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Economic impact of ethanol promotion in Mexico: A general equilibrium analysis

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ABSTRACT

In this paper we analyze the economic impact of a decision to produce ethanol in Mexico, comparing the effect of a subsidy to initiate ethanol production with that of alternative public policies. Public support of biofuels has been a public policy goal since 2008, and the promotion of ethanol remains an active part of the government agenda. The evidence used to encourage or alter the policy is (by necessity) chiefly based on international experience. In this study we use a computable general equilibrium model (CGE) to estimate the impact of ethanol production on the Mexican economy. Using cost data from Brazil we introduce ethanol into a Mexican social accounting matrix, and insert a latent sector into the model to analyze ethanol promotion. Our results show that subsidies to ethanol would increase agriculture production but at the expense of aggregate welfare. By contrast, alternative "clean energy" policies appear to advance economic growth to a greater extent.

1. Introduction

Over the course of the past decade there has been a debate among policymakers in Mexico regarding the viability of biofuels as an alternative energy source. Opponents of the promotion of fuels such as ethanol point out that it would distort prices in agricultural markets and exacerbate existing problems, such as nonpoint water pollution and water security without significantly enhancing energy security or alleviating climate change concerns. Advocates of biofuels, on the other hand, stress their potential to lower greenhouse gases (GHG), foster rural development, and increase the share of fuels coming from renewable sources. Given this controversy, it is relevant to quantifiably measure how ethanol production contributes to Mexico's national economic and environmental objectives.

Historically, in the case of Mexico, biofuels were proposed as an option to address the problem of global climate change. Therefore, even though the country has vast existing reserves of fossil fuels, policymakers made the decision to foster the use of biofuels in general, and ethanol in particular. They were soon joined in this effort by ethanol producers themselves who touted its potential environmental advantages along with its possible benefits to energy security and rural development.

The "Law for Bioenergetics Promotion and Development", enacted in 2008, established an inter-ministerial commission in charge of implementing the policy, with members from the environmental, energy, agricultural, and finance ministries. This Commission was unable to implement a policy for more than six years. The policy, however, remained an active agenda item. Presently only a few supply contracts have been signed, to supply but the policy is (slowly) being implemented. Its potential impact on the energy sector, the agricultural sector, and the aggregate economy, however, is largely unknown.

Before committing significant resources to ethanol development, Mexican policy makers need to address two fundamental questions. First, what would be the economic benefits and costs of such a policy? And second, how do these benefits and costs compare to alternative policies? More specifically, it is important to understand to what extent ethanol promotion can foster growth in the agriculture and manufacturing sectors, how it modifies land use to the benefit or detriment of other activities, as well as its impacts on the economy as a whole. The effects of this policy should then be compared to that of alternative policies, using tools that allow for the analysis of economy wide impacts.

This paper evaluates the impact of an ethanol subsidy on GDP, sectoral production, consumption and social welfare, building and adapting a computable general equilibrium model (CGE) for Mexico. These results are then compared to impact of similar subsidies applied to renewables, to improvement in automobile efficiency, and to the development of organic fertilizers respectively. All of the above have

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been considered by policy makers as options to reduce GHG emissions.

In order to adequately simulate the ethanol promotion policy, we modify the social accounting matrix (SAM) to generate a latent activity on the supply side of the economy that becomes active when the subsidization policy is implemented. Estimates on sugar cane ethanol costs are calculated and adapted from Brazilian sources based on their experience. Furthermore, the agriculture and livestock sectors of our model are modified to directly assess potential land use changes. The effects of an ethanol subsidy are then compared with the impact of alternative policies which focus on more than one of the stated objectives of ethanol promotion.

The rest of the paper is organized as follows. In Section 2, we analyze the existing literature on biofuels and review previous CGE modeling efforts in order to place our analysis within the context of current research on this subject. Section 3 explains the fundamental assumptions behind our model along with the modifications required to simulate ethanol policy as a latent activity, and to integrate land use into to the analysis. Section 4 describes the ethanol simulations along with our simulations of alternative policies on renewable energy, transport efficiency, and bio-fertilizers. Finally, in Section 5 we discuss and compare the results of our various scenarios and discuss their policy implications.

2. Literature review

The production and consumption of biofuels have historically been integrated into general equilibrium models by means of three distinct methods: (1) by implicitly modeling the biofuel sector, replacing fossil fuels by biomass inputs in the production function; (2) by disaggregating the social accounting matrix (SAM); or (3) by modeling this sector as a latent technology. Following Kretschmer and Peterson (2009), we summarize the various existing models and differentiate them by the types of methods used.

