SCELTA TRA UN'AUTO ELETTRICA ED UNA CONVENZIONALE: UN MODELLO PROBABILISTICO BASATO SULLA META-ANALISI

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Research goal: analyzing EV choice

- Which attributes?
- How important are they?
  - Meta-analysis
- Scenario and policy analysis
  - Monte-Carlo Simulation

Meta-analysis (1)

- Make up for lack of data
- Summarizing and averaging
  - robustness
- Learning by comparing
  - outcomes obtained via different methods
- Meta-regression
  - time and space transferability

…meta-analysis (2)

- Accounting for differences of:
  - sampling
    - sample size, where, when
  - data collection:
    - SP\RP, CATI, CAPI, face-to-face
  - model specification
    - model, functional form, interaction terms
  - metrics used
    - lack of description, currency conversion, reference points
  - number of estimates

Criteria of paper selection

- Driving range is one of the most important factors determining EV demand
  - Coffman et al., 2017; Liu et al., 2017; Dimitropoulos et al., 2013
- Scopus and Web of Science
  - Electric + driving range + consumer preference
  - include both EVs and ICEVs
  - 36 papers

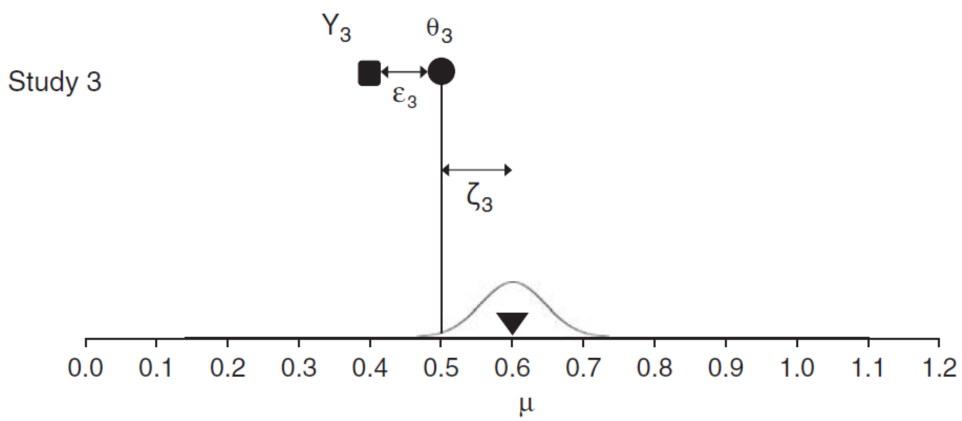
Attributes and metrics

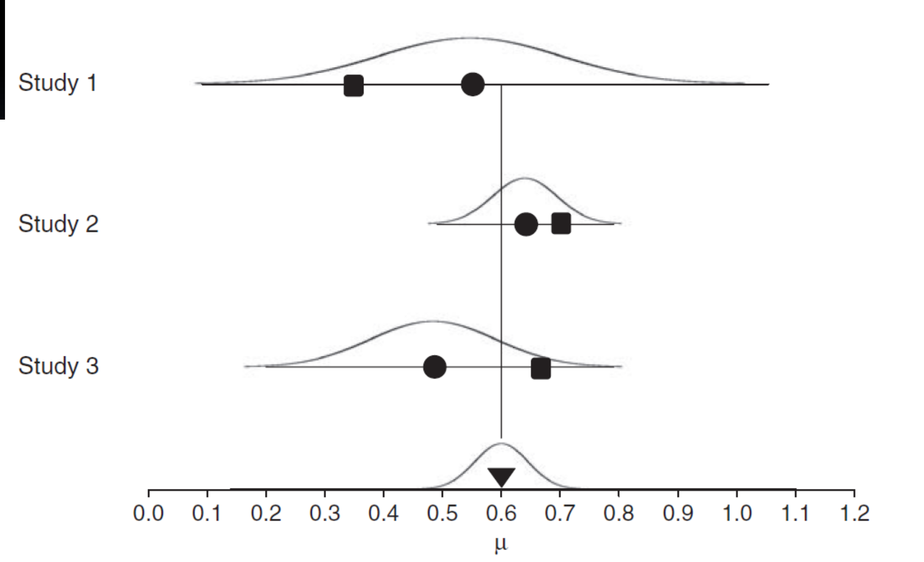
- Price
  - different currencies and at different years
- Fuel costs
  - fuel economy (cent/km) vs. fuel price (€/liter)
- Emissions (CO_2/km)
  - tailpipe vs. life cycle
- Acceleration
  - sec 0-30 miles/h; 0-60 miles/h; 0-100 km/h
- Recharging \ Refueling time
  - recharging at home vs. at station
- Driving range
  - highly heterogeneous reference values

