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Are small firms willing to pay for improved power supply? Evidence from a contingent valuation study in India

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ABSTRACT

This paper provides new estimates on Indian small-scale manufacturing firms' willingness-to-pay (WTP) for reliable power supply. Almost half of Indian manufacturing lies in the small-scale sector, and its productivity is severely affected by power outages. However, there is a surprising paucity of research on small firms' WTP for avoiding outages. We conduct a double-bounded dichotomous choice contingent valuation experiment with a random sample of 260 small-scale firms in the region around Hyderabad. We find that on average, firms are willing to pay approximately 20% more for uninterrupted power supply. The WTP estimates and the explanatory factors for the firms' decisions were tested for robustness using both probit and bivariate probit models. In addition, a two-step Heckman correction was used to control for selection bias induced by protest responses. Our results are vital to understand behavior of small firms, which are crucial to India's economic growth. Further, the government's continued emphasis on power sector reforms makes the paper even more important as it provides realistic estimates for designing tariffs while keeping in mind the preferences of the small-scale industry.

1. Introduction

Despite high electricity rates for the industrial sector, unscheduled and scheduled power outages frequently occur in India. The lack of power supply for manufacturers causes a significant decline in output (Hansen, 2008; Hanisch et al., 2010; Allcott et al., 2016; Fisher-Vanden et al., 2015). Indeed, economic costs of power outages in the context of a developing country are substantial, with variable impact depending on industry type and country. For instance, in Sri Lanka, the costs of outages in the industrial sector can mount to 0.9% of the GDP (Wijayatunga and Jayalath, 2004). In Pakistan, overall outages reduced the GDP by 1.8% (Pasha et al., 1989). In India, Bose et al. (2006) studied the state of Karnataka and pegged the loss value in high tension (HT) industries to range from 0.09% to 0.17% of state GDP. Indian industrial productivity is particularly undermined as a result. A recent estimate suggests that the reported level of electricity shortages in India lead to a reduction in plant revenues and producer surplus by 5–10% (Allcott et al., 2016).

India's small-scale industrial sector, also known as the micro, small, and medium scale enterprises (MSMEs), bears a heavy burden of these power outages given their liquidity constraints in setting up a captive power plant (Ghosh and Kathuria, 2014). As the backbone of Indian economic growth, MSMEs employ 40% of the Indian workforce, contributing to 45% of Indian manufacturing output and 40% of India's exports (Goyal, 2013). Yet, they contribute to a mere 17% of the GDP due to poor productivity (ibid). Part of the productivity losses can be attributed to interruptions in electricity supply.[1] Most of the MSMEs operate in sectors in which production is highly sensitive to electricity supply, such as food and beverages, fabricated metal products, apparel and textiles, or pharmaceuticals. Since MSMEs suffer a disproportionately higher cost of power interruptions compared to larger firms, their productivity is highly elastic to power supply. An estimation of these costs, specifically to MSMEs, therefore merits serious research.

Recent studies that engage with the issue (Allcott et al., 2016; Ghosh and Kathuria, 2014; Kim and Cho, 2017) do not single out effects of power outages on MSMEs. This dilutes the severity of its impact. Furthermore, there is little research that attempts to estimate cost of power outages by observing willingness-to-pay (WTP). In this paper, we

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[1] Gujarat is an interesting example. Between 2007 and 2013, the number of SME clusters in this western state of India increased from 115 to 369 (highest in India) (Goyal, 2013). This has been, inter alia, a response to increasing access and supply of electricity in the state during this period. Today, Gujarat has one of the highest installed capacities of electricity and also the highest number of SMEs in any Indian state.

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centralize the object of our analysis as the MSME, singling out the impact on small firms in India. In doing so, we produce most recent and robust results for estimating the cost of outages.

In the literature, different methods have been proposed to estimate the cost of power outages (Baarsma and Hop, 2009). Most studies have based their estimates on observed losses in output, the cost of coping strategies, or stated preferences methods. The stated preferences method is particularly useful since it includes the full range of costs. As revealed costs for outages are not easy to discover, several studies have previously used this approach at the household level (Carlsson and Martinsson, 2007, 2008; Carlsson et al., 2011; Blass et al., 2010). While a number of studies have investigated the costs of outages in the industrialized economies (Morrison and Nalder, 2009; Baarsma and Hop, 2009; Goett et al., 2000), evidence on developing economies is sparse. Previous studies on India have focused on coping strategies and output analysis (Gulyani, 1999; Sari, 2003; Allcott et al., 2016). These studies typically use data that do not include the full range of costs (Allcott et al., 2016; Fisher-Vanden et al., 2015). We address these shortcomings and use a stated preferences approach, namely the *contingent valuation method*, to estimate the full range of outage costs.

Contributing to a rather thin literature in this area, we make three new interventions in this study: first, by investigating heterogeneity in WTP for reduced power outages, we are able to distinguish WTP values for different types of MSME firms. This allows policy-makers and regulators to assess which firms should be prioritized and to what extent tariffs should discriminate between firms. Second, instead of asking 'how much' of a tariff would a firm be willing to pay for uninterrupted power supply, we ask 'how much extra' it would be willing to pay. This encourages the respondents to focus on the marginal costs (and benefits), making it a more reliable and accurate indicator of their preferences and costs. This difference leads to more realistic estimates as compared to the previous work (Bose et al., 2005). Third, we use probit, bivariate probit, and also Heckman models to ensure robust results, making the analysis richer and more rigorous.

