Introduction of “clean” cars in Sweden: an analysis of policies and their effects

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Outline

- The case of Sweden
  - Implemented policies and some effects
- Car fleet modeling
  - Existing models and results
  - Current and future work

Background

- Swedish car fleet heaviest in all Europe
- Implemented policies aim at transform the fleet to become more CO_2 and energy efficient by accelerating the introduction of “clean cars”

Definition of clean car

- mid-1990s: “alternatively fulled cars” (renewable fuels or hybrid)
- 2005-: “clean car” (fuel consumption, fuel type and emission level)
  - Euro 4 standard (NO_x, HC, CO and particles)
  - Petrol, diesel and electric hybrids that emit < 120 g CO_2 / km
  - Diesel particle filter (max 5 mg / km)
  - Ethanol E85, max 9.2 liters of petrol / 100 km
  - Biogas or natural gas, 9.7 m^3 of gas / 100 km

Implemented policies

- Policies to prepare the market
  - 2006-: all large refueling stations are obliged to provide at least one renewable fuel
    Approx 50% of refuelling stations have renewable fuel in 2009 (10% in 2005)
    90% of these have chosen ethanol E85
  - Tax exempt for alternative fuels (ethanol, biogas, biodiesel)

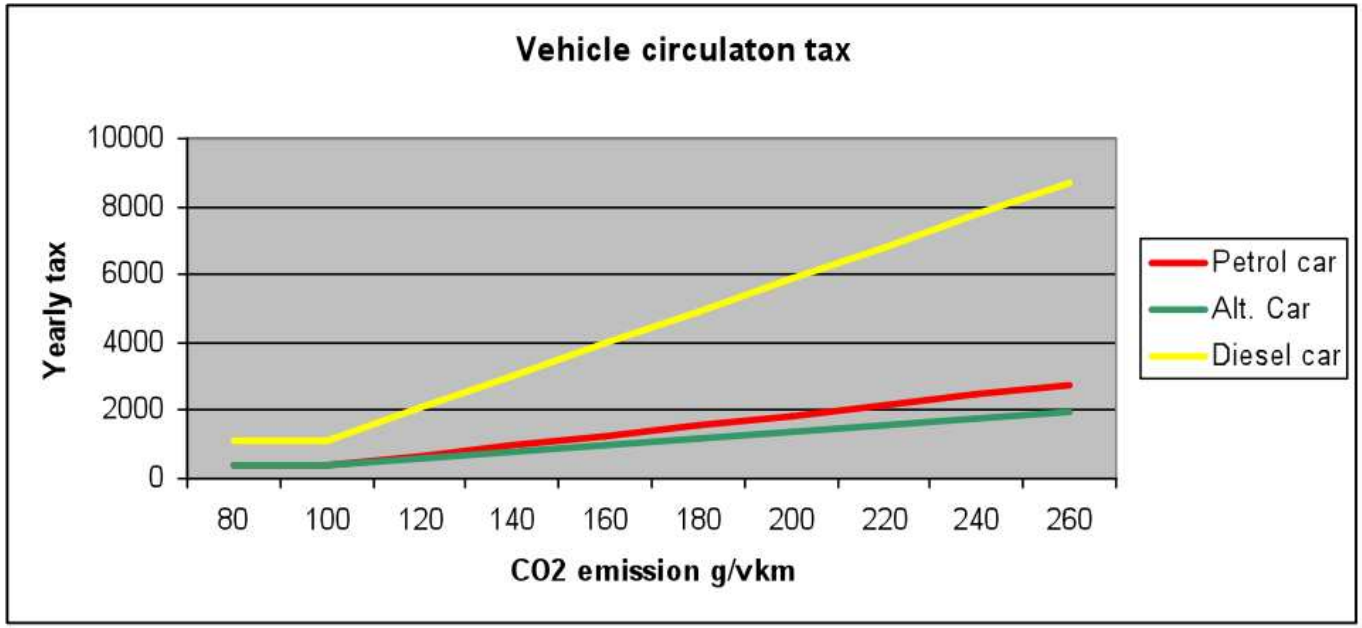
Implemented policies

- Measures to make the market change
- Actors on the demand side
  - Private buyers (approx. 50% of new car sales)
  - Company cars (for private use)
    - Company owner
    - Leasing company owner

