Financing the Global Shift to Electric Mobility*

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Abstract

Using comprehensive auto loan data, we identify a gap in financing terms between Electric Vehicles (EVs) and non-EVs. EVs, compared to their non-electric counterparts in the same make-model or make-model-power category, are financed with higher interest rates, lower loan-to-value ratios, and shorter loan durations. The primary driver of this financing gap is the risk associated with EVs. The rapid and uncertain progress in EV-specific technologies accelerates obsolescence, reducing EVs' resale value and thus increasing the cost associated with loans for these vehicles. Factors such as car buyers' willingness to pay, socioeconomic characteristics, government incentives for EVs, lenders' market power, and macroeconomic conditions play minimal roles in explaining the higher cost of EV loans. Our findings highlight that technological carbon-transition risk is priced in financing terms of green durable assets consumption.

Keywords: Green financing, Car loans, Electric vehicle, Electric vehicle battery, Carbon-transition risk, Technological risk, Technological obsolescence

JEL Codes: G21, G23, G50, O33

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1 Introduction

Electric vehicles (EVs) are expected to play a crucial role in the future global mobility systems, contributing to the reduction of transportation's impact on climate change and air quality. The European Union has legally mandated carmakers to achieve a 100 percent reduction in CO2 emissions from new cars sold by 2035. This regulation effectively prohibits the sale of new fossil fuel-powered vehicles within the 27-country bloc. Simultaneously, the U.S. White House has announced public and private commitments aiming for 50 percent of all new vehicle sales to be electric by 2030, marking a historic transition to EVs under the EV Acceleration Challenge.[1]

In discussions about the global transition to electric mobility, the significance of consumer financing in adopting EVs is often missing. This oversight persists despite the critical role that financing terms play in households' decisions to purchase durable assets. When it comes to car purchases, prior research indicates that consumers are highly sensitive to both vehicle prices and the financing terms of auto loans.[2] Notably, consumers cite lack of affordability as the primary concern when considering the adoption of EVs.[3] Therefore, the availability and terms of loans for EVs may play a crucial role in accelerating the transition to electric mobility.

In this paper, we provide a comprehensive analysis of the rapidly growing EV loan market and document a significant, systematic gap in financing terms—interest rate, loan-to-value ratio, maturity—between EVs and conventional cars. EVs, compared to non-electric models within the same car make-model or make-model-power category, are financed with higher interest rates, lower loan-to-value ratios, and shorter loan durations. We then explore the factors driving the gap in EV financing terms. Can this gap be attributed to specific tech-

[1]See "Fit for 55: Council adopts regulation on CO2 emissions for new cars and vans" and "FACT SHEET: Biden-Harris Administration Announces New Private and Public Sector Investments for Affordable Electric Vehicles".

[2]Extensive work has been done on demand elasticity to loan terms in the auto loan markets (see Charles et al., 2008; Adams et al., 2009; Einav et al., 2012; Argyle et al., 2020, 2021, for example).

[3]See, for example, "New data reveals that many Europeans struggle to afford electric cars" and "Deloitte: Affordability Concerns Slow the Road to an Electrified Future".

nological risks associated with EVs, increasing consumer demand for green products, or the market power of car manufacturers and lenders? Answering these questions will help us better understand the magnitudes and sources of the costs of green financing and thereby assist in formulating public policies responsive to climate change.

We utilize comprehensive data covering eight million car loans in Europe, sourced from public disclosures made by issuers of auto loan asset-backed securities. This dataset provides information on loan terms, borrower and lender characteristics, and the precise vehicle model associated with each loan. Most EVs in our sample are plug-in hybrid (PHEV) and non-plug-in hybrid (HEV) vehicles, which have an internal combustion engine (ICE) vehicle as a direct counterpart. This setting is uniquely suited to identify the gap in financing terms between EV and non-EV loan market segments, as we can compare financing terms between EV and non-EV loans within the same car make-model or make-model-power category. In other words, in this comparison, we can hold constant all vehicle characteristics except the type of motorization. In our most stringent tests, we compare, for example, in the model group "X3" offered by Bayerische Motoren Werke AG (BMW), the PHEV version of the model-power category combination "X3 xDrive30e" to its ICE counterpart "X3 xDrive30". Similarly, in the model group "Camry" offered by Toyota Motor Corporation (TOYOTA), we compare the PHEV version of the model-power category combination "Camry Business Edition Hybrid: 2.5-l-VVT-i" to its ICE counterpart "Camry Business Edition 2.5-l-VVT-i". We manually create car make-model and make-model-power category groups from millions of car loans, which is a novel and distinct contribution of our analysis.

By comparing car loan terms of hybrid vehicles with their respective ICE counterparts, we document a systematic gap in the financing terms between EV and non-EV car loan segments. EV loans exhibit a 0.29-percentage-point higher interest rate, a 4.7-percentage-point lower loan-to-value ratio, and a 2.5-month shorter loan maturity. These differences represent 6.5%, 6.7%, and 5.4% of the respective sample averages. This 'EV financing gap' is robust across different subsamples and sample periods, various regression specifications, and different sets of control variables at both the borrower and loan levels. Even when we conduct the most stringent fixed-effect comparison—incorporating fully interacted fixed effects for the car make-model group, finely defined geographic regions, lender, and year—the observed gap in financing terms remains quantitatively similar to our baseline results. Additionally, we document an almost identical EV financing gap using data on US auto loans available under Regulation AB II. This result suggests that the financing gap is driven by fundamental economic sources of risk priced by lenders, rather than by factors stemming from differences in institutional settings, regulations, and norms across markets.

The rest of our analysis aims to uncover the main mechanism behind the EV financing gap. Our primary hypothesis is that hybrid vehicles are more expensive to finance compared to their ICE counterparts because lenders face higher costs of lending for such vehicles. We hypothesize that the source of this cost is the rapid pace of new discoveries in EV-specific technologies, coupled with significant investments into their commercialization. Fast technological change leads to swift improvements in EV components, and the anticipated adoption of these improved EV components is a major source of risk for early-stage EVs, as they are based on nascent and immature technologies.

To examine this mechanism, we first demonstrate that the higher financing cost for hybrid vehicles in our sample cannot be attributed to differences in default rates across EV and non-EV loan segments. We then provide evidence supporting the collateral risk channel. We show that the residual values of hybrid vehicles, derived from secondary market transactions, are lower, more volatile, exhibit larger swings, and their changes are more likely to be downward. To further examine whether greater collateral risk can explain the observed gap in financing terms for hybrid vehicles, we leverage the requirement for lenders to report the vehicle's residual value for securitized leases. We find that lenders attribute lower residual value estimates to EVs at the commencement of the lease. We also find that, over the lease term, lenders are more likely to adjust their initial residual value estimates for hybrid vehicles, and that the greater frequency of residual value adjustments for hybrid vehicles is primarily driven by downward revisions. These findings suggest that the gap in financing terms for hybrid vehicles we document could be driven by a higher risk of loss to lenders in the event of a default or vehicle returns upon lease expiration, which is reflected in the financing terms for these vehicles.

To examine whether the higher collateral risk of hybrid vehicles is induced by technological change, we construct measures of the intensity and dispersion of innovations in EV-specific technologies using patent data. The intensity measure captures the speed of technological change in EV-specific technologies, while the dispersion captures the uncertainty surrounding the future direction of battery technology, a pivotal technology for EVs. Both intensity and dispersion influence the pace at which existing EV components become obsolete. To measure intensity, we follow Aghion et al. (2016) in identifying clean auto technology classes and compute the absolute and relative amount of patenting activities in these classes each month. To measure dispersion, we focus on battery technology as it is central to the clean energy transition in the automotive sector. While the first modern *lithium-ion battery* was commercialized in the early 1990s, recent innovations have increasingly opened new avenues for more efficient and renewable energy storage solutions. Examples include *flow battery*, *solid-state battery*, and *metal battery*, which were first patented in 2012, 2015, and 2018, respectively. We therefore extract battery-related bigrams from patent titles as an indication for future battery technology directions. We then count the number of unique bigrams and also use their monthly frequency to construct a Herfindahl-Hirschman Index (HHI) of technological directions in battery technology.

We utilize the panel structure of lenders' residual value estimates for hybrid vehicles and examine the evolution of these estimates within each lease contract in relation to the progression of EV-specific technological innovation. We find that lenders' residual value estimates for hybrid vehicles, in comparison to ICE vehicles, adjust to the varying intensity and dispersion in battery technology. Lenders react to increased EV-specific innovation intensity and more varied possibilities regarding the future direction of battery technology by reducing their estimates of hybrid vehicles' residual values. This analysis of residual value dynamics supports the hypothesis that EV-specific technological innovation is a key driver of the collateral value risk for hybrid vehicles we document.

Using the same set of innovation measures, we continue to show that the intensity and dispersion of EV-specific innovation is the primary driver of the financing gap documented above. Specifically, we examine the heterogeneity of the gap in interest rate between hybrid vehicles and their ICE counterparts while controlling for the LTV and maturity of the loan. We show that the gap disappears when the intensity and dispersion of EV-specific innovation have values in the lowest quartile of the distribution. More importantly, a higher value of these measures is associated with a significantly larger EV spread. For example, a one quartile increase in the intensity of clean auto patenting widens the gap in interest rate by 0.16 percentage points. Similarly, a one quartile increase in the dispersion of the future direction of battery technologies widens the gap by 0.18 percentage points.

One may argue that other factors might contribute to the high financing costs of EVs. To start with, consumers may have differential demand elasticities for hybrid vehicle loans. Many socioeconomic characteristics have been discussed as affecting consumers? preferences for "green" consumption. Their willingness to pay might also be affected by government incentives targeted at buyers of hybrid vehicles. Moreover, demand for EVs and their financing can also be influenced by global supply chain disruptions, macroeconomic uncertainty, as well as commodity and energy prices. At last, weaker competition among lenders in the hybrid vehicle loan market segments may contribute to the gap in financing terms. We conduce a wide range of tests to show that these alternatives explanations account for either little or only a small fraction of the financing gap. Importantly, the explanatory power of factors related to EV-specific technology remains similar in the presence of possible alternative mechanisms.

To rule out alternative mechanisms, we first construct several proxies for consumers' willingness to pay for EVs. For example, one proxy measures the average price premium paid by EV buyers. Higher price premium likely indicates a higher willingness to pay for "green" products, including EV loans. However, we find that the gap in financing terms does not depend on this price premium. We then hand collect information on the coverage and nature of each EV incentive program provided by European countries. The financing gap remains similar with and without EV tax benefits and purchase subsidies. We next exploit variations in the support for green parties and various socioeconomic characteristics at the regional level. We detect a significant and positive gap in interest rate between hybrid vehicles and their ICE counterparts across a wide range of NUTS3 regions that differ in their demographic composition, suggesting that the financing gap is prevalent regardless of buyers' socioeconomic characteristics. We also show that the financing gap does not vary with the degree of climate concerns using measures from Ardia et al. (2022) and neither does it vary with macroeconomic factors, including energy prices.

At last, we rule out lenders' market power as an explanation for the documented financing gap. If auto lenders possess more market power in the EV loan segment relative to the non-EV segment, they might be able to charge a higher markup for loans. To measure market power, we use the number of lenders that originate loans in the EV and non-EV segments in each region. We also calculate the HHI of lenders in each local market based on both the number and amount of loans extended by each lender. In addition, we count the overall number of active lenders and compute HHI in any given region (i.e., regardless of whether they operate in the EV or non-EV loan market), to account for the entry of existing lenders into the EV or non-EV loan segments. We find, if anything, that the EV spread tends to be lower when competition in the loan market is less fierce.

In summary, we document a systematic gap in financing terms between EVs and non-EVs — EVs are financed with a higher interest rate, a lower loan-to-value ratio, and a shorter maturity. Risks associated with fast and uncertain clean auto and battery technologies explain most of the financing gap. These results suggest that current PHEVs/HEVs are "transition assets" heavily exposed to technological carbon-transition risk. Our findings further suggest that carbon-transition risk is reflected in the financing terms of green durable assets consumption and reveal how much households pay for this risk. While constrained by a unique empirical design that utilizes car loans from a specific time period, our findings suggest that technological risks, such as obsolescence risk, are reflected in household finance products and are therefore economically significant for households.

Literature review

To the best of our knowledge, we are the first to document the systematic gap between EV and non-EV loans. There has been extensive work on demand elasticity to loan terms in the auto loan markets (see Charles et al., 2008; Adams et al., 2009; Einav et al., 2012; Argyle et al., 2020, 2021; Butler et al., 2023, for example). Yet, empirical work on the EV loan segment is scarce due to the nascency of this market segment. Consistent with our finding, Kontz (2023) shows that auto asset backed securities with low-emissions have a 6.5% higher issuance spread.

Our paper contributes to the literature on climate change that is concerned with the pricing of climate change risk. Bolton and Kacperczyk (2023) highlight the importance of climate transition risk—the uncertain rate of adjustment toward carbon neutrality—and estimate the size of a carbon-transition risk premium present in international firms' stock returns. We add to this work by studying the pricing of carbon-transition risk in the context of household finance and identifying a specific channel by which shocks to technological innovation contribute to this transition risk. We show that rapid technological changes create uncertainty about the collateral value of EVs, which makes lenders demand premium on financing of these "green" durable assets.[4] The evidence we provide is consistent with arguments in Lanteri and Rampini (2023) that, if both "clean" and "dirty" technologies are used in equilibrium, clean capital is more difficult to finance due to its limited collateralizability. We show that EV loans have lower loan-to-value ratios, which is a direct prediction of their

[4] Related work on climate change and debt contracts studies how climate risks affect the financing cost of firms. For example, Huynh and Xia (2021) study climate change news risk and Seltzer et al. (2022) examine regulatory risks. Ivanov et al. (2022) show that carbon pricing policies lead to worsening debt financing conditions for high-emission firms as banks mitigate their exposure to climate transition risks.

model. We also provide evidence on an additional collateral financing channel that is not present in Lanteri and Rampini (2023). Specifically, we show that EVs depreciate relatively faster and their collateral value is often revised downward due to technological progress, which further contributes to higher financing cost associated with EVs.[5] Moreover, while previous studies focus on the cost of financing for green *production*, our research complements this literature by studying the cost of financing for green *consumption* in the form of EV purchases.

Our study also relates to the empirical literature investigating returns on green versus brown assets. Using bond yields as proxies for expected future returns, prior work estimates a negative "greenium" where yields on green bonds are lower than those of their non-green counterparts (Pástor et al., 2022).[6] Observing lower expected returns on green assets is consistent with equilibrium models where investors have green tastes and/or green assets are a better hedge against climate risk (Pástor et al., 2021). We differ from this work by studying ex ante returns on car loans contracts that are popular among households. Using loans on pairs of EVs and non-EVs, we detect a positive greenium. This finding might seem inconsistent with the arguments in Pástor et al. (2021), but it is not. We show that EVs, relative to non-EVs, are expected to have a lower residual value in the future and that their residual value is further revised downward due to technological risks. We argue that, via this technological obsolescence risk channel, there is a difference in loan profitability between EVs and non-EVs that is reflected in the loan terms at loan origination.[7] Our results are

[5] In a related paper, Atanasova and Schwartz (2019) examine the uncertainty about the depreciation of stranded assets and their impact on firm value due to climate policy risk in the oil and gas industry.

[6] Baker et al. (2022) and Zerbib (2019) also estimate negative greenium using different samples and methodologies. In contrast, Larcker and Watts (2020) document economically identical pricing for green and non-green issues of municipal bonds and concludes that investors appear unwilling to forgo wealth to invest in environmentally sustainable projects.

[7] Our study is related to the literature investigating asset-pricing effects of innovation, particularly the adoption of new technologies and displacement risk. Gârleanu et al. (2012) study asset prices throughout the technology-adoption cycle in the presence of large infrequent technological innovations which are embodied into new capital vintages. Gârleanu et al. (2012) argue that innovation introduces an unhedgeable displacement risk due to lack of intergenerational risk sharing. Kogan et al. (2020) explore behavior of asset prices when technological progress leads to losses through creative destruction as new technologies make old capital and processes obsolete.

consistent with this channel dominating auto lenders' willingness to accept a lower return in exchange for financing "green" cars, if they have green tastes.

Last, our work complements prior research on the factors influencing EV demand, which so far has focused on the direct cost of EVs, government subsidies, and intrinsic consumer preferences (Archsmith et al., 2022). Muehlegger and Rapson (2022) and Muehlegger and Rapson (2023) study the causal impact of EV subsidies on the demand for EVs in California. Gallagher and Muehlegger (2011) evaluate how hybrid vehicle sales respond to various tax and non-tax incentives in the US. Li et al. (2017) show that a dollar spent on charging infrastructure will induce more EV demand than a dollar spent on consumer purchase subsidies. Other work examines how demand for EVs varies across demographic groups and finds income and education to be strongly correlated with EV adoption (Borenstein and Davis, 2016; Archsmith et al., 2022). More broadly, Aron-Dine et al. (2023) present survey evidence that German households' preference for green assets are correlated with political preference, education, and gender. Our research contributes to this strand of literature by documenting low-cost auto financing as a potential enabling factor for EV adoption.

2 Data Sources, Sample, and Variable Construction

2.1 Data Sources

European Data Warehouse (EDW). EDW GmbH is part of the ABS Loan Level Data initiative, established by the European Central Bank (ECB), to provide data warehousing services that ensure full disclosure for investors in asset-backed securities. EDW offers standardized loan-level data for car loans securitized by European banks and captive lenders owned by car manufacturers since 2013. It has collected over 20 million records and relevant documentation for car loans from more than 300 distinct asset-backed securities issued by 19 lenders. For each loan, the dataset includes more than 70 variables. These variables cover loan terms (loan amount, interest rate, maturity, and LTV), the manufacturer and model of each car, and borrower characteristics at the loan origination date (credit score, income, location, etc.), as well as loan performance histories throughout the life of each loan. We use

EDW data to construct our main dependent variables, which allows us to document the gap in financing terms between hybrid vehicles and their counterparts. Additionally, we utilize EDW to develop measures of competition among lenders in local markets for car loans across different market segments.

Residual Value Intelligence (RVI). RVI is a comprehensive analytical tool developed by Autovista Group, providing data and insights on the residual values of vehicles across European countries. Autovista's clientele includes finance companies and leasing firms, which utilize RVI to structure their leasing and financing products. RVI primarily bases its residual value estimations on secondary market prices and the expertise of its analysts, positioning it as the market leader in Europe.[8] RVI provides monthly residual value estimates for seven major European countries (Austria, Switzerland, Germany, Spain, France, Italy, and the UK), across seven different fuel types, various age-kilometer scenarios, and for over 50 brands.

US Regulation AB II. In accordance with Regulation AB II, US-based issuers of public asset-backed securities based on auto loans are required to submit detailed information about individual loans to the Securities and Exchange Commission (SEC) monthly. The reported information encompasses a similar set of variables to those provided by EDW. Data from Regulation AB II is freely available from the SEC website and applies to ABS issued after November 2016, which may include loans originated before 2016. We utilize asset-level data disclosed under Regulation AB II to document the gap in financing terms between hybrid vehicles and their counterparts in the US.

