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

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Abstract

We document a secular trend of increasing auto loan maturity from 30 months to over 70 months during the past 50 years, partly reflecting improved vehicle durability. Analyzing more than half of the auto loans originated during the past 16 years, we find that longer-maturity new car loans have significantly higher interest rates with a yield curve much steeper than comparable-maturity Treasury securities. In addition, we show that the majority of auto loans were prepaid, including loans of zero interest, and that many prepaying borrowers could have paid materially less interest by choosing loans of a shorter maturity. We argue that factors such as liquidity constraints, uncertainty about future income, and monthly payment targeting likely account for only a portion of borrowers' choice of long-maturity loans.

Keywords: Prepayment, Auto loan, Maturity choice, Household financial decisions, Term structure, Liquidity constraints

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1 Introduction

Few credit markets in the U.S. have evolved like the one for auto loans, where loan maturities consistently increased over the previous five decades. In addition, two other related features in this market are noteworthy. First, loans of longer maturity have higher interest rates, with a term structure appreciably steeper than the Treasury yield curve. Second, the majority of loans are paid off ahead of the scheduled maturity (prepayment), including loans with zero interest rates.

Auto loans constitue 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) was consistently above $150 billion in recent years, providing a broader constituency of investors with an exposure to such credit.

Against such a backdrop, this paper analyzes auto loan maturity—its long-term trend and relationship with loan interest rate—and the prepayment behavior, with a focus on *ex post* optimality of maturity choices and prepayment decisions. Specifically, 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. We also explore factors, such as continued improvement in vehicle durability, that have potentially propelled maturity lengthening.

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

With respect to loan prepayment, we find that, on average, about 45 percent of auto loans originated since the early 2000s were paid off within the first 36 months and about 70 percent were paid off at least 6 months ahead of maturity. We study loan and borrower characteristics

[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.

that predict prepayment and illustrate that subprime and long-maturity loans have a greater speed of prepayment.

We further introduce two potentially puzzling patterns related to maturity choices and prepayment decisions. First, a substantial share of zero interest rate loans were prepaid. 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. Various hypotheses are evaluated and we argue that liquidity constraints, income volatility, and monthly payment targeting cannot entirely account for the high prevalence of long-maturity loans that were prepaid eventually.

In the Context of the Literature

This paper is not the first on lengthening auto loan maturity, and the existent work has focused on loans originated after the year 2000 (for recent examples, see Brevoort et al., 2017; An et al., 2020; Guo et al., 2022). We broaden the analysis and document a secular trend of rising maturity going back to the early 1970s. During the same period, vehicle durability almost doubled, and we hypothesize that the ever-improving durability has been an important factor for lengthening loan maturity. In this regard, the collateral durability–loan maturity relationship may speak to financing acquisitions of durable assets in the broad credit market (for 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 debt markets.[2] However, despite the substantial maturity extension, relatively little has been formally analyzed regarding the yield curve of auto loans. A similar contrast can be found on prepayment studies. A large volume of research has been dedicated to mortgage prepayments. 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).

Only a handful of studies, however, specifically analyze prepayments of auto loans. Heitfield and Sabarwal (2004) and Agarwal et al. (2008) are two notable examples. More recently,

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

Grunewald et al. (2024) study the extent to which prepayment risk may affect dealer markups on auto loan interest rates. The meager research on auto loan prepayments is partly due to the relatively shorter 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.

Our analysis of auto loan prepayment has a particular focus on its optimality and connection with maturity choice. Specifically, we document two stylized facts that appear at odds with optimal prepayment models. First, more than half of zero-interest loans were prepaid, of which fewer than one third appeared to be driven by "trade-ins." Unlike the promotional "teaser" rates on credit cards that typically last a year or shorter, promotional rates auto loan typically apply to the entire contract maturity. Furthermore, a substantial portion of such prepaid loans had significant accelerated amortization, indicating an intended prepayment. The failure to take full advantage of low-cost loans is broadly consistent with the so-called debt-aversion behavior that has received increasing attention in recent work (for example, Martínez-Marquina and Shi, 2024, and the literature surveyed therein). Thus, this paper also contributes to the growing literature on borrower sub-optimal behaviors in consumer credit markets. For instance, Ponce et al. (2017); Gathergood et al. (2019); Agarwal et al. (2023) find potentially sub-optimal behaviors in the credit card market, Argyle et al. (2020) in the auto loan market, and Li and Smith (2010) for pension loans.[3]

Second, because longer maturity loans tend to have higher interest rates, we want to understand why many borrowers choose such contracts, but only to pay off the debt way ahead of maturity. Indeed, we estimate that thousands of dollars in interest payments could be saved in the counterfactual where the borrower chooses a maturity consistent with the realized duration. Similarly, Lehnert et al. (2006) argued that, before hybrid ARMs gained popularity, many mortgage borrowers paid high interest rates of 30-year fixed rate mortgages that did not match with their expected mobility in the next few years. We postulate that liquidity constraints and

[3] 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).

perceived uncertainty about future affordability, while playing a significant role, are unlikely the only factors leading most borrowers to choose long-maturity loans in today's market. In addition, recent studies (Argyle et al., 2020; Momeni, 2024) underscore the importance of monthly targeting with respect to maturity choice. We show that there are 1.3 percent of loans with a monthly payment of integer multiples of $100, too few to establish it as a dominating factor.[4]

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); Guo et al. (2022) all show that long-maturity auto loans have a higher default risk, conditional on observed loan 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. In addition, 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 taking the only option offered by lenders.

