Multiyear Planning Effects, Credit Transfer and Carry-Forward, and Market-Driven CAFE Increases

Toyota Results as a Case Study

Introduction

The CAFE model is a highly integrated, comprehensive model that analyzes methods individual manufacturers and the industry can use to comply with an array of potential fuel economy standards over a number of years, and analyzes the effects on each OEM and the overall industry in each model year and cumulatively, as well as private and societal economic and environmental impacts each model year and cumulatively. The model estimates how each manufacturer could add fuel-saving technology in response to new standards, and estimates resultant impacts on vehicle costs, travel demand, fuel consumption, emissions, highway safety, and monetized benefits to society. The model has been developed over 11 years and used for 5 CAFE rulemakings. Similar to how OEMs have told NHTSA they comply with CAFE standards, the model accounts for:

a. Vehicle redesign schedules, allowing all technologies to be applied during vehicle redesign, and limiting application in other years.

b. Considering and applying technologies on an individual vehicle model basis with the ability to apply technologies uniquely on each model.

c. Limits on pace over which OEMs can apply technologies across their fleet, recognizing constraints.

d. Ability for OEMs to bank credits for over-compliance and carry those credits forward or backwards, and to transfer those credits between fleets. The model uses over-compliance in some years and under-compliance in other years to estimate the most cost effective strategy over multiple years.

e. Ability of OEMs to pay civil penalties as an alternative to compliance

f. Ability to use incentives as defined by EPCA/EISA, such as for alternative fuel vehicles.

g. Ability to simulate the potential that a manufacturer would increase fuel economy in response to estimated market demand: this aspect of the model relates to many manufacturers' statements regarding the role of fuel prices vis-à-vis consumer acceptance of price increases necessary to pay for fuel economy improvements

To illustrate several of these aspects of the CAFE model, results for a specific manufacturer—Toyota—are presented below.

Background

In response to earliest version (2002) of DOT's CAFE model, commenters stated that the model should account for product cadence—that is, manufacturers' year-by-year schedules for redesigning and freshening products—because many technologies can only practicably be added as part of a vehicle

redesign or freshening. Manufacturers argued that a failure to account for product cadence could lead to standards that would not be technologically feasible or economically practicable. NHTSA agreed, especially considering EPCA/EISA's requirement that the agency set CAFE standards at their maximum feasible levels in each model year, and has since continued to refine the model in order to account for product cadence.[1]

Manufacturers have also emphasized their plans to use credit provisions as an integral part of their compliance strategies, with certain fleets overachieving standards in some model years, and using those credits to offset shortfalls in other fleets in the same or in other model years. In the December NRC meeting in Dearborn, MI, one manufacturer discussed their plans to use credits for compliance, in particular highlighting the use of credits to offset shortfalls in model year 2016. Recent versions of DOT's CAFE model simulate this balancing of credit earning and use between model years.