Several studies analyze the EU and US biofuel policies based on the Global Trade Analysis Project (GTAP) database. GTAP developed several extensions in order to adequately represent the presence of biofuels in production and consumption, GTAP6 introduced biofuels, GTAP-BIO separated by-products of ethanol and biodiesel, and GTAP-AEZ identified agro-ecological zones. Global models such as the EPPA model from MIT, the extended HTB model, the DART, and the GTAP models have extensively analyzed a variety of biofuel policies in the EU and the US (Kretschmer et al., 2008; Reilly and Paltsev, 2007; Taheripour et al., 2008, 2010; Hertel et al., 2008). These analyses concentrate on the implications of such programs for agricultural production as well as their impact on biofuel producers. Most of these studies use the information on inputs, costs and production contained in the existing databases and use disaggregated biofuels in the SAM itself. A few, however, introduce latent activities into their models and examine the subsidies needed to reach pre-specified production targets (Kretschmer et al., 2008), while simultaneously evaluating their effects on agricultural markets (Kretschmer et al., 2008; Reilly and Paltsev, 2007).

More recently, Hoefnagel et al. (2013) integrated the GTAP6 database with a bottom up model to analyze country specific effects of ethanol policy. They studied promotion policies, taking biofuels as an implicit activity in the electricity, transport and chemical sectors. Cansino et al. (2012) also assessed ethanol promotion policies using implicit technologies to quantify their effects on macroeconomic variables. They, however, used a specific database for a particular region.

In other studies, country or region specific CGE analyses disaggregate their SAMs to incorporate inputs and outputs from biofuel sectors, examining the trade-off between fossil fuels and biofuels, the impact on domestic food supply (Doumax et al., 2014; Ge et al., 2014; Arndt et al., 2012), the net effect on aggregate variables, such as government revenues, employment, and the aggregate economy (Wianwiwat and Asafu-Adjaye, 2013; Dixon et al., 2007; Arndt et al., 2012). Yet, the assumption of an existing biofuel sector in the economy can still be questioned when one is dealing with countries without existing production.[1]

The approach taken here is to model ethanol production as a “latent technology”. This method closely mimics the situation in Mexico, where a technology is poised to produce but is not yet active in the base scenario due to the lack of sufficient profits. The activity becomes active when a specific policy or event changes the initial situation. This technique is information intensive requiring knowledge about both input and cost structures. Its advantage, however is that all relevant linkages are captured.

In order to fully model the impact of biofuel policies on rural development, poverty reduction and welfare improvement, it is essential to disaggregate households according to their income, and disaggregate primarily rural sectors from urban ones. Frequently, CGE models only have one representative consumer. If the model, however can be disaggregated into different household groups, the effects on poverty and unemployment are much clearer to see. Arndt et al. (2012) for example identify rural farms, non-rural farms, and urban groups in order to analyze the ethanol production in Tanzania, dividing each group into quintiles. This allows them to then focus on the group that is being targeted by the policy in question.

3. Theoretical framework

Our work follows the tradition of computable general equilibrium modeling and is largely based on earlier work by Ballard et al. (1985), and Shoven and Whalley (1984). The model is based on Rutherford's work on nonlinear complementarity problems and utilizes the solution algorithm MPSGE (Rutherford, 1987, 1999; Böhringer et al., 2011) developed by Rutherford and integrated into the Generalized Algebraic Modeling System (GAMS).

The model employed is based on Boyd and Ibarrarán's model (Boyd and Ibarrarán, 2002, 2008), a dynamic CGE model specific for Mexico. The Boyd-Ibarrarán model has been used and adapted since the 1990s to simulate policies related to trade and later to address climate change mitigation and adaptation policies, energy policies, and carbon taxes (Centro Mario Molina, 2010); Boyd and Ibarrarán, 2002, 2006; Boyd and Ibarrarán, 2009). Energy subsidies are explicitly treated in the model, as well as the presence of a dual labor market (i.e. formal and informal (see Anton et al., 2016, and Ibarrarán et al., 2015)).

Our model is closely related to that one with several modifications. First, and most importantly the agricultural and livestock sectors have been augmented to account for the share of land as a productive factor, in addition to those of labor and capital. Second, this model has been modified to reflect the introduction of latent activities in the energy sector,[2] and third it is static rather than dynamic in nature. While the use of a static model avoids the complications of dealing with fixed inputs (e.g. land) in a dynamic context[3] it does imply that our results should be viewed as holding over an intermediate (3–5 year) period of time rather than over a more extended time horizon.

3.1. The model

The introduction of a latent activity in the social accounting matrix (SAM) will, of course lead to economic shocks following the implementation of an ethanol promotion policy. The lack of available

[1] Non producer countries or regions may define a non-relevant quantity as the initial production level. However, this can result in a modeling obstacle, since subsidies needed to detonate this activity tend to be unmanageable in percentage terms.

[2] A latent sector is a production activity that is unused for certain values of the parameters and active for others.

[3] Unlike capital and labor, (fixed) land cannot be modeled as tending to a steady state rate of growth, and, hence cannot easily be modeled within a dynamic CGE framework.