One Month Longer, One Month Later? Maturity and Prepayments in the Auto Loan Market*

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Abstract

We document that auto loan maturity increased from 30 months to 70 months during the past 50 years, partly reflecting improved vehicle durability. Analyzing over half of all loans originated since 2008, we find a yield curve substantially steeper than Treasury securities for new car loans and significantly higher rates for longer-maturity loans. In spite of longer maturities, most loans were prepaid, including zero-interest ones, and many prepaying borrowers could have paid less interest if choosing shorter-maturity loans. We argue that liquidity constraints only partly explain borrower maturity choices and prepayment decisions. Behavioral factors, such as debt aversion, may also play a role. Our analysis underscores the importance of taking into account prepayment decisions in evaluating loan terms choices.

Keywords: Prepayment, Auto loan, Maturity choice, Household financial decisions, Term structure, Liquidity constraints, NPV-neglect, Debt-aversion

JEL Codes: D14, D81, E43, G41, G51, G53, L62

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1 Introduction

Auto loans constitute the second largest category of privately-provided household debt, with an outstanding balance of more than $1.5 trillion as of the end of 2023.[1] The flow of auto credit plays a critical role in supporting vehicle purchases, the largest component of U.S. household durable goods spending. Moreover, annual issuance of auto loan asset-backed securities (ABS) averaged above $100 billion in recent years, providing auto credit exposure to a broader constituency of investors.

This paper analyzes three interrelated aspects of the auto loan market: the evolution of loan maturity, the interest rate term structure across maturity, as well as borrowers' maturity choices and prepayment decisions. We begin by documenting a steady upward trend of auto loan maturity during the past 50 years. The average maturity in the early 1970s was about 30 months, and it is currently near 70 months. This trend is unique, and we find no other credit market in the U.S. having experienced a similar change.[2] We argue that, among other factors, sustained improvement in vehicle durability has contributed to this profound transformation of auto loan maturity.

We then document a robust, pronounced relationship of interest rates rising with loan maturity, particularly for new car loans. For example, new car loans with a maturity of over 72 months have an average rate 2.4 percentage points higher than loans with a maturity of 36 months or shorter—a term structure substantially steeper than that of Treasury securities between comparable maturities and a rate gap much larger than that between 30- and 15-year residential mortgages.

With respect to loan prepayment, we find that, on average, about 70 percent of auto loans originated since the early 2000s were paid off at least 6 months ahead of maturity and about 45 percent were paid off within the first 36 months. Notably, we find that a greater share of subprime and long-maturity loans were prepaid than other loans, particularly during the first two or three years after loan origination. Among prepaid loans, only one quarter to one third were associated with "trade-ins" of existing cars. In addition, we demonstrate that mortgage

[1] The largest category is residential mortgage. In addition, the student loan outstanding balance was $1.7 trillion in 2023, but the majority of such loans are Direct Loans originated by the Department of Education.

[2] For example, in the U.S. mortgage market, the 30-year fixed rate mortgages has been the dominating contract since the 1960s.

and credit card balances of borrowers who prepay their auto loans tend to decline appreciably around the time of auto loan prepayment, a pattern not shared by borrowers paying off auto loans at maturity.

Our analysis of auto loan prepayment has a particular focus on its optimality and connection with maturity choice. Specifically, we document two puzzling patterns. First, more than half of zero-interest loans were prepaid, of which fewer than one third appeared to be driven by "trade-ins." Furthermore, a substantial portion of such prepaid loans had monthly payments significantly above the scheduled levels, indicating a proactive, intended prepayment. Second, because longer-maturity loans carry higher interest rates, in hindsight, borrowers who prepaid would have been better off if they had chosen shorter-maturity loans. We estimate that borrowers could have saved thousands of dollars of interest payments in a counterfactual of choosing a maturity consistent with the timing of prepayment.

Finally, our analysis also points to interesting strategic interactions between lenders and borrowers. We find that long maturity loans are less likely to have promotional interest rates but more likely to feature cash rebates. Conversely, holding maturity constant, loans with promotional interest rate are *less* likely to be prepaid, whereas loans with cash rebates are *more* likely to be prepaid.[3]

In the Context of the Literature

This paper is not the first on lengthening auto loan maturity, but essentially all of the extant work has focused on loans originated after the year 2000.[4] We broaden the perspective to the early 1970s and show that the lengthening of auto loan maturity is not a recent phenomenon, but an enduring trend that prevailed over the past 50 years. During the same period, vehicle durability almost doubled, and we hypothesize, in the spirit of Hart and Moore (1994), that the ever-improving durability has been an important factor propelling longer loan maturity. The maturity-durability connection is explored in Argyle et al. (2021) and Garmaise et al. (2024) for a cross-section of auto loans originated in recent years, and we argue that this effect may help account for the historical trend of auto loan maturity. In a broader context, this relationship may also speak to financing acquisitions of durable assets in the corporate credit market (for

[3]We thank David Low for suggesting this research question.

[4]For recent examples, see Brevoort et al. (2017); An et al. (2020); Guo et al. (2022).

example, Rampini, 2019; Geelen et al., 2024).

There has been a massive literature on the term structure of interest rates (the yield curve) in various credit markets.[5] However, despite the substantial maturity extension, relatively little has been formally analyzed regarding the yield curve of auto loans, a gap in the literature that our paper helps to bridge. A similar contrast can be found on prepayment studies. A large volume of research has been dedicated to mortgage prepayments.[6] By contrast, only a handful of studies analyze prepayments of auto loans, with Heitfield and Sabarwal (2004) and Agarwal et al. (2008) being two notable early examples. However, limited by the then-available data, these studies were either at the securitized-pool level or analyzing loans of a particular lender.[7] Our study takes advantage of much-larger samples that cover all types of lenders and borrowers across the whole credit risk distribution, thereby achieving more robust, generalizable results. The meager research on auto loan prepayments is partly due to the relatively short maturity of such loans compared with mortgages. However, as maturities continue to extend, a better understanding of prepayments in the auto loan market is important for borrowers, lenders, and ABS investors. Interestingly, there is a nascent trend of lenders offering refinancing products in the auto loan market, further boosting the need for research in this area.

The puzzling patterns of prepayment behavior this paper illustrates are related to several strands of literature and highlight the importance of taking into account repayment behaviors in assessing loan contract choices. First, the finding of borrowers prepaying zero-interest loans, failing to take full advantage of low-cost credit, is consistent with the so-called debt-aversion behavior that has received increasing attention in recent work in other settings (for example, Martínez-Marquina and Shi, 2024, and the literature surveyed therein). More broadly speaking, this analysis contributes to the growing literature on borrower sub-optimal behaviors in household credit markets. For instance, Ponce et al. (2017), Gathergood et al. (2019), and Agarwal et al. (2023) find potentially sub-optimal behaviors in the credit card market, Argyle et al. (2020)

[5]The classic study by Cox et al. (1985) has over 12,000 Google Scholar citations.

[6]Early work typically focused on modeling rational, optimal prepayment decisions and the implications on the valuation of mortgages and mortgage-backed securities (MBS) (see, for example, Stanton, 1995; LeRoy, 1996). Recent analysis has a broader scope, ranging from behavioral bias and racial disparity to the efficacy of monetary policy associated with mortgage refinancing and prepayment (Keys et al., 2016; Geradi et al., 2023; Berger et al., 2021).

[7]Thousands of auto loans are typically packed into one securitized pool. More recently, Grunewald et al. (2024) consider the extent to which prepayment risk may affect dealer markups on auto loan interest rates, but loan prepayment is not the focus of their analysis.

in the auto loan market, and Li and Smith (2010) for pension loans.[8]

Second, our results reinforce the notion of Argyle et al. (2020) that liquidity constraints alone are not sufficient to explain auto loan maturity choices, as a substantial share of subprime, long-maturity loans were prepaid, many within the first few years. Because liquidity constraints tend to be rather persistent (Aguiar et al., forthcoming; Kaplan and Violante, 2022), we argue that some of the borrowers prepaying long-maturity loans did not choose such a contract merely for liquidity considerations. In addition, with the quasi-universe sample of loans, we are able to estimate the prevalence of monthly scheduled payment bunching, which accounts for less than 3 percent of the entire market—a fairly modest share. Moreover, we find that loans with bunching-integer monthly payment have an even higher prepayment likelihood, lending additional support that such monthly payment bunching is not solely a result of liquidity constraints.

Third, our results highlight a mismatch between *ex-ante* loan maturity choices and *ex-post* prepayment. Similarly, Lehnert et al. (2006) argue that, before hybrid ARMs gained popularity, many mortgage borrowers paid high interest rates on 30-year fixed rate mortgages that did not match with their expected mobility in the ensuing years. This mismatch appears consistent with the so-called "NPV neglect" behavior, a term introduced in Shu (2013) and more recently studied by Argyle et al. (2021) and Bäckman et al. (2024).

Finally, our paper is also related to the work studying how borrower maturity choices are correlated with unobserved credit risks. Hertzberg et al. (2018) show that borrowers choosing longer-maturity *unsecured* consumer loans are more likely to default. More recently, An et al. (2020) and Guo et al. (2022) show that long-maturity auto loans have a higher default risk, conditional on observed loan and borrower characteristics. We find that longer-maturity loans have a comparable, or even greater, prepayment risk than loans with shorter maturities, suggesting that the connection between maturity choice and borrower type is more nuanced. Like Hertzberg et al. (2018), we emphasize that it is important to understand whether both short- and long-maturity loans are available to the borrowers so that they are making an active choice (optimal or not) instead of having to take the only option offered by lenders.

Some Cautious Caveats

[8]In addition, a sizable literature deals with the so-called credit card debt puzzle, where borrowers hold high-interest rate credit card debt and low-yield liquid assets at the same time (Telyukova and Wright, 2008; Bertaut et al., 2009; Gorbachev and Luengo-Prado, 2009).

It is important to note that auto loan contracts are intrinsically complex to study—not only because they include many term elements (maturity, loan amount, interest rate, etc.), but also because these terms can be jointly determined with the vehicle price, often involving negotiation and bargaining among lenders, dealers, and borrowers. Accordingly, elaborated structural models that take into account the optimization behaviors of these players (e.g., Einav et al., 2012; Grunewald et al., 2024) can yield interesting insights not delivered by reduced-form analysis. Conversely, counterfactual analysis based on reduced-form estimates should be mindful of such caveats.

That said, as we detail below, a unique strength of this study is the use of several large data sets that cover a substantial portion of the universe of U.S. auto loans to provide dovetailing perspectives on auto loan terms and repayment decisions. For example, the data set we use to estimate the yield curve of auto loans covers over 55 percent of the entire market. Such a sample with nearly 200 million loans allows us to estimate highly flexible specifications with few parametric assumptions. It also enables us to uncover useful heterogeneities across market segments, lenders, and borrowers. As a result, while our estimates are not structural in nature, we argue that they are fairly generalizable and capable of shedding light on the underlying relationship of interest.

One important aspect of the auto loan market is the potential predatory or discriminatory practice of lending (see, for example, Charles et al., 2008; Butler et al., 2023). Some of the empirical patterns we find may be associated with such behaviors. However, because the data we use do not have detailed information on demographic characteristics, we are not able to address this important question in the current paper. Finally, we point out that this paper does not consider leasing as an alternative to loan financing. Leasing represents an important source of auto financing and, according to an Experian study, about 20 percent of household new vehicle acquisitions in recent years were by leasing. In a seminal contribution, Hendel and Lizzeri (2002) discuss the role of leasing under adverse selection, a salient feature of the used car market (Akerlof, 1970). Interestingly, Hendel and Lizzeri (2002) also point out the role of improved vehicle durability with respect to the evolution of the leasing market.[9]

The remainder of the paper proceeds as follow: Section 2 describes the three main data sets

[9]In the corporate finance market, Eisfeldt and Rampini (2009) compare leasing and secured lending, and some of the insights therein may be applied to the auto financing market.

we use and discusses their respective strengths and limitations. Section 3 documents the auto loan maturity trend and discusses possible relevant factors. Section 4 discusses our estimates of the auto loan yield curve derived from origination data, supplemented with loan offer evidence. Section 5 outlines an array of stylized facts on prepayment, and Section 6 zooms in on two puzzling patterns in prepayment. Section 7 concludes and proposes several promising future research directions.

2 Data

We use three high-quality administrative data sources in our analysis, leveraging their respective strengths. We use data through December (or Q4) 2023 for all three samples.

2.1 The Experian AutoCount Data

This loan-level data set has a near-universe coverage of the U.S. auto loan market at origination from 2008.[10] Removing loans with incomplete maturity information, the sample includes nearly 200 million loans, accounting for more than 55 percent of all originations between 2008 and 2023. The data set includes detailed information on loan characteristics, such as maturity, interest rate, amount financed, scheduled monthly payment, and the borrower's credit score at origination, for both new and used car loans. In addition, the data cover all major lender types in this market—banks, credit unions, captive and independent finance companies—and the lender type information is available for each loan. Captive finance companies are the financing units associated with major auto manufacturers, and these lenders often offer financing incentives (e.g., zero percent interest rate) to promote vehicle sales. By contrast, independent finance companies are not affiliated with auto makers and many of such lenders concentrate on lending to subprime borrowers.[11]

Many existing studies of the auto loan market focus on either new or used car loans and use data from a single lender (Agarwal et al., 2008) or a subset of one particular type of lenders (Argyle et al., 2020). Because of the differences in business model and targeted borrowers,

[10] The data do not include loans originated in Washington DC, Delaware, Oklahoma, and Rhode Island.

[11] Another lender type categorized in the AutoCount data is the so-called Buy Here Pay Here (BHPH) lenders. BHPH lenders are auto dealerships that provide in-house financing for the vehicles purchased. These lenders provide credit primarily to used car buyers with low credit scores. Because BHPH lenders have a relatively small market share, particularly for new car loans, we do not include them in our analysis.

loan features and configurations can vary significantly across lender types—our data thus offer an opportunity for a comprehensive analysis of the market. Its limitation is that it does not track loan payment history, making it impossible to observe or infer prepayments or defaults using this data source. In addition, the loan-level AutoCount data that we use do not have any information on vehicle characteristics (e.g., make, model) and lender name. Such information is available in the ABS-EE data that we discuss below.

2.2 The ABS-EE Data

These data are collected through the U.S. Securities and Exchange Commission (SEC) form ABS-EE as a result of a post-crisis regulation change (SEC Regulation AB II) related to the ABS market. The data contain loan-level records of all auto loans in publicly issued ABS pools since 2017. Privately issued ABS under 144a are exempted from this reporting requirement. The data cover a large sample of over 20 million auto loans in more than 330 securitized pools issued between 2017 and 2023.[12] While the data include only loans in publicly issued ABS pools, Momeni and Sovich (2021) find that such loans closely resemble the universe of the U.S. auto loan market along most loan characteristics.

The ABS-EE sample also includes rich information of loan characteristics at origination. Notably, in addition to the variables available in the AutoCount data, the ABS-EE form collects information on vehicle make-model-year and on the scheduled payment-to-income ratio (a frequently used indicator for debt service burden). Furthermore, a valuable feature of the ABS-EE data is the tracking of loans at a monthly frequency until the loans are either paid off or charged-off as default, thereby allowing for observing prepayments and their exact timing.

On the other hand, the ABS-EE data have some limitations. First, the sample period of the ABS-EE data is relatively short, limiting our capability of analyzing the long-term trend of auto loan prepayments. Second, all auto loans are not securitized immediately upon origination. Instead, the loans are kept on the lenders' balance sheet for various months—known as the warehousing period (see Klee and Shin (2020) for a detailed discussion). As a result, we do not observe loans prepaid during the warehousing period. We therefore complement our analysis using the Equifax data, introduced below, to characterize prepayments during the first year

[12]See Klee and Shin (2020); Klee et al. (2024); Bena et al. (2024) for examples of using these data for auto financing analysis.

after origination, when many to-be-securitized loans remained on lenders' balance sheets.

2.3 The New York Fed/Equifax Consumer Credit Panel

The third data set used for our analysis is the Federal Reserve Bank of New York/Equifax Consumer Credit Panel (henceforth the Equifax data). The data track a 5-percent random sample of anonymized U.S. consumers with a valid credit history with Equifax on a quarterly basis and include detailed information on originations and balances of various types of debt, including auto loans. The data includes over 12 million consumers in an average quarter.[13]

The Equifax sample has two main advantages. First, it is a large, representative sample of the universe of auto loans and tracks these loans over time. Second, it contains the broad credit history of the entire household debt portfolio. That said, the exact information on loan maturities and interest rates is not available for most auto loans in the Equifax data. Therefore, we need to impute these terms using the loan amount at origination, the required monthly payment, and periodical updates on loan balances via an amortization function.

The common feature of the three data sources discussed above is their considerably large sample sizes, which facilitates the interpretation and generalization of the statistical results derived. Unless otherwise noted, all statistics reported in the text are tightly estimated, with the t-stat typically well above 10. Because of their respective strengths and limitations, when possible, we run our analysis using multiple samples to cross-validate our results.

3 Auto Loan Maturity

3.1 Recent and Historical Trends

2008 to 2023

Examining auto loans originated between 2008 and 2023 in the Experian AutoCount sample, we observe a steady trend of rising average contract maturity. As shown in the upper panel of figure 1, the average maturity of both new and used car loans has trended up in a largely parallel fashion since 2009, except in the most recent years when new car loan maturity edged lower from its pandemic-year peak. Between 2009 and 2023, the average maturity of new car loans increased 6 months on net, from 62.6 months to 68.6 months, reaching 70 months at

[13]The data do not include any personal identifiable information.

its 2020-peak. The maturity lengthening is even more significant for used car loans, with the average maturity rising from 57.8 months in 2009 to 67.7 months in 2023, compressing the average maturity gap between new and used car loans to the narrowest level in recent history. These trends are broad-based across different types of lenders, as shown in appendix figure A1.[14]

Appendix table A1 compares the characteristics of loans of different maturities in the Experian sample. Broadly speaking, we find that loan amount at origination increases with loan maturity for both new and used car loans, and the interest rate rises with maturity for new car loans. For new car loans, the average required monthly payment of longer-maturity loans is about 10 percent lower than that of shorter-maturity loans, as the higher amount financed and higher interest rate are more than offset by the effect of longer maturity. By contrast, the average monthly payment of longer-maturity used car loans is 35 percent higher than that of shorter-maturity loans. In addition, longer-maturity new car loans tend to be riskier, with lower borrower credit scores and higher loan-to-value ratios (LTV). For used car loans, those with the shortest maturities appear to have the lowest credit scores and the highest LTVs.

A Longer Perspective

The existent work (e.g., Brevoort et al., 2017; An et al., 2020; Guo et al., 2022) has only focused on the trend of auto loan maturity in the relatively recent history.[15] The rise of auto loan maturities, however, is not a new phenomenon. Unlike in the residential mortgage market, where 30-year mortgages have been the dominating contracts during at least the past five decades, maturities have been ever rising in the auto loan market. Indeed, data from the Federal Reserve's G.20 statistical release demonstrate a pronounced upward trend from the early 1970s through 2010 at domestic captive finance companies, which are major lenders in the U.S. auto loan market (particularly for new car financing). The domestic captives tracked in the G.20 release accounted for a substantial market share prior to the 2008 Global Financial Crisis.

