The Cost-Effectiveness of Alternative Policies for Reducing GHG emissions in the Freight Sector

Antonio M. Bento University of Southern California
Genevieve Giuliano abento@price.usc.edu

Project Objective

We develop a novel simulation that integrates aspects of route-level and multi-market models to evaluate the cost-effectiveness of alternative public policies that stimulate a faster adoption of cleaner technologies to reduce GHG emissions in the freight sector. The route-level model adds important spatial features that influence fuel consumption and fleet composition, such as nodes of pickup and delivery; while the multi-market model allows for adjustments in final prices, which in turn affect the sizes of fleet sectors and output markets. Most of the effort was in conceptualizing this integration and highlight its benefits. Preliminary simulations are conducted to illustrate the emissions that result from Phase 1 EPA regulations and ZEVs.

Problem Statement

Traditionally, the evaluation of the potential of alternative technologies for climate mitigation starts with simple lifecycle analysis (LCA) of the GHG emissions resulting from various technologies, including all phases of its production and use. However, if public policies that support the same technology result in different multi-market adjustments, and therefore GHG emissions impacts, per unit of the technology added to the economy, technology based LCA metrics may result in estimates of emissions savings that are misleading. Our proposed multi-market model overcomes these limitations by simultaneously considering the behavior of consumers, producers of final goods (including goods that require delivery and trucking costs), the freight sector, and the regulator/government that affects freight decisions through a variety of public policies. In turn these decisions are affected and constrained by routing choices, which are determined by pre-existing locations of drop and pick up of goods. In our case, we consider that trucks depart and return to the port of Los Angeles at the end of the day. These pre-existing nodes are critical constraints, often ignored in the economics literature that models the freight sector. Finally, the nature of the model allows for capturing economy-wide GHG emissions that are generated whenever any of the agents in the model, directly or indirectly, adjusts their behavior in response to policies introduced in the freight sector that aimed to reduce GHG emissions in that sector.

Research Methodology

Our model has unique four features relevant for the estimation of the impact of these AFV policies and resulting emissions: 1) impacts on trucking firms, which are constrained by their pre-determined routing decisions, since nodes of pick-up and delivery remain fixed (at least in the short and medium run), 2) impacts on product demands, and 3) impacts on net GHGs. Trucking firms will incur costs of purchase and operation of AFVs, including any added costs due to differences in vehicle performance and fuel consumption. For the case of ZEV trucks, we also consider refueling time and battery range. We assume that any additional costs from purchase and operation of AFVs incurred by the trucking firm will be passed forward into prices to the final consumer. An increase in price will affect demand, and hence we expect an overall decline in demand, which means a decline in freight shipments. In order to determine the net impacts on GHG emissions, we must consider not only the GHG reductions associated with the replacement of conventional diesel vehicles, but also any change in traffic conditions that would affect the level of congestion. The change could be positive or negative, depending on whether the added truck VMT due to AFV performance is offset by reduced VMT due to reduced demand. It is also possible that the use of AFVs will be subsidized by government. To the extent that trucking firms do not incur additional costs, prices should not change, and demand should be affected only by the reduced income represented by the subsidy.

Results

The diesel truck fleet has a range of FE from 4.4 mpg to 8.8 mpg. The median level of truck FE is 6.55 mpg. In other words, the average truck has a fuel economy of 6.5 mpg. At median levels of fleet fuel economy, CO2 emissions in the LA metropolitan region and in the state of California, due to diesel vehicles, in a simulated economy without any policy intervention are approximately 10 million metric tons and 26 million metric tons. The effect of Phase I regulations in enhancing the fuel economy standards results in a 5% and 16% reduction in CO2 emissions at the median level of fleet fuel economy. If instead of driving a diesel truck with fuel economy of 6.5 mpg an operator runs a ZEV with 30 minutes charging time, the amount of CO2 emissions reduction is approximately 71%. Running a ZEV with 3 hours of charging time leads to CO2 emissions reductions of about 88% compared to a diesel truck with 6.5 mpg FE. The latter effect happens through a massive contraction of demand, since with 3 hours charging prices of goods to be delivered increases substantially. In other words, with EPA Phase I regulations, the increased FE of 5-19% leads to a reduction of about 5-16% of CO2 emissions on average. Driving ZEVs reduce the corresponding CO2 emissions from 70-88%, but these drops are likely very costly, since they are achieved through large reductions in the size of the trucking sector and the demand for goods that require transport.

