Household electrification, food consumption and welfare nexus in Sri Lanka

An intertemporal analysis

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Household electrification, food consumption and welfare nexus in Sri Lanka: an intertemporal analysis

Abstract

A growing body of literature suggests that access to electricity has a positive impact on household's living standards and social welfare. This paper sheds new light on this discussion. Using expenditure dependent equivalence scales, this paper examines the impact of electricity access on food consumption economies of scale (FCES) and thereby the poverty measurements of households with and without access to electricity in Sri Lanka during 1990-2016. Results indicate that a low-income household of four adults with access to electricity spends about 20% less on food compared to a similar household without access to electricity. The results also reveal that although the incorporation of FCES into poverty measurements reduces the overall poverty levels considerably, the reduction in poverty levels is about 1.2% higher for households with electricity at the national level. These observations are consistent across the national and sub-national levels, however, with varying magnitude.

Key words: household electrification; consumption economies of scale; food consumption; poverty; intertemporal change

JEL Codes: D12 I32 D63 D19

1. INTRODUCTION

Household electrification is a core indicator in the measurement of multidimensional poverty (Alkire and Jahan, 2018). This is because household access to electricity has serious implications on poverty levels and the education and health attainments of people. A number of studies have found that household electrification has a significant impact on consumption, income and other aspects of welfare on households in developing countries (Cook et al., 2005; Fan et al., 2005; Jayasinghe et al., 2021; Khandker et al., 2009a; 2009b; 2012; 2013; van de Walle et al., 2017). However, the literature on the effects of electrification on poverty reduction is still scarce and more research is needed to understand the link between household electrification and poverty (Bernard, 2010; Kooijman-van Dijk, 2012). More specifically, the precise channels through which poverty reduction may take place due to electrification have not been adequately examined (Kooijman-van Dijk, 2012). Annemarije (2008) noted that one of the reasons for the little understanding of the link between electrification and poverty is that the relationship consists of several steps and many factors influence each of these steps, making the analysis is somewhat complicated. van de Walle et al. (2017) also noted that the lack of clarity of empirical evidence on the link between household electrification and poverty is partly due to the complexities associated with analysing the welfare implications of household electrification.

Accurate poverty measurement and welfare comparisons across different households require the possibilities for household consumption scale economies (CES) to be taken into consideration. CES implies that the extra resources required by larger families to achieve the same living standards as a smaller household are not directly proportional to the number of family members (Nelson, 1993; Lanjouw and Ravallion, 1995; Ray 2000; Meenakshi and Ray, 2002). These CES may be derived through the sharing of household goods, bulk purchases, and increasing returns to scale in home production (Nelson, 1988).

This article examines the welfare implications of electricity access by comparing the economies of scale in food consumption in households with and without electricity access, using expenditure dependent equivalence scales. This article also uncovers how the equivalence scales for households with and without electricity have changed over time together with changing patterns of household electrification. Additionally, this study reveals the implications of food consumption economies of scale (FCES) on the poverty levels of households with and without electricity. It is well-known that rural households, particularly those in developing countries, are lagging in household electrification. The disaggregated analysis undertaken in this study at the sub-national level provides some valuable insights on urban-rural disparities in electricity access, how these disparities are narrowing over time with increasing levels of rural electrification and their implications on food budget shares and poverty levels. To this end, this study makes a unique contribution to the existing literature on the welfare implications of household electrification by analysing the nexus between household electrification, FCES and poverty, using the Engel equivalence scale approach.

The empirical analysis of this study is based on four waves of cross-sectional data for the period of 1990-2016 from Sri Lanka. Sri Lanka has undergone many socio-economic changes in the past two decades, including growing income levels and increasing access to various energy sources, resulting in significant changes in household consumption patterns (Wijesekere, 2015). The per-capita Gross National Income in purchasing power parity of Sri Lanka has increased from US$470 in 1990 to US$3750 in 2015, leading the country to be an upper middle-income country, based on the World Bank classification (World Bank, 2015). In the meantime, there has been a significant change in household consumption expenditure patterns during the period of 1990-2016. One major change that could be observed is the shift in household expenditure towards non-food items, including household durable goods. There has also been a dramatic improvement in household electrification during the period from

1990 (29%) to 2015 (99.3%) (Ceylon Electricity Board, 2015b). This development in household electrification, together with rising income levels and changing consumption patterns in Sri Lanka, provides an excellent opportunity to undertake an analysis of the impact of household electrification on household welfare and poverty.

The rest of the article is organised as follows. Section 2 provides a brief literature review on the nexus between household electrification and changing food consumption patterns and their effects on FCES. Section 3 presents the descriptive analysis of data used in this study, while Section 4 describes the methodology adopted. Section 5 discusses the empirical results and Section 6 presents limitations of this current study and some insights on future research directions. Section 7 provides some policy insights deriving from this analysis and concluding remarks.

2. FOOD CONSUMPTION ECONOMIES OF SCALE AND HOUSEHOLD ELECTRIFICATION NEXUS: A REVIEW OF LITERATURE

Rapidly growing economies together with steadily rising real per-capita income among the rich and the poor, increasing availability and affordability of various household consumption goods and increasing time scarcity have brought about dramatic changes in household food consumption patterns over time (Popkin, 1999; Du et al., 2004; Kearney, 2010). Additionally, growing access to electricity, particularly in developing nations, has enabled households in these nations to use electrical appliances at home to facilitate domestic activities (Pena and Ruiz-Castillo, 1998; Reardon et al., 2003; Tuttle, 2011). Refrigerators, stoves, ovens, rice cookers, and toasters are but a few examples of the electrical appliances that have become a prominent part of the household's everyday lifestyle, particularly in relation to food preparation and preservation. There is no doubt that the use of these household electric appliances has lowered the time required to perform everyday household tasks, such as cooking and cleaning particularly by reducing the amount of labour required in the accomplishment of these tasks

(Vanek, 1978; Mokyr, 2000; Hall and Khan, 2003; de Vries, 2008). For example, rice cookers and electric stoves may have significantly reduced the food preparation time of women, particularly in the rural areas of developing countries and extended the time that can be spent on other tasks such as an income-earning activity or even on leisure (Hossain, 2010; Wickramasinghe 2011).

