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Carbon tax or emissions trading? An analysis of economic and political feasibility of policy mechanisms for greenhouse gas emissions reduction in the Mexican power sector

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ABSTRACT

This study provides a comparative assessment of carbon-pricing instruments for the Mexican electricity sector, contrasting a carbon tax with an emissions trading scheme (ETS). The assessment is performed in terms of economic impacts and political feasibility. Model-based scenarios considering different price and quantity levels are analyzed on Balmorel-MX, a cost optimization bottom-up model of the Mexican electricity system. The political feasibility is evaluated using an online survey and interviews with representatives of relevant stakeholder groups. The assessment suggests that an ETS is the most appropriate instrument for the Mexican case. We recommend to set the cap as 31% abatement in relation to a baseline, which is suggested to be 102 $MtCO_2$ by 2030, given the business-as-usual baseline used as reference by the Mexican government (202 $MtCO_2$) is found to leave cost-effective abatement potential untapped. An emission trading system with such design has higher cost-efficiency and lower distributional effects than a carbon tax at equivalent ambition level (15 USD/tCO_2). The political feasibility analysis confirms the assessment, as it is in line with the priorities of the stakeholder groups, allows earmarking carbon revenue and avoids exempting natural gas from carbon pricing.

1. Introduction

Accumulation of anthropogenic greenhouse gas (GHG) emissions in the atmosphere is "extremely likely to have been the dominant cause" of the observed increase of average global temperatures since the mid-20th century (Intergovernmental Panel on Climate Change, 2014). This change in climatic conditions impacts natural and human systems, and threatens to cause substantial damages in the short, medium and long-term (Ibid.)

Amongst the instruments that exist to tackle the challenge of reducing emissions, market-based instruments are preferred when there is important variation in the marginal abatement costs across economic sectors (Baumol and Oates, 1988), as is the case with GHG emissions reduction. By putting a common explicit price on the carbon emission, abatement costs are equalized and emission reductions can be achieved in the most efficient way (Hansjürgens, 2005). Two alternative carbon-pricing instruments, carbon tax (CT) and emissions trading scheme (ETS), are theoretically equivalent in a situation of perfect foresight and certainty, and thus the carbon shadow price set by the market in an ETS would correspond to the optimal tax level established in a CT policy (Baumol and Oates, 1988; Speck, 1999). In practice, however, uncertainty and market imperfections lead to significant differences between the two instruments (Baumol and Oates, 1988; Weitzman, 1974).

Economic research on climate policy instruments has traditionally been normative, focusing on selecting and designing a "first-best" instrument that will maximize social welfare (Goulder and Pizer, 2006), independent of the preferences of powerful stakeholder groups, or the challenges associated with institutional and legal contexts. Although valuable, this approach overlooks the widely recognized gap between normative theory and positive reality (Ellerman, 2015). A positive evaluation of the political feasibility of optimally designed instruments allows to hint a "second-best" alternative with a better probability of being fully implemented, a possibility which has previously been discussed in Bennear and Stavins (2007), Jenkins (2014) and Lehmann (2013). The conclusions of both assessments may also be complementary and point to the same direction.

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Mexico has pledged to reduce its GHG emissions, as stated in its nationally determined contributions (NDC) communicated to the United Nations Framework Convention for Climate Change (UNFCCC) in 2015 (Gobierno de México, 2015a), recently committed in a reform of its *General Law on Climate Change* published on July 2018 (Presidencia de la República, 2018). Mexico's emissions totaled 665 $MtCO_2$-eq in 2013 (Instituto Nacional de Ecología y Cambio Climático, 2013) and comprised approximately 1.5% of the global emissions (World Resources Institute, 2015). A recent energy reform carried out in the country transformed the structure of the power sector and created an electricity market, offering the possibility to introduce efficient market-based instruments to decarbonize electricity generation, which accounts for approximately 20% of the country's GHG emissions. Since then, there have been timid attempts to introduce a CT and an ETS in the country. The CT was indeed introduced in 2013, but it is far below the value originally recommended to the Mexican Congress (SEMARNAT, 2014). An ETS capacity-building exercise phase concluded in June 2018, and a three-year pilot program is set to begin in 2019 (Grupo BMV, 2018).

The presence of both carbon-pricing instruments in the rising Mexican climate policy mix raises the following question: what is the most appropriate carbon-pricing instrument for reducing GHG emissions in the Mexican power sector in terms of economic effects and political feasibility? To answer this question, we performed an economic assessment using model-based scenarios for policy implication analysis, through a bottom-up optimization tool. Additionally, we assessed the political feasibility of the instruments through an online survey and in-depth interviews with relevant stakeholders in the climate policy development process.

