[*INVESTIGATING THE POTENTIAL IMPACTS OF A LOW-CARBON FUEL STANDARD.*]

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Overview

In 2017, CO2 emissions from the transportation sector surpassed emissions from the electric power sector in the United States. This was an important milestone as the electric power sector had been the largest emitter for quite some time. Several notable factors underlie this shift in emissions, including a significant decline in emissions from power plants, while transportation emission returned to an upward trajectory (after the great recession).

To combat the increasing nature of emissions related to transportation, several governments have adopted low-carbon fuel standards (LCFS). The aim of the program is to lower the carbon intensity (CI) of transportation fuels, via a cost basis on manufacturers, by setting long-term reduction targets and incentivizing manufacturers to incorporate (blend) less carbon intense fuels. The jurisdictions that have implemented such a program include California, Oregon, British Columbia and Europe. California's LCFS, established in 2011, initially aimed for a 20% reduction by 2030 but has since raised its targets. Recently, Minnesota proposed a LCFS, seeking to reduce emission by 25% by 2030, increasing to 100% by 2050.

Research highlights several benefits from LCFS programs, including significant GHG reductions, strong public support, and increased investment in lower-carbon fuels and infrastructure. The combination of California's LCFS and the federal Renewable Fuel Standard (RFS) has also accelerated renewable fuel adoption. To comply with the standard, fuel producers generating CI deficits must blend lower-carbon fuels with the petroleum products they make or purchase credits from other fuel producers (Jordan et al., 2021). Imposing a cost on fuel producers, the question of pass-through to end consumers arises. However, retail gasoline prices — the price consumers pay at the pump — are influenced by multiple factors.

According to Chouinard and Perloff (2007), a plurality of factors affect retail gasoline prices, including demand, cost, market power, differences in government policies, and geographic location. According to the Energy Information Administration Energy Information Adminstration (2024b), crude oil prices are the largest single contributor, accounting for approximately 55% of the retail price of gasoline. The magnitude of this component is unsurprising given its essential role in the production of both regular gasoline and diesel fuel. Indeed, the strength of this relationship is demonstrable via a comparison between the price of U.S. crude oil — as represented by the benchmark West Texas Intermediate - with U.S. retail gasoline prices. Over the period June 2000 to April 2024 the correlation coefficient is 0.9355, indicative of a strong, positive relationship between the two prices.

Other salient features driving the retail price of gasoline include taxes, refining costs and distribution. Taxes imposed across multiple levels of government contributed approximately 16% to the retail price of a regular gallon of gasoline (Energy Information Adminstration, 2024a). Currently, federal taxes include an $0.183 per gallon excise tax and a fee of $0.001 per gallon for the Environmental Protection Agency's Leaking Underground Storage Tank Trust Find. Environmental compliance costs associated with refining crude oil are significant and multifaceted, as refineries must adhere to strict regulations aimed at minimizing pollution and environmental impact. According to Brown et al. (2008), the implementation of the federal Clean Air Act amendments in 1990 led to distinct changes in gasoline formulation requirements. The law, which stipulated gasoline content requirements for metropolitan areas with air pollution levels above predetermined federal thresholds, effectively divided previously unified wholesale gasoline markets into geographically segmented regions. Different states or regions have unique fuel specifications based on local environmental regulations that can also add to refining costs. For example, California has stricter standards due to its commitment to reducing air pollution.

As LCFS programs have emerged as a policy tool to address climate change, interest lies in evaluating the impact of such policies on gasoline prices. A 2024 fact-sheet created by the California Air Resources Board (2024) (CARB) — the agency that governs California's LCFS program — visually presents the relationship between retail gas prices in California and the LCFS credit price. At first glance, there does not appear to be a strong relationship between the implementation of California's LCFS policy and retail gasoline prices. Supporting this finding,

The findings from Bates White (2022) are supportive of this hypothesis. In analyzing the relationship between the LCFS and retail gasoline prices, the authors report that "the combination of crude oil price, cap-andtrade costs and taxes explains fully 90% of regular gasoline pricing over time" and that the remaining unexplained price cannot be linked to the implementation of the LCFS.

The Kleinman Center's study (Cullenward, 2024) argues that, to date, most conventional fuels have incurred only a small CI deficit per unit of fuel sold and have, therefore, not been particularly burdensome for producers. However, under a new California law, the authors suggest that fuel prices in the state could increase between $0.26 to $0.65 per gallon by 2030 and between $0.60 to $1.50 per gallon by 2035, depending on the credit price. A similar study by University of California Davis (Murphy and Ro, 2024) models price changes under the new amendments, and found that a 39% CI reduction target combined with a $50 credit price would be expected to yield just over $0.20 per gallon in increased retail gasoline cost by 2030.

Methods

To examine the potential impacts from the imposition of a low-carbon fuel standard, several approaches are applied. To begin, the stationarity of the seasonally-adjusted data is determinedutilizing standard tests from the literature [ADF, Phillip-Perron, Modified ADF, KPSS], as well as the unit root test of Zivot and Andrews (2002), which allows for an endogenously determined structural break. After establishing the nonstationarity of the series, the residual-based cointegration test of Gregory and Hansen (1996) is utilized. The test also allows for endogenously determined structural breaks to be identified, across the gasoline price series of interest. Finally, the structural breaks are estimated a third way using the methodology proposed by Bai and Perron, 1998, 2003. The third step then involves using Ordinary Least Squares regression analysis using dummy variables to account for the break dates. This allows the modeler to estimate the directionality of the breaks given by the Bai and Perron, 1998, 2003 methodology.

Results

To capture the dynamics of imposition of the LCFS on the US retail gasoline market, we utilize weekly data on retail gasoline prices, at the aggregate US level, as well as multiple states. Preliminary analysis suggests that retail gasoline prices are nonstationary, and the presence of a cointegrating relationship is identified. The next steps in the analysis are to examine if the endogenously determined structural breaks align with the establishment of the LCFS policies.

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