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Regional Credit Trading: Economic and GHG Impacts of a National Low Carbon Fuel Standard

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Description of the Problem

In the quest to reduce greenhouse gas (GHG) emissions regulators face the question of whether to target specific sectors of the economy or simply set reduction targets for the nation as a whole. Most economic models projecting the effects of economy-wide carbon targets find that the transportation sector is likely to be unresponsive to carbon pricing compared to other sectors of the economy. Thus, if the transport sector is to play a significant role in reducing GHG emissions, sector-specific policies may be necessary. No single technology or policy action offers a promising means of achieving 50% - 80% reductions in transport sector emissions. This level of emission reduction calls for a mix of technologies, policies, and strategies. The mix will likely require sustained increases in vehicle fuel economy, switching to fuels that emit lower GHGs per mile, and reducing the demand for transport services through actions ranging from modal diversion to changing urban form. Addressing the *fuel* side of the fuel-vehicle unit is EPA's Renewable Fuel Standard (RFS), implemented pursuant to the Energy Policy Act of 2005 (EPACT). It was updated by the Energy Independence and Security Act of 2007 (EISA) and is now generally known as RFS2. EISA established minimum annual volume requirements - and minimum GHG reduction targets - for several categories of renewable fuels that must be sold by producers and importers of petroleum-based transportation. A national low carbon fuel standard (LCFS) would set the maximum average carbon intensity for fuel supplied to the road transport sector. The critical difference between RFS2 and a LCFS is that the former specifies volume targets for broad categories of biofuels, while the latter specifies an average carbon intensity (CI) across all fuels, including natural gas and electricity, without any requirement for volumes of specific fuels. Moreover, a LCFS is thought to have two distinct advantages over a RFS. First, a LCFS is technologically neutral, meaning it does not promote any type of fuel (i.e., biofuel) or fuel-vehicle system over another. Secondly, a LCFS, unlike a RFS, rewards inframarginal reductions in CI. That is, rather than viewing each fuel as attaining a particular biofuel carbon target or not, as is done in the RFS2 program, it also rewards further reductions in CI for fuels within each category.

Approach & Methodology

To quantitatively estimate the regional impacts of a LCFS we adapt the Transportation Regulation and Credit Trading (TRACT) Model (Rubin and Leiby, 2013) to account for regional differences in fuel availability, carbon intensity, fuel costs (taxes) and projected use of low carbon fuels due to the existing and proposed regional low carbon fuel programs. The simulation model implements the partial equilibrium equations and is solved using GAMS non-linear optimization algorithms.

The actual level of carbon emissions for each fuel is based on the firm's choice of feedstock, production, refining and transportation technologies. For each firm and fuel class *v*, the total credits (or deficits) generated (G) each year (in units of grams CO_2e) is given by the quantity of emissions below (or above) what would have been allowed at the regulatory standard CI:

$$G_v = \sum_{f \in F_v} \sum_{r \in R} R_{fvr} \, E_f \tag{1}$$

Here, for each fuel *f* and region *r,* variable R_{fvr} is the amount by which the replacement fuel CI $\left(I_{fr}\omega\right)$ differs from standard fuel CI $(\overline{I_v})$ adjusted for motive energy efficiency, ϵ_{fv}, for fuel in category *v* (e.g., gasoline or diesel). In other words, R_{fvr} gives *the rate of credit generation* in units of grams CO_2e per megajoule of fuel sold (adjusted for motive energy). The sum in Eq. (2) is over all fuels that can replace fuel category *v* in region *r*. Without credit trading or banking, or any other flexibility provision, the LCFS would require that G_v be non-negative for each firm and year. In determining *R,* we also allow for a reference CI scaling parameter $\overline{\omega}_{fv}$ and choice variable is ω_{fvr} to account for different carbon intensities of conventional and replacement fuels.

$$\begin{aligned} \mathrm{R_{fv}} &\equiv \left(\left(\overline{\mathrm{I_v}} - \frac{\mathrm{I_{fr}}\omega}{\epsilon_{fv}}\right) \cdot \epsilon_{fv}\right) \\ &= \overline{\mathrm{I_v}}\epsilon_{fv} - \mathrm{I_{fr}}\omega_{\mathrm{fvr}} \end{aligned} \tag{2}$$

