics of rural electrification and groundwater pumping in India.

The results offer a different picture, however, as rural electrification increases the number of both kinds of pumps. Depending on the model specification, the expected number of electric pumps increases between 37 and 111 percent. The estimated association between rural electrification and diesel pumps is even larger, ranging from 59 to 149 percent. Most interestingly, rural electrification does not result in the replacement of diesel with electric pumps; rather, the number of each increases. Instead, the frequency of both kinds of irrigation devices grows rapidly. The results seem to be driven by differences across, rather than within, states. In the 1982–1999 period, some states made more progress in rural electrification than others, and these states also saw large increases in the number of electric and diesel pumps.

Although initially surprising, the positive association between rural grid extension and diesel pumps has a natural interpretation in contemporary India. Major progress in rural electrification during the 1982–1999 period was concentrated in states with bankrupt and ineffective electric utilities, which lagged behind states that with better governance in the power sector. Therefore, rural electrification provides farmers with access to electricity that is often virtually free but notoriously unreliable (Mukherji, 2006, 2007; Joseph, 2010; Chatterjee, 2012; Szakonyi and Urpelainen, 2013). In such a context, it is understandable that as electricity becomes available, farmers invest in electric pumps. This increases the use of irrigation in agriculture, and many farmers also purchase diesel pumps as a reliable source of power in the case of an outage or problems with the voltage of electricity. Rural electrification allows an expansion of irrigation, and the scale effect also creates demand for diesel pumps unless the supply of electricity is completely reliable.

We also note that access to credit for agricultural equipment, which is one of our control variables, turns out to be an excellent predictor of both electric and diesel pumpsets. Villages that gain access to credit between 1982 and 1999 increase their counts of electric and diesel pumps between 92–94 and 50–53 percent, respectively. To our understanding, the credit dimension of pumpset installation has been largely ignored in the literature on groundwater irrigation in India.

For energy economists, our main results are of interest. Although groundwater irrigation is both central to the agricultural economies of many developing countries and highly dependent on access to energy, the role of rural electrification in shaping the incentives of farmers has not been investigated in previous research. Qualitative studies notwithstanding (Mukherji, 2007; Shah, 2009), the vast majority of research has focused on diesel generators for industrial uses (Reinikka and Svensson, 2002; Rud, 2012b,a; Steinbuks, 2012; Szakonyi and Urpelainen, 2013). We offer the first systematic econometric study of rural electrification and pumpset installation by farmers in a large sample of rural communities in India, opening new

[1] See Table IX at http://micensus.gov.in/reports/national/int/int_nat09.pdf (accessed 08.09.15).

[2] The study period is chosen based on data availability. Unfortunately, there are very few publicly available panel datasets for rural India.