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Household welfare and CO_2 emission impacts of energy and carbon taxes in Mexico

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ABSTRACT

We analyse the effects of environmental taxes on welfare and carbon emissions at the household level for the case of Mexico. The integrated welfare-environmental analysis, which is based on a censored energy consumer demand system, extends previous work in two ways. First, the estimation of a full matrix of substitution elasticities allows us to test the necessity of incorporating second-order effects into the welfare analysis. Second, the substitution elasticities derived from the demand system are used to estimate the shortrun CO_2 emission-reduction potential. We find that first-order approximations of welfare effects provide reasonable estimates, particularly for carbon taxes. Analog to evidence in other low- and middle-income countries, the taxation of all energy items is found to be regressive, with the exception of motor fuels. The analysis of the emission implications of different tax scenarios indicates that short-run emission reductions at the household level can be substantial - though the effects depend on how revenue is recycled. This effectiveness combined with moderate and manageable adverse distributional impacts renders the carbon tax a preferred mitigation instrument. Considering the large effect of food price increases on poverty and the limited additional emission-saving potential, the inclusion of CH_4 and N_2O in a carbon tax regime is not advisable.

1. Introduction

Mexico has become a major emitter of greenhouse gas emissions in recent decades, with both economic and population growth as driving forces. In response, the Mexican government committed to carbon dioxide emission reductions relative to a baseline scenario and passed a climate change law in 2012 with legally binding emission-reduction goals (Vance, 2012). Additionally, substantial reform efforts have been made in the energy sector since 2013, which may affect energy prices. The oil and gas industry has been opened to competition in the up-, middle-, and downstream sectors, and Mexican households will be subjected to international gasoline prices by 2018. The Federal Electricity Commission (CFE) has been reformed with the objective of forming and regulating a competitive electricity market with incentives for private investment (IEA, 2017). In the residential electricity market, large seasonal subsidies continue to exist in warmer regions of Mexico to cover higher demand for air conditioning (IEA, 2016; Davis et al., 2014; Komives et al., 2009).

While the effects of these reforms on energy consumer prices may be uncertain in some cases (oil sector) or modest in others (gasoline price subsidies), energy subsidy cuts and an ambitious climate policy are likely to increase energy prices in a country with a fossil-fuel reliant energy system. Higher energy prices are thus likely to lead in the short-run to welfare losses that may not be equally distributed. In developed countries, poorer households tend to be more vulnerable to energy price increases, as energy goods usually represent a larger proportion of their total expenditure, with some exceptions for transport fuels (Speck, 1999; Flues and Thomas, 2015). For developing countries, although there is less evidence on the distributional effects, Shah and Whalley (1991) as well as

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Shah and Larsen (1992) pointed out early on that the emerging distributional patterns are apparently different. Recent results in Sterner (2011) and Arze del Granado et al. (2012) show that high-income households capture significantly higher amounts of subsidies for fuels than low-income households. A similar result is found by Datta (2010), who investigates the distributional welfare effects of a fuel tax in India. Gillingham et al. (2006) show that the direct (consumption losses via higher prices) and indirect (income effects) welfare impacts of fuel price increases (both domestic and transport fuels) are either regressive or distributionally neutral in relative terms for a range of developing countries.

For Mexico, recent evidence on the distributional effects of subsidy removal and carbon taxes is provided by Rosas-Flores et al. (2017) who find that a reduction of gasoline subsidies is progressive. In a theoretical general equilibrium model for Mexico, Gonzalez (2012) shows how the distributional effect strongly depend on revenue recycling. While not explicitly covering distributional effects, Rivera et al. (2016) find a possible double dividend for climate policy in Mexico.

Most of the growing partial equilibrium literature on the welfare effects of energy price changes or subsidy reforms focuses on single fuels, with a strong emphasis on gasoline. As households usually spend income on more than just one fuel, an understanding of substitution patterns between fuels and other goods is essential to understanding the welfare effects of energy price changes. With the exception of Rosas-Flores et al. (2017), there is limited evidence for Mexico, where a clear understanding of household responses and welfare effects is particularly critical. In Mexico, nearly half of the population still lives below the official poverty line (Consejo Nacional de Evaluacion de la Politica de Desarrollo Social (CONEVAL, 2014)). Potentially large welfare losses due to higher energy prices are particularly critical in a country with relatively high CO_2 emissions; ambitious climate policy targets; and the need for further economic development, growth, and poverty reduction.