Caveat

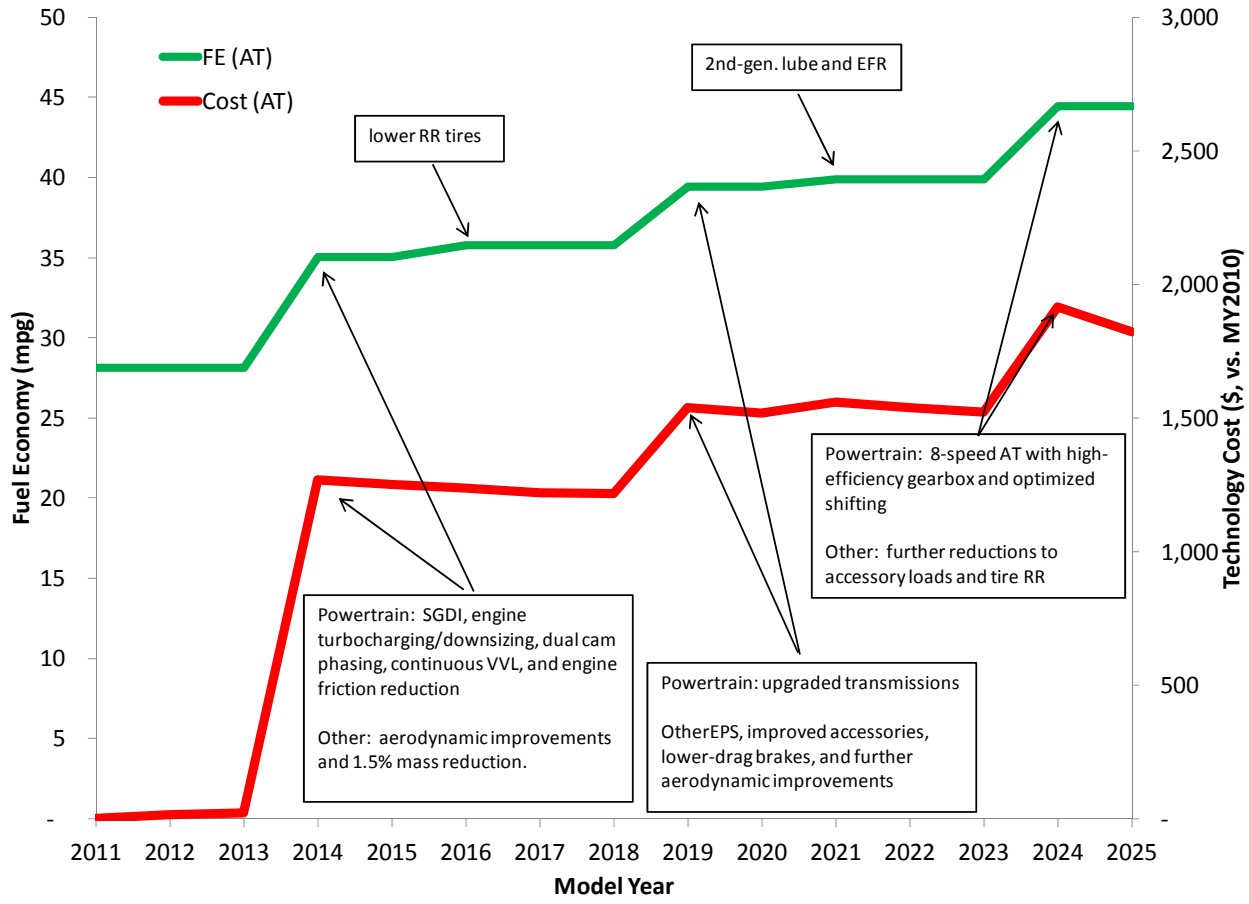
These results should not be interpreted as indicative of Toyota's actual product plans. For the two rulemakings issued since 2009, DOT has collaborated with EPA to build market forecasts using public and commercial sources. The market forecast used for the current example used the MY2010 baseline fleet (from publicly available CAFE compliance data), assuming that the same vehicle models would be sold through MY2025. Production volumes were estimated based on a segment-level and brand-level commercial forecast acquired from LMC (then J.D. Power), and on an EIA forecast of overall volumes of passenger cars and light trucks. While NHTSA and EPA jointly used this market forecast for analysis supporting the agencies' 2012 rulemaking, NHTSA recognizes that Toyota's actual plans may differ from this forecast in significant ways.

[1] See, e.g., discussion at Federal Register / Vol. 68, No. 66 / Monday, April 7, 2003 / Rules and Regulations, pp. 16882-16883.

Model-Level Application of Technologies Based on Estimated Product Design Cycles

The CAFE model limits the application of most technologies to vehicle redesign timing. A few technologies may be applied during a vehicle refresh. Having applied technology, the CAFE model "carries" the technology forward until the next redesign. The CAFE model "looks forward" when making decisions on adding technologies, considering the ability to facilitate compliance in future model years, based on refresh and redesign schedules. This simulates manufacturers' multiyear planning (*i.e.*, adding "extra" technology in years with many planned redesigns to facilitate compliance in a later year with fewer planned redesigns) and emphasizes the packaging of technologies to coincide vehicle redesigns.

For example, DOT's MY2010-based market forecast assumed Toyota could redesign the Tacoma in model years 2014, 2019, and 2024, freshening the truck in model years 2016 and 2021.[2] For the automatic transmission versions of the Tacoma, the following chart shows how the CAFE model timed the addition of technology based on this estimated design cycle.[3]

