Attitude of car drivers towards Alternative Fuelled Vehicles: a survey in Milan

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Abstract

Among the different strategies for achieving sustainable mobility and a better quality of life, alternative fuel vehicles (AFVs) and electric vehicles (EVs) are identified as a good solution for decreasing private transport sector's external costs. Nonetheless, their market penetration level is still very low, because they are considered, on average, less performing than gasoline vehicles as concerns price, recharging times and "range anxiety".

Policy makers and the automotive industry are particularly concerned about the diffusion of these vehicles, and several applied economists have carried out studies on the topic in order to measure the willingness to pay of potential buyers, and their purchasing behaviour.

The present paper aims at investigating the propensity to buy an AFV ora an EC among the inhabitants of Milan, one of the main Italian cities investing in infrastructures (i.e. recharging stations) for this typology of vehicles. The database adopted consists of 997 observations concerning those inhabitants who indicated the typology of car (i.e. gasoline, diesel, hybrid, electric and methane/LPG) they would like to buy in the next future. This database is part of a broader databank developed within the Green Move project by the Politecnico di Milano in 2012, and financed by the Regione Lombardia. The propensity to buy an AFV is investigated by means of descriptive statistics and econometric estimation. Specifically, discrete choice models have been developed, which include explanatory variables on socio – economic aspects, individual travel patterns and the reaction to exogenous events, like the oil price increase or the introduction of a congestion charge. A binomial logit model analyses the respondents' propensity to change their traditional car in favour of an alternative fuelled vehicle, while a multinomial logit distinguishes among the different characteristics of those who would choose an electric car instead of gasoline, diesel, hybrid, electric and methane/LPG cars. (RESULTS to add).

Keywords: Electric cars, alternative fuel vehicles, discrete choice models, Milan

1. Introduction

Several strategies for both transport demand and supply can be adopted for achieving a more sustainable mobility and healthier cities. Specifically, four main drivers have been identified: new technologies, land use planning, transport policies and green attitudes (Holden, 2007; Maltese and Mariotti, 2011). Within this framework, the diffusion of alternative fuel vehicles, and particularly electric vehicles, can be seen as a complex and all-encompassing strategy, related to the above mentioned drivers: (i) new

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engine technology; (ii) park-and-charge area planning; (iii) Government policies and incentives to consumers and producers; (iv) car users' propensity for "green/zero-emission" vehicles.

In particular, electric vehicles and plug-in hybrids are considered a good solution for reducing environmental damages caused by the private transport sector, since over 10% of global greenhouse gas emissions come from road transport (OECD, 2010). Policy makers are thus particularly concerned with the diffusion of electric vehicles, trying to get the most in terms of environmental gains and public expenditure savings; as a matter of fact, electric vehicles appear among the top priorities of the European political agenda (Zubaryeva *et al*., 2012; Eurocities, 2007). Automakers are also very interested in understanding consumer preferences and choices, in order to get some market forecasting, and people living in the cities claim a way out to pollution and congestion. Nevertheless, despite this great interest for less polluting vehicles (ACI- Censis, 2012; Saracino, 2011), and some market share's increase (+12% in 2012) (ACI, 2012), the market penetration of electric cars (hereinafter ECs) is still negligible. Actually, electric vehicles are, on average, more expensive than traditional ones discouraging people from purchasing them. Besides, the recharging infrastructure appears lacking, the refuelling time is perceived as being too long, and the limited cruising range provokes the so-called "range anxiety" (Hidrue, 2011). Fuel value expectations have also been under observations, but no final result has emerged (Greene, 2010).

As concerns Italy, the diffusion of full electric vehicles is still negligible; although in recent years the number of ECs has increase in percentage, the absolute value remains extremely low. In 2012, of the 53.150 circulating electric vehicles (ACI-Censis, 2012) about 6% were cars, 76% were motorbikes and quadri-cycles, while 18% is represented by buses, trucks and vans, probably belonging to public fleets or used for deliveries in controlled traffic zones. Nevertheless, few Italian cities showed some interest for ECs, starting the construction of a public recharging infrastructure. In addition, some electric-based car/vehicle sharing systems have been launched. Specifically, the city of Milan hosts a large number of recharging stations, which has recently increased.

The present paper focuses on the municipality of Milan and aims, by means of a survey, at investigating the propensity of the inhabitants to buy an alternative fuelled car (hereinafter AFC), and specifically an EC. The database adopted consists of 997 observations concerning the interest expressed by respondents on the purchase of different typologies of car (i.e. gasoline, diesel, hybrid, electric and methane/LPG). This database is part of a broader databank developed within the Green Move project by the Politecnico di Milano in 2012, and financed by the Regione Lombardia.

