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The automotive sector at the end of the ICE age? Market insights to manage a new ecosystem

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Abstract: The automotive ecosystem is experiencing a *perfect storm* where new technologies, new business models and sociological changes are bound to reshape the structure of the industry, leading to a new paradigm affecting strategies and performances of carmakers and actors of the supply chain. As electrification arguably represents the key factor of such transition, there is a need to shed light on market perceptions in terms of attitudes, expectations and concerns about electric vehicles. To this end, we performed a cross-national study based on primary data collected in two distinct markets: Brazil and Italy (N = 1,086). In presenting emerging results, we illustrate both common traits and specificities of the two contexts and we discuss the role of different legislative frameworks and public discourse in framing market sentiment, as to provide players with a solid informational background on which to shape their strategies.

Keywords: automotive; battery electric vehicle; BEV; electric vehicles; fit for 55.

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1 Introduction

Climate change is a global challenge threatening ecosystems, human health and the social and economic development of countries and industrial sectors. The anthropogenic origin of the problem is unquestioned by the scientific community (IPCC, 2023), with the transport sector being under particular scrutiny given its contribution to around 24% of global CO₂ emissions (Khurshid et al., 2023), half of which ascribable to private vehicle use. As the calls for a shift to new, sustainable mobility paradigms and for a *greening* of involved industries are gaining momentum around the globe, many initiatives are being developed to guide the envisaged transition, taking heterogeneous forms such as policies and legislative frameworks, subsidies and other economic incentives, R&D investments, and awareness campaigns. Simplifying, such initiatives can be aimed either at decreasing the use of private cars (fostering active transportation, public transport or shared mobility) or at supporting the diffusion of cleaner vehicles, consistently with the so-called Avoid-Shift-Improve framework (UNEP, 2022) which advocates for an approach where “policies to limit GHG emissions in the transport sector need to consist of measures aimed at avoiding the need to travel, for example by improved urban planning, or teleworking; shifting travel to the lowest-carbon mode, such as cycling; and improving vehicles to be more energy-efficient and fuels to be less carbon-intensive” [Creutzig et al., (2018), p.262].

The impacts on the automotive industry could not be overemphasised, with unprecedented leaps that are bound to change the entire industry ecosystem in years to

come. Such changes are so deep and pervasive that some suggest we are witnessing a paradigm shift (Pardi and Calabrese, 2020), with new rules of the game, new business models and even new actors in the competitive arena: the synergic interaction of social, legislative and technological factors is producing, in other words, what can be labelled as *a perfect storm* for automakers, which are to enter uncharted territory (Lanzini, 2023).

From a sociological standpoint, the market (i.e., drivers and commuters) is changing as never before, on the wake of unprecedented environmental awareness in increasing shares of the population and of new perspectives on the intrinsic value of transportation, such as the concept of *servitisation* (triggering a shift from the concept of ownership to that of access), the emerging trend of sharing mobility or even the adoption of multi-modal approaches, with mobility as a service (MaaS) schemes supporting sustainable mobility by conveniently combining and integrating different modes of transport (Hauslbauer et al., 2024).

Further, from a legislative standpoint and acknowledging that regulation is currently needed for the automotive sector to cope with the dictates of ecological transition and decarbonisation, policymakers are framing normative initiatives aimed at curbing (or in some cases eliminating at the tailpipe) CO₂ emissions (EPA, 2024; EU Parliament, 2023).

Consistently with such decarbonisation agenda, a disruptive leap is taking place from a technological standpoint. As a matter of fact, the dominant paradigm of internal combustion engines (ICEs) has not been challenged for over a century, and their improvements in terms of efficiency and environmental performance have been extraordinary: for one, new models of ICEs emit less than half of CO₂ and 99% less pollutants compared to those sold in the 1970s (Stocchetti, 2023). This is now rapidly changing, with new technological paradigms such as fuel cell vehicles (FCVs) or battery electric vehicles (BEVs) emerging, with different degrees of success. Electrification currently represents the most promising alternative to traditional engines, rapidly gaining market shares worldwide thanks to huge public incentives coupled with policies supporting their development: in 2023, BEV sales reached 5.4 million in China, 2.2 million in Europe and 1.1 million in the US (IEA, 2024).

While the electrification trend seems bound to continue in years to come, many issues are heating the debate, ranging from the actual environmental benefits of a mass production and diffusion of BEVs to geopolitical consequences (e.g., battery supply chains) as well as the impacts on entire industrial ecosystems and consequently occupation).

In this paper, we argue that automakers investing (or considering to invest) in electrification and willing to keep the ship steady in such a turbulent environment need to shed further light on the demand side (Herberz et al., 2020; Higuera-Castillo et al., 2021; Lanzini, 2018; Sovacool, 2017), as to gain insights about the attitudes, expectations and concerns of consumers that might support or hinder a rapid diffusion of BEVs and to frame coherent communicational and competitive strategies. To this end, and in response to a call in the automotive literature to perform cross-national comparisons (Llopis-Albert et al., 2021) given increased awareness of how “national culture is an important cross-country factor that influences the rate and the direction of the adoption of electric cars” [Novotny et al., (2022), p.1], we performed a survey-based empirical investigation (N = 1,086) to identify both the commonalities and the context-specific variations in two distinct markets and geographical, cultural and normative settings: Italy (a western country and EU member) and Brazil (a Latin-American country and member of BRICS).

The reasons behind the choice of these countries are many fold, as the selection was based on the following criteria: relevance of the markets (i.e., circulating fleet size), absence of domestic champions triggering demand (like the US with Tesla or China with BYD), thus mitigating self-serving country-of-origin effect and consumer ethnocentrism (Vuong et al., 2020) and substantial differences in policies to support sales of electric vehicles.

Italy has the largest circulating fleet of private vehicles in the EU after Germany (that, however, is home to VW and has been therefore excluded for the aforementioned criteria), while Brazil has the largest circulating vehicle fleet in Latin America and ranks sixth in sales on a global scale (Aquino, 2023). Furthermore, electrification in the two countries is spurred by means of different policies: an envisaged ban on ICE vehicles sales by 2035 in Italy, in contrast with market-based mechanisms in Brazil. This might be relevant as we argue that (along with economic and performance-related factors) the binding regulation is likely to have a relevant impact on consumer perceptions about BEVs, triggering a debate on the pros and cons of electrification and decreasing consumers' support for the new product, perceived as an imposition rather than a choice. Indeed, "in some countries, like Italy, the top-down transition to electric has been perceived by many as overly prescriptive, leading to disaffection in relevant shares of the population that might be enticed by more gradual policy trajectories" [Lanzini, (2024), p.11].

The paper is structured as follows: Section 2 illustrates the two settings of the empirical investigation; Section 3 provides a description of the methods for data collection and analysis; Section 4 presents the results of the study; Section 5 proposes some concluding remarks of the paper, with its limitations and possible avenues for future research.

