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Income and energy use in Bangladesh: A household level analysis

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ABSTRACT

We examine how energy use at the household level moves with income in Bangladesh. Using the 2010 wave of Bangladesh Household Income and Expenditure Survey data, our analyses indicate a U-shaped relationship of both electricity use and other types of energy use (combined) with household expenditure. The findings imply that as income grows households increase their energy expenditure less than proportionally, up to a threshold level of income. Beyond the threshold income, energy use increases as a proportion of income, particularly for electricity use. We identify the threshold (turning point) for both electricity and other types of energy use. Based on the current level of expenditure and its growth, reaching the turning point would require 17years for the former category but only 7years for the latter group.

1. Introduction

Bangladesh is making steady economic progress in the midst of acute energy shortage. Per capita annual energy consumption in the country is 371 kW h which is one of the lowest in the world (World Bank, 2016). Electricity is the major source of energy for most economic activities in Bangladesh. While around 78% of the population now has access to electricity, highly intermittent power supply makes their life quite miserable (Mujeri et al., 2014). A large portion of households, on the other hand, do not have access to electricity while other sources of energy are not adequate to meet the rising demand, resulting in a high rate of energy poverty in the country. A recent study finds that 58% of rural households in Bangladesh are energy poor compared to the income poverty of 45% (Barnes et al., 2011).

The energy resources and infrastructure in Bangladesh are not only inadequate but also poorly managed. In particular, electricity generation plants have been unable to meet demand over the past decade. Corruption, high system losses, low plant efficiency, erratic power supply, electricity theft, blackouts, and poor maintenance are major issues in the power sector in Bangladesh (World Bank, 2017). Unavailability of modern energy leads to a high share of energy consumption from traditional sources such as fuel wood, animal waste and crop residues. Fortunately, the country has small reserves of oil and coal and relatively large reserves of natural gas, to enhance the energy security of the country.

Bangladesh has joined in the group of lower–middle income countries in 2015 and currently has a per capita GDP of US$1384 (Finance Division, 2016). Energy consumption rises sharply between per capita income US$1000 and US$10,000, the range in which Bangladesh would belong to at least for a decade with the current growth scenario (Mujeri et al., 2014). The country has also set up an agenda to promote itself to a middle-income economy by 2021, which would require an annual GDP growth rate of 7.5–8.0% for the remaining period. Such growth is beyond historical rates (around 6.3% since 2010) and will need substantial improvement in the physical infrastructure of the country including the energy sector (World Bank, 2016). High economic growth is also expected to substantially increase the residential use of energy (Burke and Csereklyei, 2016). At the same time, Bangladesh is aiming to ensure access to electricity for 96 % of its citizens together with an uninterrupted power supply to the industries (Planning Commission, 2015).

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Anticipating this rapid increase in the future energy demand, the Government plans to increase its electricity generation capacity from 14,000 MW in 2015 to 23,000 MW by 2020. With this goal, the current energy policy of the country largely focuses on expanding energy generation capacity from all available sources, which combines both large projects based on traditional sources (fossil fuel, hydro and nuclear energy) as well as expanding off grid small projects based on renewable sources (wind, solar and biogas) (Planning Commission, 2015).

While focusing on energy supply is essential, a better understanding of its demand can provide critical insights for forecasting its future consumption. In particular, an effective knowledge of the changes in energy demand with respect to income, illustrated by the Energy Engel Curve (EEC), may provide useful insights into many aspects of consumer behavior. For example, the EEC may provide important policy implications which can be useful for a country to develop an effective energy and power management strategy. Most importantly, EECs may provide forecasts of future energy demand as a result of changing demographic scenario (e.g., average household size) in an economy. Such forecasts can be useful in predicting changes in demand to match with the energy generation capacity. EECs are also useful to analyze the share of burden borne by the low-income people resulting from a tax imposed on energy (Almås, 2012; Banks et al., 1997; Blundell et al., 1998; Deaton and Muellbauer, 1980; Hasan, 2016).

Most of the studies on Bangladesh that model the relationship between energy expenditure and income are based on aggregate data and do not cover the behavioral dynamics at the household level. For instance, Mozumder and Marathe (2007) examine the causal relationship between per capita electricity consumption and per capita GDP in Bangladesh over time. They find a unidirectional causality from per capita GDP to per capita electricity consumption. Interestingly, studies find a similar unidirectional causality for the consumption of natural gas and for the aggregate energy use in the country (e.g., Das et al., 2013; Paul and Uddin, 2011). In contrast, Ruhul et al. (2008) find no causal relation between GDP and energy use for Bangladesh. Among the few studies that rely on household survey data to investigate the dynamics of energy use with income, Barnes et al. (2011) estimate an energy poverty line (the critical minimum amount of energy needed to sustain life) for rural Bangladesh.