Implemented policies - National

- CO_2 based circulation tax
  - Base tax 36 Euros / vehicle, and 1.5 Euros / g CO_2 (over 100 g / km) for conventional cars and 1 Euro / g alternatively fueled cars
  - For diesel cars the tax is 3.5 times the one of a petrol car (to compensate for low fuel tax on diesel)
  - From 2009, clean car exempt for first 5 years

Circulation tax



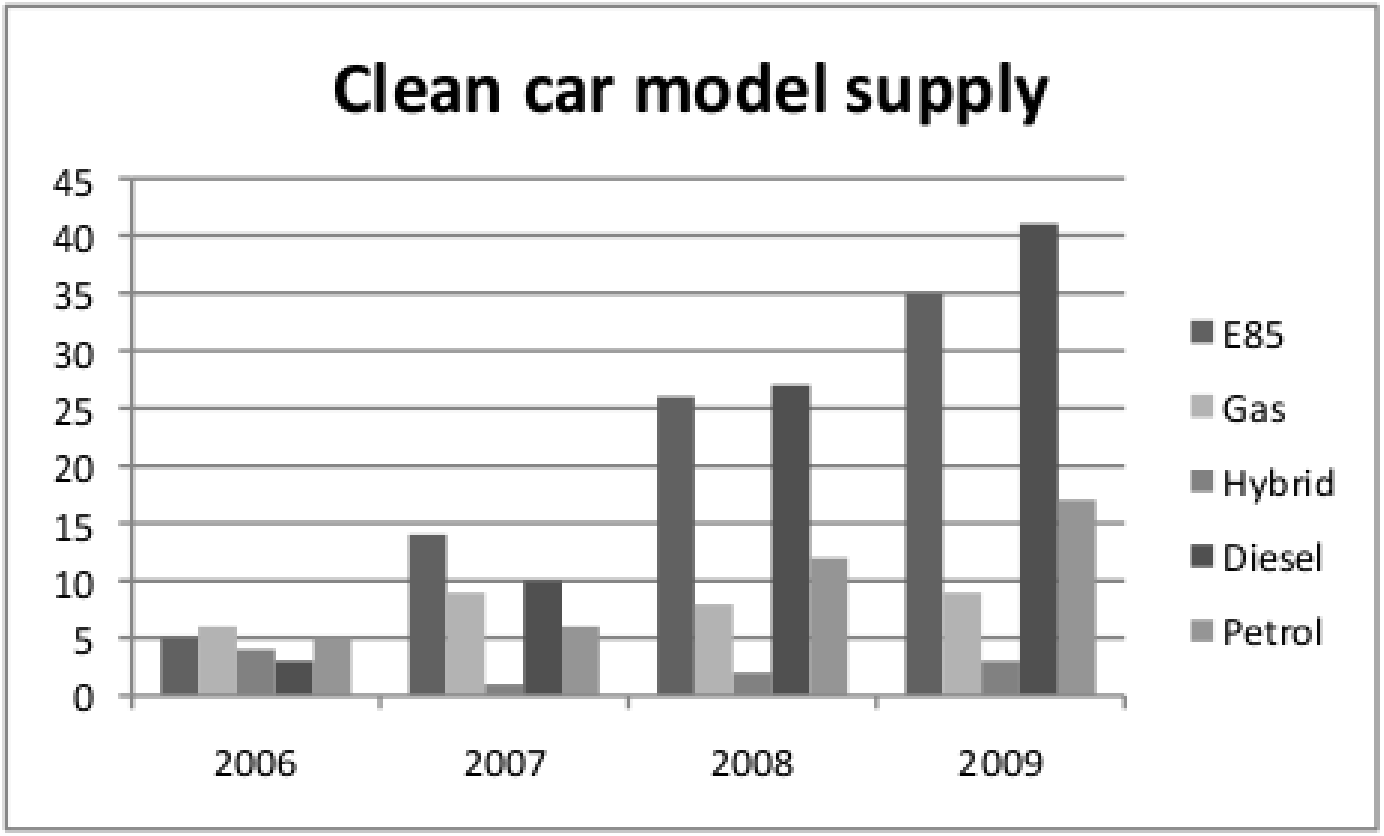
Implemented policies - National

- Company car benefit tax reduction
  - Worth 700-1100 Euros per year after tax
  - 20% for ethanol cars and 40% for gas or electric hybrid cars
- Subsidy (1000 Euros) for privately bought clean cars (2007-2009)