2 Automotive in Brazil and Italy: an overview

2.1 Italy

A traditional leader in automotive manufacturing, Italy is currently facing a critical juncture as stringent legislation mandating the phase-out of ICEs, heightened environmental consciousness and evolving mobility paradigms converge to create a turbulent environment: a setting where the path to mass electrification is paved with question marks and economic, environmental and geo-strategic concerns (Cabigiosu and Lanzini, 2023). Historically, the Italian automotive industry was connected to the FIAT group (established in Turin in 1899), the dominant player for over a century until the merger with Chrysler in 2014 (which gave birth to FCA) and the subsequent 2021 merger with French company PSA to form Stellantis. These changes encompassed a decentralisation abroad of both headquarters and production sites, with a strong impact on the Italian production capacity, as in 2023 Italy had a domestic production of around 541,000 cars, distant from the numbers of the early 2000s. The reasons of such decrease are manifold, ranging from the above-mentioned re-location of former FIAT production sites (e.g., in Eastern Europe, to exploit lower labour force costs) to changes in demand, or even the crisis of semi-conductors, raw materials and logistics triggered by the COVID-19 pandemic of 2020 and exacerbated by the international crisis in Ukraine, which started in 2022. Yet, the role of automotive (carmakers and actors of the supply

chain) is still crucial for the Italian economy: with sales nearing 90 billion euros, the sector is worth over 5% of national GDP and is composed of 5,400 firms employing over 270,000 workers, or 7% of the Italian manufacture workforce (ANFIA, 2024).

The Italian circulating fleet (<https://www.anfia.it/it/automobile-in-cifre/statistiche-italia/parco-circolante>) nears 40 million cars, with a predominance of gasoline and diesel engines (18 and 17 million, respectively). BEVs are roughly 200,000 (0.5%), and hybrid cars (HEV and PHEV) are around 1,500,000 (3.75%). While an overwhelming majority of vehicles on Italian roads is hence still represented by traditional ICEs and the circulating fleet is one of the oldest in the EU (UNRAE, 2022), recent years are experiencing an increase in the sale of EVs. In 2023, for instance, BEV represented 4.2% of total car sales, PHEV 4.4% and HEV 36.1% (UNRAE, 2024).

The evolution of car registrations in Italy is illustrated in Table 1.

Table 1 Car registrations in Italy 2016–2023 (%)

	2016	2017	2018	2019	2020	2021	2022	2023
BEV	0.1	0.1	0.3	0.6	2.4	4.6	3.7	4.2
PHEV	0.1	0.2	0.3	0.3	2.0	4.8	5.1	4.4
HEV	2.0	3.2	4.3	5.7	16.1	29.0	34.0	36.1
<i>Total EV</i>	2.2	3.5	4.9	6.6	20.5	38.4	42.8	44.7
Gasoline	32.8	31.9	35.5	44.4	37.8	30.0	27.7	28.6
Diesel	57.0	56.4	51.2	39.8	32.7	22.1	19.6	17.5
Other*	8.0	8.2	8.4	9.2	9.0	9.5	9.9	9.2

Notes: BEV = battery electric vehicles; PHEV = plug-in hybrid electric vehicles;
HEV = hybrid electric vehicles.

*Mainly GPL and methane.

Source: Elaboration on UNRAE data

Although the table suggests that electric vehicles Italy are rapidly gaining market shares, it is worth noting that most of the sales refer to HEV, where the role of the electric motor is marginal.

The growth of electric vehicles in Italy is spurred both by financial incentives and by legislative measures (Sileo and Bonacina, 2024). As far as incentives are concerned, these are made necessary by the gap in the price that makes electrified cars not competitive with traditional ICE counterparts: indeed, although the difference is thinning over the years, most consumers would not be willing to pay such a high premium. The incentives of the Italian government are typically based on the two factors of:

- 1 scrapping of an old (thus highly polluting) vehicle
- 2 family income: in other words, there is a standard incentive, which gets integrated if the purchaser scraps an old vehicle and/or has a low family income.

In 2023, for instance, there was a 3,000€ incentive to buy a BEV, rising to 5,000€ in case of old (Euro0 to Euro4) vehicle scrapping for a total of 190 billion euros available, while currently there is no extra incentives for low-income families as in previous years.

As far as legislative measures are concerned, to date most of these pertain to legal permits for BEV to drive through restricted areas, or in so-called ecological days where most cars cannot circulate. Yet, the turning point for electrification in Italy (and the EU)

could be represented by the so-called Fit for 55 package, which includes a ban (approved by the European Parliament in February 2023) on the sales of traditional ICE vehicles, from 2035. More specifically, the regulation would allow the production of combustion engines provided they are zero-emissions (at the tailpipe), which can be achieved with carbon-neutral fuels such as hydrogen or e-fuels. Concerns in the Italian automotive sector are big, as there are fears for the loss of jobs such a revolution would imply, the consequences for incumbent carmaker companies and the risks of suffering from the geo-political and commercial leverage of international actors such as China, which holds a semi-monopoly in the battery industry. Indeed, Italy (along with other EU member States) initially opposed the provisions of the Fit for 55 package, to protect domestic automotive industry and (perhaps even more) supply chain actors, which would likely suffer more from a shift to EVs (Stocchetti, 2023).

2.2 Brazil

Brazil, on the other hand, despite a recent plan to encourage sustainable mobility is insisting on regulating the market through taxes and price mechanisms, with no bans on traditional engines in sight (Brasil, 2024). Issues of sustainability, as well as infrastructure and economic competitiveness have been relegated to an ancillary role, since electric vehicles are currently imported from Europe, Asia and the USA and the key discussions in the sector are led by the private sector (vehicle manufacturers, importers and infrastructure manufacturers) (ABVE, 2024; Gomes, 2024; Reis and Ferreti, 2024; Schvartz, 2024).

Compared to Italy, Brazilian automotive industry has a more recent history, with a steady development that begun in the second half on the 20th century. Nowadays, it ranks 4th in Latin America and producing 1.6 million cars in 2022 (50% less than a decade before) and employing around 1.2 million people (Anfavea, 2023). The overwhelming majority of cars produced in Brazil are from foreign manufacturers, with Stellantis being curiously one of the key players.

Brazil has a circulating fleet of around 38 million cars, comparable to that of Italy although distributed on a much larger population. There is a marked predominance of vehicles running on flex fuel (a blend of ethanol and gasoline), while electric vehicles (both full electric and hybrid) are still at the infancy stage of diffusion, though increased from 0.2% in 2016 to 6.9% in 2023 (like in Italy, mainly ascribable to HEVs).

Table 2 Car registrations in Brazil 2016–2023 (%)

	2016	2017	2018	2019	2020	2021	2022	2023
BEV	0.0	0.0	0.0	0.1	0.1	0.2	0.5	0.7
PHEV	0.0	0.0	0.0	0.1	0.4	0.9	1.2	1.6
HEV	0.2	0.3	0.4%	0.8	1.7	2.7	3.9	4.6
<i>Total EV</i>	<i>0.2</i>	<i>0.3</i>	<i>0.4</i>	<i>1.0</i>	<i>2.2</i>	<i>3.8</i>	<i>5.6</i>	<i>6.9</i>
Gasoline	4.0	3.2	3.3	2.7	2.9	2.6	2.3	2.6
Flex	87.7	88.1	86.9	86.2	82.3	77.3	75.9	74.9
Diesel	7.8	8.1	8.9	9.3	10.4	12.6	10.7	8.9

Source: Own elaboration on Neocharge and ANFAVEA data (sales include also commercial light vehicles)

The evolution of car registrations in Brazil is illustrated in Table 2.