Jayasinghe et al. (2018) argued that the adoption of domestic electrical appliances has a positive impact on households' ability to achieve CSE. It can be argued that household electrification together with increasing usage of household electrified goods could theoretically affect two of the three main sources of CES; namely, the bulk purchases and the increasing returns to scale in home production. The use of household goods such as refrigerators, freezers and microwave ovens that facilitate the preservation, preparation and processing of food may have enabled households to buy food in bulk and contributed in significant reduction of household food waste. For example, Reardon et al. (2003) found that with the dramatic increase in the availability of supermarket offers of bulk purchase discounts, especially in developing countries in Africa, Asia and Latin America, many households have been able to stretch their food dollar via bulk buying. Studies have shown that bulk purchases of food have been more attractive in recent years due to the increased use of storage facilities of perishable food items (such as refrigerators and freezers), together with electrification and increased access to transport (own automobiles and public transport services) (Pena and Ruiz-Castillo, 1998; Reardon et al., 2003; Tuttle, 2011). In addition to that, with technological advancements, a considerable reduction in food preparation, preservation and processing time costs may have contributed to increasing returns to scale in the home production of food (Popkin, 1999; Vernon, 2005). This, in turn, can be expected to reduce the marginal cost of food of an additional household member, reflecting greater FCES. Bittman et al. (2004) also noted that

advancements in food preparation and processing technologies may have allowed households to harvest economies of scale in meal production at home.

Various studies have shown that access to electricity significantly increases household income, particularly farm income (Khandker et al., 2009a) and nonfarm income (Cook et al., 2005). Additionally, household electrification may also facilitate home-based enterprises, such as ironing and sewing services and small scale catering (Hossain, 2010; van de Walle et al., 2017). This may have contributed to a significant number of households moving out of poverty. Some studies also showed that electric lighting facilitates households to rearrange domestic tasks to evening hours and thereby extend the time availability of other activities, such as reading, income-earning activities and even leisure (Chowdhury, 2010; Hossain, 2010). Another body of literature discusses the implications of electrification on time allocation on household activities, particularly by women in rural areas of developing countries (Popkin, 1999; World Bank, 2004; Mathur and Mathur, 2005; Hossain, 2010). However, as suggested by Annemarije (2008) and Kooijman-van Dijk (2012), the effects of electrification on poverty reduction remain underexplored. This current study fills this gap in the existing literature, using data from Sri Lanka.

3. HOUSEHOLD INCOME AND EXPENDITURE SURVEY DATA FOR SRI LANKA

The empirical analysis of this study is based on four waves of Household Income and Expenditure Surveys, namely 1990/91, 2001/02, 2009/10 and 2016 conducted by the Department of Census and Statistics (DCS) in Sri Lanka. These datasets provide detailed data on demographic characteristics, household expenditure on food and beverages and non-food items and household income. Food and beverage expenditure (hereinafter referred to as food) consists of spending on cereal, prepared food, pulses, vegetables, meat, fish, eggs, condiments, milk products, fats and oils, fruits, confectionery, other foods, and non-alcoholic beverages.

The expenditure on food also includes imputed expenditure on home-produced food and freely received food (DCS 2003). Expenditure on non-food items covers expenditure on housing, personal and health care, transport and communication, recreation, education, clothing and footwear and other ad hoc expenditure. In this analysis, food expenditure has been adjusted for possible district level price variability, using a spatial price index for each survey year (DCS, 2017b). The income and expenditure data of all four survey periods have been adjusted for inflation using the Colombo Consumer Price Index (2010=100). Therefore, the possible dependence of equivalence scales on prices will henceforth be dropped from the discussion of results. All descriptive statistics and estimation results in this study are presented at the national level and sub-national/sectoral level; urban, rural and estate. According to the sub-national classification of the DCS (2003), the urban sector refers to the areas governed by either Municipal or Urban Councils. The estate sector refers to tea and rubber plantation areas. The rural sector refers to residential areas, which do not belong to the urban or estate sectors. Households belong to these three sub-national classifications have distinctive socio-economic characteristics, which is quite evident in the descriptive analysis in this section. Table 1 provides descriptive summary statistics about the four samples.

[Table 1 about here]

As a result of a number of rural electrification projects implemented in the country, the percentage of electrified households in the rural sector has seen an unprecedented increase from 20% in 1990 to 92% in 2012 (Ceylon Electricity Board, 2008; 2011; 2012). At present, there are about two hundred thousand houses in the country without electricity. Inability to afford the initial connection cost due to financial difficulties is the main obstacle that prevents many of the rural households from getting connected to the national grid (Siyambalapitiya, 2002). Furthermore, significant disparities in electrification rates occurred in Northern and Eastern provinces, where the civil conflict continued until 2009. The war severely damaged the

distribution network, which has hampered the development of new rural electrification programs in these provinces (Ceylon Electricity Board, 2012). Figure 1 illustrates the change in household electrification, by sector, during 1990-2016.