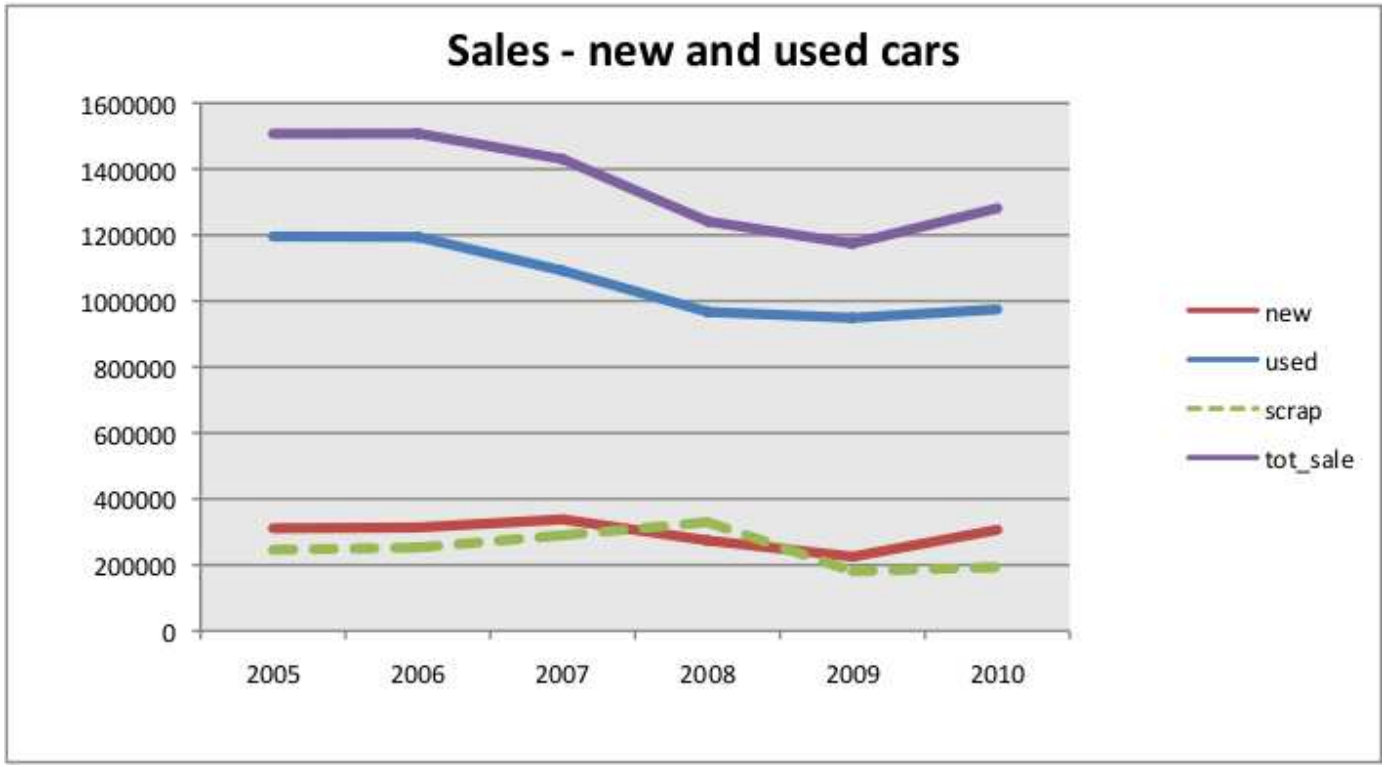
Implemented policies - Local

- Congestion charge exempt for alternatively fueled cars
  - Worth max 900 Euros per year for a regular car commuter
  - Will close 2012
- Free city residential parking for clean cars
  - In Stockholm worth approx. 70 Euros per month or 5 Euros per day
  - Closed in 2009