Notwithstanding, severe problems connected to traffic congestion in most urban areas (Lanzini et al., 2023), Brazil has been long praised as a virtuous example in the transport sector, thanks to the development of biofuels which is nowadays mirrored by the majority of the circulating fleet running on flex fuel. Indeed, “Brazil invest[ed] in ethanol as a clean fuel, being the world leader in production from sugarcane. However, this lead[s] to other environmental problems such as deforestation, soil, water and air contamination” [de Oliveira et al., (2022), p.419].

Investments in alternative technologies might explain the initial reluctance to invest in electrification, along with other factors as “history has shown that there are many forces against the idea of an electric car. There are institutional and political barriers, in addition to marketing ones, to be overcome for the electric car to consolidate itself in the market (...) However, the imperative of depleting fossil resources and environmental issues leave electric vehicles in a unique position to become a reality” [Baran and Legey, (2011), p.222] and the numbers of the last years make it realistic that electric vehicles will gain relevant numbers in new vehicles purchases in the near future. Yet, for the time being, Brazilian policies are focusing on market regulation through taxes and price mechanisms rather than by means of incisive normative interventions like in the EU, with no bans on traditional engines in sight (Brasil, 2024; Gomes, 2024; Schwartz, 2024).

In a country where the majority of the population is currently not in the financial conditions to afford the premium price that electric vehicles purchase still entails, policy makers are showing commitment to the greening of the automotive industry mostly by means of subsidies and incentives. According to Aoyague (2024, p.36) “(...) government policies such as subsidies for EVs, which may include tax incentives, tax breaks and trade-in programs for old electric vehicles, and strict regulations on vehicle GHG emissions are essential to accelerate the transition to EVs and reduce dependence on internal combustion vehicles”.

These supporting measures, in a recently approved Law (Law 14902/2024, Brasil, 2024), range from a tax deduction on taxes levied on production, to greater incentives for hybrid vehicles.

In addition, some states have annually published decrees reducing the tax paid annually by the owners. But recently the government is discussing about increasing taxes on these vehicles, with a likely increase in sales price.

Lastly, the diffusion of electrification in Brazil could be supported by the great availability of renewable energy (Reis and Ferreti, 2024), with the country having a quite a specific energy matrix as renewables make up for approximately 45% of the country’s energy, well above world average (Brasil, 2022).

3 Methods

Stemming from the acknowledgement that electrification is bound to represent one of the cornerstones of sustainable mobility in years to come, our study investigates the demand-side perspective focusing on market perceptions about BEV benefits and drawbacks, and intentions to purchase. Such aspects are investigated for both empirical settings, as to identify general patterns and features that are more context-specific.

To this end, we performed a cross-sectional study by means of a self-administered online survey, distributed among drivers and commuters in the two countries. The

questionnaire, has been designed in compliance with well-established survey guidelines and protocols (Brancato et al., 2006; EU, 2014) as regards sample size adequacy, survey framing and length, structure (e.g., questions format, phrasing and ordering), pre-testing and distribution. First drafted in English, it has been then translated in Portuguese and Italian and pre-tested on a small sample of respondents to check for the clarity of all questions, as to avoid ambiguities that might lead to unreliable answers (back-translation has been also implemented, to control for possible changes in the meaning of the questions along the process). The surveys in the two languages of the study have been then uploaded on Google Modules and distributed online: the Brazilian sample is composed of 531 respondents while the Italian sample is composed of 555 respondents.

The survey consists of 4 sections, the first of which is devoted to socio-demographics. The two samples (Brazilian and Italian) are similar in terms of age (median age 41.1 and 39.7 years, respectively), gender (54.2% and 54.0% males, respectively) and occupation (34.4% and 27.7% are university students, respectively). Socio-demographics of the sample are described in Table 3.

Table 3 Socio-demographics

<i>Demographics</i>	<i>Italian sample</i>	<i>Brazilian sample</i>
Age		
18–39	269	235
40–59	227	235
60 and over	59	57
Gender		
Male	301	288
Female	252	241
Other-prefer not to answer	2	2
Occupation		
Unemployed	11	8
Worker	320	270
Student*	153	184
Other	69	69
Income		
Below average	112	65
Average or above average	435	448

Note: *Including both full time students and working students.

In the second section of the questionnaire, respondents are asked mobility related questions, such as type of vehicles used and driving habits (Table 4).

The answers regarding the fuel supply of the vehicle used reflect the characteristics of the fleet circulating in the two countries: in fact, while in Brazil the vast majority of respondents state that they use gasoline-engine cars (mostly in the flex-fuel version, blended with ethanol), in Italy these have percentages only marginally higher than diesel-engine vehicles (though the latter are experiencing a sensible decline in new car registrations, so that the gap is likely to increase in years to come). Furthermore, in Italy the electric market, especially in the hybrid version, has already reached much more

significant market shares compared to Brazil, with a steady increase over the past five years (see Tables 1 and 2).

The third section presents Likert and multipoint scale questions about opinions on electrification, the intention of purchasing BEVs and the factors that are perceived as advantages and disadvantages over traditional ICEs, besides other questions that have not been considered in the present study. Potential benefits and drawbacks included in the survey have been selected according to the relevant literature on BEV market penetration from a consumer perspective (Cabigiosu and Lanzini, 2023; Münzel et al., 2019). Benefits pertain to lower environmental impacts, lower maintenance costs, engine silence, purchase incentives, admission to areas restricted to general traffic/parking lots, and other fiscal incentives; drawbacks on the other hand pertain to cost of purchase, travel range, low diffusion of charging infrastructures, charging time and aversion to new technologies.

Table 4 Driving habits

	<i>Italian sample</i>	<i>Brazilian sample</i>
How often do you drive a car?		
1 = never	26	80
2	47	68
3	52	66
4	71	63
5 = every day	353	250
How is the car you usually drive powered?		
Gasoline*	196	430
Diesel	237	21
Hybrid	33	6
Full electric	10	5
Other/I do not drive	76	61

Note: *Including flex fuel.

We used IBM SPSS Statistics 20 package for the statistical analysis of collected data. We performed a binary logistic regression, considering perceived benefits as independent variables and intention to purchase an electric vehicle as the dependent variable, assigning the dummy variable 1 to high scores in responses (4 and 5 on a five-point scale) and the dummy variable 0 to low scores in responses. Further, to identify differences between means (as regards both benefits and drawbacks) and their statistical significance (Hair et al., 2010) we performed hypothesis testing for means of independent samples: we included Levene's test for equality of variances as to verify equality of variance between data from Brazilian and Italian respondents (Field, 2009) and performed T-test statistics for the difference between means (assuming significance at p-values < 0.05).

We used a five-point scale (Barbetta, 2008) to analyse respondents' answers and, as for differences to be meaningful, we considered questions where the p-value was less than 1% to get 99% confidence that the results from analyses are reliable, as for a t-test comparing two independent groups (McClave et al., 2021).

4 Results

Results of the statistical analyses are presented in the following tables. Tables 4a and 4b illustrate emerging evidence with reference to perceived advantages and hindrances of BEV, in both samples, while Tables 5a and 5b focus on the former, illustrating the results of the regression analysis as well as the correlation with purchase intentions.

