A dynamic approach to model the impact of imitation and experience

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Predicting the diffusion of EV. A dynamic approach to model the impact of imitation and experience

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Outline

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Background and motivation

Environmental concerns have led governments to push for pro-EV policies, and users to lean towards this technology. As a result, interest in predicting the market penetration of electric vehicles has grown

However, many different predictions have been provided, some of them being too optimistic, and some others suggesting a low penetration

The reasons of this under/over estimation are that they either consider only substitution, or they use diffusion curves that consider only a single product whith characteristics and no competition

Background and motivation

Any prediction of new products should involve 3 elements:

- Substitution: i.e. replacing an ICV by an EV, purchasing an additional EV vehicle for the household, upgrading to a new generation of EV… or even by selling an EV back.
- Diffusion: relates to the spread of a new product through social channels (Rogers, 2010).
- Dynamics: diffusion not only depends on the context at a particular moment, but also on what occurred in the previous periods.

Background and motivation

Some recent work in predicting innovations:

- Jun and Kim (2011) combine diffusion and substitution. However, they use simple aggregate demand models.
- Kieckhafer, Volling and Spengler (2014) used a richer disaggregate demand model and integrate it into a dynamic system. However, they do not account for diffusion effect.
- Jensen et al. (2016) combined the diffusion process with a richer disaggregate demand model. However, their diffusion parameter is not dependent on any social attribute, and it is not truly dynamic.

Social Influence and Conformity

None of these works in predicting innovations fully explore the role of the diffusion. This spread, which occurs through social channels, involves two key concepts.

- Social influence, which is the process whereby people agree or disagree about appropriate behavior, from or maintain social norms and the social conditions that give rise to, and the effects of such norms." (Turner, 1991).
- Social conformity, which is a type of social influence involving change in attitudes, beliefs and behaviors in order to fit in with a group matching the groups norms belief (Cialdini and Goldstein, 2004)

Objective

Only a few works in the field of Transportation study the role of Social Influence and Conformity in demand for EV (Kwano et., 2012; Rasouli and Timmermans, 2013; Cherchi, 2017) but they use only the substitution models.

The objective of this paper is to explore more this role in the prediction of EV.

In particular we extend the work of Jensen et al. by including explicitly Social Conformity elements that we take from the work of Cherchi, who included several measures of social conformity (namely Informational and Normative Conformity and Social Signaling)

In addition, we also tried to make Jensen's model properly dynamic

Model formulation in Jensen et al. (2016)

Sales of each period are given by:

$$S_t^{EV} = (M^{EV} - Y_{t-1}^{EV}) \cdot \Pr(EV_t)$$

$$= (M^{EV} - Y_{t-1}^{EV}) \cdot \frac{\exp(V(EV_t))}{\exp(V(ICV_t) + \exp(V(EV_t)))}$$

$$V(EV_t) = ASC + q(t - \tau + 1) + \lambda(\hat{\beta} X_t^{EV})$$

q is the diffusion parameter

τ is the period in which the EV is available

λ is the substitution parameter

X_t^{EV} is a vector that includes all the EV atributes

$\hat{\beta}$ is the vector of parameters corresponding to the atributes and estimated in the substitution process

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Model specification

From Cherchi's work, we have available the following variables related to Social Conformity:

- Number of EV sold
- Negative information received from a good friend on need to change activities, parking options and range
- Agreement by the individual that his or her behavior would be approved by people important to him or her.
- Impact of social signalling

$$V(EV_t) = ASC + q(t - \tau + 1) + \Lambda\left(\hat{\beta} Social + \hat{\beta} X_t^{EV}\right) + \beta_1 ANTIC$$

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Model specification

We started with a specification that includes 2 of the 4 social conformity effects and will allow the model to be dynamic.

$$V(EV_t) = ASC + q(t - \tau + 1) + \lambda\left(\hat{\beta} Ln\left(N_{t-1}^{EVsold}\right) + \hat{\beta} INFO + \widehat{\beta} X_t^{EV}\right) + \beta_1 ANTIC$$

N_{t-1}^{EVsold} is the number of EV sold in the period t-1

ANTIC is a dummy variable for the Dec2015 peak

X_t^{EV} is a vector that includes all the EV atributes

INFO is information about range, parking options and the need of changing activities