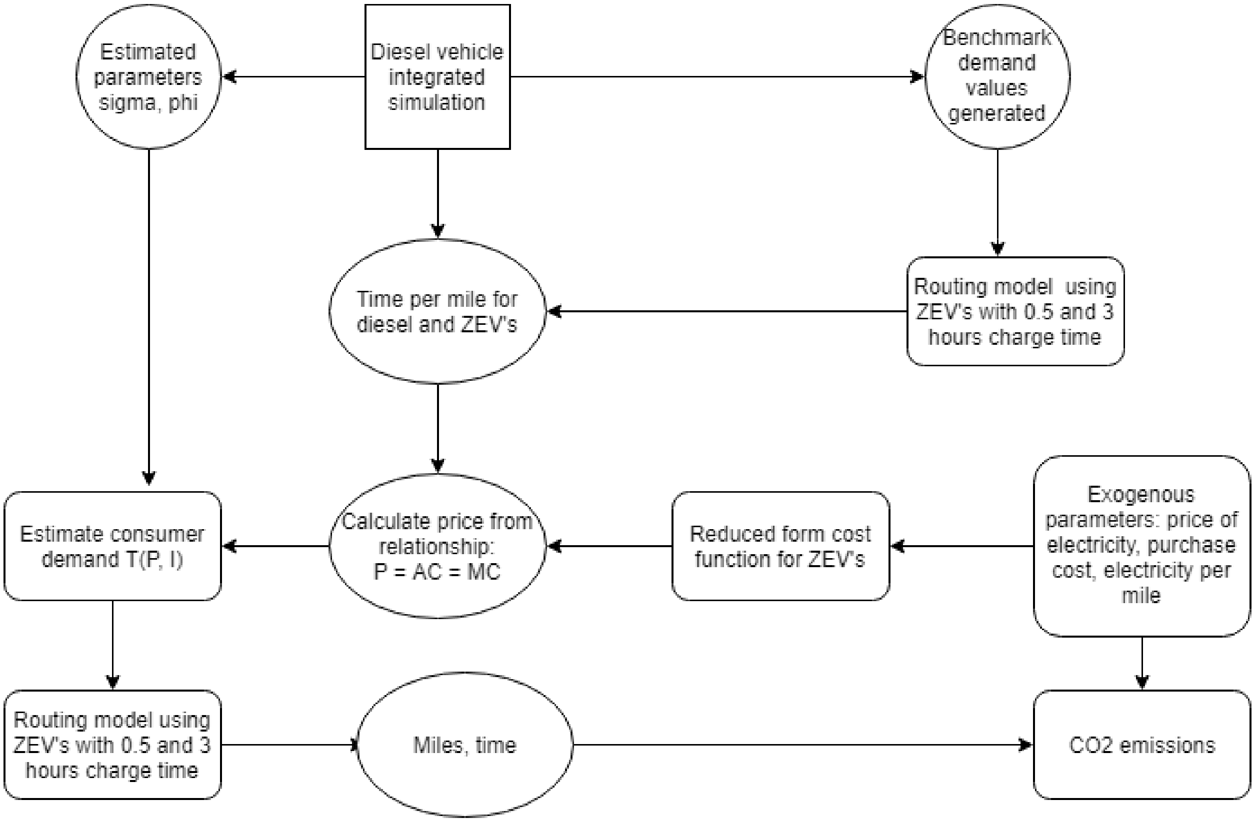

Figure 1. Algorithm for ZEVs