Table 4a Advantages of BEVs

Variable	Italian sample*	Brazilian sample*	t-test for equality of means			
			t	df	sig	Mean difference
Lower environmental impact	3.36	4.31	-12.962	1,062	< 0.001	-0.950
Lower maintenance costs	3.07	4.25	-16.447	1,040	< 0.001	-1.178
Incentives to purchase	3.02	3.98	-12.825	1,065	< 0.001	-0.968
Other fiscal incentives	3.39	4.12	-9.912	1,070	< 0.001	-0.726
Silence	2.88	4.06	-15.324	1,060	< 0.001	-1.176
Free access to limited traffic zones	3.38	3.60	-2.838	1,070	0.005	-0.227

Note: *Scores on a 1 to 5 scale.

Table 4b BEVs hindering factors

Variable	Italian sample*	Brazilian sample*	t-test for equality of means			
			t	df	sig	Mean difference
Cost of purchase	3.58	4.37	11.514	1,061	< 0.001	-0.788
Driving range	3.54	3.38	2.026	1,076	0.043	0.155
Infrastructures – charging stations	3.63	3.37	3.340	1,054	0.001	0.259
Charging time	3.50	3.27	3.004	1,074	0.003	0.076
Energy prices	3.40	3.09	4.080	1,073	< 0.001	0.078
Use of new technology	1.69	1.27	7.372	995	<0.002	0.303

Note: *Scores on a 1 to 5 scale.

Results suggest that the Brazilian sample holds a markedly more optimistic view compared to the Italian sample as regards the potential benefits of BEVs. It is the case of lower environmental impacts, representing the typical advantage of electric vehicles over internal combustion ones as the winning argument of BEVs is the factual absence of tailpipe emissions. However, skeptics of electrification stress that to assess the effective environmental sustainability of BEV a broad set of variables need to be taken into consideration. For instance, given the need to satisfy the increasing charging needs of BEV adopters, it is essential to consider the energy mix of a country, and “the extent to which electricity used by the vehicles is produced in an environment-friendly manner” [Kucukvar et al., (2022), p.2]. Or even to consider emissions other than those at the tailpipe, such as those entailed by the production of a vehicle and more specifically the

energy intensive production of batteries (Buberger et al., 2022). Such concerns are legitimate, yet most available studies suggest that even considering the whole life-cycle emissions of comparable BEV and ICE models, the former perform much better (IEA, 2021).

Table 5a Regression analysis (ITA)

<i>Variable</i>	<i>Correlation with INT</i>	<i>B</i>	<i>S.E.</i>	<i>Wald</i>	<i>df</i>	<i>Sig.</i>	<i>Exp (B)</i>
ENV	0.452**	1.222	0.342	12,808	1	0.000	3.395
MAI	0.399**	0.755	0.318	5,621	1	0.018	2.127
SIL	0.225**	0.503	0.282	3,190	1	0.074	1.653
PUR	0.304**	0.377	0.307	1,506	1	0.220	1.458
LTZ	0.180**	-0.162	0.321	0.254	1	0.614	0.851
FIS	0.238**	0.258	0.352	0.540	1	0.462	1.295
Constant		-3.250	0.294	122.463	1	0.000	0.039
<i>Dependent variable INT</i>							
<i>Model summary and probabilities of high intention to purchase BEVs</i>							
<i>Step</i>	<i>-2 log likelihood</i>	<i>Cox & Snell R square</i>	<i>Nagelkerke R square</i>	<i>P (Y = 1) when all X = 0</i>	<i>P (Y = 1) when all X = 1</i>		
1	396.775 ^a	0.132	0.229	3.73%	42.65%		

Notes: **Correlation is significant at the 0.01 level (2-tailed).

^aEstimation terminated at iteration number 6 because parameter estimates changed by less than 0.001.

ENV = lower environmental impact; MAI = lower maintenance costs;

PUR = incentives to purchase; FIS = other fiscal incentives; SIL = silence;

LTZ = access to limited traffic zones; INT = intention to purchase BEV.

Further, while GHG emissions undoubtedly represent a relevant aspect of sustainability, there are many other factors that impact on the environmental performance of vehicles, and that should be hence considered: for instance, battery-related impacts from extraction of raw materials to end-use disposal (Temporelli et al., 2020), or even non-exhaust emissions deriving from brakes and tires, whose impact gets exacerbated by the weight of vehicles which is on average increasing over the years and is especially problematic for BEVs due to the weight of the battery (Beddows and Harrison, 2021). Indeed, as public debate develops and consumers gain confidence with electrification, a black or white scenario considering electric vehicles as green and internal combustion ones as highly polluting is replaced by more sophisticated evaluations of the shades of grey of the pros and cons of different technologies.

Similarly, in the case of maintenance costs Brazilians tend to overemphasise the advantages of a shift to electric, while skepticism is greater in the Italian sample. The total cost of ownership concept (Franzò et al., 2022) encompasses all costs involved in the purchase, use and disposal of the vehicles, and is becoming increasingly important in orienting market choices. This is slowly shifting the balance towards electric vehicles which, although more expensive as far as the purchasing price is concerned, are perceived as more convenient in the long run thanks (among other factors) to maintenance costs that are on average lower (Franzò et al., 2022; Liu et al., 2021).

Table 5b Regression analysis (BRA)

<i>Variable</i>	<i>Correlation with intention to purchase BEVs</i>	<i>B</i>	<i>S.E.</i>	<i>Wald</i>	<i>df</i>	<i>Sig.</i>	<i>Exp (B)</i>
ENV	0.202**	0.442	0.294	2.267	1	0.132	1.556
MAI	0.132**	0.326	0.303	1.162	1	0.281	1.386
SIL	0.237**	0.566	0.252	5.065	1	0.024	1,762
PUR	0.121**	−0.067	0.265	0.063	1	0.802	0.936
LTZ	0.149**	0.422	0.231	3.356	1	0.067	1.526
FIS	0.119**	−0.134	0.308	0.189	1	0.664	0.875
Constant		−1.875	0.297	39.828	1	0.000	0.153
<i>Dependent variable INT</i>							
<i>Model summary and probabilities of high intention to purchase BEVs</i>							
	<i>Step</i>	<i>−2 Log likelihood</i>	<i>Cox & Snell R square</i>	<i>Nagelkerke R square</i>	<i>P(Y = 1) when all X = 0</i>	<i>P(Y = 1) when all X = 1</i>	
	1	642.472 ^a	0.048	0.068	13.30%	42.13%	

Notes: **Correlation is significant at the .01 level (2-tailed).

^aEstimation terminated at iteration number 6 because parameter estimates changed by less than .001.

ENV = lower environmental impact; MAI = lower maintenance costs;

PUR = incentives to purchase; FIS = other fiscal incentives; SIL = silence;

LTZ = access to limited traffic zones; INT = intention to purchase BEV.

Incentives represent a necessary condition for the development of BEV markets and can be aimed both at producers and at prospective purchasers: “government’s primary aim of [R&D subsidy] programs is to help manufacturers overcome the technical difficulties encountered in developing EVs and improving the related environmental attributes. Instead, the consumer subsidy program directly targets consumers in [...] attempt to increase their incentives to use environment-friendly EVs” [Zhang and Huang, (2021), p.2]. The present study investigates the latter category, which is currently object of a growing literature: while market oriented incentives can be very heterogeneous (Münzel et al., 2019), they can be categorised into one-time monetary incentives received upon purchase (e.g., grant/subsidy/rebate for BEV purchase, point-of-sale (POS)/registration tax reduction or exemption, value-added tax reduction or exemption, etc.), other recurring monetary and fiscal incentives (e.g., circulation tax or annual vehicle license fee reduction, free or discounted toll/road/congestion charges, etc.) and non-monetary incentives (e.g., access to restricted traffic zones).