It is important to note that auto loan contracts are intrinsically complex to study—not only because they include many terms (maturity, loan amount, interest rate, etc.), but also because these terms are typically 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 results. Conversely, counterfactual analysis based on reduced-form estimates should be mindful of such caveats.

That said, as we will detail below, a unique strength of this analysis is the use of several large, universe-scale data sets that provide dovetailing perspectives on auto loan terms and payment decisions. For example, the data set we use to estimate the yield curve covers about 55 percent of the entire market. 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

[4] The share expands to less than 4 percent when including monthly payments such as $299, $399, $499, etc.

estimates are not structural in nature, we expect 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 (Charles et al., 2008; Butler et al., 2023, see, for example). Some of the empirical patterns we find may be associated with such behaviors. However, because the data we use do not have detailed demographic characteristics information, 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. 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. Leasing is a particularly relevant option for car buyers who plan to trade-in their car periodically to keep driving new cars, which is also one of the major factors triggering prepayment. We plan to study the optimal loan contract and prepayment choices with leasing as an option of financing in future analysis.

The remainder of the paper proceeds as follow: Section 2 describes the three main data sets we use and discusses their respective strengths and limitations. Section 3 documents the auto loan maturity trend over the past 50 years and discusses possible factors associated with this trend. 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 data set includes nearly 200 million auto loans, covering more than 55 percent of all originations between 2008 and 2023.[5] The data set includes detailed information on loan characteristics, such as loan maturity, interest rate, amount financed, scheduled monthly payment, and the borrower's credit score at origination. In addition, the data include information on lender type—banks, credit unions, captive finance companies, and independent finance companies. 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.[6]

The advantage of the Experian AutoCount data set is its universe-scale coverage of auto loans at origination, which is particularly valuable for the interpretation and generalization of the statistical results derived from this sample. 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.

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. By contrast, 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.[7]

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

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

[6] 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.

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

(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 the exact timing.

On the other hand, the ABS-EE data have three main limitations. First, the data include only loans in publicly issued ABS pools. Such ABS accounted for over 50 percent of the entire auto loan ABS issuance between 2017 and 2023, and the characteristics and prepayment speed of loans in such pools may not be identical to those in privately issued ABS pools or the loans lenders keep on-book. Second, the sample period of the ABS-EE data is relatively short, limiting our capability of analyzing the long-term trend of auto loan prepayments. Third, and importantly, most 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. To ensure the robustness of our results, we experiment with various thresholds of warehousing period.

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.[8]

The Equifax data have two main advantages. First, it covers a large random sample of the universe of auto loans and tracks these loans over time. Second, it contains the broad credit history of 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 in the section is the large, universe-scale sample size and extensive information. Because of their respective strengths and limita-

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

tions, 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 loans originated between 2008 and 2023 in the Experian AutoCount sample, we observe a steady trend of rising average auto loan 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 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 A2.[9]

Appendix table A1 compares the characteristics of loans of different maturities in the Experian sample. Broadly speaking, we findthe 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 greater financing volume and higher interest rates 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), consistent with Brevoort et al. (2017); An et al. (2020); Guo et al. (2022). Interestingly, for used car loans, those with shortest maturities appear to have the lowest credit scores and highest LTVs.

[9]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.

A Longer Perspective

The existent work has largely focused on the trend of auto loan maturity in the relatively recent history.[10] The rise of auto loan maturities, however, is not a recent 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.[11] 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. As seen in 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 A2 together, new and used car loans originated by captive finance companies have similar maturities over the past three decades.[12]

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 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.

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

[11] The series were discontinued in early 2011 because of industry changes that prevented the collection of such data.

[12] The lower panel of figure 1 tracks only the three major domestic captives, and the captives appendix figure A2 tracks a broader set of captives that are affiliated with both domestic and international vehicle manufacturers.

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 short 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.[13]

3.2 Possible Factors That Propelled Longer Maturities

While exploring why auto loan maturities have increased so much in the past 50 years is not the main analytical focus of the current paper, we postulate that two 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 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, perhaps even more tangibly, 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 loan contract, particularly the maturity. 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. The financial market developments discussed earlier picked up momentum in the 1980s. For example, Ford Credit issued the first major auto loan ABS in the late 1980s. By contrast, the enhancing vehicle durability appears to share a similar trend with lengthening loan maturity from at least the early 1970s.

Furthermore, we find a significant cross-sectional correlation between maturity and vehicle age at origination. For example, 13.6 percent of loans on two-year old used cars originated by Carvana (an independent finance company) in 2023 have a maturity beyond 72 months, compared with 6 percent among loans on five-year old cars. More broadly, we estimate the

[13]Relative to Experian, the loan maturity distribution in the ABS-EE data is one- or two-month right-shifted (see appendix figure A1). 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. 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.

maturity-vehicle age at origination relationship using the sample of used car loans in the ABS-EE data originated in various years, controlling for an array of lender, make-model, origination state, year, and month fixed effects.

$$\underset{}{Maturity\ Months} = \alpha - \underset{(0.001)}{1.02}\ Vehicle\ Age\ Years\ + F.E. \tag{1}$$

The data indicate that loans collateralized by vehicles one year older have, on average, a one month shorter maturity. In comparison, 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. 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 72 months or longer. We should caveat that the correlation is estimated in a cross-sectional context and may not be applicable for extrapolating loan maturity dynamics over time.