The propensity to buy an EC is investigated by means of descriptive statistics and discrete choice models including several explanatory variables grouped into: socio – economic aspects, individual travel patterns and the reaction to exogenous events, like the oil price increase or the introduction of a congestion charge.[1]

The propensity for alternative fuel car, and specifically EC, is then explored by means of two discrete choice models (Manski and McFadden, 1981; Ben-Akiva and Lerman, 1985; Train, 2003; Hensher et al., 2005; Marcucci, 2011). The first – a binomial logit – aims at analysing the propensity of the respondents to change their traditional car in favour of an Alternative fuelled one. The second model – multinomial logit – investigates the different characteristics of those who would choose an EC instead of

[1] For a detailed description of the variables of the Green Move database see Beria and Laurino (2013, 2014; Mariotti et al., 2013a).

another car. The models include several explanatory variables, considering socio-demographic variables, , car fleet characteristics, travel behaviour of the respondents, exogenous variables (i.e. oil price increase, Area C congestion charge).

The paper is structured into six sections. The Introduction is followed by the literature review on the empirical analyses on the propensity to purchase alternative fuelled vehicles. Section three focuses on data, while the methodology and the empirical results, provided by descriptive statistics and discrete choice models, are described in Sections four and five. The last section is devoted to conclusions.

2. Literature review on the propensity to buy an AFV

This section is dedicated to the description of the literature on the propensity for Alternative Fuelled Vehicles in general, and electric ones, in particular.

(ADD PART ON AFVs)

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2.1 A focus on Electric Cars

It is worthwhile considering that most of the economic studies concern market forecasting and analyses focusing on consumer preferences and their acceptance of electric vehicles. Indeed, as long as clean-fuel vehicles have not been available on the market, it has not been possible to observe the consumer behaviour or to measure the consumer preferences. As a result, stated preference approaches have been applied, that is when the consumer is asked to choose among various alternatives defined by their attributes (Hensher *et al*., 2005; Morwitz, 2007; Kalwani and Silk, 1982) [2].

Nevertheless, the increased availability of ECs on the market fostered the development of studies trying to measure not only the willingness to pay of potential buyers (using *Bass Diffusion models*, *Total Cost of Ownership*, and *Stated Preference techniques*. Hidrue, 2011; Ko and Hahn, 2013; Massiani, 2013; Massiani, 2012; Massiani and Radeke, 2013; Hensher, 1994), but also their purchase decision (Caulfield *et al*., 2010).

Within the empirical literature assessing the consumer preferences for an EC, two main branches can be identified. The object of the first branch is to investigate the importance given by potential consumers to the attributes of the vehicles (conventional *versus* alternative fuelled), while the object of the second branch is to analyse the potential buyer profile, thus helping automakers and policy makers in identifying their own targets, on one side, and price and subsidy levels, on the other side.

The studies belonging to the first branch trace back to the 80s (Table 1), and have mainly provided information to automakers, pushing them into improving the product; those of the second branch are obviously more recent (Table 2). Specifically, the earliest studies of the first branch (Beggs et al., 1981; Calfee, 1985) focused on investigating the multi-car households' motivations towards ECs, finding out that "range anxiety" was the primary concern for consumers. During the 90s, scholars moved to targeting the entire population and including a measure of emission level as a standard vehicle

[2] For a detailed list of contributes on the topic in the period 1980-2000 see, for example, Hidrue *et al.(*2011).

attribute, by comparing conventional gasoline vehicles with alternative fuel vehicles. Even in these studies range anxiety played a key role (Dagsvike, 2002), together with long charging time and high purchase price in limiting ECs market penetration (Molin *et al*., 2007). Low emissions and the possibility of fuel savings appear, instead, favourable characteristics (Bunch, 1993; Ewing and Sarigöllü, 2000).

Despite price subsidy was likely to be an effective tool, in the early 2000s, its impact on vehicle choice still appeared much smaller than that of vehicle performance characteristics (Ewing and Sarigöllü, 2000). On the other side, in the last ten years, due to a better known product, its increased performance level and higher penetration market, prices and subsidies have gone under observation. Propfe *et al.* (2013) and Shepherd (2012) emphasised that fuel savings[3] and price incentives represent the best drivers for purchasing an EC, and Ko and Hahn (2013) stressed that the availability of lump sum subsidies, instead of installed ones, encourage buyers. Besides, if range keeps on representing a concern for potential buyers (Lieven *et al*., 2011), performance does not seem anymore to be a hindrance to EC purchase. In addition, the availability of alternative transportations modes (Tamor *et al*., 2013), the extent of the recharging network (Caulfield *et al*., 2010; Potoglou and Kanaroglou, 2007) and battery swappability (Ko and Hahn, 2013), foster the acceptance of electric vehicles.

Table 1: **S**tudies on electric vehicles[4].

Study	*Scope*	*Year*
Beggs et al.	USA	1981
Calfee	USA	1985
Bunch et al.	California	1993
Brownstone and Train	California	1999
Ewing and Sarigöllü	Canada	2000
Dagsvike et al.	Norway	2002
Saracino	Italy	2011
Lieven et al.	Germany	2011
Shepherd et al.	United Kingdom	2012
Tamor et al.	USA	2013
Ko and Hahn	Korea	2013
Propfe et al.	Germany	2013

Source: Authors' elaboration.

