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To cite this article: Gracia Brückmann *et al* 2021 *Environ. Res. Lett.* **16** 124027

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Is resale anxiety an obstacle to electric vehicle adoption? Results from a survey experiment in Switzerland

OPEN ACCESS

RECEIVED
15 June 2021REVISED
8 October 2021ACCEPTED FOR PUBLICATION
1 November 2021PUBLISHED
24 November 2021

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E-mail: gracia.brueckmann@unibe.ch**Keywords:** battery electric vehicles, transport, emissions, survey experiment, value estimation**Abstract**

Electrification of private motorised transport is one of the most effective pathways to net-zero carbon emissions in the road transport sector. However, adoption rates of battery-electric vehicles (BEVs) are still relatively low in most advanced industrialised countries. One of the most widely discussed but so far understudied potential obstacles to BEV adoption is resale anxiety. It refers to the fear of comparatively low expected resale values of BEVs, resulting, among other reasons, from expectations concerning rapid progress in battery technology. However, based on three survey-embedded vignette experiments in Switzerland ($N = 3901$ in total), we find the opposite of resale anxiety: a higher expected resale value of BEVs compared to conventional cars. Our findings suggest that regulatory policy and social norm signals in this area are gaining ground, boding well for consumer acceptance of BEVs in the coming years.

1. Introduction

Shifting from internal combustion engines to battery electric vehicles (BEVs) is widely regarded as the most effective approach for reducing emissions from individual motorised transport, notably if BEVs are powered with renewable energy. While the BEV share of new car registrations has increased in many countries in recent years (International Energy Agency 2020), it still remains low in absolute terms. In the EU, only around 5% of new cars registered in 2020 were BEVs (European Alternative Fuels Observatory 2021). Slow fleet turnover leads to even lower shares of BEVs in car fleets. In Switzerland, for instance, only 0.7% of all cars on the road, as of 2020, were BEVs (Swiss Federal Statistical Office 2021), and in the European Union, this share was only 0.4% (ACEA 2021).

Existing research points to various reasons for slow adoption; for example, limitations in terms of range and charging infrastructure (e.g. Egbue and Long 2012, Graham-Rowe *et al* 2012, Axsen and Kurani 2013, Carley *et al* 2013, Lim *et al* 2015, Hardman *et al* 2018, Cheah 2021). We add to this

literature by focusing on one particular (potential) obstacle that is frequently mentioned but has thus far not been systematically studied from a consumer perception perspective: resale anxiety. Resale anxiety refers to consumers' fears deriving from uncertain future resale values of BEVs that are, in turn, related to unknown durability (Lim *et al* 2015). Such anxiety may result from a seemingly paradoxical situation: On the one hand, rapid progress in battery technology and other BEV attributes is highly desirable because it improves current characteristics of BEVs that are widely considered obstacles to adoption, such as vehicle weight, range, charging speed, and total cost of ownership. On the other hand, rapid progress along these lines may make consumers worried that a BEV bought today will depreciate in value even faster than the conventional cars that they are more likely to be familiar with.

Based on original data from three survey-embedded experiments with holders of conventional cars and BEVs in Switzerland, we study how vehicles with different drive train types (BEV, petrol/gasoline, diesel) depreciate over time from a consumer perspective. In contrast to what the resale anxiety

argument leads us to expect, we find higher expected resale values for BEVs compared with other car types.

The following section discusses the current literature on resale anxiety as an obstacle to BEV adoption. We then outline the study design, present the findings, and discuss study limitations, options for further research, and policy implications.

2. What do we know already?

Two lines of research provide an entry point for addressing the question of interest here. One is the literature on ‘resale (value) anxiety’ and related consumer concerns about the (presumably more rapid, compared to conventional or hybrid cars) depreciation of BEVs (Lim *et al* 2015, Thananusak *et al* 2017, Kumar and Alok 2020, Zhang and Zhao 2021). The main argument here is that technological innovation places current BEVs at risk of being outdated relatively soon (e.g. battery capacity and longevity). If so, the associated depreciation will increase the total cost of ownership (Graham-Rowe *et al* 2012). The term ‘resale anxiety’ emerged to highlight consumer concerns arising from uncertainty about technological developments and associated BEV resale values—notably in the absence of a large market for used BEVs that would generate helpful information for prospective BEV buyers (Lim *et al* 2015, Dua *et al* 2019, Guo and Zhou 2019).

As the market for BEVs has grown in the past few years, one might expect that resale anxiety should decrease. Moreover, car manufacturers and vendors have responded to presumed or real ‘resale anxiety’ with guarantees regarding resale values comparable to conventional cars or providing guarantees on battery capacity (Lim *et al* 2015, Zhang and Zhao 2021). On the consumer side, some researchers suggest that BEV buyers who are nervous about depreciation tend to lease rather than buy BEVs (Dua *et al* 2019). On top of this, when respondents in surveys or survey experiments were asked about how they estimate the total cost of ownership, only small minorities tend to consider depreciation (Hagman *et al* 2017). In other words, there are reasons to assume that resale anxiety should have decreased in recent years but demonstrating that this assumption holds true requires empirical research, which remains to be done.

The second line of research examines *de facto* depreciation rates. Such research is rather time- and location-specific because a mass market for BEVs is only emerging, and second-hand markets for BEVs are still small. Because more energy-efficient technologies often have a higher initial price tag but lower operation costs, consumers need convincing that adopting such technologies is worthwhile (Hagman *et al* 2017). In the BEV case, this can be supported by helping consumers compare the total costs of ownership (TCOs) between more (BEVs’) and less energy-efficient (conventional cars’) technologies

(Hagman *et al* 2017). To assist consumers, many academics and professionals have estimated and compared the TCOs of differently powered cars. Yet, only very few such studies examine the resale value and associated depreciation. In their landmark overview study, Gnann *et al* (2018) identified only 5 out of 40 TCO studies that looked at resale values. This finding is quite puzzling since the resale value can make up a large share of a car’s total value (Propfe *et al* 2012, Letmathe and Soares 2017), and it is usually the most important part of the TCO (Lévay *et al* 2017).

Traditionally, the resale value of a car depends on age, mileage, and initial purchase price. The (anticipated) resale value also depends on the vehicle’s condition and is, to some degree, location-specific. It may also depend on make, model, and drivetrain (Hagman *et al* 2016). Some studies also include the cars’ body types (Propfe *et al* 2012) and different engine types’ depreciation rates (Zhao *et al* 2015). It is widely noted that BEV resale values are subject to more uncertainty because there is little historical data and samples are small (Hagman *et al* 2016). While some analysts claim that it is currently (still) not possible to assess BEVs resale prices (Letmathe and Soares 2020), others assume them to be equal to conventional cars (e.g. Sharma *et al* 2012, Carley *et al* 2019, König *et al* 2021).

A few studies have, nevertheless, sought to estimate resale values based on data from existing transactions. The loss in value (depreciation) is often determined directly from the purchase price (Runkel and Stubbe 2019, Wietschel and Timmerberg 2019). Earlier studies have also used a hedonic pricing method from Dexheimer (2003) and adapted it to the BEV case (Plötz *et al* 2014, Wu *et al* 2015, Letmathe and Soares 2017). Plötz *et al* (2014) showed analytically that the relative loss in value would be higher for higher purchase prices (a common scenario for BEVs even today). As Ajanovic and Haas (2019) point out, the assumptions in TCO studies regarding the time of vehicle ownership differ enormously and are usually between 3 and 15–20 years. The same holds for vehicle kilometres travelled and body type (see also Moon and Lee 2019).

Lévay *et al* (2017) analyse resale values based on data from multiple popular car sales platforms. They find that smaller BEVs depreciate faster than larger BEVs, a pattern that is very similar to conventional cars. They also found that BEVs lost more value at the beginning of their lifetime, which the authors partly attributed to technological advances, such as battery-cost reductions. The information they provide on the remaining values of BEVs compared to conventional cars shows an inconsistent pattern: sometimes BEVs have more, and sometimes they have less remaining value (as a percentage of the initial purchase price). However, the authors also highlight the uncertainty of their estimates due to the market for second-hand BEVs being small (Lévay *et al* 2017).