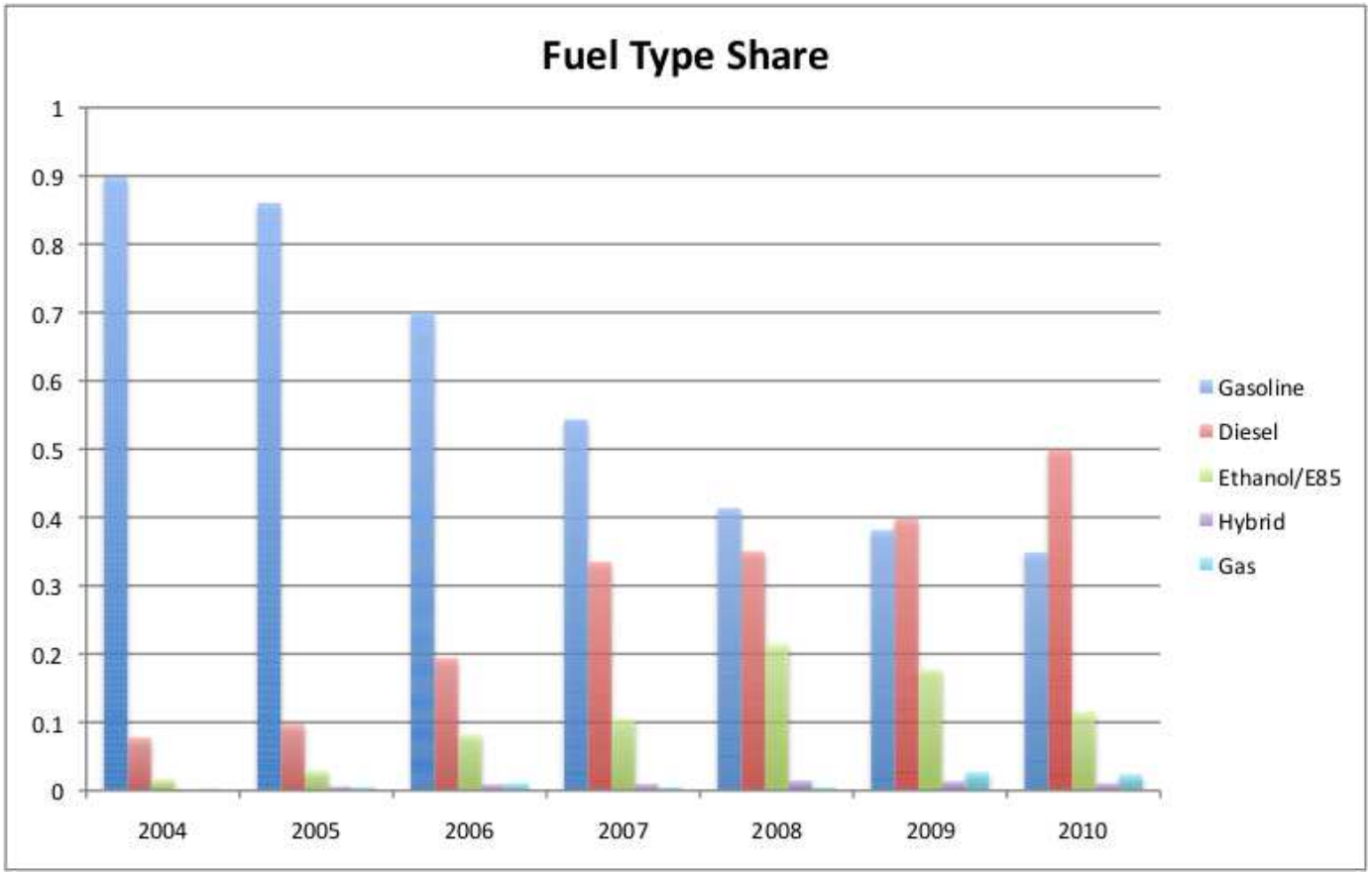
Supply


Clean car model supply
45
40
35
30
25
20
15
10
5
0
2006
2007
2008
2009
E85
Gas
Hybrid
Diesel
