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Poverty and distributional effects of a carbon tax in Mexico

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ABSTRACT

Mexico recently declared ambitious goals in reducing domestic CO_2 emissions and introduced a carbon tax in 2014. Although negative effects on household welfare and related poverty measures are widely discussed as possible consequences, empirical evidence is missing. We try to fill this gap by simulating an input-output model coupled with household survey data to examine the welfare effects of different carbon tax rates over the income distribution. The currently effective tax rate is small and has negligible effects on household welfare. Higher simulated tax rates, maintaining the current tax base, show a slight progressivity but welfare losses remain moderate. Welfare losses, regressivity and poverty rise more with widening the tax base towards natural gas and the other greenhouse gases methane (CH_4) and nitrous oxide (N_2O) mainly through food price increases. For a complete analysis of the policy, we simulate a redistribution of calculated tax revenues and find that the resulting effects become highly progressive, also for high rates, wider tax bases and even in the absence of perfect targeting of social welfare programs.

1. Introduction

Among the group of middle income countries, Mexico has become one of the most significant emitters of CO_2 in absolute and per capita terms in recent years. In 2014, it was ranked the 15th biggest economy and the 12th biggest carbon emitter in the world with more economic growth and fossil fuel intensive energy use to be expected in the future (Olivier et al., 2015; World Bank, 2016). Since the beginning of the 1970s, emissions have increased by over 350%, reflecting both per capita economic and large population growth (Fig. 1). On average, income per capita has increased by over 80 and carbon emissions per capita by over 100%. This unequal growth rates can be linked to the rising carbon intensity (CO_2/GDP) of the economy until the 1990s; since then we observe a decline accompanied by more efficient energy use. Although the economy became less carbon intensive, energy efficiency improvements since 2000 have been small.

Among Mexican policymakers, a rising awareness of this development can be observed over recent years. Mexico started to voluntarily commit itself to greenhouse gas emission reduction targets in 2010 at the Cancun Climate Change Conference. In 2013, the government launched additional and further reaching reforms to the Mexican energy markets and thus prepared the ground for a green fiscal reform (Metcalf, 2015). In October 2013, the Mexican Congress approved the Government's proposal of a tax on the sale and import of fossil fuels which came into effect on January 1, 2014, making Mexico the first non-developed country to adopt such a policy. The price of the proposed carbon tax was calculated by weighting the carbon price of various international markets and the carbon content of each fossil fuel sold in Mexico using emission factors of the combustion process. However, the tax is not levied on all emissions but only on those generated by fossil fuels other than natural gas and jet fuel. The currently rather low tax rate with major exceptions in the tax base is unlikely to create large disincentives for the use of fossil fuels. In 2015, Mexico submitted its Nationally Determined Contribution (NDC) to the UNFCCC in 2015 as the first middle income country. Although the instruments to realize the planned emission savings are not mentioned in detail, an increase in the carbon price appears as one highly suitable candidate. If Mexico wants to change its growth path towards a low carbon pathway as discussed in its national climate strategy and its NDC pledges, a massive decarbonization of the energy system is the major challenge. Additionally, the taxation of other greenhouse gases such as NH4 and N_2O could widen the tax base significantly.

A scaled up carbon tax with higher tax rates and a wider tax base could on the other hand create severe conflicts with development and social equity goals such as distributional and poverty outcomes. However, the final effect of environmental taxation on household welfare is less than straightforward as has been pointed out by Fullerton (2008, 2011). In the short-run, prices of fossil-fuel intensive products are likely to rise which affects the consumption costs of households, the so called “uses” side. For developed countries, a general finding is a

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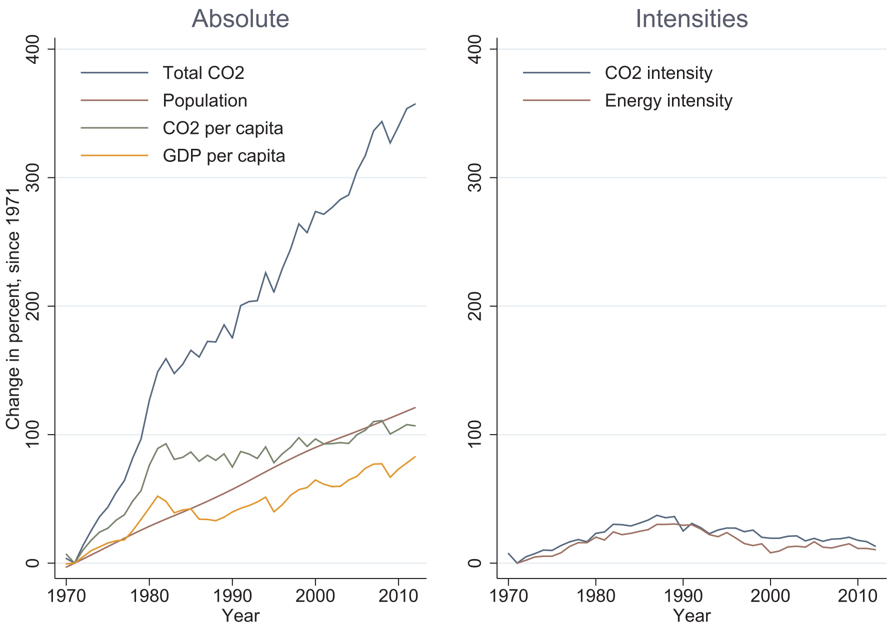