A recent survey conducted by Saracino (2011), aiming to explore the propensity towards ECs in Italy, finds that 13.3% of the population considers ECs as the solution to pollution and congestion, while the most of the respondents choose to walk or to use the bike (44.6%) or the Local Public Transport (LPT) (about 32%) for their trips in order to reduce pollution and congestion. When the respondents have been asked about the future purchase of a car, 64% of them answered they would prefer an Electric or Hybrid one because of environmental concern (78%) or for fuel saving (14%). Furthermore, among those who would not choose an electric or a hybrid car, the motivations were: high price (36.6%), battery capacity (18.4%), lower performance level (about 13%), and

[3] For a in-depth analysis on how consumers value fuel savings see Greene, 2010.

[4] A more in-depth review of survey design practice in studying the market diffusion of alternative fuelled vehicles can be found in Massiani (2012).

the “experimental” nature (about 30%) of the product. Compared to other Europeans, Italian people seem more concerned not only about range (Senn, 2011), but also about the fuel price increase (Deloitte, 2011).

The second branch of studies introduces more heterogeneity by taking also into account the potential buyer profile, thus helping automakers and policy makers in identifying their own targets, on one side, and price and subsidy levels, on the other side. In Table 2 some contributions on the topic are listed, detailing the explanatory variables and their impact on the decisional process of the potential or actual EC buyers. Specifically, the explanatory variables have been grouped into four categories: socio-economic (demographic) aspects, green attitude, characteristics of the owned car fleet, and exogenous factors. As it is easy to notice, some variables used in the studies belonging to the second branch are proxy of those used in the first branch of studies; range, for example, is strictly interacting with refuelling network, while vehicle’s emissions are a good matter of decision for green-friendly people.

Table 2: **Studies on electric vehicles–** Explanatory Variables

	Study	*Hidrue et al. (2011)*	*Brownstone et al. (2000)*	*Dagsvike et al (2002)*	*Caulfield et al (2010)*	*Zito and Salerno (2004)*	*Potoglou and Kanaroglou (2007)*	*Mabit and Fosgereau (2011)*	*Deloitte (2011)*	*Saracino (2011)*
		US	*California*	*Norway*	*Ireland*	*Palermo*	*Hamilton, Canada*	*Denmark*	*World/EU*	*Italy*
Socio demographic features	Gender (male)	+	°	-	-	-	-	-	+/°	°
	Age	-	°	-	+	-	-	n.s.	-	-
	Income	n.s.	n.s.	°	+	n.s.	+	n.s.	+	°
	Education/ Occupation**	n.s.	+	°	n.s.	°	+	n.s. **	+	+
	Propensity to new products	+	°	°	°	°	°	°	+	°
	Family size	°	°	°	°	°	-	n.s.	°	°
Green attitude	Environment friendliness/concern	+	°	°	n.s.	°	+	+	+	°
	Future car: hybrid	+	°	°	°	°	°	°	°	°
Car fleet characteristics	Number of cars	n.s.	+	°	+	+	n.s.	°	°	°
	Expected future car expenses	n.s.	°	°	°	°	°	°	°	°
	Expected future car size	-	-	°	°	°	°	°	°	°
	Expected driving length	+	-	°	°	-	-	n.s.	-	°
	New car (*vs* used)	°	n.s	°	°	°	°	°	°	°
	Car age	°	n.s.	°	°	n.s.	°	°	°	°
	Garage ownership	+	°	°	°	n.s.	°	°	+	°
Exogenous factors	Recharging network proximity/availability	+	+	+	°	°	+	+	°	°
	Expected fuel price*	+	+	°	+	°	+	+	+	°
	Subsidies	°	°	°	n.s.	°	+	°	+	°
	Privileges (free park or fast tracks)	°	°	°	°	°	n.s.	°	°	°

°= not available, that is, the variable has not been considered in the model; n.s. = not significant, i.e., the variable has not proved to affect the choice of the car

* the variable looks different according to the fuel type – oil or electricity prices, for example, are expected to increase or decrease in order to favour the EC purchase.

Source: Authors' elaboration.

Most of the studies find that the early adopters of an EC are likely to be younger, well-educated, richer, belonging to a small family, having an alternative car at his/her disposal, and living in a city where the land use mix and density are higher. They also show environmental consciousness, are favourable to innovation and sensitive to government incentives and fuel efficiency. Only in few studies, considering US and worldwide samples (Hidrue, 2001; Deloitte, 2011), males are marginally more likely to buy an EC than females. Besides, it results that having more than one car at one's own disposal proved to be positive and significant (Caulfield et al. 2010, Brownstone et al. 2000), while owning/renting a garage seems to be crucial (Deloitte 2011; Hidrue 2011). Besides, commuting within a certain (low) distance can contribute to EC diffusion (Zito and Salerno 2004; Potoglou and Kanaroglou 2007; Brownstone et al. 2000).