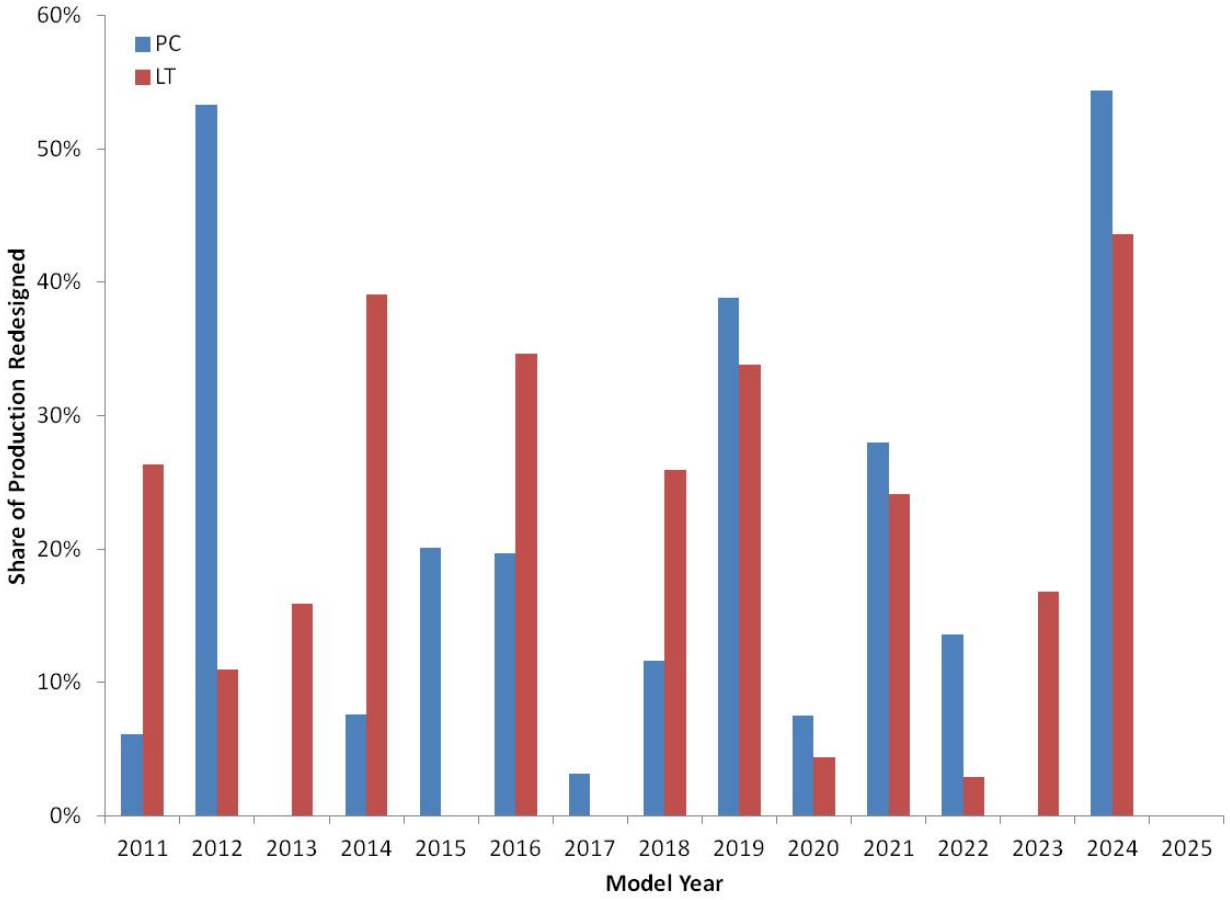


[2] For the recent MYs 2017-2025 final rule, NHTSA developed redesign and refresh schedules for each of a manufacturer's vehicles included in the analysis, essentially based on the last known redesign year for each vehicle, and projected forward using a 4 to 8-year redesign and a 2–3 year refresh cycle. NHTSA used publicly-available data to estimate the last known redesign schedule for the vehicles produced by the manufacturers.

[3] Time-based "learning effects" are evident in the downward slope evident in the cost "plateaus" (e.g., 2014-2018).