Some other TCO studies postulate that the depreciation of BEVs per year is 10.5 percentage points higher for BEVs (Gass *et al* 2014), or the resale value of BEVs is 30 percentage points lower relative to conventional cars (Hoekstra *et al* 2017). These conclusions are based on information obtained by consulting experts from car importing companies, dealerships, and leasing firms, who attributed lower resale values of BEVs to unfamiliarity and lack of trust in the technology. Hoekstra *et al* (2017) concluded: ‘So in practice EVs had a much lower resale value while from a TCO perspective they should have a much higher resale value’ (Hoekstra *et al* 2017, p 5). Hoekstra *et al* (2017) assumed the cars were sold to new buyers who looked at tax incentives and were not interested in resale value because they leased the car anyway (which is the case for about 90% of (Plug-In Hybrid) EVs in the Netherlands). They expect similar or better resale values with consumer learning around the years 2025/26 (Hoekstra *et al* 2017).

Finally, a study undertaken in the United States (US) finds that resale values of BEVs follow a pattern known from conventional cars: the bigger the vehicle, the higher its resale value. This observed pattern also translates to the observed real second-hand market value of BEVs, as found in a study on more than 26 000 U.S.-based transactions (Guo and Zhou 2019). After five years, the remaining value of a Tesla car was still very high, while small mass-market BEVs had lower remaining values than conventional cars in the same segment. While studies focusing on market transactions offer a present and retrospective view, our study adds to this literature by focusing on consumer expectations concerning future resale values of currently bought BEVs.

3. Study design

When BEVs first appeared on the market, the total cost of ownership was certainly more unpredictable than for conventional cars (Haddadian *et al* 2015), but such uncertainty may have decreased in recent years. As Lim *et al* (2015, p 102) point out, ‘As the market matures, resale anxiety will likely diminish as the durability of EVs will be observed as well as the true EV resale price.’ Similarly, it is predicted to decrease step-by-step with higher visibility of BEVs and through word-of-mouth (Rajper and Albrecht 2020).

However, (expected) resale value was a concern for more than half of the participants in a recent study in the United Kingdom (UK) (Berkeley *et al* 2018). Similarly, based on a study of consumers in Denmark and Sweden, Haustein *et al* (2021, p 5) state, ‘The resale value of electric cars is very unpredictable.’ (See also Habich-Sobiegalla *et al* 2018, Zhang and Zhao 2021.) Xu *et al* (2017) studied resale value perceptions in Singapore. They show that a large majority of around two-thirds of their Singaporean respondents

assigned negligible remaining values to BEVs. Only a small share (less than 18%) think that BEV resale values compare well to those of conventional cars (Xu *et al* 2017).

Since these studies are based on simple survey questions, they are likely prone to an upward bias in resale anxiety measurement. When respondents are asked to what extent they are concerned about the resale value of a BEV, they will not anchor their response within the set of various concerns they may have about purchasing a BEV. As a result, they will focus on BEVs alone rather than BEVs compared to other types of cars. Our study design addresses these potential limitations in two ways. First, we opt for an experimental design, which allows for more robust causal inferences than a conventional survey. Second, our study design allows for an explicit comparison of resale value expectations between different car types (BEVs, petrol/gasoline, and diesel cars) and between current BEV holders and holders of conventional cars.

Like the large majority of studies on the subject (see above), our study is also based on data for a single country. However, Switzerland is an interesting setting for our experiment because there are only very weak public regulatory or financial incentives to promote BEV adoption and discourage conventional cars (Brückmann and Bernauer 2020, Brückmann *et al* 2021). Assuming that strong policies for enhancing BEV adoption, phasing out fossil-fueled vehicles, or a strict car retirement age might mitigate BEV resale anxiety, we believe that weak policies⁵ to those ends in Switzerland make this country a likely setting for us to be able to find sizable levels of resale anxiety. However, further research using a similar study design will have to show whether our findings are relevant to other country contexts (e.g. countries with stronger policies for enhancing BEV adoption, countries with higher shares of less expensive BEVs, countries with a different mean car age, i.e. not nine years as in Switzerland Swiss Federal Statistical Office (2021)).

In Switzerland, as of now, there are differently sized and priced cars among the top-selling BEVs. While Tesla cars make up 33% of the new BEVs registered in Switzerland until July 31, 2021, the second largest share with 14% is held by Renault, followed by VW (8%), BMW (7%) and Hyundai (5%)⁶. In the current year, 2021, Tesla Model 3 accounts for

⁵ In contrast to the case of a subsidy exclusively for new vehicles which instantaneously decreases the resale value by the amount of this subsidy.

⁶ Own calculations based on data from https://files.admin.ch/astra_ffr/mofis/Datenlieferungs-Kunden/opendata/1000-Fahrzeuge_IVZ/1300-Fahrzeugbestaende/1330-Bestaende_nach_Typen/1333-Datensaetze/ which is as of July 31, 2021. In each sheet filter B (Fahrzeugart) to ‘Personenwagen’ and ‘Schwerer Personenwagen’, Column N (Treibstoff) to ‘elektrisch’ or ‘E’ (depending on file) and remove data if Column J (Aussverkehrssetzung) is not empty. The created file can be found here: https://osf.io/5ctpz/?view_only=8fd73edf6b12431696c4cf733af5679e.

Table 1. Overview of three surveys used for this study.

Survey	Sampling	Sample size	Fielded from	Fielded to	IRB approval	Survey instrument available at
1	A random sample from population ≥ 18 years of the canton of Zurich	1065 out of 2075	20 August 2020	11 October 2020	EK 2020 N-14	Link 1
2	A random sample of car holders without BEV, registered in Aargau, Schwyz, Zug and Zurich	1917	1 October 2020	30 November 2020	EK 2017 N-85	Link 2
3	A random sample of car holders with BEV registered in Aargau, Schwyz, Zug and Zurich	919	1 October 2020	30 November 2020	EK 2017 N-85	

Note: Experiment in Survey 1 randomly allocated to around 50% of the survey participants.

around 18% of the newly registered BEVs, followed by VW ID.3 with 11.1%, Renault Zoe with 7.2%, and Fiat 500 with 5.8%, followed by ID.4 with 4.9% (Swiss Federal Office of Energy 2021). Given some studies suggesting higher resale values of more expensive BEVs (see above), the wide range of BEVs available and bought in Switzerland implies that our findings should not be biased, for instance, by respondents generally viewing BEVs as very expensive cars and thus expecting a high resale value. However, we also avoid such possible bias by randomly varying the price of BEVs in our experimental design, implementing the experiments both for current BEV holders and holders of conventional cars, and setting up the experiment as a comparison of BEVs and conventional vehicles.

Our experiment was embedded in three surveys with representative samples from the metropolitan area of Zurich, with the largest city in Switzerland (Zurich). It will be useful to examine whether our findings uphold in other geographic regions of the country and other countries. However, using data from an experiment implemented at two different points in time with three samples, including both BEV and non-BEV holders, allows for a meaningful first assessment of whether the findings are robust. The experiment was placed in the following three surveys (see also table 1):

- (a) Residents of the Canton of Zurich: For this survey, 10 000 randomly selected residents from the canton of Zurich were contacted in August 2020 and invited to take a survey, of which 2075 people completed the survey in full, corresponding to a response rate of 20.8%. The survey consisted of questions on attitudes, knowledge and acceptance of electric cars. Half of the participants completed a decision experiment on the resale value of different car types (petrol, diesel, EV).
- (b) A panel of conventional car holders with no BEV registered at the time of sampling (Spring 2018). The sample frame was all registered car holders

in the Swiss cantons of Aargau, Schwyz, Zug and Zurich (all surrounding Zurich). From 20 000 randomly selected car holders, everyone was invited by postal mail to participate in a mixed-mode survey either online or in pen-and-paper mode. After each survey wave, consent to participate in a subsequent wave was obtained for the invitations to the next survey waves. Whenever respondents consented to the next survey, they were invited to complete it by their mode of choice (email or postal mail). The sample used for this experiment is the third wave. Data were collected between October and November 2020 in an online survey. From this panel, 1908 persons remained in the sample. Note that some acquired a BEV over time (or had one in their household before sampling).