EV-volumes. EV-volumes is a database dedicated to global electric vehicle sales, providing monthly registrations for all types of electric vehicles by country, make, and model. We

[8]Based on our interviews with Autovista, their residual values are influenced by the vehicle's perceived resale value, reliability, safety, concurrent market conditions, new technological advances, and general economic conditions.

utilize this dataset to examine the coverage of our sample of cars financed by loans that are securitized.

PatentsView. PatentsView offers detailed bibliographic information on all patents filed with the U.S. Patent & Trademark Office (USPTO). Utilizing this data, we identify EV-specific technological innovations through the International Patent Classification (IPC) and textual analysis of patent titles.

VentureXpert. The commercialization of technological innovations often begins with venture capital (VC) investment in startup companies established for this purpose. VentureXpert offers insights into early-stage startups and their financing rounds. We use data on startups in the auto industry to calculate the amount of VC investment in such startups and the relative importance of these investments compared to all VC investments.

2.2 Key Variable Construction

EV Indicator. Our analysis relies on the ability to distinguish electric vehicles (EVs) from internal combustion engine (ICE) vehicles. This is possible using the "manufacturer" and "model" fields in the EDW data, which are, however, noisy. For each manufacturer, there can be thousands of unique values in the model field since lenders report this field following their own format with very different levels of precision. For instance, for the same model, BMW 330e, one lender might report string "330e" while another reports "BMW 330e i Performance 190kw" in the "model" field. Different languages might also be used since many banks in the sample, such as Santander or Deutsche Bank, are not from English-speaking countries.

To clean up car model names and create a flag for EVs, we follow several steps. First, we compile a complete list of official model names for EVs using information from the EV-volumes dataset. Second, for each manufacturer, we use regular expressions to match all the unique model values to the list of official model names. We set different thresholds for each manufacturer and for each lender to determine a match vs. a non-match, depending on the accuracy level and the language of the model field. We set rather conservative thresholds given the noise in the data. Third, for any non-matches, we manually check each case and decide whether the reported model is an EV.

Car Make-Model and Make-Model-Power Category Groups. To ensure that EVs and ICE vehicles are comparable in all aspects except for their type of motorization, we manually bundle vehicles that belong to the same car make-model groups. For better brand recognition and positioning within established market segments, manufacturers typically introduce hybrid versions of their existing gasoline models, positioning them as part of the existing model group. This grouping by manufacturers allows us to compare hybrid and ICE vehicles that belong to the same model and are identical except for their motorization. We review all the car models from the top ten manufacturers to identify each manufacturer's specific naming conventions for EVs and categorize them within model groups. For example, for BMW, we categorize all vehicles into model groups such as "3 series," "5 series," "7 series," "X3," "X5," "Z," etc.

Additionally, we clean up the motor power information for each model whenever possible to form an even closer pair of hybrid and ICE vehicles that share the same motor power category, creating car make-model-power category groups. For instance, "BMW X3 xDrive30e" is the plug-in hybrid version of "BMW X3 xDrive30" with the same motor power (248-hp). We provide a detailed description of all the make-model and make-model-power category groups that contain hybrid vehicles in Appendix B.

EV-Specific Technological Innovation. We primarily use patent to capture both the intensity and dispersion of innovation in technologies specifically related to electric vehicles and their components. We additionally use VC investment to examine the robustness of our results to alternative measures of EV-specific innovation intensity.

We begin by constructing variables that capture the *intensity* of innovations most relevant for EVs. First, for each calendar month, we count the number of patents granted in the five- to eight-digit International Patent Classification technology classes, referred to as IPC "main groups," that have been identified as capturing the evolution of clean auto technology in Aghion et al. (2016) (henceforth "ADHMV2016"). Second, we expand the ADHMV2016 clean auto IPC main groups using the co-classification of patents, following the approach in Yan and Luo (2017).[9] We then similarly count the number of patents granted in the expanded clean auto IPC main groups for each calendar month. Third, in addition to the dynamics of the absolute level of clean auto patenting, we consider the dynamics in clean auto patenting relative to overall innovation in a broader technology space. To achieve this, for both the ADHMV2016 list and the expanded list of clean auto IPC main groups, we scale the number of patents in these groups by the total number of patents in the corresponding IPC "subclasses" (i.e., four-digit IPCs) that contain the main groups from the lists. The IPC subclasses that encompass the clean auto IPC main groups are predominantly automotive-related fields of technology.

To capture the commercialization of EV-specific technologies, we compute the dollar value of VC investments in EV-related startups and the share of such investments in the total value of VC investments for each calendar month. To identify EV-related startups, we perform a keyword search in their company descriptions using the following list: "EV(s)", "battery", "batteries", "electric vehicle(s)", "electric car(s)", "automobile(s)", "fuel cell(s)", "lithium". The rapid pace of new discoveries in EV-specifc technologies, coupled with significant investments into their commercialization, leads to swift improvements in EV components. The anticipated adoption of these improved EV components may be a major source of risk for early-stage EVs since they are based on nascent and immature technologies.

Next, we construct variables that capture the *dispersion* in battery-related innovations. We focus on battery technology as it is central to the clean energy transition in the automo-

[9]The co-classification between any technology field pair (at the IPC "main group" level in our case) is defined as the count of shared patents normalized by the total count of unique patents in each pair of technology fields. We calculate this ratio and update the list of relevant clean auto IPC main groups on a yearly basis. Specifically, the technology groups that have a higher-than-90th-percentile relevance ratio with any ADHMV2016 technology group are included in the expansion of the original list.

tive sector and on dispersion as it captures the uncertainties about the future advancements in this pivotal technology. To measure dispersion, we first identify the universe of USPTO patents that mention "battery" in the title. We pool all these titles together and consider each battery-related bigram (e.g., "lithium battery," "solid-state battery," "flow battery," "metal battery") as a direction of future battery technology. We then count the number of unique battery-related bigrams as a proxy for the number of technological directions regarding battery technology. Next, using the unique number of bigrams and their respective frequency in each calendar month, we construct the monthly Herfindahl-Hirschman Index (HHI) of technological directions in battery technology. A greater number of unique bigrams or a lower HHI corresponds to higher uncertainty about the future direction of battery technology.

2.3 Sample of EV Loans in Europe

Our sample contains car loans originated between January 2010 and August 2021 and securitized by European lenders.[10] We focus on 10 brands of manufacturers that produce both hybrid and ICE vehicles: BMW, Ford, Honda, Hyundai, Lexus, Mercedes, Peugeot, Toyota, Volkswagen, and Volvo.[11]

Table 1 Panel A shows the loan volume for the 10 manufacturers that have a presence in the EV market. The largest three car manufacturers in the EDW dataset are Volkswagen, Peugeot, and BMW, while Toyota, BMW, and Peugeot produce the most EVs.

We evaluate the coverage of EVs in our sample using external EV sales data from EVvolumes. Between 2015-2019, EV loans in our sample represent 6.8%, 7.2%, 6.5%, 8.3%, and 7.9% of all EV sales in the 11 countries covered by EDW. The stable coverage suggests that lenders do not significantly change their securitization practices regarding EVs loans.[12]

[10] Although the EDW started to provide data in 2013, some loans in the securitized portfolios were originated years before 2013. We downloaded the data in August 2021.

[11] Other manufacturers are either insignificant in EDW data or produce in one market only, such as Tesla.

[12] We focus on the data after 2015 because the data points from EVvolumes before 2015 is sparse. We do not report the coverage in 2020 as some loans originated in 2020 are yet to be securitized at the time of data collection.

Figure 1 depicts the total number of EV loans and the share of EV loans over all auto loans by year. Both series reveal the exponential growth of the EV loan originations. This is not surprising given the same trend in EV sales in Europe and globally, which we show in Appendix Figure C.1, using market-level data from EVvolumes.

2.4 Summary Statistics

In Table 1 Panel B, we report summary statistics of the loans terms. The average loan has a 4.67% annual interest rate, 76% LTV ratio, and a 51-month maturity. In Appendix Table C.1, we report the characteristics of EV loans separately. The average EV loans have a lower rate of 4.46%, a lower LTV ratio of 65%, and a shorter maturity of 48-month maturity. Although the average interest rate appears more favorable for EV loans, we show in the next section that once we narrow down to the comparison between hybrid and ICE vehicles within the same make-model and account for borrower-, lender-, market-specific characteristics, the gap flips signs. Comparing the performance of EV and non-EV loans, EV loans appear to be less likely to default than non-EV loans as of August 2021, the end of our sample period. For example, the share of non-performing loans is 3.7% for EVs and 4.0% for non-EVs.

Panel C of Table 1 shows the summary statistics of the technological risk measures. The average monthly log number of clean patents granted based on the ADHM2016 definition is 5.34, which accounts for 2% of the auto-related patents. The dispersion in battery innovation is substantial, with the average monthly number of battery bigrams reaching 31, and the respective HHI of battery bigrams being 0.11.

3 The Gap in Financing Terms Between Hybrid and ICE Vehicles

3.1 Baseline Estimates

This section compares the contractual terms of loans for electric vehicles with those for ICE vehicles. To identify the gap in the financing terms between these two car loan segments, we compare loans financing vehicles of the same make and model. This restriction to the same car make and model means that we effectively compare hybrid vehicles with their respective

ICE counterparts. Specifically, we estimate the regression

$$Y_i = \alpha_{make\text{-}model} + \alpha_{region,t} + \alpha_{lender} + \alpha_{deal} + \beta Hybrid_i + \delta' X_i + \varepsilon_i, \tag{1}$$

where i denotes a car loan, t denotes the loan origination year or year-month, and *make-model* denotes a car by the same brand and product category. *region* is defined at the NUTS3 level, which has similar geographic granularity to counties in the US. We consider three outcome variables: the interest rate of the loan, the loan's LTV ratio, and the loan's maturity. The variable $Hybrid_i$ is an indicator equal to one for EVs and zero otherwise. The vector X_i includes borrower and loan characteristics, which, in the baseline specification, are the borrower's income, the borrower's income verification status, and car price.

Car make interacted with car model fixed effects, $\alpha_{make\text{-}model}$, controls for make-model-specific factors affecting the demand for or supply of the vehicle. NUTS3 interacted with year or year-month fixed effects, $\alpha_{region,t}$, absorb regional time-varying shocks. Lender fixed effects, α_{lender}, control for any time-invariant lender characteristics, and deal fixed effects, α_{deal}, control for factors that influence the terms of loans included in the same ABS. In our most detailed specification, we include fully interacted car make-model, region, lender, and year fixed effects, $\alpha_{make\text{-}model,region,lender,t}$, to absorb any supply or demand shocks affecting the same model cars, financed by the same lender in the same region and year. The coefficient β captures the difference in loan terms for hybrid vehicles compared to their ICE counterparts. Standard errors are double-clustered at the deal and region (NUTS3) level.

Estimates of Equation 1 presented in Table 2 show that financing terms of hybrid vehicles are consistently less favorable compared to their ICE counterparts. According to Panel A, loans for hybrids have an interest rate that is 0.29 percentage points higher, an LTV ratio that is 4.7 percentage points lower, and a maturity that is 2.5 months shorter, with all these differences statistically significant at the 1% level. These differences are also economically significant, representing 6.3%, 6.2%, and 4.8% of the respective sample averages for these variables. In Panels B and C, we employ more stringent fixed effects regression specifications. Particularly in Panel C, our fixed effects control for changes in the market structure of lenders or car dealers, liquidity shocks to the lenders, as well as shifts in the sociodemographic characteristics of car buyers that relate to specific car makes and models (Benetton et al., 2022). Estimates of β remain statistically significant at the 1% level across all specifications of Panels B and C. In both panels, the gap in the interest rate slightly decreases to 0.24 percentage points and remains almost unchanged for LTV and maturity.

Table 3 presents estimates of Equation 1 with car make-model-power category fixed effects, comparing hybrid vehicles with their ICE counterparts, including keeping the same engine size category. Despite a 40% reduction in sample size, we continue to find a higher interest rate, a lower LTV ratio, and a shorter maturity for hybrid vehicles compared to their ICE counterparts, all statistically significant at the 10% level.

3.2 Robustness Using Subsamples and Alternative Specifications

In Figure 2, we demonstrate that our results are robust to using subsamples and alternative regression specifications. First, we consider five alternative samples, starting with loans originated since 2015 and 2018 onwards. These samples are motivated by the surge in consumer interest in EVs later in our sample period, which may affect loan pricing. Second, we exclude leases, which represent about 30% of the sample. Next, we apply the sampling criteria from Benetton et al. (2022).[13] Lastly, we restrict the sample to loans that fall within the common support of control variables and fixed effect units.

Next, we apply alternative regression specifications, including replacing the car make-model fixed effect with car make (i.e., manufacturer) fixed effects, adding product type fixed effects, and controlling for additional borrower characteristics and loan features: borrower type and employment status, interest rate basis, loan origination channel, payment frequency,

[13]Specifically, we only include loans associated with cars purchased by individuals that are priced in Euros and have a monthly payment schedule with fixed rates.

and payment method.[14] We also replace NUTS3-by-year fixed effects with NUTS3-by-year-by-month fixed effects and lender-by-NUTS3-by-year fixed effects to control for local shocks that vary within a given year and differential exposure to local shocks across lenders, respectively. Finally, we double-cluster the standard errors by lender and NUTS3 instead of by deal and NUTS3.

For each of these tests, the point estimates for the gap in the interest rate, LTV ratio, and maturity, along with their 95% confidence intervals, are displayed in Figure 2. At the top of each panel, for ease of comparison, we show the baseline point estimate from Panel A of Table 2. For all three outcome variables, the magnitudes of the estimated coefficients of β are largely similar across these robustness tests and are always statistically significant at the 5% level or better.

Lastly, we exclude, one at a time, each of the top ten manufacturers and the top ten lenders from the sample and repeat the analysis. The Internet Appendix Figure D.1 reports the results and shows that the point estimates are statistically indistinguishable from our baseline estimates in Panel A of Table 2. In summary, we conclude that our results are not driven by our choice of a particular sample or regression specification, nor are they driven by any specific manufacturer or lender.

3.3 Evidence Using Car Loans in the US

To determine whether the gap in financing terms is specific to the European market for car loans, we repeat our baseline analysis from Panel A of Table 2 on a sample of securitized auto loans in the US, available publicly under Regulation AB II. The US, with the highest EV sales after China and Europe (Figure C.1), is an important market for EVs. The most popular EV makes in the US are Toyota, Lexus, Hyundai, and Kia. We provide more details on the US sample in Appendix E.

[14]The most frequent product types are finance lease, operating lease, loan - amortizing, and loan-balloon. Interest rate basis includes 1/3/6/12 month GBP LIBOR or EURIBOR, BoE base rate, ECB base rate, fixed-rate. Loan origination channel can be dealer, broker, direct, indirect, and other. Payment frequency can be weekly, fortnightly, monthly, quarterly, semi-annually, and annually. Payment method includes direct debit, standing order, cheque, cash, and other.

In this sample, we estimate a 0.25 percentage points gap in the interest rates and a 1.8-month gap in maturity, as shown in Table E.2. The interest rate gap represents 7.3% of the sample average, a magnitude comparable to that in our European sample.[15] These results demonstrate that the financing gap between hybrid and ICE vehicles is not an EU phenomenon and is also not specific to certain car makes. Our findings also suggest that the gap is driven by fundamental economic sources of risk priced by lenders, rather than factors stemming from differences in institutional settings, regulations, and norms across markets.

4 Lending Cost of Hybrid Vehicles

Our main hypothesis is that hybrid vehicles are more expensive to finance since lenders face higher costs of lending for such vehicles. To examine this hypothesis, we first show that the higher financing cost for hybrid vehicles in our sample cannot be attributed to differences in default rates across EV and non-EV loan segments. We then provide evidence supporting the collateral risk channel: hybrid vehicles present a higher risk of loss to lenders in the event of a default or vehicle returns upon lease expiration, which is reflected in the financing terms for these vehicles.

4.1 Default Incidence

To examine car loan defaults, we utilize the monthly loan performance reports recorded in the EDW data. This information comes from mandatory reporting by lenders and is available from the time a loan is included in the securitized loan instrument until the loan matures or exits the instrument. To capture incidences of default, we use the loan status variable, which can have ten different values, ranging from performing to arrears and repurchased.[16] Based on the loan status as of August 2021, which is the end of our sample period, we construct an ex-post loan performance variable, *non-performing*, to indicate whether a loan has ever

[15]We do not examine the gap in LTV ratio as it is not available in the US. Additionally, the vehicle price reported by lenders does not reflect the actual purchase price but rather the manufacturer's suggested retail price of the car.

[16]The ten possible account statuses are: Performing; Restructured-no arrears; Restructured - arrears; Defaulted; Arrears; Repurchased by Seller - breach of reps and warranties; Repurchased by Seller - restructure; Repurchased by Seller - special servicing; Redeemed; Other.

been in arrears or default during its lifespan. We estimate the difference in defaults between loans for hybrid vehicles and their counterparts by regressing the *non-performing* indicator on the indicator for hybrid vehicles, following the regression specification in Equation 1. The results are reported in Table 4. Regression specifications in columns 1 and 3 are analogous to those used in Panel A of Table 2, while columns 2 and 4 include the interest rate, LTV ratio, and maturity of the loan as control variables.

Columns 1 and 2 show that the coefficient of the indicator for hybrid vehicles is negative, nearly zero, and not statistically significant in both instances. In columns 3 and 4, we examine a subsample of loans that had matured by or before August 2021. The results are very similar, except that the coefficient of the indicator for hybrid vehicles in column 3 is statistically significant at the 10% level.[17] These findings suggest that there is no significant difference in the incidence of defaults for loans on hybrid vehicles compared to their ICE counterparts. Consequently, the observed gap in financing terms for hybrid vehicles cannot be attributed to a differential default risk between these two car loan segments.

4.2 Estimates of Vehicle Residual Values from Secondary Market Transactions

We study the collateral risk channel by analysing the differences in residual value estimates between electric and ICE vehicles from the RVI dataset. In this dataset, the residual value estimates primarily stem from observed secondary market retail prices coupled with expert assessments. We use the variable *RV/price*, defined as the ratio of the estimated residual value to the vehicles's price, as the primary dependent variable. *RV/price* is calculated on a monthly basis, separately for different car makes, countries, and various car age-mileage scenarios. To account for this heterogeneity, in our regressions we include car make, country-by-year, and car age-by-mileage fixed effects. Column 1 of Table 5 shows that the coefficient of the indicator for hybrid vehicles is -0.045, statistically significant at the 1% level, implying that hybrid vehicles have lower residual values compared to ICE vehicles.

[17] The summary statistics in Table C.1 show that loans for hybrid vehicles have a lower unconditional probability of default. This disparity is likely attributable to the selection of high-income borrowers into more expensive hybrid vehicles, among other factors.

Next, we examine the volatility of the residual value estimates. To this end, we define variable *SD (6m)* as the standard deviation of *RV/price* computed over a six-month rolling window. Additionally, we create indicator variables based on month-on-month changes in *RV/price*, categorizing them according to whether the change falls within a 1% range, within a 3% range, within a 5% range, as well as whether it is below -1%, and above 1%. The results for these dependent variables are reported in Table 5, columns 2 to 7, respectively.