Petrol

New and used car sales



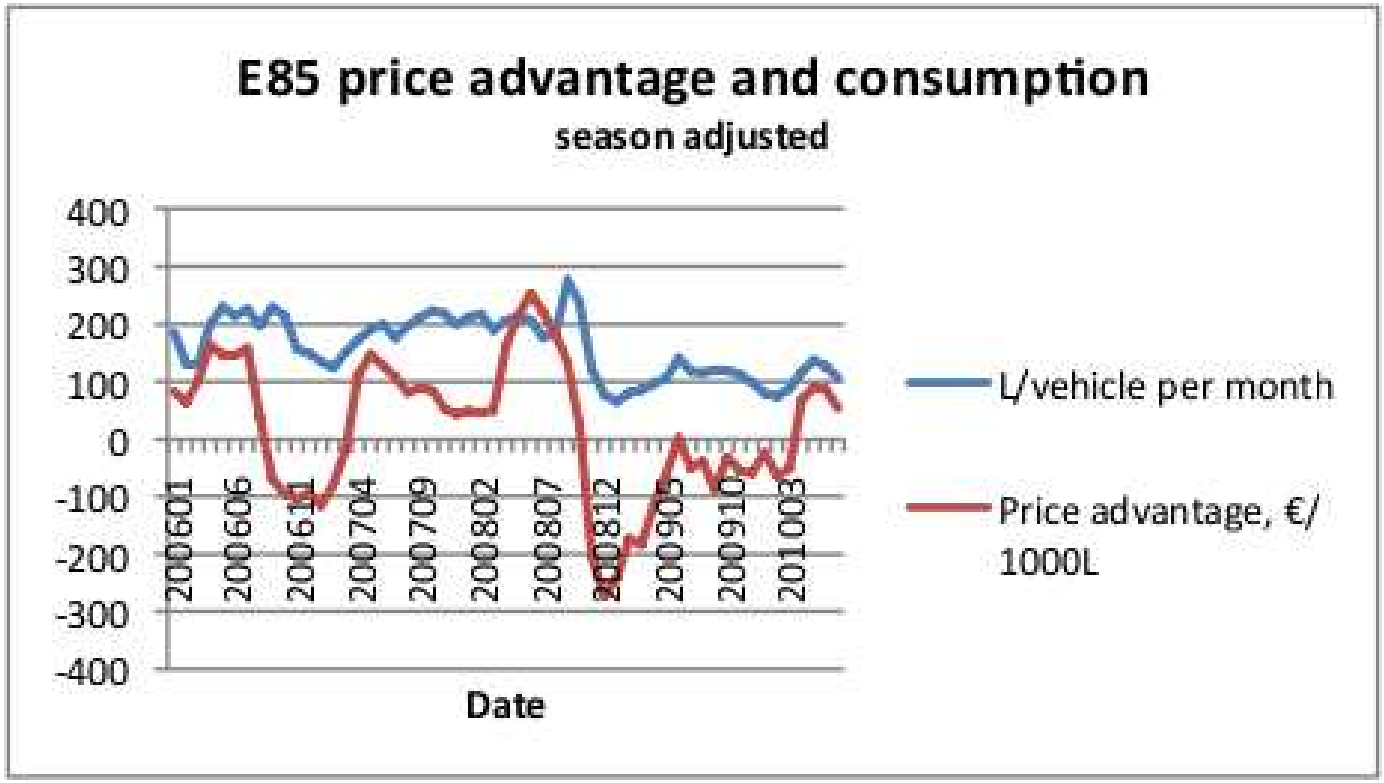
New car sales per fuel type



What explains ethanol car sales?