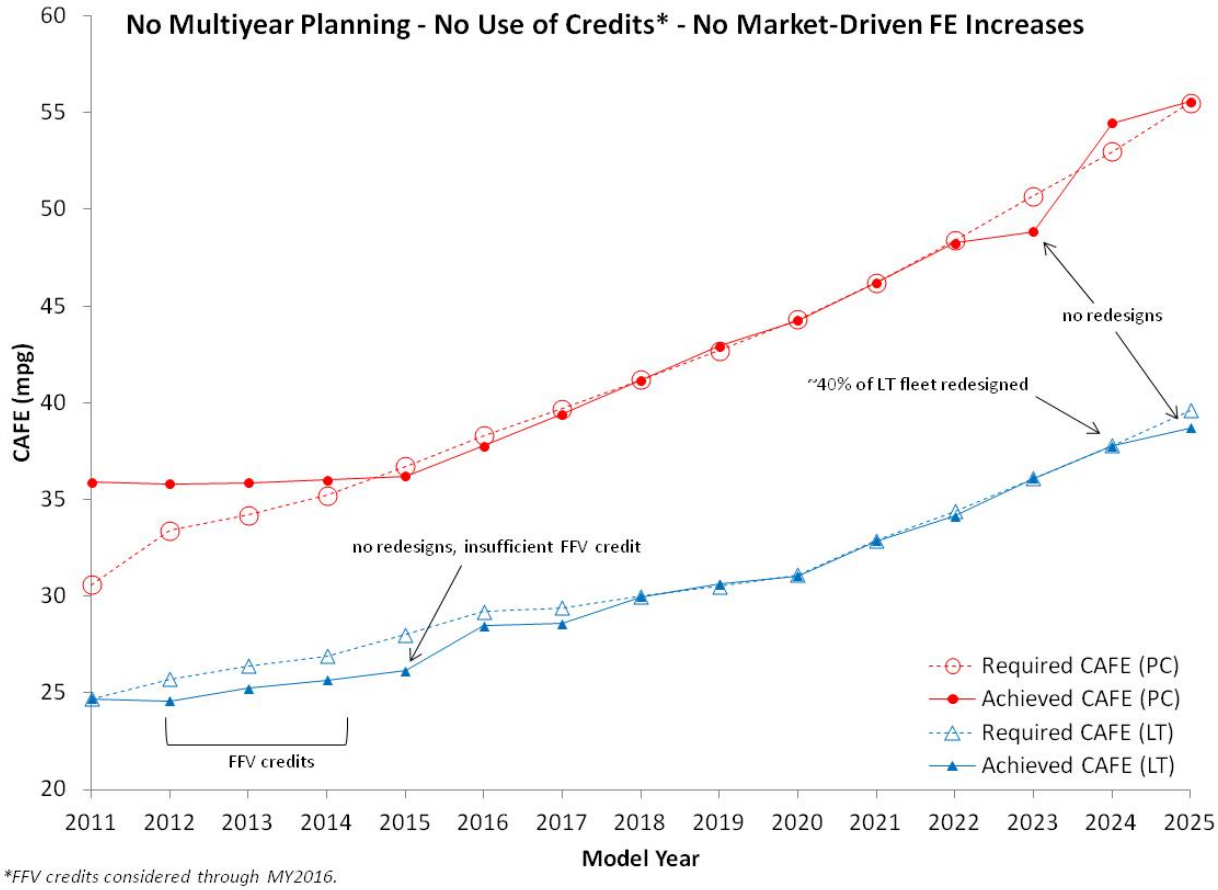
Estimated Redesigns in MY2010-Based Market Forecast

Because the CAFE model times the addition of most technologies to coincide with product redesigns, the estimated timing of those redesigns plays an important role in the model's estimates of when CAFE levels and corresponding average costs could increase, and by how much. Particularly given the model's representation of multiyear planning effects, increases in technology application (and resultant fuel economy and cost increases) can be significant during model years with high concentrations of redesigns, and less significant during model years with few redesigns. (Of course, not timing additional technology to be applied during redesigns would involve additional costs.) Typical of product plans manufacturers have previously provided to NHTSA, the following chart showing NHTSA's estimates of Toyota redesigns in the agency's MY2010-based forecast has varying concentrations of redesigns:



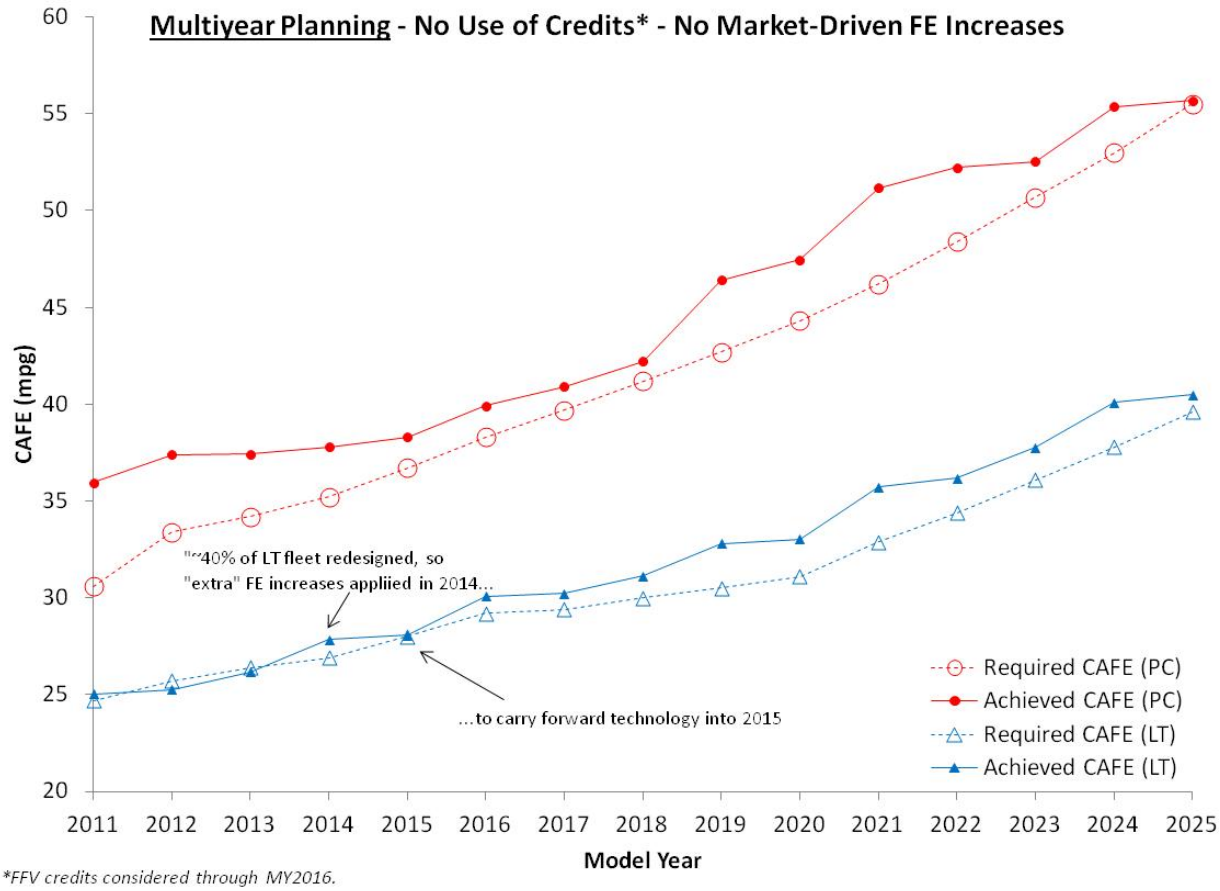
Given this estimated redesign schedule, it would be reasonable to anticipate that under a regulatory alternative defined by steady, rapid increases in the stringency of CAFE standards, "extra" technology might be added during MYs 2014-2016 and 2024 to facilitate compliance in MYs 2017 and 2025, respectively.

Below, a series of charts illustrates the year-by-year impact of different aspects of the CAFE model's operation that interact with the refresh and redesign cadence.