Column 2 shows that the coefficient of the indicator for hybrid vehicles is 0.002, statistically significant at the 1% level, suggesting that hybrid vehicles exhibit higher volatility of residual values compared to ICE vehicles. This finding is confirmed by the results in columns 3 to 5. In each of these three columns, the coefficient of the indicator for hybrid vehicles is positive and statistically significant at the 1% level, indicating that changes in *RV/price* of any magnitude are more likely to occur for hybrid vehicles. Furthermore, the magnitude of the estimated coefficients, when compared to the means of each respective outcome variable, increases from columns 3 to 5. This implies that hybrid vehicles, when compared to ICE vehicles, are more likely to exhibit larger changes in residual values. For example, column 3 implies that a change within a 1% range is 11% more likely for hybrid vehicles compared to ICE ones, while a change within a wider 5% range is 67% more likely.

Lastly, columns 6 and 7 of Table 5 indicate that changes in *RV/price* are more asymmetric for hybrid vehicles compared to ICE ones. Specifically, column 6 shows that hybrid vehicles are more likely to exhibit negative changes in their residual values and less likely to exhibit positive changes. Taken together, our results show that the residual values of hybrid vehicles, derived from secondary market transactions, are lower, more volatile, exhibit larger swings, and their changes are more likely downward. These findings suggest that the gap in financing terms for hybrid vehicles we document could be driven by a higher loss given loan default or lease returns.

4.3 Lenders' Loan-Level Estimates of Vehicle Residual Values

To further examine whether the greater collateral risk explains the observed gap in financing terms for hybrid vehicles, we leverage the requirement for lenders to report the vehicle's residual value for securitized leases. Specifically, lenders must estimate the vehicle's end-of-lease residual value on a monthly basis throughout the lease contract's duration. For each lease contract in our sample, we define the variable *RV/price* as the ratio of the vehicle's estimated residual value by the lender at lease origination, divided by the vehicle's price. We then use *RV/price* as the dependent variable in the regression specifications used in Panel A of Table 2, where we additionally include the interest rate, LTV ratio, and maturity of the loan as control variables. The findings, presented in Table 6, show that the coefficient of the indicator for hybrid vehicles is -0.048, statistically significant at the 1% level, indicating that hybrid vehicles have lower residual values compared to their ICE counterparts. The size of this coefficient is nearly identical to that obtained using the RVI dataset in column 1 of Table 5.

We also explore whether lenders adjust their initial residual value estimates for hybrid vehicles differently than for their ICE counterparts over the lease term. We define the following variables: (i) an indicator for whether the lender has adjusted the residual value estimate at any point during the lease (*RV adjustment ever*), (ii) an indicator for whether the lender has reduced the residual value estimate at any time during the lease (*RV adj. down ever*), and (iii) an indicator for whether the lender has never decreased the residual value estimate, meaning the lease has only seen increases or no changes in the residual value estimate (*RV adj. down never*). The results using these dependent variables are reported in columns 2-4 of Table 6. We find that, over the lease term, lenders are (i) more likely to adjust their initial residual value estimates for hybrid vehicles (column 2), (ii) more likely to reduce their initial residual value estimates for hybrid vehicles (column 3), and (iii) equally likely to maintain or increase their initial residual value estimates for hybrid vehicles (column 4), all in comparison to ICE counterparts. These findings indicate that the greater frequency of residual value adjustments for hybrid vehicles is primarily driven by downward revisions.

Taken together, the results in Table 5 and Table 6, which are based on two distinct datasets and methodologies, indicate that the residual values of hybrid vehicles are systematically lower. Moreover, the residual values of hybrid vehicles exhibit greater volatility, a trend driven by more frequent and larger downward revisions. These results strongly suggest that loans for hybrid vehicles have greater exposure to collateral value risk.

4.4 Lenders' Exposure to Collateral Value Risk

In this section, we examine the relationship between lenders' exposure to collateral value risk of hybrid vehicles and the loan terms under which these vehicles are financed. From the perspective of lenders, collateral value risk influences loan terms at the time of origination in situations where lenders have a high exposure to this risk. This could be due to a higher perceived probability of a borrower defaulting on the loan or through loan types that are highly exposed to collateral risks. Following this logic, we use variable *fully guaranteed* from the EDW data, which serves as a direct measure of the low default risk of a borrower as perceived by the lender at loan origination. We then compare leases to loans. Since lessors retain ownership of the vehicles until the leases expire, lease contracts increase lenders' exposure to collateral risks compared to loans.

Table 7 presents the results. We offer estimates of regression specifications similar to those used in Panel A of Table 2, but with the addition of the interaction between the indicator for hybrid vehicles and *fully guaranteed* in Panel A, and an indicator for *leases* in Panel B. In Panel A, we show that for loans classified as fully guaranteed, the gap between hybrid vehicles and their ICE counterparts diminishes by 0.17 percentage points for the interest rate, 1.9 percentage points for the LTV ratio, and 1.1 months for maturity. All three outcomes are statistically significant at conventional levels. Conversely, in Panel B, we show that for leases compared to loans, the gap between hybrid vehicles and their ICE counterparts increases by 0.35 percentage points for the interest rate and 5.8 percentage points for the LTV ratio (both statistically significant at conventional levels), while there is no significant difference in maturity. These results suggest that lenders charge a higher interest rate due to a greater expected loss upon default or lease returns when financing hybrid vehicles. Furthermore, lenders reduce their exposure to higher expected collateral value losses by financing a smaller fraction of the vehicle's value, thereby further increasing the financing cost of hybrid vehicles.

4.5 Collateral Value Risk and EV-Specific Innovation

A critical question that emerges is why hybrid vehicles exhibit a higher collateral value risk. Since we have shown that there are similar gaps in financing terms between hybrid vehicles and their ICE counterparts in both Europe and the US, it appears the gap is likely driven by fundamental economic sources of risk, rather than risks stemming from differences in institutional settings, regulations, and norms across markets.

Hybrid vehicles are possibly seen by lenders as a riskier type of collateral. Notably, in response to car buyers' concerns, auto manufacturers are offering significantly more generous warranties for all types of electric vehicles (EVs) compared to ICE vehicles. The nature of these warranties suggests that EVs face more technological risks. Table C.2 summarizes the warranties by car make and engine type. While the median warranty for EVs stands at 96 months/160,000 kilometers, for ICE vehicles, it is 48 months/100,000 kilometers. Moreover, the table indicates that a typical EV warranty explicitly covers EV-specific technological components, for example, warranties mention: "extensive battery warranty"; "BEV/hybrid-related components"; "EV/HEV/PHEV systems"; or "battery/hybrid control modules". These EV-specific components are associated with a lack of reliable data on their real-world performance, lifespan, and maintenance requirements. More importantly, EV-specific technologies, especially battery technologies, have advanced at a significant rate during our sample period. The rapid pace of new discoveries in EV-related technologies leads to swift improvements in EV components. The anticipated adoption of these improved technologies and components corresponds with our findings on large, downward revisions in the residual values of hybrid vehicles and can therefore be a principal source of the collateral value risk for hybrid vehicles.

To test this hypothesis, we utilize the panel structure of lenders' residual value estimates for hybrid vehicles in our sample and examine the evolution of these estimates within each lease contract in relation to the progression of EV-specific technological innovation. We estimate the regression

$$Y_{i,t} = \alpha_i + \alpha_t + \beta Hybrid_i \times EV\text{-}Tech_t + \varepsilon_{i,t}, \qquad (2)$$

where $Y_{i,t}$ corresponds the vehicle residual value estimate for lease contract i in calendar year-month t.[18] We consider two dependent variables: first, an indicator for whether the residual value estimate in a given year-month is lower than that at loan origination, *below origination RV*, and second, the logarithm of the estimated residual value in Euro, *RV (log)*. The variable $EV\text{-}Tech_t$ represents measures that capture the intensity and dispersion of EV-specific innovation, constructed using patent data. To facilitate the interpretation of the coefficients across different continuous technological risk variables $EV\text{-}Tech_t$, we categorize them into quartiles, coding them as a categorical variables that ranges from 0 to 3. The interaction term between the indicator for hybrid vehicles and the measures of EV-specific technological innovations is our key variable of interest. Its coefficient, β, captures how lenders' residual value estimates for hybrid vehicles, in comparison to ICE vehicles, adjust to the varying intensity of EV-specific technological innovation and the varying dispersion in battery technologies.

Table 8 presents the results, where measures of EV-specific technological innovations are constructed using the clean auto patent definition from ADHMV2016 in Panel A and battery-related bigrams in patent titles in Panel B. Across all measures of technological risk and outcome variables, we observe that when the intensity and dispersion of innovation in

[18] α_i denotes lease contract fixed effects, and α_t denotes calendar year-by-month fixed effects. Lease contract fixed effects absorb any time-invariant characteristics at the borrower-, car-, and loan-level, while year-month fixed effects control for the impact of macroeconomic factors and changing market conditions on residual value estimates.

EV-specific technologies are high, lenders are more likely to revise the residual value estimates for hybrid vehicles downward. For instance, according to column 3 of Panel A, the residual value of hybrid vehicles decreases by an additional 0.9% relative to ICE vehicles when the number of clean auto patents increases by one quartile of its distribution. We obtain similar findings using measures of the dispersion of battery technologies in Panel B. Lenders react to increased uncertainty and more possibilities regarding the future direction of battery technologies by reducing their estimates of hybrid vehicles' residual values. Overall, this analysis of residual value dynamics supports the hypothesis that EV-specific technological innovation is a key driver of the collateral value risk for hybrid vehicles we document.

5 Determinants of the Gap in Financing Terms

Having established the role of EV-specific technological innovation in influencing collateral value, we now ask if this force could in turn explain why we observe less favorable financing terms for hybrid vehicles compared to their ICE counterparts. We explore three broadly defined mechanisms. First, we investigate whether the gap in financing terms we document can be explained by consumers' differential demand elasticities for hybrid vehicle loans, government incentives targeted at buyers of hybrid vehicles, or socioeconomic characteristics that have been discussed as affecting consumers' preferences for "green" consumption. Second, we examine the possibility that weaker competition among lenders in the hybrid vehicle loan market segments contributes to the gap in financing terms. Third and most importantly, motivated by the finding that EV-specific innovation is an important driver of hybrid vehicles' collateral value risk, we explore the role of EV-specific innovation in explaining the gap in financing terms.

To provide evidence on these mechanisms, we examine the heterogeneity of the gap in financing terms between hybrid vehicles and their ICE counterparts. Specifically, we estimate regression specifications similar to those used in Panel A of Table 2, but with the addition of the interaction between the indicator for hybrid vehicles and the variable $Z_{i,t}$, which captures the source of heterogeneity specific to each mechanism we consider:

$$Y_i = \alpha_{make\text{-}model} + \alpha_{region,t} + \alpha_{lender} + \beta Hybrid_i + \delta Hybrid_i \times Z + \gamma' X_i + \varepsilon_i. \qquad (3)$$

To facilitate the interpretation of the coefficients across different mechanisms, if variable Z is continuous, we categorize it into quartiles, coding it as a categorical variables that ranges from 0 to 3. This allows us to interpret the coefficient of the indicator for hybrid vehicles as the gap in financing terms in the first quartile of a specific distribution of $Z_{i,t}$, while the coefficient of the interaction term captures the change in the gap when moving from one quartile to the next. To streamline the presentation of the results, we focus our analysis on one dependent variable, the loan interest rate, while we also include the LTV ratio and maturity of the loan as control variables.

5.1 Demand Elasticity

Buyers of hybrid vehicles may exhibit different characteristics compared to buyers of ICE vehicles. Specifically, hybrid vehicle buyers may have lower demand elasticity with respect to loan interest rates or a higher willingness to pay for loans, enabling lenders to charge higher prices for hybrid vehicle loans if they have some market power. To test this hypothesis, we construct proxies for consumers' willingness to pay for hybrid vehicles, examine the effect of government incentives targeted at buyers of electric vehicles, and analyze socioeconomic characteristics that have been suggested as influencing consumers' preferences for "green" consumption. We also consider the role of changing climate change concerns and macroeconomic factors.

Hybrid vehicle price premium and buyer sophistication. Hybrid vehicles typically command higher prices compared to their ICE counterparts. Since they are willing to purchase more expensive vehicles, buyers of hybrid vehicles may have a lower sensitivity to the interest rates charged on loans for such vehicles. We use the vehicle purchase price available for each loan in the EDW dataset to construct four measures that test this mechanism.[19] First, we calculate the average price difference between hybrid vehicles and their ICE counterparts within the same car make-model category, sold in the same region and year (*EV price premium*). Second, we compute the difference between the purchase price paid by a given borrower and the average price paid by all other borrowers in the same region and year for the same car make-model-engine type combination. This loan-level variable can be interpreted as capturing each individual borrower's willingness to pay or, alternatively, the borrower's sophistication (*overpay (model-year-NUTS3)*). Sophisticated borrowers may shop around for the best deals on car sales, including car loan deals. The third variable is an indicator for whether the car make belongs to one of four luxury car brands in our sample: BMW, Mercedes-Benz, Volvo, and Lexus (*Luxury car make*). Fourth, we create an indicator variable for high-end car models, defined as those priced over 40,000 euros, the 91st percentile of the car price distribution. The results are reported in Panel A of Table 9. We find that the coefficients of the interaction terms are small in magnitude and statistically insignificant for all four measures, suggesting that higher willingness to pay is unlikely to drive the interest rate gap between hybrid vehicles and their ICE counterparts.

Government incentives. Governments in many European countries have introduced incentive programs targeted at buyers of electric vehicles. We hand collect information on the onset and nature of each incentive program across countries and also categorized them based on their direct applicability to a given hybrid vehicle in our sample. The results obtained using these variables are reported in Panel B of Table 9. We interact the hybrid vehicle indicator with an indicator for the existence of a tax benefit for EV purchase (column 1) and with an indicator for the existence of a tax benefit for EV ownership (column 2) in a given country-year pair. In column 3, we interact the hybrid vehicle indicator with the amount of the subsidy in euros associated with the purchase of a given car make-model in

[19] The car purchase prices available in the EDW dataset represent the actual purchase price of the vehicle, not the Manufacturer's Suggested Retail Price (MSRP).

each country-year pair. Low-end EVs are more likely to qualify for such purchase subsidies. Out of the three measures, only the purchase subsidy in euro amount exhibits statistically significant explanatory power, as shown in column 3. However, the coefficient of the hybrid vehicle indicator at 0.28 remains highly statistically significant, and its magnitude remains unchanged compared to our baseline estimate reported in Panel A of Table 2.

Socioeconomic characteristics. We explore the heterogeneity in social and economic characteristics that have been shown to correlate with green preferences in Europe and may thus affect demand for EVs (Aron-Dine et al., 2023). These variables are available at the granular NUTS3 level, typically for each year in our sample. The results are reported in Panel C of Table 9. We find that the gap in the interest rate between hybrid vehicles and their ICE counterparts does not depend on local population size (column 1), population density (column 2), birth rate (column 6), and the share of votes for green parties in European parliamentary elections (column 7). The coefficients of the interaction terms in these four columns are all close to zero and statistically insignificant. GDP per capita (column 3) and median population age (column 5) have a positive, statistically significant, but economically small association with the gap in the interest rate. For instance, the estimates in column 3 suggest that the gap in the interest rate in regions in the lowest quartile of GDP is 0.27 percentage points, while in regions in the highest quartile, the gap is 0.37 percentage points ($0.37 = 0.27 + 0.035 \times 3$). Lastly, the gap in the interest rate is negatively associated with the share of females, with the spread in the lowest (highest) quartile being 0.44 (0.33) percentage points. Notably, in all specifications considered in Panel C, the baseline coefficient of the hybrid vehicle indicator is positive, highly statistically significant, and similar in magnitude compared to our baseline estimate reported in Panel A of Table 2.

We complement the findings presented in Panel C of Table 9 with plots that enable visual inspection of the relationship between the gap in the interest rate and selected socioeconomic characteristics. For this purpose, we estimate Equation 1 for each NUTS3 region separately, obtaining region-specific estimates of the interest rate gap between hybrid vehicles and their ICE counterparts. We then plot this region-specific gap against each characteristic. Figure 3 presents the results, where each subfigure displays one socioeconomic variable, and each dot within the subfigure represents one NUTS3-level region. Statistically significant and insignificant gap estimates are denoted using blue circles and red diamonds, respectively. Two patterns merit attention. First, the point estimates are predominantly positive and statistically significant, suggesting that the gap exists across regions with varying characteristics and thus our baseline estimate of the gap in the financing terms is not driven by a small set of outlier regions. Second, across all subfigures, we fail to find visually evident relationships between the magnitude of the gap and the socioeconomic characteristics considered. This suggests that differences in the composition of hybrid versus ICE vehicle purchasers along social and economic characteristics cannot explain the gap in the financing terms we document.

Climate change concerns. We next explore the possibility that hybrid vehicle buyers' willingness to pay for loans or lenders' pricing of these loans reacts to changes in climate change concerns. We capture this possibility using the Media Climate Change Concerns Index (MCCC), constructed by Ardia et al. (2022) using news articles. The index accounts for the quantity of climate-related news stories and the extent of negativity in these news stories, with an emphasis on mentions of risks. In addition to the MCCC aggregate index, we also consider four subindexes focusing on themes: business impact, environmental impact, societal debate, and research. To the extent that climate concerns influence buyers' willingness to pay or lenders' pricing of loans, temporal fluctuations in the indexes should lead to time-series variations in the interest rate gap between hybrid vehicles and their ICE counterparts. In Internet Appendix Table F.1, we show that the gap does not vary with the degree of climate concerns: the coefficients of interaction terms are close to zero and statistically insignificant in all cases we consider.

Macroeconomic factors. Lastly, demand for hybrid vehicles and their financing can also be influenced by global supply chain disruptions, macroeconomic uncertainty, as well as commodity and energy prices. For instance, it could be argued that when the supply of electric vehicle components is low, consumers who opt to purchase expensive hybrid vehicles may also demonstrate a high willingness to pay for the vehicles' loans. To rule out the possibility that differential exposure to macro factors could contribute to the observed gap in financing terms between hybrid vehicles and their ICE counterparts, we examine a range of macroeconomic indicators that could potentially affect the gap. The results are reported in Internet Appendix Table F.2. We find that the gap in financing terms does not vary with any of the macroeconomic factors we consider, suggesting that such factors, including energy prices, do not contribute to the observed gap.

5.2 Lenders' Market Power

If auto lenders possess more market power in the hybrid vehicle loan segment compared to the ICE vehicle loans segment, they might charge a higher price for loans that finance hybrid vehicles. To measure lenders' market power in each local market, we use the number of lenders that originate loans for hybrid vehicles and ICE vehicles, respectively, in each geographic (NUTS3) region. We also calculate the HHI (Herfindahl-Hirschman Index) of lenders in each local market based on both the number and amount of loans extended by every lender active in the region, again separately for hybrid and ICE vehicle loan segments. To capture potential entry into the hybrid vehicle loan segment, we calculate the number of active lenders and lenders' HHI in a given region, regardless of whether they operate in the hybrid or ICE vehicle loan segments. In particular, existing lenders in the region that have not originated hybrid vehicle loans in the past may enter this market segment.