Decarbonization of the Mexican economy has previously been explored to determine deep decarbonization pathways by comparing energy and economy models from the CLIMACAP-LAMP project (Veysey et al., 2016), and through macroeconomic scenario analysis assessing the medium and long-term impacts of various CT revenue recycling strategies (Landa Rivera et al., 2016). Existing scenario-based analysis of the Mexican electricity system have focused on determining the renewable/fossil fuel power combination with the highest cost-benefit ratio (Islas et al., 2003); establishing the optimal mix of renewables (Vidal-Amaro et al., 2015); detecting supply and demand-side high-impact mitigation options (Grande-Acosta and Islas-Samperio, 2017); and assessing the short-term implications of long-term ambitious climate targets with regards to the development of a gas-based power system (Solano-Rodríguez et al., 2018). The role played by certain technologies, such as efficient cogeneration, for meeting the country's clean energy goals has also been studied (Llamas and Probst, 2018).

Carbon-pricing policy evaluation has mainly been centered around the distributional impacts of a Mexican CT (Gonzalez, 2012; Renner, 2018; Rosas-Flores et al., 2017). Mehling and Dimantchev (2017) have assessed carbon-pricing policy mixes aimed at reaching the Mexican mitigation targets, using a qualitative analysis of international experiences and quantitative model-based scenarios on a system dynamics model covering the electricity, transportation, buildings, industry, and land-use sectors.

Our research focuses exclusively on the power sector, but introduces a bottom-up approach with detailed technological representation to ensure that decarbonization targets are not only economically efficient but also technically feasible. In addition, marginal abatement costs are endogenously calculated as a result of the optimization, which avoids underestimating or overestimating the potential for low-carbon technologies in the power system. A comprehensive comparative assessment of a CT and ETS to decarbonize the Mexican electricity sector, incorporating the economic impacts and political feasibility (characterized as a struggle between stakeholders with different levels of influence) has not been performed before, thus this study will fill a research gap.

The paper is organized as follows. After this introduction, Section 2 provides a background on the Mexican policy context. Section 3 will outline the methods of research, followed by Section 4 which describes the data sets. Sections 5 and 6 present and discuss the results of the model-based scenarios and the survey and interviews, respectively. The conclusions and policy recommendations are presented in Section 7.

2. Policy background for Mexico

The Mexican electricity sector is undergoing a period of profound transformation. In this context, the legal and institutional framework, which had been the status quo for the past decades, is being renewed in line with the recent Energy reform (Chanona Robles, 2016). Enacted in 2013, one of the most publicized objectives of the reform was to reduce the cost of energy, including the electricity tariffs (Presidencia de la República, 2013). Following an initial “partial liberalization” of the electricity sector in 1992 (Ramírez-Camperos et al., 2013), which allowed private participation in the electricity generation under a single-buyer system, private competition is now allowed in both electricity generation and commercialization through a newly created wholesale electricity market (Presidencia de la República, 2014).

Mexico was the second country in the world to adopt a comprehensive legislation package on climate change –the *General Law on Climate Change*–, after the UK (International Energy Agency, 2016; SEMARNAT-INECC, 2016), and the first emerging country to set an absolute emissions reduction target for 2050 (ECOFYS, Climate Analytics, 2012). The Law gives the Federal government the faculty of establishing and designing the necessary “economic, fiscal, financial and market instruments” for climate change mitigation (Presidencia de la República, 2012). In particular, it gives the Ministry of Environment and Natural Resources (SEMARNAT) the faculty of establishing an emissions trading scheme, which was made mandatory in the reform of the *General Law on Climate Change* enacted on July 2018 (Presidencia de la República, 2018). The reform requires the establishment of a 3-year pilot program with “no economic effects”. The Law of the Electricity Sector, enacted as part of the Energy Reform, establishes the obligation of the electricity sector to participate in market-based mechanisms for emissions reduction which SEMARNAT decides upon (Presidencia de la República, 2014).

Amendments made to the *Law of Special Tax on Products and Services* in 2013 to levy the carbon contents of fuels effectively constituted the first Mexican CT (SHCP, 2013). Originally, the value of the CT presented to congress was meant to be set at approximately 5 USD/tCO_2[1] for all fuels (see Table 1). The real tax was set in 2013 at a value between 8% and 66% of the proposed value depending on the fuel, and at 0 USD/tCO_2 for natural gas (SHCP, 2016) (SEMARNAT, 2014). The CT value has increased gradually, and effective as of January 2018 varies between 10% and 78% of the initial proposed value, although the zero-rate is maintained for natural gas (SHCP, 2017).

Meanwhile, SEMARNAT and the Mexican Stock Exchange ran a capacity-building ETS simulation exercise, which concluded in June 2018 (Grupo BMV, 2018; SEMARNAT, 2017). More than 90 companies representing 67% of the national GHG emissions participated in the exercise phase (Grupo BMV, 2017).

Additionally, the *Law of the Energy Transition* (Presidencia de la República, 2015) set a goal of 25% electricity generation by clean sources (defined in the Law as renewables, nuclear, efficient co-generation and fossil-fuel powered power plants with carbon capture and storage technologies) by 2018, 30% by 2021, and 35% by 2024. Furthermore, a Clean Energy Certificates market was established with mandatory obligations to be fulfilled starting 2018 (SENER, 2015).

[1] The exchange rate in 2013, when the amendments were enacted, was 12.8 MXN/USD.