



# Barriers to electrification in Latin America: Income, location, and economic development



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## ABSTRACT

This article examines three intrinsic, underlying variables affecting the provision of electricity services: household income, household location, and the country's level of economic development. The analysis is based on a cross section of nationally representative household surveys from 12 Latin American countries. Potential nonresponse biases in these surveys are discussed. The results show that location and economic development outweigh household income as drivers of electrification. That is, economic development and household geographical location explain most of the lack of access. Nonetheless, the weight of income continues to be sizeable in some less developed economies. Based on these drivers, the study performs simulations that closely replicate the observed empirical patterns of electricity access, showing that poor households in less developed economies face significantly lower chances of having electricity services. This represents an access penalty associated with the country's stage of development, which is borne by families regardless of their income or the area in which they live.

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## 1. Introduction

The availability of electricity services constitutes a necessary condition for most activities in modern life, and has been shown to play a role in boosting socioeconomic-outcomes. On the one hand, access to electricity allows a more productive time allocation between household members, mainly benefiting children and women, raising educational outcomes, as well as, household incomes [2,8–10,15]. At the same time, the development of economic activities relies on this infrastructure as a primary element for enhancing productivity and competitiveness [13]. Besides, access to electricity represents an initial step toward reducing energy poverty, a relevant vector in multidimensional poverty measures [3,18]. Further, electricity infrastructure seems to have significant positive external effects on safety, employment opportunities, wages, and land market value [21].

Through these channels, electricity access is expected to

contribute with better living standards, raising economic opportunities in a decentralized way across a country territory. However, and regardless of the benefits of electrification, finding economically sustainable ways to provide access remains a major challenge. The effectiveness of electrification programs has been varied, resulting in slow-paced electrification [6,7] with around 1.2 billion people still lacking this basic infrastructure as of 2013. Economic factors and the dispersion of rural settlements are frequently cited as explanations for this slow progress; however, there is limited quantitative evidence about the basic patterns characterizing electrification [14,22].

This article examines three intrinsic, underlying variables affecting the provision of electricity services: household income, household location, and the country's level of economic development. I exploit a singular collection of nationally representative household surveys from 12 Latin American (LA) countries, providing an empirical overview of the role of these determinants. The LA region is a suitable case study, as it comprises a heterogeneous set of countries at different stages of development, with different degrees of electricity coverage, and with significantly

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diverse geographical conditions. These characteristics provide an important source of variability to meaningfully address the distinctive role of each driver. In addition, the collection of nationally representative household surveys allows for providing a recent snapshot of the electrification rates across household income quantiles in the LA region.

This work is mainly related to the literature on determinants of electricity access. The findings of several case studies suggest that household income, household location, and political support play a role in determining the effectiveness of rural electrification programs [12,14,17,22]. From this body of literature, two market-driven dimensions for understanding the process of electrification are household income and household geographic location. Higher incomes facilitate to afford electricity services, including connection costs, which sometimes may be prohibitive [4]. In addition, household income levels are strongly associated with appliance ownership, leading to high levels of electricity demand among richer households, which makes them more attractive clients for electricity providers.

With regard to location, the geographic sorting of communities may represent a technical challenge to the extension of traditional electric grid at a reasonable cost [1,17,22]. Further, typical characteristics of isolated areas are lower rural population density, more dispersed demand, and higher costs of transmission and distribution, which translate into lower financial incentives for electrification in such areas. These two factors—income and location—are not necessarily exclusive, and they may interact in ways that multiply the difficulties of providing electricity. In the case of Kenya [14], document how grid extension does not necessarily translate into greater electrification, mainly because of household financial constraints.