- (c) In Spring 2018, another panel was created from registered BEV holders in the same Swiss cantons (Aargau, Schwyz, Zug and Zurich). Everyone who had at least one BEV registered was, in the same method as described for sample 2, invited by postal mail to participate in a mixed-mode survey, either online or in pen-and-paper mode. After the first wave, consent for the next wave was asked. Whenever respondents consented to a subsequent survey, they were invited again. The experiment took place in the second wave of that panel between October and November 2020 and was administered entirely online. The sample size is 919. Note that not everyone (still) has a BEV registered.

Appendix A.1 provides additional information on the three surveys, including response and contact rates (The American Association for Public Opinion Research 2016).

The three samples differ in important ways, which is useful for assessing how robust our findings are. The first sample covers the population of age ≥ 18 years in the most populated Swiss canton (Zurich). The second sample includes car holders

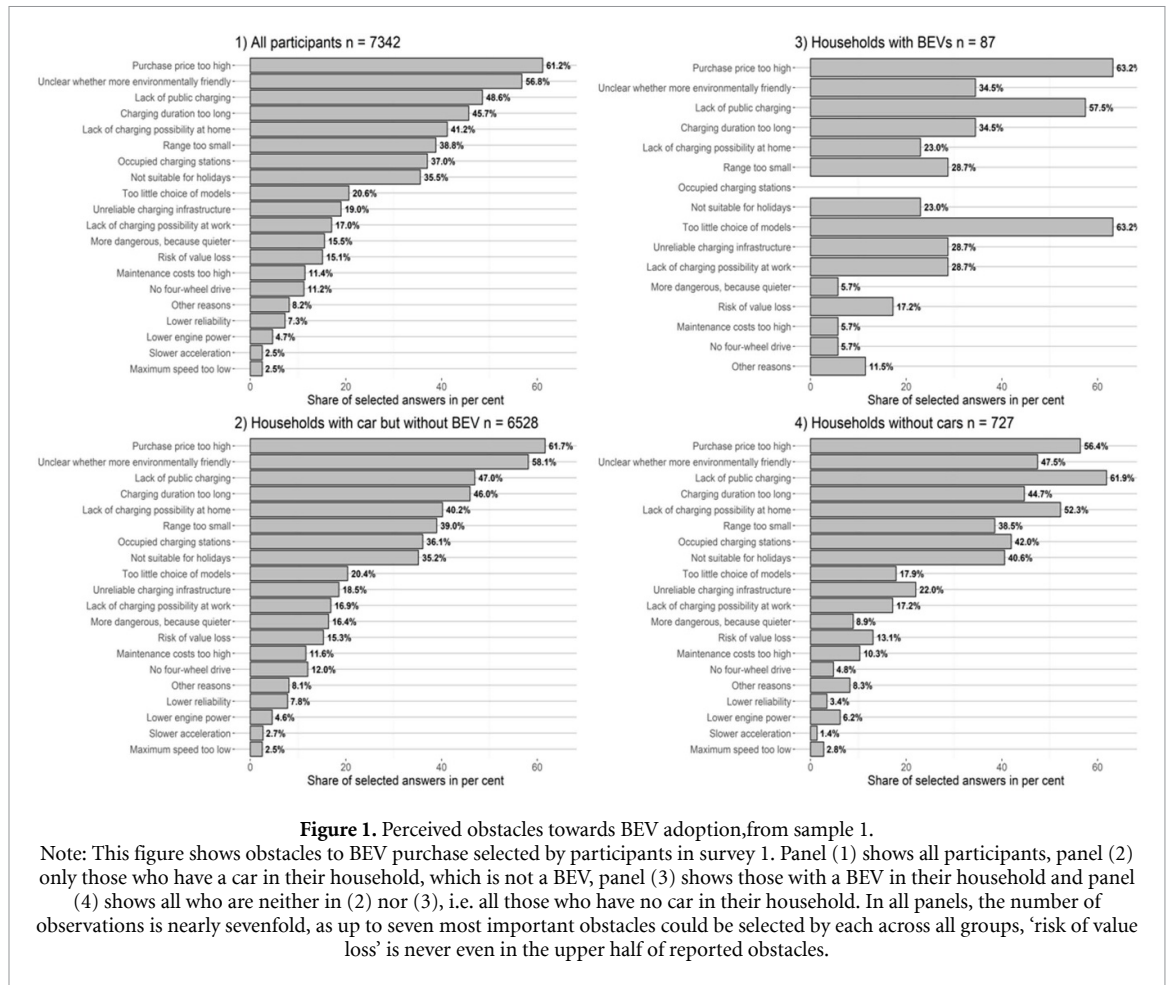


Figure 1. Perceived obstacles towards BEV adoption, from sample 1.

Note: This figure shows obstacles to BEV purchase selected by participants in survey 1. Panel (1) shows all participants, panel (2) only those who have a car in their household, which is not a BEV, panel (3) shows those with a BEV in their household and panel (4) shows all who are neither in (2) nor (3), i.e. all those who have no car in their household. In all panels, the number of observations is nearly sevenfold, as up to seven most important obstacles could be selected by each across all groups, 'risk of value loss' is never even in the upper half of reported obstacles.

from four Swiss cantons (where around 30% of all cars in Switzerland are registered) who did not own a BEV. And the third sample covers persons who held at least one BEV in the same four cantons as covered by the second survey. One of our three samples (BEV holders) might be regarded as biased towards higher estimated BEV resale values because these car holders are early BEV adopters. However, the other two samples include mostly non-BEV adopters. Because the results are very similar for all three samples, this makes us reasonably confident that this potential bias only plays a minor role in driving resale valuations.

The three surveys covered various aspects of BEV related attitudes and behaviour. To assess resale anxiety, we evaluate the relative importance of BEV resale values among other potential obstacles but focus on three vignette experiments, one in each survey. In these vignette experiments, survey participants were randomly allocated to differing versions (varying in the brackets) of the following question (translated from the German original):

Assume that you buy a new [petrol/diesel/purely battery-electric] car today for a price of CHF [different prices]. If you sell this car in [different car ages] years in perfect condition (regular service, no damages), how

much do you think you could ask for it then?

As can be seen, we manipulated the car type, the initial purchasing price, and the car's age. Other car attributes were held constant: in the sense that no information on car brand or model or mileage was provided, and respondents were asked to assume that the car was in perfect condition.