Moving to the so-called "exogenous variables" like economic conditions (fuel price or subsidies for car purchasing) or the availability of the recharging network, other interesting outcomes emerged. Indeed, prices and range have long represented the biggest hindrances to EC purchase; as long as technology has not managed in reducing costs and extending range, public subsidies (Potoglou and Kanaroglou 2007) or a more widespread recharging infrastructure (Dagsvike et al. 2002) have played a key role. Besides, sensitivity to fuel price has also driven buyers towards EC, while the possibility to use fast tracks or to park for free did not prove to be significant (Potoglou and Kanaroglou 2007).

Moreover, in the most recent contributes, some urban characteristics have also been taken into account: Potoglou and Kanaroglou (2007), for example, considered land use mix and density, while Mabit and Fosgereau (2011) or Deloitte (2011) focused respectively on work distance and urban form.

Since the EC diffusion has not proved to be so strong in Italy (Danielis, 2014) and in Milan, the interest here is to explore the individual propensity towards AFVs and ECs, by analysing the specific characteristics of the potential buyers, in order to understand which are the main drawbacks to an EC purchase that do not depends on its intrinsic characteristics.

3. Data

The present paper investigates the propensity of the Milan inhabitants to buy, in the near future, an alternative fuel car (hybrid, electric and methane/LPG) instead of a conventional one (gasoline, diesel).

In the year 2011 the motorization rate (number of cars/100 inhabitants) in Milan was about 53, quite below the Italian average5 (about 61) and still decreasing (Euromobility, 2012). Although this index shows a propensity for the cutting down of the individual vehicles fleet, the vehicles density within the city still proves to be very high (about 3.940 cars/sqkm), not only above the average (832.6) but also showing a little increase since 2010 (ibidem), arousing troubles about land and public space shortage. Within this context, in 2011 Area C congestion charge has been implemented in order to prevent the city-centre of Milan from congestion[6] and to push car ownership reduction.

[5] Calculated on the 50 major cities in Italy, that is the 20 Region Capitals, the Autonomous Province Capitals and other Municipalities with a population of more than 100,000 inhabitants (Euromobility, 2012).

[6] For a review on the Area C congestion charge see Rotaris et al. (2011), Mariotti et al. (2013b).

The database used in the present analysis consists of 997 observations and is part of a broader databank developed within the Green Move project by the Politecnico di Milano in 2012, and financed by the Regione Lombardia[7].

Table 3 reports the specific questions, whose answers have been used for the present analysis. It is worth mentioning that during the survey a table comparing the characteristics of the different engine technologies and fuel supplies of the cars has been provided to all respondents to inform their answers.

Table 3: **Questions on alternative fuel cars**

Number	*Text*	
Q.1	Fuel supply of your car	1. gasoline; 2.diesel, 3.hybrid, 4**. electricity**; 5. Methane/LPG
Q.3	Fuel supply of your next (possible) car	1. conventional (gasoline or diesel); 2. **electric**; 3. hybrid or LPG/Methane; 4. not decided yet, don't' know
Q. 23	Fuel supply of the car sharing service	1. conventional; 2. **electric**; 3. don't' know
Q4.2 – Q5.8	Motivations for unavailability to buy an **EC**	1. high price; 2. low range; 3. other reasons

The profile of the potential buyer of alternative fuel car, and specifically electric car, is provided by the following information:

- Socio-demographic aspects: gender, age, education and occupation, civil status, family size, presence of kids or babies, home address.
- Car fleet characteristics: number of owned cars and typology (conventional or alternative fuel); status (new or second-hand); price at the purchase time; fuel supply; parking typology.
- Travel behaviour of the interviewees: transport modes, driving length, trip motivation, Car Sharing and/or Bike Sharing membership, present and expected attitude towards sustainable mobility strategies like car sharing (both traditional and peer-to-peer[8]);
- Stated impact of the oil price increase or of the introduction of the Area C congestion charge on the private car use.

4. Survey results

The 997 Milan inhabitants of the survey, own 1,622 cars, and, as expected, only 10% of the fleet is not conventionally fuelled. Among this, the number of electric cars is negligible (0,3%) (Figure 1a, Question Q1). These figures are in line with general statistics. When asked about a possible future new car, they are more likely to buy a low(er) emission car (hybrid or LPG/methane) (60.2%) than a conventional (gasoline or diesel) (18.5%) or electric one (9.6%) (Figure 1b, Question Q3).

[7] The Green Move project aimed at designing and testing a vehicle sharing system to be implemented in the city of Milan (Italy) (Luè et al., 2012). In addition, the purpose of the project was to explore a peer to peer CS scheme: a carsharing in which cars are not centrally provided, but are owned by individuals who rent them when unused, in exchange of a monetary reward. For a review of the project, see Beria and Laurino (2013, 2014); Mariotti et al. (2013a).