Although as described in Section 2 these incentives can be extremely generous, they are not perceived as a relevant advantage of BEVs especially in the Italian sample, as they get overshadowed by the cost of purchase which still makes electrification non-convenient from an economic standpoint. In Brazil, on the other hand, incentives are perceived as more effective (Schvartz, 2024). This might be due to a distorted perception of the actual magnitude of the incentive, driven by lower awareness of the details of public policies to support the purchase of electric vehicles.

There are several psychological theories that could explain this phenomenon. For instance, according to prospect theory (Kahneman and Tversky, 1979), people tend to

evaluate losses more heavily than gains. In the case of BEV purchase incentives Italians, having greater knowledge of the costs associated with purchasing an electric car, may be more focused on the economic sacrifice to be made, rather than the benefit derived from the incentive. Brazilians, on the other hand, having less knowledge of the costs, may focus more on the concrete benefit of the incentive, perceiving it as a net gain. This mechanism is further triggered by cultural differences between the two countries. As pointed out by Hofstede's (1984) country comparison¹, Brazilians score much higher than Italians on the Indulgence dimension, which reflects more positive attitudes and a general tendency towards optimism.

A particularly interesting topic concerns the silence of electric vehicles, as the consumer appeal of such defining feature is multifaceted. As silence could strengthen the perception of BEVs as premium products with a prestigious image, potentially offering a more enjoyable driving experience (Ingeborgrud and Ryghaug, 2019), some car manufacturers are capitalising on this distinct advantage and tailoring their communication strategies accordingly. However, certain consumer segments remain hesitant due to cultural factors, such as the ingrained association of roaring engines with high performance and a rewarding driving experience (Lanzini, 2024). Additionally, safety concerns persist, with some consumers expressing anxieties about the quiet operation of electric vehicles, particularly in areas with limited visibility (Simsekoglu and Nayum, 2019). This complexity is mirrored by the results of the study, as differences between the samples of the two countries are substantial: while silence is considered a major advantage by the Brazilian sample, in Italy there is a prominence of respondents that do not consider noise as a priority (or even, in some cases, do not consider silence as a benefit). As anticipated, this might be due to both cultural and practical reasons. From a cultural standpoint, Italy has a strong automotive tradition also linked to the experiential dimension of driving, of which the roar of the engine represents a fundamental aspect. Engine noise is therefore perceived as an added value and not as a disturbing factor by a relevant share of Italian respondents. Further, there is a safety issue, which is more salient in a country like Italy where BEVs (or vehicles running on electric mode) in circulation, although remaining a niche, reached a critical mass so that commuters have already seen accidents (presumably) linked to the silence. Individuals still have the habit of perceiving cars as noisy vehicles and consequently the dangerous habit of crossing the road without paying adequate attention in the absence of noise from an endothermic vehicle is still widespread (Edwards et al., 2024). As a consequence of this, in the EU the production of an artificial noise up to a certain driving speed is required for new models of BEVs, in order to warn pedestrians of the arrival of a vehicle (Terenzi et al., 2020).

Last but not least, free access to restricted areas is considered as the key advantage of BEVs in Italy, consistently with growing municipalities enforcing policies (ranging from free entry to concessions granted to electric vehicles only) aimed at limiting vehicular traffic in urban centres (Ruggieri et al., 2021).

The regression analysis suggests, however, that the acknowledgement of specific advantages only marginally translates into actual purchasing behaviours: this holds true for both samples, and is particularly striking in the case of Brazilians. In other words, most consumers base their purchasing decisions on factors where ICEs still perform better, or at least are perceived to do so (Paradies et al., 2023). They might consider, for instance, BEVs to be actually an environmentally friendly alternative to traditional vehicles, yet (regardless of their environmental values) they would weight more other

factors which can be both economic (e.g., the upfront cost of purchase) or non-economic (e.g., driving range or availability of charging stations).

As a consequence, the study also investigated perceptions of consumers about the hindering factors and the perceived drawbacks of electrification. Results confirm, once again, that Brazilians are much more optimistic compared to Italians: on average (with the relevant exception of cost of purchase), they appear to be less concerned about potential drawbacks of electric vehicles. This is consistent with the differences in mobility policies that are introduced in the two countries, as a thorough shift to electric is likely to be perceived as something distant and voluntary in Brazil, and something policy-driven with a stringent top-down approach and over a defined time horizon in Italy (Lanzini, 2024). The sentiment towards electrification, in the early stages of promotion and public debate, tends to make more salient the key aspects of BEVs in terms of costs and benefits: these, for most commuters, are environmental protection and cost of purchase, respectively. This is in other words the first impact that many individuals have with electrification, the perception that electric vehicles pollute much less, yet are much more expensive.

As regards the cost of purchase, from the analysis of the data it clearly emerges that for a vast majority of the Brazilian sample it represents an extremely relevant problem, while for the Italian sample this aspect is considered important, but to a lesser extent. In Italy there is on the one hand growing awareness that the gap between prices of endothermic and electric vehicles is bound to shrink in years to come (Zhou et al., 2023). On the other hand, the focus on cost of purchase is being substituted by the total cost of ownership concept which, encompassing all costs involved in the purchase, use and disposal of the vehicles, is much more favourable to electric. Further, it should be noted that the upfront cost of electric vehicles, thanks to advancements in battery technology and the efficiencies of automated mass production (Zhou et al., 2023), decreased over the years (IEA, 2024): this, combined with the inherent cost advantages of BEVs in terms of energy and maintenance, leads to a faster payback period for the initial purchase price. Yet, while BEVs are consequently becoming an increasingly attractive proposition within a typical ownership cycle (Liu et al., 2021), recent increases in the costs of raw materials and energy slowed down the process, so that the premium price is still relevant.

As concerns the problem of availability of charging stations, charging time and (to a lesser extent) driving range, the Italian sample is more concerned by the potential limitations in question. The differential aspect is represented by the fact that, while on the one hand technological advancements are sensibly reducing charging time (fast chargers charge up to 80% in around 30 minutes) and increasing driving range (600 kms or more, from some cutting-edge models), the availability of an adequate and extensive infrastructure network is still perceived as a problem that might get worse in the future, if the building of new charging stations cannot keep the pace of the likely increase of circulating electric vehicles (Lanzini, 2024). This explains why the infrastructural issue tops concerns in the Italian sample and ranks second in the Brazilian one.

More in detail, the lack of readily available charging stations is a major hurdle for electric vehicles (Falchetta and Noussan, 2021; Illmann and Kluge, 2020), as building a widespread network of public chargers requires significant investment and is not under the control of companies (except for those installing own charging points). An improved network would ease consumer worries, especially for long trips. The strong concern revealed by the Italian sample mirrors an institutional awareness where EU Governments

are tackling this issue, with new regulations requiring member states to increase charging capacity alongside electric car sales and mandate fast-chargers (over 60 kW) at regular intervals on major highways (every 60 km) (EU Parliament, 2023). While the goal of a quick diffusion of a charging network is certainly ambitious, Italy is rapidly improving as in March 2024 there were around 54,000 public charging stations, up from 41,000 in 2023², of which around 9,000 providing 50 kilowatts of power or more (private charging stations are above 400,000).

