



An analysis of elasticity of electricity demand in West Bengal, India: Some policy lessons learnt

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ABSTRACT

This paper estimates price and income elasticities of electricity demand for four consumer categories, Agriculture, Commerce, Industry and Domestic, for two major utilities (one public and the other private) that supply electricity in West Bengal, India. We use panel data analysis covering 15 years for the four consumer categories. The comparison of the responsiveness in demand due to changes in tariff for the two utilities reveals some interesting differences in the demand pattern of the consumers served by the different utilities when the private sector supplies to the highly urbanized areas and the public sector supplies to the rest of the state. We get an idea about the difference in tariff structure of a public and a private utility as well. Our study suggests that any policy to entirely remove the cross subsidy is not a viable option as there is considerable differences in the elasticity of demand for power among the different category of consumers. Further, for the success of the policy of 'open access' which is an important and integral part of the power sector reform some regulatory mechanism is required to control market power in the power sector.

1. Introduction

The pattern of electricity usage has changed with time in India. For households the number of uses has increased with the increase in the number of electrical gadgets. The increase in accessibility has brought in more consumers into the electricity network. The improved reliability has reduced the requirement for electricity backup systems. The number of electrical appliances has increased along with the inclusion of power saving appliances. With a greater penetration of electricity as a source of energy in our society changes have occurred in the demand for electricity in India. Increased electricity intensity of the industries has also made them more dependent on electric power. With the passage of time the households as well as commerce and industry have become more dependent on electricity. The increased usage of ground water irrigation through electric pump sets has increased power requirement in the agricultural sector as well.

Other things remaining constant tariff rate should be the determinant of demand for electricity. Looking at the tariff structure in India as a whole and particularly in the state of West Bengal we will find that the tariff rates widely vary across the different segments of electricity consumers – domestic (residential), industrial, commercial and agricultural. The existence of cross subsidy is evident from the high tariff rate for the industries and quite low rates for households and

agriculture. The Electricity Act 2003 (Government of India, 2003) has envisaged phasing out of the cross subsidies. Removing the cross subsidies would mean charging according to the average cost of supply for each consumer category. This implies that removal of cross subsidies would increase the tariff rates for domestic and agricultural consumers whereas it will be reduced for industrial and commercial consumers. This change in tariff structure is expected to bring about drastic changes in the consumption of electricity by the different consumer categories. The elasticity of electricity demand will let us know to what extent the consumption of electricity would be responsive to the changes in tariff, for each consumer category. The increase/decrease in consumption will affect the consumer surplus. This will affect welfare. Thus the intended changes in the tariff structure make the study of elasticity of electricity demand for each consumer category an important and relevant issue. To know the welfare implications of tariff restructuring we need to know the changes in consumer surplus that can occur from restructuring and to assess the consumer surplus we need to know the nature of elasticity of demand.

It is quite obvious that the electricity demand pattern across consumer categories will vary from region to region depending on the population characteristics, types of industries and economic activities prevailing in that region. Thus the national level elasticity estimates are not likely to match the elasticity estimates of each state of the country.

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The comparison of the national level estimates with that of the state level estimate can reveal interesting features of electricity demand as well as generate a better understanding of the factors that influence the demand and the elasticity in a region. We note that some of the studies (e.g. Bose and Shukla, 1999) on elasticity of electricity demand in the Indian context were conducted years back. Demand pattern has changed since then. Moreover, the studies were all based on national level aggregate data and mainly pertain to the public sector utilities. In this paper we attempt to estimate the elasticity of electricity demand of a particular state of India, West Bengal where demand for electricity is served by both the public sector utility and the private sector utility.

The difference in the two sets of elasticities allows us to make important inferences about the spatial pattern of electricity consumption in the state where the public sector serves mostly the rural consumers and the private sector covers the most urbanized areas of the state's capital city. We estimate the price elasticity of demand for electricity for four major categories of electricity consumers – Agriculture, Commercial, Domestic and Industrial for the period 2000–01 to 2014–15 for the two major utilities in West Bengal. The public utility, the West Bengal State Electricity Board (WBSEB) was a vertically integrated entity till 2007. In 2008 the public utility was de-integrated to form the West Bengal State Electricity Transmission Company limited (WBSETCL) and the West Bengal State Electricity Distribution Company Limited (WBSEDCL) to take the charge of transmission and distribution of electricity respectively. The major private utility in West Bengal is the Calcutta Electric Supply Corporation Limited (CESC). This is a vertically integrated company that supplies power to the city of Kolkata and its suburbs which lies under the Kolkata Metropolitan Area (CEA, 2013). The power supply from CESC and WBSEDCL cover 98% of domestic and commercial power consumption in West Bengal (Planning Commission, 2010). Almost 60% of industrial power is supplied by these two entities and 100% of agricultural power need is catered to by the WBSEDCL. Our elasticity study covers these two major utilities in West Bengal. The comparison between the power supply scenarios of the two utilities is likely to unfold some interesting differences in the consumption and pricing pattern under private and public utilities.