As shown in the lower panel of figure 1, both new and used car loan maturities trended up through the four decades between July 1971 and December 2010, when the series were

[14]These figures have several noteworthy features. First, in contrast to banks and credit unions, new car loan maturities declined in recent years at captive finance companies. Second, new and used car loans at captive finance companies have similar maturities, a pattern that began in the mid-1990s. Third, for independent finance companies, new car loan maturity stayed roughly flat over this period. However, such lenders play a rather secondary role in the market of new car loans.

[15]Brevoort et al. (2017) show the trend from 2009 and An et al. (2020) from 2001.

discontinued. New car loan average maturity rose from 35 months in 1971 to above 62 months in 2010, whereas used car average maturity rose even more, from 28.5 to 64.5 months, during the same period. Looking through both panels of figure 1, the average maturity of new car loans extended more than six months per decade during the past 50 years and that of used car loans lengthened at an even faster pace. It is also interesting to point out that, taking the lower panel of figure 1 and the captives panel in the appendix figure A1 together, new and used car loans originated by captive finance companies had similar maturities over the past three decades.[16]

Loan Maturity Distribution

Loan maturity is not uniformly distributed. Instead, the majority of auto loans have maturities of multiples of 12 months. As shown in figure 2, the lengthening of average loan maturity reflects a shift toward 72-month and longer-maturity loans. More specifically, the modal-maturity of loans originated in 2008 in the Experian AutoCount data was 60 months (accounting for over 30 percent of all originations), and 84-month loans were rather rare. In 2023, however, 60-month loans accounted for only about 16 percent of originations, 72-month loans became the mode, and 12 percent of loans had a maturity of 84 months or longer.

Figure 2 also indicates that the overwhelming majority of loans have maturities of 36, 48, 60, 72, 75, or 84 months. Accordingly, for referencing convenience, we will often refer to loans with a maturity shorter than 37 months as "shorter-maturity," 38–61 months as "60-month," 62–73 months as "72-month," and above 74 months as "longer-maturity" loans.[17]

3.2 Possible Factors That Propelled Longer Maturities

While a comprehensive study of why auto loan maturities have increased so much in the past 50 years forms an entire research agenda itself, we postulate that two sets of factors have helped make lenders willing and able to offer longer-maturity contracts of auto credit. First, the advancement of loan underwriting technology, the advent of the securitization market, and

[16]The lower panel of figure 1 tracks only the three major domestic captives, and the captives appendix figure A1 tracks a broader set of captives that are affiliated with both domestic and international vehicle manufacturers.

[17]Relative to Experian, the loan maturity distribution in the ABS-EE data is one- or two-month right-shifted (see appendix figure A2), likely reflecting differences in loan booking conventions. We therefore label loans with a maturity lower than 38 months as "shorter-maturity," 39–62 months as "60-month," 63–74 months as "72-month," and above 75 months as "longer-maturity" loans in the ABS-EE data. We suspect that the difference in loan term coding convention between the Experian and ABS-EE data reflects how they count the first and last month of a loan contract.

a series of deregulations over the past several decades gave lenders more tools and flexibility to manage credit and interest rate risks in their loan portfolio and to match maturities of loans with maturities of their funding sources. These developments have likely, in turn, enabled lenders to offer longer-maturity debt contracts.

Second, vehicles have become more durable. Auto loans are collateralized with the vehicles they finance to purchase. The quality and durability of the collateral therefore affect the loan contract, particularly the maturity.[18] As shown in figure 3, the average age of passenger cars rose from below 6 years in 1970 to above 12 years in 2022. Interestingly, the average loan term also doubled during the same period. Moreover, we underscore that the enhancing vehicle durability had shared a similar trend with lengthening loan maturity from at least the early 1970s, whereas the financial market developments discussed earlier did not pick up momentum until the 1980s. For example, Ford Credit issued the first major auto loan ABS in the late 1980s.

Corroborating the vehicle durability hypothesis above, we find a significant cross-sectional correlation between maturity and vehicle age at origination. As a concrete example, 13.6 percent of loans on two-year old used cars originated by Carvana (a large independent finance company) and present in the ABS-EE sample in 2023 had a maturity beyond 72 months, compared with 6 percent among loans on five-year old cars. More broadly, we estimate the relationship between loan maturity and vehicle age at origination using a sample of used car loans in the ABS-EE data, controlling for an array of lender, make-model, origination state, year, and month fixed effects and find the following coefficient:

$$\underset{}{Maturity\ Months} = \alpha - \underset{(0.001)}{1.02}\ \ Vehicle\ Age\ Years\ + F.E.$$

These results indicate that loans collateralized by vehicles one year older have, on average, a one month shorter maturity (standard error in parenthesis). In an alternative specification (not shown), the estimate indicates that vehicles one year older have a 10 percent lower likelihood of having a loan maturity of 72 months or longer. While this cross-sectional estimate cannot be used directly to extrapolate the loan maturity trend over time, it confirms the relationship between collateral durability and financing terms (Hart and Moore, 1994). In comparison,

[18]The relationship between debt structure and capital durability has been recently explored also in the corporate finance literature (e.g., Rampini, 2019; Geelen et al., 2024).

Argyle et al. (2021) show that average loan maturity decreases by an average of about 2 months after cars aged across a maturity discontinuity on January 1. Garmaise et al. (2024) find that the discontinuation of a model reduces loan maturity of vehicles of the same model by $\frac{3}{4}$ months because discontinuation lowers the expected durability of these vehicles.[19]

4 Term Structure of Auto Loan Interest Rates

4.1 Baseline Relationship

We now explore the relationship between auto loan maturity and interest rate, controlling for other loan characteristics. To do so, we estimate the following specification using the Experian AutoCount data.

$$R = \alpha + \beta M + \gamma CreditScore + \theta Amount + \eta LTV + \omega_{Type} + \omega_{St} + \omega_{Y} + \omega_{M} + \varepsilon, \qquad (1)$$

where interest rate R is projected on a vector of loan maturity bins, M, controlling for the borrower's credit score, loan amount, and LTV—all at the time of origination—as well as fixed effects of lender type, borrower state, and the year and month of origination. Taking advantage of the large sample size of the Experian data, we saturate the model with highly-flexible controls (10-point bins for credit scores, $200-bins for loan amounts, and 1-percentage point bins for LTVs) to account for potentially nonlinear effects of these characteristics on interest rates.

The estimated β coefficients are reported in table 1, with the upper and lower panels illustrating results of new and used car loans, respectively. As shown in column 1 of the upper panel, compared with shorter-maturity loans (37 months or shorter, the omitted group), loans in other maturity-bins have significantly higher interest rates. Rates of 48- and 60-month loans are about 0.6 to 0.8 percentage points higher, whereas rates of 72-month and longer-maturity loans are more than 2 percentage points higher. Compared with loans of middle-range maturities (e.g., 60-month loans), 72-month loans and longer-maturity loans have an average interest rate that is 1.3 and 1.7 percentage points higher, respectively. Because the 60- and 72-month loans had the largest shares in recent originations, we will often use the β_{72}–β_{60} gap as an informative, convenient reference.

[19]Relatedly, Bena et al. (2024) estimate that, on average, loans that finance hybrid cars have a 2.5 months shorter maturity than internal combustion engine cars, which they also attribute to the durability (obsolescence) of the technology.

Putting these estimates in context, we find that the interest rate gap is much larger than what the typical Treasury yield curve would imply. For example, between 2008 and 2023, the average spread between seven- and three-year Treasury yields was about 80 basis points, only about one third of the average interest rate differential between the longer-maturity and the 36-month auto loans. The larger gap across maturity indicates that much of this interest rate difference is not merely attributable to higher funding costs of financing longer-term loans. Indeed, using interest rate spreads over Treasury yields of comparable maturity only partially flattens the estimated gradients. As shown in table 2, spreads over comparable-maturity Treasury yields are 1.7 percentage points wider for the longest-maturity new car loans, and the β_{72}–β_{60} gap remains sizable at 1.2 percentage points. Moreover, the auto loan interest rate gap across maturities is appreciably larger than that of mortgages. Over this period, the average gap between 30- and 15-year fixed rate conforming mortgages was about $\frac{2}{3}$ of a percentage point—a 15-year maturity differential in the mortgage market is associated with only a fraction of the interest rate gap between 7- and 3-year auto loans.

As presented in columns 2 to 5, the interest rate gap holds across all four major types of lenders, although the magnitude of the gap is not uniform. The β_{72}–β_{60} gap is the largest at captive and independent finance companies and smaller at banks and credit unions.[20] Finally, as shown in the lower panel, unlike new car loans, the maturity–interest rate relationship estimated from used car loans is not monotonic and less consistent. The 72-month loans typically have higher interest rates than loans of shorter and longer maturities. In addition, the β_{72}–β_{60} gap varies a lot across different types of lenders, with the gap being more sizable at finance companies than at credit unions and banks. Accordingly, our subsequent analysis on the term structure of auto loan interest rates focuses on new car loans.

Appendix figure A3 plots the estimated coefficients for the control bins with 95-percent confidence intervals. Interest rates of both new and used car loans have a nonlinear but largely monotonic relationship with borrowers' credit scores (upper panels). New car loan rates decline with amount financed up to around $50,000 before slowly rising for larger-amount loans, whereas the estimates of used car loans mostly decline monotonically (middle panels).[21]

[20]The gradient estimates are more variable and not monotonic at independent finance companies. Such lenders cater mostly to credit demand of subprime borrowers and have a limited footprint in the market of new car loans (less than 5 percent).

[21]The estimates associated with loans with credit scores below 400 can be noisy, and such loans account for

4.2 Anecdotal Evidence from Lenders' Posted Rate Sheets

We underscore that estimates from equation (1) are not intended to be interpreted as structural, and any counterfactual exercise based on these estimates should bear some caveats. In particular, our data reflect equilibrium maturities and interest rates agreed upon between lenders and borrowers, therefore reflecting both credit supply and demand influences.

An alternative approach of studying this relationship is to look at lenders' rate sheets that describe the maturity–interest rate menu they offer. Unlike residential mortgages, data of such rate offer sheets are not broadly available for the auto loan market. We therefore surveyed over 200 websites of the largest auto loan lenders to retrieve such information for anecdotal evidence, which corroborates our baseline statistical results. Not all lenders post interest rates online and, for those that do, many do not specify a maturity-interest rate schedule. However, among the lenders that do post such a schedule online, the posted rates for longer-term loans are consistently higher than those for shorter-term loans.

The upper panel of figure 4 illustrates an example from a large credit union that originated nearly 300,000 loans in 2023. There are several noteworthy aspects in what the lender posted online. First, the lender offers a full menu of maturity (from below 36 months to 96 months) for new car loans, but does not offer maturities above 72 months for used car loans. Second, there is a substantial interest rate gap between short- and long-maturity new car loans, the magnitude of which is also broadly consistent with our estimates. Third, by contrast, the interest rate gradient of maturity is much less pronounced for used car loans, also consistent with the results in table 1.[22]

The example in the lower panel is retrieved from a smaller lender that originated about 13,000 loans in 2023. For borrowers with a credit score of 720 or higher, the advertised rate of 72- and 84-month loans is, respectively, 1.4 and 1.9 percentage points higher than that of 36-month loans. Clicking through other credit score buckets, we find that similar maturity-interest rate gradients prevail across the credit score distribution. While the details differ somewhat, the patterns shown in figure 4 are seen on the websites of a large number of lenders we explored.

fewer than 0.3 percent of all loans in our sample. Similarly, the widening confidence intervals in the middle right panel reflect that only few used car loans finance amounts greater than $60,000.

[22] Another interesting aspect is that this lender offers refinance loans, consistent with the market trend of lengthening auto loan maturities.

4.3 Understanding the Maturity-Interest Rate Relationship

We now experiment with an array of analyses to evaluate the extent to which the maturity-interest rate relationship introduced above reflects heterogeneous loan and borrower characteristics that were not sufficiently accounted for by our statistical model, as opposed to an underlying structural pattern of longer-maturity loans being more expensive.

Credit Score and LTV Heterogeneity

While the baseline model controls for borrowers' credit scores, the question remains whether the estimated maturity-interest rate relationship manifests a selection effect. For example, if high-credit risk borrowers are more likely to choose longer-maturity loans, we will find a positive association between loan maturity and interest rate, even after controlling for credit scores in a regression pooling borrowers of all credit score levels. To address this possibility, we next estimate equation (1) separately for three sub-samples: borrowers with credit scores below 600, between 600 and 700, and above 700. Two patterns are notable from the results in columns 1 to 3 of table 3. First, the positive maturity–interest rate relationship prevails among loans within each credit score range, reassuring that the baseline results are not primarily driven by the underlying correlation between credit score and loan maturity choice. Second, the interest rate gradient of maturity is the steepest among loans extended to lower credit score borrowers (column 1). The β_{72}–β_{60} gap is 0.9 percentage point for borrowers with credit scores above 700 but widens to 2.3 percentage points among borrowers with middle credit scores, and to a whooping 3.4 percentage points among low credit score borrowers.[23]

Next, it is well known that loan amount and maturity are subject to lender-borrower negotiations. A liquidity-constrained borrower who wants to acquire a larger loan may need to stretch the loan to a longer term in order to lower its monthly payment. In such a scenario, the loan may carry a higher interest rate to compensate for the higher default risk, and this effect may not be perfectly controlled for by the baseline specification. To evaluate if this factor is driving our results, we estimate equation (1) for each LTV quartile separately. As shown in columns 4 to 7, the positive gradient holds across the LTV distribution, with the gradient being the greatest for loans with the highest LTV (column 7).[24]

[23]However, low-score borrowers account for only few than 10 percent of new car loan originations.

[24]The premise of this exercise is that the vehicle price is determined separately from the loan contract, whereas

Subventions and Promotions

Another concern is whether the maturity-interest rate relationship is affected by the existence of rate subventions (promotional interest rates). If loans with shorter maturities are more likely to have rate promotions, for example, we will find a positive association between loan maturity and interest rate. The Experian-AutoCount data cover the majority of auto loan originations but do not flag loans with promotional rates. As these loans are often associated with low interest rates, we re-estimate equation (1) using a sub-sample of loans with interest rates greater than 2 percent. The estimates, shown in column 8 of table 3, indicate that the positive association between loan maturity and interest rate holds among loans with higher rates.

In addition, the ABS-EE data set allows us to distinguish two type of promotional deals: rate subventions and cash rebates. Exploiting this additional information, we note that the interest rates of over 60 percent of loans with rate subvention are below 2 percent, compared with only 2 percent among loans without promotional rates—reassuring the sub-sample used for the Experian analysis above. Conversely, nearly a quarter of loans under rate subvention have an interest rate above 3 percent.

Our ABS-EE data analysis, shown in table 4, indicates that the maturity-interest rate relationship holds even among loans with promotions. Indeed, re-estimating equation (1) using a sub-sample of loans with rate subventions, we continue to see a pronounced positive interest rate gradient along loan maturity (column 1). The positive gradient also holds among loans with cash rebates (column 2). In addition, we estimate a linear probability model to correlate the likelihood of having promotional interest rates and loan maturity. The results in column 3, along with those in column 1, indicate that long-maturity loans are less likely to have promotional rates and that those under rate subventions are less likely to have very low (e.g., zero percent) interest rates. Interestingly, long-maturity loans are more likely to receive cash rebates (column 4), highlighting the strategic interactions between lenders and borrowers, a topic we explore further in the next section.

Lender-level Analysis, with Make-Model Fixed Effects

We now consider if the baseline results are driven by cross-lender variation in loan maturity

some recent work (e.g., Grunewald et al., 2024) focuses on the interactions between dealers' offering of vehicle price and loan terms, particularly interest rates.

and interest rate. We resort to the ABS-EE sample, which has lender name information, for this exercise. In addition to the controls included in equation (1), the ABS-EE data allow for both lender and vehicle make-model-year fixed effects. The maturity-interest rate relationship estimated with these fixed effects are plotted in the left-most set of bars in figure 5, which reaffirms a substantial positive gradient.[25] We further estimate the model for each of the largest seven lenders in the ABS-EE sample separately and plot the coefficients in the same figure. The positive maturity–interest rate gradients continue to prevail in these estimates, with that of Santander (a subprime lender) being particularly steep.

4.4 Additional Robustness Analysis and Discussion

The baseline results in table 1 are estimated using a sample of loans originated between 2008 and 2023, a period during which the interest rate environment went through significant cycles. It is, therefore, reassuring that the results robustly hold during each of the four sub-sample periods that roughly corresponds to the Great Recession, recovery, pre-pandemic, and pandemic episodes (see appendix table A2). In addition, we rerun the model for each of the 46 states in our sample. The estimated β coefficient of longer-maturity loans range between 1.98 and 2.88 and the estimated β_{72}–β_{60} gaps are between 0.77 and 1.72 percentage points (all statistically significant).[26]

In a recent exercise, and contrary to our results, Guo et al. (2022) report inverted yield curves of auto loan interest rates across credit score buckets. We suspect that variations in sample, model specification, control variables included, and interest rate measurement all may have contributed to the different results. Notably, Guo et al. (2022) use imputed interest rates and a smaller sample of loans. Their model pools new and used car loans together and does not control for other loan characteristics (e.g., loan amount and LTV).

Following their approach, we estimate our model for each year and each of the six credit score buckets they defined but separately for new and used car loans (a total of 96 pairs of regressions). The distribution of the estimated coefficients of longer-maturity loans (74+ months) and the β_{72}–β_{60} gaps are plotted in figure 6. We find that for new car loans, all β_{72}–β_{60} and the vast majority of β_{longer} are positive and significant (top two panels). For used car loans, about half of

[25] All coefficients and the differences between coefficients in figure 5 are statistically significant.

[26] These results are available upon request.

the models render a negative β_{longer}, but all render a positive β_{72}–β_{60} (middle panels). We then run the specification of Guo et al. (2022) that does not include loan amount, LTV, origination month, and state controls and pools new and used car loans. The majority of β_{longer} from these models turn negative and over 20 percent of β_{72}–β_{60} are also negative (bottom panels).

Summary of the Maturity–Interest Rate Relationship

To summarize, we find a substantial, robust positive relationship between auto loan maturity and interest rates for new car loans. The results are corroborated by what we see from lenders' loan offers online. This relationship holds whether loans with promotional rates are included, across the credit score distribution, over various sub-sample periods, and at each of the largest auto lenders. Furthermore, the interest rate gradient of maturity is estimated to be steeper among riskier loans. We underscore that caveats should be applied for counterfactual analysis. That said, estimated using flexible controls and a sample covering over half of all auto loans originated during this period, the results are expected to inform us on the underlying structural relationship between auto loan contract maturity and interest rate, despite the reduced-form nature of our statistical approach.

