Contents lists available at ScienceDirect

Energy Policy

Elements for the development of public policies in the residential sector of Mexico based in the Energy Reform and the Energy Transition law

Jorge Alberto Rosas-Flores

Instituto de Investigaciones Eléctricas, Reforma 113, Col. Palmira, Cuernavaca 62490, México

A B S T R A C T

Mexico has entered in an important dynamic of structural changes in the energy area, proof of this, it is the Energy Reform 2013 and the Energy Transition Law published the last December 24th, 2015, thus it is important to carry out studies of the impacts of future politics in the consumption of the population, so this study estimate an energy demand system using microdata collected from 97,817 households in a National Households Income and Expenditure Survey (ENIGH acronyms in Spanish, *Encuesta Nacional de Ingresos y Gastos de los Hogares*) in the 20-years period from 1994 to 2014.

The magnitudes of all the fuels are smaller than one indicating that electricity, LPG, gasoline and public transport are normal goods, while LPG is the most inelastic energy source. The geographic factor shows that households in the north of Mexico tend to consume more gasoline, whereas in the south of the country, the lowest share of LPG expenditure is reported. The rigorous evaluation of energy demanded in households will help policy makers to put forward more efficient reforms.

1. Introduction

Mexico has entered into a period of important structural changes in energy area with the Energy Reform and the Energy Transition Law approved in the last December 24, 2015. Mexican Energy Ministry established as goals, they will reduced the price of electricity, make strategies to have a supply of fuels with better prices, moreover the increasing of participation of clean energies in the generation of electricity, 25% for the year 2018, 30% for the year 2021 and 35% for the year 2024, on the other hand, promote the reduction of polluting emissions through of the Energy Efficiency and the Fuel substitution in the use of individual transport that employ Hydrocarbons, make free the importation of gasoline and its sale at market price. To achieve these objectives, they will need some studies that support the policy makers to create the best way forward. It is important to know the demand of energy in the households to prepare ourselves to these structural energy sector changes in Mexico.

Though in 2009 global energy demand fell by an unprecedented 0.7% in response to the global economic slowdown, the International Energy Agency (IEA) forecasts, in its recently released World Energy Outlook 2011, a continuing upward trend in demand for the next 20–25 years (IEA, 2011). Based on the assumption of population and economic growth, the agency forecasters contend that total energy consumption is projected to rise by approximately 40% over the 2009–2035 period. In the Americas, Brazil, Mexico and Chile are among the

developing countries that are predicted to have an important growth rate of energy consumption, and where households will remain an important power consuming sector. In the face of this projected growth, issues such as financial resources constraints, energy security, energy poverty, energy price volatility and environmental concerns surge as substantial reasons to study deeply household consumption patterns and energy requirement, especially for large developing countries like Mexico. It is well documented that energy contributes to household welfare, improving services that satisfied a varied range of needs spanning from necessity to luxury consumption. Therefore, questions of efficiency and the spending levels of energy must be understood to evaluate the impact of energy prices on household lifestyles and overall level of well-being, and also the potential consequences of energy policies. The objective of this paper, it is provide elements to the policy makers for the fulfilment of the new Energy Transition Law in Mexico, as described further on, the fuels prices had been controlled, but from 1 January 2017 the price of gasoline and LPG will be at free, market-based prices.

The studies of residential energy demand can be divided into two approaches (See Appendix A). The first approach applies the aggregated data, which is usually based on variables such as price and income along with other factors like climatic variables and urbanization characteristics. For developed countries, various studies have been carried out to address the various aspects of energy demand and its determinants (Zachariadis and Pashourtidou (2007); Narayan and

Smyth (2006); Kamerschen and Porter (2004); Hondroyiannis (2004); Hunt et al. (2003); Silk and Joutz (1997)). At the same time, some recent work has attempted to do similar analysis for developing countries: one can refer to Ziamba (2008) for the South of Africa; Athukorala and Wilson (2010) for Sri Lanka; De Freitas and Kaneko (2011) for Brazil; De Vita et al. (2006) for Namibia; Holtedahl and Joutz (2004) for Taiwan; Nasr et al. (2000) for Lebanon, Pesaran et al. (1998) for 10 Asian countries, and Lima Azevedo et al. (2011) makes a study of electricity consumption in USA and UE and the efforts to achieve the sustainability and show it is not only necessary increase the prices but they can implement better technologies.

The second approach of the residential energy demand uses microeconomic data taking into consideration a wide range of country specific variables. Some recent work for the developed world, classified in this category, includes Labenderia et al. (2006); Blazquez et al. (2013) for Spain;Filippini (1999) for Switzerland; Poyer et al. (1997) for USA; Boonekamp (2007) for The Netherlands; Leth-Petersen (2002) for Denmark; Larsen and Nesbakken (2004) for Norway. Despite the scarcity of household energy demand studies for developing countries, only little work can be mentioned (e.g., Mariana et al. (2009) for Brazil; Khattak et al. (2010) for Peshawer City in Pakistan; Rajmohan and Weerahewa (2007) for Sri Lanka). Yet, previous statistical analyses of energy demand in these countries, including Mexico, remain extremely limited.