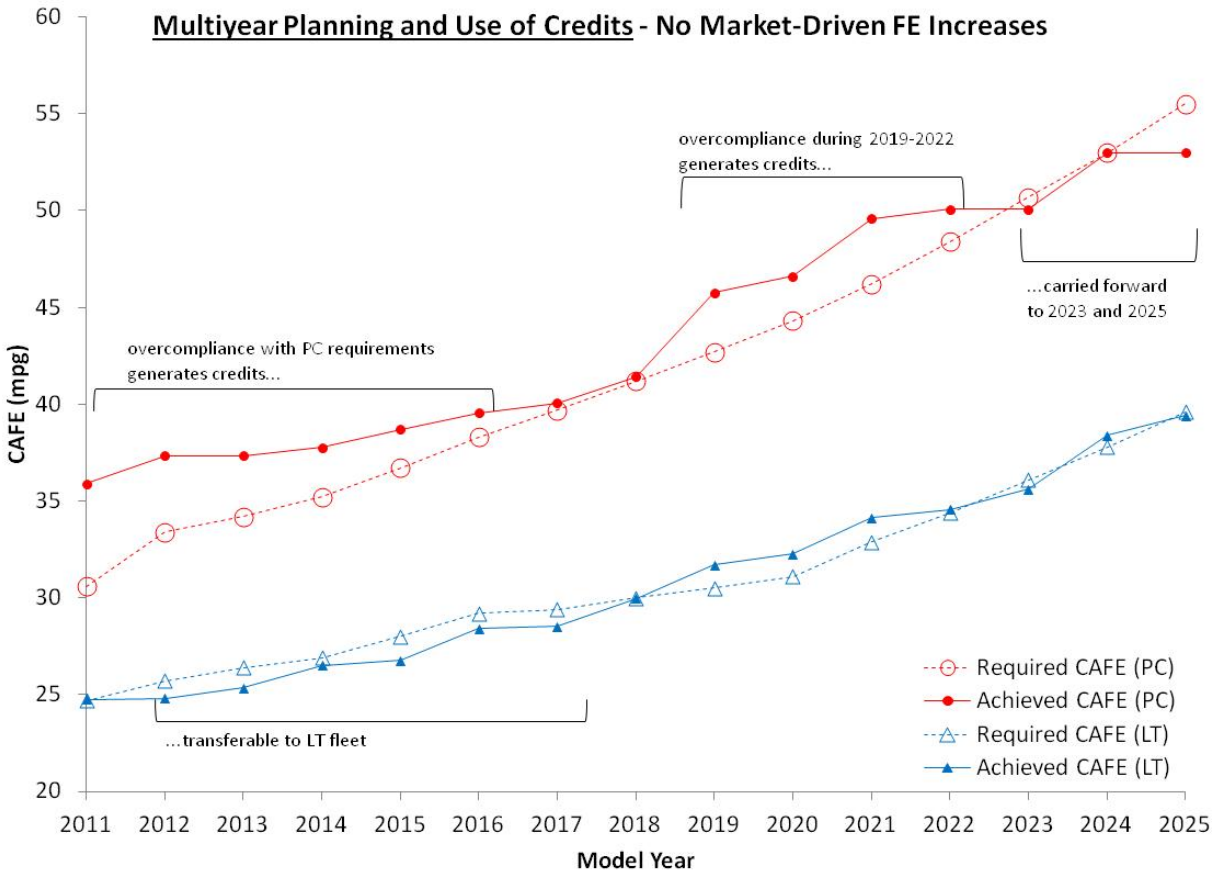


When multiyear planning effects (and credit and market effects) are not included in the simulation, Toyota appears to have difficulty complying with either or both standards in several model years (2015, 2017, 2022, 2023, and 2025). This occurs because, in any given model year, the model applies only as much technology as is needed to achieve compliance in that model year, and adds most technology only to vehicles being redesigned in that model year (although the model "carries forward" technology applied to other vehicles in prior model years).

NOTE regarding FFV credits and AFVs: For purposes of determining the maximum feasible stringency of CAFE standards, EPCA/EISA does not allow NHTSA to consider manufacturers ability to apply CAFE credits or increase AFV production. However, even for its "standard setting" analysis, NHTSA is allowed to consider the potential that manufacturers would be able to apply credits in earlier model years. For the MY2017-2025 rulemaking, NHTSA did so by assuming manufacturers could take full advantage of FFV credit provisions through MY2016.