5 Stylized Facts of Auto Loan Prepayments

We next turn to the prepayment behaviors in the auto loan market, against the backdrop of lengthening loan maturity. To the best of our knowledge, this paper is the first comprehensive study of auto loan prepayment using large, comprehensive data sets that include millions of loans that were originated and paid off during a relatively long period. Thus, it is useful to describe the basic patterns (*what, when, who, why, and how*) concerning loan prepayment, which could in turn shed light on the optimality of loan maturity choices given longer-maturity loans are more expensive.

Our primary data source for the prepayment analysis is the ABS-EE data because the loan maturities and payoff dates are directly observed. We also use the Equifax data to complement our analysis, with the caveat that loan maturities are imputed and the payoff dates are therefore imprecisely measured. In defining loans that were prepaid, we impose a "six months ahead of maturity" requirement to ensure the observed prepayments reflect an active debt paying-off decision, in addition to addressing any potential measurement and imputation errors associated

loan maturity or paying off date.

5.1 The Majority of Auto Loans Are Prepaid

We use several metrics to illustrate the trend and prevalence of prepayments in the auto loan market. First, we compute the share of prepaid loans among all loans that were being paid off in a given month or quarter. Using the Equifax data, we are able to track this share from the early 2000s, shown in the blue series in the upper panel of figure 7. The trend and contour of our estimate are consistent with the analysis produced by the credit industry.[27] The share declined from well over 70 percent to below 60 percent in the years that led up to the Global Financial Crisis, before rebounding in the subsequent years to about 70 percent in 2021. Subsequently, the share lowered noticeably in 2022 and 2023, back to around 60 percent.

The appreciable slowdown in prepayment observed in the Equifax data is consistent with an alternative measure constructed using the ABS-EE data. Specifically, we create a series of actual-to-scheduled payment ratios for all loans in the securitized pools covered by the ABS-EE data. If all loans are being repaid on schedule, this ratio should be equal to one, whereas greater prepayment speed implies a higher actual-to-scheduled ratio. As shown in the lower panel, this ratio has been trending down since early 2022, reaching its lowest level in recent years by the end of 2023.[28]

Finally, we compute loans eventually prepaid as a share of all loans originated in a given year (excluding defaulted loans) for loans that completed their repayment cycle. As the majority of loans originated in recent years have a maturity of six years or longer, we show this series through the 2017 vintage.[29] As shown by the orange series in the upper panel, this estimate fluctuated within a relatively narrow range for all the vintages, and the level is consistent with that of the blue series pulling forward several years.

[27] For example, an auto loan prepayment index can be acquired from KBRA, a rating agency.

[28] In the next section, we study further the actual-to-scheduled payment ratio, decomposing it into an accelerated amortization and a bullet payment component.

[29] We exclude loans originated in more recent years because many of these loans remain in repayment with unknown final prepayment status.

5.2 Why Are Loans Prepaid? The Role of Trade-ins

Residential mortgage prepayments are frequently triggered by refinancing and relocation. However, refinancing has been rare historically in the auto loan market.[30] Auto loan prepayment, instead, may reflect borrowers selling or trading in the vehicle under the lien to purchase another vehicle as a replacement—similar to mortgage prepayment associated with homeowner relocation. The current loan will be paid off with either the sale proceed or covered by the new loan financing the purchase.

The Equifax data include the entire liability portfolio of the same borrower, thereby allowing us to infer whether another auto loan was extended to the borrower around the same time as the prepayment occurred. We find that about 25 percent of the prepaid loans were accompanied by the origination of another auto loan in the same quarter of pay-off. Because there can be a reporting lag of new loans in the Equifax data, we also experiment with including auto loans appearing in the data up to three months after the pay-off month. Doing so, we find the share increases to about 35 percent, which we take as a conservative estimate of the share of prepayment triggered by selling (or trading in) the old vehicle.[31] Therefore, the majority of prepaid auto loans were not associated with trade-ins. We next describe patterns in which loans were prepaid that speak to other factors associated with prepayments.

5.3 How Are Loans Prepaid? Bullet Payment versus Accelerated Amortization

A loan can be paid off ahead of maturity by paying more than the scheduled amount due each month (accelerated amortization), paying off all the remaining balance with one large "bullet" payment, or using a combination of both. In the ABS-EE data, we find that the majority of prepaid loans are paid off with a large bullet payment, and a significant, but not majority, share of prepaid loans also had accelerated amortization before paying-off.

We calculate the ratio between the last payment and the loan amount at origination, and figure 8 compares the distribution of this ratio between prepaid and matured loans in the

[30] We do not have data on the share of auto loan originations that are refinancing existing loans. However, conversations with major lenders indicate that auto loan refinancing was rare historically, but some lenders began offering such products in recent years.

[31] In comparison, a much smaller share (less than 10 percent) of matured auto loans were associated with another loan originated in the paying-off quarter or the subsequent quarter.

ABS-EE sample. As shown in the upper panel, on the one hand, most prepaid loans were paid off with a sizable last bullet payment, with about half of the prepaid loans having a last payment greater than 60 percent of the loan amount at origination. On the other hand, the distribution of this ratio has a fairly broad support, without any conspicuous bunching points. By contrast, as shown in the lower panel, this ratio is much lower and has a more concentrated distribution for matured loans (including loans paid off within six months of the scheduled maturity). Comparing with the median of this ratio for prepaid loans (57.6 percent), the median ratio for matured loans is only 2.1 percent.

In addition, there is appreciable accelerated amortization among prepaid loans. To see this, we calculate the ratio between the actual and scheduled monthly payments, excluding the pay-off month in which a large bullet payment is often made. The means of this ratio for matured and prepaid loans are 1 and 1.15, respectively. Thus, the average monthly payment made is equal to the scheduled payment for matured loans but is 15 percent higher than the scheduled payment for prepaid loans.

This extra payment is not uniform across all prepaid loans and the distribution is rather skewed. For example, in a given month, about 15 percent of the loans that were eventually prepaid had a payment 15 percent above the scheduled payment. But two thirds of such loans (10 percent of all prepaid loans) had a monthly payment 50 percent above the scheduled payment. Furthermore, excluding the last payment, about 35 percent of prepaid loans had more than five monthly payments when payments were 20 percent higher than the scheduled amount.

Overall, our analysis demonstrates that the majority of prepaid loans had large final bullet payments, some of which likely reflect vehicle trade-ins discussed above. At the same time, a significant share of paid loans experienced accelerated amortization, a signal of proactive (or intended) prepayments. We next explore the broad debt portfolio of borrowers with prepaid auto loans that were not linked to trade-ins to study sources of liquidity for the bullet payments.

5.4 Where Was the Money Coming From?

How does prepaying an auto loan affect borrowers' overall debt levels and composition? For vehicle replacement-related prepayments, borrowers typically take a new loan to replace the old one. However, for other prepayments, the answer is less straightforward. If borrowers take more

of other forms of debt (e.g., credit card or home equity loans) in order to pay off their auto loan, the debt portfolio is merely reshuffled and the overall indebtedness is not necessarily lower.

We focus on the sample of borrowers with prepaid auto loans not associated with trade-ins and zoom in over the eight quarters before and after the time of the auto loan paying-off (quarter 0).[32] Specifically, the left panels on figure 9 illustrate outstanding balances of auto, mortgage (including home equity debt), and credit card debt for a balanced panel of borrowers in the Equifax data aged 18 to 65 at the moment of prepayment.

As expected, the total auto loan balance for such borrowers shows a sharp decline during the pay-off quarter. Interestingly, both credit card and mortgage balances also declined appreciably during the quarter of auto loan pay-off, inconsistent with borrowers taking on other debt to pay off auto loans ahead of maturity. Instead, it appears that borrowers used cash or liquid assets to pay down various types of debt they owed.

The right panels on figure 9 show balances of auto, mortgage and credit card debt for borrowers with auto loans maturing at quarter 0, which demonstrate patterns rather different to the left panels.[33] Total auto loan balances decline smoothly in the eight quarters before pay-off and no sharp decline is observed around that time, as expected for borrowers paying it off to maturity. Credit card balances increase smoothly in the eight quarters prior to quarter 0 before reversing the increasing, potentially reflecting that some of the additional funds freed up after the auto loan pay-off were used to pay down the credit card debt. Mortgage balances also increase smoothly, without any appreciable decrease.

Overall, comparing balance changes of various types of debt around the time of prepaying versus maturing an auto loan indicates that auto loan prepayments not involving trade-ins were associated with a broader, discernible decline of borrowing, a pattern not shared at the time when a loan matured.

[32]We take a more conservative approach and remove from the sample borrowers who opened another auto loan within a year of the prepayment to best isolate the influence of these new loans in the analysis. About 55 percent of borrowers opened an auto loan within a year of prepayment. Thus, this sample is a more restricted sample than what we discussed in Section 5.2. Results are qualitatively similar if we adopt the definition there and only exclude those opening a loan within 3 months of prepayment.

[33]To have a comparable sample, we also require that borrowers did not open another auto loan within a year of the loan maturing. Fewer than 25 percent of borrowers who paid off the loan at maturity opened another auto loan within a year.

5.5 What Loans Are Prepaid?

We now provide an exposition of characteristics of prepaid loans and their borrowers. Figure 10 contrasts key loan characteristics between prepaid and matured new car loans across maturities. For exposition convenience, we are not doing a conditional comparison, as most of the pairwise correlations among the characteristics considered here are modest, with the exception of the correlation between loan amount and monthly scheduled payment and that between interest rate and credit scores (see appendix table A3 for details). A salient feature of the comparison is that prepaid loans have higher interest rates than matured loans across the maturity distribution. Prepaid loans also have larger loan amounts at origination for 72-month and longer-maturity loans, which account for the majority of the market in recent years. As a result, prepaid loans have, on balance, higher monthly scheduled payments. For example, among 72-month loans, the average scheduled monthly payment of prepaid loans is around $475, compared with about $300 for loans paid off upon maturity. Interestingly, despite the appreciably higher scheduled monthly payment, the payment-to-income (PIR) ratio does not differ as much between prepaid and matured loans, neither is there a significant gap regarding the LTV ratio. Finally, borrowers of prepaid loans tend to have a somewhat lower credit score, averaging across loan maturities.

5.5.1 Prepayment across Maturity and Credit Score Distribution

The fact that prepaid loans are associated with lower credit scores can be interesting, as these borrowers are often viewed as more liquidity constrained, thereby having a more limited capacity of paying off debt. In a similar spirit, because longer maturity-loans have lower required monthly payments, holding amount financed and interest rate constant, if borrowers' loan maturity choices are mainly driven by their debt service capacity, one may expect longer maturity-loans to have a lower prepayment speed.

It is therefore useful to explore how prepayment likelihood differs across maturity and credit score distributions, which may inform us on the bearing of liquidity constraints over loan maturity choice and subsequent repayments. In particular, we estimate the prepayment likelihood in each month for 60-month, 72-month, and longer-maturity loans, respectively, conditional on that the loan remains in good standing using the ABS-EE sample. Taking advantage of the large sample, we are able to characterize the prepayment likelihood in a nonparametric, flexible

fashion. We further estimate the prepayment likelihood of subprime, nearprime, and prime loans separately for each of these maturity bins.

As shown in the upper-left panel of figure 11, longer-maturity loans do not necessarily have a lower prepayment speed. For example, during the first 40 months after origination, the prepayment likelihood of longer-maturity loans (74+ months, the yellow line) is higher than that of 72-month loans (the green line), which, in turn, is higher than that of 60-month loans (the red line), with the shaded 95-percent confidence intervals for the longer-maturity estimates illustrating these difference being statistically significant. In addition, as shown in the other panels, the prepayment speed of subprime borrowers (the red line) is typically higher than that of nearprime and prime borrowers (the green and yellow lines, respectively). Finally, we note another interesting pattern emerging from these results consistent with Heitfield and Sabarwal (2004) and Agarwal et al. (2008): Prepayments accelerate as the loans age, particularly during the year before maturity, across all maturities and the credit score distribution.

An alternative to the month-by-month characterization of prepayment speed is to estimate the cumulative share of loans prepaid during the first M months. Table 5 shows the share of loans prepaid between the 12th and the 36th months by maturities and credit scores. Similar to figure 11, we find that a greater share of longer-maturity loans were prepaid during 12–18, 12–24, and 12–36 months, compared to 60- and 72-month loans (upper panel). For example, 33.5 percent of longer-maturity loans were prepaid during the second and third years, relative to 28.5 percent of 60-month loans. Moreover, across loan maturity, a greater share of subprime loans were prepaid between the 12th and the 36th months (lower panel). For example, among longer-maturity loans, 38.5 percent of subprime loans were paid off during the second and third years, relative to below 30 percent of prime loans.[34]

[34]We note that we do not necessarily have a representative estimate of the share of loans prepaid within the first 12 months (often referred to as early prepayment) using the ABS-EE data because of the variable warehousing period. However, we are able to infer such early prepayment from the Equifax data. Our estimate in the memo line of the upper panel of table 5 indicates that about 15 percent of auto loans were paid off during the first 12 months. The early prepayment may be motivated by very different factors than later prepayments. Anecdotally, dealers may give some concession on vehicle price if buyers are willing to take a loan. Some intended cash buyers often pay off the loan shortly after origination. Overall, our results are reassuringly consistent with Grunewald et al. (2024), who estimate that about 35 percent of loans were paid off during the first two years.

5.5.2 Loan Subvention and Prepayment Likelihood

Finally, we assess how the prepayment likelihood varies by subvention status. In Section 4.3, we show that longer-maturity loans are less likely to have interest rate subventions (promotional rates) but more likely to receive cash rebates. How loans with such promotions differ in their prepayment likelihood? We estimate a linear probability model with a sample of new car loans originated between 2015 and 2018, for which we observe their entire duration. We focus on new car loans because subventions have been rare among used car loans. In addition, our sample includes only loans of lenders with a significant subvention footprint.[35]

We find that loans with promotional interest rates are nearly 7.4 percentage points *less* likely to be prepaid, compared to other loans with similar borrower credit score, amount financed, LTV ratio, PIR ratio, warehousing period, and loan maturity.[36] Notably, the lower likelihood does not entirely reflect the lower interest rates of these loans. Controlling for interest rate, we continue to see a 3.4 percentage points lower prepayment likelihood for loans with interest rate subvention. By contrast, loans with cash rebates are 4 percentage points *more* likely to be prepaid, and the margin is not as sensitive to loan characteristic controls (including interest rate).

These patterns indicate that borrowers' maturity choices and prepayment decisions are likely influenced by promotions and incentives offered by lenders, and borrowers seem to be taking advantage of promotions offered. Borrowers of loans with promotional interest rates are more likely to hold their loans through maturity because these loans are relatively cheaper, which may imply a higher cumulative cost for lenders over the loan duration. Similarly, if cash rebates are more commonly offered to long-maturity loan borrowers, borrowers may take advantage of this incentive by taking a long-maturity loan, receiving the rebate, and subsequently prepaying the loan, which will lower lenders' interest income over the loan duration. Indeed, at equilibrium, lenders offering promotions should take into account expected prepayment speed when configuring these incentives. Characterizing such strategic interactions can be a promising research agenda.

[35] Most subprime lenders, for example, do not offer interest subvention or cash rebate.
[36] We control for these loan characteristics using flexible bins.

6 Two Puzzling Patterns Regarding Auto Loan Prepayment

We have so far demonstrated key stylized facts of auto loan prepayments as well as a number of nuances and intricacies concerning maturity choices and payment decisions. We conclude this paper with two salient, puzzling patterns and a discussion of possible explanations.

6.1 Why Do People Prepay Zero-Interest Loans?

Section 5.5 shows that loans with lower interest rates, including promotional rates, are less likely to be prepaid, reflecting borrowers taking advantage of cheaper credit. That said, we find that a substantial fraction of loans with very low, including zero, interest rates are prepaid, after all.

In the ABS-EE sample, among the 3.8 million loans originated before 2019 that have matured or been prepaid, nearly one third had an interest rate below 1 percent, and two thirds of those had a zero interest rate. About 50 percent of these low-interest-rate loans were prepaid ahead of maturity, with more than half being paid off within 30 months of origination. Similar patterns are also found in the Equifax sample. In addition, we also find in the Equifax sample that fewer than $\frac{1}{3}$ of prepaid loans with interest rates below 1 percent were associated with "trade-ins," implying that the majority of these loans were actively paid off ahead of maturity. Unlike the promotional "teaser" rates on credit cards that typically last a year or shorter, promotional auto loan rates usually apply to the entire contract maturity. The question is, therefore, why are these borrowers not taking advantage of the cheap, or even free, financing?

One potential explanation goes as follows: because total indebtedness bears on a borrower's credit score, which in turn affects credit access and borrowing costs, people who are planning to apply for a major loan (such as a mortgage) may want to reduce total borrowing ahead of their loan application. However, analyzing the Equifax sample, we do not find that, compared with other prepaying borrowers, the borrowers prepaying zero- or very low-interest loans significantly increased their borrowing of mortgage or credit card debt in the subsequent quarters, regardless of whether the prepayment was associated with trade-ins. More specifically, figure 12 contrasts the dynamics of balances of various types of debt (similar to figure 9) between borrowers pre-paying promotional-rate loans (1-percent or lower, left column) and other pre-paying borrowers (right column). We find no evidence that borrowers who prepaid promotional-rate auto loans

tend to have more significant increases of debt balances in the quarters following paying off the auto loan. Thus, a credit history "window-dressing" consideration does not explain the majority of the prepayment of zero-interest loans.

Instead, we argue that this type of prepayment is consistent with the "debt-aversion" behavior recently discussed in Martínez-Marquina and Shi (2024). In an experimental setup, they show a substantial share of study participants neglecting high returns of investment opportunities and focusing on debt repayments. Relatedly, a debt-averse investor requires a sizable premium between guaranteed returns on investment and borrowing costs, leading to under investment and suboptimal balance-sheet choices. In some sense, the prepayment behavior documented here illustrates a more polarized version of debt-version. These borrowers appear to be eager to be clear of any debt, even those with zero borrowing costs.

6.2 Why Borrow Long, Pay High, but Prepay?

We have documented earlier that (1) loan maturities have become longer, (2) longer maturities have higher interest rates, and (3) the majority of loans are prepaid, many within the first 36 months. A question emerging from these three facts is why people take more expensive, longer-maturity loans but subsequently pay them off way ahead of maturity. The pattern can be especially puzzling if the prepayment is intended or anticipated. After all, only up to $\frac{1}{3}$ of prepayments were associated with trade-ins, and some trade-ins and car replacement themselves could also be anticipated. In this section, we calculate the excess interest payment relative to a contract of ex-post optimal maturity that is consistent with the realized duration of prepaid loans and explore possible factors that may help account for such excess payment. The patterns demonstrated concerning loan contract and prepayment decisions are broadly consistent with the "NPV neglect" behavior—borrowers choosing contracts with lower initial payments but higher lifetime costs, even without a binding liquidity constraint forcing them to do so. Such a behavior was discussed earlier in Shu (2013) and more recently explored in Argyle et al. (2021); Bäckman et al. (2024).