Most of the studies in Mexico have focused mainly on fuel demand in the transportation context. Berndt and Botero (1985) use annual time series and panel data to analyze the demand for energy in the Mexican transport sectors. Their time series model consists of few observations and suffers from misspecification problems. Eskeland and Feyzioglu (1997) investigated gasoline demand elasticities in Mexico City during the 80's by applying a dynamic panel model and found that price elasticities were above unity. In another analysis for gasoline demand in Mexico City, Galindo and Salinas (1997) use a cointegration technique and an Error Correction Model to estimate the short and long-run price elasticities for the period 1987–1995. They found that short and long run price elasticities of the demand for gasoline are negligible. More recently, Galindo (2005) use annual data to estimates the price elasticity of energy demand in Mexico by applying a cointegration approach. He obtained an estimate of 0.4 for the gasoline demand elasticity. Crotte et al. (2010) employed both time series cointegration model and panel GMM model for Mexican states to estimate elasticities with respect to price, income, vehicle stock and metro fares. They provided evidence that gasoline elasticities changed over time and differed at national and local levels, with smaller price responses in Mexico City.

For other types of energy, the studies that have been conducted in Mexico are even scarcer. The study of Berndt and Samaniego (1984) goes back to the 80's in which they estimated a two-equation system and examined the partial income elasticity for electricity (for the population that already has access to electricity) and the total income elasticity for electricity that includes the effect of income on increasing the demand for access to electricity. They found that total income elasticities are 40% larger than partial income elasticities in both the short and the long run.

In this paper, we estimate the household price and income elasticities of demand for different types of energy in Mexico. In a first study (Rosas-Flores et al., 2017) we realised an evaluation of change of prices in fuels consumption but with information until 2010, now the information has been updated up to 2014, and we add the public transportation that it use fossil fuels with the purpose to get more elements to decisions making for policy makers to fulfilment with the goals of the energy reform approved in 2013 and the Energy Transition Law 2015, Also, it hope new studies that discuss these results and improve them.

The existing disparities of lifestyles and energy use in Mexico, the use of micro-data which reflects individual and household behavior would provide an interesting insight on the nature of consumer responses. The micro approach of household energy demand permits a thorough analysis across different heterogeneous household groups and enable also for incorporating a wide range of household characteristics within the analysis. Hence, in this context, we apply a system of demand which includes almost all types of energy used in a Mexican household, while bearing due attention to the important socioeconomic factors that affect this demand. Moreover, the outcome of this analysis can be used as input to help policymakers in the settlement of appropriate environmental and energy policies in Mexico, and also assess the distributional impact of policy measures on households.

The remainder of this paper is organized as follows. Section 2 describes the energy sector in Mexico. In Section 3, the AIDS model applied to energy demand is detailed, while Section 4 describes the data. Section 5 discusses the results while summary and conclusions are reported in Section 6.

2. The energy sector in Mexico

Mexico is considered as one of the largest oil producers in the world where the State-owned Petroleos Mexicanos (Pemex) has been one of the largest oil companies worldwide. The oil sector is a crucial component of Mexico's economy, its relative importance to the general Mexican economy has declined in an oil depressed economy in the long-term, the oil sector still generated 14% of the country's export earnings in 2010, according to Mexico's central bank. More importantly, the government relies upon earnings from the oil industry (including taxes and direct payments from Pemex) for 32% of total government revenues.[1] Therefore, any decline in oil production has a direct effect upon the country's overall fiscal balance.

Despite its status as one of the world's largest crude oil exporters, Mexico is a net importer of refined petroleum products. Effectively, as a result of substantial industry expansion and living standards improvement. Mexico's energy consumption, according to the national energy balance (SENER, 2011), has grown from 3555 *PJ* in 1994 to 5128 *PJ* in 2014 at an annual rate of almost 1.68%. In 2014, the transport sector accounted for the largest share in total energy consumption at 43% followed by industry at 32% and residential at 16%, in which LPG, firewood (foremost in poor communities) and electricity constitute the main source of energy consumption.

The household sector in Mexico is regarded as one of the main energy consumers among all consuming energy sectors. Fig. 1 shows the final energy demand of the different sectors in Mexico during the period 1996–2014. While the residential sector's energy usage has increased 0.25%, its share of total energy usage fell from 20% in 1996 to 16% in 2014.[2] This is largely due to the 2.58% growth in the energy use of transport sector in the same period. The residential sector is one where considerable expansion has occurred in recent years with 77% increase in the number of households reaching 31.1 million over the period 1990–2014.[3] Energy use in the residential sector includes energy for cooking, heating, lighting, cooling and entertainment. To satisfy residential energy demand different energy sources are used, such as electricity, LPG, natural gas, kerosene and firewood.

As depicted in Fig. 2, electricity experienced the biggest growth rate over that period (3.4% per year on average) closely followed by natural gas (3.3% per year on average), while other fuels declined over the

---