The relationship between debt structure and capital durability has been recently explored in the corporate finance literature (e.g. Rampini, 2019; Geelen et al., 2024). However, little is known about this link in the household credit market, and the extent to which enhanced vehicle durability helped push loan maturity longer warrants more research in the future. In addition, we hypothesize that if loan maturity can be stretched as the underlying collateral becomes more lasting, purchasing more durable assets may make more sense than in an environment of constant maturity (Rampini, 2019). This is particularly true for cash-constrained firms, because a longer loan maturity lowers the scheduled payment, all else being equal.

4 Term Structure of Auto Loans

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.

$$R = \alpha + \beta M + \gamma CreditScore + \theta Amount + \eta LTV + \omega_{Lender\ Type} + \omega_{State} + \omega_{Year} + \omega_{Month} + \varepsilon, \quad (2)$$

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 use a flexible specification for the credit score, loan amount, and LTV controls by including vectors of fairly narrow bins of the respective controls.[14] We estimate the equation separately for new and used car loans because they have different collateral value risks and their respective borrowers have potentially large credit risk differentials.

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 point 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), longer-maturity loans have an average interest rate that is 1.7 percentage points higher. Because the 60- and 72-month loans had the largest shares in recent originations, we will often use this $\beta_{72} - -\beta_{60}$ gap as a convenient reference.

Putting these estimates in context, we find 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 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. Specifically, 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 $\beta_{72} - -\beta_{60}$ gap

[14] Specifically, we use 50-point bins for credit scores, \$1,000-bins for loan amounts, and 10-percentage point bins for LTVs.

remains sizable at 1.2 percentage points.[15] 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 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 $\beta_{72} - -\beta_{60}$ gap is the largest at captive and independent finance companies and smaller at banks and credit unions. We note that the maturity–interest rate relationship of new car loans is 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). Finally, as shown in the lower panel, unlike new car loans, the maturity–interest rate relationship estimated from used car loans is not monotonic. The 72-month loans typically have higher interest rates than loans of shorter and longer maturities. In addition, the $\beta_{72} - -\beta_{60}$ gap varies a lot across different types of lenders, with the gap being more sizable at finance companies than at credit unions and banks. Because the maturity–interest rate relationship is more pronounced and consistent for new car loans, our subsequent analysis focuses on such loans.

Besides loan maturity, interest rates are strongly correlated with borrower credit scores and loan amount. Appendix figure A3 plots the estimated coefficients of 50-point credit score bins (top panel) and $1,000-loan amount bins (middle panel), with the lowest credit scores (300–349) and below-$5,000 loans being the respective omitted groups. Both panels show pronounced downward trends for new and used car loans. Finally, the statistical relationship between interest rates and LTV is more nuanced. As shown in the bottom panel of figure A3, used car loan interest rates increase monotonically with LTV, whereas there is not a monotonic relationship for new car loans.

4.2 Anecdotal Evidence from Lenders' Rate Sheets

We underscore that estimates from equation (2) are not intended to be interpreted as structural, and any counterfactual exercise based on these estimates should bear some caveats. In partic-

[15] Similar to the interest rate level results, the gradient is more pronounced and consistent for new car loans than used car loans. Among new car loans, the gradient is most pronounced at captive finance companies.

ular, our data reflect equilibrium maturities and interest rates agreed upon between lenders and borrowers. An alternative approach of studying this relationship is to look at lenders' rate sheets that describe the maturity–interest rate menu they offer.[16]

Unlike residential mortgages, data of such rate offer sheets are not broadly available for the auto loan market. We therefore surveyed over 200 webpages of the largest auto loan lenders to retrieve such information for anecdotal evidence that corroborates the baseline 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, and the magnitude 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.[17] While the details differ somewhat, these patterns are seen on the webpages of most lenders we explored.

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 buckets, we find that similar maturity-interest rate gradients prevail across the credit score distribution.

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

[16]See, for example, Han et al. (2018) for a discussion on using lender offers as a measure of credit supply.

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

structural pattern of longer-maturity loans being more expensive.

We first analyze the effect of promotional interest rates, which we define as those lower than 1 percent, as the typical promotional auto financing rates are 0 percent or 0.99 percent.[18] We re-estimate equation (2) using a sub-sample of non-promotional rate loans, and the results, shown in column 1 of table 3, indicate that the positive association between loan maturity and interest rate holds among non-promotional loans. However, the β coefficients are somewhat smaller than the baseline estimates in table 1, suggesting that part of the maturity–interest rate relationship reflects the fact that loans of shorter maturities carry promotional rates. Indeed, as seen in column 2, a linear probability model shows that loans with longer maturities are significantly less likely to have promotional rates. In particular, very few (about 3 percent) of promotional loans have a maturity over 74 months.[19]

While the baseline model controls for borrowers' credit scores, the question remains whether the estimated maturity-interest rate relationship manifests a selection result. For example, if lower credit score borrowers are more likely to choose longer-maturity loans, we will find a positive association between loan maturity and interest rate. Does this relationship hold among borrowers with similar credit scores? To address this question, we next estimate equation (2) separately for three sub-samples: (1) borrowers with credit scores below 600, (2) between 600 and 700, and (3) above 700. Two patterns are notable from the results in columns 3 to 5. First, the positive maturity–interest rate relationship prevails among loans within each credit score range, reassuring that the baseline results are not entirely 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 3). The $\beta_{72} - -\beta_{60}$ 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.

Third, we note that loan amount and maturity can be negotiated and determined jointly between the borrower and lender. A liquidity-constrained borrower who wants to acquire a

[18] Some promotional rates are 1.99 percent, but in a low interest rate environment, the regular rate may also reach this level.