Meanwhile, Brazil is still in the process of implementing charging station infrastructure, starting 2024 with around 3,200 stations, the vast majority of which are private, with the prospect of reaching 15,000 charging stations in 2025 (ABVE, 2024). In this country, private agents have led discussions about infrastructure to support electric vehicles, while government agents have focused on discussing taxation and revenue from this market. Although tax incentives are important, it is also necessary to invest in infrastructure and a fleet fitting the needs of the Brazilian market (Gomes, 2024). Even safety issues, such as encouraging the training of security agents, such as fighting fires in these vehicles, have been the focus of initiatives by companies operating in this sector, as indicated by ABVE (2024). Schwartz (2024) points out, for example, that batteries represent one of the key factors of concern for consumers of electric vehicles in Brazil.

Limited driving range and range anxiety, the fear of running out of power before finding a charger, have historically been major barriers to electric vehicle adoption (Dimitropoulos et al., 2013; Rainieri et al., 2023). Several factors affect driving range, including speed, temperature, and battery technology. Fortunately, recent years have seen significant improvements in battery technology, leading to a noticeable increase in driving range (Woo and Magee, 2020): however, despite these advancements, BEV technology still lags behind internal combustion engine vehicles (ICEVs) and electric vehicles with the best range performances are still high-end products for a wealthy niche (Ou et al., 2023).

While charging times for electric vehicles have not yet reached parity with those of ICE vehicles, significant progress has been made. A 2023 report by Energy & Strategy indicates that BEVs launched between 2021–2023 require 35% less time for a full charge compared to models introduced from 2018–2020. Nevertheless, charging times remain a crucial obstacle to broader BEV adoption which, coupled with range anxiety and fears of depleting the battery before reaching a charging station, reinforces the perception that BEVs are currently unsuitable for long-distance travel. Unless this perception gets deactivated, electric vehicles might be considered an option for households affording multiple vehicles: one electric for urban areas and short range trips, and a traditional ICE vehicle for longer trips (Qorbani et al., 2024).

The significantly increasing prices of electricity starting from 2022 due to a series of concomitant factors (from international instability to the post-covid recovery of large economies) seem to represent a more relevant factor of concern for the Italian sample. Italy, indeed, has been hit hard by skyrocketing energy prices (mainly ascribable to natural gas prices), and many consumers are worried that the situation might worsen in case of a stress on energy supply triggered by a steady development of electric mobility (Falfari and Bianchi, 2023).

On the other hand, the theme of a new product and above all of a new technology to be adopted does not seem to represent a discriminating factor in the intention of the Italian and Brazilian samples to purchase an electric vehicle. Although one might argue that resistance to change could play a relevant role in the transition to products with a

high rate of innovation (Ninh, 2021), entailing in the case of mobility significant changes in daily behaviour pertaining to procedures and charging times, emerging results of the study are not consistent with such assumption.

5 Conclusions

The study performed a cross-national comparison of consumer perspectives on electrification in the automotive sector, analysing the results of an online survey performed in Italy and Brazil.

Results suggest that Brazilian consumers are more inclined towards and optimistic about electrification in the mobility sector, showing greater interest for the new product and a stronger intention to purchase, as a consequence of positive attitudes towards the benefits of BEVs and a minimisation of potential drawbacks. Different factors concur in providing a possible explanation for these differences, ranging from cultural factors (e.g., Brazilians being by nature more optimistic, as illustrated by the Hofstede framework) to awareness issues (e.g., public debate in Italy framing specific reference points for consumers who, consistently with prospect theory, weight more the disadvantages than the benefits of BEVs). It is the opinion of the authors that also policy measures are a powerful determinant of market sentiment, with the Fit for 55 package being perceived by many as an imposition, thus weakening intrinsic motivation to purchase, in accordance with Self-Determination theory (Deci and Ryan, 1985).

Notwithstanding a more positive inclination of Brazilian consumers, persistent skepticism can be found in both samples. Concerns linger regarding the environmental benefits of BEVs alongside practical considerations like charging infrastructure limitations. To bridge this gap, a collaborative effort is necessary. This needs to encompass not only infrastructural and technological issues, but also sound communicational strategies with car manufacturers, governmental bodies and media outlets collectively developing effective messages that directly address these market anxieties.

The study offers a comprehensive analysis of the results, which can contribute to support carmakers and policy makers in formulating data-driven EV strategies. Moreover, the research contributes to the existing knowledge base by providing up-to-date insights into the transformed competitive landscape – one shaped by recent legislative changes, evolving social attitudes, and technological advancements. However, the study acknowledges limitations, such as the reliance on self-reported questionnaires based on individual perceptions which may not fully capture actual consumer behaviour. Future research could address this limitation by integrating additional methodologies to capture consumer behaviour beyond self-reported attitudes, focusing for instance on choice experiments which, although prone to so-called hypothetical bias (Hensher, 2010), simulate real-world decision-making by presenting consumers with hypothetical scenarios where they choose between different product options with varying attributes (Hackbarth and Madlener, 2013). Further, the cross-sectional nature of the study limits its ability to draw causal inferences: future research should address this issue by implementing longitudinal studies capable of singling out the role exerted by different factors on consumers' perceptions and attitudes, ranging from different policies (Lieven, 2015) to developments in key factors such as the charging infrastructure network (Wang et al., 2022), whose proximity to respondents should also be taken into consideration.