4. Results

To provide an initial, descriptive idea of how relevant resale value concerns might be in terms of an obstacle to BEV adoption, we asked respondents to select up to seven reasons from a more extensive list of potential reasons for not switching from internal combustion engine cars to BEVs. The item, which was placed before the vignette experiment in the first survey only, reads as follows (translated from German, for the original wording in German, see appendix A.2.1):

Below are some potential impediments to switching from petrol or diesel cars to electric cars. Please read the whole list carefully first, think about it briefly, and select and rank the

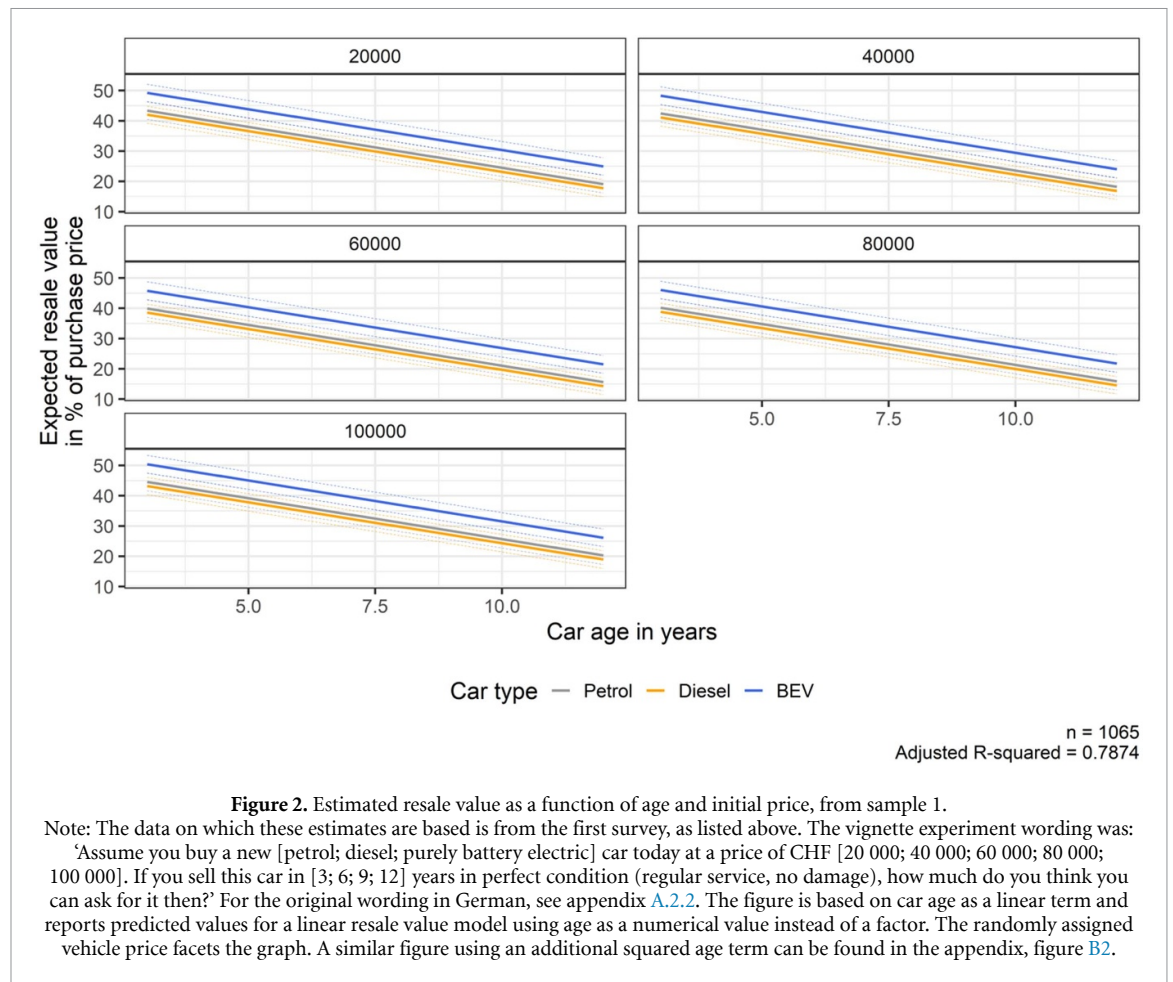


Figure 2. Estimated resale value as a function of age and initial price, from sample 1.

Note: The data on which these estimates are based is from the first survey, as listed above. The vignette experiment wording was: ‘Assume you buy a new [petrol; diesel; purely battery electric] car today at a price of CHF [20 000; 40 000; 60 000; 80 000; 100 000]. If you sell this car in [3; 6; 9; 12] years in perfect condition (regular service, no damage), how much do you think you can ask for it then?’ For the original wording in German, see appendix A.2.2. The figure is based on car age as a linear term and reports predicted values for a linear resale value model using age as a numerical value instead of a factor. The randomly assigned vehicle price facets the graph. A similar figure using an additional squared age term can be found in the appendix, figure B2.

seven most important reasons for you personally.

As shown in figure 1, panel 1, it turns out that only 15% of our respondents in survey 1 regarded value loss as an important obstacle to BEV adoption. While this perceived risk is slightly higher (17.2%) among the BEV adopters in this sample, it is never in the upper half of the list of potential obstacles. This finding contrasts with some of the studies referred to above, which report a much higher prevalence of resale anxiety among barriers to BEV adoption.

The main limitation of the findings shown in figure 1 is that they do not engage consumers compared with BEV obstacles and those for other car types. Our original survey experiment addresses this limitation. Figure 2 shows the main results. It depicts the expected resale value (in per cent of the initial purchase price) as a function of experimentally manipulated car attributes (drivetrain type, car age, initial price).

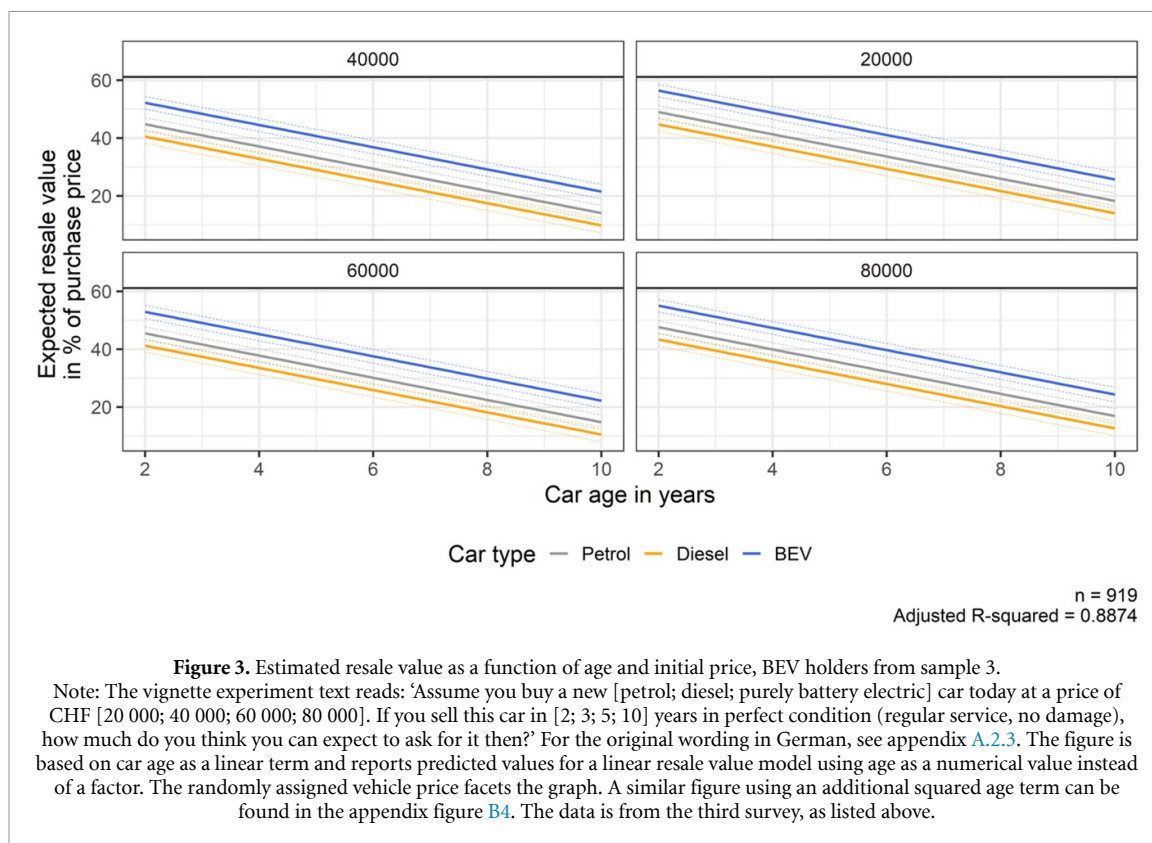
Unsurprisingly, we find that the older the car, the lower the resale value. A very high initial purchase price (CHF⁷ 100 000) has a slight positive effect on the estimated resale value. In contrast, in the upper price

range (CHF 40 000 and CHF 80 000), the resale values are slightly lower than the cheaper cars (CHF 20 000). This resembles findings based on data for other countries (see above).