Against this background, the present study adds to the literature in two ways. First, we provide some evidence on the short-run poverty and distributional effects of energy price changes for Mexico. We calculate the welfare impacts of hypothetical price increases for electricity, motor fuels, gas, and public transportation. Since these price changes can be interpreted as environmental taxes, we can also assess how tax revenues can be redistributed for example, by employing cash transfers to households. In addition to assessing price changes for energy items, we simulate the welfare impacts of scaling up the carbon tax that was initially introduced in 2014. By drawing on the demand estimates, we examine whether second-order effects need to be calculated for the welfare analysis in our context. By estimating a censored consumer-demand system, we incorporate the discrete choice to use certain energy types and the exact pattern of substitution between them and other goods. Second, we calculate the short-run CO_2-emission-savings potential of consumer responses due to energy and carbon taxes. CO_2 emissions are calculated from a demand-side perspective on the basis of household consumption, also known as carbon footprints.

The rest of the paper proceeds as follows. First, we present the database on which the analysis is based, with some descriptive statistics, in Section 2. In Section 3 we describe the theory and the closely connected empirical strategy for measuring welfare effects and household-induced CO_2 emissions. We present the results in Section 4, before concluding in Section 5 with some policy recommendations.

2. Household energy use

We use household expenditure data from Encuesta Nacional de Ingresos y Gastos de los Hogares (ENIGH) surveys conducted by the Instituto Nacional De Estadistica y Geografia (INEGI), the national institute for geography and statistics in Mexico. The data are representative at both the national level and for rural and urban areas. They contain itemised expenditure information for every household, as well as an extensive list of variables capturing household and sociodemographic characteristics. The expenditure categories used in the analysis are (1) electricity, (2) motor fuels (including low-/ and high-octane gasoline as well as diesel and gas), (3) gas (aggregate of natural gas and liquefied petroleum gas [LPG]), (4) public transportation, (5) food (excluding alcohol and tobacco), and (6) other goods. Fig. 1 shows the distribution of energy expenditures over

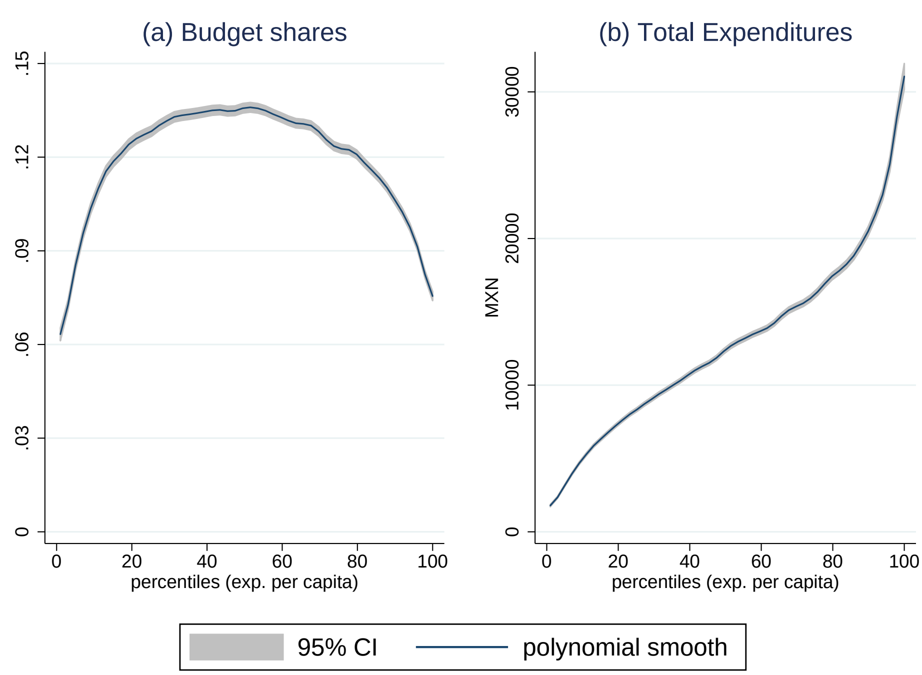

Fig. 1. Energy expenditures.