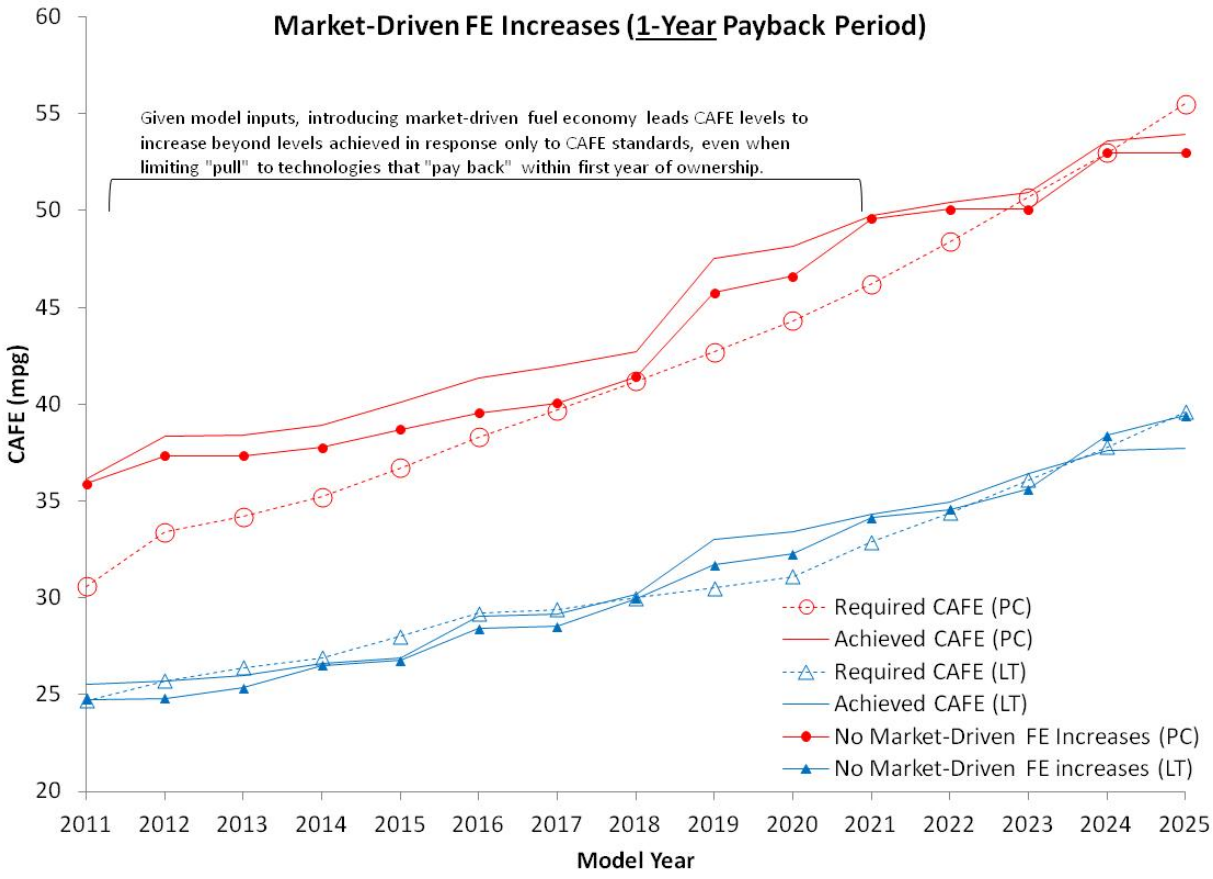


By simulating multiyear planning effects, the CAFE model suggests that Toyota could apply "extra" technology in some early model years (e.g., 2014, for light trucks), in order to facilitate compliance in later model years, when more stringent standards are in place and/or fewer redesigns are anticipated.



DOT's model also simulates credit carry-forward (aka banking) and transfers.

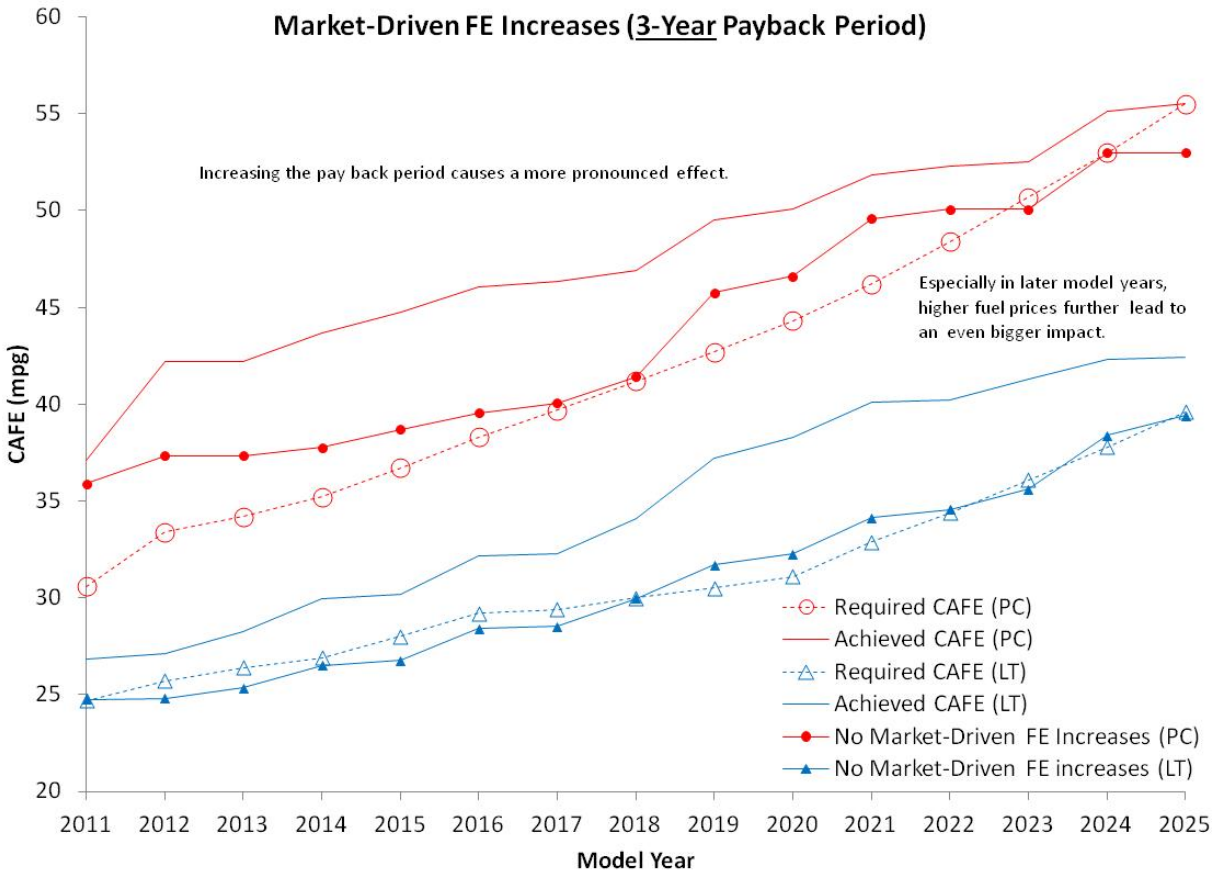
With the model set to apply EPCA/EISA's statutory limitations on carry-forward and transfer limits, DOT's model suggests Toyota could transfer credits from the passenger car to the light truck fleet, and carry forward credits to apply to the passenger car fleet in 2023 and 2025.



