



Motivation

Technology transitions occur when an economy sector undergoes significant structural changes. Products, producers, suppliers, consumers and policymakers change to build a different ecosystem. Here, we focus on the automotive industry that is going through such a transformation that is questioning how we manufacture, sell and use cars?

Preparing the future technology portfolio that will comply with low emissions, like CAFEx regulations, is a challenging endeavour that requires adapted solutions like alternative fuel vehicles AFV.

In this research, we present a method to estimate an optimized technology mix that is complying with CO₂ regulations and is constrained to past technology diffusion speeds.

Research Questions

- How fast does a technology diffuse?
- How to consider speed of diffusion in a technology mix model?
- What does past diffusion of technologies tell us about the future?

Diffusion of Technologies Framework

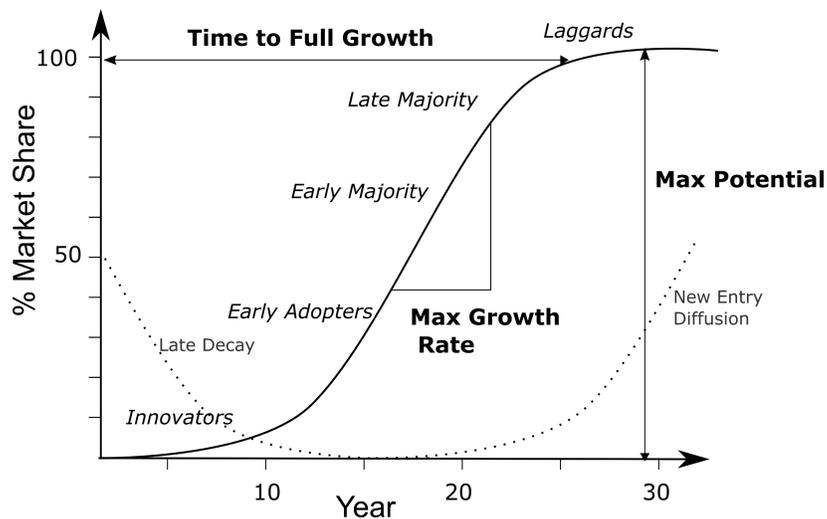


Figure 1. Stages of Product Diffusion and Key Metrics of Measuring diffusion.