6.2.1 Costs Accounting of Long-Maturity Loans

Longer-Maturity Loans Cost More If Held Through Maturity

The monthly payment, Pmt, of an auto loan with original principal amount P, annual interest rate r, and term of M months is given by the following formula

$$Pmt \;=\; \frac{rP(1+r)^M}{(1+r)^M-1}, \tag{2}$$

It is straight forward to show that $\partial Pmt/\partial M < 0$. That is, holding the original loan amount and interest rate constant, loans with longer maturities have lower monthly payments, making them "more affordable." However, borrowing a longer-maturity loan is certainly not costless, even with the same level of interest rate. Borrowing an auto loan with longer maturity implies a slower process of amortization and, therefore, paying more interest during the loan's life cycle. To see this, the total interest payment, $\mathcal{I}$, of a loan held through maturity is given by

$$\mathcal{I} = Pmt \times M - P \;=\; \frac{rMP(1+r)^M}{(1+r)^M-1} - P, \tag{3}$$

and

$$\frac{\partial \mathcal{I}}{\partial M} \approx \frac{r(1+r)^M}{[(1+r)^M-1]^2}[(1+r)^M - rM - 1] > 0, \forall\, r > 0. \tag{4}$$

If we allow for the liquidity saved from the lower monthly payment to earn a return q, then the return-adjusted total auto loan interest payment remains monotonically increasing with M as long as $r \;>\; q$. For the moment, we assume $q = 0$ for illustration convenience. As a concrete example, for a \$35,000, 6 percent loan, the total interest payment over a 36-month maturity is about \$3,330, compared with \$6,760 for a 72-month maturity loan with the same interest rate. The total interest payment of a 72-month loan essentially doubles that of a 36-month loan.

Furthermore, our analysis in Section 3 shows that, compared with a 36-month new car loan, a 72-month loan with similar loan and borrower characteristics, on average, has an interest rate more than 2 percentage points higher. If the 36-month loan has an interest rate of 6 percent, a 72-month loan with an 8 percent interest rate will have a total interest payment of \$9,180, nearly tripling that of the 36-month loan.

Prepaying Long-Maturity Loans Costs More than *ex-post* Optimal Contracts

We now compare the total interest payments of prepaid long-maturity loans with the counterfactual of borrowers choosing loan maturities consistent with the actual loan duration. For example, for 72-month loans prepaid at the 24th or 36th month, we calculate how much the realized interest payment is above that of holding a 24- or 36-month loan through maturity—a

gap we label as the excess interest payment—using our estimated interest rate gradient across maturity. The comparisons are summarized in table 6, where we consider a number of scenarios.

The upper panel of the table simulates the experience of borrowers with middle-range credit scores in a moderate interest rate environment, where they pay an interest rate of 5 percent for shorter-maturity loans.[37] The interest rate margins of loans of other maturities follow the estimates in table 3. In addition, we run the simulation with three levels for the discounting factor across columns to mimic various levels of return of borrowers' investment.

Consider a borrower taking a 60-month loan, which has an interest rate 0.9 percentage point higher and prepaying it at the 24th month and assume that the discount rate is zero. This borrower will pay $1,570 more in interest payment (column 1), compared with borrowing a 24-month loan and paying it off on maturity. This excess interest payment increases with loan maturity because longer-maturity loans have higher interest rates and slower amortization. For example, the simulated excess payment increases to over $3,400 for loans in the longest-maturity bucket. The excess payment also rises with loan duration. Compared with prepaying at the 24th month, paying it off at the 36th month leads to an excess payment of almost $4,600 (column 4). Even with a 2 percent discount rate, the excess interest payments remain sizable (columns 3 and 6). The break-even discount rate that renders zero excess payment is as high as 4.6 percent and 5.4 percent for a 72-month loan prepaid at the 24th and 36th month, respectively.

The lower panel of the table simulates the experience of borrowers with low credit scores in a high interest rate environment, where they pay an interest rate of 7 percent for shorter-maturity loans. Because of a higher short-term rate and a steeper maturity–interest gradient, the simulated excess interest payment is even more substantial. With a zero percent discount rate, prepaying a longer-maturity loan at the 24th and 36th month implies an excess payment of about $5,100 and $6,900, respectively. In such a scenairo, the break-even rate discount rates are even higher. For example, for a 72-month loan prepaid at the 36th month, the break-even rate is over 7 percent.

6.2.2 Discussion

The Role of Liquidity Constraints

[37] We set the interest rate of 24- and 36-month loans to be the same for simplicity.

The comparison above underscores a potential time-inconsistency between borrowers' maturity choices and subsequent loan repayment decisions. Why do people borrow expensive, long-maturity loans with high interests, only to prepay them later? One prominent explanation for people choosing long-maturity loans is liquidity constraints—borrowers cannot afford shorter-maturity loans that have higher monthly payments. However, Argyle et al. (2020) find that, in a sample of used car loans originated at credit unions, liquidity constraints cannot fully account for loan maturity choices. Our results reinforce this conclusion through the lens of loan prepayment.

Most prepaying borrowers, including subprime borrowers and those who take long-maturity loans, were unlikely constrained when the auto loans were being paid off—some even had additional liquidity to pay down other debt (Section 5.3). Moreover, we show in section 5.5 that the prepayment likelihood of longer-maturity loans is higher than that of shorter ones, and subprime borrowers prepaid their loans at a faster speed than higher-rated borrowers. Furthermore, we documented that a significant portion of the prepaid loans involved accelerated amortization—another indication of not being liquidity constrained. To the extent that liquidity constraints tend to be considerably persistent (e.g., Aguiar et al., forthcoming; Kaplan and Violante, 2022), we argue that, in line with Argyle et al. (2020), many of the prepaying borrowers were probably not constrained at the time of loan origination either, in spite of their choosing long-maturity loans.

That said, we are by no means ruling out the role of liquidity constraints in this context. For example, We find that, holding other characteristics constant, prepayment likelihood lowers essentially monotonically with PIR—another indicator for borrowers' liquidity constraints. For example, in a sub-sample of loans of maturity 72 months or longer, the prepayment odds ratio of loans in the top PIR decile (most likely constrained) is estimated to be about 25 percent lower than that in the bottom PIR decile (least likely constrained).[38]

The Role of Monthly Payment Bunching

In addition to liquidity constraints, Argyle et al. (2020) and, more recently, Momeni (2024), propose that many borrowers engage in "budgeting heuristics," which sometimes manifests as choosing a loan with an integer monthly payment (e.g. \$400, \$500, etc.). We next document

[38]Still, while the difference is material, the majority of loans were prepaid even for loans in the top PIR decile.

the prevalence of monthly payment bunching around these values and assess its relationship with liquidity constraints in the context of loan prepayment.

In the Experian data, which provide a majority-coverage of the market, we find statistically significant scheduled monthly payment bunching around integer multiples of $100. As shown in the upper panels and the lower-left panel of figure 13, the histograms show discreet jumps at key integer values of monthly payments ($200, $300, and $400 per month) or one dollar lower. For example, the frequency of loans with a monthly payment of $399 doubles those of loans with a monthly payment of $401. We also find such a pattern across lender types, loan maturities, and for both new and used car loans, thereby confirming the prevalence of monthly payment bunching in the broad U.S. auto loan market.[39]

That said, as shown in the lower right panel, in the context of the entire distribution of loans, targeting on any dollar value of monthly payment does not appear to significantly change the shape of the distribution. Indeed, only 2.8 percent of loans in the sample had a monthly payment that resembles $300 or $299. The share increases to 3.8 percent if we include numbers like $295 or $395. Reassuringly, essentially the same level of prevalence was estimated in the ABS-EE data.

In addition to the monthly dollar payment, borrowers may also target a particular level of PIR, as keeping this ratio under certain thresholds may help budget management or qualifying for better loan terms. Consistent with this hypothesis, as shown in figure 14, there are disproportionately more loans with PIRs at or right below the integer thresholds, such as 10, 15, and 20 percent. However, similar to dollar payment bunching, PIR bunching around such integer values appears to account for only a modest share (lower than 1.5 percent) of all loans in the ABS-EE sample (the lower-right panel).

Finally, we estimate that loans with a bunching-integer monthly payment or integer PIR were 20 percent *more* likely to be prepaid in the ABS-EE pool of loans originated between 2015 and 2018. Therefore, similar to Argyle et al. (2020), our analysis also indicates that monthly payment bunching is not exclusive to liquidity constrained borrowers.

Other Potential Factors

[39] Argyle et al. (2020) data set only covers direct auto loans originated by credit unions that financed the purchase of used cars.

In the discussion above, we postulate that many borrowers who prepaid their auto loans were likely not liquidity constrained upon the time of loan origination, on the premise that liquidity constraints tend to be persistent. We caveat that it is also possible that some borrowers were constrained when choosing a loan but subsequently experienced improved liquidity situations that enabled prepaying the expensive loan. In addition, currently unconstrained borrowers may face or perceive volatile future income flows, and they may choose long-maturity, low-monthly payment loans as a hedge against such risks. While quantifying such risks and the associated premium requires a more elaborate optimization model, the substantial excess interest payment estimated in table 6 suggests that very volatile future income, high risk aversion, or both are needed to account for the pervasive long-maturity loans later prepaid.

6.2.3 Are Shorter-Maturity Loans Available at All Lenders?

Borrowers may save money by taking shorter-maturity loans instead of borrowing longer-maturity loans and prepaying them later. While prepaying long-maturity loans is widespread and not limited to borrowers with certain characteristics, we ask whether short-maturity loans are available to all borrowers—are certain borrowers rationed out of the short-maturity segment of the market? To answer this question, we screen loans of various maturities originated by each of the largest 100 auto loan lenders in the Experian data.[40] We find no evidence that borrowers in any credit score bucket were rationed out of short-maturity loans. For example, table 7 lists the number of new car loans of different maturities originated in 2021 by the largest lenders. We find that, while the number of short maturity loans differed across lenders, none of them shut subprime borrowers off outright from short-maturity loans. The extensive anecdotal evidence from lenders' websites (e.g., figure 4) also confirms that lenders offer loans of a wide range of maturity to borrowers across the credit risk distribution. The example shown in the lower panel of that figure also indicates explicitly that short maturity loans are available to borrowers of all credit score levels.

[40]The Experian loan level data do not include lender information. We can retrieve aggregated statistics at the lender level through its web portal subscription.

7 Concluding Remarks

This paper makes three main contributions: First, we document a unique, secular trend in the U.S. auto loan market that was not shared by other major credit market. Namely, over the past 50 years, average loan maturity more than doubled from about 30 months in the early 1970s to near 70 months in recent years. Second, we show that long-maturity auto loans carry substantially higher interest rates than short-maturity loans. The interest rate on a 72-month new car loan can be over 2 percentage points higher than an otherwise similar 36-month loan. Third, we present an array of novel stylized facts on auto loan prepayment and introduce two patterns that appear at odds with optimal prepayment decisions and maturity choices. In the first scenario, borrowers failed to take full advantage of cheap credit and prepaid zero-interest loans, demonstrating a "debt-aversion" attitude. In the second scenario, borrowers chose loan contracts that can be ex post suboptimal given their prepayment, leaving them potentially overpaying thousands of dollars of interest—a behavior broadly consistent with an "NPV neglect" behavior. These results underscore the importance of taking into account loan repayment behaviors in evaluating loan contract terms choices.

We use several large proprietary or administrative data sets that cover either the majority or a substantial share of the U.S. auto loan market and we leverage their respective unique strength in our analysis. Owing to these rich data, our results are robust and tightly estimated, and they likely shed light on the underlying market trends and dynamics in spite of being derived from reduced-form models.

We conclude and underscore that there are more questions for which we cannot entertain a quantitative, definitive answer for the lack of a more structural approach. How does the rising average loan maturity interplay with the capitalization of maturity in purchase prices of durable goods? What portion of the rising loan maturity can be attributed to financial market developments versus enhanced vehicle durability? Why do new and used car loans originated by captive lenders have similar maturities? Do borrowers miscalculate the excess interest payment, or are they making a rational pick conditional on their current and perceived future constraints? Were borrowers pressured or lured to taking longer-maturity, more expensive loans by lenders? Are the subventions lenders offer optimal for them given borrowers' loan terms and payment choices? Answering these question requires an in-depth treatment on dynamic household balance

sheet optimization and strategic interactions among lenders, dealers, and borrowers. In addition, our analysis does not consider leasing as a financing option, which may alter the calculus of loan maturity and prepayment decisions. Thus, this paper merely scratches the surface regarding what we can learn about the auto loan market and borrowers' choices when we take into account their debt repayment choices.

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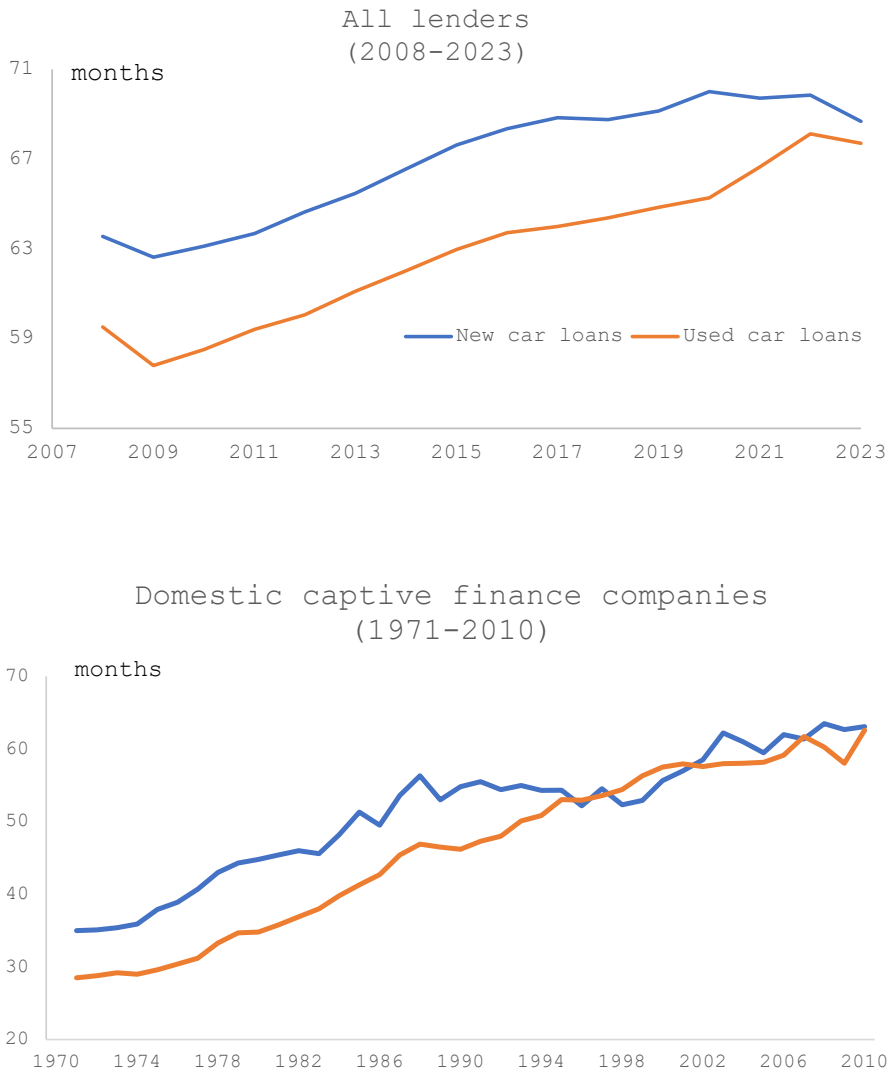
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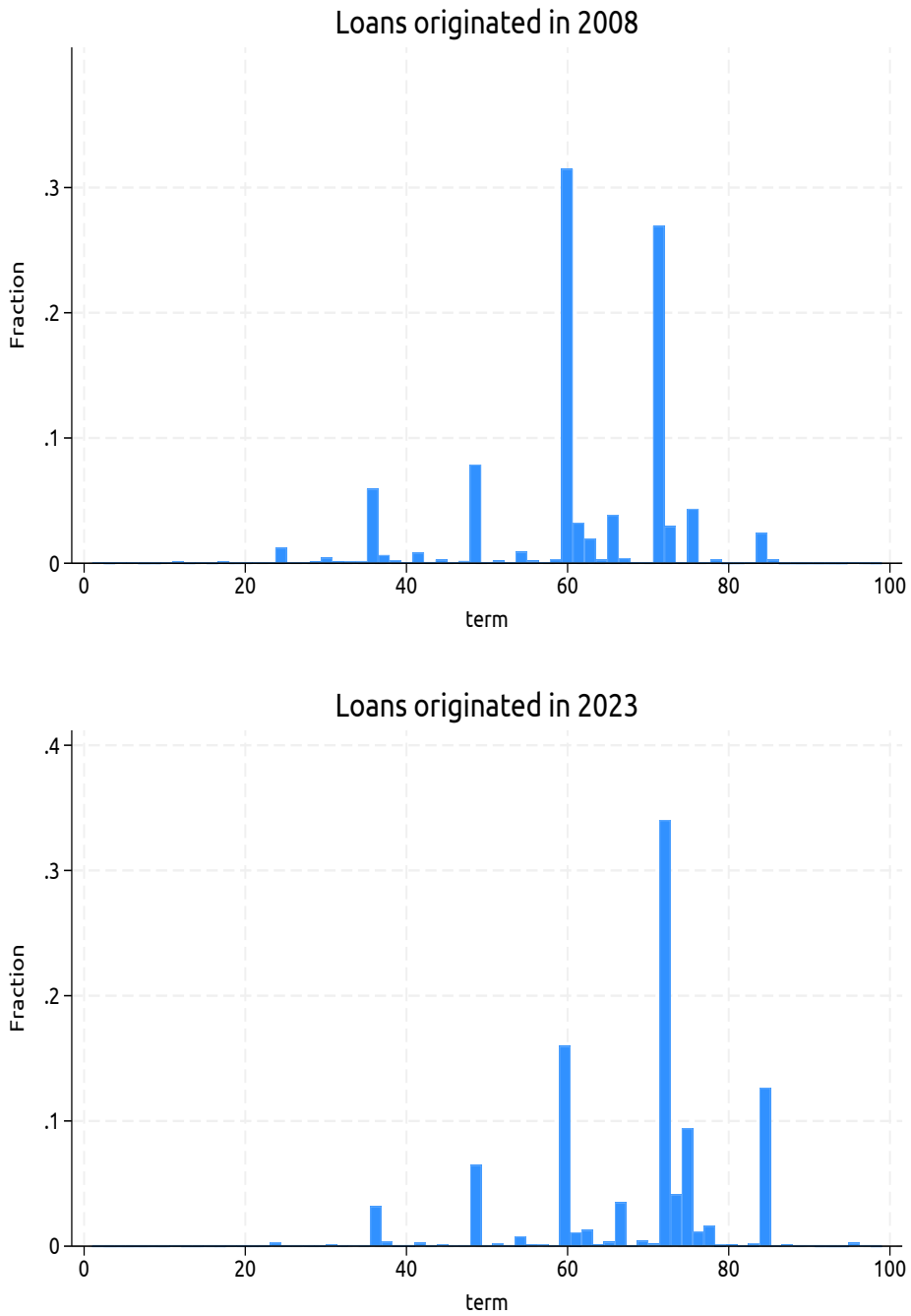
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Figure 1: Recent Trend of Average Auto Loan Maturity



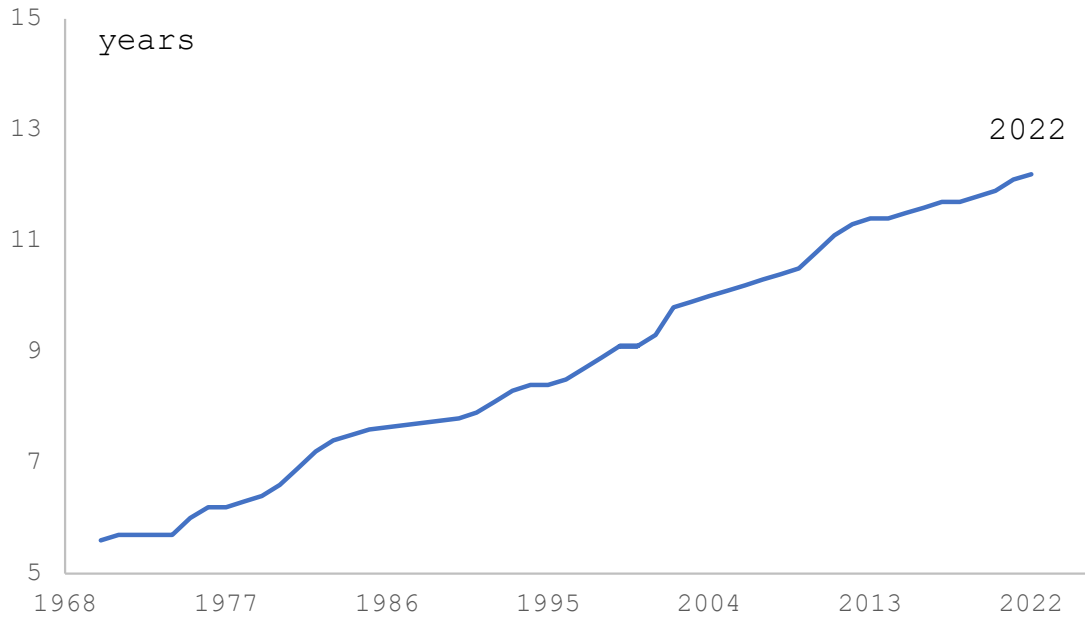
Note: The panels show the average auto loan maturity over time for new and used car loans. Source: For all lenders, Experian AutoCount data; for captive finance companies, Federal Reserve Board. Statistical Release G.20, "Finance Companies."