Table 10 presents the results. We use $1-\text{HHI}$ instead of HHI so that a larger value indicates a higher level of competition across all variables considered, and we continue to categorize the interaction variables into quartiles, coding the quartiles from 0 to 3. The coefficients on the interaction terms are all positive and statistically significant in three specifications out of six, suggesting that the gap in financing terms between hybrid vehicles and their ICE counterparts tends to be larger when competition in the hybrid vehicle loan market segment is more intense or when lenders have less market power. Furthermore, in all specifications considered, the baseline coefficient of the hybrid vehicle indicator is positive, statistically significant at the 5% level or better, and comparable in magnitude to our baseline estimate reported in Panel A of Table 2. These findings suggest that the lack of competition, or larger market power of lenders, cannot explain why hybrid vehicles are more expensive to finance compared to their ICE counterparts.

Analogous to the results presented in Figure 3, we visualize the gap in the interest rate between hybrid vehicles and their ICE counterparts and the degree of competition in the market for car loans across different geographic regions in Europe. Figure 4 demonstrates that there is no noticeable relationship between measures of competition and the NUTS3-level interest rate gap, corroborating our claim that the higher financing cost of hybrid vehicles is unlikely to be driven by lenders' market power.

5.3 EV-Specific Innovation

At last, we turn to EV-specific technological innovation and examine if this alone can drive the gap in the interest rate between hybrid vehicles and their ICE counterparts. To do this, we estimate Equation 3 using the four innovation measures that capture the intensity and dispersion of EV-specific innovation, mirroring those used in Table 8. We also use the quartile transformation of these continuous measures. Importantly, we also include the interaction terms between the indicator for hybrid vehicles and other factors examined above in the same regression. This horse race between EV-specific innovation and other statistically significant forces documented earlier would help us establish the role of EV-specific innovation in the presence of possible alternative mechanisms. All non-innovation variables are standardized to have a zero mean and a standard deviation of one to make the key coefficients on innovation variables comparable across specifications.

Table 11 Panel A examines the intensity of EV-related innovation while Panel B focuses on the dispersion in battery innovations. For each measure of technological risks, we report the results from two specifications. In columns 1 and 3, we include only the baseline fixed effects, and borrower and loan characteristics. In columns 2 and 4, we further include interaction terms between EV and standardized EV purchase subsidy, log(GDP), the share of female population, median age, and NUTS3-level HHI based on loan volume, all of which exhibit mild but statistically significant explanatory power for the gap in the interest rate.

Panel A shows that the intensity of EV-specific innovation exhibit a strong association with the interest rate gap. To begin with, the coefficient on the standalone indicator for hybrid vehicles is not significantly different from zero in any specification, suggesting a negligible gap in financing terms in the months where innovation is in the lowest quartile. More importantly, moving up in the distribution by one quartile increases the EV spread substantially, by 0.162 percentage points in column 3, for example. Controlling for other factors discussed above only reduces this coefficient slightly to 0.136 (column 4). This suggests a nearly 0.41 percentage points ($0.41 = 0.136 \times 3$) larger interest rate gap during periods in the highest of the intensity of clean patenting relative to periods in the lowest quartile.

In Panel B of Table 11, we present evidence that the dispersion in battery technologies plays an equally important role. The coefficients on the interaction term are always positive and significant at 1% level. The coefficients on the standalone indicator for hybrid vehicles are largely insignificant except column 3. According to column 1 where we study number of battery bigrams, a small and insignificant interest rate gap show up when the possibilities regarding the future direction of battery technologies is in the lowest quartile. Moving up in the distribution by one quartile increases the gap by 0.18 percentage points. Including the interaction between other factors and the indicator for hybrid vehicles leave our findings unchanged.

In Appendix Section G, we show that our results are robust to other measures of EV-related technology measures. The first set of alternative measures are based on an expanded list of clean technology classes, described in Section 2. The results stay very similar, as shown in Panel A of Table G.1. Moreover, we gauge the technology advancements using the amount of VC investments in EV-related startups, which we identify based on the company descriptions. As such, we expect to find a higher interest rate gap in months with more VC investments. Panel B of Table G.1 presents the results consistent with our prediction.

Taken together, the horse race between EV-related innovation and a wide range of alternative factors suggests that the gap in financing terms is primarily driven by the former. This finding is consistent with the important role of EV-related innovation in driving the higher collateral value risk for hybrid vehicles.

6 Conclusion

We provide the first comprehensive analysis of the rapidly growing EV loan market and document a significant, systematic gap in the financing terms—interest rate, maturity, loan-to-value ratio—between EVs and non-EVs. EVs are costlier to finance and this financing gap can be explained by the risks associated with technologies embedded in EVs. While most policy discussions of the global shift to electric mobility focus on the affordability of EVs in terms of their purchase price, less attention is paid to the role of consumer financing of EVs. Our research fills this gap and can inform public policies that aim at making EV financing more accessible. Nascent initiatives include Bank Australia's decision to stop offering loans for new fossil fuel cars from 2025.

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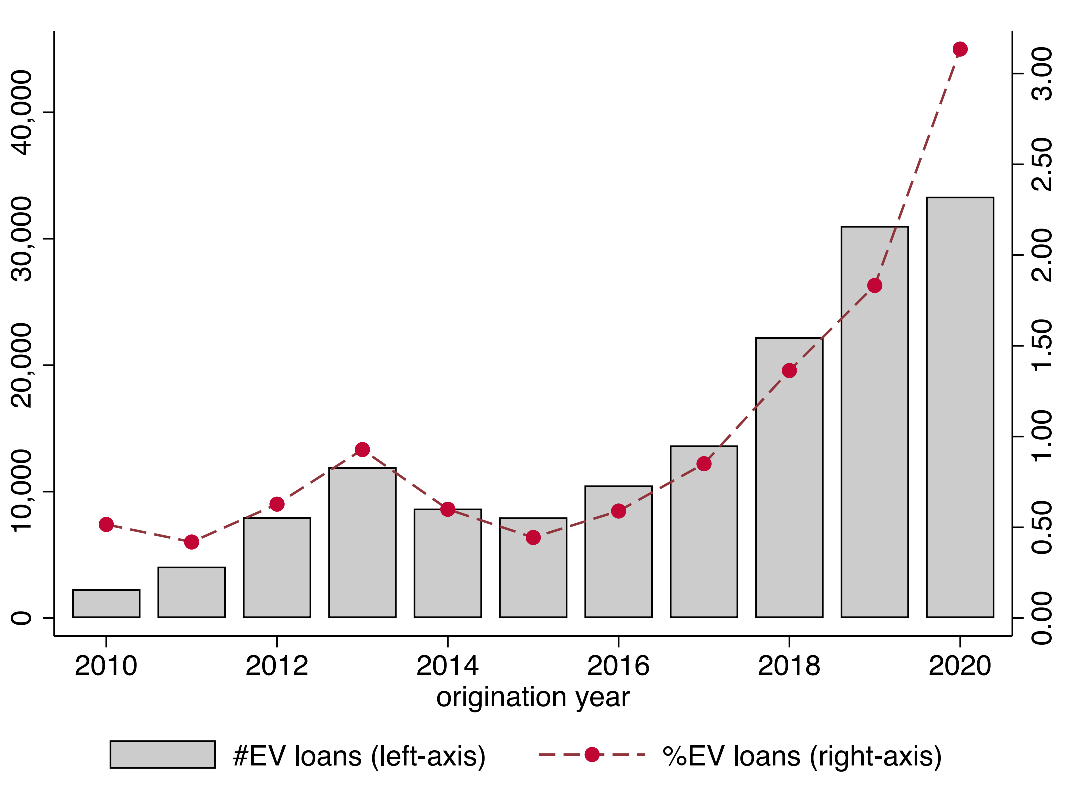
Figure 1: Growth of EV Loans



Note.—Figure 1 illustrates the total number of EV loans originations (left axis) and the percentage of EV loan (right axis) over all auto loans in our sample period 2010-20.

Figure 2: Alternative Samples and Specifications

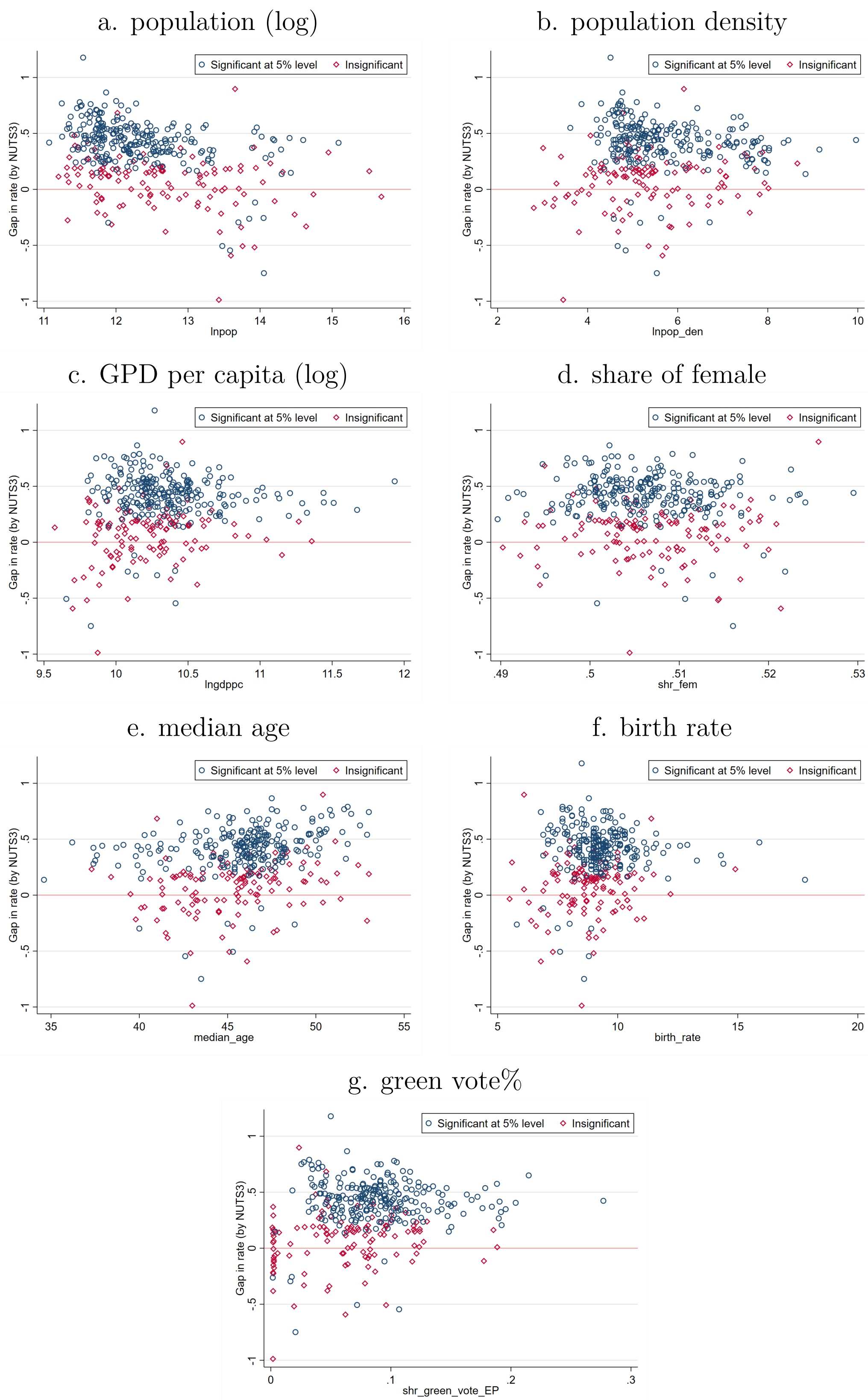
a. Interest Rate

b. LTV

c. Maturity

Note.—Figure 2 presents the point estimates of the hybrid indicator using alternative regression samples and regression specifications for each of the three outcome variables: interest rate, LTV, and maturities in the three panels.

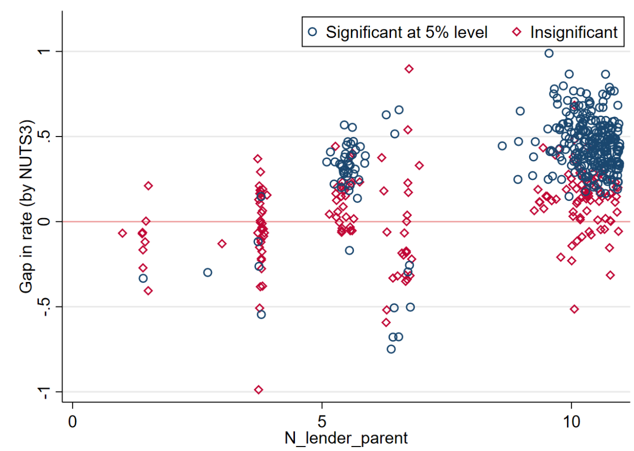
Figure 3: Socioeconomic Factors and the Gap in Financing Terms



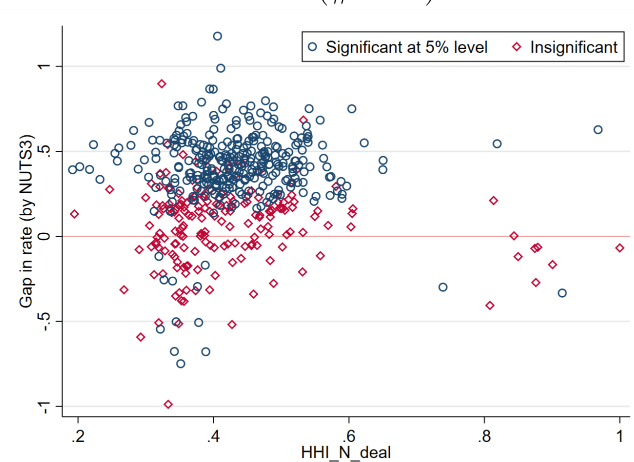
NOTE.— This figure plots the NUT3-level cross-sectional relationship between the estimated gap in interest rate and local socioeconomic factors. The NUTS3 level gap in interest rate between HEVs/PHEVs and their ICEs counterparts is estimated using all loans originated in a given NUTS3 over our sample period.

Figure 4: Market Power and the Gap in Financing Terms

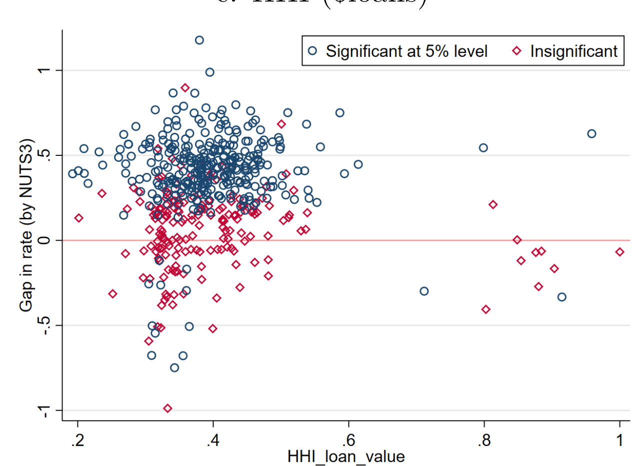
a. number of lenders



b. HHI (#loans)



c. HHI ($loans)



Note.— This figure plots the NUT3-level cross-sectional relationship between the estimated gap in interest rate and measures of local market power. The NUTS3 level gap in interest rate between HEVs/PHEVs and their ICEs counterparts is estimated using all loans originated in a given NUTS3 over our sample period.

Table 1: Summary Statistics

Panel A. loan origination by make

	#Hybrid/BEV loans	#ICE loans
toyota	83,132	467,177
bmw	13,089	760,401
peugeot	11,445	1,522,020
volkswagen	8,328	3,123,450
hyundai	5,621	526,848
volvo	1,952	114,197
lexus	1,553	3,407
honda	1,540	66,204
ford	761	930,852
mercedes	595	392,253

Panel B. loan characteristics

	mean	sd	p10	p25	p50	p75	p90	count
rate (%)	4.669	2.68	1.50	3.00	4.00	6.00	8.95	7,906,809
LTV (%)	76.199	26.37	39.46	60.00	80.00	99.44	105.00	7,458,362
maturity (month)	51.017	15.70	36.00	38.00	48.00	60.00	72.00	7,906,809
car price (€1,000)	19.222	9.76	8.50	12.36	17.56	24.48	31.60	7,906,809
income (€1,000)	33.795	27.43	12.82	18.00	26.00	41.00	60.00	7,906,809
income verified	0.749	0.43	0.00	0.00	1.00	1.00	1.00	7,906,809
non-performing	0.040	0.20	0.00	0.00	0.00	0.00	0.00	7,906,809

Panel C. technological innovation

	mean	sd	p10	p25	p50	p75	p90	count
Intensity of battery innovation								
number of clean patents ADHM2016 (log)	5.34	0.58	4.54	4.71	5.64	5.83	5.97	139
share of clean patents ADHM2016	0.02	0.00	0.01	0.01	0.02	0.02	0.02	139
Dispersion in battery innovation								
HHI of battery bigrams	0.11	0.02	0.09	0.10	0.11	0.13	0.15	139
number of battery bigrams	31.76	9.72	19.00	23.00	32.00	39.00	45.00	139

NOTE.—Panel A presents the number of EV loans and non-EV loans. Panel B presents summary statistics on loan characteristics. Panel C presents the summary statistics of the measures of EV-related technological innovation. The sample period is January 2010 to August 2021.