[Figure 1 about here]

Studies have shown that household electrification is positively related to household ownership of electrical appliances (Cook et al., 2005) and Sri Lanka is no exception. The data on household spending on electrical appliances shows that household spending on the acquisition of domestic electrical appliances (e.g. refrigerators, rice cookers, electric stoves, and other cooking appliances), used in households to facilitate food storage and preparation, has been gradually increasing with growing household electrification over time. Figure 2 shows that household spending on household electrified goods has gradually increased at the national level.

[Figure 2 about here]

4. METHODOLOGY

Equivalence scales are commonly used to measure the magnitude of CES (Nelson, 1988; Meenakshi and Ray, 2002; Balli and Tiezzi, 2013). While a significant amount of econometric work has been carried out in relation to household equivalence scales (Rothbarth, 1943; Prais and Houthakker, 1955; Barten, 1964; Deaton and Muellbauer, 1980), there is no consensus in the literature on the best approach to estimate equivalence scales. In practical contexts, policymakers and statisticians tend to use simple forms of equivalence scales, commonly known as "subjective equivalence scales", such as the OECD-modified scales that assign a value of 1 to the first household member, 0.5 to each additional adult, and 0.3 to each child. However, these pre-defined equivalence scales do not allow CES to vary according to various socio-economic and demographic characteristics of the household and assume 0.5 to every

additional adult and 0.3 to every additional child. However, because not all the large or small households are part of a homogenous group, the level of CES enjoyed by households may vary based on various household characteristics and behavioural choices. For example, a significant number of studies have shown that income, geographical location, gender of the head of the household and types of food consumed affect the level of CES (see, for, example, Bosch-Domènech, 1991; Balli and Tiezzi, 2013; Jayasinghe and Smith, 2021; Jayasinghe et al., 2016; 2017). Therefore, the analysis of this study is based on self-estimated household equivalence scales that take household composition, location and income into account. Below we discuss the methodology used to calculate these equivalence scales.

Engel curves and equivalence scales

This study uses the Engel equivalence scale approach to compare the levels of FCES in households with and without access to electricity. For this purpose, firstly, the Engel curves for food were estimated using the Model (1) for all four survey periods at the national and the sectoral level (urban, rural and estate).

Model 1

$$w_f = \beta_0 + \beta_1 \ln\frac{x}{n} + \beta_2 (\ln\frac{x}{n})^2 + \beta_3 n_a + \beta_4 n_c + \beta_5 n_a n_c + \beta_6 ELEC\_D + \varepsilon$$

where w_f refers to budget share on food, $\ln\frac{x}{n}$ is the logarithm of per-capita expenditure (PCE), $\left(\ln\frac{x}{n}\right)^2$ is the square of the logarithm of PCE, n_a and n_c is the number of adults and children in the household, respectively, $n_a n_c$ is the interaction term between the number of adults and children and $ELEC\_D$ is a dummy variable indicating the access to electricity (yes=1, no=0). Households reporting positive expenditure for electricity were considered as households with access to electricity. The interaction term, $n_a n_c$, is expected to capture the joint effect of adults and children on food budget share. The joint effect on the expenditure share on food in

households that have both adults and children may be different to the individual effect of adults and children on the expenditure share on food. Since food budget shares and PCE are derived from the same household expenditure data, inclusion of PCE into the model may pose endogeneity issue. To overcome this problem, following Lewbel (1989) and Deaton and Paxson (1998), per capita income (PCI) was used as an instrumental variable (IV). This is because, income is highly correlated with expenditure but is measured independently of expenditure, serving as a good IV for expenditure. Similar to Deaton and Paxson (1998), 'income' consists of the 'cash income' only.

As elaborated in Deaton (1981), Jayasinghe et al. (2016) and Lelli (2005) the expenditure dependent equivalence scales were calculated, using the Engel curve estimations. Two-adult and no-children household, (2,0) was used as the reference household. Expenditure-dependent equivalence scales were calculated for households with and without access to electricity for all time periods under investigation. These equivalence scales were compared to identify the differences in FCES in households with and without electricity and their intertemporal patterns. If electricity access enhances household welfare, the equivalence scales for households with electricity access expected to be lower than those of the households without access to electricity, as lower equivalence scales indicate a lower cost per additional adult (and child) and hence higher FCES. We also expect the equivalence scales to decrease over time due to various changes in household food consumption patterns discussed in detail in Section 5.

The standard errors for equivalence scales were estimated using the bootstrapping method with 1000 replications. These standard errors were used to test the hypothesis whether the difference between the equivalence scales of households with and without electricity is statistically significant for a given household size (where the null hypothesis is the difference

between the equivalence scales of households with and without access to electricity for a given household size is zero). The results are discussed in Section 5.1.