Particularly interesting for us, however, is the finding that the price curves for BEVs are consistently and statistically significantly above (in the order of around 6%) those for petrol or diesel cars. That is, at any given age, BEVs are perceived to depreciate less than other car types. The conventional regression table on which figure 1 is based can be found in the appendix (table C1). It includes three models, with a linear (model 1) or a quadratic age term (model 2), as well as the combination thereof (model 3). In each of the three models in the appendix (table C1), the coefficients for BEVs are statistically significantly (on the 95%-level) different from the coefficients of either petrol or diesel cars.

The results from the experiment embedded in the second and third surveys are very similar. Figures equivalent to figure 2 for sample 2 are shown in appendix B, figure B1. Using data from the second survey, we still find that estimated resale values are higher for BEVs than for the petrol cars, and on the 95%-level, significantly higher than diesel cars (see table C2). However, the differences are smaller than for the first survey (the resale value for BEVs is around 2.6% higher than for Diesel cars and 1.9% higher than

⁷ 1 CHF (Swiss Franc) = 0.95 EUR (Euro) = 1.09 USD (US Dollar) as of November, 8 2021.



for petrol cars). As shown in figure 3, for the third sample, we find no evidence for resale anxiety but quite the opposite: a premium on the expected resale value of BEVs compared to other car types. Diesel cars are estimated to resell at 11.7% lower than BEVs, and the difference between BEVs and petrol cars is minus 7%. These results do not change if we use alternative model specifications (see figures B1–B4 in the appendix), and in all models, the difference is significant on the 95%-level (see table C3).

5. Discussion and conclusion

Electric vehicles powered by renewables are widely regarded as the best option societies currently have for putting individual motorised transport on a more sustainable footing. Yet, adoption rates of BEVs are still low and picking up only slowly, particularly in countries that have not enacted strong policies for incentivising BEV uptake (Sierzchula *et al* 2014, Narassimhan and Johnson 2018, Hardman 2019). The existing literature on the subject sheds light on many (perceived and actual) obstacles consumers face when considering whether or not to acquire a BEV (Wicki *et al* 2021).

This paper focuses on a particular perceived financial obstacle: resale value anxiety (Graham-Rowe *et al* 2012, Lim *et al* 2015). Some market analysts and scholars believe that resale value anxiety is likely to have decreased because BEV technology (including batteries) has become more mature. Yet, others still regard such anxiety as real and important, mainly

because there is not yet a large enough used car market for BEVs that would allow consumers to anticipate what the value of a newly bought BEV might be in a few years from now (e.g. Zhang and Zhao 2021). However, whether one or the other view is correct is ultimately an empirical matter, which is the main contribution of this paper.

While empirical research on market transactions in the (relatively small) second-hand market for BEVs can provide some insights into the present and past resale values of BEVs, relative to conventional cars (e.g. Lévy *et al* 2017, Schoettle and Sivak 2018, Guo and Zhou 2019), it is ultimately consumers’ perceptions about future resale values that shape choices today. Therefore, our experimental research is important in complementing research on market transactions. Based on a (vignette) experiment placed in three surveys in Switzerland, a country with weak policies for promoting BEVs or phasing out conventional cars, we find support for the first of the two orthogonal views mentioned above. From a consumer perspective, the anticipated value loss turns out to be significantly lower for BEVs than for vehicles with other drive trains (petrol/gasoline, diesel).

Although we are quite confident in the robustness of our findings, mainly because they are based on detailed data from three original survey experiments with very different samples (random samples from the population, from non-BEV conventional car holders, and the population of BEV holders), the Swiss context unavoidably differs to some extent from other countries.

High-income levels in Switzerland might make car owners generally less susceptible to resale anxiety. The high share of rather expensive BEVs in Switzerland might induce consumers to generally think of high-end BEVs that tend to have a higher resale value when engaging in our experiment. Other countries have stronger policies to promote BEV adoption than Switzerland, whereas subsidies for BEVs, for instance, are likely to cause lower expected BEV resale values. Yet another potential factor that could differ between countries is leasing, compared to buying cars. To the extent leasing rates do not price in technology risks (which is rather unlikely), leasing instead of buying might reduce BEV resale value anxiety—though it is also possible that conventional car holders experience technology-related resale anxiety, too. This resale anxiety is related to a new market where used non-BEVs are challenging to sell because they are regarded as old, outdated technology.

Because we do not seek to estimate expected BEV resale values in an absolute sense but do so relative to non-BEVs, and with samples of BEV and non-BEV holders, and because we experimentally vary vehicle purchase costs from low to high, this suggests that our results might uphold in other country contexts as well. However, this is ultimately an empirical matter, and we hope that other researchers will study BEV resale anxiety in other countries, perhaps using our study design as a template. As regards leasing, based on the limited evidence we were able to gather from Swiss car importers and car dealers, we found that leasing was not more common for BEVs than for non-BEVs. This suggests that our results are unlikely to be driven by disproportionately high leasing rates in the Swiss BEV market. Further research could look in greater depth into this issue to determine how car dealers set leasing rates for BEVs relative to non-BEVs, and how this affects expected resale values of the different car types.

Our finding that perceived depreciation is higher for non-BEVs suggests that changing social norms and policy signals are beginning to affect consumer preferences, even in a country with weak policies for promoting BEVs. Although further research will have to explore this in greater depth, our findings are consistent with the interpretation that consumers

expect less demand for used fossil-fuelled cars in the future, possibly due to regulatory restrictions on non-BEVs, increasing carbon taxes, or an increasing environmental stigma of non-BEVs. Another noteworthy finding is that the perceived depreciation of BEVs is lower in the BEV-holder sample. We cannot really tell whether this reflects purpose optimism among the early adopters of the technology, so further research into this would be useful.

Data availability statement

The data that support the findings of this study are openly available at the following URL/DOI: <https://dataverse.harvard.edu/dataverse/ResaleValue/>. Data will be available from 30 June 2023.

Acknowledgments

We are grateful to Janek Bruker, Maja Schoch, Chiara Vogel, Colin Walder, and Fredrik Wallin for valuable research assistance in conducting these surveys and Franziska Quoss for valuable project collaboration and inputs. We are also grateful for Najmeh Karimian's help in spell-checking this manuscript. We thank the Swiss Federal Statistical Office and the car registries of the Swiss cantons of Aargau, Schwyz, Zug, and Zurich for supporting the data collection. We gladly acknowledge funding from the Energieforschungsstelle Zürich, the Swiss Federal Office of Energy, and ETH Zurich Institut of Scienc, Technolog and Policy. We thank the car registry of Zurich as well as Kia Schweiz AG and Renault Suisse for answering our request on data for the manuscript's revision. We thank the editors and referees for their helpful feedback.

Ethical statement

The research conducted here (surveys with human subject) and was in full approved by the institutions ethics committee with the numbers EK 2020-N-14 and EK 2017-N-85. These ethics committee approval information can also be found in the table 1 of the manuscript and is in accordance with ethical guidelines.