Along with these factors, an empirical regularity is that economic development shapes the path of electrification. This factor has received less attention in the literature, restricting the understanding of the electrification access gap. A channel from economic development to higher rates of electrification is related to the fact that dynamic economic growth tends to translate into greater demand for physical infrastructure to sustain economic activity and attend the energy needs of a population with rising incomes. An interrelated channel is that as national income grows, a country's financial fiscal capability to face the above challenges also increases. Indeed, aggressive rural electrification programs have typically relied heavily on fiscal resources, under subsidized schemes that cover a significant part of capital costs, as well as, variable costs of providing services through social tariffs [13,16].

Given the interrelations between these determinants, it is important to address them jointly, to contribute toward a more comprehensive understanding of the drivers and nature of the electricity access gap. The relative importance of each driver has direct implications for the design of electrification programs. For example, if regardless of household location and the economic development stage of the country, income is the main factor explaining the lack of access, it would be an indication of severe affordability problems and ineffective program design. That is, if regardless of the availability of electricity supply in the area, households are unable to connect, this would represent a severe sunk cost for public infrastructure. This situation implies that the expected economic and social benefits, which are usually accounted for during the design stage of electrification projects, will not be realized. By contrast, if the lack of access can be explained mainly by household location, this would indicate a lack of available infrastructure, requiring further characterization of the causes of such deficiency (e.g., suitable sources of financing, institutional planning, and implementation capabilities).

However, disentangling the independent effects of each factor is

not straightforward. On the one hand, splitting the effects of household income from the effects of economic development is difficult, because household income in less developed countries tends to be lower than in more advanced economies for the same income group (see the household income distributions for our sample in Appendix 1). Besides, scarce literature has focused on household-specific location. Including finer household geographical location identifiers in the analysis is important to analyze the roots of household take-up behavior of electricity connections—i.e. the availability of electricity services in the village, or household financial capacity to afford the connection. Distinguishing between the relative role of each driver constitutes the main contribution of this article. The main results indicate that location and economic development outweigh household income as drivers of rural electrification. That is, given similar levels of household income and taking geographical characteristics into account, a family in a poorer country has a lower probability of having electricity.

This article is structured as follows. Section 2 presents a descriptive review of the electrification process over the past few decades, comparing the performance of LA with other regions. Section 3 describes the data and methodology for the regression analysis. Section 4 presents the results, and Section 5 lays out the final remarks.

## 2. Stylized facts

Over the past few decades, there has been significant growth in access to electricity; however, the speed of electrification has differed dramatically from country to country. Table 1 presents the average rates of electrification by income group and region over 1990–2012. The table shows that in low-income countries—mainly in Sub-Saharan Africa—the electrification process has been slower than in wealthier countries. In low-income economies, low rates of electricity coverage have persisted in rural and urban areas. In fact, the developing world represents the bulk of lack of access [19]. As reported by the International Energy Agency, in 2013, around 1200 million people lacked electricity, of which around 97% were in Africa and Developing Asia [11].

Countries in Latin America and the Caribbean (LAC) have seen notable progress over the past 25 years. At the beginning of the 1990s, most urban populations in the region already had access to electricity, and most of the progress since then has occurred in rural areas, where the electrification rate increased from 65% in 1990 to 87% in 2012. This translates into a regional access gap of around 22 million people without electricity [11].

Throughout this process, the growth in electrification has closely followed the path of economic growth, although with different patterns in urban versus rural areas. Fig. 1 plots the electrification rates and per capita income by rural and urban, distinguishing country income classification (according to the World Bank's income classification). LA countries are presented in bold, and countries from other regions are in hollow circles. In general, the relationship between electricity access and per capita income appears to be nonlinear, non-surprisingly, indicating that reaching higher levels of economic development is strongly associated with higher electricity coverage. A more interesting pattern is that this relationship differs markedly between urban and rural areas. At low-income levels, electricity access grows at a more accelerated rate in urban than in rural areas. This pattern is reversed closer to and at lower-middle-income levels, where electrification grows at a higher rate in rural areas than in urban ones. As per capita income increases, rural electricity coverage rises steeply until it reaches about 80–90%, after which electrification expansion decelerates.

An explanation of how income per capita shapes the path of

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