Poverty head-count rate

The poverty head-count rate is one of the most commonly used poverty measurements. This indicator is often estimated using PCE, ignoring the effects of CES on these poverty measures. This is because PCE is obtained by dividing the household expenditure by household size, without allowing for any possibilities for CES. The commonly used approach to circumvent this problem is to use the expenditure per adult equivalent (EPEA), which allows the necessary adjustments for CES into the measurement of poverty (Lanjouw and Ravallion, 1995; Deaton and Paxson, 1998). To illustrate how do these differences in FCES in households with and without access to electricity affect the poverty levels, the poverty head-count rates were calculated for 2016, using EPEA. Depending on the actual household size and whether a particular household has access to electricity or not, an equivalence scale for each household in the sample was estimated using the coefficient estimates of Model 1 (at the mean expenditure level). Here, a one-adult (1,0) household was considered as the reference household. Then by dividing the household food expenditure by the equivalence scales of respective households, we obtained the food expenditure per equivalent adult. To highlight the effects of FCES due to electricity access on poverty measurements, we assumed that CES were absent in other expenditure categories, and hence used PCE for non-food expenditure. Finally, the per adult equivalent food expenditure and per-capita non-food expenditure were added together to obtain EPEA. We then estimated the percentage of the population whose EPEA (with and without electricity) falls below the official poverty line (OPL) in 2016. The OPL for 2016 is Rs. 4,166 real total expenditure per person (DCS 2017a). The poverty head-count rates were calculated at the national level and the sectoral level. For further comparisons, the poverty head-count rates were also calculated under the conventional method, that is using the PCE (total). Once

the differences in FCES in households with and without access to electricity is taken into consideration, a lower poverty rate among the households with access to electricity is expected at the national and the sectoral level. We also expect the poverty rates under EPEA to be substantially lower than PCE as EPEA accounts for FCES, while PCE does not. Furthermore, a higher percentage reduction in poverty rates under PCE and EPEA is expected for households with access to electricity as these households materialise more FCES. The results are discussed in Section 5.2.

5. RESULTS AND DISCUSSION

5.1 Food consumption economies of scale and electricity access nexus

The marginal equivalence scales, calculated using the Engel curve estimates are reported in Table 2, 3, 4, and 5.[1] Equivalence scales are estimated under three different expenditure levels of households with and without access to electricity; the top and bottom expenditure quartiles and the mean expenditure at the national and sectoral level in each survey year. The marginal equivalence scale of 0.22 for the 2,0-3,0 in Column 2 of Table 5 implies that when the household size increases from two adults (2,0) to three adults (3,0), the three-adult household with access to electricity requires to spend 22% more on food to remain in the same level of welfare (measured in terms of the budget share on food) of a two-adult (reference) household.

Overall, three important observations could be drawn from the marginal equivalence scales presented in Tables 2, 3, 4, and 5. These include, a) marginal equivalence scales increase with expenditure at a given point of time across all household sizes, b) marginal equivalence scales for given household size in all expenditure levels decline over time, and c) households with access to electricity show lower marginal equivalence scales than those of the households without access to electricity. A detailed discussion about these observations is given below.

[1] In the interest of brevity, we do not provide all Engel curve estimation results here. These results are available upon request.

[Table 2 about here]

[Table 3 about here]

[Table 4 about here]

[Table 5 about here]

Increasing marginal equivalence scales with expenditure

As can be seen from Tables 2, 3, 4, and 5, in the majority of instances, the marginal equivalence scales increase with expenditure at a given point of time across all household sizes, at the national level as well as in the sectoral level, irrespective of whether they have access to electricity or not. For example, in 2016 (in Table 5), the marginal equivalence scale for the 3,0-4,0 household category increases from 0.10 in 1st (bottom) expenditure quartile to 0.11 at mean expenditure level and further increases to 0.12 in the top expenditure quartile for households with access to electricity at the national level. The respective marginal equivalence scales for households without electricity also follow a similar trend at the national level with 0.12, 0.13 and 0.15 at the 1st quartile, mean and 3rd quartile expenditure, respectively. While the change in equivalence scales is minimal, hypothesis testing on the difference between two equivalence scales in two expenditure levels (for example, H_0: equivalence scale of mean expenditure - equivalence of 1st expenditure quartile = 0; H_A: equivalence of mean expenditure - equivalence of 1st expenditure quartile $\neq$ 0) indicated that the equivalence scales are significantly different from each other in the majority of instances in all survey periods. The sectoral level trends across expenditure levels in each survey period hold a similar pattern as of the national level in the majority of instances.

Overall, this observation suggests that low-income households materialise more FCES than high-income households. These results are consistent with the findings in the literature (see, for example, Burch and Matthews, 1987; Leibtag and Kaufman, 2003; Griffith et al., 2009; Beatty, 2010; Logan, 2011; Jayasinghe et al., 2016). Beatty (2010), for example,

indicated that poor households tend to purchase commodities with quantity discounts to lower their costs on food. Low-income households also tend to economise more on discounted and/or economy brand products and less expensive food products within a product class.

However, although the estate sector households are the poorest, as discussed in Section 3, in most of the instances, the marginal equivalence scales of the estate sector households are very much closer to those of the urban households. Due to the very poor socio-economic status of most of the estate households, they may not have the same flexibility in liquidity, storage and transportation to reap the benefits of bulk purchase discounts. This observation supports the argument raised in Griffith et al. (2009) that middle-income households buy the most from sales or quantity discounts, while lower households buy least from sales due to lack of resources and flexibility.

Declining marginal equivalence scales over time

If increasing equivalence scales (and hence decreasing FCES) with expenditure pattern holds, naturally, we expect the equivalence scales to increase over time, as the real household income levels, on average, have increased by about 14% during the period of 1990-2016 in Sri Lanka (DCS 2017a).