[19] Besides promotional interest rates, another common vehicle sales incentive is a cash rebate. However, we do not have data on these incentives to analyze how receiving a cash rebate may be correlated with loan maturity and interest rate.

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 loan amount bins included in the baseline specification. To evaluate if this factor is driving our results, we estimate equation (2) for each LTV quartile separately. As shown in columns 6 to 9, the positive gradient holds across the LTV distribution. We note, however, that the maturity–interest rate gradient is the greatest among loans with the highest LTV (column 9). The result is broadly consistent with that in column 3, both indicating that riskier borrowers pay a greater premium to acquire longer-maturity loans.[20]

We further consider if the baseline results are driven by cross-lender variation in loan maturity and interest rate. Because our Experian AutoCount sample does not include lender names, we resort to the ABS-EE sample. In addition to the controls included in equation (2), the ABS-EE data allow for both lender and vehicle make-model-year fixed effects. The estimated coefficients are plotted in the left-most set of bars in figure 5, which reaffirms a substantial positive gradient.[21] We further estimate the model for each lender separately and plot the coefficients estimated for seven selected large lenders. 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 subsample 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 46 states in our sample. The estimated β coefficient of longer-maturity loans range between 1.98 and 2.88 and the estimated $\beta_{72} - -\beta_{60}$ gaps are between 0.77 and 1.72 percentage points (all statistically significant).

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

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

In a recent exercise, Guo et al. (2022) report inverted yield curves of auto loan interest rates across credit score buckets, contrary to our results. 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 $\beta_{72} - -\beta_{60}$ gaps are plotted in figure 6. We find that for new car loans, all $\beta_{72} - -\beta_{60}$ and the vast majority of β_{longer} are positive and significant (top two panels). For used car loans, about half of the models render a negative β_{longer}, but all render a positive $\beta_{72} - -\beta_{60}$ (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 are negative and over 20 percent of $\beta_{72} - -\beta_{60}$ 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 using these reduced-form estimates. That said, estimating this model using flexible controls and a near-universe sample of loans, the results are expected to shed light 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. One theme of our analysis is to understand whether the borrowers who are perceived as being more liquidity constrained are able to prepay their auto loans. Studying loan prepayment could in turn shed light on the optimality of loan maturity choices because, as documented earlier, longer-maturity loans carry higher interest rates.

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 less precisely measured. In defining loans that were prepaid, we build in a six-months-ahead requirement to ensure the observed prepayments reflect an active debt paying-off decision, in addition to address the measurement errors associated with imputed loan terms in the Equifax data.

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 broadly consistent with industry analysis.[22] 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

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

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.[23]

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. This measure sheds light on potential variations in prepayment speed by year of origination. 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.[24] 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.

5.2 What Loans Are Prepaid?

5.2.1 Prepayment Likelihood across Maturity and Credit Score Distribution

One appealing feature of loans with longer maturities is their lower monthly payments, holding amount financed and interest rate constant. If borrowers' loan maturity choices are mainly driven by their debt service capacity and borrowers choose long-maturity loans because they cannot afford servicing loans with shorter maturities of higher monthly payments, we would expect loans with longer maturities to have a lower prepayment speed. Such a hypothesis is consistent with the finding that longer-maturity loans have a greater default risk (Li and Smith, 2010; Guo et al., 2022). Similarly, if subprime borrowers are, on average, more liquidity constrained than other borrowers, their loans will be less likely to be prepaid.

We evaluate these hypotheses by estimating the prepayment likelihood for each month conditional on that the loan remains in good standing using the ABS-EE sample. Taking advantage of the large sample, we estimate the prepayment likelihood in a nonparametric, flexible fashion and show the estimates of 60-month, 72-month, and longer-maturity loans in the upper left

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

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

panel of figure 8.[25] We further estimate the likelihood of prepayment by subprime, nearprime, and prime borrowers separately for each of these maturity bins and show the results in the other panels. Because the warehousing period varies across loans, we use the loans securitized within 12 months of origination and estimate the prepayment probability from the 12th month onward.[26]

This figure has several notable patterns. First, 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. Second, as shown in the upper-left panel, longer-maturity loans do not necessarily have a lower prepayment speed than 60- and 72-month loans. For example, during the first 40 months, the prepayment likelihood of longer-maturity loans (74+ months, the green line) is higher than that of 72-month loans (the red line), which, in turn, is higher than that of 60-month loans.[27] Thus, the connection between maturity choice and borrower (unobserved) credit risk is more nuanced. On average, longer-maturity loan borrowers have both a greater default risk and prepayment risk. Third, notably, as shown in the other panels, the prepayment speed of subprime borrowers (the blue line) is typically higher than that of nearprime and prime borrowers (the orange and gray lines, respectively).

This contrast is also evident in the *unconditional* prepayment likelihood seen in table 4, which shows that a larger share of loans in the longest-maturity category are prepaid within the first 36 months than loans with shorter maturities. In addition, while we cannot have a representative estimate of the share of loans prepaid within the first 12 months (the so-called early prepayment) using the ABS-EE data because of the warehousing period, we are able to infer such early prepayment from the Equifax data. Our estimates, reported in the memo line of table 4, indicate 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

[25]Similar to equation (2), the multinominal model includes the following variables: array of 50-point credit score bins, $5,000 loan amount bins, 10 percent LTV bins, 2.5 percent PIR bins, a new car loan dummy, maturity term dummies, and origination year dummies.