Table 2: Financing Terms of Hybrid vs. ICE Vehicles

Panel A. within-make-model comparison

	(1) interest rate	(2) LTV	(3) maturity
Hybrid	0.294***	−4.704***	−2.480***
	(0.06)	(0.87)	(0.50)
lender FE	Y	Y	Y
deal FE	Y	Y	Y
make-model FE	Y	Y	Y
nuts3 × year FE	Y	Y	Y
borrower controls	Y	Y	Y
Observations	7,906,809	7,458,371	7,906,823
R-sq	0.720	0.327	0.327

Panel B. within make-model×geography×month comparison

	(1) interest rate	(2) LTV	(3) maturity
Hybrid	0.236***	−4.462***	−2.327***
	(0.05)	(0.96)	(0.44)
lender FE	Y	Y	Y
deal FE	Y	Y	Y
make-model × nuts3 × year-month FE	Y	Y	Y
borrower controls	Y	Y	Y
Observations	6,726,222	6,264,739	7,746,956
R-sq	0.821	0.510	0.398

Panel C. within make-model×geography×year×lender comparison

	(1) interest rate	(2) LTV	(3) maturity
Hybrid	0.239***	−4.616***	−2.223***
	(0.06)	(1.02)	(0.46)
deal FE	Y	Y	Y
make-model × nuts3 × lender × year FE	Y	Y	Y
borrower controls	Y	Y	Y
Observations	7,471,046	7,028,766	7,471,057
R-sq	0.783	0.430	0.443

Note.—This table shows the difference in financing terms between HEVs/PHEVs and their ICE counterparts within the same make and model. The unit of observation is at car level. *EV* is an indicator variable for whether the underlying car is HEV or PHEV as opposed to ICE. In all panels, we include ABS deal fixed effects and control for car value in log form, as well as borrower income and the verification status of income. Panel A includes make-model, lender, and NUTS3×year fixed effects. Panel B includes lender and make-model×month×NUTS3 FE. Panel C includes make-model×month×NUTS3×lender FE. The sample period is January 2010 to August 2021. Standard errors double clustered by ABS deal and NUTS3-level region are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 3: Financing Terms of Hybrid vs. ICE Vehicles
A Within-Make-Model-Power Comparison

	(1) interest rate	(2) LTV	(3) maturity
Hybrid	0.128**	−3.792**	−1.708**
	(0.05)	(1.80)	(0.79)
lender FE	Y	Y	Y
deal FE	Y	Y	Y
make-model-power FE	Y	Y	Y
nuts3 $\times$ year FE	Y	Y	Y
borrower controls	Y	Y	Y
Observations	3,147,949	2,983,847	3,147,961
R-sq	0.701	0.394	0.354

Note.— This table shows the difference in financing terms between HEVs/PHEVs and their ICE counterparts within the same make-model-power group. The unit of observation is at car level. *EV* is an indicator variable for whether the underlying car is HEV or PHEV as opposed to ICE. We include ABS deal, lender, and NUTS3×year fixed effects. We control for car value in log form, as well as borrower income and the verification status of income. The sample period is January 2010 to August 2021. Standard errors double clustered by ABS deal and NUTS3-level region are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 4: Default Risk of Hybrid vs. ICE Vehicles

	(1)	(2)	(3)	(4)
	non-performing (0/1)			
Hybrid	−0.006	−0.003	−0.009*	−0.006
	(0.00)	(0.00)	(0.00)	(0.00)
rate		0.003***		0.002***
		(0.00)		(0.00)
LTV		0.001***		0.001***
		(0.00)		(0.00)
maturity		0.000***		0.000***
		(0.00)		(0.00)
sample	Full	Full	Matured loans	Matured loans
lender FE	Y	Y	Y	Y
deal FE	Y	Y	Y	Y
family FE	Y	Y	Y	Y
nuts3 × year FE	Y	Y	Y	Y
borrower controls	Y	Y	Y	Y
Mean outcome var.	0.041	0.041	0.044	0.044
Observations	7,458,362	7,458,362	5,450,191	5,450,191
R-sq	0.033	0.042	0.032	0.040

Note.— This table studies the difference in default risk between HEVs/PHEVs and their ICE counterparts. The unit of observation is at car level. The outcome variable is a dummy indicating whether the loan has ever been in arrears or in default during the course of the loan. Columns 1-2 include the full sample. Columns 3-4 include only loans that have matured before August 2021, the end of the sample period. We include ABS deal, lender, make-model, and NUTS3×year fixed effects. We control for car value in log form, as well as borrower income and the verification status of income. The sample period is January 2010 to August 2021. Standard errors double clustered by ABS deal and NUTS3-level region are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 5: The Collateral Risk Channel
Estimates of Vehicle Residual Values from Secondary Market Transactions

	(1) RV/price	(2) SD (6m)	(3) $\Delta \in [-1\%, 1\%]$	(4) $\Delta \in [-3\%, 3\%]$	(5) $\Delta \in [-5\%, 5\%]$	(6) $\Delta < -1\%$	(7) $\Delta > 1\%$
EV	−0.045***	0.002***	0.033***	0.016***	0.010***	0.047***	−0.014**
	(0.001)	(0.000)	(0.007)	(0.003)	(0.002)	(0.005)	(0.006)
make FE	Y	Y	Y	Y	Y	Y	Y
country × year FE	Y	Y	Y	Y	Y	Y	Y
age × mileage FE	Y	Y	Y	Y	Y	Y	Y
mean outcome var.	0.626	0.014	0.299	0.055	0.015	0.127	0.173
Observations	49,922	43,705	48,654	48,654	48,654	48,654	48,654
R-sq	0.785	0.258	0.146	0.068	0.021	0.133	0.117

Note.— This table compares the industry benchmark estimates of residual values of EVs and non-EVs. Those monthly estimates are estimated based on retail prices of used vehicles for 10 makes in our sample and expert analysts from Autovista. The unit of observation is at country-make-age-mileage-fuel type-month level. In column 1, the outcome variable is residual value divided by vehicle price, or RV/price. In column 2, the outcome variable is the standard deviation of RV/price over the past 6 months. In columns 3-7, the outcome variables are based on monthly changes in the RV/price: whether the change is within 1% range, within 3% range, within 5% range, whether it is below -1%, and above 1%. *EV* is an indicator variable for whether the underlying car is EV as opposed to ICE. In all columns, we include make, country×year, and age×mileage fixed effects. There are four age×mileage scenarios: 12 months/20k km, 24 months/40k km, 36 months/60k km, and 48 months/80k km. The sample period is January 2020 to January 2024. Standard errors double clustered by the calendar year-month and country are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 6: The Collateral Risk Channel
Lenders' Loan-Level Estimates of Vehicle Residual Values

	(1) RV/price	(2) RV adjustment ever	(3) RV adj. down ever	(4) RV adj. down never
Hybrid	−0.048***	0.025***	0.023***	0.002
	(0.006)	(0.006)	(0.005)	(0.002)
lender FE	Y	Y	Y	Y
deal FE	Y	Y	Y	Y
model-make FE	Y	Y	Y	Y
nuts3 × year FE	Y	Y	Y	Y
borrower controls	Y	Y	Y	Y
loan controls	Y	Y	Y	Y
mean outcome var.	0.403	0.125	0.114	0.011
Observations	1,261,987	1,370,360	1,370,360	1,370,360
R-sq	0.357	0.293	0.284	0.070

Note.— This table compares lenders' own residual value estimates between HEVs/PHEVs and their ICE counterparts. The unit of observation is at car level. In column 1, the outcome variable is residual value divided by vehicle price, or RV/price. In column 2, the outcome variable is an indicator for whether the lender has ever revised the residual value estimate during the course of the financing contract. In column 3, the outcome variable is an indicator for whether the lender has ever revised the residual value estimate downward. In column 4, the outcome variable is an indicator for whether the lender has never adjusted the residual value estimate downward (i.e., only upward adjustments). We include ABS deal, lender, make-model, and NUTS3×year fixed effects. We control for car value in log form, as well as borrower income and the verification status of income. We additionally include loan controls - interest rate, LTV, and maturity. The sample period is January 2010 to August 2021. Standard errors double clustered by the year-month of loan origination and NUTS3-level region are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 7: Financing Terms of Hybrid vs. ICE Vehicles
Effect of Lenders' Exposure to Residual Value Risks

Panel A. ex ante default probability

	(1) rate	(2) LTV	(3) maturity
Hybrid	0.343***	−5.142***	−3.008***
	(0.08)	(0.78)	(0.46)
Hybrid × full guarantee	−0.166*	1.903*	1.120***
	(0.09)	(1.01)	(0.41)
full guarantee	−0.021	3.071***	1.892***
	(0.02)	(0.36)	(0.22)
lender FE	Y	Y	Y
deal FE	Y	Y	Y
make-model FE	Y	Y	Y
nuts3 × year FE	Y	Y	Y
borrower controls	Y	Y	Y
Observations	7,454,508	7,454,508	7,454,508
R-sq	0.723	0.329	0.320

Panel B. lease vs. loan

	(1) rate	(2) LTV	(3) maturity
Hybrid	0.303***	−4.206***	−2.711***
	(0.07)	(0.98)	(0.52)
Hybrid × lease	0.345*	−5.784***	0.229
	(0.20)	(1.68)	(1.13)
lease	−1.605***	−24.090***	−5.618
	(0.34)	(6.01)	(3.89)
lender FE	Y	Y	Y
deal FE	Y	Y	Y
make-model FE	Y	Y	Y
nuts3 × year FE	Y	Y	Y
borrower controls	Y	Y	Y
Observations	7,458,362	7,458,362	7,458,362
R-sq	0.724	0.329	0.318

NOTE.— This table examines if the gap in financing terms between HEVs/PHEVs and their ICE counterparts varies depending on the lenders' exposure to the residual value risks. The unit of observation is at car level. Panel A studies ex ante default probability, captured by whether the loan is fully guaranteed or not. Panel B differentiates between leases and loans. *EV* is an indicator variable for whether the underlying car is HEV or PHEV as opposed to ICE. We include ABS deal, lender, make-model, and NUTS3×year fixed effects. We control for car value in log form, as well as borrower income and the verification status of income. The sample period is January 2010 to August 2021. Standard errors double clustered by ABS deal and NUTS3-level region are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 8: The Collateral Channel - Technological Innovation and Residual Values

Panel A. intensity of clean patenting - ADHMV2016

	below origination RV (0/1)		RV (log)	
	(1)	(2)	(3)	(4)
Hybrid × number of clean patents ADHMV2016 (log)	0.032***		−0.009***	
	(0.012)		(0.003)	
Hybrid × share of clean patents ADHMV2016		0.028**		−0.004*
		(0.013)		(0.002)
loan FE	Y	Y	Y	Y
Year-month FE	Y	Y	Y	Y
mean outcome var.	0.296	0.296	9.384	9.384
Observations	20,891,354	20,891,354	20,734,647	20,734,647
R-sq	0.938	0.938	0.990	0.990

Panel B. dispersion in battery technology

	below origination RV (0/1)		RV (log)	
	(1)	(2)	(3)	(4)
Hybrid × 1-HHI of battery bigrams	0.022**		−0.006***	
	(0.010)		(0.002)	
Hybrid × number of battery bigrams (log)		0.020**		−0.006**
		(0.010)		(0.002)
loan FE	Y	Y	Y	Y
Year-month FE	Y	Y	Y	Y
mean outcome var.	0.296	0.296	9.384	9.384
Observations	20,891,354	20,891,354	20,734,647	20,734,647
R-sq	0.938	0.938	0.990	0.990

NOTE.— This table studies the relationship between technological innovation and residual value estimates of HEVs/PHEVs and their ICE counterparts. The unit of observation is at car-month level. In columns 1-2, the outcome variable is an indicator for whether the residual value in a given month is lower than that at loan origination. In columns 3-4, the outcome variable is the monthly residual value estimate in log dollar terms. Various measures of EV-related technological innovation are interacted with the EV indicator. In Panel A, we measure the intensity of innovation in EV-related technologies using the number (in log form) and the share of clean patents relative to all patents in the corresponding parent groups. In Panel B, we measure the dispersion in battery technology using the number (in log) and HHI of battery-related bigrams in the title of patents. All measures are constructed at the monthly frequency. To facilitate the interpretation of the coefficients, we divide these measures based on the quartiles and use the categorical values (0, 1, 2, 3). In all columns, we include loan and year-month fixed effects. The sample period is January 2010 to August 2021 in both panels. Standard errors double clustered by loan and calendar year-month are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 9: Demand Elasticity and the Gap in Financing Terms

Panel A. willingness to pay: price premium and buyer sophistication

	interest rate			
	(1)	(2)	(3)	(4)
Hybrid	0.274***	0.375***	0.333***	0.333***
	(0.09)	(0.08)	(0.07)	(0.07)
Hybrid × WTP	0.032	−0.024	−0.080	−0.174
	(0.03)	(0.02)	(0.18)	(0.12)
WTP proxies	hybrid price premium	overpay (model-year-NUTS3)	luxury car make	price above 40k
lender FE	Y	Y	Y	Y
deal FE	Y	Y	Y	Y
make-model FE	Y	Y	Y	Y
nuts3 × year FE	Y	Y	Y	Y
borrower controls	Y	Y	Y	Y
loan controls	Y	Y	Y	Y
Observations	7,458,362	7,458,362	7,458,362	7,367,913
R-sq	0.728	0.729	0.728	0.730

Panel B. government incentives

	interest rate		
	(1)	(2)	(3)
Hybrid	0.367***	0.318***	0.282***
	(0.08)	(0.06)	(0.08)
Hybrid × incentives	−0.145	0.012	0.083**
	(0.09)	(0.07)	(0.04)
incentive measures	acquisition tax benefits	ownership tax benefits	purchase subsidy
lender FE	Y	Y	Y
deal FE	Y	Y	Y
make-model FE	Y	Y	Y
nuts3 × year FE	Y	Y	Y
borrower controls	Y	Y	Y
loan controls	Y	Y	Y
Observations	7,458,362	7,458,362	7,458,362
R-sq	0.728	0.728	0.728

Panel C. socioeconomic factors

	interest rate						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Hybrid	0.399***	0.330***	0.272***	0.425***	0.322***	0.316***	0.361***
	(0.10)	(0.07)	(0.05)	(0.07)	(0.05)	(0.09)	(0.06)
Hybrid × socioeconomic	−0.014	0.021	0.035***	−0.032**	0.061***	0.029	0.007
	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
socioeconomic factors	population (log)	population density	GDP per capita (log)	share of female	median age	birth rate	green votes%
lender FE	Y	Y	Y	Y	Y	Y	Y
deal FE	Y	Y	Y	Y	Y	Y	Y
make-model FE	Y	Y	Y	Y	Y	Y	Y
nuts3 × year FE	Y	Y	Y	Y	Y	Y	Y
borrower controls	Y	Y	Y	Y	Y	Y	Y
loan controls	Y	Y	Y	Y	Y	Y	Y
Observations	5,272,999	4,801,024	4,012,753	5,272,999	4,018,758	4,798,651	5,184,418
R-sq	0.763	0.770	0.768	0.763	0.787	0.770	0.758

Note.— This table shows that potential differences in consumers' demand elasticity for EVs and non-EVs do not explain the gap in interest rate. In panel A, we examine four measures: the average price difference between EV and non-EVs from the same make-model category, sold in the same region in the same year (column 1), the difference between the purchase price and average price of cars in the same model-engine-type combination, sold in the same region in the same year (column 2), whether the make belongs to one of four luxury makes (BMW, Mercedes-Benz, Volvo, and Lexus) out of the ten makes in our sample (column 3), and whether the car price is above 40,000 euros (column 4).In panel B, we examine government incentive programs. In columns 1-2, we consider the existence of tax benefits for EV purchase and EV ownership, both varying at country×year level. In column 3, we hand collect the amount of government subsidy for EV purchase, which varies at model×country×year level since the amount of subsidy depends on the price of the car. In panel C, we examine various socioeconomic factors. To facilitate the interpretation of the coefficients, we divide continuous measures based on the quartiles and use the categorical values (0, 1, 2, 3). We include ABS deal, lender, make-model, and NUTS3×year fixed effects. We control for car value in log form, as well as borrower income and the verification status of income. We additionally include loan controls - LTV and maturity. The sample period is January 2010 to August 2021. Standard errors double clustered by ABS deal and NUTS3-level region are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 10: Lender Competition and the Gap in Financing Terms

	interest rate					
	(1)	(2)	(3)	(4)	(5)	(6)
Hybrid	0.228***	0.253***	0.154**	0.228***	0.257***	0.153**
	(0.06)	(0.07)	(0.07)	(0.06)	(0.06)	(0.06)
Hybrid × competition	0.080	0.078	0.133**	0.085*	0.045	0.102***
	(0.06)	(0.06)	(0.06)	(0.05)	(0.04)	(0.03)
competition measures	# segment lenders	1-segment HHI(# loans)	1-segment HHI(€ loans)	# lenders	1-HHI (# loans)	1-HHI (€ loans)
lender FE	Y	Y	Y	Y	Y	Y
deal FE	Y	Y	Y	Y	Y	Y
make-model FE	Y	Y	Y	Y	Y	Y
nuts3 × year FE	Y	Y	Y	Y	Y	Y
borrower controls	Y	Y	Y	Y	Y	Y
loan controls	Y	Y	Y	Y	Y	Y
Observations	7,458,362	7,458,362	7,458,362	7,458,362	7,458,362	7,458,362
R-sq	0.728	0.728	0.728	0.728	0.728	0.728

NOTE.— This table shows that market power of lenders do not explain the gap in interest rate. We interact various measures of local competition with the EV indicator. To facilitate the interpretation of the coefficients, we divide continuous measures based on the quartiles and use the categorical values (0, 1, 2, 3). We include ABS deal, lender, make-model, and NUTS3×year fixed effects. We control for car value in log form, as well as borrower income and the verification status of income. We additionally include loan controls - LTV and maturity. The sample period is January 2010 to August 2021. Standard errors double clustered by ABS deal and NUTS3-level region are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 11: Technological Innovation and the Gap in Financing Terms

Panel A. intensity of clean patenting - ADHMV2016

	interest rate			
	(1)	(2)	(3)	(4)
Hybrid	0.101	0.038	0.039	0.002
	(0.10)	(0.10)	(0.08)	(0.10)
Hybrid × number of clean patents ADHMV2016 (log)	0.162***	0.134***		
	(0.03)	(0.03)		
Hybrid × share of clean patents ADHMV2016			0.169***	0.136***
			(0.02)	(0.02)
baseline FE, borrower & loan controls	Y	Y	Y	Y
Hybrid × incentive controls	N	Y	N	Y
Hybrid × socioeconomic controls	N	Y	N	Y
Hybrid × competition controls	N	Y	N	Y
Observations	2,816,501	2,816,501	2,816,501	2,816,501
R-sq	0.805	0.805	0.805	0.805

Panel B. dispersion in battery technology

	interest rate			
	(1)	(2)	(3)	(4)
Hybrid	0.074	0.033	0.170**	0.111
	(0.09)	(0.10)	(0.08)	(0.08)
Hybrid × number of battery bigrams (log)	0.180***	0.144***		
	(0.03)	(0.03)		
Hybrid × 1-HHI of battery bigrams			0.136***	0.108***
			(0.02)	(0.02)
baseline FE, borrower & loan controls	Y	Y	Y	Y
Hybrid × incentive controls	N	Y	N	Y
Hybrid × socioeconomic controls	N	Y	N	Y
Hybrid × competition controls	N	Y	N	Y
Observations	2,816,501	2,816,501	2,816,501	2,816,501
R-sq	0.805	0.805	0.805	0.805

NOTE.— This table shows the role of technological innovation in explaining the gap in interest rate between HEVs/PHEVs and their ICEs counterparts. We interact various measures of EV-related technological innovation with the EV indicator. In Panel A, we measure the intensity of innovation in EV-related technologies using the number (in log form) and the share of clean patents relative to all patents in the corresponding parent groups. In Panel B, we measure the dispersion in battery technology using the number (in log) and HHI of battery-related bigrams in the title of patents. All measures are constructed at the monthly frequency. To facilitate the interpretation of the coefficients, we divide these measures based on the quartiles and use the categorical values (0, 1, 2, 3). In columns 2 and 4 of each panel, we control for significant interaction terms in previous analysis, including interaction terms of EV indicator and EV purchase subsidy, socioeconomic factors (population density, GDP per capita, median age) and competition (segment HHI - $loans). We include ABS deal, lender, make-model, and NUTS3×year fixed effects. We control for car value in log form, as well as borrower income and the verification status of income. We additionally include loan controls - LTV and maturity. The sample period is January 2010 to August 2021. Standard errors double clustered by ABS deal and NUTS3-level region are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Financing the Global Shift to Electric Mobility