Figure 2: Shift of Auto Loan Maturity Distribution



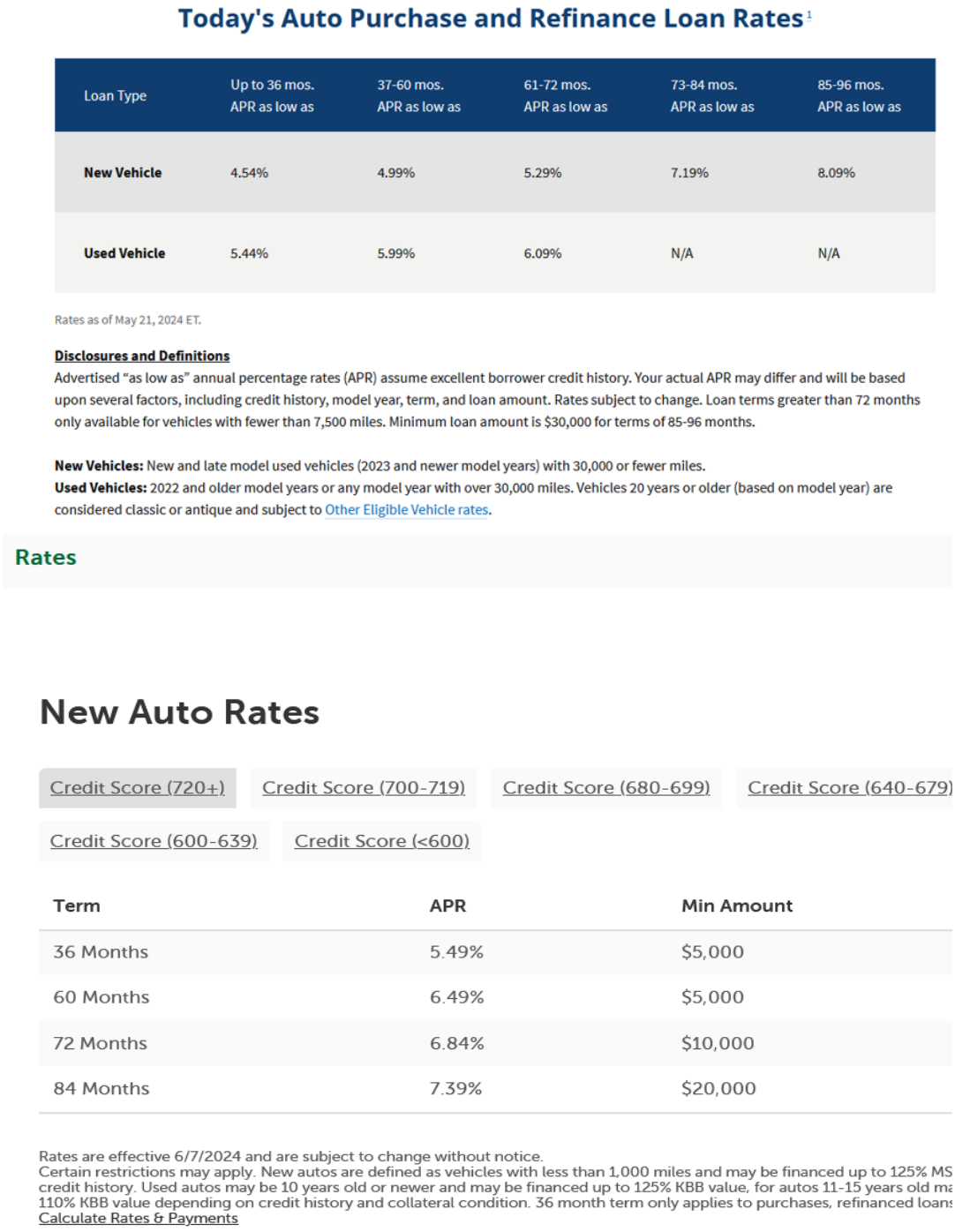
Note: The panels show the distribution of auto loan maturities for loans originated in 2008 (top panel) and 2023 (bottom panel). Source: Experian AutoCount data.

Figure 3: Average Age of Passenger Cars in Operation



Note: Data are unavailable from 1986 to 1989 and were linearly interpolated. Source: Bureau of Transportation Statistics.

Figure 4: Two Samples of Rate Sheets on Lender's Webpage



Today's Auto Purchase and Refinance Loan Rates[1]

Loan Type	Up to 36 mos. APR as low as	37-60 mos. APR as low as	61-72 mos. APR as low as	73-84 mos. APR as low as	85-96 mos. APR as low as
New Vehicle	4.54%	4.99%	5.29%	7.19%	8.09%
Used Vehicle	5.44%	5.99%	6.09%	N/A	N/A

Rates as of May 21, 2024 ET.

Disclosures and Definitions

Advertised "as low as" annual percentage rates (APR) assume excellent borrower credit history. Your actual APR may differ and will be based upon several factors, including credit history, model year, term, and loan amount. Rates subject to change. Loan terms greater than 72 months only available for vehicles with fewer than 7,500 miles. Minimum loan amount is $30,000 for terms of 85-96 months.

New Vehicles: New and late model used vehicles (2023 and newer model years) with 30,000 or fewer miles.
Used Vehicles: 2022 and older model years or any model year with over 30,000 miles. Vehicles 20 years or older (based on model year) are considered classic or antique and subject to Other Eligible Vehicle rates.

Rates

New Auto Rates

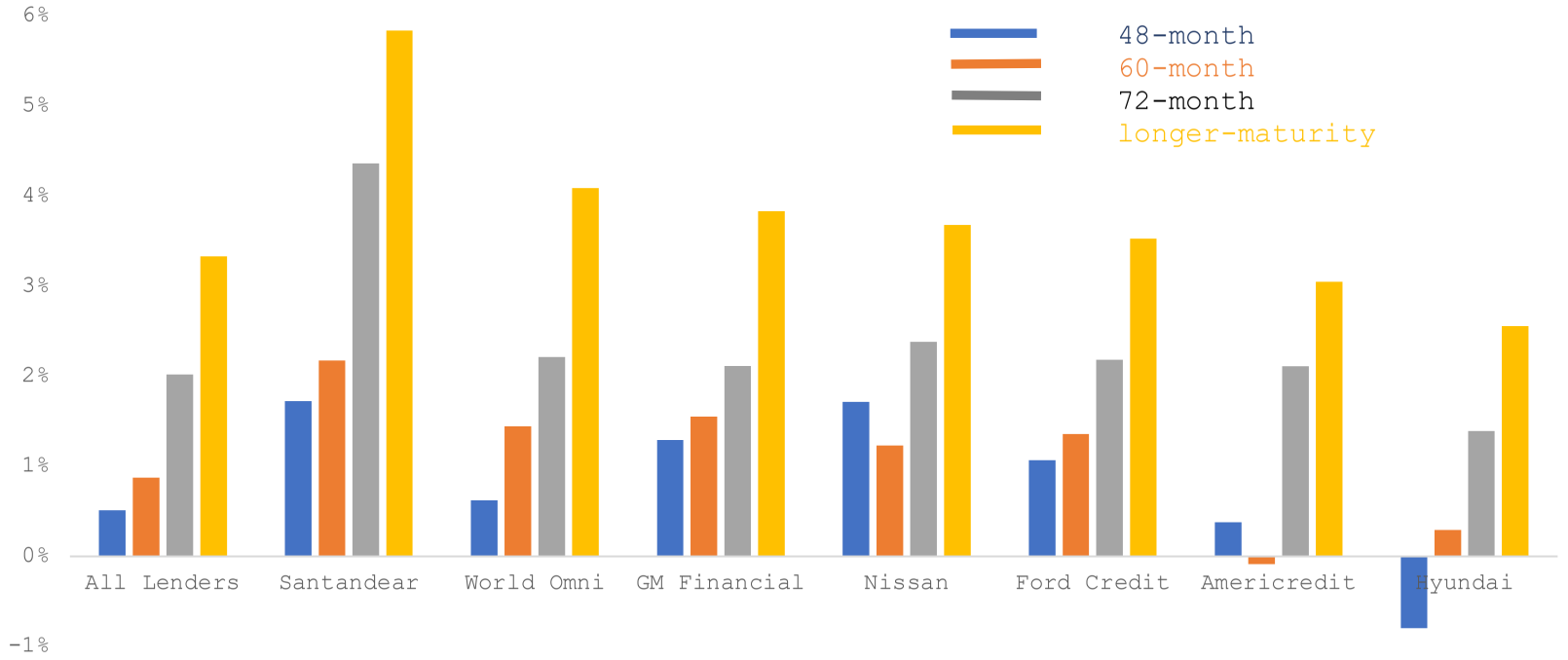
Credit Score (720+) | Credit Score (700-719) | Credit Score (680-699) | Credit Score (640-679) | Credit Score (600-639) | Credit Score (<600)

Term	APR	Min Amount
36 Months	5.49%	$5,000
60 Months	6.49%	$5,000
72 Months	6.84%	$10,000
84 Months	7.39%	$20,000

Rates are effective 6/7/2024 and are subject to change without notice.
Certain restrictions may apply. New autos are defined as vehicles with less than 1,000 miles and may be financed up to 125% MS
credit history. Used autos may be 10 years old or newer and may be financed up to 125% KBB value, for autos 11-15 years old ma
110% KBB value depending on credit history and collateral condition. 36 month term only applies to purchases, refinanced loans
Calculate Rates & Payments

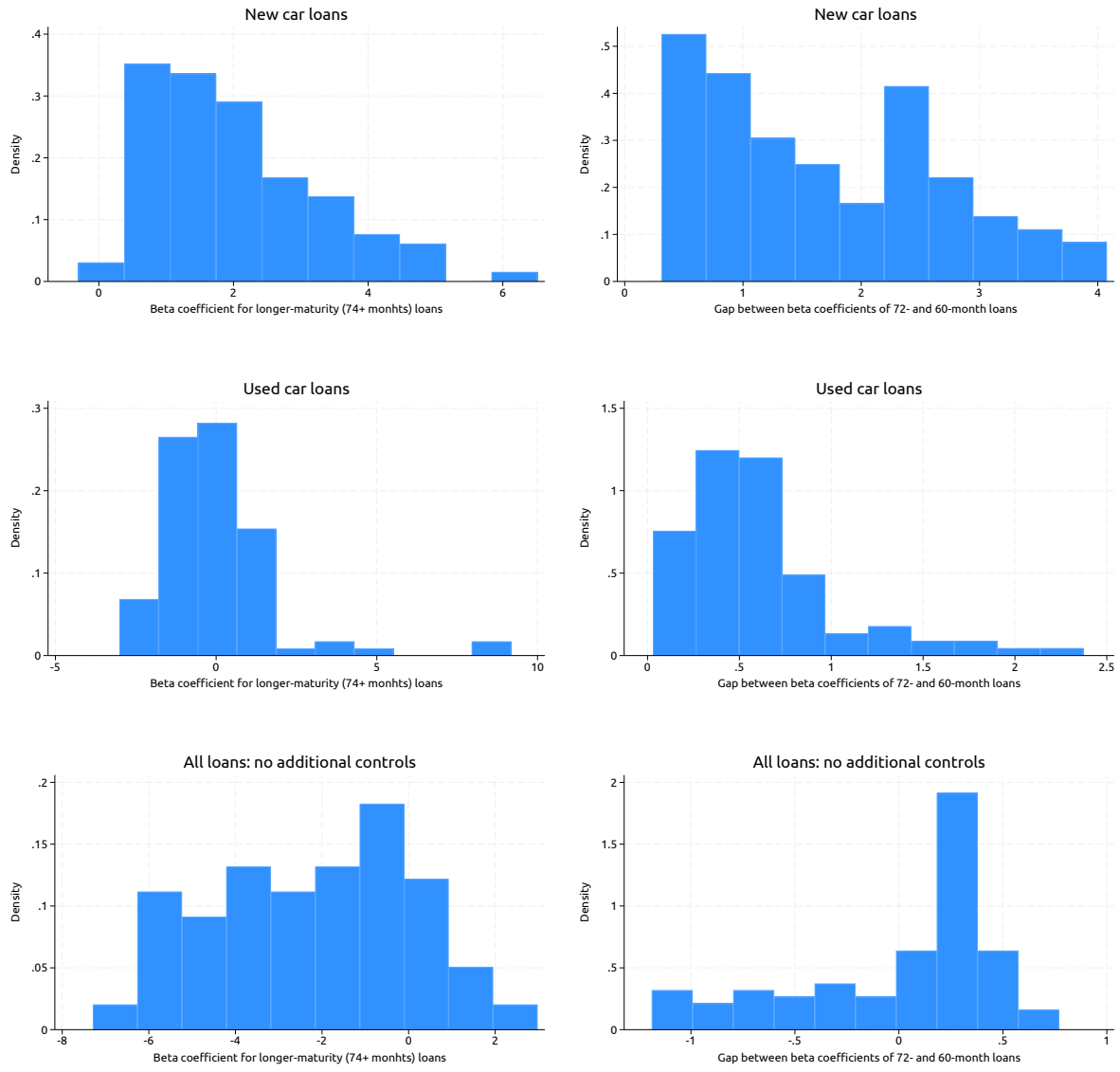
Note: The upper panel is retrieved from a large lender that originated about 300,000 auto loans in 2023, and the lower panel from a smaller lender that originated about 14,000 loans in the same year.

Figure 5: Maturity-Interest Rate Relationship at Large Lenders



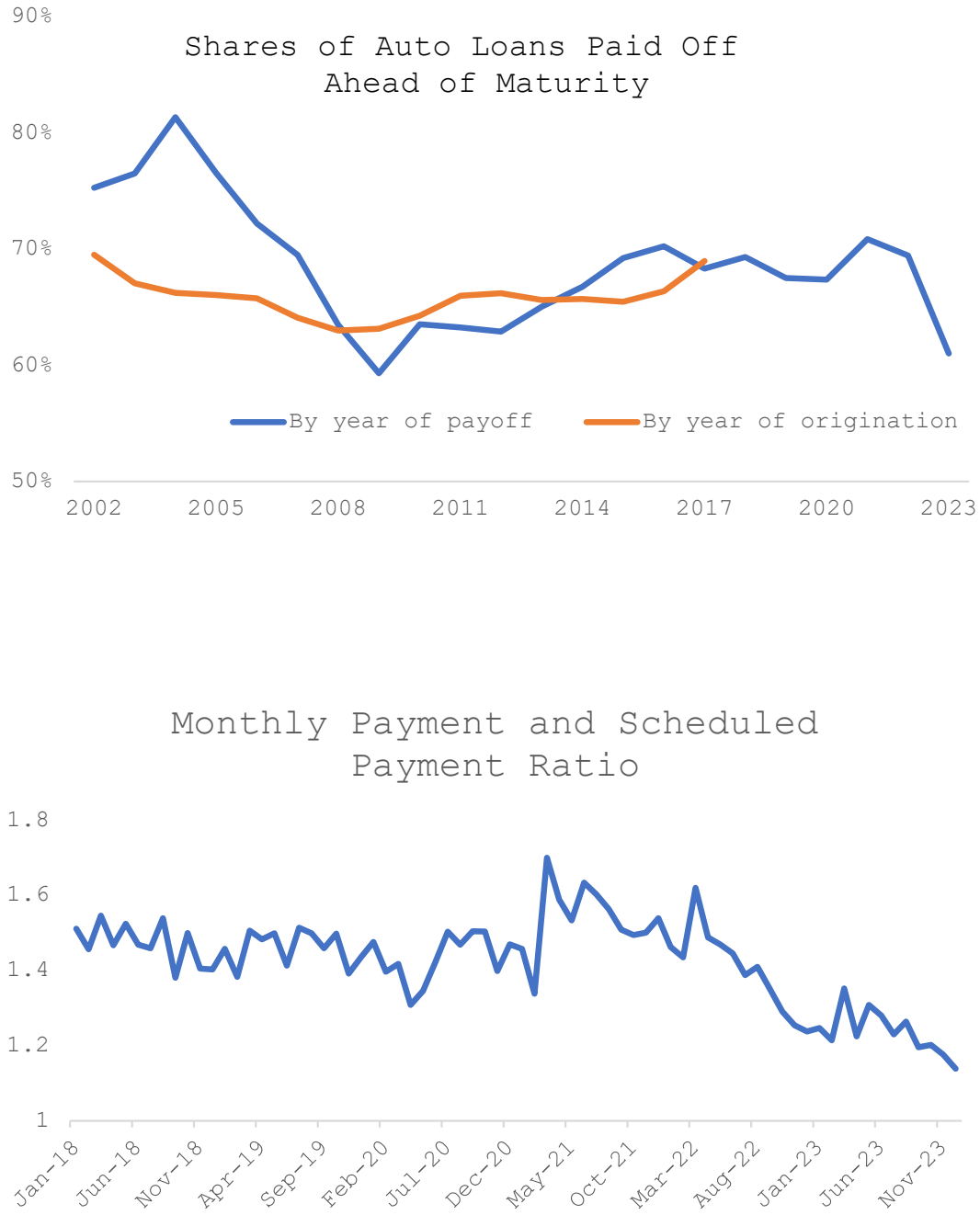
Note: The figure plots the estimated β coefficient of equation (1), adding vehicle make-model and vehicle-year fixed effects. The left-most set of bars plot the term-bin coefficients estimated using the entire sample, also controlling for lender fixed effects. The other sets of bars plot the lender-specific estimates for the seven largest lenders in our sample. Source: Authors' estimation using the ABS-EE data.