[26]The estimates are qualitatively the same when we use different warehousing period thresholds. The trade-off is that a lower threshold implies a smaller sample but enables us to see prepayments that occur in early months.

[27]While figure 8 does not plot standard errors, such differences are statistically significant, as a result of the large sample size we use to estimate the prepayment likelihood.

results are broadly consistent with Grunewald et al. (2024), who find that about 35 percent of loans in the Consumer Financial Protection Bureau supervisory data were paid off during the first two years.

5.2.2 Characteristics of Loans That Are Prepaid

A Descriptive Comparison

We then analyze what loan and borrower characteristics are more prominent among prepaid and matured loans and, in the next sub-section, which of these characteristics help predict prepayment. Figure 9 illustrates the comparison of key loan characteristics between prepaid and matured new car loans across different maturities. The comparison for used car loans, shown in appendix figure A4, is similar qualitatively.

The most salient feature of the comparison is that prepaid loans have higher interest rates than matured loans across the maturity distribution and have larger loan amounts at origination for 72-month and longer-maturity loans. As a result, prepaid loans have higher monthly scheduled payments. For example, the average scheduled monthly payment is over $500 for prepaid new car loans with a maturity of 60 months or longer, compared with about $450 or less for such loans paid off upon maturity. Interestingly, despite the higher scheduled monthly payment, the payment-to-income (PIR) ratio does not differ as much between prepaid and matured loans, indicating a higher average income among borrowers who prepay their loans. In addition, there is not any significant gap regarding the LTV and, consistent with the conditional analysis shown in figure 8, borrowers of prepaid loans tend to have a somewhat lower credit score, averaging across maturity bins.

Multinomial Logit Analysis

We now characterize the factors associated with auto loan prepayment risks in a parsimonious multinomial logit model.[28] Such a model allows us to compare the load of these factors on prepayment risks against that on default risks. Specifically, we estimate the following equation:

$$PMD = \alpha + \beta_1 Score + \beta_2 Amt + \beta_3 PIR + \beta_4 LTV + \gamma_1 Term + \gamma_2 New\ Car. \quad (3)$$

The equation is estimated using an ABS-EE subsample of loans that were originated between

[28]It is useful to point out that most of the pairwise correlations among the six major loan and borrower characteristics explored in figure 9 are modest, with the exception of those between loan amount and monthly scheduled payment and between interest rate and credit scores (see appendix table A3 for details).

2016 and 2018, had a maturity of 60 months or longer, and had a warehousing period shorter than 12 months (near 3 million loans). Because our ABS-EE data run through the end of 2023, the vast majority of loans originated in 2018 and before are over their scheduled maturity. It is also useful to recall that the multinomial logit model corresponds to the *eventual* prepayment and default risk over the entire life cycle of the loans instead of period-by-period competitive hazards.

In the model, PMD is an indicator of whether a loan was prepaid (P), matured (M), or defaulted (D, defined as ever becoming 60+ days delinquent), where matured loans are used as the base outcome in the multinomial logit. The β coefficients will shed light on how borrower credit score, loan amount at origination, scheduled PIR, and LTV are associated with prepayment and default risks.

We begin with borrower credit score. As shown in the upper left panel of figure 10, both prepayment and default risks diminish with credit scores. The gradient for default risk, however, is much greater than that for prepayment risk. For loan amounts, the gradient is more pronounced and consistent for prepayment risk, with loans greater than $50,000 at origination being twice as likely to be prepaid than loans less than $15,000 at origination (upper right). The relationship for default risk is not monotonic, with small and large loans at origination having greater default risk than medium-sized loans ($30,000 to $50,000). Because credit scores and interest rates are highly correlated, equation (**??**) includes only the former. We also separately estimate the model for loans of subprime, nearprime, and prime credit scores and replace score bins with interest rate bins. We find that both prepayment and default risks increase with interest rate within each credit score group.

Similarly, our estimates indicate that loans with a higher PIR are about 10 to 20 percent less likely to be prepaid (lower left panel), whereas the PIR gradient on the default risk is estimated to have an inverse-U shape. Thus, debt service burden appears to predict more consistently the prepayment than default risk. Conversely, as shown in the lower right panel, LTV predicts default better, and loans with an LTV greater than 140 percent are seven times more likely to default than loans with an LTV lower than 80 percent. By contrast, the LTV-prepayment relationship has a U-shape, with loans of an LTV near 100 percent registering the lowest prepayment risk.

Regarding the γ coefficients on loan term and new car loan dummies, the estimates indicate that, consistent with section 5.2, 72-month and longer-maturity loans have a 50 percent higher prepayment risk but a 150 percent higher default risk than 60-month loans. New car loans are 50 percent less likely to be either prepaid or defaulted than used car loans of comparable characteristics.

Comparing with the Existing Work

Our estimates echo findings in existent analysis on auto loan prepayment and default risks. For example, both Heitfield and Sabarwal (2004) and Agarwal et al. (2008) note a higher LTV as a stronger predictor for default. That said, our results also demonstrate certain patterns at odds with earlier work. Notably, Agarwal et al. (2008) find that loans extended to higher-credit score borrowers and new car loans have a higher prepayment risk, whereas we find a negative prepayment risk gradient for credit scores and that used car loans are twice as likely to be prepaid, conditional on other loan or borrower characteristics.