Online Appendix

Jan Bena Bo Bian Huan Tang

A Variable Definition

Table A.1: Variable Definition and Data Source

Variable Name	Definition	Source
rate	interest rate (%)	European Data Warehouse (EDW)
LTV	loan to value ratio (%)	European Data Warehouse (EDW)
maturity	loan maturity (in months)	European Data Warehouse (EDW)
loan amount	loan amount (in €1,000)	European Data Warehouse (EDW)
income	income of the borrower (in €1,000)	European Data Warehouse (EDW)
income verification status	an indicator of whether the borrower's income is verifed or self-reported without verification	European Data Warehouse (EDW)
car price	car purchase price, use the sum of down payment and loan value if missing	European Data Warehouse (EDW)
non-performing	an indicator of whether a loan is ever in arrears or in default during the course of the the financing contract	European Data Warehouse (EDW)
EV	an indicator of EVs	European Data Warehouse (EDW)
Hybrid	an indicator of HEVs/PHEVs	European Data Warehouse (EDW)
full guarantee	an indicator of whether the full loan is guaranteed	European Data Warehouse (EDW)
lease	an indicator of lease (product type is finance lease or operating lease)	European Data Warehouse (EDW)
RV/price	residual value estimate divided by car price	Autovista-Residual Value Intelligence (RVI)
SD (6m)	standard deviation of RV/price over the past 6 months	Autovista-Residual Value Intelligence (RVI)
$\Delta \in [-1\%, 1\%]$	monthly-on-month change in RV/price is between -1pp and 1pp	Autovista-Residual Value Intelligence (RVI)
$\Delta \in [-3\%, 3\%]$	monthly-on-month change in RV/price is between -3pp and 3pp	Autovista-Residual Value Intelligence (RVI)
$\Delta \in [-5\%, 5\%]$	monthly-on-month change in RV/price is between -5pp and 5pp	Autovista-Residual Value Intelligence (RVI)
$\Delta < -1\%$	monthly-on-month change in RV/price is below -1pp	Autovista-Residual Value Intelligence (RVI)
$\Delta > 1\%$	monthly-on-month change in RV/price is above 1pp	Autovista-Residual Value Intelligence (RVI)
RV adjustment ever	an indicator of whether the lender has ever revised the residual value estimate during the course of the financing contract	European Data Warehouse (EDW)
RV adj. down ever	an indicator of whether the lender has ever revised the residual value estimate downward	European Data Warehouse (EDW)
RV adj. down never	an indicator of whether the lender has never revised the residual value estimate downward (i.e., only upward adjustments)	European Data Warehouse (EDW)
below origination RV	an indicator of whether the residual value in a given month is lower than that at loan origination	European Data Warehouse (EDW)
RV (log)	residual value estimate in log euro terms	European Data Warehouse (EDW)
hybrid price premium	the average price difference between EV and non-EVs from the same make-model category, sold in the same region in the same year	European Data Warehouse (EDW)
overpay (model-year-NUTS3)	the difference between the purchase price and average price of cars in the same model-engine-type combination, sold in the same region in the same year	European Data Warehouse (EDW)
luxury car make	an indicator of whether the make belongs to one of four luxury makes (BMW, Mercedes-Benz, Volvo, and Lexus)	European Data Warehouse (EDW)
price above 40k	an indicator of whether the car price is above 40,000 Euros	European Data Warehouse (EDW)
acquisition tax benefits	an indicator of whether the government provide tax benefits for EV acqusition, varying at country-year level	European Automobile Manufacturers' Association (AECA)
ownership tax benefits	an indicator of whether the government provide tax benefits for EV ownership, varying at country-year level	European Automobile Manufacturers' Association (AECA)
purchase subsidy	amount of government subsidy for EV purchase, varies at model-country-year level	European Automobile Manufacturers' Association (AECA)
population	Population by NUTS 3 region; online data code: demo_r_pjanaggr3 - total	data.europa.eu
population density	Population density by NUTS 3 region; online data code: demo_r_d3dens	data.europa.eu
GDP per capita	GDP per inhabitant by NUTS 3 region, purchasing power standard (PPS, EU27 from 2020); online data code: nama_10r_3gdp - pps_eu27_2020_hab	data.europa.eu
share of female	Share of female population; online data code: demo_r_pjanaggr3 - females	data.europa.eu
median age	Median age of population by NUTS 3 region, online data code: demo_r_pjanind3 - medagepop	data.europa.eu
birth rate	Crude birth rates by NUTS3 region; online data code: demo_r_gind3 - gbirthrt	data.europa.eu
green votes	share of votes for green parties in European parliamentary elections	Schraff et al. (2023)
number of (segment) lenders	number of (EV or non-EV) lenders that originate car loans in each region; two segments: EV and non-EV	European Data Warehouse (EDW)
segment HHI (# loans)	HHI based on the number of (EV or non-EV) loans of each lender	European Data Warehouse (EDW)
segment HHI (€loans)	HHI specific to each loan segment based on the amount of (EV or non-EV) loans by each lender	European Data Warehouse (EDW)
number of clean patents ADHM2016	number of clean patents (per Aghion et al., 2016 clean patent class)	Patent View
share of clean patents ADHM2016	share of clean patents (per Aghion et al., 2016 clean patent class) relative to the total number of patents in the corresponding parent groups	Patent View
HHI of battery bigrams	Herfindahl-Hirschman Index (HHI) constructed based on the quantity of unique bigrams and their frequencies in each month	Patent View
number of battery bigrams	number of unique battery-related bigrams in each month	Patent View
number of clean patents expanded	number of clean patents (expanded list of clean technology class): the extension is based on the co-classification of patents with Aghion et al., 2016 clean patent class	Patent View
share of clean patents expanded	share of clean patents (expanded list of clean technology class) relative to the total number of patents in the corresponding parent groups	Patent View
VC investment in EV	dollar amount of VC investment in the EV-related startups	VentureXpert
share of VC investment in EV	share of VC investment dollar amount in the EV-related startups relative to investment to all startups	VentureXpert
T10Y3M	10-Year Treasury Yield Minus 3-Month Treasury Yield	FRED
AAAFF	Moody's Seasoned Aaa Corporate Bond Minus Federal Funds Rate	FRED
AAABAA	Moody's Seasoned Aaa Corporate Bond Minus Baa Corporate Bond	FRED
VIXCLS	CBOE Volatility Index	FRED
SPXret	log return on the S&P 500 index	FRED
Crude Oil return	Crude Oil Returns	FRED

B Classification of EVs and make-model- and make-model-power groups

In this Appendix section, we describe the classification of EVs, make-model, and make-model-power groups. Different car manufactures follow different naming conventions. We refer to as "make-model" the series or the most general car model categories within a brand. For BMW, the model categories will be the 1 to 8 series, X, Z, and i series. For Toyota, the model categories will be the different car model names, like Corolla, Camry, and RAV4.

We refer to as "make-model-power" the combination of make-model and engine displacement provided in the data field AA45. Models within the same make-model-power group are identical in all observable specifications except for motor type. When the displacement information is not provided in the original data, we code the make-model-power group as missing. Therefore, the make-model-power group is only coded for loans with detailed car model specifications.

We manually code the EV indicator for all unique model names available in the EDW data, based on the combination of make, make-model, and make-model-engine specifications in data field AA45. A car model is assigned a EV flag if it is plug-in hybrid (PHEV), non-plug-in hybrid (HEV), battery powered (BEV), and general hybrid (GHEV). When we narrow down to the same car make and model, we are effectively left with hybrid vehicles with their respective ICE counterparts.

Below we illustrate how we classify make-model and make-model-power categories for different makes. Take BMW as an example, Table B.1 shows the exhaustive list of make-model and make-model categories that offer both hybrid and ICE models. There are eight model families (series) that offer hybrid options. For example, in model category "x3", BMW offers the ICE version "x3 xDrive30d" and the plugin hybrid counterpart "x3 xDrive30e". These two models only differ in the engine type, where *d* stands for diesel and *e* for hybrid.

Table B.1: BMW - Make-Model and Make-Model-Power Groups

Make-Model group	Make-Model-Power group	ICE example	Hybrid example
2er	2er 225	BMW 2-sarja 225 F45 Active Tourer 225i A xDrive Business Sport	BMW 2-SARJA F45 Active Tourer 225xeA Business Luxury Navi Plus Panorama Glass Roof Driving Asst. P
	2er active-tourer	2er-Reihe Active Tourer Diesel (F45	2er-Reihe Active T. Allrad Hybrid (
3er	3er 320	BMW 320 d A Luxury TwinPower Turbo F30 Sedan *Huipputarjous korko 2.9% ilman kuluja + kasko 0e vuode	BMW 320 F31 Touring 320e A Business M Sport
	3er 330	BMW 330 Gran Turismo F34 330i A xDrive Gran Turismo Business Exclusive M Sport	BMW 3-SARJA F30 Sedan 330eA Business Exclusive Edition Sport Navi HiFi
	3er 335	BMW 335 I A E93 CABRIO **OIKEALLA V?RILL? JA VOIMAKONEELLA**	BMW 335i ACTIVEHYBRID SEDAN A
	3er f30	BMW 3-sarja F30 Sedan A xDrive Business Exclusive	3er-Reihe Hybrid (F30)
5er	5er 520	BMW 5-SARJA 520d Turbo A F11 Touring Busin Auto Luxury Line / Navi / HIFI / Vetokoukku / Mukautuvat	520 ACTIVE HYBRID GA
	5er 530	BMW 530 F07 Gran Turismo TwinPower Turbo M-Sport xDrive 190Kw Autom. Webasto Prof.Navi Comfort Ac	BMW 5-SARJA G30 Sedan 530e A iPerformance Launch Edition Sport # 20 -tuumaset / HIFI / Sport-Line
	5er 545	BMW 545 IA E60/N62	545e xDrive Limousin
	5er f10	BMW 5-sarja i TwinPower Turbo F10 Sedan Busi18	SERIE 5 F10 ACTIVEHYBRID 5
	5er g30	5er-Reihe Diesel Allrad (G30)	5er-Reihe Hybrid Allrad (G30)
	5er g31	5er-Reihe Kombi Allrad Diesel (G31)	5er-Reihe Kombi Hybrid Alrrad (G31)
7er	7er 730	BMW 730 D TwinPower Turbo AUT FACELIFT K. WEBASTO ADAPT.	730I Active Hybrid
	7er 740	BMW 740 D AUT XDRIVE M-SPORT LASERVALOT BMW HUOLTOSOPIMU	BMW 7-sarja 740 Le iPerformance A xDrive G12 Sedan Business Exclusive M-Sport Automaatti Neliveto
	7er 745	Baureihe 7 (E65/E66) (2001->) 745i	BMW 745Le xDrive Sedan (AA) 4ov 2998cm3 A
	7er f01	7er-Reihe Allrad Diesel (F01)	7er-Reihe Hybrid (F01)
	7er f02	7er-Reihe Allrad Diesel (F02)	7er-Reihe Hybrid (F02)
	7er g11	7er-Reihe Allrad Diesel (G11)	7er-Reihe Hybrid (G11)
x1	x1 25	BMW X1 xDrive25d TwinPower Turbo A E84 Business Sport 160kW	BMW X1 F48 xDrive25e A Charged Edition M Sport
x2	x2 25	X2 25D XDRIVE MSPORT AUTO	BMW X2 F39 xDrive 25e A Charged Edition M sport
x3	x3 30	BMW X3 xDrive30d TwinPower Turbo A F25 M-Sport - Lhes kaikin saatavissa olevin varustein-	BMW X3 xDrive30e Farmari (AC) 4ov 1998cm3 A
x5	x5 40	BMW X5 xDrive40d A TwinPower Turbo E70 SAV - HUD - IMUOVET - Adaptiivinen vakkari	BMW X5 F15 xDrive40e PURE EXCELLENCE ADAPT. LED-AJOVALOT 360-KAMERAT PANORAMA COMFORT-PENKIT NA

Table B.2: Toyota - Make-Model and Make-Model-Power Groups

Make-Model group	Make-Model-Power group	ICE example	Hybrid example
auris	auris 18	Toyota TOYOTA AURIS Monikyttajoneuvo (AF) 4ov 1364cm3	Toyota Auris 1 8 HSD Linea Sol Plus 5ov. Nyt korko 2 9% ilman kuluja ja kasko 0EUR vuodeksi 5.-10.9
camry	camry 25	Camry Business Edition 2,5-l-VVT-i, 131 kW (178 PS) Limousine Stufenloses Automatikgetriebe	Camry Business Edition Hybrid: 2,5-l-VVT-i, 131 kW (1 Limousine Stufenloses Automatikgetriebe
chr	chr 18	CHR ADVANCE 122 CC	TOYOTA C-HR 1 8 Hybrid Premium Edition Musta-ruskea osanahkaverhoilu - Bi-LED-ajovalot - Navi - L
	chr 20	C-HR Style Selection 2,0	Toyota C-HR 2 0 Hybrid Limited Launch Edition
corolla	corolla 18	Toyota COROLLA VERSO 1.8 VVT-i Sol LOHKO+SP KAHDET HYVT RENKAAT AUT. ILMASTOINTI HYV HK SUOMIA	Corolla Business Edition 1,8-l-Hybrid Touring Sports Stufenloses Automatikgetriebe
	corolla 20	Toyota Corolla Verso 2 0 D-4D 116 Linea Sol 7p Business	Corolla Business Edition 2,0-l-Hybrid Touring Sports Stufenloses Automatikgetriebe
rav4	rav4 25	RAV 4 2.5 HDF SQUARE COLLECTION+FP	Toyota RAV4 2 5 Hybrid AWD Premium - Vetokoukku Adaptiivinen vakionopeudensdin Peruutuskamera N
yaris	yaris 15	Yaris Style Selection White 1,5-l -VVT-iE 5-TÃŒrer stufenloses Automatikgetriebe	TOYOTA Yaris 1 5 Hybrid Launch Edition 5ov Toyota Touch with Go -mediakeskus suomenkielisell na

Table B.3: Volkswagen - Make-Model and Make-Model-Power Groups

Make-Model group	Make-Model-Power group	ICE example	Hybrid example
golf	golf 10	Volkswagen GOLF Variant Comfortline 1 0 TSI 85 BLUEM DSG - Suomiauto 1-omistaja Lohkolmmitin	VOLKSWAGEN Golf Variant Variant 1 0 eTSI (MHEV) 81 kW DSG-automaatti
	golf 14	VOLKSWAGEN Golf Variant Comfort 1.4 Tsi 103 kw Dsg-aut Nyt korko 2 9% ilman kuluja + kasko 0 e vuode	Volkswagen GOLF GTE 1.4 TSI 150kW/204hv DSG-AUTOMAATTI
	golf 15	VOLKSWAGEN Golf Sportsvan Comfortline 1 5 TSI EVO 96 kW (130 hv) DSG-automaatti Football Edition	VOLKSWAGEN GOLF First Edition 1 5 eTSI 110 kW (MHEV) DSG-automaatti
jetta	jetta 14	VOLKSWAGEN Jetta Comfort 1 4 TSI 92 kW (125 hv) Blue-Motion Technology DSG-automaatti	VOLKSWAGEN Jetta Hybrid 1 4 TSI 110 kW (150 hv) DSG-automaatti
passat	passat 14	Volkswagen Passat Variant Comfortline 1 4 TSI 90 kW (122 hv) DSG-automaatti BlueMotion Technology Hy	Volkswagen Passat 1.4 GTE Variant Plug-In Hybrid 160kW Autom.Navi LED-Valot Adapt.Cruise CarPlay
touareg	touareg 30	VOLKSWAGEN Touareg 3 0 V6 TDI 180 kW (245 hv) 4MOTION BlueMotion Technology Tiptronic-automaatti R-L	TOUAREG 3.0 HYB

Table B.4: Peugeot - Make-Model and Make-Model-Power Groups

Make-Model group	Make-Model-Power group	ICE example	Hybrid example
3008	3008 16	PEUGEOT 3008 Active Pack 120 VTi (Korko 1 69% ja 1. er? kes?kuussa!)	3008 1.6 HYBRID ALLURE PACK E-EAT8
	3008 20	3008 BUSINESS PACK 2.0L HDI 150CH FAP BVM6 +OPT	3008 HYBRID4 104G 2.0L HDI 163 CH FAP BMP6 +ACC
508	508 16	Peugeot 508 1.6 8V E-HDI ALLURE S&S ""CIEL"" SW ROBO	508 SW 1.6 HYBRID GT LINE E-EAT8
	508 20	Peugeot 508 2.0 16V HDI ACTIVE ""CIEL"" 163CV SW AUT	508 RXH 2.0 HDI HYBRID4 LIMITED EDITION

Table B.5: Hyundai - Make-Model and Make-Model-Power Groups

Make-Model group	Make-Model-Power group	ICE example	Hybrid example
i30	i30 16	Hyundai I30 1 6 GDI ISG iNNOVATION **Korko 1% ja 3 kk lyhennysvapaata**	i30 Kombi 1.6 CRDI 48V-Hybrid DCT N-Line
kona	kona 10	Hyundai Kona Monikyttajoneuvo (AF) 5ov 998cm3 1.0 TGDI FRESH MY 20	Hyundai Kona N-Line 1.0 T-GDI Hybrid 48V
	kona 16	HYUNDAI Kona 1.6 T-GDI 177 hv 4WD 7-DCT-aut. Comfort MY19 WLTP	Hyundai KONA 1 6 hybrid 141 hv 6-DCT Comfort MY20
tucson	tucson 20	Hyundai 5D TUCSON MPV 2.0 J-81BP-4X4/263 2.0i GLS 4WD A/C	HYUNDAI Tucson 2.0 CRDi 48V hybrid 4WD 8AUT Premium Exclusive MY19

Table B.6: Lexus - Make-Model and Make-Model-Power Groups

Make-Model group	Make-Model-Power group	ICE example	Hybrid examplee
es	es 300	Lexus ES300 Executive	LEXUS ES300 2 5 Hybrid Comfort Navi
gs	gs 300	Lexus 4D GS300 SEDAN 3.0 AUTOMATIC-GRS190L-BETQHW/285	GS 300H NG LUXE 17
	gs 450	LEXUS GS450 0	Lexus GS 450h V6 Executive A KORKO NYT ALK.1 99%
is	is 200	LEXUS IS SALOON 200t F-Sport 4dr Aut	Lexus Is200h
	is 300	Lexus IS 300	LEXUS IS 300h F-SPORT PREMIUM SPORT+ ALUSTANS??T? AVAIMETON NAVI L?MM + ILMAST. S?HK. PENKIT MUIS
nx	nx 25	LEXUS NX 2.5H ECVT 4WD MY15	LEXUS NX ESTATE 300H 2.5 LUXURY 5DR
	nx 300	NX 300 EXECUTIVE	Lexus NX 300h Hybrid A AWD Executive NAHKAT NAVI LASIKATTO ACC CRUISE YMS.
rc	rc 300	RC 300	Lexus LEXUS RC300H Coup (AD) 2ov 2494cm3
rx	rx 400	LEXUSRX40033V6PRESIDENT	LEXUS RX 400hybrid 4WD Nyt korko 2.9% ilman kuluja +kasko 0e vuodeksi 1.7 saakka !
	rx 450	RX TOUS CHEMIN 450	LEXUS RX 450h Hybrid 4WD A F Sport Lhes kaikilla varusteilla / Led / ML Premium Surround / 360