Appendix A. Additional survey information

A.1. Survey information

Survey	Response rate	Contact rate
1 (Cross-section)	0.208	0.987
2 (Sample used here stems from wave 3)	Wave 1: 0.207 Wave 2: 0.871 Wave 3: 0.846	Wave 1: 0.994 Wave 2: 0.998 Wave 3: 0.971
3 (Sample used here stems from wave 2)	Wave 1: 0.448 Wave 2: 0.883	Wave 1: 0.995 Wave 2: 0.976

A.2. Original survey wording

A.2.1. Original (German) survey item for BEV obstacles in Survey 1

*Unten sind einige potentielle Hinderungsgründe für einen Wechsel von Benzin oder Dieselaautos zu Elektroautos aufgeführt. Bitte lesen sie die ganze Liste zuerst genau durch, denken Sie kurz darüber nach, und wählen Sie daraus die für Sie persönlich **sieben** wichtigsten Gründe aus und ordnen Sie diese.*

A.2.2. Original (German) survey item for the resale experiment in Survey 1

Nehmen Sie an Sie kaufen heute ein [benzinbetriebenes, dieseltbetriebenes, rein batterieelektrisch betriebenes] Auto zum Preis von CHF [20 000; 40 000; 60 000; 80 000; 100 000]. Wenn Sie dieses Auto in [3; 6; 9; 12] Jahren im perfektem Zustand (regelmässiger Service, keine Beschädigungen) verkaufen, was denken Sie wie viel Sie dafür noch verlangen können?

A.2.3. Original (German) survey item for the resale experiment in Surveys 2 & 3

Nehmen Sie an, Sie kaufen heute ein neues [benzinbetriebenes; dieseltbetriebenes; rein batterieelektrisch betriebenes] Auto zum Preis von CHF [20 000; 40 000; 60 000; 80 000]. Wenn Sie dieses Auto in [2; 3; 5; 10] Jahren in perfektem Zustand (regelmässiger Service, keine Beschädigungen) verkaufen, was denken Sie wie viel Prozent des ursprünglichen Kaufpreises würden Sie bei einem Wiederverkauf erhalten?

The experiments in survey 2 and 3 are slightly different from survey 1, as they consider shorter periods (2, 3, 5 and 10years) and omit the option of a 100000 CHF car. Besides that, the randomisation is entirely equal, and as appendix A.2.3 shows, the survey texts are identical.

Appendix B. Appendix figures

Figure B1 provides results for survey 2.

In sample 2, as depicted in figure B1, the effects are slightly different in the linear case regarding prices. The linear model presented in figure 2 shows that the highest expected resale value (in %) is found for the 20 000 CHF group, followed by 80 000 and 60 000 and 40 000, respectively. These differences are not statistically significant on the 95%-level. As in the previous sample, we find the highest estimated resale values for BEVs. However, the difference in percentage points is more petite. It is only 2.6 for Diesel cars and 1.9 for petrol cars.

Figures 2 and 3 from the main text and figure B1, with an additional quadratic term that allows the relevant age range a steeper decrease in earlier years, improve the model fit.

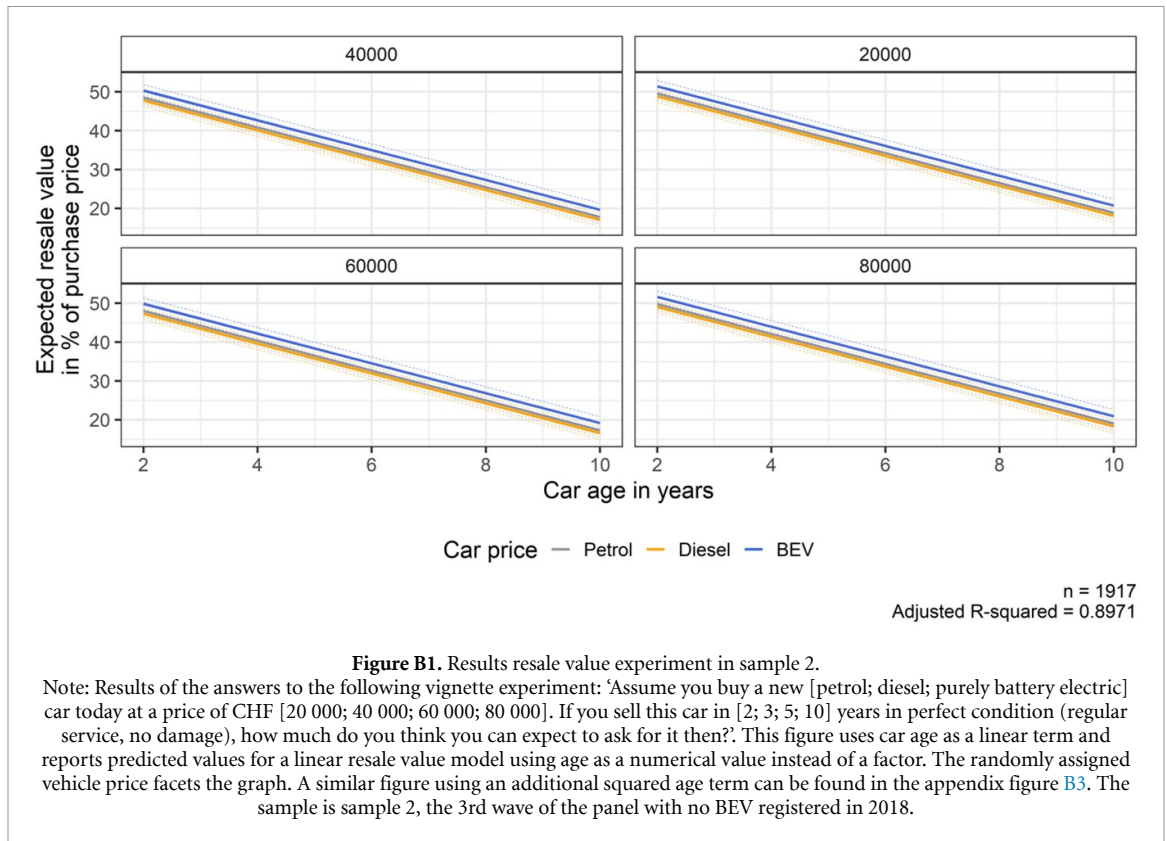


Figure B1. Results resale value experiment in sample 2.

Note: Results of the answers to the following vignette experiment: 'Assume you buy a new [petrol; diesel; purely battery electric] car today at a price of CHF [20 000; 40 000; 60 000; 80 000]. If you sell this car in [2; 3; 5; 10] years in perfect condition (regular service, no damage), how much do you think you can expect to ask for it then?'. This figure uses car age as a linear term and reports predicted values for a linear resale value model using age as a numerical value instead of a factor. The randomly assigned vehicle price facets the graph. A similar figure using an additional squared age term can be found in the appendix figure B3. The sample is sample 2, the 3rd wave of the panel with no BEV registered in 2018.