A number of factors (e.g., sample, period, and statistical method) may have contributed to these discrepancies. Our analysis uses, for example, loan-level data in auto ABS pools (including both prime and subprime auto ABS), while Heitfield and Sabarwal (2004) use pool-level data from a sample of subprime ABS, and Agarwal et al. (2008) use loan-level data from "a large financial institution that originates *direct* automobile loans" (p.18). In addition, our sample includes primarily loans originated after 2015 and follows them through 2023, whereas the loans analyzed in Heitfield and Sabarwal (2004) were originated in the mid-1990s and the sample of Agarwal et al. (2008) covers the late 1990s to the early 2000s.

In general, the discrepancies among these results underscore the early-stage nature of auto loan prepayment risk analysis. Over decades, market participants and academics have done thorough research on factors influencing mortgage prepayment and its implications on MBS pricing, household balance sheets, and the effectiveness of monetary policy. By contrast, their auto loan counterparts remain significantly lagged and under-explored. In an auto lending market where loan maturities are much longer than before and refinancing opportunities become more readily available, more analytical and empirical work on auto loan prepayment is warranted.

5.3 How Are Loans Prepaid?

A loan can be paid off ahead of maturity by paying more than the scheduled amount due each month, 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 11 compares the distribution of this ratio between prepaid and matured loans in the ABS-EE sample. As shown in the upper panel, on the one hand, most prepaid loans were paid off with a substantial last bullet payment, with about 50 percent of the prepaid loans having a last payment greater than 60 percent of the loan amount at origination.[29] 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 more concentrated for matured loans (loans paid off within six months of the scheduled maturity). Comparing with the median of this ratio for prepaid loans (57.6 percent), we determine the median ratio for matured loans is only 2.1 percent.

In addition, there is appreciable accelerated amortization among prepaid loans. To see this accelerated amortization, we calculate the ratio between the actual and scheduled monthly payments in the ABS-EE data, 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, the payment for about 15 percent of the loans that are eventually prepaid was 15 percent above the scheduled payment. But two thirds of such loans (10 percent of prepaid loans) had a monthly payment 50 percent above the scheduled payment. Furthermore, during the time prior to pay-off, about 35 percent of prepaid loans had more than five monthly payments when payments were 20 percent higher than the scheduled amount, not including those catching up on previous delinquent payments.

[29] About one-fourth of prepaid loans have a last payment greater than 80 percent of the loan amount.

5.4 Why Are Loans Prepaid?

The distinction between accelerated amortization and bullet payment helps to infer whether the prepayment was proactive (intended) or passive (induced by other household decisions). For residential mortgages, refinancing and relocation are the two most important events triggering prepayment. However, refinancing has been less common 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 pre-existing loan will be paid off with either the sale proceed or covered by the new loan.

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 at the same time as the prepayment occurred. We find that 15 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 in the Equifax data, we also experiment with including auto loans originated up to three months either before or after the pay-off month. Doing so, we find the share increases to about 30 percent, which we interpret as an upper bound of prepayment triggered by selling (or trading in) the old vehicle.

Prepayments unrelated to trade-ins are more likely to be anticipated by borrowers, and loans with accelerated amortization are particularly likely reflecting borrowers' intention to pay them off quickly. For example, if loan financing costs are greater than returns on investment, borrowers may have incentives to prepay. However, as we will discuss in detail in Section 6, a substantial share of loans with promotional interest rates were also prepaid without being triggered by a vehicle sale. Such prepayments cannot be explained by interest rate differentials and may reflect borrowers' behavioral biases (e.g., debt aversion).

5.5 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

[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.

one. However, for other prepayments, the answer is less straightforward. If borrowers take more of other forms of debt (e.g., credit card) in order to pay off their auto loan, the debt portfolio is merely reshuffled and the overall indebtedness is not necessarily lower. Because the Equifax data track the entire debt portfolio of borrowers, we can analyze the dynamics of various types of debt, concentrating on the eight quarters before and after the time of the auto loan pay-off (quarter 0).[31] Specifically, figure 12 illustrates outstanding balances of mortgage, credit card, and auto debt. We also plot borrowers' credit scores—as measured by the Equifax Risk Score 3.0—over this period to assess how prepaying auto loans may affect their access to the credit market and, potentially, broader financial well-being.

We focus on the sample of borrowers who prepaid their auto loans but did not take a new auto loan within the twelve months before and after the pay-off (the intended prepayments). As expected, the total auto loan balance for such borrowers shows a sharp decline during the pay-off quarter. We also note that auto loan balances stayed largely flat before and after the payoff among such borrowers. Interestingly, both credit card and mortgage balances also declined appreciably during the quarter of auto loan pay-off, inconsistent with the hypothesis of borrowers taking on other debt to pay off auto loans ahead of maturity. Instead, it appears that borrowers used cash or other liquid assets to pay down various types of debt they owed, and we speculate that many of such borrowers may have experienced an inflow of income or liquidity around that time, which enabled them to pay down debt and deleverage. Indeed, borrowers' credit scores stayed flat up to the payoff quarter before subsequently increasing more than 10 points.

6 Two Puzzling Patterns

6.1 Why Do People Prepay Promotional Loans?

As discussed in the previous section, besides selling or trading in the vehicle under the lien, one of the most intuitive reasons for prepaying an auto loan is it being more expensive relative to the return on the borrower's other investments. Thus, we expect loans with promotional interest rates to have low prepayment risk. In the ABS-EE sample, among the 9.6 million loans

[31] The charts show unconditional trends for a balanced panel of borrowers aged 18 to 65 at the moment of prepayment.

that have been paid off, over 15 percent have an interest rate below 1 percent, and 10 percent have a zero interest rate. Testing the hypothesis above using this sample yields mixed results.