Figure 6: Comparison with Guo, Zhang, and Zhao Estimates



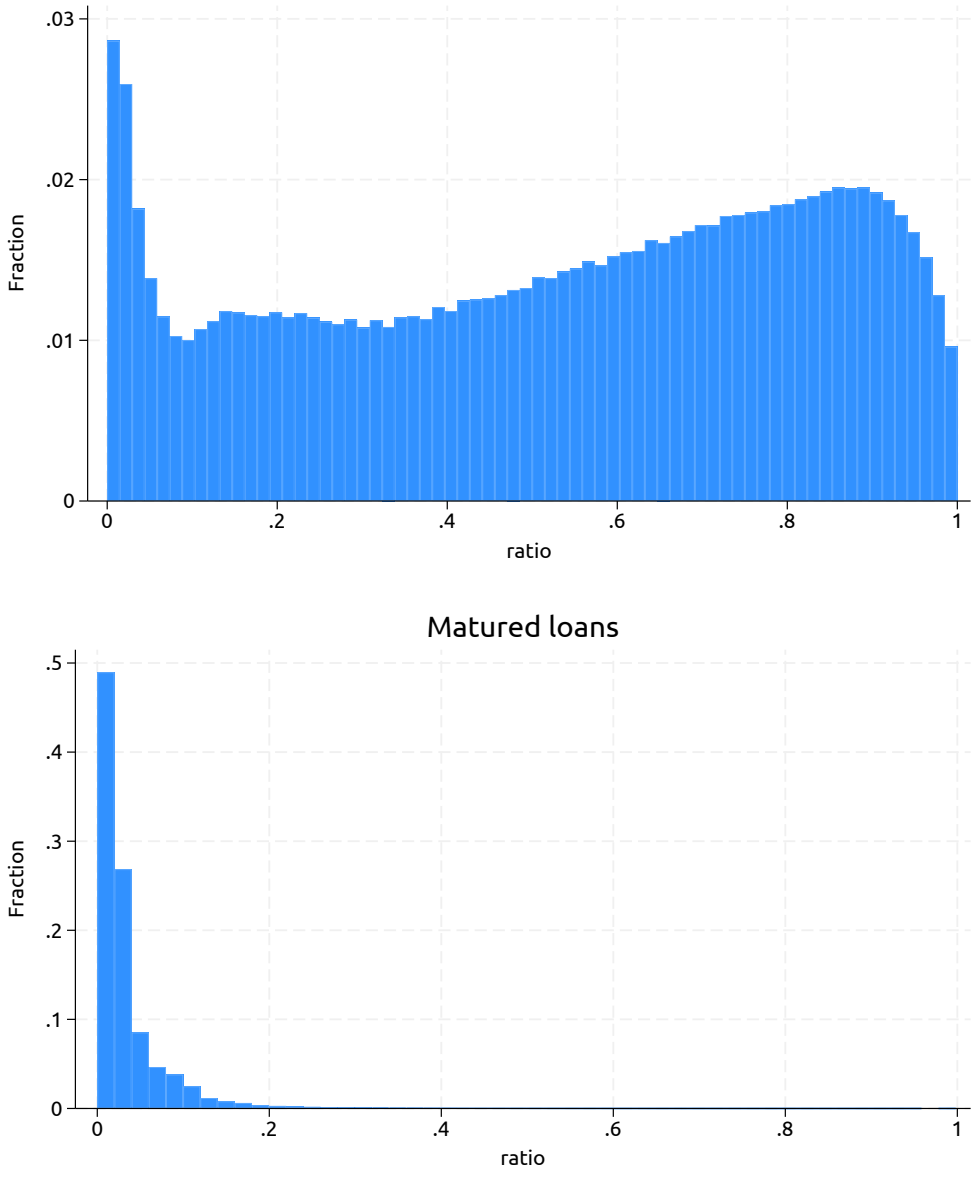
Note: The top two panels show the distribution of the coefficients of longer-maturity (74+ months) loans and the $\beta_{72} - \beta_{60}$ gaps estimated with the baseline model (equation 1) for new car loans, while the middle panels are for used car loans. The model is estimated separately for each year and credit score bucket defined in Guo et al. (2022). The bottom panels show the distributions estimated with the sample that pools new and used car loans and only including lender type controls, as in Guo et al. (2022). Source: Authors' estimates using the Experian AutoCount data.

Figure 7: Trends of Prepayments of Auto Loans



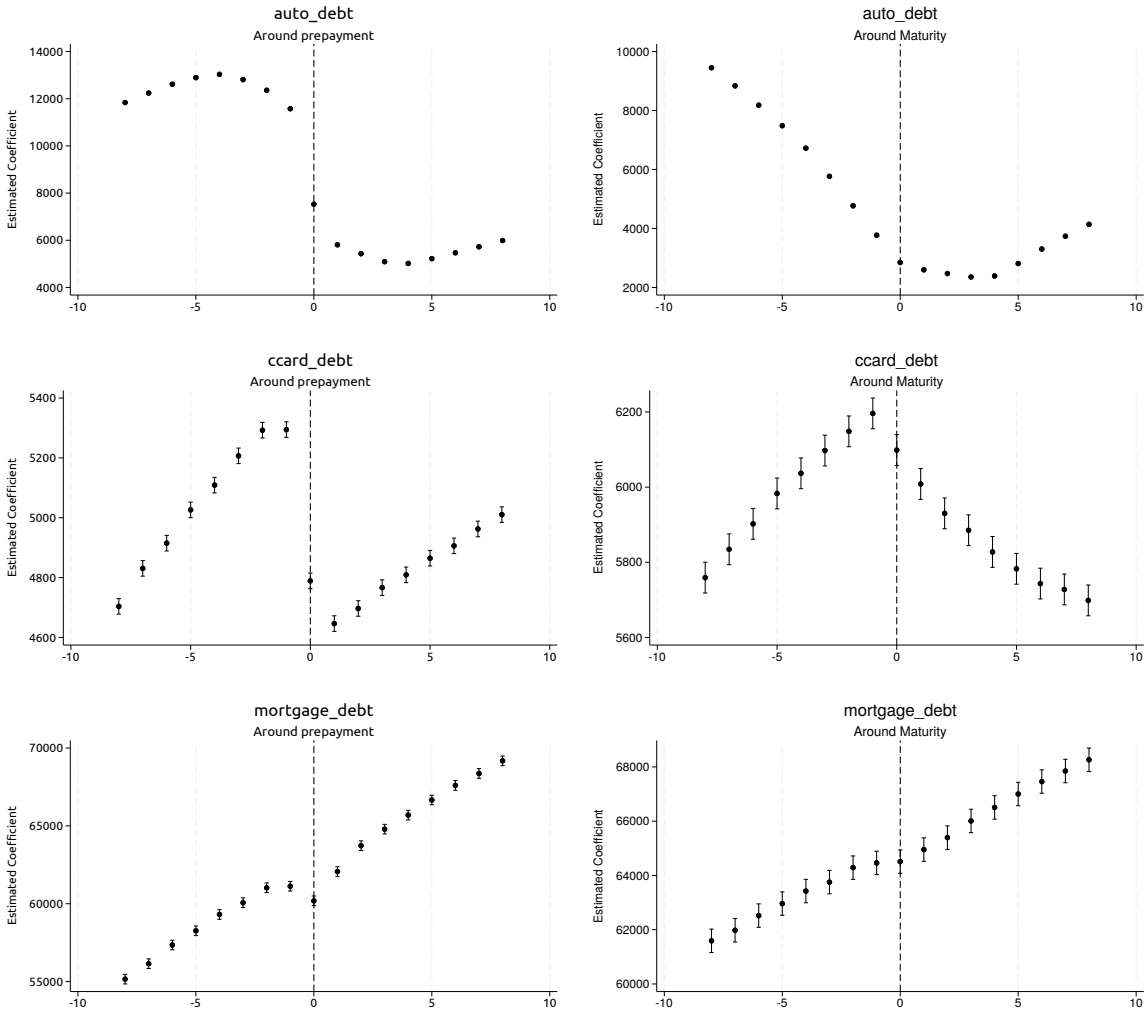
Note: In the upper panel, the blue series plots the share of loans that were prepaid among all loans paid off in a given year, and the orange series plots the share of loans that were eventually prepaid by year of origination. In the lower panel, the series plots the ratio between the actual and the scheduled monthly payments. Source: For the upper panel, the FRBNY/Equifax CCP data; for the lower panel, ABS-EE data.

Figure 8: Last Payment to Loan Amount Ratio



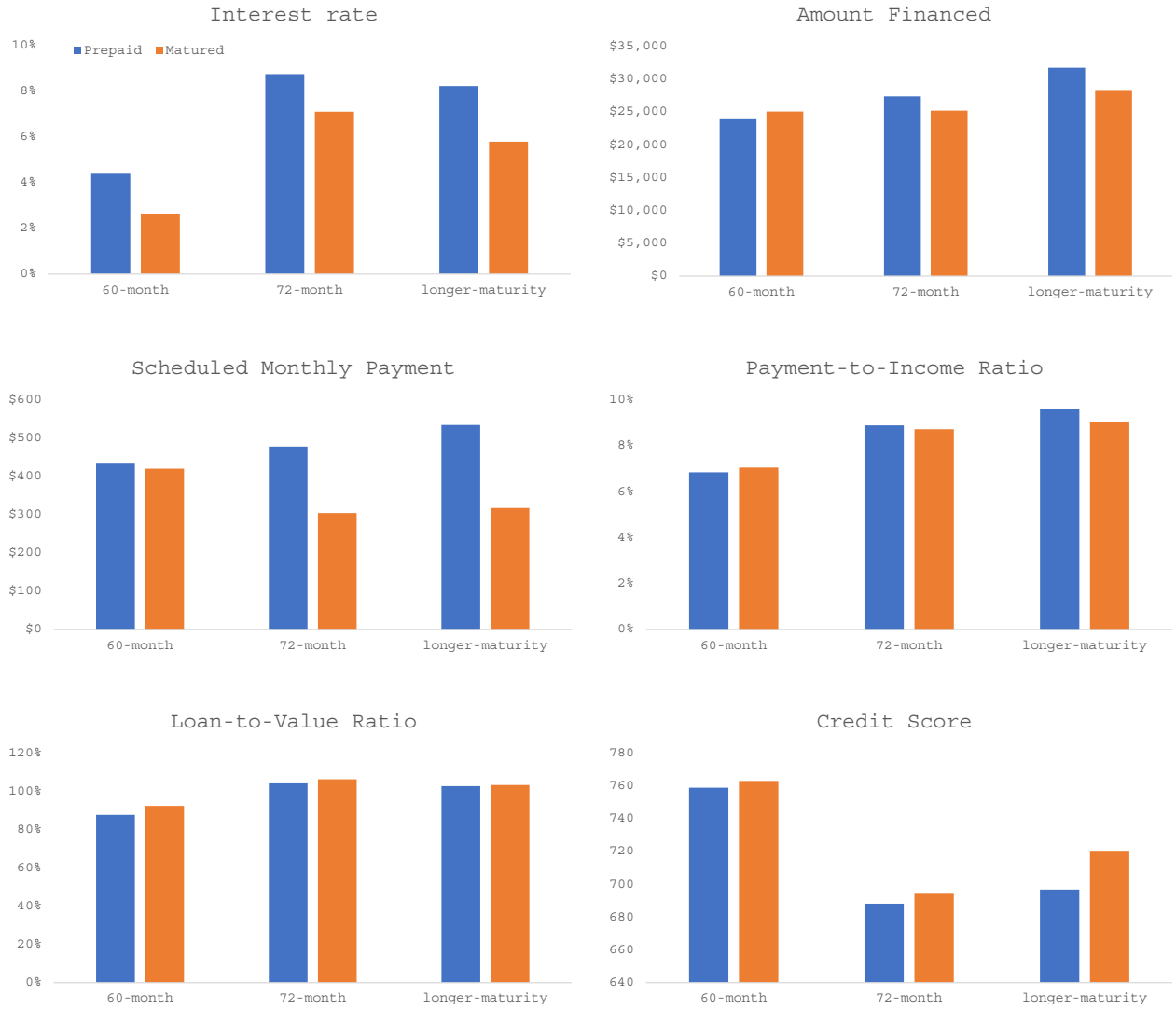
Note: The panels display the ratio between the last payment and the loan amount at origination for prepaid loans (top panel) and matured loans (bottom panel). Source: Authors' estimation using the ABS-EE data.

Figure 9: Loan Balances around the Time of Paying Off the Auto Loan



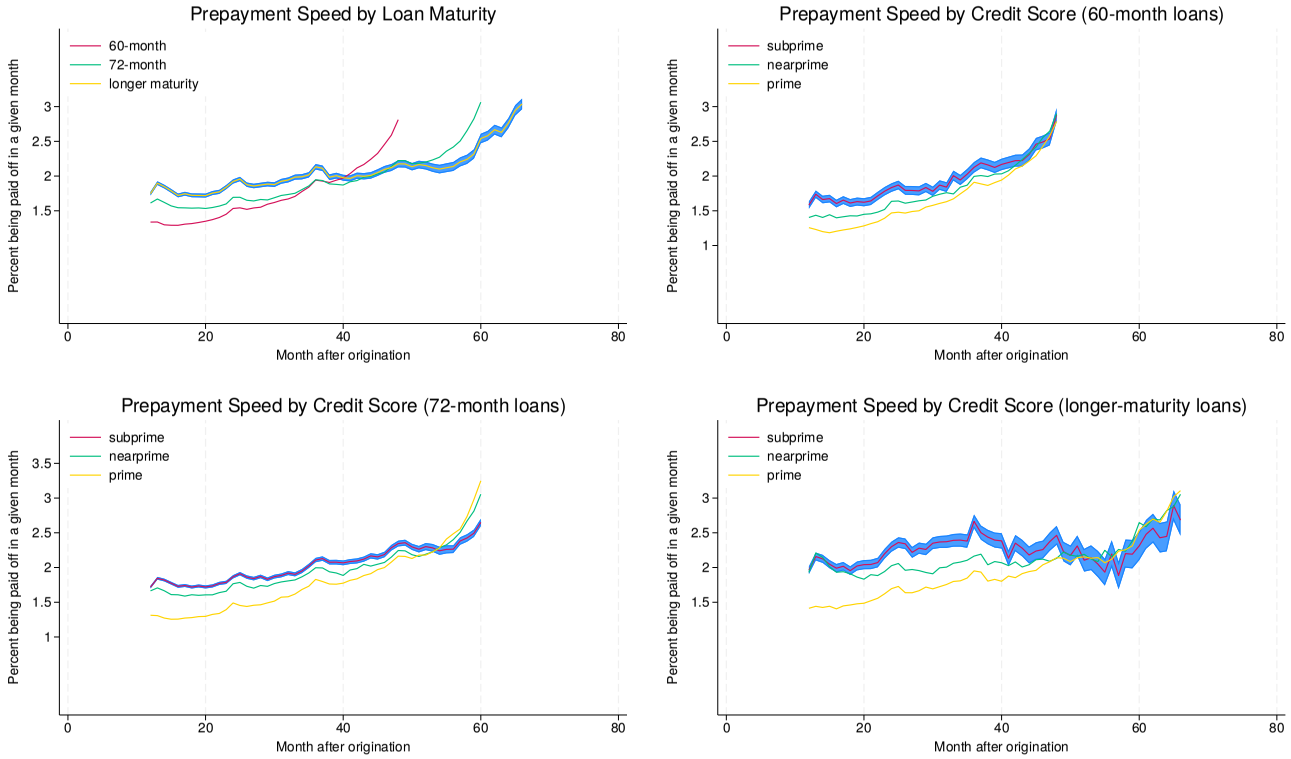
Note: The panels illustrate the dynamics of auto loan, credit card, and mortgage balances 8 quarters before and after an auto loan was prepaid (left panels) or before an auto loan was paid at maturity (right panels) in quarter 0 . Samples only include borrowers who did not open another auto loan within a year of quarter 0. Source: Authors' estimation using the FRBNY/Equifax Consumer Credit Panel data.