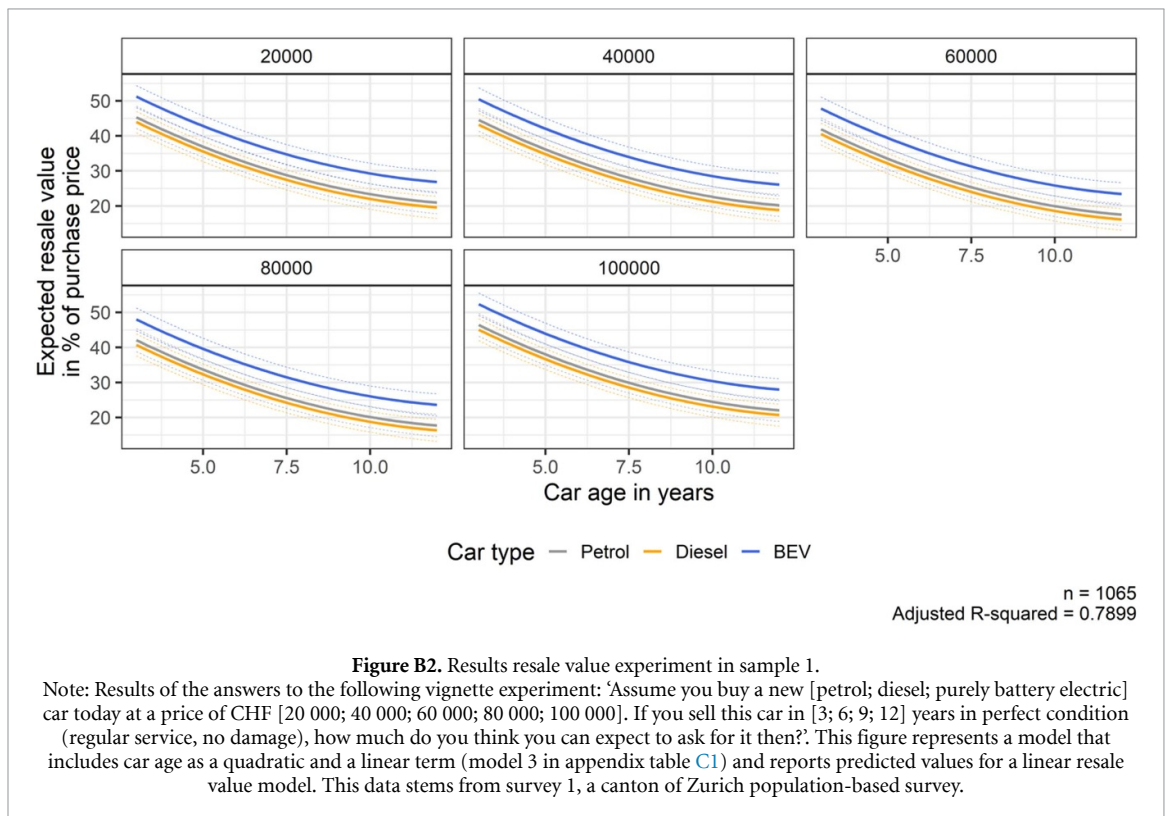


Figure B2. Results resale value experiment in sample 1.

Note: Results of the answers to the following vignette experiment: 'Assume you buy a new [petrol; diesel; purely battery electric] car today at a price of CHF [20 000; 40 000; 60 000; 80 000; 100 000]. If you sell this car in [3; 6; 9; 12] years in perfect condition (regular service, no damage), how much do you think you can expect to ask for it then?'. This figure represents a model that includes car age as a quadratic and a linear term (model 3 in appendix table C1) and reports predicted values for a linear resale value model. This data stems from survey 1, a canton of Zurich population-based survey.

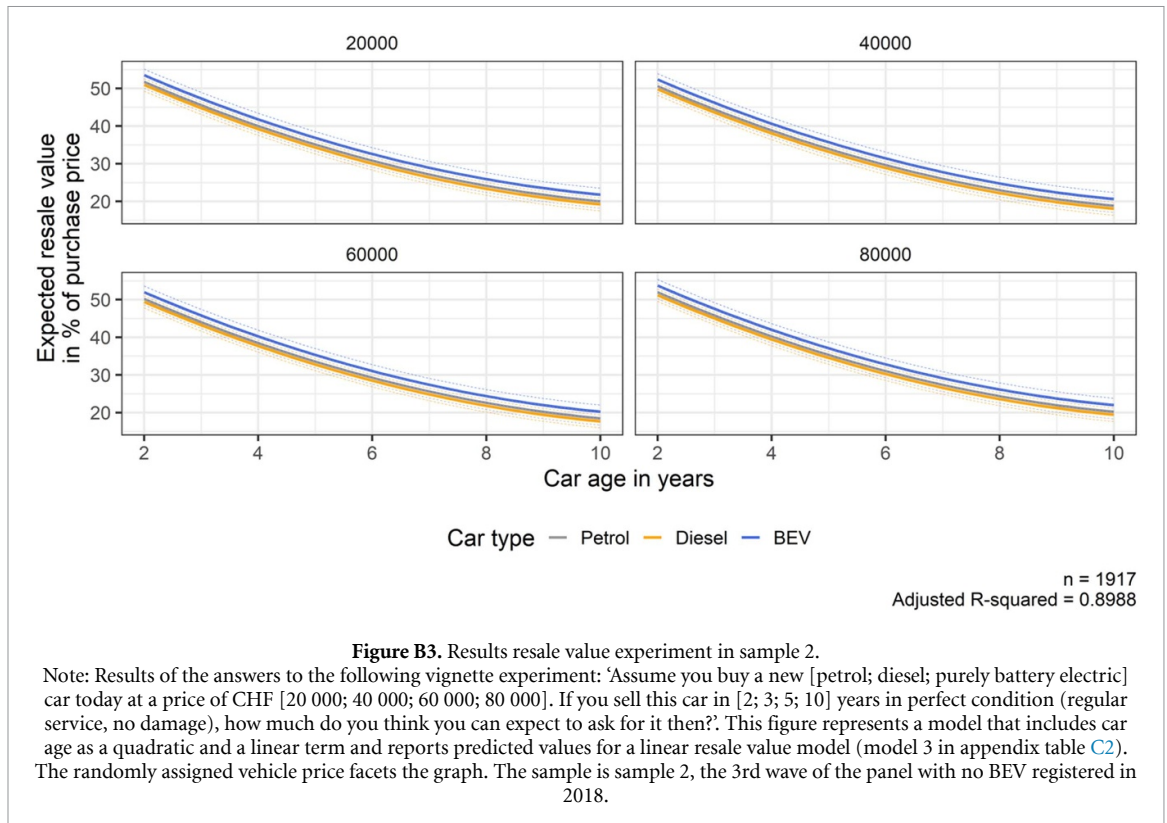


Figure B3. Results resale value experiment in sample 2.

Note: Results of the answers to the following vignette experiment: 'Assume you buy a new [petrol; diesel; purely battery electric] car today at a price of CHF [20 000; 40 000; 60 000; 80 000]. If you sell this car in [2; 3; 5; 10] years in perfect condition (regular service, no damage), how much do you think you can expect to ask for it then?'. This figure represents a model that includes car age as a quadratic and a linear term and reports predicted values for a linear resale value model (model 3 in appendix table C2). The randomly assigned vehicle price facets the graph. The sample is sample 2, the 3rd wave of the panel with no BEV registered in 2018.