On the one hand, we find that, consistent with the hypothesis, low-interest loans have a significantly lower prepayment risk than higher-interest loans. In the ABS-EE sample, 55.7 percent of the loans originated between 2015 and 2018 with a promotional rate (below 1 percent) were prepaid. In comparison, over 80 percent of loans of the same vintages with an interest rate greater than 9 percent were prepaid.[32] In addition, as shown in figure 13, the promotional-rate loans that were prepaid tend to be paid off later relative to other prepaid loans, and this pattern holds across loans of different contract maturities (not shown).

On the other hand, the share of loans with promotional rates that were prepaid is perhaps surprisingly large. Even among loans with zero interest, about 54 percent were prepaid, with more than half being paid off within 30 months of origination. These results are also confirmed by the estimates derived from the Equifax sample. Unlike the promotional "teaser" rates on credit cards that typically last a year or shorter, promotional rates auto loan typically apply to the entire contract maturity. Therefore, the prepayments unlikely reflect the expiration of the low interest rates. Furthermore, we find no evidence that a larger share of the prepayment of promotional-rate loans is triggered by sales or trade-ins. In the Equifax data, about $\frac{1}{4}$ to $\frac{1}{3}$ of prepaid promotional rate loans were associated with the origination of another loan, a share similar to that of all prepaid loans. The puzzling questions is, therefore, why are these borrowers not taking advantage of the cheap, or even free, money? In some sense, this question is related, but opposite, to the so-called credit card debt puzzle that borrowers hold high-interest credit card debt and low- or zero-return liquid assets at the same time.

One potential explanation goes as the following: because total indebtedness affects a borrower's credit score, which in turn influences credit access and borrowing costs, people who are planning applying for a loan (such as a mortgage) may want to reduce total borrowing ahead of their loan application. However, analyzing the Equifax data, we do not find that borrowers significantly increase their borrowing of mortgage, credit card, or other consumer debt after prepaying auto loans with promotional interest rates, regardless whether that was associated

[32] These high-interest rate loans account for about one-fourth of the paid off loans (prepaid and matured) in our sample.

with the acquisition of a replacement vehicle.[33] Thus, the prepayment of promotion-rate loans appears remaining a puzzle.

6.2 Why Borrow Long, Pay High, but Prepay?

We have documented above that (1) loan maturities 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. In this section, we will calculate the excess interest payment borrowers made relative to a contract with ex post optimal maturity that is consistent with the realized duration of prepaid loans. We will then explore possible factors that may help account for such excess payment.

Using two universe-scale data sets, we find that the majority of auto loans are paid off ahead of scheduled maturities, and some of the prepayments may be associated with the purchase of a replacement vehicle. We find that loans with the longest maturities had a similar or even higher prepayment speed than loans with shorter maturities, and prepaid loans tend to have higher interest rates and higher monthly payments. These patterns are consistent with borrowers paying off more expensive loans but do not seem to suggest that most borrowers of long-maturity loans or high-payment loans are particularly liquidity constrained. If longer-maturity loans are more expensive and their borrowers are not particularly constrained and are able to pay them off way ahead of schedule, the question that arises is whether the borrowers made the optimal maturity choice.

6.2.1 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

$$Pmt = \frac{rP(1+r)^M}{(1+r)^M - 1}, \tag{4}$$

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

[33] The loan interet rates in the Equifax data are imputed.

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

$$\mathcal{I} = Pmt \times M - P \; = \; \frac{rMP(1+r)^M}{(1+r)^M - 1} - P, \tag{5}$$

and

$$\frac{\partial \mathcal{I}}{\partial M} \approx \frac{r(1+r)^M}{[(1+r)^M - 1]^2}[(1+r)^M - rM - 1] > 0, \forall\, r > 0. \tag{6}$$

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.

6.2.2 Costs of Prepaying Long-Maturity Loans

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, using our estimated interest rate gradient across maturity. We label these gaps as the excess interest payment. The comparisons are summarized in table 5, where we consider a number of scenarios.

Specifically, 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.[34] 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 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. 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 almost $4,600 (column 4). Even with a 2 percent discount rate, the excess interest payments remain sizable (columns 3 and 6). In addition, we calculate the break-even discount rate that renders zero excess payment. For prepaying a 72-month loan at the 24th and 36th month, the break-even rate needs to be as high as 4.6 percent and 5.4 percent, 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 higher short-term rate and steeper maturity–interest gradient, the simulated excess interest payment is even more substantial. With a 0 percent discount rate, prepaying a 72-month loan at the 24th and 36th month implies an excess payment of about $5,100 and $6,900, respectively.

6.2.3 Potential Considerations Leading to Excess Interest Payment

The choice to borrow long, pay high, but then prepay can be financially costly. So why do many borrowers do it? We explore several possible factors and evaluate their relevance.

First, one of the most straightforward explanations is that people choose long-maturity loans because the lower monthly payment allows them to afford a car that they would have been unable to afford otherwise with shorter-maturity loans. Such liquidity constraint is not consistent with the prepayment with significant accelerated amortization described in section 5.3. Many of such borrowers able to pay extra above scheduled payment should also be able to

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

handle the required payment of a shorter-maturity loan.