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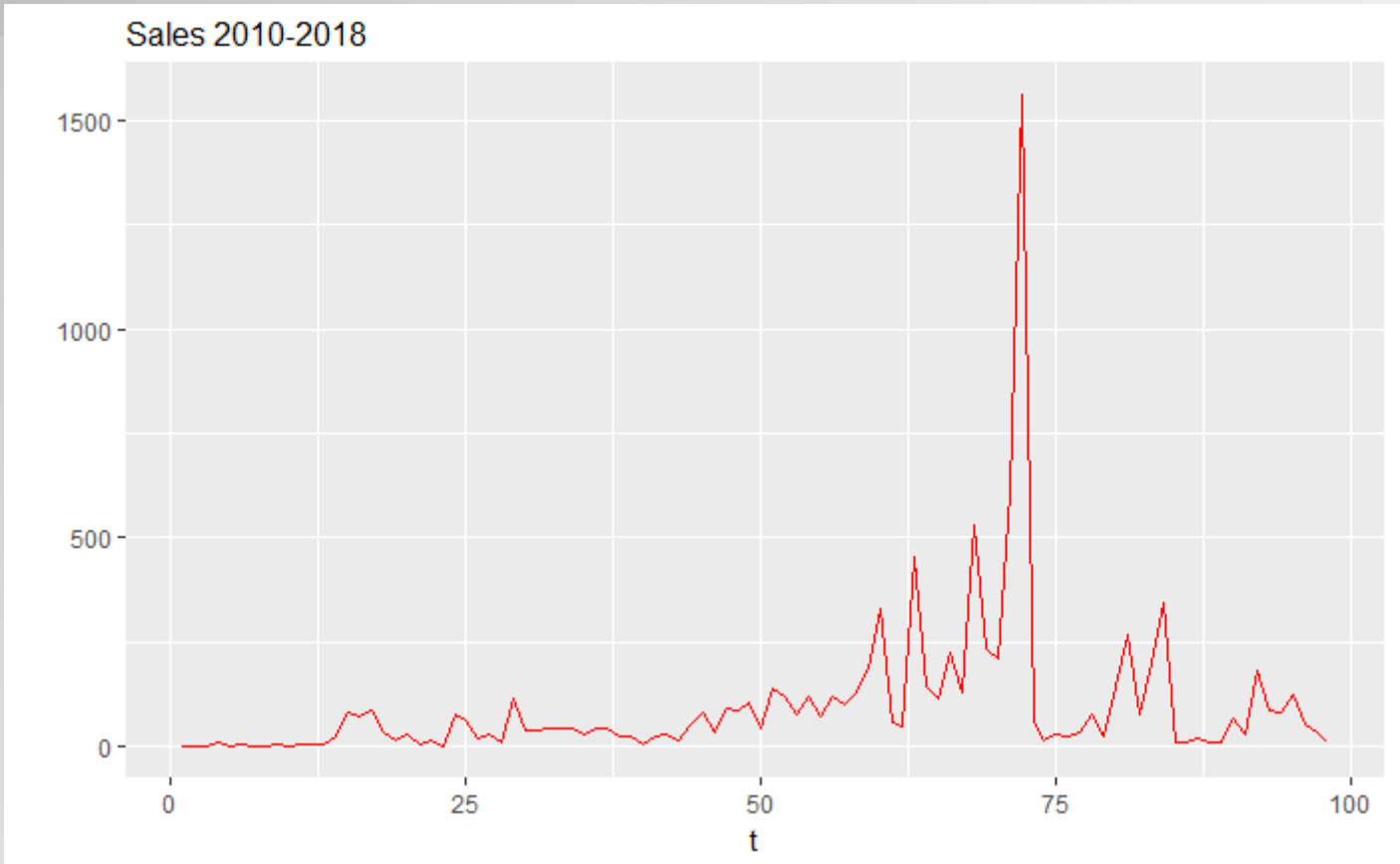
Data



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Data

For the estimation, we use real monthly data sales from 2010 to 2018, 96 observations

These data are different from Jensen's and have been computed by the Danish Energy Agency