[8] The "peer to peer carsharing" is a carsharing in which cars are not centrally provided, but are owned by individuals who rent them when unused, in exchange of a monetary reward.

Figure 1a: Car fleet by fuel supply

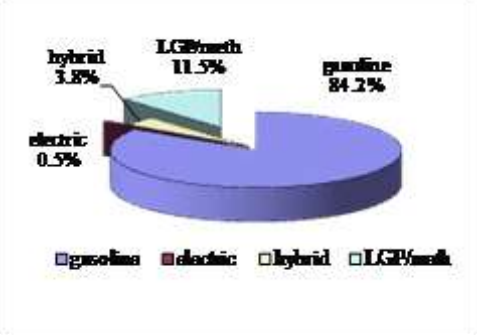
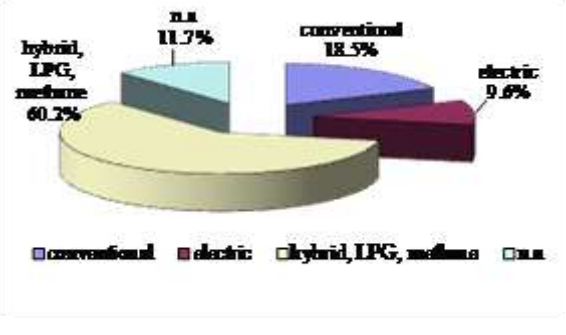


Figure 1b: Future purchase car



Source: Authors' elaboration.

Despite the stated interest towards non-conventional vehicles, the propensity to buy an EC is rather low mainly because it is, on average, more expensive (43%) than the other typologies, and has a lower range (27%) (Questions 4.2, 5.8). Nevertheless, 55% of the respondents declared that they would instead prefer an Electric CS to a traditional one, since the vehicle is owned and managed by a CS organization, and it is usually shared for urban (i.e. short) trips.

Moving to socio-demographic features, as emphasised also by the literature review, females seem more likely to buy a non conventional car (70%) than a conventional one (19%); men preferring an EC are about 23% *versus* 66% of those who would choose an AFC.

If age and education do not prove to be significant, skilled workers appear more interested in ECs than in a different AFC are 13%; the same percentage of not skilled workers preferring ECs to other AFC, is only 10% (Figure 5b).

Looking at the geographical distribution of the sample, the respondents living in the centre and in the semi-central zones of Milan seem less interested in AFCs: 22% of them would choose a conventional car, while in the periphery they are only the 17%. On the other hand, ECs seem more appealing for those living in the centre (15%) than elsewhere.

The question concerning the impact of the Area C tool introduction in the car use behaviour of the respondents shows that the majority of those affected by the charging affirm that they could buy in the near future an EC or at least an AFC. This can be explained by the fact that the Area C tool does not apply to ECs and, for the first years, also to new alternative fuel cars.

Finally, the respondents who declared they would buy a new AFC have been the most affected by the fuel price's increase: specifically 74% of those who prefer an EC and 70% of those who would choose another kind of AFC.

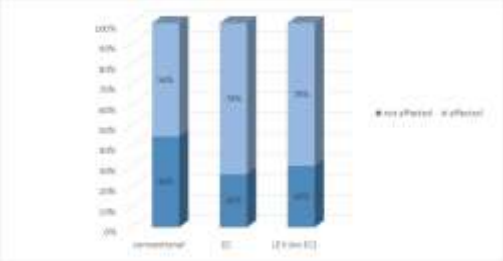
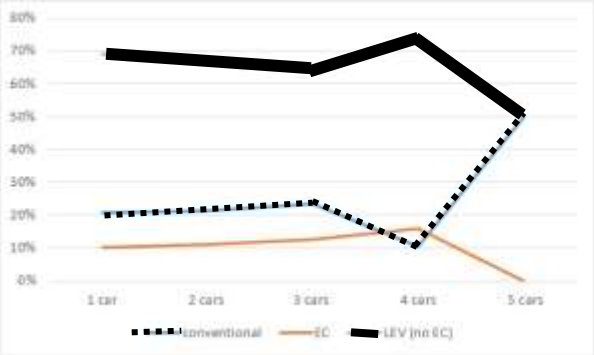


Figure 2: ECs choice – oil price increase impact.
Source: Authors' elaboration.

This outcome is in accordance with the literature (Table 2) and confirms the importance of the fuel saving concern as a key driver for buying an EC.

Focusing on car fleet characteristics, it is interesting to notice that, as expected, the larger is the owned fleet, the higher is the ECs potential buyers' share (Figure 3).



Note: LEV stands for low emission vehicles, not including electric car

Figure 3: ECs choice – number of owned cars.
Source: Authors' elaboration.

Actually, since EC limited range can worry a driver, it is important to have at least another not electric car in the fleet. Besides, having one or more alternative fuelled cars in the fleet increases the propensity to buy an electric one.