References

- ABVE (2024) Associação Brasileira de Veículos Elétricos [online] <https://abve.org.br> (accessed November 2024).
- Anfavea (2023) Anuário da Indústria Automobilística Brasileira [online] <https://anfavea.com.br/site/wp-content/uploads/2023/04/ANUARIO-ANFAVEA-2023.pdf> (accessed July 2024).
- ANFIA (2024) *Comunicato stampa 02.01.2024*, Associazione Nazionale Filiera Industria Automobilistica, Turin.
- Aoyague, H.Y.S. (2024) *Impactos dos veículos elétricos no sistema elétrico brasileiro e no meio ambiente*, UNESP, Rosana, SP.
- Aquino, V. (2023) ‘Brasil foi o sexto maior mercado de carros em 2022, veja o ranking global’, *Jornal do Carro – Estadão* [online] <https://jornaldocarro.estadao.com.br/carros/brasil-foi-o-sexto-maior-mercado-de-carros-em-2022-veja-o-ranking-global/> (accessed July 2024).
- Baran, R. and Legey, L.F.L. (2011) *Veículos elétricos: história e perspectivas no Brasil*, BNDES Setorial, Rio de Janeiro, March, No. 33, pp.207–224.
- Barbetta, P.A. (2008) *Estatística Aplicada às Ciências Sociais*, 6th ed., Editora da UFSC, Florianópolis.
- Beddows, D.C. and Harrison, R.M. (2021) ‘PM10 and PM2.5 emission factors for non-exhaust particles from road vehicles: dependence upon vehicle mass and implications for battery electric vehicles’, *Atmospheric Environment*, Vol. 244, p.117886.
- Brancato, G., Macchia, S., Murgia, M., Signore, M., Simeoni, G., Blanke, K. and Hoffmeyer-Zlotnik, J. (2006) *Handbook of Recommended Practices for Questionnaire Development and Testing in the European Statistical System*, European Statistical System [online] https://www.istat.it/en/files/2013/12/Handbook_questionnaire_development_2006.pdf.
- Brasil (2022) *Plano Nacional de Energia 2030*, Ministério de Minas e Energia, Brasília.
- Brasil (2024) *Programa Mobilidade Verde e Inovação (Mover)*, Lei 14902/2024 [online] https://www.planalto.gov.br/ccivil_03/_ato2023-2026/2024/lei/114902.htm (accessed November 2024).
- Buberger, J., Kersten, A., Kuder, M., Eckerle, R., Weyh, T. and Thiringer, T. (2022) ‘Total CO₂-equivalent life-cycle emissions from commercially available passenger cars’, *Renewable and Sustainable Energy Reviews*, Vol. 159, p.112158.
- Cabigiosu, A. and Lanzini, P. (2023) *The Green Transition of the Automotive Industry. From Technological Sustainable Innovation to Mobility Servitization*, Springer International Publishing, Cham.
- Creutzig, F., Roy, J., Lamb, W.F., Azevedo, I.M., Bruine de Bruin, W., Dalkmann, H. and Weber, E.U. (2018) ‘Towards demand-side solutions for mitigating climate change’, *Nature Climate Change*, Vol. 8, No. 4, pp.260–263.
- de Oliveira, M.B., da Silva, H.M.R., Jugend, D., Fiorini, P.D.C. and Paro, C.E. (2022) ‘Factors influencing the intention to use electric cars in Brazil’, *Transportation Research Part A: Policy and Practice*, Vol. 155, pp.418–433.
- Deci, E.L. and Ryan, R.M. (1985) *Intrinsic Motivation and Self-Determination in Human Behavior*, Plenum, New York.
- Dimitropoulos, A., Rietveld, P. and Van Ommeren, J.N. (2013) ‘Consumer valuation of changes in driving range: a meta-analysis’, *Transportation Research Part A: Policy and Practice*, Vol. 55, pp.27–45.
- Edwards, P.J., Moore, S. and Higgins, C. (2024) ‘Pedestrian safety on the road to net zero: cross-sectional study of collisions with electric and hybrid-electric cars in Great Britain’, *J. Epidemiol Community Health*, Vol. 78, No. 8, pp.487–492.
- Energy & Strategy (2023) *Smart Mobility – Short Report 2023*, Milan.

- Environmental Protection Agency (EPA) (2024) *Multi-Pollutant Emissions Standards for Model Years 2027 and Later Light-Duty and Medium-Duty Vehicles: Final Rule*, EPA-420-F-24-016 [online] <https://www.govinfo.gov/content/pkg/FR-2024-04-18/pdf/2024-06214.pdf>.
- European Union (EU) (2014) *List of 'Best Practice' for the Conduct of Business and Consumer Surveys*, Economic and Financial Affairs, European Commission, Brussels.
- European Union (EU) Parliament (2023) *Fit for 55: Zero CO₂ Emissions for New Cars and Vans in 2035*, europarl.europa.eu. European Parliament, 14 February.
- Falchetta, G. and Noussan, M. (2021) 'Electric vehicle charging network in Europe: an accessibility and deployment trends analysis', *Transportation Research Part D: Transport and Environment*, Vol. 94, p.102813.
- Falfari, S. and Bianchi, G.M. (2023) 'Concerns on full electric mobility and future electricity demand in Italy', *Energies*, Vol. 16, No. 4, p.1704.
- Field, A. (2009) *Discovering Statistics using SPSS: Introducing Statistical Method*, 3rd ed., Sage Publications, London.
- Franzò, S., Nasca, A. and Chiesa, V. (2022) 'Factors affecting cost competitiveness of electric vehicles against alternative powertrains: a total cost of ownership-based assessment in the Italian market', *Journal of Cleaner Production*, Vol. 363, p.132559.
- Gomes, J.B. (2024) 'Incentivos fiscais ao uso de veículos elétrico-híbridos no Brasil. O Conselho Federal de Contabilidade no contexto da Reforma Tributária', *Revista Brasileira de Contabilidade*, Vol. 53, No. 268, pp.53–68.
- Hackbarth, A. and Madlener, R. (2013) 'Consumer preferences for alternative fuel vehicles: a discrete choice analysis', *Transportation Research Part D: Transport and Environment*, Vol. 25, pp.5–17.
- Hair, J.F., Black, W.C., Babin, B.J. and Anderson, R.E. (2010) *Multivariate Data Analysis*, 7th ed., Prentice Hall, New York.
- Hauslbauer, A.L., Verse, B., Guenther, E. and Petzoldt, T. (2024) 'Access over ownership: barriers and psychological motives for adopting mobility as a service (MaaS) from the perspective of users and non-users', *Transportation Research Interdisciplinary Perspectives*, Vol. 23, pp101005.
- Hensher, D.A. (2010) 'Hypothetical bias, choice experiments and willingness to pay', *Transportation Research Part B: Methodological*, Vol. 44, No. 6, pp.735–752.
- Herberz, M., Hahnel, U.J. and Brosch, T. (2020) 'The importance of consumer motives for green mobility: a multi-modal perspective', *Transportation Research Part A: Policy and Practice*, Vol. 139, pp.102–118.
- Higueras-Castillo, E., Guillén, A., Herrera, L.J. and Liébana-Cabanillas, F. (2021) 'Adoption of electric vehicles: which factors are really important?', *International Journal of Sustainable Transportation*, Vol. 15, No. 10, pp.799–813.
- Hofstede, G. (1984) *Culture's Consequences: International Differences in Work-Related Values*, Vol. 5, Sage, London.
- Illmann, U. and Kluge, J. (2020) 'Public charging infrastructure and the market diffusion of electric vehicles', *Transportation Research Part D: Transport and Environment*, Vol. 86, p.102413.
- Ingeborgrud, L. and Ryghaug, M. (2019) 'The role of practical, cognitive and symbolic factors in the successful implementation of battery electric vehicles in Norway', *Transportation Research Part A: Policy and Practice*, Vol. 130, pp.507–516.
- International Energy Agency (IEA) (2021) 'Comparative life-cycle greenhouse gas emissions of a mid-size BEV and ICE vehicle' [online] <http://www.iea.org> (accessed July 2024).
- International Energy Agency (IEA) (2024) *Global EV Outlook 2024* [online] <https://iea.blob.core.windows.net/assets/a9e3544b-0b12-4e15-b407-65f5c8ce1b5f/GlobalEVOutlook2024.pdf>.
- IPCC (2023) *Synthesis Report of the IPCC Sixth Assessment Report (AR6)*, Geneva.
- Kahneman, D. and Tversky, A. (1979) 'Prospect theory: an analysis of decision under risk', *Econometrica*, Vol. 47, No. 2, pp.363–391.