The primary sources of data are the Annual Energy Outlook (AEO) 2012, BioTrans, and the GREET and VISION models from Argonne National Laboratory (see Rubin et al. 2014 cited below for the references to these models). GREET is a full life-cycle model that evaluates energy and emission impacts of advanced and new transportation fuels. VISION is a vehicle stock, energy usage, and emissions model developed by

Argonne National Laboratory. The data from VISION relate to PHEV usage by electricity and motor gasoline as well as ratios of BEV to PHEV electricity usage. The 2012 AEO provides reference fuel usage by census division, with the limitation of non-specific biodiesel and cellulosic ethanol sources. The costs of production for advanced biofuels are computed by fitting supply curves to varying regional production levels and costs within BioTrans. The primary source of CI estimates is GREET.

Findings

When credit trading between regions and fuel sectors is not allowed, but credit banking is permitted we find that most regions face a sharply binding constraint that leads to use of safety-valve credits by 2025. Additionally, prior year credit prices rise smoothly to the safety-valve level due to intertemporal arbitrage through banking. The difference in credit prices between divisions reflects regional fuel use, CI, and predominantly biofuel supplies. The East North Central (ENC) region, including Illinois, Indiana, Wisconsin, Michigan and Ohio, is able to meet the LCFS at lowest cost. The diesel category shows a similar pattern of regional diversity, but the standard reaches the safety valve price earlier reflecting the lower availability of biofuel substitutes for diesel. An interesting result is that while emissions for the nation as a whole decline, individual regions decrease or increase their emissions depending on regional costs and fuel use. The dip and then rise in the national GHG emission curve reflects the CI standard declining through 2025 to a 10% reduction, eventually offset by growth in fuel demand, primarily from the diesel sector.

The degree of flexibility in the LCFS implementation has a substantial impact on regulatory cost. Flexibility may be included by allowing credit trading across fuel categories (gasoline or diesel), across regions and over time (banking). We determine the percentage savings relative to having no flexibility – all regions and fuel classes must meet the LCFS target on their own in each period without being able to bank credits for future use. These are determined for control costs alone and when we include the benefits of reduced GHG emissions valued at $50 per metric ton (3% discount rate) avoided based on recent guidance from the EPA. The avoided damages are, depending on the case, about 30% -50% of the control costs. The greatest gains come with the largest amount of flexibility (approximately 25-40% cost reductions), as expected. It is noteworthy that when we isolate the impact of regions trading credits for similar fuel classes (gasoline credits for gasoline credits), regional diversity adds about a third of the total reductions in costs. Banking (time flexibility) and credit trading between fuel categories are estimated to have lesser yet still significant benefits in terms of cost reductions as well. When considering both control costs and the benefits of GHG emission reductions, the value of added flexibility is even more valuable. This is because lower compliance cost mean that the safety value credit price is reached in fewer years leading to additional avoided emissions (damages).

Conclusions and Recommendations

This research looks at the costs and impacts of implementing a LCFS given the major existing regulations of CAFE, RFS2 and California LCFS that impact the on-road transportation sector. Rather than treat the nation as a whole, we implement the national policy at the level of the 9 census districts. We find significantly different costs of compliance by region. At the same time, flexibility mechanisms in such as credit trading and banking can lower costs substantially. We conclude that a national LCFS implemented at the regional level may be a promising way to reform RFS2 to allow for greater GHG emission reductions and provide for greater regulatory flexibility.

Results Achieved

Rubin, Jonathan, Paul Leiby, Maxwell Brown, "Regional Credit Trading: Economic and GHG Impacts of a National Low Carbon Fuel Standard," *Transportation Research Record: Journal of the Transportation Research Board 2454, pp. 28-35 (2014).*

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Rubin, Jonathan and Paul Leiby, “National Low Carbon Fuel Standard: Economics and Energy Security,” A Clean Fuel Sector for the Northeast and Mid-Atlantic, Pace Energy & Climate Center, Pace Law School, New York City,13 January 2013