Table B.7: Honda - Make-Model and Make-Model-Power Groups

Make-Model group	Make-Model-Power group	ICE example	Hybrid example
civic	civic 13	CIVIC 1.3 DSI I-VTEC HY.EL.EC	CIVIC 1.3 DSI I-VTEC HYBRID EXECUTIVE
	civic 14	HONDA Civic 1 4i Sport Business 5d *Korko 2 9 % ilman kuluja ja kasko vuodeksi 0 ? 10.9.asti *	HONDA Civic 4D 1.4i CVT AT Hybrid (ESITTELY)
crv	crv 20	HONDA CR-V 2 0i Elegance Plus Automaatti neliveto Xenon-valot lasikatto ym..	HONDA CR-V ESTATE 2000 2.0 I-MMD HYB
jazz	jazz 13	Jazz 1.3 CVT-Automatikgetriebe Comfort	Jazz 1,3 IMA Hybrid Exclusive CVT
	jazz 14	Honda JAZZ 1.4i LS 5d AT 1-OMISTAJALTA HUOLLETTU AUTOMAATTIVAIHTEINEN	JAZZ 1.4 HYBRID ELEGANCE

Table B.8: Ford - Make-Model and Make-Model-Power Groups

Make-Model group	Make-Model-Power group	ICE example	Hybrid example
cmax	cmax 20	Ford Grand C-Max 2 0 TDCi 163 hv PowerShift autom. Titanium Business A6 5-ovinen(webasto 7henk)	FORD Grand C-Max 2 0 TDCi 140 hv PowerShift autom. Titanium Business A6 5-ovinen
	cmax cb3	Grand C-Max (CB7)(2010->) Champions Edit	CMAX 2010 GD C-MAX 2TDCI140FAP
kuga	kuga 20	FORD Kuga 2 0 EcoBlue 190hv A8 AWD Titanium X Launch Edition 5-ovinen	FORD Kuga 2 0 TDCi 150 hv Diesel PowerShift AWD Titanium Business Automaatti NELIVETO
	kuga 25	Kuga 2,5 Turbo Titanium 4x4 Aut.	FORD Kuga 2 5 Ladattava hybridi (PHEV) 225hv CVT FWD Titanium X Launch Edition 5-ovinen
puma	puma 10	Puma ST Line X 1.0 E	FORD Puma 1 0 EcoBoost Hybrid (mHEV) 155hv M6 ST-Line X Launch Edition 5-ovinen
transit	transit 125	AMBULANCE G-MAX TYPE A1 TRANSIT 125CV FINITION TRE	FORD Transit Custom 340 (1 0 EcoBoost 125 hv) PHEV 1-AUTO Etuveto Trend Van N1 L1H1
	transit 20	FORD Transit Van etuveto 300M 2 0TDI 100 av.3300. Nyt korko 2 9% ilman kuluja ja kasko 0EUR vuodeksi	FORD Transit Custom 320 2 0TDCi 130 hv mHEV M6 Etuveto Trend Van N1 L2H1

Table B.9: Volvo - Make-Model and Make-Model-Power Groups

Make-Model group	Make-Model-Power group	ICE example	Hybrid example
v60	v60 d2	Volvo V60 D2 Momentum Business A (MY13.4)	Volvo V60 PLUG IN HYBRID 2.4D Autom.
	v60 d3	Volvo V60 D3 Automat. City Safety Webasto Vetokoukku 2alut. Hihna vaihdettu	V60 T6 AWD 304ch Summum Gear
	v60 d5	VOLVO V60 D5 Momentum A *Korko 2 9% ilman kuluja ja ilmainen kasko vuodeksi 31.7.asti*	VOLVO V60 D5 AWD Plug in hybrid
	v60 d6	Volvo V60 D6 AWD Pure Edition nro.53 VOC + Driver Support	Volvo V60 D6 AWD Twin Engine R-Design plug in hybrid 162kW Autom. Webasto Navi P.kamera Volvo on
v70	v70 d5	Volvo V70 D5 AWD Summum aut. AC seats Dynaudio Premium Audio BLIS Adaptive Cruise Bluetooth.	Volvo 5D 5D V70 Plug In Hybrid
xc90	xc90 20	VOLVO XC90 DIESEL ESTATE 2.0 D5 Powe	VOLVO XC90 2.0 T8 Plug-in Hybrid Inscription ACC 7-paik

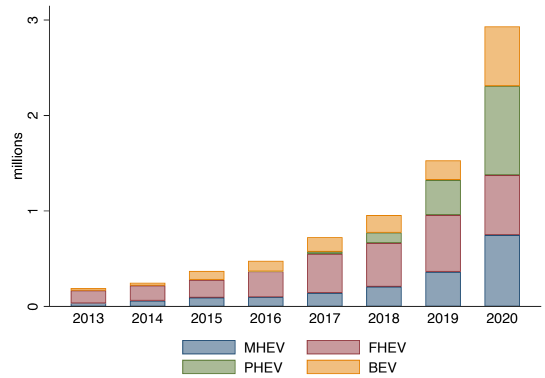
Table B.10: Mercedes - Make-Model and Make-Model-Power Groups

Make-Model	Make-Model-Power	ICE example	Hybrid example
aclass	a250	MERCEDES-BENZ A 250 BE A AMG-LINE 211HV *KUNNON KARKKI! NIGHT PANORAMA HARMAN KARDON ILS COMAND	MERCEDES-BENZ A 250 e A sedan Business Style Edition EQ Power
cclass	c200	MERCEDES-BENZ C 200 CDI BE A Premium Business Facelift Korko 1 95 / kotiintoimitus 0 EUR / ILS /	Mercedes-Benz C 200 T A Hybrid Business Avantgarde
	c205	MERCEDES-BENZ C-farmari (S205) Mercedes-AMG C 43 4Matic T A WLTP	C-Klasse Kombi Diesel/Hybrid (S205)
	c300	MERCEDES-BENZ C 300 CDI BE T 4MATIC A AVANTGARDE KORKO 1.9%	MERCEDES-BENZ C 300 e 4Matic A Business Avantgarde Edition EQ Power
	c350	Mercedes-Benz C 350 CDI 4MATIC Farmari (AC) 4ov 2987cm3 A	MERCEDES-BENZ C 350 E AUTOMAT TOURING AVANTGARDE NAVIGAATTORI BURMESTER AUDIO 360 KAMERA ILS-VAL
eclass	e212	E-Klasse Kombi Diesel Allrad (W212)	E-Klasse Kombi Diesel/Hybrid (W212)
	e213	E-Klasse Kombi Diesel Allrad (W213)	E-Klasse Diesel Hybrid (W213)
	e250	Mercedes-Benz E 250 CDI BE Avantgarde 204 hv Autom. AMG-Sport Pack SUOMI-AUTO ! LUUTA LAKAISI HINNA	E 250 Elegance BlueEfficiency CDI Aut.
	e300	MERCEDES-BENZ E 300 Bluetec 7G-Tronic Plus Avantgarde	Mercedes-Benz E 300 de A AMG-Line EQ Power Plug In Hybrid Distronic Plus Widescreen HUD 360 Pan
	e350	Mercedes-Benz E 350 CDI BE A Tydellinen merkkiliikeen huoltohistoria Kilometreihin nhden hienoss	MERCEDES-BENZ E 350 AVANTGARDE Limousine Plug-in Hybrid Benzin/Elektro AMG AMG Styling paketti -
gla	gla 250	MERCEDES-BENZ GLA 250 4Matic A Premium Business	MERCEDES-BENZ GLA 250 e A Business EQ Power
glc	glc 253	GLC CoupÃ© Diesel Allrad (C253)	GLC CoupÃ© Hybrid Allrad (C253)
	glc 300	MERCEDES-BENZ GLC 300 d 4Matic A Business Facelift	Mercedes-Benz C GLC 300 e 4MATIC Viistoper (AB) 5ov 1991cm3 A
	glc 350	MERCEDES-BENZ GLC GLC 350 D 4MATIC Viistoper (AB) 5ov 2987cm3 A	Mercedes-Benz GLC 350 e 4Matic Luxury Package Burmester Sporttinahat IHC+ Comand 360
gle	gle 350	Classe GLE / GLE 350 D 4M EXCLUSIVE PLUS (DA1/DA2) COUP+	MERCEDES-BENZ GLE 350 350e COUPE 4MATIC EQ POWER
	gle 500	Mercedes Benz GLE 500 0	MERCEDES-BENZ GLE 500 e 4matic A 442hv Ladattava Hybridi Airmatic Tutkat Park Assist Kulutus 3
sclass	s221	MERCEDES-BENZ S 4D S 500 SEDAN 4MATIC-221186-4X4/317	S-Klasse Lang Hybrid (V221)
	s222	S-Klasse Lang Allrad Diesel (W222)	S-Klasse Lang Hybrid (V222)
	s300	S 300	Mercedes-Benz S 300 BLUETEC HYBRID Sedan (AA) 4ov 2143cm3 A
	s400	Classe S / S 400D 4MATIC PREMIUM PLUS	Mercedes-Benz S 400 HYBRID Sedan 0
	s500	Mercedes-Benz S 500 4MATIC Sedan (AA) 4ov 4663cm3 A	Mercedes-Benz S 500 PLUG IN HYBRID Sedan (AA) 4ov 2996cm3 A
	s560	Classe S / S 560 PREMIUM PLUS	MERCEDES-BENZ S S 560 e Sedan (AA) 4ov 2996cm3 A

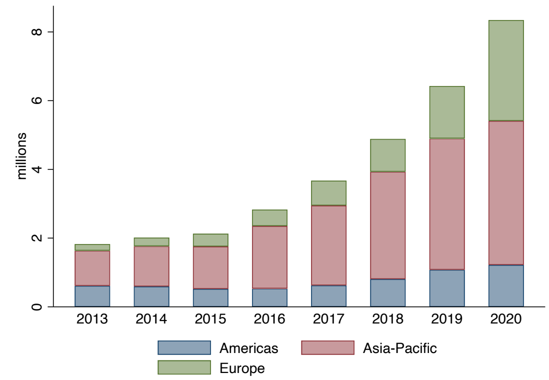
C EV Growth

C.1 Sales by vehicle type and region

a. Europe only

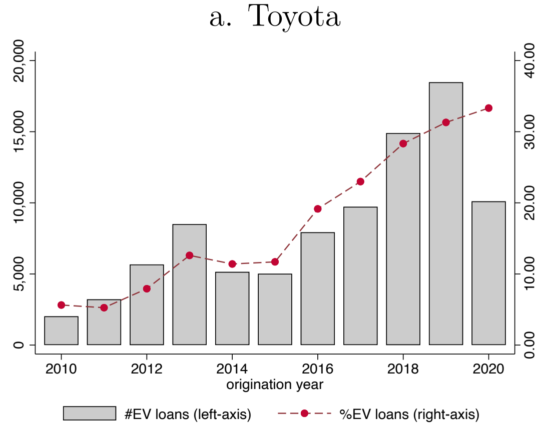


b. Worldwide

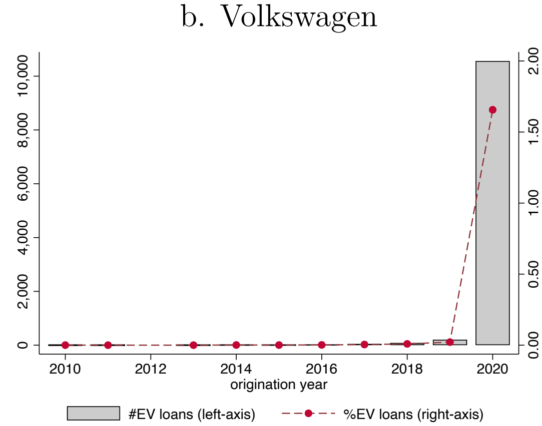


C.2 Loans by make

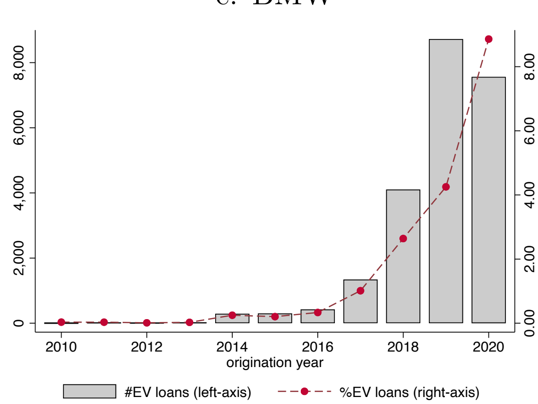
a. Toyota



b. Volkswagen



c. BMW



d. Peugeot

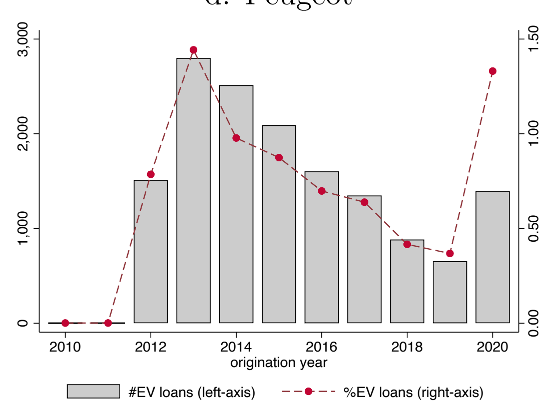


Table C.1: Loan Characteristics by Vehicle Type

Panel a. Hybrid/BEV loans

	mean	sd	p10	p25	p50	p75	p90	count
rate (%)	4.460	1.98	3.00	3.00	4.00	5.00	7.00	128,016
LTV (%)	65.385	24.66	33.50	47.72	64.77	89.19	94.26	117,240
maturity (month)	48.413	14.90	36.00	36.00	48.00	60.00	60.00	128,016
car loan value (€1,000)	23.340	11.71	10.79	14.90	21.00	30.00	38.28	128,016
car price (€1,000)	26.802	9.75	15.33	18.99	25.80	34.20	39.80	27,760
income (€1,000)	38.133	33.18	12.00	22.95	28.00	44.00	72.00	128,016
income verified	0.350	0.48	0.00	0.00	0.00	1.00	1.00	128,016
non-performing	0.037	0.19	0.00	0.00	0.00	0.00	0.00	128,016

Panel b. ICE loans

	mean	sd	p10	p25	p50	p75	p90	count
rate (%)	4.673	2.69	1.50	3.00	4.00	6.00	8.95	7,778,793
LTV (%)	76.371	26.36	40.00	60.00	80.00	100.00	105.00	7,341,122
maturity (month)	51.060	15.71	36.00	40.00	48.00	60.00	72.00	7,778,793
car loan value (€1,000)	19.154	9.71	8.50	12.32	17.50	24.40	31.47	7,778,793
car price (€1,000)	19.634	8.75	10.12	13.45	18.03	24.30	31.00	4,397,023
income (€1,000)	33.724	27.32	12.92	18.00	26.00	41.00	60.00	7,778,793
income verified	0.756	0.43	0.00	1.00	1.00	1.00	1.00	7,778,793
non-performing	0.040	0.20	0.00	0.00	0.00	0.00	0.00	7,778,793

NOTE.—This table presents summary statistics for our key explanatory and outcome variables. Panel a. includes EV loans and Panel b non-EV loans. The sample period is January 2010 to August 2021.

Table C.2: Warranty Summary

manufacturer	power type	after year	coverage	components	months	distance km
BMW	green - hybrid/electric	2022	powertrain - battery	Extensive Battery Warranty	96	160000
BMW	green - hybrid/electric	2022	powertrain - used	Powertrain Limited Warranty - Certified Pre-Owned Hybrid/Electric (from the vehicle in-service date)	60	unlimited
Ford	green - hybrid/electric	2022	powertrain	Hybrid/Electric unique components	96	160000
Honda	green - hybrid/electric	2022	powertrain	Hybrid system	36	60000
Honda	green - hybrid/electric	2022	powertrain	Hybrid system (some parts, see mannual p13-14)	96	160000
Hyundai	green - hybrid/electric	2019	powertrain	HEV and PHEV system	96	160000
Hyundai	green - hybrid/electric	2019	powertrain	EV system	96	160000
Lexus	green - hybrid/electric	NA	powertrain	Hybrid-related components	96	160000
Lexus	green - hybrid/electric	NA	powertrain - battery	Hybrid High Voltage battery	120	240000
Mercedes	green - hybrid/electric	NA	overall	EQB SUV	96	160000
Mercedes	green - hybrid/electric	NA	overall	EQE, EQS	120	250000
Peugeot	green - hybrid/electric	NA	powertrain - battery	Traction battery	96	unlimited
Toyota	green - hybrid/electric	2023	powertrain	Hybrid-Related Components Warranty (includes Battery Control Module, Hybrid Control Module, Inverter with Converter)	96	160000
Toyota	green - hybrid/electric	2023	powertrain - battery	Hybrid Battery Warranty	120	240000
Toyota	green - hybrid/electric	2023	powertrain	BEV Specific Components Warranty (inlcudes Transaxle, Inverter with Converter)	96	160000
Toyota	green - hybrid/electric	2023	powertrain - battery	Electric Vehicle Battery Warranty	96	160000
Toyota	green - hybrid/electric	2023	powertrain - battery	Electric Vehicle Battery Capacity Warranty (applied to battery capacity below 70% of original capacity)	96	160000
Volkswagen	green - hybrid/electric	NA	overall	New Vehicle Limited Warranty (wear & tear items and adjustments excluded after initial 12 months / 20,000 km)	48	80000
Volkswagen	green - hybrid/electric	NA	powertrain	Mechanical Powertrain	60	100000
Volkswagen	green - hybrid/electric	NA	powertrain - battery	High Voltage System Limited Warranty	96	160000
Volvo	green - hybrid/electric	2022	powertrain - battery	any material defect of the hybrid Lithium battery pack (Loss of battery capacity due to or resulting from normal gradual capacity loss is not covered)	96	150000