- Khurshid, A., Khan, K. and Cifuentes-Faura, J. (2023) '2030 Agenda of sustainable transport: can current progress lead towards carbon neutrality?', *Transportation Research Part D: Transport and Environment*, Vol. 122, p.103869.
- Kucukvar, M., Onat, N.C., Kutty, A.A., Abdella, G.M., Bulak, M.E., Ansari, F. and Kumbarglu, G. (2022) 'Environmental efficiency of electric vehicles in Europe under various electricity production mix scenarios', *Journal of Cleaner Production*, Vol. 335, p.130291.
- Lanzini, P. (2018) 'The automotive industry and the increasing relevance of a consumer perspective: a research agenda', *International Journal of Automotive Technology and Management*, Vol. 18, No. 1, pp.46–58.
- Lanzini, P. (2023) 'Mobility and individual choices in turbulent times – an overview', in *The Green Transition of the Automotive Industry: From Technological Sustainable Innovation to Mobility Servitization*, pp.111–130, Springer International Publishing, Cham.
- Lanzini, P. (2024) 'Charging ahead: a survey-based study of Italian consumer readiness for electric vehicle adoption', *Urban Science*, Vol. 8, No. 3, p.142.
- Lanzini, P., Pinheiro, D. and Jara, E. (2023) 'Toward a new paradigm for urban mobility in Brazil: an empirical investigation in the city of Florianópolis', *International Journal of Sustainable Transportation*, Vol. 17, No. 4, pp.319–332.
- Lieven, T. (2015) 'Policy measures to promote electric mobility – a global perspective', *Transportation Research Part A: Policy and Practice*, Vol. 82, pp.78–93.
- Liu, Z., Song, J., Kubal, J., Susarla, N., Knehr, K.W., Islam, E., Nelson, P. and Ahmed, S. (2021) 'Comparing total cost of ownership of battery electric vehicles and internal combustion engine vehicles', *Energy Policy*, Vol. 158, p.112564.
- Llopis-Albert, C., Rubio, F. and Valero, F. (2021) 'Impact of digital transformation on the automotive industry', *Technological Forecasting and Social Change*, Vol. 162, p.120343.
- McClave, J., Benson, P. and Sincich, T. (2021) *Statistics for Business & Economics*, Pearson, Harlow.
- Münzel, C., Plötz, P., Sprei, F. and Gnann, T. (2019) 'How large is the effect of financial incentives on electric vehicle sales? – A global review and European analysis', *Energy Economics*, Vol. 84, p.104493.
- Ninh, N.G. (2021) 'Resistance to change and purchase intention of electric vehicles: empirical evidence from Vietnam', *Asian Journal of Business Research*, Vol. 11, No. 2, pp.83–101.
- Novotny, A., Szeberin, I., Kovács, S. and Máté, D. (2022) 'National culture and the market development of battery electric vehicles in 21 countries', *Energies*, Vol. 15, No. 4, p.1539.
- Ou, S., Zhang, S., Lin, Z. and Davis, S. (2023) 'A method for determining optimal electric range by considering electric vehicle lightweighting on perceived ownership cost', *Journal of Cleaner Production*, Vol. 385, p.135606.
- Paradies, G.L., Usmani, O.A., Lamboo, S. and van den Brink, R.W. (2023) 'Falling short in 2030: simulating battery-electric vehicle adoption behaviour in the Netherlands', *Energy Research & Social Science*, Vol. 97, p.102968.
- Pardi, T. and Calabrese, G.G. (2020) 'Paradigm Shift? The automotive industry in transition to electric vehicles', *International Journal of Automotive Technology and Management*, Vol. 20, No. 2, pp.131–136.
- Qorbani, D., Korzilius, H.P. and Fleten, S.E. (2024) 'Ownership of battery electric vehicles is uneven in Norwegian households', *Communications Earth & Environment*, Vol. 5, No. 1, p.170.
- Rainieri, G., Buizza, C. and Ghilardi, A. (2023) 'The psychological, human factors and socio-technical contribution: a systematic review towards range anxiety of battery electric vehicles' drivers', *Transportation Research Part F: Traffic Psychology and Behaviour*, Vol. 99, pp.52–70.
- Reis, G.A.S. and Ferreti, A. (2024) 'Veículos elétricos no Brasil: benefícios, desafios e perspectivas de impacto socioambiental', *Revista Competitividade e Sustentabilidade-ComSus*, Vol. 11, No. 1, pp.21–36.

- Ruggieri, R., Ruggeri, M., Vinci, G. and Poponi, S. (2021) 'Electric mobility in a smart city: European overview', *Energies*, Vol. 14, No. 2, pp.1–29.
- Schvartz, M.A. (2024) *Análise dos fatores que influenciam a decisão de compra de veículos elétricos no Brasil*, UFSM, Santa Maria (SP).
- Sileo, A. and Bonacina, M. (2024) 'The automotive industry: when regulated supply fails to meet demand. The case of Italy', *FEEM WP*, January.
- Simsekoglu, Ö. and Nayum, A. (2019) 'Predictors of intention to buy a battery electric vehicle among conventional car drivers', *Transportation Research Part F: Traffic Psychology and Behaviour*, Vol. 60, pp.1–10.
- Sovacool, B.K. (2017) 'Experts, theories, and electric mobility transitions: toward an integrated conceptual framework for the adoption of electric vehicles', *Energy Research & Social Science*, Vol. 27, pp.78–95.
- Stocchetti, A. (2023) 'Greening the car – mission impossible or not pursued?', in *The Green Transition of the Automotive Industry: From Technological Sustainable Innovation to Mobility Servitization*, pp.67–91, Springer International Publishing, Cham.
- Temporelli, A., Carvalho, M.L. and Girardi, P. (2020) 'Life cycle assessment of electric vehicle batteries: an overview of recent literature', *Energies*, Vol. 13, No. 11, p.2864.
- Terenzi, A., Spinsante, S. and Cecchi, S. (2020) 'Review on electric vehicles exterior noise generation and evaluation', in *2020 AEIT International Conference of Electrical and Electronic Technologies for Automotive (AEIT AUTOMOTIVE)*, IEEE, November, pp.1–6.
- United Nations Environment Programme (UNEP) (2022) *Emissions Gap Report 2022: The Closing Window – Climate Crisis Calls*, Nairobi.
- UNRAE (2022) *Automobile: Italiani a confronto*, September, Report Unione Nazionale Rappresentanti Veicoli Esteri, Rome.
- UNRAE (2024) [online] <https://unrae.it/dati-statistici/immatricolazioni/tag/2024> (accessed November 2024).
- Vuong, B.N. and Khanh Giao, H.N. (2020) 'The impact of perceived brand globalness on consumers' purchase intention and the moderating role of consumer ethnocentrism: an evidence from Vietnam', *Journal of International Consumer Marketing*, Vol. 32, No. 1, pp.47–68.
- Wang, Y., Chi, Y., Xu, J.H. and Yuan, Y. (2022) 'Consumers' attitudes and their effects on electric vehicle sales and charging infrastructure construction: an empirical study in China', *Energy Policy*, Vol. 165, p.112983.
- Woo, J. and Magee, C.L. (2020) 'Forecasting the value of battery electric vehicles compared to internal combustion engine vehicles: the influence of driving range and battery technology', *International Journal of Energy Research*, Vol. 44, No. 8, pp.6483–6501.
- Zhang, J. and Huang, J. (2021) 'Vehicle product-line strategy under government subsidy programs for electric/hybrid vehicles', *Transportation Research Part E: Logistics and Transportation Review*, Vol. 146, p.102221.
- Zhou, W., Cleaver, C.J., Dunant, C.F., Allwood, J.M. and Lin, J. (2023) 'Cost, range anxiety and future electricity supply: a review of how today's technology trends may influence the future uptake of BEVs', *Renewable and Sustainable Energy Reviews*, Vol. 173, p.113074.

Notes

- 1 Data retrieved from: <https://www.hofstede-insights.com/country-comparison-tool>.
- 2 Elaboration on Motus-e data.