Diffusion of Automotive Technologies

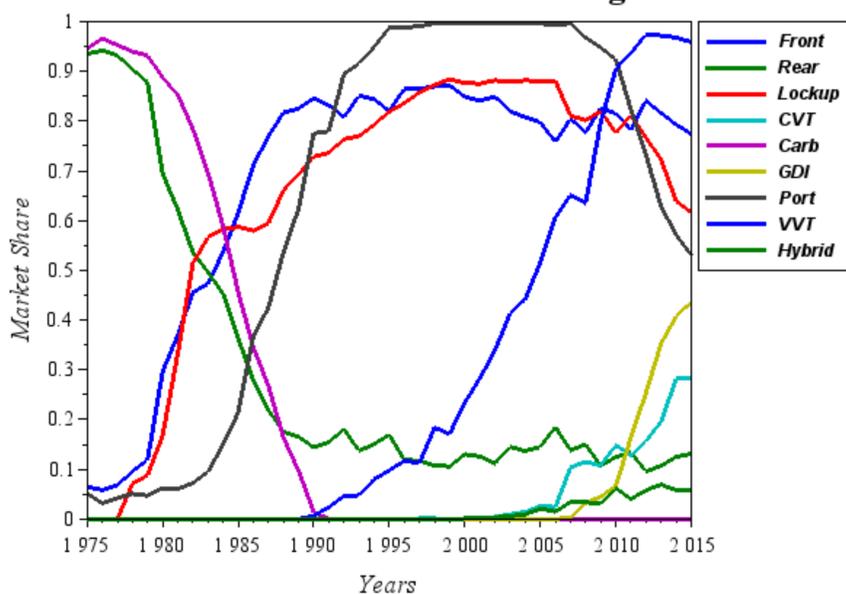


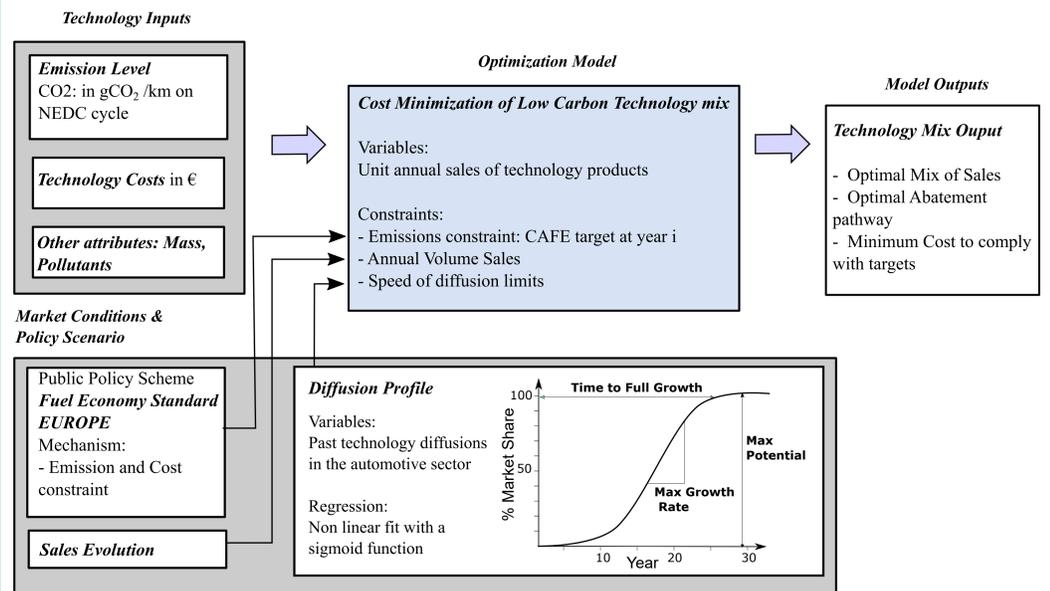
Figure 2. Automobile Technology Deployment in the USA market: drivetrain, powertrain, fuel injection and transmission technologies. Source: EPA, 2016

References:
Vogt-Schilb, A., Meunier, G., Hallegatte, S., 2018. When starting with the most expensive option makes sense: Optimal timing, cost and sectoral allocation of abatement investment. Journal of Environmental Economics and Management 88, 210-233.

Vera, J., Guivarch, C., Path dependency of technology choices with consecutive fuel economy targets. To be submitted

Model

Optimization Model of Low Carbon Automotive Technologies: Minimization of total costs to comply with CO₂ regulations under diffusion constraints.



Applications

1) The path dependency of vehicle technology choices with consecutive fuel economy targets.

A study of implications of short term decisions on long term abatement capabilities.

Scenarios:

- Myopic: prepares the near term target but neglects the longer term target
- Foresight: considers all target at the time of choosing technologies

Key Message:

A myopic strategy to prepare future technology portfolio might fail to achieve an ambitious longer term target and the near term compliance is not a sufficient condition for longer term compliance.

2) The impacts of mass-indexed fuel economy standard on technology choices.

A study on the neutrality of fuel economy standard policy and what are the implications for car manufacturers, policymakers and consumers.

Scenarios:

- CAFE indexed to mass: fuel economy standard in Europe with a curb weight factor
- CO₂ only: same emission target without mass indexation

Key Message:

A car manufacturer does not have an incentive to develop lightweight technologies and when comparing a CAFE standard with indexation and non indexation it will develop more electric vehicles that have zero emissions and high mass.

3) Impact of Local and global environmental policies on technology portfolio.

A study of synergies and trade-offs of multiple policy tools applied to the automotive sector to correct the impact of vehicle emissions.

Scenarios:

- CAFE only
- CAFE + Euro Standard
- CAFE + ZEV Mandate
- CAFE + LEZ progressive restriction of ICE vehicles
- CAFE + ULEZ only LEV allowed in cities

Key Message:

For stringent CAFE targets, this policy dominates the others. There is a distortion on the emission distribution of technology choices when applying a ZEV Mandate: high share of "clean" and "dirty" technologies. LEZ with fossil fuel based engines ban causes higher difficulties to comply with a CAFE target and develops Diesel vehicles in non urban areas.