- Operating costs
  - annual \monthly fuel expenses, sometimes including also maintenance, insurance, and parking for highly heterogeneous (not always specified) reference distance travelled

Random effect summary model

- The observed coefficient Y_i for any study is given by
  - the grand mean,
  - the deviation of the study's true effect from the grand mean (between study variance),
  - and the deviation of the study's observed effect from the study's true effect (within study variance).





Driving range coeff: linear specification (Non_BEV)

Authors	Parameter	St. Err.	Lower Limit	Upper Limit	Weight (random)
Beggs et al. (1981)	0.0025	0.0003	0.0019	0.0031	5.8%
Golob et al. (1997)	0.0009	0.0003	0.0003	0.0016	5.6%
Tompkins et al. (1998)	0.0014	0.0004	0.0005	0.0023	4.9%
Ewing and Sarigöllü (1998)	0.0024	0.0006	0.0012	0.0036	3.9%
Dagsivik et al. (2002)	0.0019	0.0006	0.0007	0.0030	4.0%
Train and Weeks (2005)	0.0057	0.0022	0.0013	0.0101	0.6%
Hesse et al. (2006)	0.0035	0.0015	0.0005	0.0065	1.1%
Knockaert (2010)	0.0026	0.0005	0.0016	0.0036	4.4%
Christensen et al. (2010)	0.0017	0.0002	0.0014	0.0020	6.7%
Ziegler (2012)	0.0020	0.0004	0.0012	0.0027	5.3%
Chorus et al. (2013)	0.0014	0.0002	0.0011	0.0017	6.7%
Hackbarth and Madlener (2013)	0.0008	0.0003	0.0003	0.0013	6.2%
Jensen et al. (2013)	0.0004	0.0001	0.0001	0.0007	6.8%
Hoen and Koetse (2014)	0.0024	0.0004	0.0016	0.0032	5.2%
Tanaka et al. (2014)	0.0004	0.0000	0.0003	0.0005	7.0%
Valeri and Danielis (2015)	0.0016	0.0002	0.0011	0.0020	6.3%
Dimitropoulos et al. (2016)	0.0025	0.0003	0.0019	0.0031	5.8%
Cherchi (2017)	0.0008	0.0001	0.0005	0.0010	6.8%
Giansoldati et al. (2018)	0.0010	0.0002	0.0006	0.0013	6.7%
Summary Effect	**0.00154**		**0.00133**	**0.00188**	

Attributes and summary effects

BEV	metrics	summary	lower	upper	spread/summary
Price	€	-0.00012	-0.00014	-0.00011	17%
Fuel economy	cent €/km	-0.02612	-0.03028	-0.02197	32%
CO_2 life cycle	kg/km	-0.00287	-0.00331	-0.00244	30%
Acceleration	sec (0 – 100 km/h)	-0.05040	-0.07053	-0.03027	80%
Recharging time (at station)	min	-0.00122	-0.00154	-0.00089	53%
Driving range	km	0.00299	0.00263	0.00335	24%
ASC	dummy	-0.7746	-1.0368	-0.5124	68%
NON_BEV	**metrics**	**summary**	**lower**	**upper**	**spread/summary**
Price	€	-0.00013	-0.00015	-0.00012	17%
Fuel economy	cent €/km	-0.02612	-0.03028	-0.02197	32%
CO_2 life cycle	kg/km	-0.00301	-0.00337	-0.00266	24%
Acceleration	sec (0 – 100 km/h)	-0.04144	-0.05503	-0.02784	66%
Refueling time	min	-0.00143	-0.00154	-0.00131	16%
Driving range	km	0.00154	0.00133	0.00175	28%