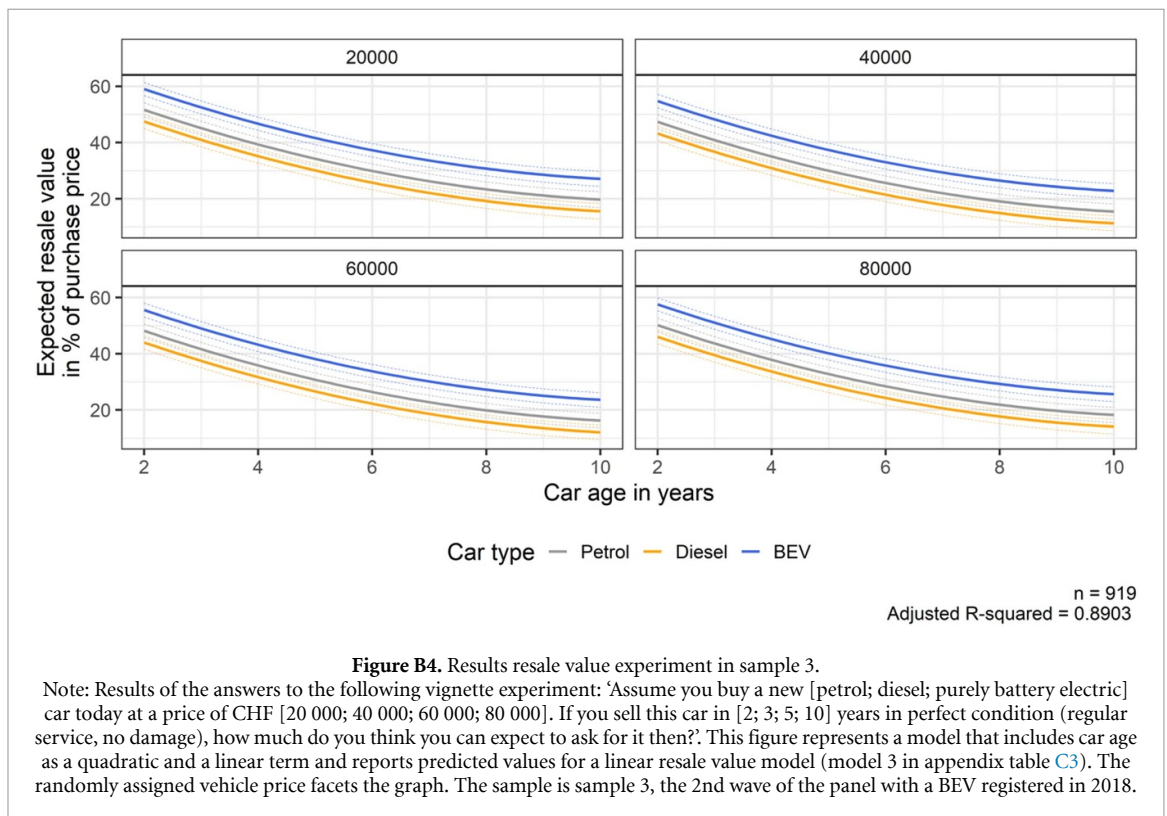


Figure B4. Results resale value experiment in sample 3.

Note: Results of the answers to the following vignette experiment: 'Assume you buy a new [petrol; diesel; purely battery electric] car today at a price of CHF [20 000; 40 000; 60 000; 80 000]. If you sell this car in [2; 3; 5; 10] years in perfect condition (regular service, no damage), how much do you think you can expect to ask for it then?'. This figure represents a model that includes car age as a quadratic and a linear term and reports predicted values for a linear resale value model (model 3 in appendix table C3). The randomly assigned vehicle price facets the graph. The sample is sample 3, the 2nd wave of the panel with a BEV registered in 2018.

Appendix C. Appendix tables

Table C1. Comparison of three models for resale value, based on sample 1, with a linear (model 1) or a quadratic age term (model 2), as well as the combination thereof (model 3).

Survey 1	Model 1					Model 2					Model 3				
	Estimates	Std. error	Conf. Int (95%)	P-value		Estimates	Std. error	Conf. Int (95%)	P-value		Estimates	Std. error	Conf. Int (95%)	P-value	
Petrol	50.56	1.83	46.97–54.15	<0.001		41.47	1.57	38.38–44.55	<0.001		60.37	3.20	54.10–66.65	<0.001	
Diesel	49.21	1.77	45.74–52.68	<0.001		40.21	1.53	37.21–43.20	<0.001		59.01	3.16	52.81–65.22	<0.001	
BEV	56.41	1.83	52.82–60.00	<0.001		47.28	1.58	44.19–50.37	<0.001		66.29	3.21	59.98–72.59	<0.001	
Car price: 20 000	2.09	1.64	–1.13–5.32	0.203		2.28	1.67	–0.99–5.55	0.171		1.87	1.63	–1.34–5.07	0.254	
Car price: 60 000	0.91	1.62	–2.27–4.09	0.575		1.08	1.65	–2.15–4.31	0.513		0.76	1.61	–2.40–3.93	0.637	
Car price: 80 000	–2.55	1.64	–5.77–0.66	0.119		–2.48	1.66	–5.74–0.78	0.136		–2.67	1.63	–5.86–0.53	0.102	
Car price: 100 000	–2.28	1.65	–5.52–0.95	0.166		–2.14	1.67	–5.42–1.14	0.200		–2.47	1.64	–5.69–0.74	0.131	
Car age	–2.70	0.15	–3.00 to –2.39	<0.001		–0.17	0.01	–0.19 to –0.15	<0.001		–5.92	0.88	–7.64 to –4.19	<0.001	
Car age ²											0.21	0.06	0.10–0.33	<0.001	
Observations	1065					1065					1065				
R ² /R ² adjusted	0.789/0.787					0.783/0.781					0.792/0.790				
Coefficient test BEV-Petrol	F 20.132 Pr(>F) <0.001					F 19.314 Pr(>F) <0.001					F 20.803 Pr(>F) <0.001				
Coefficient test BEV-Diesel	F 32.581 Pr(>F) <0.001					F 30.568 Pr(>F) <0.001					F 33.66 Pr(>F) <0.001				

Note: Bold values are significant on the 95%-significance level.

Table C2. Comparison of three models for resale value, based on sample 2, with a linear (model 1) or a quadratic age term (model 2), as well as the combination thereof (model 3).

Survey 2	Model 1			Model 2			Model 3		
	Estimates	Std. error	P-value	Estimates	Std. error	P-value	Estimates	Std. error	P-value
Coefficient									
Petrol	56.15	0.88	<0.001	47.15	0.81	<0.001	64.83	1.63	<0.001
Diesel	55.42	0.89	<0.001	46.46	0.81	<0.001	64.04	1.63	<0.001
EV	58.02	0.89	<0.001	49.10	0.81	<0.001	66.61	1.63	<0.001
Car price: 20 000	1.08	0.86	0.211	0.94	0.88	0.288	1.16	0.85	0.172
Car price: 60 000	-0.46	0.85	0.586	-0.53	0.87	0.541	-0.38	0.84	0.649
Car price: 80 000	1.29	0.87	0.138	1.25	0.90	0.162	1.38	0.86	0.111
Car age	-3.84	0.10	<0.001	-0.29	0.01	<0.001	-7.76	0.63	<0.001
Car age ²									
Observations	1917			1917			1917		
R ² /R ² adjusted	0.897/0.897			0.891/0.891			0.899/0.899		
Coefficient test	F 6.067 Pr(>F) 0.014			F 6.218 Pr(>F) 0.013			F 5.608 Pr(>F) 0.018		
BEV-Petrol									
Coefficient test	F 12.318 Pr(>F) <0.001			F 12.001 Pr(>F) <0.001			F 12.242 Pr(>F) <0.001		
BEV-Diesel									

Note: Bold values are significant on the 95%-significance level.

Table C3. Comparison of three models for resale value, based on sample 3, with a linear (model 1) or a quadratic age term (model 2), as well as the combination thereof (model 3).

Survey 3	Model 1			Model 2			Model 3		
	Estimates	Std. error	P-value	Estimates	Std. error	P-value	Estimates	Std. error	P-value
Coefficient									
Petrol	52.44	1.37	<0.001	43.14	1.26	<0.001	62.64	2.44	<0.001
Diesel	48.18	1.39	<0.001	38.72	1.26	<0.001	58.47	2.47	<0.001
EV	59.88	1.33	<0.001	50.58	1.20	<0.001	70.01	2.41	<0.001
Car price: 20 000	4.21	1.30	0.001	4.27	1.34	0.001	4.27	1.28	0.001
Car price: 60 000	0.72	1.28	0.578	0.60	1.32	0.648	0.77	1.27	0.543
Car price: 80 000	2.84	1.28	0.027	2.93	1.32	0.027	2.78	1.26	0.028
Car age	-3.84	0.15	<0.001	-0.29	0.01	<0.001	-8.34	0.91	<0.001
Car age^2							0.36	0.07	<0.001
Observations	919			919			919		
R ² /R ² adjusted	0.888/0.887			0.881/0.880			0.891/0.890		
Coefficient test	F 45.453 Pr(>F) <0.001			F 42.783 Pr(>F) <0.001			F 45.947 Pr(>F) <0.001		
BEV-Petrol									
Coefficient test	F 113.73 Pr(>F) <0.001			F 109.91 Pr(>F) <0.001			F 113.61 Pr(>F) <0.001		
BEV-Diesel									

Note: Bold values are significant on the 95%-significance level.

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