Our findings show that firms are willing to pay 20% in addition to the prevailing tariff for a reduction of scheduled and unscheduled power outages to zero. The current estimates are significantly lower than those of Bose et al. (2006) who pegged this value at 37%. The higher conservativeness and, arguably, greater reliability of our results owes itself to the design of the present questionnaire. This will be further discussed in Section 3.

2. Survey design and data

The experiments were conducted with MSMEs in and around Hyderabad, the joint capital of the Indian states of Andhra Pradesh and Telangana. The region has over 18,000 industrial units employing more than 220,000 people, which makes it a prominent location for small and medium scale manufacturers in south India. It houses several key industrial clusters.[2] Most notably, metallurgy, paper and printing, plastic and rubber, engineering machinery, food processing, wood, chemical, and repair and services dominate. With a consistent growth in the number of MSMEs in the previous decade, the region offers a valuable setting to examine the small-scale firms' WTP for a reliable power supply. Our sample consisted of 260 small-scale firms and was geographically stratified. In the first step, we pre-selected four different industrial areas in the Greater Hyderabad Municipal Area. The selection was based on expert interviews. In the second step, using detailed maps of the selected areas, we did a random walk to approach industrial units. In order to administer the survey, we trained enumerators for two days together with a local consultant who possessed vast experience with industrial surveys. The enumerators were graduates in social sciences. After the training, enumerators were sent to industrial estates where they approached firms based on the pre-determined random walk. We asked enumerators to approach suitable management staff members that (a) have a clearly defined management role in the firm and are able to make firm relevant decisions and (b) have the necessary key information on electricity usage of the firm. Wherever such suitable management staff was unavailable, was not willing to respond, or was not involved in electricity-related decisions, the enumerators were instructed not to conduct the survey at the firm. Such firms were marked on a separate list of 'no response' data. For the purposes of monitoring and verification, we asked enumerators to collect the individual respondents' business cards. Sometimes, one of the authors would accompany the enumerators randomly.

The survey questions were developed by a team of Indian and German researchers from Humboldt-Universität zu Berlin and The Energy Resource Institute (TERI) in Delhi. The survey was conducted during September-December 2010. We ran two pretests on the survey and adjusted the questionnaire before the final round. The 14-page questionnaire contained four modules: (a) general questions on the company, e.g., the number of employees, annual turnover, and productions cycles; (b) energy topics, such as energy carriers, changes in energy use, the use of captive generation, and the frequency of power outages; (c) the contingent valuation study; and (d) attitudes and knowledge.

There is a long debate among economists on the best practice of contingent valuation method (CVM) studies (Welsh and Poe, 1998; Hanemann, 1994; Carson et al., 2003; Johnston et al., 2017). The contingent valuation part of our survey generally followed an up-to-date methodology. A text describing a specific scenario was read aloud to respondents. We chose this procedure to ensure creating homogeneous conditions across respondents and enumerators. Respondents were offered a hypothetical improvement in electricity services with a reduction of all scheduled and unscheduled power outages to zero. At the end of the text, a budget reminder was included. Then, respondents were asked if they were generally willing to pay for the described improvement (cf. question 1.1 in Appendix C). If they replied 'no,' they were asked why they were unwilling to pay in order to distinguish protest zeros from true zeros (Yu and Abler, 2010).[3] If respondents replied 'yes,' the enumerators continued with the double-bounded dichotomous choice questions as described above. (We provide the exact wording and questions in Appendix C.)

The bid vector must be carefully chosen in a dichotomous choice CVM study (Johnston et al., 2017). Different approaches exist for designing bid vectors. In a recent study, Chung and Chiou (2017) test the validity of the CVM method using a triple-bound dichotomous choice model with multiple follow-up questions. In general, plausibility and statistical efficiency guide the choice. Plausibility means that bids should be realistic, credible, and accepted by respondents (Arrow et al., 1993; Bateman et al., 2002; Johnston et al., 2017). If, for example, bid values are unrealistically high, the probability of protest increases. Efficiency refers to the statistical properties of the bid vector. Especially in small samples, standard errors should be as small as possible. Bids should center around the median WTP (Alberini, 1995a, b; Cooper, 1993). From a statistical perspective, an equal distribution of yes and no responses is desirable. Thus, we used data from a previous study (Hanisch et al., 2010)

[2] See, *Brief Industrial Profile of Hyderabad* and *Brief Industrial Profile of Medak* published by MSME Development Institute, Ministry of MSME, Government of India, available at http://dcmsme.gov.in/dips/hyd%20profile.pdf and http://dcmsme.gov.in/dips/medak.pdf respectively (last accessed on 21 January 2017).

[3] The literature discusses different ways to treat those observations (Meyerhoff and Liebe, 2006; Yu and Abler, 2010). Because the determinants of a general willingness-to-pay (e.g., missing trust) differ from those of the amount (e.g., size of the firm or dependency on reliable supply), it is not advisable to jointly estimate one coefficient per variable for both decisions. In addition, different protest motives may have different determinants or at least coefficients of different size. One way to deal with the problem is to estimate a multi-step hurdle model (Yu and Abler, 2010). However, a larger number of observations would be needed to accurately distinguish between the different protest motives and their determinants in our case. Therefore, we excluded "true zeros" from the analysis.