Montecarlo simulation

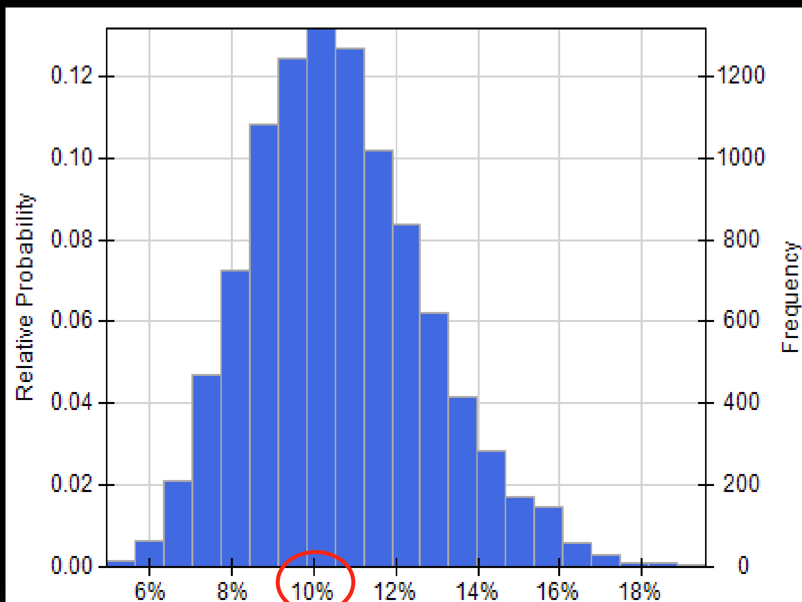
- substituting frequency distributions for the coefficients' point value of the discrete choice models
  - stochastic sampling obtaining a number of random draws from the coefficients' probability distribution
  - estimation of the corresponding EV choice probability
- output
  - probability distribution of EV choice

Scenario analysis: base case

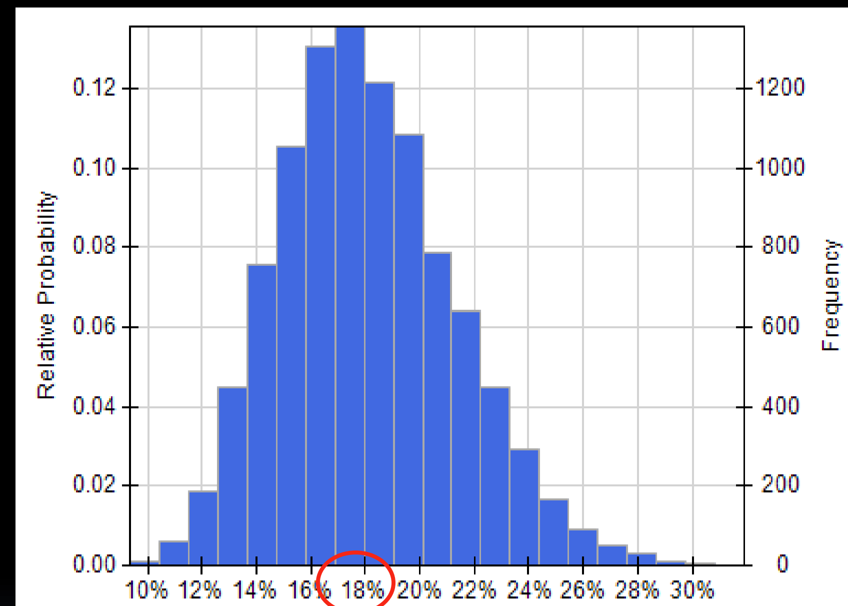
	Smart Forfour Electric	Smart Forfour Fuel Cell	Nissan Leaf	Nissan Pulsar
Price	24,000 €	17,000 €	36,360 €	23,640 €
Fuel economy	0.047 cent €/km	0.067 cent €/km	0.044 cent €/km	0.12 cent €/km
CO_2 life cycle	0.07 kg/km	0.10 kg/km	0.07 kg/km	0.117 kg/km
Acceleration	12.7 sec (0 – 100 km/h)	15.9 sec (0 – 100 km/h)	7.9 sec (0 – 100 km/h)	10.7 sec (0 – 100 km/h)
Recharging time (at station) \ Refueling time	60 min	7 min	30 min	7 min
Driving range	160 km	670 km	300 km	920 km
Summary functional form	Triangular			
N draws	10.000			
Algorithm	Halton			