Figure 10: Characteristics of Prepaid and Matured Loans (New Car Loans)



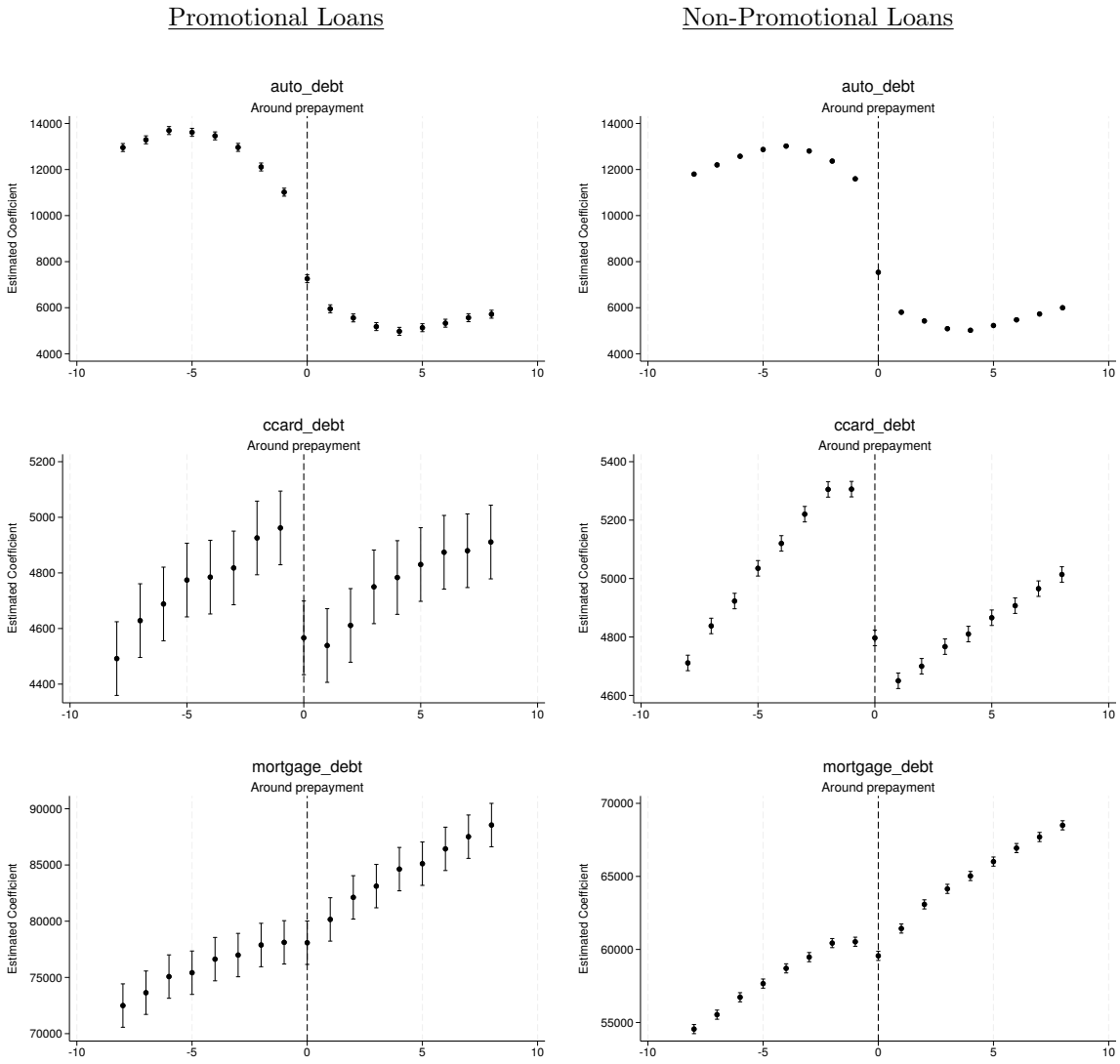
Note: The panels compare key characteristics between new car loans prepaid at least 6 months ahead of maturity (blue bars) and matured loans (orange bars). Source: Authors' estimation using the ABS-EE data.

Figure 11: Prepayment Speed, by Maturity and Borrower Credit Score



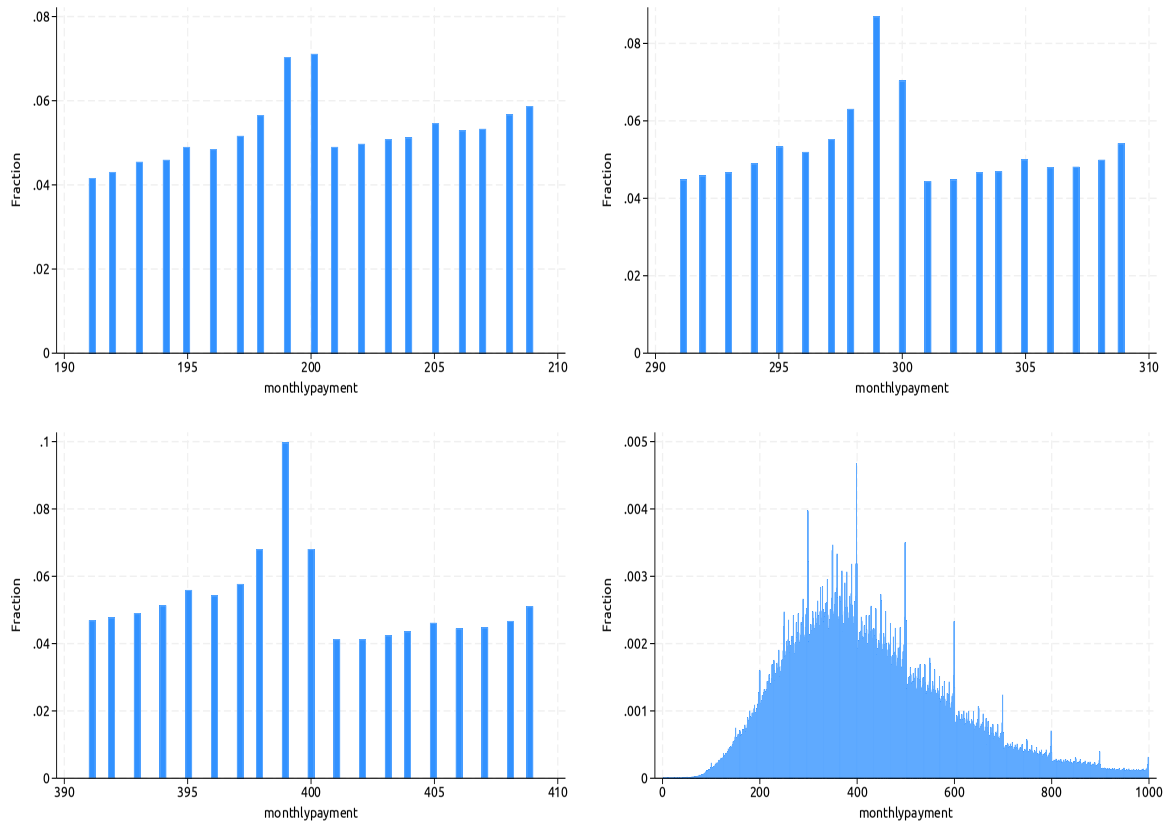
Note: All series plot the likelihood of a loan being paid off in a loan-age month for loans with a positive balance and in good standing. The shaded area around the longer-maturity (top left panel) and the subprime series (rest of the panels) represents 95 percent confidence intervals around the respective estimates. Source: Authors' estimation using the ABS-EE data.

Figure 12: Loan Balances around the Time of Prepaying the Auto Loan for Loans with and without a Promotional Rate



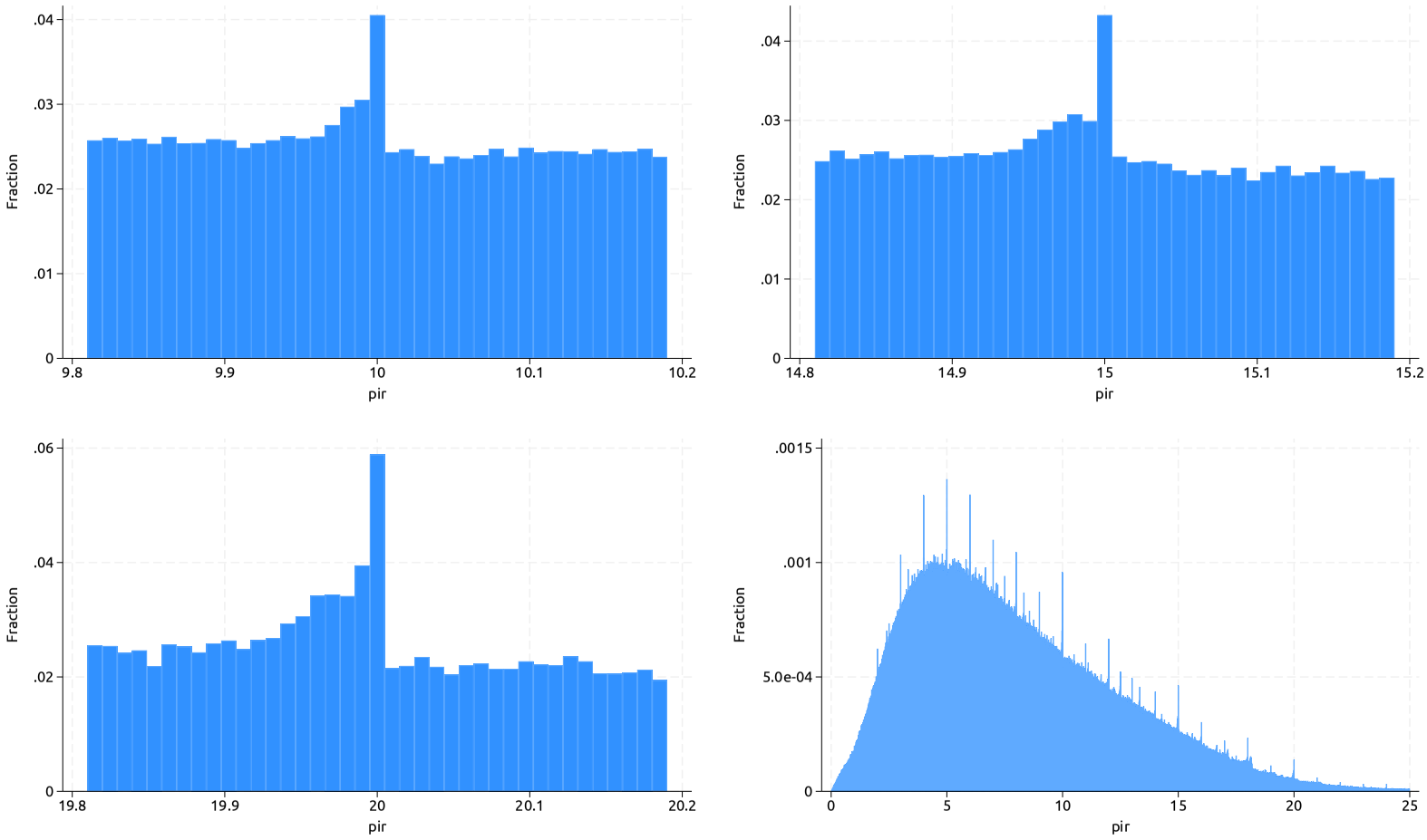
Note: The panels illustrate the dynamics of auto loan, credit card, and mortgage balances 8 quarters before and after prepayment of the auto loan for prepaid loans with a promotional rates (interest rates of 1 percent or lower, left panels) and for prepaid loans without a promotional rate (interest rate higher than 1 percent, right panels). The prepayment quarter is denoted as quarter 0 . Samples only include borrowers who did not open another auto loan within a year of quarter 0. Source: Authors' estimation using the FRBNY/Equifax Consumer Credit Panel data.

Figure 13: Distributions of Monthly Payments
around Key Integers and the General Distribution



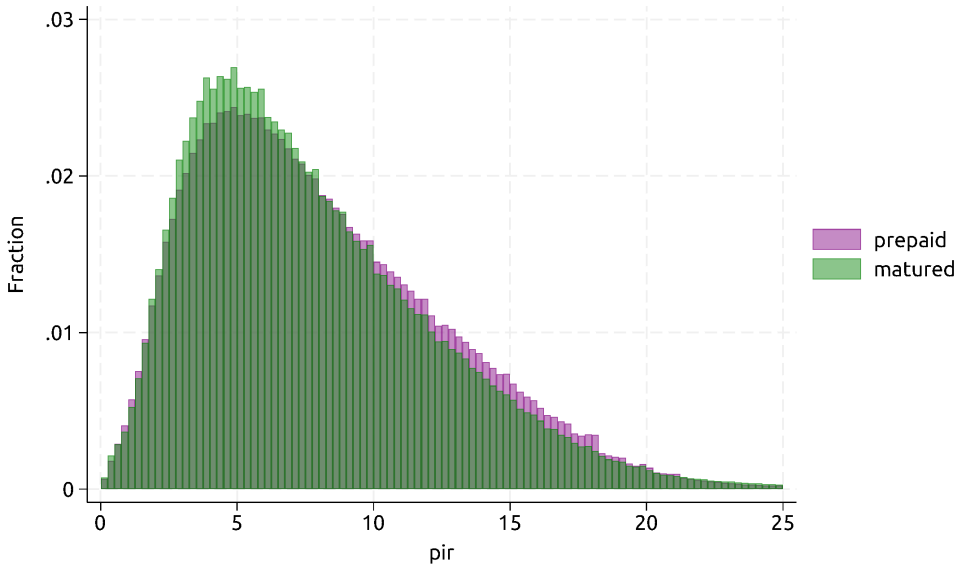
Note: The panels illustrate significant bunching at integer monthly payment levels. However, these loans account for a minor share of all loans (lower right panel). Source: Authors' estimation using the Experian AutoCount data.

Figure 14: Distributions of Monthly Payment-to-Income Ratio
around Key Integers and the General Distribution



Note: The panels illustrate significant bunching at integer monthly payment-to-income ratio levels. However, these loans account for a minor share of all loans (lower right panel). Source: Authors' estimation using the ABS-EE data.

Figure 15: Distributions of Monthly Payment-to-Income Ratio
around Key Integers and the General Distribution



Note: The chart compares the distribution of monthly scheduled payment-to-income ratio between prepaid (purple) and matured (green) loans. Source: Authors' estimation using the ABS-EE data.

Table 1: Auto Loan Maturity and Interest Rate Levels

	All lenders (1)	Bank (2)	CU (3)	Captive (4)	FinCon (5)
			New car loans		
48-month	0.615***	0.196***	0.477***	0.883***	1.013***
	(0.002)	(0.003)	(0.004)	(0.003)	(0.023)
60-month	0.783***	0.604***	0.584***	0.865***	0.920***
	(0.002)	(0.003)	(0.003)	(0.002)	(0.019)
72-month	2.098***	1.367***	1.078***	2.620***	3.751***
	(0.002)	(0.003)	(0.003)	(0.002)	(0.019)
longer-maturity	2.435***	1.492***	1.486***	4.107***	2.221***
	(0.002)	(0.003)	(0.003)	(0.003)	(0.019)
R-Squared	0.516	0.537	0.461	0.403	0.647
N	73,378,559	28,161,105	12,291,640	29,382,774	3,543,040
			Used car loans		
48-month	0.661***	0.503***	0.167***	0.890***	1.544***
	(0.002)	(0.003)	(0.003)	(0.007)	(0.006)
60-month	0.683***	0.338***	0.079***	0.474***	2.284***
	(0.002)	(0.003)	(0.003)	(0.006)	(0.006)
72-month	1.440***	0.888***	0.369***	2.028***	3.523***
	(0.002)	(0.003)	(0.003)	(0.006)	(0.006)
longer-maturity	1.044***	0.485***	0.405***	1.919***	0.505***
	(0.002)	(0.003)	(0.003)	(0.007)	(0.010)
R-Squared	0.671	0.544	0.416	0.476	0.346
N	101,490,971	43,396,165	30,404,317	10,316,933	17,373,556
Controlling for					
Credit score bins	Yes	Yes	Yes	Yes	Yes
Loan amount bins	Yes	Yes	Yes	Yes	Yes
Loan LTV bins	Yes	Yes	Yes	Yes	Yes
Lender type	Yes	NA	NA	NA	NA
Origination state FE	Yes	Yes	Yes	Yes	Yes
Origination year FE	Yes	Yes	Yes	Yes	Yes
Origination month FE	Yes	Yes	Yes	Yes	Yes

Note: The table reports the β coefficients of equation (1), estimated separately for new and used car loans. The first column shows the results for all lenders and the other columns for each of the four major types of lenders. The dependent variable is the loan interest rate. The regressions include a set of flexible controls reported at the bottom of the table (such as 10-point bins for credit scores, $200-bins for loan amounts, and 1-percentage point bins for LTVs). *** denotes statistical significance at the 99.9 percent level. Source: Authors' estimation using the Experian AutoCount data.

Table 2: Auto Loan Maturity and Interest Rate Spreads over Treasury Yields

	All lenders (1)	Bank (2)	CU (3)	Captive (4)	FinCon (5)
			New car loans		
48-month	0.335***	-0.098***	0.282***	0.572***	0.971***
	(0.002)	(0.003)	(0.004)	(0.003)	(0.023)
60-month	0.351***	0.122***	0.223***	0.428***	0.812***
	(0.002)	(0.003)	(0.003)	(0.002)	(0.019)
72-month	1.494***	0.698***	0.566***	2.021***	3.496***
	(0.002)	(0.003)	(0.003)	(0.003)	(0.019)
longer-maturity	1.720***	0.690***	0.860***	3.431***	1.852***
	(0.002)	(0.003)	(0.003)	(0.003)	(0.019)
R-Squared	0.494	0.496	0.408	0.374	0.653
N	73,378,559	28,161,105	12,291,640	29,382,774	3,543,040
			Used car loans		
48-month	0.430***	0.273***	-0.047***	0.673***	1.286***
	(0.002)	(0.003)	(0.003)	(0.007)	(0.006)
60-month	0.252***	-0.112***	-0.320***	0.044***	1.840***
	(0.002)	(0.003)	(0.003)	(0.006)	(0.006)
72-month	0.857***	0.273***	-0.171***	1.442***	2.944***
	(0.002)	(0.003)	(0.003)	(0.006)	(0.006)
longer-maturity	0.371***	-0.227***	-0.223***	1.249***	-0.130***
	(0.002)	(0.003)	(0.003)	(0.007)	(0.010)
R-Squared	0.671	0.530	0.409	0.461	0.357
N	101,490,971	43,396,165	30,404,317	10,316,933	17,373,556
Controlling for					
Credit score bins	Yes	Yes	Yes	Yes	Yes
Loan amount bins	Yes	Yes	Yes	Yes	Yes
Loan LTV bins	Yes	Yes	Yes	Yes	Yes
Lender type	Yes	NA	NA	NA	NA
Origination state FE	Yes	Yes	Yes	Yes	Yes
Origination year FE	Yes	Yes	Yes	Yes	Yes
Origination month FE	Yes	Yes	Yes	Yes	Yes

Note: The table reports the β coefficients of equation (1), estimated separately for new and used car loans. The first column shows the results for all lenders and the other columns for each of the four major types of lenders. The dependent variable is the spread of loan interest rate over comparable-maturity Treasury yield. The regressions include a set of flexible controls reported at the bottom of the table (such as 10-point bins for credit scores, $200-bins for loan amounts, and 1-percentage point bins for LTVs). *** denotes statistical significance at the 99.9 percent level. Source: Authors' estimation using the Experian AutoCount data.

Table 3: Robustness Analysis of the Term-Interest Rate Relationship: New Car Loans

	Credit score range			LTV quartiles				Rates over 2%
	Low	Middle score	High	Bottom	Lower middle	Upper middle	Top	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
48-month	1.842***	0.983***	0.631***	0.447***	0.403***	0.308***	0.312***	0.375***
	(0.032)	(0.009)	(0.001)	(0.002)	(0.005)	(0.009)	(0.014)	(0.002)
60-month	1.071***	0.899***	0.905***	0.622***	0.547***	0.411***	0.130***	0.569***
	(0.027)	(0.007)	(0.001)	(0.002)	(0.004)	(0.007)	(0.011)	(0.002)
72-month	4.435***	3.220***	1.805***	1.422***	1.756***	1.977***	2.100***	1.587***
	(0.027)	(0.007)	(0.001)	(0.002)	(0.004)	(0.007)	(0.011)	(0.002)
longer	4.327***	3.447***	2.557***	1.665***	2.058***	2.271***	2.524***	1.895***
	(0.028)	(0.007)	(0.001)	(0.003)	(0.004)	(0.007)	(0.011)	(0.002)
R-Squared	0.351	0.253	0.356	0.435	0.553	0.558	0.472	0.521
N	7,044,776	21,670,349	44,663,434	16,749,706	16,469,779	15,898,614	15,381,703	68,121,415

Note: The table reports the β coefficients of equation (1). The dependent variable is the loan interest rate. Columns (1)–(3) are estimated with subsamples of borrowers with credit scores below 600, 600–700, and above 700, respectively. Columns (4)–(7) are estimated with subsamples of LTV quartiles, from lowest to highest, respectively. Column (8) is estimated with a sample of new car loans with interest rates greater than 2 percent. *** denotes statistical significance at the 99.9 percent level. Source: Authors' estimation using the Experian AutoCount data.