- Fuel availability; 90% of refueling stations have E85
- Prize advantage compared to petrol

E85 vs petrol prize and consumption



(Petrol prize minus E85 prize multiplied by 1.35)

What explains diesel car sales?

- 1000 Euro clean car subsidy replaced in 2009 by a 5 year circulation tax exempt
- Diesel cars more subsidized than low emission petrol cars and alternatively fueled cars

Yearly circulation tax	120g CO_2	220g CO_2
	Euros	Euros
Petrol	66	216
Alternative fuel	56	156
Diesel	208	680

Summary effects

- Large change of demand
- Share of clean cars: 5% in 2005 and 40% in 2010
- Mostly low emission diesel and E85 capable cars
- Flexifuel cars often driven on petrol

Summary effects

- Average fuel consumption (using petrol equivalents for E85 and gas cars)

Year	l/100km
2005	8.0
2006	7.8
2007	7.3
2008	7.1

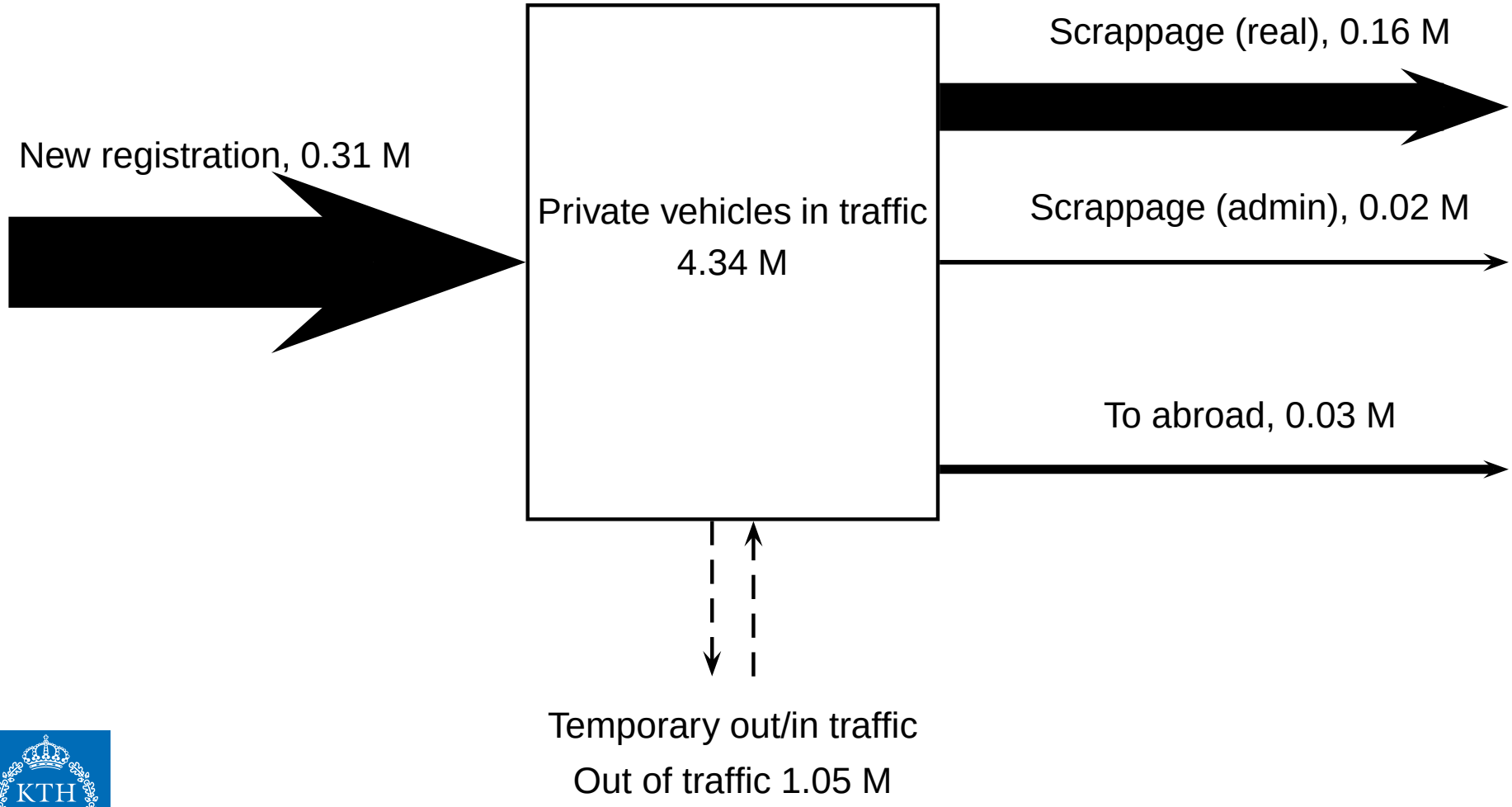
- Rebound effects: increased use because of decreased cost per km or more powerful engines at the same fuel consumption