…scenario analysis 1: SMART

Prob. Base case



Prob. with a subsidy of € 5.000



- Mean: 11%
- S.D. 2%
- Min: 5%
- Max: 20%

Mean: 18%

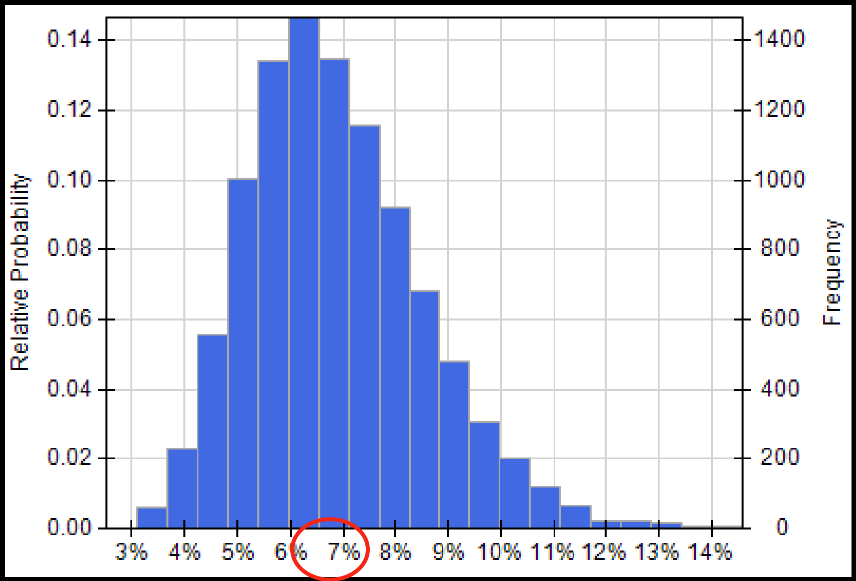
S.D. 3%

Min: 9%

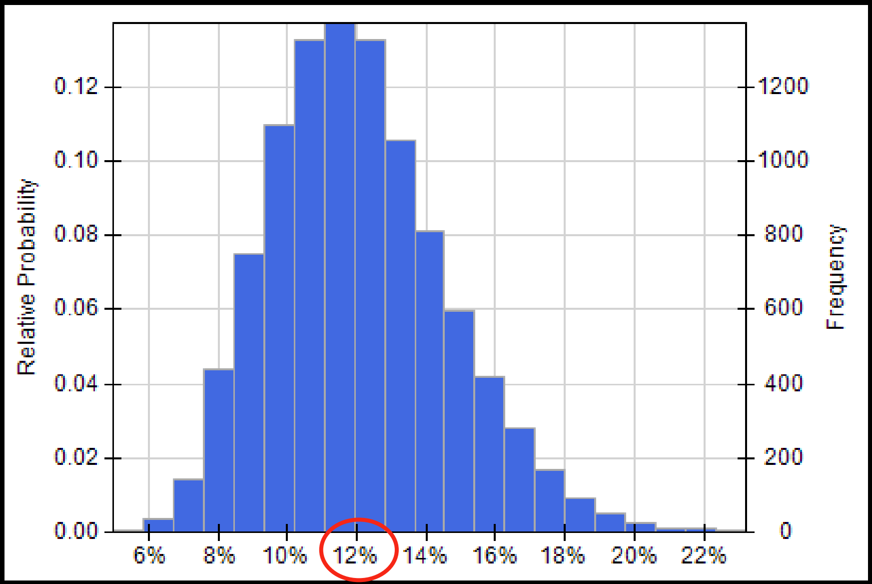
Max: 32%

…scenario analysis 1: Leaf\Pulsar

Prob Base case



Prob With a subsidy of € 5000



- Mean: 7%
- S.D. 2%
- Min: 3%
- Max: 15%

Mean: 12%

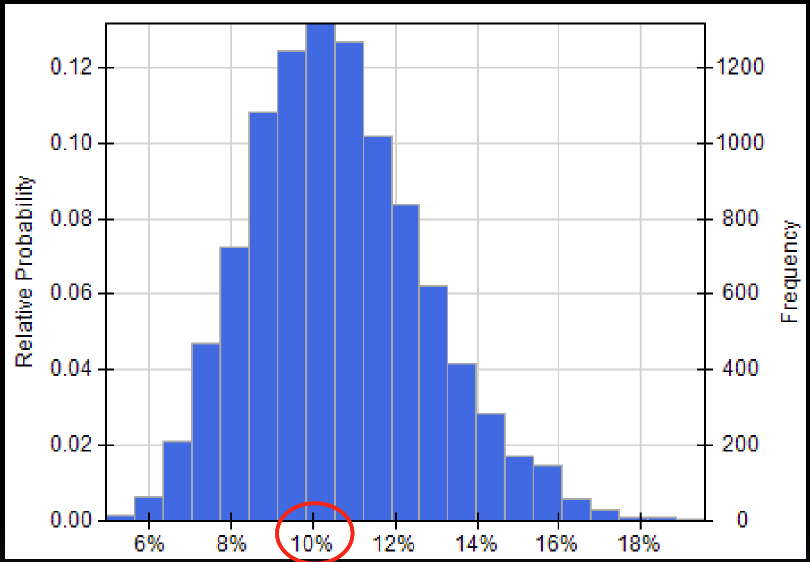
S.D. 3%

Min: 5%

Max: 23%

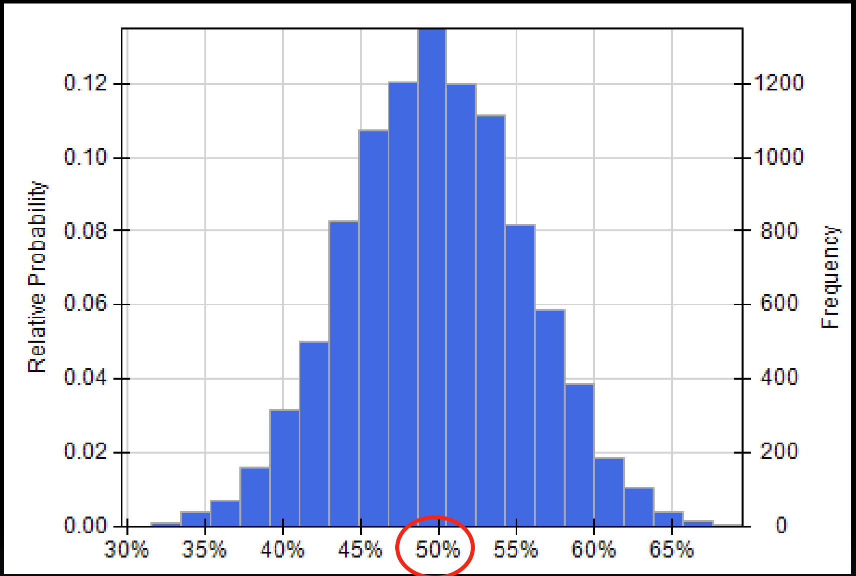
…scenario analysis 2:prob E_SMART

Prob. Base case



- Mean: 11%
- S.D. 2%
- Min: 5%