Table C.2: Warranty Summary - Cont'd

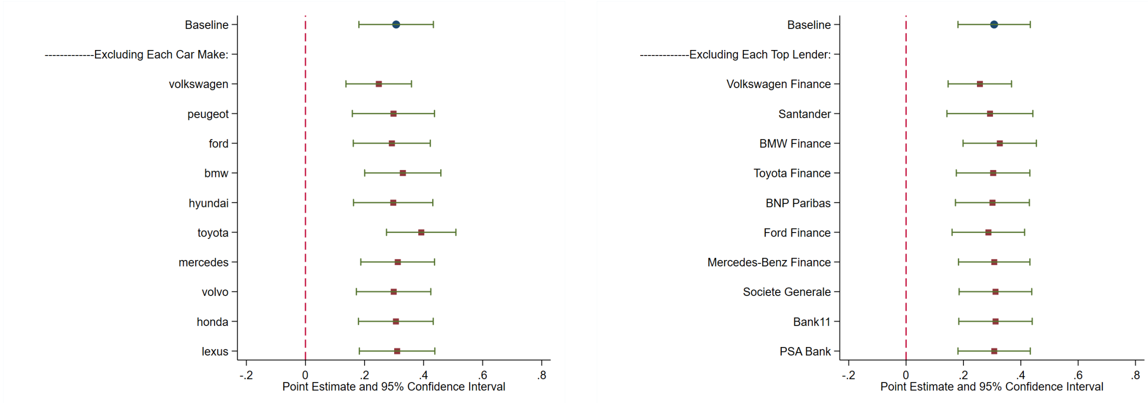
manufacturer	power type	after year	coverage	components	months	distance km
BMW	all	2022	overall	Basic New Vehicle Limited Warranty	48	80000
Ford	all	2022	overall	Basic New Vehicle Limited Warranty	36	60000
Ford	all	2022	powertrain	powertrain	60	100000
Ford	conventional - diesel	2022	powertrain	Diesel engine	60	160000
Ford	conventional - diesel	2022	powertrain	Diesel engine unique powertrain	60	160000
Honda	all	2022	powertrain	Powertrain	60	100000
Honda	all	2022	overall	Basic new vehicle parts (distributor's warranty)	36	60000
Honda	all	2022	powertrain - battery	Battery 100%	24	unlimited
Honda	all	2022	powertrain - battery	Battery 50% retail price (excluding labor)	36	unlimited
Hyundai	all	2019	overall	Basic New Vehicle Limited Warranty	60	100000
Hyundai	all	2019	powertrain	Powertrain	60	100000
Hyundai	all	2019	powertrain - battery	Battery	24	40000
Lexus	all	NA	overall	Comprehensive Coverage (any original Lexus part)	48	80000
Lexus	all	NA	powertrain	Powertrain & Safety Restraints	72	110000
Mercedes	all	2014	overall	Basic New Vehicle Limited Warranty	48	80000
Peugeot	all	NA	overall	Defective parts, except normal wear and tear	36	unlimited
Toyota	all	2023	overall	Basic New Vehicle Limited Warranty	36	60000
Toyota	all	2023	powertrain	Powertrain New Vehicle Limited Warranty (Hybrid Transaxle (w/motors) is covered by Powertrain Warranty)	60	100000
Volkswagen	conventional	2018	overall	New Vehicle Limited Warranty (wear & tear items and adjustments excluded after initial 12 months / 20,000 km)	48	80000
Volkswagen	conventional	2018	powertrain	Powertrain Limited Warranty	60	100000
Volvo	all	2022	overall	any component failure attributable to faulty materials or workmanship during manufacture	36	100000

D Additional Robustness Checks

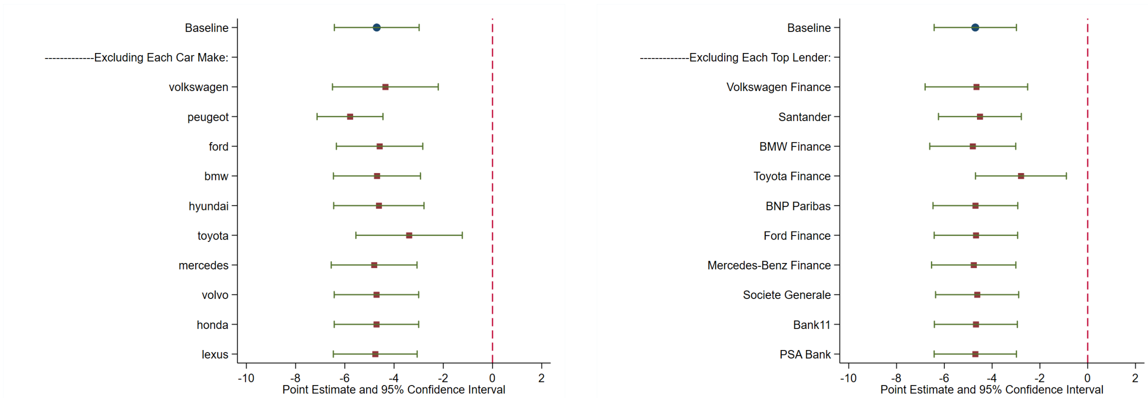
Figure D.1: Robustness Checks Across Makes and Lenders

Make **Lender**

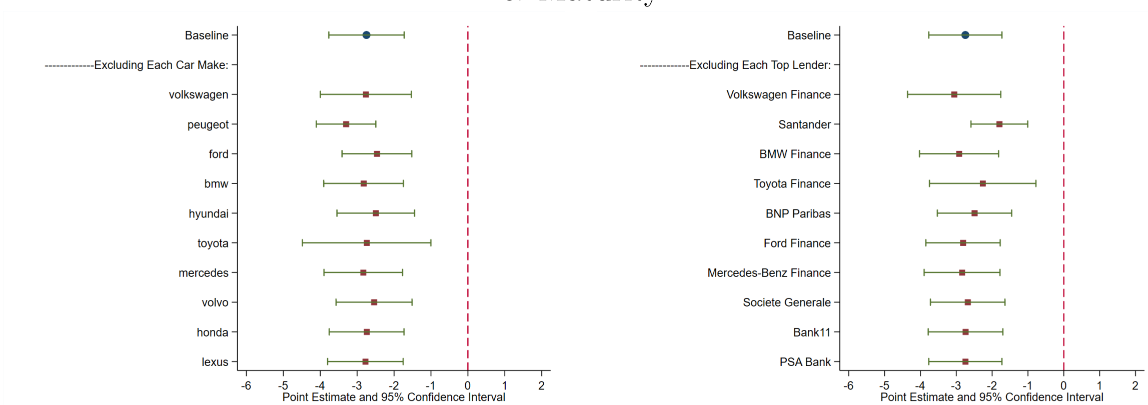
a. Interest Rate



b. LTV



c. Maturity



NOTE.—Figure D.1 presents the point estimates of the EV indicator using alternative regression samples, in which we exclude one significant car manufacturer or lender at a time. We study each of the following three outcome variables: interest rate (panel a), LTV (panel b), and maturity (panel c).

E The Financing Gap in the US

The auto data for the US is available under Regulation AB II. Momeni and Sovich (2022) and Hankins et al. (2022) provide a detailed description of the data and find it to be a nationally representative sample. We followed the same procedure to clean up car model names and flag different types of EVs. Because different ABS issuers report model names with different levels of accuracy, we identified and kept only the ABS issuers with high accuracy for our analysis. Those issuers are Harley-Davidson Customer Funding Corp., BMW Auto Leasing LLC, BMW Financial Services (FS) Securities LLC, CarMax Auto Funding LLC, Carvana Receivables Depositor LLC, Daimler Retail Receivables LLC, Daimler Trust Leasing LLC, Hyundai ABS Funding LLC, Toyota Auto Finance Receivables LLC. The most popular EV makes in our analysis sample are listed in Table E.1 - Panel A with the respective number of hybrid/BEV and ICE auto loans reported. The sample covers loans originated between 2013 January and 2022 June.

Table E.1 - Panel B presents the summary statistics on the loan and borrower characteristics. Compared to the auto loans in the EDW data, US auto loans in our analysis sample on average have a lower interest rate (3.44 p.p. vs. 4.67 p.p.) and a longer maturity (66 months vs. 51 months). 12% of the loans are associated with a hybrid/BEV and this fraction is 3.8% when we include the full list of ABS issuers. We control for a rich array of borrower characteristics including the income and employment verification status, credit score, as well as the subvention status. The vast majority of the borrowers have their income and employment verified. Around 38% and 33% of the loans received interest rate subsidy and cash rebate, respectively.

Our regression specification is largely similar to the baseline specification, except that we replace the NUTS3-level region with state in Table 2 Panel A. We do not examine the gap in LTV ratio as it is not available in the US dataset. The results are reported in Table E.2. We estimate a 25-basis-point gap in the interest rates and a 1.8-month gap in the maturity. The rate gap represents 7.3% the sample average rate.

Table E.1: Summary Statistics on Loan Characteristics

Panel A. Loan origination by make

	#Hybrid/BEV loans	#ICE loans
toyota	271,265	1,822,966
lexus	29,661	228,856
hyundai	25,651	435,934
kia	24,652	393,355
ford	1,763	29,593
chevrolet	1,626	29,9463
nissan	1,373	25,333
honda	1,171	21,320
bmw	847	12,565

Panel B. Loan characteristics

	mean	sd	p10	p25	p50	p75	p90	count
rate (%)	3.44	3.57	0.00	0.90	2.90	4.90	7.34	2,999,868
maturity (month)	66.20	8.07	61.00	61.00	67.00	73.00	74.00	2,999,868
car price ($1,000)	28.10	11.09	16.63	20.77	26.59	34.34	41.60	2,999,868
credit score	758.11	73.19	665.00	709.00	760.00	816.00	850.00	2,999,868

NOTE.—Panel A presents the number of hybrid/BEV loans and ICE loans by car make in the US using data from ABS-EE. Panel B presents summary statistics on loan characteristics. The sample period is January 2013 to June 2022.

Table E.2: Financing Terms of HEVs/PHEVs vs. ICEs: US Data

	(1) rate	(2) maturity
Hybrid	0.252***	−1.823***
	(0.04)	(0.15)
lender FE	Y	Y
deal FE	Y	Y
make-model FE	Y	Y
state × year FE	Y	Y
borrower controls	Y	Y
Observations	2,999,868	2,999,868
R-sq	0.721	0.157

NOTE.— This table shows the financing gap in interest rates and loan maturity using data from ABS-EE. In both columns, we include lender, ABS deal, make-model, state×year fixed effects, and control for car price (in log), income and employment verification status, credit score, and subvention category. Standard errors double clustered by ABS deal and state are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table E.3: The Collateral Risk Channel - Alternative Samples
Estimates of Vehicle Residual Values from Secondary Market Transactions

Panel A. RV estimates based on trade-in prices

	(1) RV/price	(2) SD (6m)	(3) $\Delta \in [-1\%, 1\%]$	(4) $\Delta \in [-3\%, 3\%]$	(5) $\Delta \in [-5\%, 5\%]$	(6) $\Delta < -1\%$	(7) $\Delta > 1\%$
EV	−0.034***	0.002***	0.029***	0.017***	0.009***	0.038***	−0.010*
	(0.001)	(0.000)	(0.006)	(0.003)	(0.001)	(0.005)	(0.006)
make FE	Y	Y	Y	Y	Y	Y	Y
country × year FE	Y	Y	Y	Y	Y	Y	Y
age × mileage FE	Y	Y	Y	Y	Y	Y	Y
mean outcome var.	0.538	0.013	0.279	0.047	0.012	0.121	0.158
Observations	49,922	43,705	48,654	48,654	48,654	48,654	48,654
R-sq	0.789	0.290	0.153	0.063	0.014	0.148	0.114

Panel B. RV estimates based on retail prices from all makes

	(1) RV/price	(2) SD (6m)	(3) $\Delta \in [-1\%, 1\%]$	(4) $\Delta \in [-3\%, 3\%]$	(5) $\Delta \in [-5\%, 5\%]$	(6) $\Delta < -1\%$	(7) $\Delta > 1\%$
EV	−0.051***	0.002***	0.029***	0.014***	0.009***	0.048***	−0.018***
	(0.001)	(0.000)	(0.007)	(0.003)	(0.002)	(0.005)	(0.005)
make FE	Y	Y	Y	Y	Y	Y	Y
country × year FE	Y	Y	Y	Y	Y	Y	Y
age × mileage FE	Y	Y	Y	Y	Y	Y	Y
mean outcome var.	0.629	0.014	0.305	0.058	0.017	0.132	0.173
Observations	147,961	128,457	143,956	143,956	143,956	143,956	143,956
R-sq	0.785	0.257	0.136	0.069	0.029	0.121	0.108

NOTE.— This table compares the industry benchmark estimates of residual values of EVs and non-EVs. In panel A, the monthly estimates are estimated based on trade-in prices of used vehicles for 10 makes in our sample and expert analysts from Autovista. In panel B, the monthly estimates are estimated based on retail prices of used vehicles for all makes and expert analysts from Autovista. The unit of observation is at country-make-age-mileage-fuel type-month level. In column 1, the outcome variable is residual value divided by vehicle price, or RV/price. In column 2, the outcome variable is the standard deviation of RV/price over the past 6 months. In columns 3-7, the outcome variables are based on monthly changes in the RV/price: whether the change is within 1% range, within 3% range, within 5% range, whether it is below -1%, and above 1%. *EV* is an indicator variable for whether the underlying car is EV as opposed to ICE. In all columns, we include make, country×year, and age×mileage fixed effects. There are four age×mileage scenarios: 12 months/20k km, 24 months/40k km, 36 months/60k km, and 48 months/80k km. The sample period is January 2020 to January 2024. Standard errors double clustered by the calendar year-month and country are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

F Climate Change Concerns and Macroeconomic Factors

Table F.1: Media Climate Change Concerns and the Gap in Financing Terms

	interest rate				
	(1)	(2)	(3)	(4)	(5)
Hybrid	0.257**	0.268***	0.259***	0.253**	0.354***
	(0.10)	(0.09)	(0.09)	(0.11)	(0.06)
Hybrid × MCCC index - aggregate	0.038				
	(0.04)				
Hybrid × MCCC subindex - bus. impact		0.034			
		(0.03)			
Hybrid × MCCC subindex - environ. impact			0.037		
			(0.04)		
Hybrid × MCCC subindex - societal debate				0.041	
				(0.05)	
Hybrid × MCCC subindex - research					−0.015
					(0.02)
lender FE	Y	Y	Y	Y	Y
deal FE	Y	Y	Y	Y	Y
make-model FE	Y	Y	Y	Y	Y
nuts3 × year FE	Y	Y	Y	Y	Y
borrower controls	Y	Y	Y	Y	Y
loan controls	Y	Y	Y	Y	Y
Observations	7,458,362	7,458,362	7,458,362	7,458,362	7,458,362
R-sq	0.728	0.728	0.728	0.729	0.728

Note.— This table shows that climate change concerns of consumers do not explain the gap in interest rate between HEVs/PHEVs and their ICEs counterparts. We use the Media Climate Change Concerns Index from Ardia et al. (2022). The MCCC index is a proxy for unexpected changes in climate change concerns computed from news articles. We interact various MCCC indexes with the EV indicator. From column 1 to column 5, we use the aggregate MCCC index, the subindexes based on the business impact theme, the environmental impact theme, the societal debate theme, and the research theme, respectively. To facilitate the interpretation of the coefficients, we divide these measures based on the quartiles and use the categorical values (0, 1, 2, 3). We include ABS deal, lender, make-model, and NUTS3×year fixed effects. We control for car value in log form, as well as borrower income and the verification status of income. We additionally include loan controls - LTV and maturity. The sample period is January 2010 to August 2021. Standard errors double clustered by ABS deal and NUTS3-level region are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table F.2: Macroeconomic Factors and the Gap in Financing Terms

	interest rate					
	(1)	(2)	(3)	(4)	(5)	(6)
Hybrid	0.434***	0.443***	0.303***	0.308***	0.326***	0.305***
	(0.09)	(0.09)	(0.05)	(0.06)	(0.07)	(0.11)
Hybrid × T10Y3M	−0.108					
	(0.08)					
Hybrid × AAAFF		−0.117				
		(0.09)				
Hybrid × AAABAA			0.017			
			(0.02)			
Hybrid × VIXCLS				0.013		
				(0.02)		
Hybrid × SPXret					0.001	
					(0.01)	
Hybrid × Crude Oil return						0.015
						(0.03)
lender FE	Y	Y	Y	Y	Y	Y
deal FE	Y	Y	Y	Y	Y	Y
make-model FE	Y	Y	Y	Y	Y	Y
nuts3 × year FE	Y	Y	Y	Y	Y	Y
borrower controls	Y	Y	Y	Y	Y	Y
loan controls	Y	Y	Y	Y	Y	Y
Observations	7,458,362	7,458,362	7,458,362	7,458,362	7,458,362	7,458,362
R-sq	0.728	0.728	0.728	0.728	0.728	0.728

NOTE.—This table shows that macroeconomic factors do not explain the gap in interest rate between HEVs/PHEVs and their ICEs counterparts. We interact various macroeconomic factors with the EV indicator. To facilitate the interpretation of the coefficients, we divide these measures based on the quartiles and use the categorical values (0, 1, 2, 3). We include ABS deal, lender, make-model, and NUTS3×year fixed effects. We control for car value in log form, as well as borrower income and the verification status of income. We additionally include loan controls - LTV and maturity. The sample period is January 2010 to August 2021. Standard errors double clustered by ABS deal and NUTS3-level region are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

G Alternative Measures of Technological Innovation

Table G.1: Technological Innovation and the Gap in Financing Terms: Additional Measures

Panel A. ADHMV2016 expanded

	interest rate			
	(1)	(2)	(3)	(4)
Hybrid	−0.018	−0.037	−0.350**	−0.285*
	(0.11)	(0.11)	(0.14)	(0.16)
Hybrid × number of clean patents (log)	0.221***	0.179***		
	(0.04)	(0.04)		
Hybrid × share of clean patents			0.326***	0.273***
			(0.06)	(0.06)
baseline FE, borrower & loan controls	Y	Y	Y	Y
Hybrid × EV incentive controls	N	Y	N	Y
Hybrid × socioeconomic controls	N	Y	N	Y
Hybrid × competition controls	N	Y	N	Y
Observations	2,816,501	2,816,501	2,816,501	2,816,501
R-sq	0.805	0.805	0.805	0.805

Panel B. VC investments

	interest rate			
	(1)	(2)	(3)	(4)
Hybrid	0.301***	0.191***	0.330***	0.208***
	(0.06)	(0.07)	(0.06)	(0.07)
Hybrid × VC investment in EV	0.068***	0.058***		
	(0.01)	(0.01)		
Hybrid × share of VC investment in EV			0.054***	0.049***
			(0.01)	(0.01)
baseline FE, borrower & loan controls	Y	Y	Y	Y
Hybrid × incentive controls	N	Y	N	Y
Hybrid × socioeconomic controls	N	Y	N	Y
Hybrid × competition controls	N	Y	N	Y
Observations	2,816,501	2,816,501	2,816,501	2,816,501
R-sq	0.805	0.805	0.805	0.805

NOTE.— This table shows the role of technological innovation in explaining the gap in interest rate between HEVs/PHEVs and their ICEs counterparts. We interact various measures of EV-related technological innovation with the EV indicator. In Panel A, we measure the intensity of innovation in EV-related technologies using the number (in log form) and the share of clean patents relative to all patents in the corresponding parent groups. Both measures are derived using the *expanded* classification of clean patents in Aghion et al. (2016). In Panel B, we replace the patent-based measures with the dollar amount of VC investment in the EV-related firms (in log form) and the share of dollar amount of VC investment in the EV-related firms relative to all firms. All measures are constructed at the monthly frequency. To facilitate the interpretation of the coefficients, we divide these measures based on the quartiles and use the categorical values (0, 1, 2, 3). In columns 2 and 4 of each panel, we control for significant interaction terms in previous analysis, including interaction terms of EV indicator and EV purchase subsidy, socioeconomic factors (population density, GDP per capita, median age) and competition (segment HHI - $loans). We include ABS deal, lender, make-model, and NUTS3×year fixed effects. We control for car value in log form, as well as borrower income and the verification status of income. We additionally include loan controls - LTV and maturity. The sample period is January 2010 to August 2021. Standard errors double clustered by ABS deal and NUTS3-level region are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.