A comparative study between the different states of the US, by the National Renewable Energy Laboratory reveals that the relationship between price and demand for electricity of the residential sector is somewhat similar between states in a region but this relationship shows noticeable variations between regions. The demand-price relationship in the commercial sector shows lower variations within states and regions compared to the residential sector (Bernstein and Griffin, 2006). This study finds the demand price elasticity to be -0.2 both for residential and the commercial sector. A World Bank study on the price elasticities of electricity demand for some developing countries like Costa Rica, Paraguay and Dominican Republic shows the residential and commercial price elasticity of demand to be around -0.5 (World Bank, 1992). A study on residential energy demand in China using the Almost Ideal Demand System Model shows the price elasticity of demand for electricity for households to be -0.3874 and income elasticity to be 0.6262 (Sun and Ouyang, 2016). A recent study (Schulte and Heindl, 2017) shows that the price elasticity of electricity demand depends on the level of total household expenditure. The study estimates both the price and expenditure elasticity of electricity demand in the residential sector in Germany. It indicates that households at higher expenditure strata react more to price changes, a change in energy price can alter the burden of energy expenditure borne by the households at different expenditure levels (Schulte and Heindl, 2017).

A microdata study for the power sector in Spain shows residential price elasticity of demand to be -0.25 and for large companies -0.0518 (Labandeira et al., 2010). Seasonal variation in elasticity for electricity demand has also been observed in a recent study in Taiwan (Hung and Huang, 2015). A study by (Okajima and Okajima, 2013) establishes the relation between weather differences and income differences on elasticity of electricity demand. The generalized method of

moments applied to the estimation of elasticity in the Spanish residential sector shows the short run elasticity to be -0.07 and long run elasticity -0.19 (Blazquez et al., 2013).

One of the ongoing concerns over rising electricity demand has induced an increased emphasis on demand side management programme (DSM) in many countries and that has induced a number of investigations on the efficacy of such policies in controlling electricity demand. These studies have based their analyses on the elasticity of electricity demand. A recent study uses structural time series model to estimate elasticity with the real electricity prices, the level of GDP, population and also human efficiency as the control variables (Atalla and Hunt, 2016). The study finds the income elasticity to vary within a range of 0.43 and 0.71 and the long run price elasticities of residential electricity demand vary from -0.16 to zero. Price elasticity of electricity demand varies across hours in a day and also with seasons. Genc (2016) finds that the elasticity estimates vary within a range of -0.013 and -0.133 . A log linear form of demand model (Cho et al., 2015) used in the determination of price elasticity of demand in South Korea reveals significant differences in price elasticities between manufacturing, retail, agricultural and residential sectors. The demand for electricity in the agricultural and residential sector appears to be almost perfectly inelastic. The manufacturing demand is also highly inelastic whereas demand for electricity in the retail sector is unitary elastic. The study also throws light on the regional differences in the elasticity for all the four categories of consumers.

Among the few studies on elasticity of electricity demand in India the study by Bose and Shukla (1999) is quite significant. It covers 19 Indian states for the period 1985–86 to 1993–94. The study presents the income elasticity, cross-price elasticity and own price elasticity for four major consumer categories. It finds the short-run price elasticity of electricity demand to be -1.35 for agriculture. For the residential sector the elasticity is -0.65 , -0.26 for the commercial sector and the industries exhibit a price elasticity of -0.32 .

Some studies on India focus on the seasonal demand for electricity (Filippini and Pachauri, 2002). Filippini and Pachauri (2002) use household micro data from the household expenditure surveys of the National Sample Survey Organisation (NSSO). They find the price elasticities to be -0.32 during winter, -0.39 during monsoon and -0.16 during summer. Our study follows a similar methodology as used by Bose and Shukla (1999). However, our period of study is 10 years later and is focused on the state of West Bengal, for the period 2000–01 to 2014–15.

We begin our study with a brief discussion on the changes in the energy demand conditions in West Bengal and the trend in average tariff for the four categories of consumers in Section 2. In Section 3 we present the econometric model for the estimation of consumer category-wise elasticity of demand. This is followed in Section 4 by a brief description of the data that we have used in our estimation and their sources. We present the results and its analysis in Section 5. Section 6 concludes our study and discusses the policy implications of the results that we have obtained.

2. Electricity demand in West Bengal

Electricity consumption in West Bengal has increased along a steady growth path especially for industrial and domestic consumers (Fig. 1). For agriculture there are fluctuations in consumption. This can be explained by the fact that agricultural consumption occurs mainly for irrigational purposes. So, annual agricultural demand for electricity depends, to a large extent, upon the volume of rainfall in a particular year. Since the volume of rainfall varies due to the erratic nature of monsoon in India as a whole and West Bengal in particular, demand for electricity by the agricultural sector is fluctuating in nature.

For the private utility consumers consumption has increased consistently especially for the commercial and domestic category. Consumption by the industrial segment has not increased much during

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