Differently from literature findings, in Milan owning at least one garage does not prove to be crucial for deciding to prefer an EC or not, as well as the car fleet age. By contrast, the value of the car fleet itself, considered as the car price at the purchase time, seems to be more important. As long as the value of the car fleet increases, the share of those who prefer a conventional car also rises, from 14% up to 33%. This is probably due to the strict link between the higher performance and the price, which is requested for the most expensive cars.

As concerns the distance covered by the respondents, it results, as expected, that the choice for the EC starts decreasing after a 20.000 km of driven distance. Besides, among those who cover minimal distance, typically into the city, the share of respondents who would prefer an EC are larger: 17% who do not use the car often (less than 2.000 km) and 13% who cover distance between 2.000 and 5.000 km every year.

At last, focusing on car sharing services[9], about 27% of current or former car sharing members do prefer an EC, compared to 10% of those who are not and were not CS members (Figure 4a).

Figure 4a:ECs choice– traditional CS

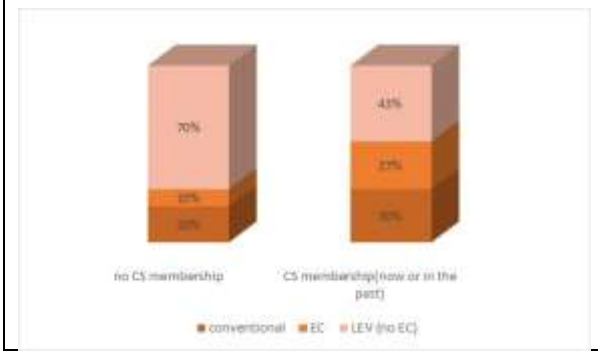
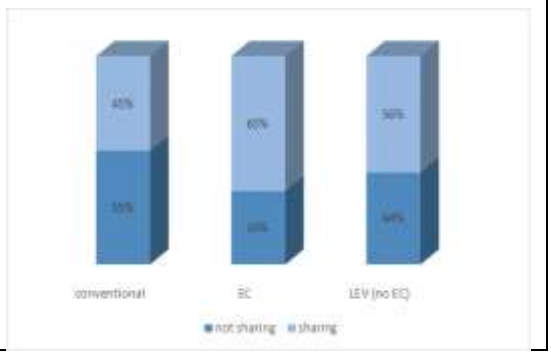


Figure 4b: ECs choice –P2P CS



Note: LEV stands for low emission vehicles, not including electric car
Source: Authors' elaboration.

Even considering a non-traditional CS service like the peer to peer CS (P2P CS) proposed within the Green Move project (see Beria, Laurino, 2013, 2014; Mariotti et al., 2013a), which explores the propensity to share one's own vehicle, results do not change. Among those who would choose an EC as their next car, the majority (65%) would also share his/her own car (Figure 4b).

5 Econometric estimation (DRAFT)

The results of the descriptive statistics are partially corroborated in this section by the discrete choice models (binomial logit model). The probability to buy conventional car or hybrid, LPG/methane, and ECs is:

$$F(x'_i \beta) \text{ where } F(.) = \exp(.)/[1+\exp(.)], \quad (1)$$

In the formula, β is the vector of coefficients. For the discrete choice 0 represents the respondents willing to buy a conventional car and 1 represents the respondents preferring any non-conventional car, and the random utility components are assumed to be independent and identically Gumbel (extreme value) distributed (Greene, 2003).

According to the literature review, the explanatory variables, which capture the difference in characteristics between those preferring an AFC or a conventional car, have been grouped into four categories: socio-demographic aspects; characteristics of the car fleet; travel behaviour; exogenous variables (impact of the oil price increase or of the introduction of a congestion charge) (Table 4).

Table 4: Explanatory variables

[9] The car sharing systems in Milan, at the moment of the survey, were: GuidaMI and E-vai. Since August 2013 additional car sharing systems have been implemented like Car2Go, Enjoy.

Variable	Description
Socio-demographic variables	
Gender	Dummy variable: "1" if male, "0" if female.
Skilled worker	Dummy variable: "1" if the respondent is a skilled worker, "0" otherwise
Zone of residence	Dummy variable concerning the nine zones in Milan
Car fleet characteristics	
No. owned cars	Number of owned cars. Categorical variable = 1, 1 car; 2, 2 cars; 3, 3 or more than 3 cars.
Owned (new) cars' price	Average purchase price of the owned new cars. Continuous variable
Owned (new) cars' age	Average age of the owned new cars. Continuous variable
Garage	Dummy variable: "1" if the respondent owns at least one garage; "0" otherwise.
Share AFC	This variable states the share of alternative fuel cars owned by the respondent over the total number of owned cars.
Travel behaviour	
Km	Number of Km covered yearly. Dummy variable: "0" if the respondent covered 0-10,000 km yearly; "1": more than 10,000 km.
Modal choice: -LPT - Bike -Foot - Motorbike	Four dummy variables suggesting the main modal choice adopted by the respondent.
Car sharing membership	Dummy variable: "1" if the respondent is or has been member of car sharing services in Milan (Guidami and E-Vai), "0" otherwise.
Peer-to-peer CS	Dummy variable: "1" if the respondent is favourable to become a member of a car sharing peer-to-peer, "0" otherwise
Exogenous economic measure	
Oil price	Dummy variable: "1" if the respondent has reduced the car use because of the oil price's increase, "0" otherwise.
Area C	Dummy variable: "1" if the respondent has reduced the car use because of the AREA C tool introduction; "0" otherwise.