DOT's CAFE model can simulate the potential that if "extra" fuel economy increases are sufficiently attractive to buyers, manufacturers will apply these increases even beyond the point required for compliance with CAFE standards.

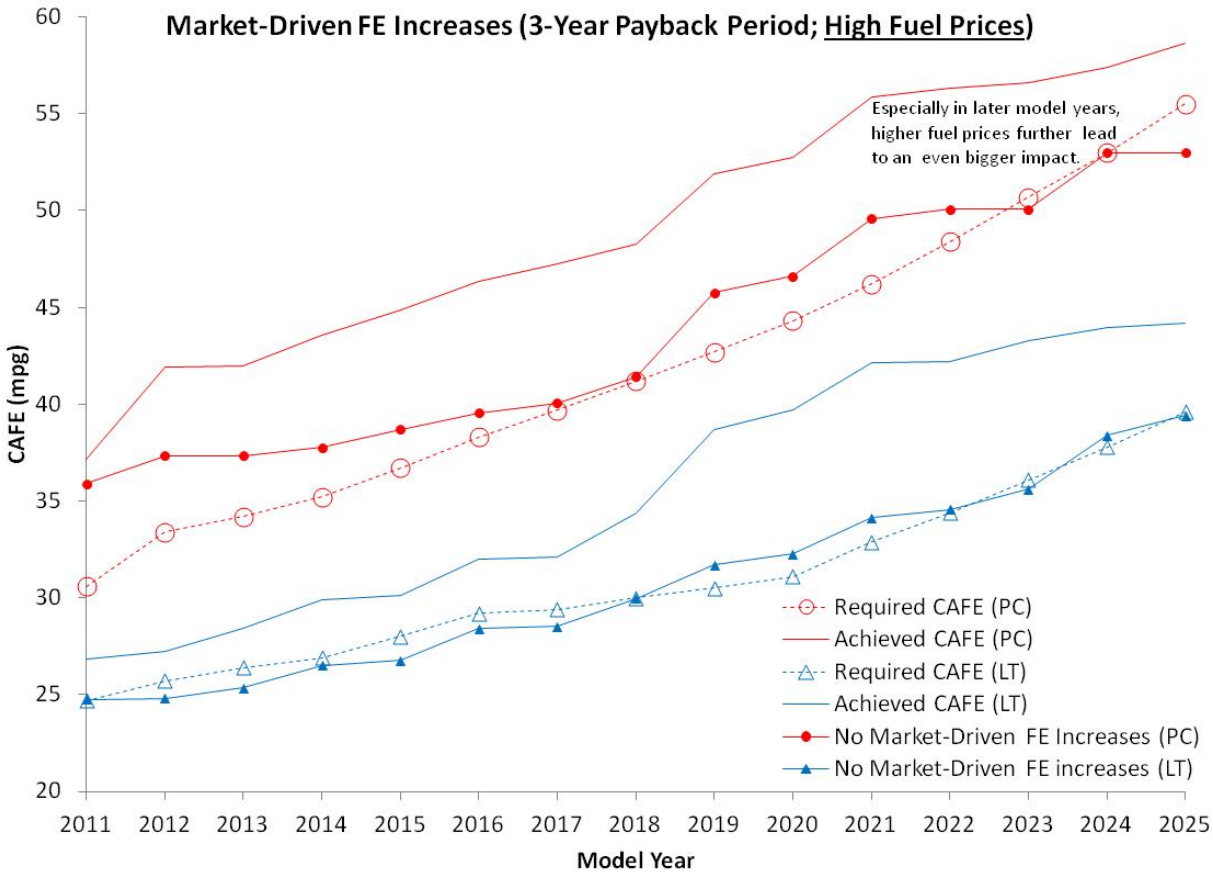
This effect is controlled by setting the "payback period" and discount rate applicable to fuel savings realized over a vehicle's useful life.

For the MYs 2017-2025 final rule, DOT showed a side case applying a 1-year payback period. This is equivalent to assuming that, except as necessary to achieve compliance with CAFE standards, no manufacturer will increase the fuel economy of any vehicle beyond the point at which additional costs require longer than a year to "pay for themselves in fuel savings to the buyer".



For the final rule, DOT also examined side cases involving longer payback periods.

Relative to a vehicle's average full useful life of more than 15 years, a 3-year payback period reflects considerable "undervaluation" of fuel economy improvements.



Like estimates of technology cost and effectiveness, fuel prices play a major role.