However, in contrast, the results in Tables 2, 3, 4, and 5, reveal that in the majority of cases, marginal equivalence scales, for all expenditure levels, decline over time, irrespective of whether households have access to electricity or not. For example, for households with electricity, the marginal equivalence scale for the 2,0-3,0 household category decreases from 0.43 in 1990/91 to 0.32 in 2001/02, to 0.27 in 2009/10 and to 0.22 in 2016, in the mean expenditure level at the national level in Column 3. This decline in equivalence scales over time implies that FCES are gradually increasing, resulting in about a 48% decline in the cost of an additional adult measured in terms of food expenditure. A similar pattern could be observed at the sectoral level as well. Our results are in line with those of Logan (2011), who

observed that there were fewer FCES in the past. While further research is needed to explore why FCES increases over time, this trend could be attributed to changing food consumption patterns of households, such as eating away from home, increasing rates of supermarkets offering bulk purchase promotions (Pena and Ruiz-Castillo, 1998; Reardon et al., 2003; Tuttle 2011) and reduced food budget shares with increasing income levels. Byrne and Capps (1996), in analysing the food-away-from-home consumption of households in the United States showed that the strength of the negative relationship between household size and food consumed away-from-home has been declining in recent years. This is attributable to the fact that fast food industries have started providing more affordable 'family' offerings (or deals) for larger households.

Lower marginal equivalence scales for households with access to electricity

The most important observation with respect to the objective of this study is that households with electricity access consistently have lower equivalence scales in all survey years compared to households without access to electricity. This implies that households with access to electricity spend less PCE on food for an additional adult. The results are consistent at the national and sectoral levels, in the majority of instances. This makes households with access to electricity better off compared to their counterparts who do not have access to electricity. For example, in 2016 (Table 5), when household size increases from three-adults (3,0) to four-adults (4,0), a household in the 1st expenditure quartile level who has access to electricity spend about 20% less on food consumption than their counterparts who do not have access to electricity. Therefore, it is reasonable to conclude that the households with access to electricity materialise greater FCSE compared to the households without access to electricity.

As discussed in Section 2, greater FCSE in households with access to electricity could be observed because these households are able to buy food in bulk and take advantage of quantity discounts and bulk-buy seasonal products for a lower price and store them in

refrigerators or freezers for later use, reducing the per-unit cost significantly (Pena and Ruiz-Castillo, 1998; Reardon et al., 2003; Tuttle 2011). Furthermore, as suggested by Popkin (1999) and Vernon (2005), these electrified households could save a significant amount of food preparation, preservation and processing time by adopting household electrified goods. This may allow them to materialise more FCES through increasing returns to scale in the home production of food and thereby reducing the marginal cost of food of an additional household member.

5.2 Implications on poverty measurements

[Table 6 about here]

Two main observations emerging from the results on poverty estimates in Table 6. Firstly, the results reveal that, overall, when the necessary adjustments for FCES in households (with and without access to electricity) are allowed for, that is when EPEA is used, there is a considerable reduction in the poverty head-count rates at the national and the sectoral level. At the national level, for households with access to electricity, the reduction in the poverty head-count rate is about 5.4% when EPEA is used. A similar pattern could be seen at the sectoral level as well. This observation is in line with the findings in the literature that often poverty measures based on the PCE overestimate the poverty levels of large households as PCE method does not take possible CES into account. Secondly, the difference between the poverty head-count rates under PCE and EPEA (reported in Table 6 as the percentage decline) is higher for households with access to electricity than those without access to electricity at the national level and the sectoral level. For example, at the national level, the decline in the poverty head-count rate for households with access to electricity is 5.4%, while that is for households without access to electricity is 4.2%. This observation is not surprising given that households with access to electricity materialise more FCES and hence these households show greater sensitivity for poverty measurements that take possible FCES into account.

6. LIMITATIONS AND FUTURE RESEARCH DIRECTION

The results indicate that household electrification enables households to materialise greater FCES through bulk purchases and increasing returns to scale in home production. This is because domestic electrical appliances, such as refrigerators, freezers, rice cookers and microwave ovens facilitate food preparation, preservation and processing related activities. In this study, we have considered households that report positive expenditure on 'electricity' as households with access to electricity. However, some studies have shown that often rural households in developing countries use electricity predominantly for lighting and powering televisions and fans (Barnes, 2007; Bernard, 2010). However, IEG (2008) noted that in rural South Africa, often households used electricity for cooking. Although there is some general evidence that households are increasingly using electrical appliances to ease the domestic work in Sri Lanka (for example, see Rajmohan and Weerahewa, 2010; Wickramasinghe, 2011; Wijesekere, 2015), due to lack of data, in this study, we are unable to distinguish the proportion of expenditure on electricity used on food preparation, preservation and processing appliances in Sri Lanka. Therefore, while this study uncovers the impact of electrification on food expenditure and FCES, further research is required to examine the sensitivity of the findings if a smaller proportion of electricity is used for food preparation, preservation and processing related activities.

7. CONCLUSIONS AND POLICY IMPLICATIONS

Policymakers around the world believe that access to modern energy, including electricity is a necessary requirement for sustainable development. This is because, modern energy use may enable the poor in developing countries to engage in improved income-generating activities (DFID, 2002; Practical Action, 2012). As such, access to reliable energy sources may have a direct impact on reducing household poverty and enhancing a higher standard of living. Recognizing the role of electrification in enhancing the standard of living and poverty, access

to electricity is also considered as one of the indicators in the measurement of multidimensional poverty (Alkire and Jahan, 2018).

This study uncovered the role of electrification in explaining household welfare and poverty dynamics through a different lens. In doing so, firstly, this study examined the differences in food consumption economies of scale (FCES) in households with and without access to electricity during the period of 1990/91 to 2016. Our results revealed that electrified households, through increased utilisation of electrical appliances that enhance the efficiency of food preparation and storage, are able to materialise higher FCES compared to households without access to electricity. This means that when household size increases, households with electricity incur lower additional costs to remain in the same level of welfare (as measured in terms of food consumption).