Objectives

- Forecast the composition of the Swedish car fleet, short and long term
- Evaluate policies e.g. clean car subsidy, scrappage subsidy

Car fleet modeling

Flows 2010 and totals for December (Source: Trafikanalys)



Existing models

- Scrapping
  Fixed shares per vehicle age and brand
- Car ownership (number of new cars)
  Individual based, petrol cost the only policy variable
- Car type choice
  - Nested logit
  - Three segments
  - Choice set: more than 300 car models
  - Estimated based on 2004 register data (individuals)

Existing models

- Attributes
  - Price / benefit tax
  - Running cost (fuel and vehicle tax)
  - Fuel type
  - Tank volume
  - Rust protection guarantee
  - Safety (insurance company index)
  - Engine power (hp)
  - Share of fuel stations with alternative fuel
  - Make

Existing models

- Car type choice does not take into account
  - Choice set restrictions
  - Socio-economic variables

Scenario analysis

- All private buyers get a 10000 SEK (approx. 1000 Euros) refund when buying a clean car
- Predict in 2006, share of clean cars in new car sales 2007
- Model recalibrated for 2006

Assumptions and real figures

- Assumption: number of new cars sold in 2007 equal to 2006 (100000 cars)
  Reality: 155000 cars
- Assumption: 35 new car models
  Reality: 85 new car models

Predictions

	Actual	Original prediction	Corrected prediction Supply	Corrected prediction Supply and sales
Total new car sales	155 000	100 000	100000	155 000
Total number clean cars	28027	9600	16397	25416
Clean car share	18 %	10 %	16 %	16 %
Deviation %	0	-66 %	-41 %	-9%
Deviation nb.	0	-18427	-11630	-2612

Current research

- Data
  - Register (whole car fleet) 2004-2010
  - Available alternatives (new car models/versions) 1999-2010
  - Car ownership and usage data for individuals (and households) (gender, work and home locations, number persons in household, driving licenses, income, fortune, number of cars, yearly driving distance,...)

Current research

- PhD student Shiva Habibi
- Issues related to uncertain choice sets and attributes of alternatives in future scenarios
- First step: empirical analysis
  - Definition of different models (substitution patterns) and different future scenarios
  - Aggregation

Future research

- Combining car type, usage and car ownership data
- Dynamic models
  Schiraldi (2010) “Automobile replacement: a dynamic structural approach”
- Integrate car ownership, car type choice and scrapping
- Critical issues
  - Definition of alternatives and substitution pattern
  - Modeling segments (private buyers, company owned/leased)