Similarly, a multinomial logit model is carried out in order to distinguish between the willingness to buy conventional car (Group 1), electric car (Group 2) and hybrid, LGP and methane car (Group 3) (Table 6).

Both in the case of binomial and multinomial logit, four sets of models are run in sequence. When dummy variables are included, the model fit improves as reflected by the small increase of the pseudo R2. Logit models are in general known for their in on average very low R2 values (Norušis, 2005, Lammers et al, 2007).

The results of the binomial logit model (Table 5) show that the respondents willing to buy an AFC already own one or more AF car(s). They have been negatively affected by the oil price increase, are and have not been members of the CS systems in Milan; besides, they are more willing to adopt a P2P car sharing, and they would prefer a car sharing system using electric vehicles. All the variables related to travel behaviour are not significant. Besides, the zone variables confirm that there are fixed geographical effects.

Table 5: Binomial logit estimation - results

	AFC (LGP/methane, hybrid, electric)			
Explanatory Variables	**(1)**	**(2)**	**(3)**	**(4)**
Gender	-0.2500	-0.1891	-0.2011	-0.2341
Share_AFC	1.9883***	2.0185***	2.0036***	2.0188***

Oil price	0.6341***	0.6284***	0.6260***	0.6377***
CS-Member	-0.7515***	-0.6921***	-0.7396***	-0.7483***
P2P CS	0.4037***	0.4138***	0.4288***	0.4437***
Area C	-0.2226	-0.2365	-.2305	-.2510
Electr CS	1.0425***	1.0460***	1.0296***	1.0399
LPT		0.2811	0.3019	0.3052
Bike		-0.1886	-.2041	-0.1650
Foot		-0.0918	-.0897	-0.0853
Motorbike		-0.2150	-.2846	-0.2680
Skilled				-0.0836
Car price				-0.0000
Car age				0.0195
Garage				-0.1614
Km				0.2145
n.car 1				-0.1314
n.car 2				-0.1197
Dummy zone	No	No	Yes	yes
Cons	0.3623***	0.2953	0.3603	0.2896
Obs.	997	997	997	997
Prob.	0.0000	0.0000	0.0000	0.0000
Pseudo R2	0.0951	0.0998	0.1102	0.1152
Log likelihood	-463.2360	-460.8566	-455.4904	-452.9338

Notes: *** significance at the 1% level; ** at the 5% level; at the 10% level.
N.car: reference group is n.car 3. Travel behaviour choice is car.

In order to investigate more in depth the choice of an EC and, specifically, the characteristics of the respondents aiming to buy this type of car, a multinomial logit model (MNL) has been developed. This allows distinguishing between respondents willing to buy a new conventional car (reference Group 1), those aiming to buy an electric car (Group 2), and those preferring a LGP, methane and hybrid car (Group 3).The aim is to understand which characteristics distinguish reference Group 1 from those belonging to Group 2 and 3 (Table 5).

It results that those willing to buy an EC (Group 2), if compared to those preferring a conventional one (Group 1), are those who: already own alternative fuel cars, have been negatively affected by the oil price increase, are willing to share their own car (P2P CS), and prefer an electric CS. Differently from literature, inhabitants of Milan seem not positively influenced by garage ownership and by an high number of cars owned when preferring ECs. Group 3 (those preferring hybrid, LGP and methane), if compared to those belonging to Group 1, already own an alternative fuelled car, are not or have not been CS members, have been affected by oil price increase, are willing to share their own car, would prefer a CS using electric cars, and are more willing to use LPT instead of car. Again, the different zone of residence does not influence significantly the result.