Secondly, to investigate the implications of such differences in FCES on poverty measurements, the poverty head-count rates were calculated using per-capita expenditure (PCE) and expenditure per equivalent adult (EPEA) for households with and without electricity. The results revealed that once the possibilities of FCES are taken into consideration, a significant reduction in poverty rates was seen at the national and the sectoral level. Nevertheless, households without electricity experienced a lower reduction in poverty head-count rates compared to households with access to electricity.

The findings of this study further reinforce the argument that household electrification and the adoption of an appropriate level of technology in everyday life may positively contribute to the household standard of living and welfare. These findings not only highlight the importance of enhanced levels of household electrification but also emphasise the necessity for policies towards encouraged domestic technology adoption. As the Global Energy Assessment (2012) suggests, the provision of subsidies that allow for a greater level of access to electricity in rural areas, and subsidising the electricity prices for low-income households in

disadvantaged areas within the rural and estate sectors, for example, could act to improve the standard of living of these households in a well-targeted manner.

Households, particularly low-income households may reluctant to use domestic electric appliances due to two reasons; the possibility of increasing electricity cost and the majority of these appliances are beyond the financial reach of the low-income households. One way to encourage these households to use electric appliances is to allocate funding or provide interest-free loans for low-income households to purchase energy-saving domestic appliances. Encouraging the use of solar power to generate electricity could be considered as one approach to reducing the financial burden on increasing electricity costs due to the use of electrical appliances. Policies directed towards introducing rebates for households to installing solar panels and subsidising the installation of solar panels for very poor households may make their transition from traditional methods to technologically advanced and efficient methods that enable greater FCES both smoother and financially less stressful. This may also ease the burden of their electricity bills in the longer term. On the other hand, such an initiative may be especially useful for households in those rural areas where access to the grid is prohibitively expensive.

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Table 1: Summary statistics, by sector and survey year

(1)	1990				2002				2009/10				2016			
	National (2)	Urban (3)	Rural (4)	Estate (5)	National (6)	Urban (7)	Rural (8)	Estate (9)	National (10)	Urban (11)	Rural (12)	Estate (13)	National (14)	Urban (15)	Rural (16)	Estate (17)
Part A: Demographic characteristics																
Number of households	18,191	6,017	10,940	1,234	16,662	3,090	12,372	1,200	17,002	4,113	11,160	1,729	21,756	3,429	17,394	933
Household size	4.7	5.2	5.0	4.7	4.4	4.6	4.3	4.5	4.3	4.4	4.2	4.5	4.1	4.2	4.0	4.4
Percentage of households with access to electricity (%)	33.1	62.9	20.1	4.2	66.8	86.7	64.1	42.3	87.2	95.8	86.1	71.2	95.8	99.2	96.2	92.8
*Poverty head-count rate (%)	26.1	16.3	29.4	20.5	22.7	7.9	24.7	30.0	8.9	5.3	9.4	11.4	4.1	1.9	4.3	8.8
Part B: Average monthly household expenditure share																
Food and beverages	0.60	0.57	0.61	0.63	0.48	0.41	0.50	0.59	0.41	0.37	0.42	0.51	0.36	0.33	0.37	0.48
Alcohol	0.07	0.03	0.09	0.13	0.02	0.02	0.03	0.05	0.02	0.02	0.02	0.05	0.02	0.01	0.02	0.04
Non-food items (including electricity)	0.33	0.39	0.30	0.23	0.50	0.57	0.48	0.36	0.57	0.61	0.56	0.44	0.62	0.66	0.61	0.48
Electricity	0.01	0.02	0.00	0.00	0.02	0.03	0.02	0.01	0.02	0.03	0.02	0.01	0.02	0.03	0.02	0.01

Source: Author's compilation based on micro data of household income and expenditure survey data 1990/91, 2002, 2009/10 and 2016. ***** based on official data published by the DCS (1993, 2003, 2011, 2017a)

Table 2: Marginal equivalence scales of the households with and without electricity - 1990

	National			Urban			Rural			Estate		
(1)	1st quartile (2)	Sample mean (3)	3rd quartile (4)	1st quartile (5)	Sample mean (6)	3rd quartile (7)	1st quartile (8)	Sample mean (9)	3rd quartile (10)	1st quartile (11)	Sample mean (12)	3rd quartile (13)
Part A: ***marginal equivalence scales for households with access to electricity***												
1,0-2,0	0.48 (0.000)	0.48 (0.001)	0.48 (0.000)	0.47 (0.001)	0.48 (0.000)	0.48 (0.002)	0.47 (0.001)	0.48 (0.000)	0.48 (0.002)	0.48 (0.001)	0.48 (0.002)	0.48 (0.000)
2,0-3,0	0.43 (0.001)	0.43 (0.002)	0.44 (0.000)	0.42 (0.001)	0.43 (0.000)	0.44 (0.000)	0.42 (0.002)	0.44 (0.001)	0.44 (0.002)	0.45 (0.001)	0.45 (0.001)	0.45 (0.000)
3,0-4,0	0.39 (0.001)	0.39 (0.000)	0.40 (0.002)	0.36 (0.003)	0.39 (0.000)	0.40 (0.001)	0.38 (0.000)	0.39 (0.003)	0.40 (0.002)	0.40 (0.001)	0.42 (0.000)	0.42 (0.000)
Part B: ***marginal equivalence scales for households without access to electricity***												
1,0-2,0	0.48 (0.000)	0.49 (0.000)	0.50 (0.000)	0.48 (0.001)	0.48 (0.001)	0.48 (0.002)	0.48 (0.001)	0.48 (0.000)	0.49 (0.001)	0.48 (0.001)	0.48 (0.001)	0.50 (0.002)
2,0-3,0	0.44 (0.000)	0.45 (0.002)	0.46 (0.001)	0.45 (0.003)	0.46 (0.002)	0.47 (0.000)	0.44 (0.000)	0.46 (0.001)	0.45 (0.001)	0.46 (0.001)	0.47 (0.002)	0.47 (0.000)
3,0-4,0	0.42 (0.000)	0.43 (0.001)	0.43 (0.000)	0.38 (0.001)	0.40 (0.000)	0.40 (0.000)	0.39 (0.002)	0.40 (0.001)	0.42 (0.002)	0.42 (0.001)	0.43 (0.000)	0.43 (0.001)