Among studies estimating the EEC (or some variants of it) for other developing countries, Navajas (2009) explores the contribution of income and other household characteristics to explain household consumption of natural gas and liquefied petroleum (but not electricity) in Argentina. The study estimates Engel curves for these two types of energy use and explores welfare implications of tariff reforms in natural gas. Related to this strand of literature, a number of studies investigate the price and income elasticities of electricity consumption. For instance, to evaluate energy policies in India, Gundimeda and Köhlin (2008) estimate the price and income elasticities for different types of fuel (electricity, kerosene, liquefied petroleum gas and fuelwood) for different income groups in urban and rural areas in the country. Golley and Meng (2012) find that richer households in China consume more energy compared to their poor counterparts, both directly and indirectly through consuming energy intensive goods and services. In a recent paper, Youn and Jin (2016) study the sensitivity of price increases on household electricity use in Seoul, Korea and find that progressive pricing has substantial curbing effects on household electricity use.

From developed country perspectives, Ironmonger et al. (1984) have estimated Engel curves for disaggregated energy use in Australia. Using longitudinal household expenditure survey data, they estimate Engel curves for electricity, natural gas, gasoline and other fuels for different demographic groups. They find that while aggregate energy is a necessity, gasoline is a luxury good in Australia. More recently, Meier et al. (2013) estimate Engel curves for electricity and gas expenditures using British household panel survey data and find that income elasticities for energy spending are U-shaped. They show that income elasticities for both gas and electricity expenses are less than one (implying energy services are a necessity) although they rise in the long-run.

Energy consumption, especially when it is clean, may have improved outcomes on health, education and welfare of household members (Barnes et al., 2011; Pachauri and Jiang, 2008). Thus raising household energy consumption is critical, especially in developing countries with rapidly growing income like Bangladesh. For instance, a large portion of households in Bangladesh do not have access to electricity while other sources of energy are not adequate to meet the rising demand, resulting in a high rate of energy poverty in the country (Barnes et al., 2011). As a result, the type of relationship between energy use and income may provide key insights for policy formulation. However, the issue has not been widely explored in empirical Engel curve literature.

Against this background, we make an attempt to analyze how the use of energy at the household level varies with income in Bangladesh. For our analysis we disaggregate energy use into two major categories, electricity and all other energy combined (other energy hereafter). Using the 2010 round of Bangladesh Household Income and Expenditure Survey (HIES) data, we estimate EECs for both categories. Our investigation employs a wide range of empirical techniques for estimation, including quantile, nonparametric and semiparametric regression methods. Our study finds that, as we move towards higher income households, expenditure shares reduce initially for both types of energy but exhibit an opposite pattern thereafter. We identify the threshold level (turning point) for both categories and, relying on the current expenditure and its growth, the number of years required to reach the turning point. Due to a close association between income and expenditure, the findings imply a U-shaped relation between energy use and income. Our findings contribute to the literature on energy demand by estimating disaggregated energy Engel curves for Bangladesh and discussing the policy implications for energy management and planning in similar countries.

We organize the rest of the article as follows. In Section 2 we discuss the empirical strategy and identification issues. A brief discussion on the data is presented in Section 3. Estimated results are presented and discussed in Section 4. Section 5 concludes.

2. Empirical strategy and identification

This study follows Hasan (2016) in using similar methods and data. The latter study is a methodological exercise to indicate that the empirical specification of food Engel curve has important consequences on food consumption in response to income shocks. This study uses the same technique and data to understand how the pattern of energy use changes with income, a relatively unexploited area in the field of Energy Economics.

We use household survey data to estimate Engel curves for electricity and other energy use. An important consideration in using household surveys is that the data on expenditure are more reliable than income, which is particularly true for low-income and agricultural economies (Deaton, 1997; Engel and Kneip, 1996). Thus studies commonly use expenditure instead of income in modeling Engel curves. Furthermore, to capture a range of functional forms, dependent variables in such models are usually defined as the share of a good in total expenditure (budget/expenditure share Engel curves) (Lewbel, 2008). Since Bangladesh is a low-income country that relies highly on agriculture, we estimate budget share Engel curves in our analysis. However, some lumpy non-consumption expenditures are dropped from our sample and we use expenditure and consumption