Fig. 1. CO_2 emissions, GDP and CO_2 intensities Mexico.

regressive effect for household consumption, reflecting a negative relation between spending shares of carbon intensive items and total consumption expenditures (Brännlund and Nordström, 2004; Wier et al., 2005; Kerkhof et al., 2008; Callan et al., 2009; Metcalf, 2008; Rausch et al., 2011). A regressive effect is not found for every developed country though. Labandeira and Labeaga (1999) and Tiezzi (2005) do not find regressive effects of carbon tax scenarios for Spain and Italy respectively. For developing countries, the regressivity result does not need to hold as well, particularly due to often lower energy spending shares for the poor Shah and Larsen (1992). Still, empirical results are largely missing with some exceptions and mixed results for China. Brenner et al. (2007) find regressive effects while Liang and Wei (2012) and Liang et al. (2013) find carbon taxation to lead to progressive results.

Beyond the very short-run, more effects are gaining in importance. Depending on how factor demand changes through the price increase, the income of workers or capital owners will be affected through the "sources" side. Additionally, the distribution of resulting environmental benefits such as reduced air pollution, employment effects and the capitalization into asset prices may change the distributional burden over time. Empirical evidence for these mid- to long-term effects is missing but analytical and ex-ante general equilibrium modelling can provide some orientation. Fullerton and Heutel (2007) describe the effects of carbon taxation on the different factor prices and conclude they depend critically on the substitutability of capital, labor, and emissions. Eventually, redistribution of tax revenues has the potential to make any carbon tax reform progressive, although as Rausch et al. (2011) notes, this may come at the cost of efficiency.

For Mexico, we neither find ex-post evidence nor ex-ante simulation results for the effects of a carbon tax in the literature. Gonzalez (2012) uses an analytical general equilibrium model to simulate a stylized carbon tax scenario for Mexico and finds that the direction of the effect is determined by the way the tax revenue is recycled. Redistribution towards food subsidies would lead to an overall progressive effect.

With no empirical analysis available for Mexico and little evidence for low- and middle income countries in general, we try to fill the gap in the literature by simulating carbon tax scenarios for Mexico and examine poverty and distributional effects. The simulation is based on an input-output model to calculate carbon intensities of various product categories. We match the production side with consumption expenditure on the household level in order to determine the short-run impact of carbon tax scenarios on household welfare. Besides calculating welfare effects for the current tax regime in place, we add scenarios including more CO_2 emissions from natural gas, jet fuel and other greenhouse gas emissions from methane (CH_4) and nitrous oxide (N_2O). We also include redistribution scenarios and check for welfare effects of border tax adjustments.

The rest of the paper proceeds as follows. In Section 2 we describe the methodology of the input-output model and the integration with the household consumption side used in the analysis. In Section 3, we describe the data and general trends in emissions, energy use, consumption and poverty are supplied as background material for the analysis in Section 4. We summarize results and provide some policy recommendations in Section 5.

2. Methodology

Our analysis consists of two steps, which have been applied in the previous literature on the calculation of price effects of carbon taxes (Proops et al., 1993; Symons et al., 1994; Cornwell and Creedy, 1996; Labandeira and Labeaga, 2002). First, we calculate sector specific price changes following a taxation of CO_2 emissions by drawing on an environmentally extended input-output model. In the second step the price changes are translated into welfare effects on the household level.

2.1. Input-output analysis and price changes per sector

We obtain carbon intensities of production sectors (Table 1) by combining input-output tables with energy and emission data taken from the World Input Output Database (Timmer et al., 2015).

The resulting carbon intensities per production sector contain direct as well as indirect emissions from other sectors. By assumption, production is described by a Leontief production function which implies no substitution between sectors so that price increases are fully shifted towards consumers. The model is theoretically valid for small tax changes in the short-run but increases in uncertainty with time and the size of the tax. For calculating the carbon intensities we follow Proops et al. (1993) and distinguish between different fuel types as these naturally contain different amounts of CO_2 per physical unit.[1] Total fossil fuel use per energy carrier is represented by F_f, whereby f

[1] Fossil fuels included are hard coal, brown coal, coke, diesel, gasoline, light fuel oil, fuel oil, naphtha, other petroleum and other gases excluding natural gas.