Note: Bootstrapped standard errors are given in parenthesis. Household expenditure data has been adjusted for inflation using the Colombo Consumer Price Index (CCPI) (2010=100).

Table 3: Marginal equivalence scales of the households with and without electricity - 2001

	National			Urban			Rural			Estate		
(1)	1st quartile (2)	Sample mean (3)	3rd quartile (4)	1st quartile (5)	Sample mean (6)	3rd quartile (7)	1st quartile (8)	Sample mean (9)	3rd quartile (10)	1st quartile (11)	Sample mean (12)	3rd quartile (13)
Part A: ***marginal equivalence scales for households with access to electricity***												
1,0-2,0	0.42 (0.000)	0.43 (0.001)	0.44 (0.000)	0.44 (0.001)	0.44 (0.001)	044 (0.002)	0.42 (0.001)	0.43 (0.001)	0.44 (0.002)	0.44 (0.001)	0.45 (0.002)	0.45 (0.000)
2,0-3,0	0.29 (0.001)	0.32 (0.002)	0.33 (0.000)	0.33 (0.001)	034 (0.002)	0.34 (0.000)	0.28 (0.001)	0.31 (0.002)	0.32 (0.000)	0.33 (0.001)	0.36 (0.001)	0.37 (0.000)
3,0-4,0	0.18 (0.001)	0.22 (0.000)	0.23 (0.002)	0.23 (0.001)	0.25 (0.000)	0.26 (0.001)	0.17 (0.001)	0.22 (0.000)	0.23 (0.001)	0.24 (0.001)	0.27 (0.000)	0.29 (0.000)
Part B: ***marginal equivalence scales for households without access to electricity***												
1,0-2,0	0.44 (0.000)	0.44 (0.000)	0.45 (0.000)	0.44 (0.002)	0.45 (0.001)	0.45 (0.002)	0.43 (0.001)	0.44 (0.001)	0.44 (0.002)	0.45 (0.001)	0.45 (0.001)	0.46 (0.002)
2,0-3,0	0.32 (0.000)	0.35 (0.002)	0.36 (0.001)	0.34 (0.000)	0.35 (0.001)	0.36 (0.001)	0.32 (0.003)	0.34 (0.002)	0.35 (0.000)	0.34 (0.001)	0.37 (0.002)	0.37 (0.000)
3,0-4,0	0.23 (0.000)	0.26 (0.001)	0.7 (0.000)	0.26 (0.001)	0.27 (0.001)	0.27 (0.000)	0.21 (0.001)	0.26 (0.000)	0.27 (0.000)	0.26 (0.001)	0.29 (0.000)	0.31 (0.001)

Note: Bootstrapped standard errors are given in parenthesis. Household expenditure data has been adjusted for inflation using the Colombo Consumer Price Index (CCPI) (2010=100).

Table 4: Marginal equivalence scales of the households with and without electricity – 2009/10

	National			Urban			Rural			Estate		
(1)	1st quartile (2)	Sample mean (3)	3rd quartile (4)	1st quartile (5)	Sample mean (6)	3rd quartile (7)	1st quartile (8)	Sample mean (9)	3rd quartile (10)	1st quartile (11)	Sample mean (12)	3rd quartile (13)
Part A: ***marginal equivalence scales for households with access to electricity***												
1,0-2,0	0.40	0.41	0.42	0.44	0.43	0.43	0.43	0.42	0.43	0.43	0.44	0.45
	(0.001)	(0.002)	(0.001)	(0.003)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)
2,0-3,0	0.25	0.27	0.28	0.30	0.31	0.31	0.27	0.29	0.30	0.29	0.33	0.35
	(0.000)	(0.001)	(0.000)	(0.001)	(0.003)	(0.000)	(0.002)	(0.000)	(0.000)	(0.002)	(0.000)	(0.000)
3,0-4,0	0.12	0.16	0.17	0.21	0.22	0.22	0.15	0.19	0.20	0.18	0.24	0.25
	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)	(0.000)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Part B: ***marginal equivalence scales for households without access to electricity***												
1,0-2,0	0.41	0.42	0.43	0.43	0.43	0.43	0.42	0.43	0.43	0.44	0.45	0.45
	(0.002)	(0.000)	(0.002)	(0.002)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)
2,0-3,0	0.27	0.29	0.30	0.31	0.32	0.33	0.29	0.31	0.32	0.32	0.35	0.36
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)	(0.003)	(0.001)
3,0-4,0	0.16	0.19	0.20	0.22	0.23	0.23	0.18	0.22	0.23	0.21	0.26	0.28
	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.002)	(0.001)

Note: Bootstrapped standard errors are given in parenthesis. Household expenditure data has been adjusted for inflation using the Colombo Consumer Price Index (CCPI) (2010=100).