Table 4: Term-Interest Rate Relationship: Promotional Loans

	Promotional rates (1)	Cash rebate (2)	Prob(rates) (3)	Prob(cash) (4)
48-month	0.302***	0.651***	-0.088***	0.065***
	(0.004)	(0.010)	(0.001)	(0.001)
60-month	0.891***	0.919***	-0.071***	0.014***
	(0.004)	(0.008)	(0.001)	(0.001)
72-month	1.649***	2.384***	-0.294***	0.189***
	(0.004)	(0.008)	(0.001)	(0.001)
longer	3.102***	3.967***	-0.580***	0.109***
	(0.005)	(0.009)	(0.001)	(0.001)
R-Squared	0.537	0.513	0.217	0.074
N	5,922,140	3,949,713	10,543,300	10,543,300

Note: Columns (1)–(2) report the β coefficients of equation (1) for loans with a promotional interest rate and cash rebate, respectively. The dependent variable is the loan interest rate. Columns (3)–(4) report the estimates of linear probability models of a loan having a promotional interest rate or cash rebate. *** denotes statistical significance at the 99.9 percent level. Source: Authors' estimation using the ABS-EE data.

Table 5: Share of Loans Prepaid by Contract Maturity and Loan Age

	Prepayment share (percent)		
Months after orig.	60-month (1)	72-month (2)	longer-maturity (3)
12–18	8.3	10.4	12.0
12–24	15.3	18.2	20.7
12–36	28.4	30.6	33.6
Memo: first 12 months		15	

	Prepayment share (percent) between the 12th and 36th months		
Credit score bin	60-month (1)	72-month (2)	longer-maturity (3)
Subprime	32.7	33.9	38.5
Nearprime	29.7	31.5	35.8
Prime	27.6	27.1	29.7

Source: Authors' calculation using the ABS-EE data.

Table 6: Excess Interest Payments of Prepaid Loans

Contract maturity (months) and interest rate margin	Prepay at the 24^{th} month Discounting rate				Prepay at the 36^{th} month Discounting rate			
	0%	1%	2%	break-even	0%	1%	2%	break-even
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Moderate interest rate environment 5 percent for maturity shorter than 36 months							
60-month (+0.9%)	1,570	916	298	2.51%	1,783	1,104	478	2.82%
72-month (+3.2%)	3,138	2,383	1,669	4.59%	4,086	3,185	2,352	5.35%
longer-maturity (+3.4%)	3,402	2,592	1,827	4.65%	4,586	3,556	2,605	5.23%
	High interest rate environment 7 percent for maturity shorter than 36 months							
60-month (+1.1%)	2,580	1,891	1,240	2.70%	2,902	2,168	1,491	3.09%
72-month (+4.5%)	5,001	4,194	3,432	5.86%	6,537	5,540	4,619	7.01%
longer-maturity (+4.3%)	5,089	4,231	3,421	5.49%	6,875	5,752	4,714	6.27%

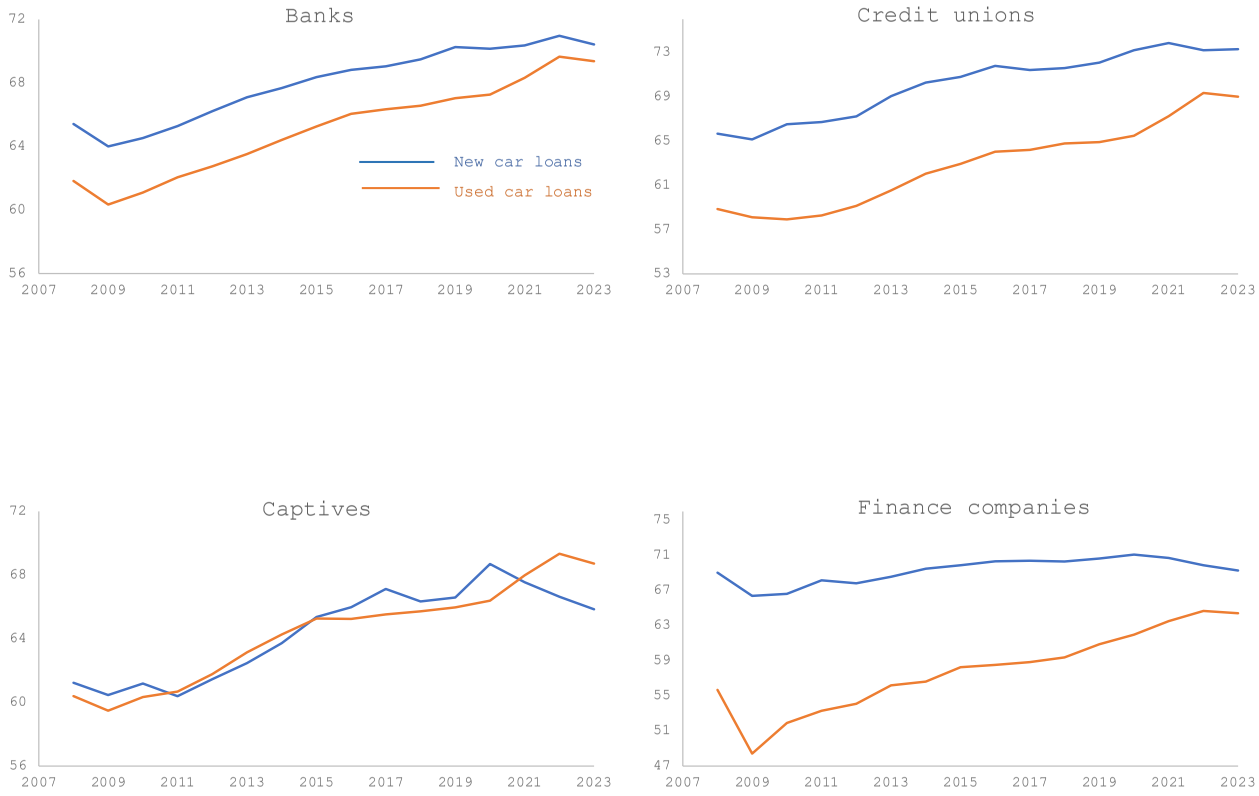
Note: Results based on simulations. The upper and lower panels of the table simulate the experience of middle- and low-score borrowers with a $35,000 loan and an interest rate of 5 and 7 percent, respectively, for shorter-maturity loans, which is set to both 24- and 36-month loans for simplicity. The interest rate margins of loans of other maturities follow the estimates in table 3. The columns reflect three levels for the discounting factor across to mimic various levels of return of borrowers' investment.

Table 7: Auto Loan Maturity Distribution for Subprime Borrowers at the Largest Lenders

Lender	shorter-maturity	37–48 months	49–60 months	61–72 months	longer-maturity
American Honda	5,551	997	1,492	8,722	4,037
Ford Motor Credit	203	572	2,327	17,581	10,722
GM Financial	13,135	415	1,586	8,033	566
Hyundai	3,803	831	512	6,959	3,157
Nissan	3,479	1,199	370	3,812	5,978
Santander	548	1,740	9,529	70,728	54,578
Toyota	8,240	2,473	3,888	25,238	11,658
World Omni	704	144	193	2,051	5,152

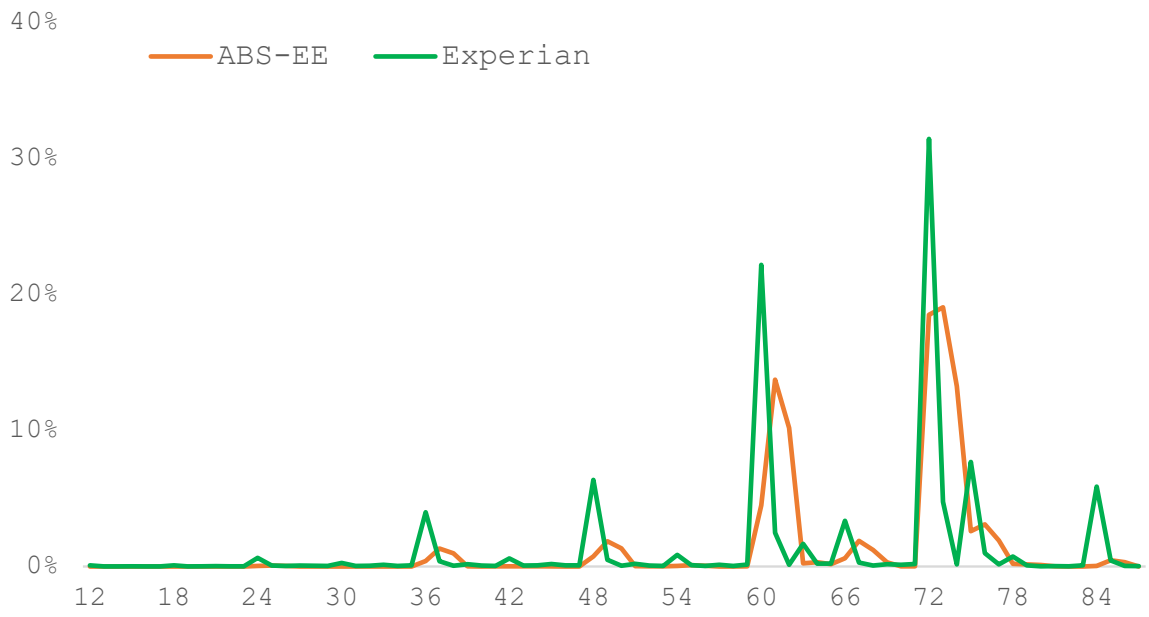
Note: Authors' calculation using the Experian AutoCount data.

Figure A1: Loan Maturity by Lender Type



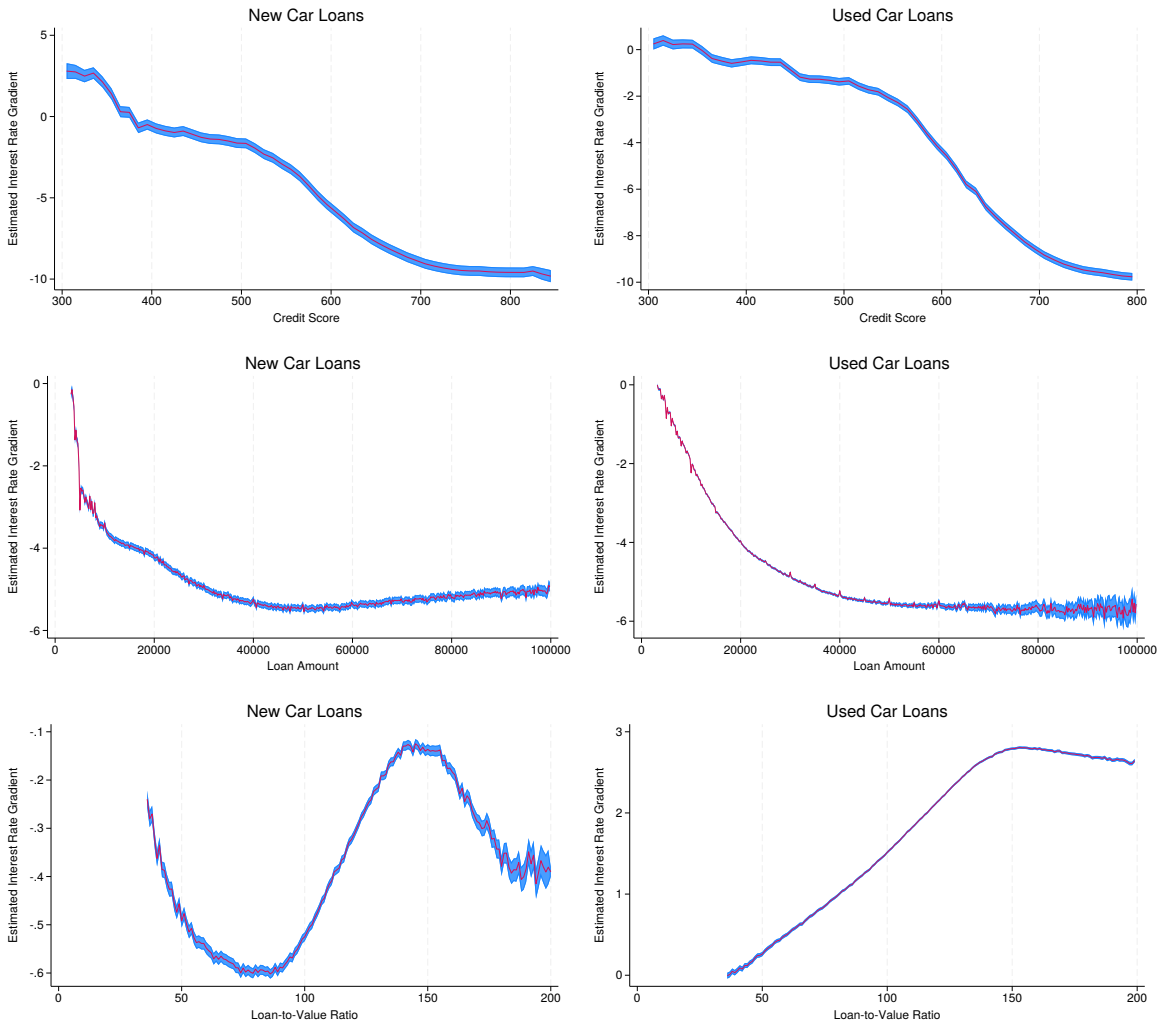
Source: The Experian AutoCount data.

Figure A2: Loan Maturity Distribution in the Experian and ABS-EE Data



Source: The Experian AutoCount and ABS-EE data.

Figure A3: Other Characteristics and Loan Interest Rates



Note: Authors' estimation using the Experian AutoCount data. The charts illustrate the coefficients estimated (in red) and the 95-percent confidence intervals (blue shaded areas) from equation (1) for credit score, loan amount, and LTV control bins for new car loans (on the left) and used car loans (on the right).

Table A1: Auto Loans Characteristics By Contract Maturity

Maturity Months	Amount Financed (1)	Interest Rate (2)	Monthly Pmt. (3)	Credit Score (4)	LTV (5)	Share of Market (6)
	New car loans					
shorter-maturity	20,842 [17,613]	3.08% [2.51%]	628.1 [508]	776.9 [797]	68.0 [64]	4.90%
48-month	23,258 [20,593]	3.61% [3.04%]	513.4 [455]	771.6 [793]	77.4 [77]	4.71%
60-month	27,028 [24,450]	3.51% [2.97%]	485.1 [437]	753.5 [771]	92.2 [96]	26.75%
72-month	31,694 [28,719]	6.15% [4.89%]	523.0 [480]	697.7 [704]	113.8 [117]	42.42%
longer-maturity	37,423 [34,717]	6.00% [5.28%]	568.9 [530]	695.4 [696]	126.4 [128]	21.22%
	Used car loans					
shorter-maturity	8,921 [7,500]	11.11% [8.18%]	335.1 [278]	655.8 [646]	153.7 [127]	7.34%
48-month	12,293 [11,029]	11.34% [8.40%]	322.2 [301]	657.9 [651]	154.7 [135]	10.94%
60-month	17,376 [15,435]	8.27% [5.93%]	351.5 [322]	687.9 [692]	130.9 [124]	26.03%
72-month	22,867 [20,599]	9.93% [7.64%]	421.7 [390]	660.7 [657]	138.3 [132]	42.66%
longer-maturity	30,688 [28,290]	6.82% [5.93%]	483.7 [447]	687.9 [687]	141.8 [132]	13.04%

Note: Experian AutoCount. The table reports the mean and median (in brackets) of main terms of new and used car auto loans originated between 2008 and 2023.

Table A2: Maturity-Interest Rate Relationship for Different Subsample Periods

		Credit score bucket		
	Whole sample	Low	Middle	High
		2008-10		
48-month	1.266***	2.257***	1.578***	1.283***
	(0.005)	(0.059)	(0.019)	(0.004)
60-month	1.452***	3.809***	1.889***	1.442***
	(0.004)	(0.048)	(0.014)	(0.003)
72-month	3.076***	6.407***	4.337***	2.562***
	(0.004)	(0.048)	(0.014)	(0.003)
longer-maturity	3.435***	6.076***	4.333***	3.466***
	(0.005)	(0.050)	(0.015)	(0.004)
		2011-15		
48-month	0.474***	1.249***	0.701***	0.501***
	(0.004)	(0.051)	(0.013)	(0.002)
60-month	0.392***	-0.206***	0.235***	0.539***
	(0.003)	(0.044)	(0.010)	(0.002)
72-month	1.897***	3.648***	2.557***	1.466***
	(0.003)	(0.044)	(0.011)	(0.002)
longer-maturity	1.799***	3.238***	2.286***	1.863***
	(0.003)	(0.044)	(0.011)	(0.002)
		2016-19		
48-month	0.359***	1.330***	0.682***	0.375***
	(0.005)	(0.071)	(0.019)	(0.003)
60-month	0.336***	-0.863***	0.227***	0.427***
	(0.004)	(0.063)	(0.016)	(0.002)
72-month	1.488***	2.402***	2.129***	1.154***
	(0.004)	(0.062)	(0.016)	(0.002)
longer-maturity	1.997***	2.574***	2.687***	2.020***
	(0.004)	(0.062)	(0.016)	(0.003)
		2020-23		
48-month	0.462***	1.491***	0.676***	0.426***
	(0.004)	(0.083)	(0.018)	(0.003)
60-month	1.172***	0.827***	1.208***	1.150***
	(0.004)	(0.075)	(0.016)	(0.002)
72-month	2.045***	3.080***	2.740***	1.764***
	(0.004)	(0.074)	(0.016)	(0.002)
longer-maturity	2.702***	3.289***	3.472***	2.634***
	(0.004)	(0.074)	(0.016)	(0.003)

Note: Authors' estimation using the Experian AutoCount data. The table reports the β coefficients of equation (1), estimated separately for each sample period.

Table A3: Correletions among Auto Loans Characteristics

	Interest rate	Loan amount	Monthly payment	PIR	LTV	Credit Score
Interest rate	1.00					
Loan amount	-0.34	1.00				
Monthly payment	0.01	0.81	1.00			
Payment-to-income ratio (PIR)	-0.03	0.01	-0.01	1.00		
Loan-to-value ratio (LTV)	0.33	0.12	0.19	-0.00	1.00	
Credit score	-0.79	0.22	-0.05	0.03	-0.33	1.00

Note: Authors' estimation using the ABS-EE data.