No major changes in policy measures are assumed

For the forecast the atributes are projected up to 2050

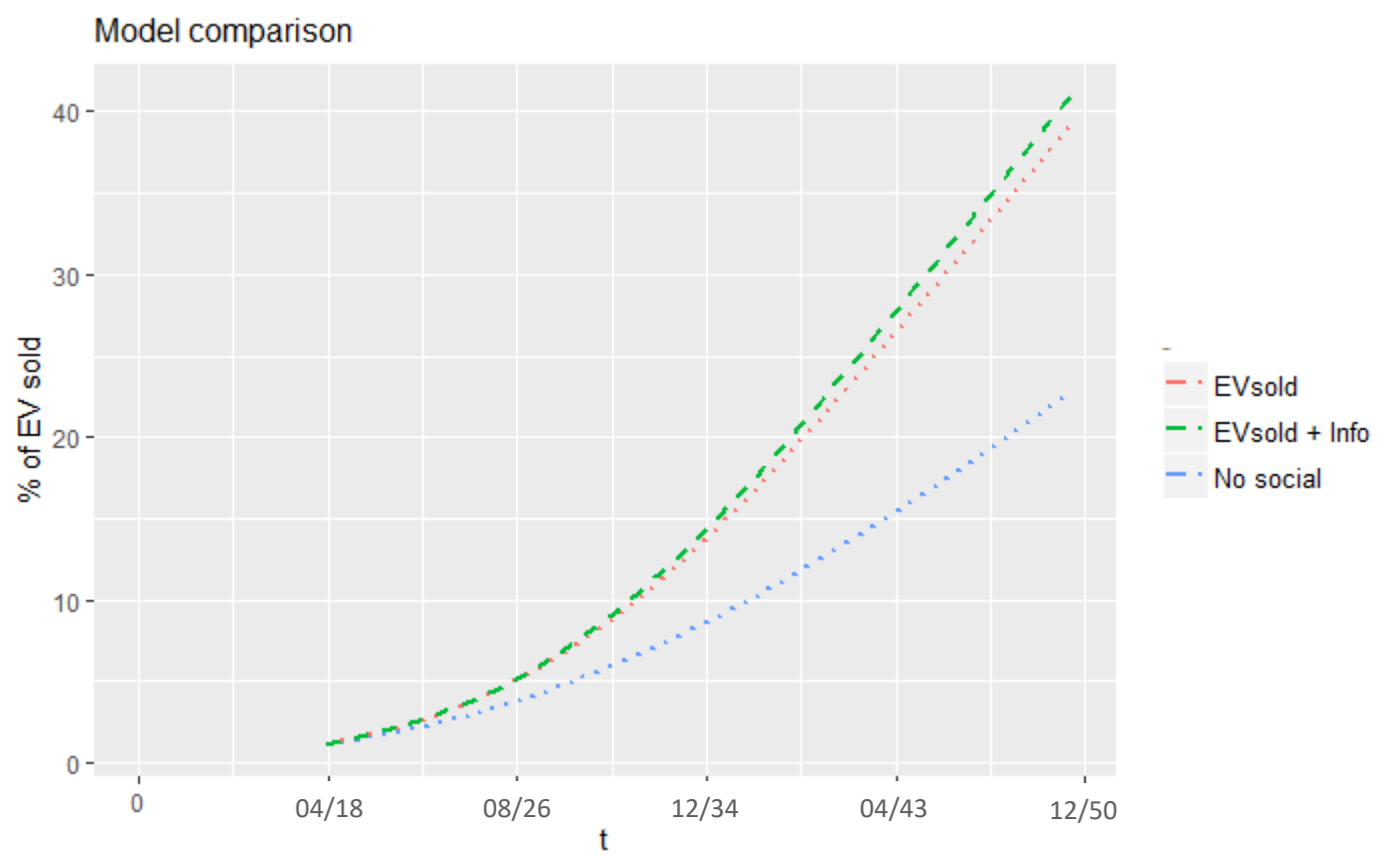
Data

The parameters for the disaggregated model come from 2 studies:

- $\hat{\beta}$ regarding Social conformity come from Cherchi´s
- $\hat{\beta}$ regarding the vehicles attributes come from Jensen et al.

The samples used in these studies are different although they come from the same panel (17,300 individuals)

Model results



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Conclusions

Social Conformity effects seem to play an important role in accelerating the diffusion of EV;

- The number of EV sold makes a big difference in the forecast
- Positive feedback received from close people slightly increase the market share

THANKS FOR YOUR ATTENTION

ANY QUESTIONS?