Table 5: Marginal equivalence scales of the households with and without electricity – 2016

	National			Urban			Rural			Estate		
(1)	1st quartile (2)	Sample mean (3)	3rd quartile (4)	1st quartile (5)	Sample mean (6)	3rd quartile (7)	1st quartile (8)	Sample mean (9)	3rd quartile (10)	1st quartile (11)	Sample mean (12)	3rd quartile (13)
Part A: ***marginal equivalence scales for households with access to electricity***												
1,0-2,0	0.38	0.38	0.39	0.39	0.40	0.41	0.38	0.38	0.39	0.40	0.41	0.41
	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.002)	(0.001)	(0.002)	(0.000)	(0.000)	(0.002)
2,0-3,0	0.22	0.22	0.24	0.25	0.26	0.29	0.21	0.21	0.23	0.23	0.26	0.27
	(0.000)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)
3,0-4,0	0.10	0.11	0.12	0.15	0.15	0.19	0.10	0.10	0.12	0.11	0.15	0.16
	(0.000)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.003)	(0.000)	(0.001)	(0.002)	(0.000)	(0.002)
Part B: ***marginal equivalence scales for households without access to electricity***												
1,0-2,0	0.39	0.39	0.40	0.41	0.42	0.42	0.39	0.39	0.40	0.41	0.42	0.42
	(0.000)	(0.002)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.002)	(0.001)	(0.002)	(0.002)	(0.000)
2,0-3,0	0.23	0.24	0.25	0.28	0.30	0.31	0.22	0.23	0.24	0.25	0.27	0.27
	(0.001)	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.003)	(0.001)
3,0-4,0	0.12	0.13	0.15	0.19	0.20	0.22	0.12	0.12	0.14	0.11	0.16	0.16
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)

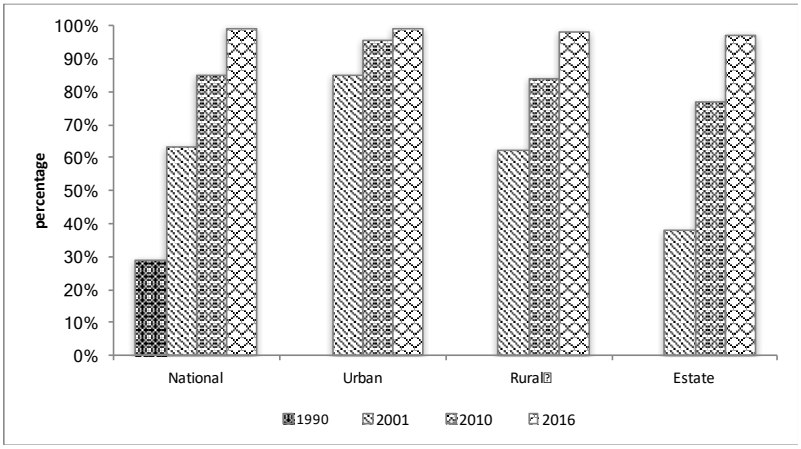
Note: Bootstrapped standard errors are given in parenthesis. Household expenditure data has been adjusted for inflation using the Colombo Consumer Price Index (CCPI) (2010=100).

Table 6: Impact on poverty status, 2016

Poverty head-count rate (1)	National (2)	Urban (3)	Rural (4)	Estate (5)
Households with access to electricity (PCE)	6.5%	2.5%	6.8%	13.1%
Households with access to electricity (EPEA)	1.1%	0.4%	1.2%	2.0%
Percentage decline	*5.4%*	*2.1%*	*5.6%*	*10.9%*
Households without access to electricity (PCE)	8.1%	3.7%	7.9%	15.7%
Households without access to electricity (EPEA)	3.9%	1.9%	3.7%	7.6%
Percentage decline	*4.2%*	*1.8%*	*4.2%*	*8.1%*

Note: The OPL for 2016 is Rs. 4,166 real total expenditure per person. (DCS, 2017b). The average annual exchange rate of Sri Lankan Rupee/US$ in 2018 was Rs.162.54 (Central Bank of Sri Lanka 2018).

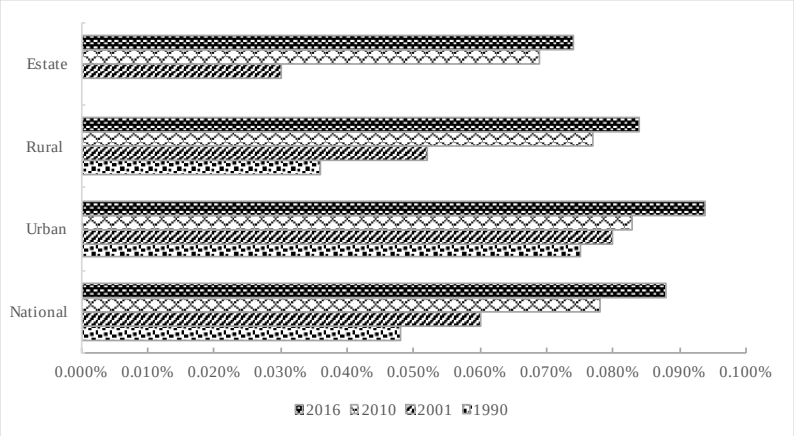
Figure 1: Percentage of households with access to electricity, by survey year



Note: The data on sectoral level percentages access to electricity is not available for 1990/91

Source: (CEB 2008, 2011, 2012, 2015a, 2017)

Figure 2: Household expenditure on electric cooking appliances (as a percentage of total expenditure), by survey year



Note: Household expenditure on electric cooking and electric storage appliances in the estate sector in 1990/91 very small.