- Max: 20%

Prob. with a subsidy of € 7.000 and driving range km 560



Mean: 50%

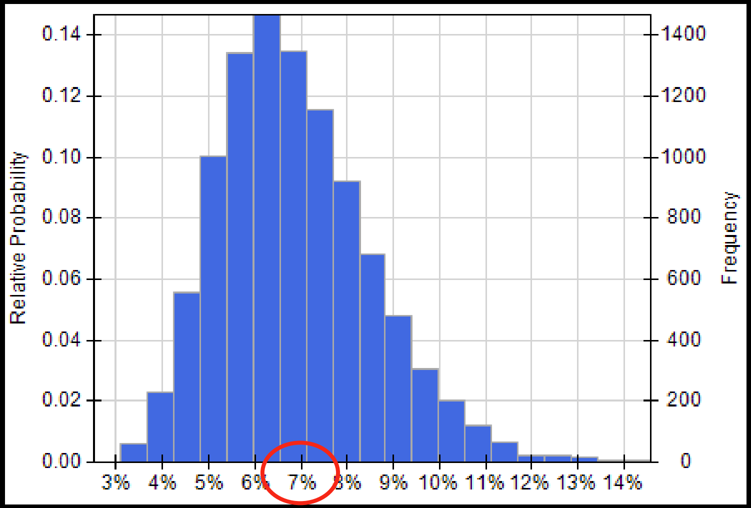
S.D. 6%

Min: 30%

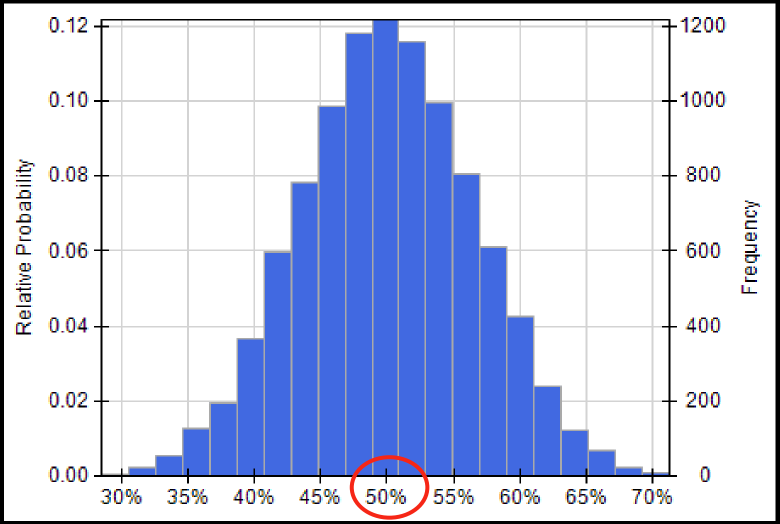
Max: 69%

…scenario analysis 2: Leaf\Pulsar

Prob. Base case



Prob. with a subsidy of € 7.000 and driving range km 890



- Mean: 7%
- S.D. 2%
- Min: 3%
- Max: 15%

Mean: 50%
S.D. 7%
Min: 29%
Max: 71%

Conclusions

- Most important attributes
  - sensitivity analysis Monte Carlo simulation:
  - price, driving range, acceleration
    - charging time, fuel economy, CO_2 emissions

…conclusions (2)

- Meta-analysis critical factors:
  - selection criteria, heterogeneity of models, attributes, metrics, functional forms, sample size, data collection techniques
  - transparency and transferability of metrics used
    - reference points
- Advantages:
  - ex-ante: how to set a new experiment
  - ex-post: validation \ comparison of the results obtained
  - a priori: make up for lack of data

…conclusions (3)

- To be done:
  - Sensitivity analysis
    - Additional attributes
    - Uncertainty on exogenous variables (price, driving range, …)

THANK YOU FOR YOUR ATTENTION!