Table 6: Multinomial logit estimation - results

Explanatory variables	**(1)**	**(2)**	**(3)**	**(4)**
	Group =2 (electric car)			
Gender	-0.3053	-0.2409	-0.2179	-0.2243
Share_AFC	1.4490***	1.4326***	1.4553***	1.4820***

Oil price	0.5955***	0.5805***	0.5748***	0.5722***
CS-Member	0.4780	0.5517	0.5008	0.4855
P2P CS	0.5015**	0.5004**	0.5357***	0.5153**
Area C	0.0233	0.0273	0.0364	0.0173
Electr CS	2.1333***	2.1534***	2.1688***	2.1662***
LPT		0.0887	0.0861	0.0879
Bike		-0.0281	-0.0462	-0.0265
Foot		0.0882	0.0836	0.0878
Motorbike		-0.5224	-0.5877	-0.6104
Skilled				0.1917
Car price				-0.0000
Car age				-0.0040
Garage				-0.1702
Km				0.141
n.car 2				0.0429
n.car 3				0.0673
Dummy zone	No	No	Yes	Yes
Cons	-2.5871***	-2.6232***	-2.1526***	-2.1037***
	Group = 3 (hybrid, LPG, methane)			
Gender	-0.2462	-0.1874	-0.2023	-0.2419
Share_AFC	2.0785***	2.1148***	2.1090***	2.1208***
Oil price	0.6432***	0.6374***	0.6350***	0.6466***
CS-Member	-1.0871***	-1.0320***	-1.0820***	-1.0891***
P2P CS	0.3924***	0.4016***	0.4138***	0.4292***
Area C	-0.2601	-0.2773	-0.2735	-0.2953
Electr CS	0.8838***	0.8813***	0.8599***	0.8734***
LPT		0.3125**	0.3364**	0.3382*
Bike		-0.2239	-0.2410	-0.1933
Foot		-0.1137	-0.1157	-0.1135
Motorbike		-0.1529	-0.2255	-0.2029
Skilled				-0.1140
Car price				0.0000
Car age				0.0225
Garage				-0.1570
Km				0.2433
n.car 2				-0.1464
n.car 3				-0.1567
Dummy zone	No	No	Yes	Yes
Cons	0.3237*	0.2529	0.2504	0.2183
Obs.	997	997	997	997
Prob.	0.0000	0.0000	0.0000	0.0000
Pseudo R2	0.0893	0.0942	0.1092	0.1142
Log likelihood	-752.9363	-748.9295	-736.483	-732.398

Notes: Group=1 (conventional car) is the base outcome. N.car: reference group is n.car 1. Travel behaviour choice is car. *** significance at the 1% level; ** at the 5% level; at the 10% level.

6 Conclusions

The motivations behind the lacking propensity for ECs in Italy are several: the poor willingness of the users to invest in technologically advanced automobiles; the lower sensitivity to air pollution; the lack of financial means to buy a new car; the relatively large diffusion in the country of other low-emission cars, especially methane, that anyhow guarantee good environmental and energy efficiency levels; the higher propensity of the main national automobile producer for methane cars instead or ECs;

the shorter number of Km yearly travelled by Italian car drivers that does not allow to make up for the EC's advantage in terms of variable costs compared with the higher fixed costs; the lack of dedicated infrastructures (recharging stations) (Danielis, 2014).
Within this context, the present paper aimed to investigate the propensity of the inhabitants of the municipality of Milan to buy an alternative fuelled car and, specifically, an electric car in order to identify the factors most likely to influence the demand for it.

The results of the empirical analysis show that the propensity of the respondents to prefer an alternative fuelled car (either hybrid, LPG, methane and electric), if compared to those aiming to buy a conventional one, is positively and significantly related to the ownership of one or more alternative fuelled car(s), the willingness to adopt a P2P-CS, the preference for a car sharing using electric cars, and to have experienced a negative impact of the oil price increase. Besides, when investigating the propensity towards the different typologies of alternative fuelled cars, it results that those privileging an EC already own alternative fuelled cars, have been negatively affected by the oil price increase, are willing to adopt a P2P CS.

Therefore, alternative fuelled cars are mainly chosen by those "knowing" them because they own at least another one, and by those more willing to share their own car (P2P CS). This information allows depicting a potential user more concerned about environmental pollution, more "open" to new sharing modes, and less interested about "status" and "pleasure" that cars can provide (Steg and Gifford, 2005).

Even if no market prediction is the aim of this work, the feeling is that the market for ECs remains marginal because of people's attitude towards private car utility and because of high purchase costs. This reduces the effectiveness of any regulation, or financial aid in spreading out EC market. Moreover, along with an "education" program for drivers and car purchasers, the supply side should keep on improving the EC performance level, in terms both of range and recharging times. This will also help in reducing the final price.

Nevertheless, this study presents some limits. Being faced with a hypothetical decision, respondents did not perceived the real extent and impact (positive or negative) to buy an alternative fuelled car. Indeed, when faced with real decision, instead of a hypothetical one, respondents may consider more carefully the full impact of this decision.

Further research might then focus on face-to-face interviews to a sample of respondents in order to specifically investigate their propensity towards EC according the characteristics of this car. Moreover, additional information should be collected not only about the awareness on the new performances of an EC and on the existing recharging network, but also on the economic conditions of the respondents and on the regulatory and fiscal system (taxes and subsidies), at any administrative level (from national up to local). Public transport effectiveness is also a good context analysis. Indeed, a good LPT discourages a car purchase in general, not only the electric one's.

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