Second, people may overestimate returns on their investment and use long-maturity car loans as a funding source. We cannot reject this hypothesis outright. However, as we discussed in Section 5.2, higher interest rate loans also have higher prepayment risk. 25 percent of the prepaid loans in the ABS-EE sample, for example, have an interest rate above 10 percent. Such borrowers need a very bullish investment prospect to believe their auto loans were a good deal. Furthermore, as shown in figure 7, prepayment remained strong during the Great Recession era, when stock market returns were low.

Third, the prepayment triggered by trade-ins can be puzzling if the timing of car replacement is expected. If borrowers know that they will change their car in three years, the optimal choice is to choose a loan with similar duration instead of one with six-year maturity.

In all these hypotheses, uncertainty appears to play a central role. For example, borrowers with volatile income may be unsure about whether they have enough cash to service the loan next month, even if on average they can afford to overpay a little. Or they do not know whether they will receive a large bonus that could allow them to prepay the loan later. Similarly, they may be unsure about their investment returns or exactly when they may need a bigger car. Therefore, we can potentially rationalize choosing long-term loans as acquiring an insurance against such uncertainties. That said, given the substantial excess interest payment estimated in table 5, these are quite pricey hedges, and it is not clear whether consumers with typical risk aversions would find them attractive.[35]

6.2.4 Role of Monthly Payment Targeting

Besides these hypotheses, Argyle et al. (2020) and, more recently, Momeni (2024) highlight the role of monthly payment targeting on the choice of loan maturities. Borrowers may target a certain dollar amount of monthly payment. Anchoring monthly payments at integer levels—such as $200, $300, and $400 per month—may facilitate borrowers' budgeting heuristics. As longer loan maturities lower monthly payments, they would give more flexibility to borrowers who have such monthly payment targets.

Consistent with the existent analysis, we find evidence of dollar amount targeting and bunch-

[35] Estimating a structural model and quantifying the hedging value of long-term loans could be a fruitful future research direction.

ing. As shown in the upper and lower left panels of figure 14, the histograms show discreet jumps at key integer values of monthly payments ($200, $300, and $400 per month, or one dollar lower) in the Equifax sample, confirming the findings of Argyle et al. (2020) in a universe-scale sample of auto loans. For example, the frequency of loans with a monthly payment of $399 doubles those of loans with a monthly payment of $401. 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. The same patterns are observed for the monthly payments in the ABS-EE sample.

The ABS-EE data also have information on the PIR. We hypothesize that borrowers may also target a particular level of PIR, as keeping the ratio under certain thresholds may help qualify for better loan terms. Indeed, we also find that borrowers appear to target the ratio below certain thresholds. As shown in figure 15, there are disproportionately more loans with PIR right below the thresholds of 10, 15, and 20 percent. However, these loans do not account for a significant mass among all loans in the ABS-EE sample (the lower-right panel). Thus, on balance, while we find concrete evidence of monthly-payment and PIR targeting, this behavior alone is unlikely to drive the choice of longer loan maturities.

Finally, we note that we find little evidence that loans with an integer monthly payment or a scheduled PIR had lower prepayment risk. Estimating an augmented model of equation (3) with dummy variables indicating integer monthly payments or PIR using loans originated between 2015 and 2018, we find that loans with integer monthly payments are 33 percent more likely to eventually be prepaid, relative to the base outcome of being paid off at maturity. In addition, while figure 15 shows statistically significant masses around integer PIR levels, loans with these PIR values have the same likelihood of being prepaid as other loans.

6.2.5 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. A remaining question is whether shorter-maturity loans were available to them. Are there any borrowers rationed out of the short-maturity segment of the market? To test this hypothesis, we screen loans of various maturities originated by each of the largest 100 auto loan lenders in the Experian data. We find no evidence that borrowers in any credit score bucket were rationed out of loans of short maturity of 36 or 48 months. For example, the results in table 3 suggest that subprime borrowers are encountering the steepest interest rate gradient with respect to contract maturity of new car loans. Table 6 lists the number of new car loans originated in 2021 by the largest lenders of new car loans for different maturities. 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' webpages (e.g. figure 4) also confirms that lenders offer loans of a wide range of maturity. The example shown in the lower panel of the figure also indicates explicitly that short maturity loans are available to borrowers of all credit score levels.

7 Concluding Remarks

This paper makes three main contributions: First, we document a secular trend of rising maturity that have prevailed in the U.S. auto loan market over the past five decades. 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 stylized facts on auto loan prepayment and introduce two patterns that can be at odds with optimal prepayment decisions and maturity choices—namely, prepaying zero-interest loans and what we refer to as the "borrow long, pay high, and prepay" behavior. We further postulate that liquidity constraints, vehicle trade-ins, borrower uncertainty, and monthly payment targeting are unlikely to completely account for these puzzling patterns.

On the other hand, the paper asks more questions than it can provide a quantitative, definitive answer because of data or methodology limitations. For example, 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? What role do lenders and dealers play in steering borrowers to certain maturity choices? Is debt aversion a primary reason for the prepayment of zero-interest loans? Do borrowers miscalculate the excess interest payment, or are they making a rational pick conditional on their information and constraints? Were borrowers pressured or lured to taking longer-maturity, more expensive loans by lenders?

This paper merely scratches the surface of some of these questions and leaves many others for future research. In addition, our analysis does not consider leasing as a financing option, which may change the optimality of loan maturity and prepayment decisions. In this regard, we hope that the paper can serve as a research agenda for future analysis. Furthermore, while the analysis herein is reduced-form in nature, we want to underscore the need for structural modeling to advance our understanding of the auto loan market—a market where many loan terms are determined jointly, often involving negotiation and bargaining among lenders, dealers, and borrowers.

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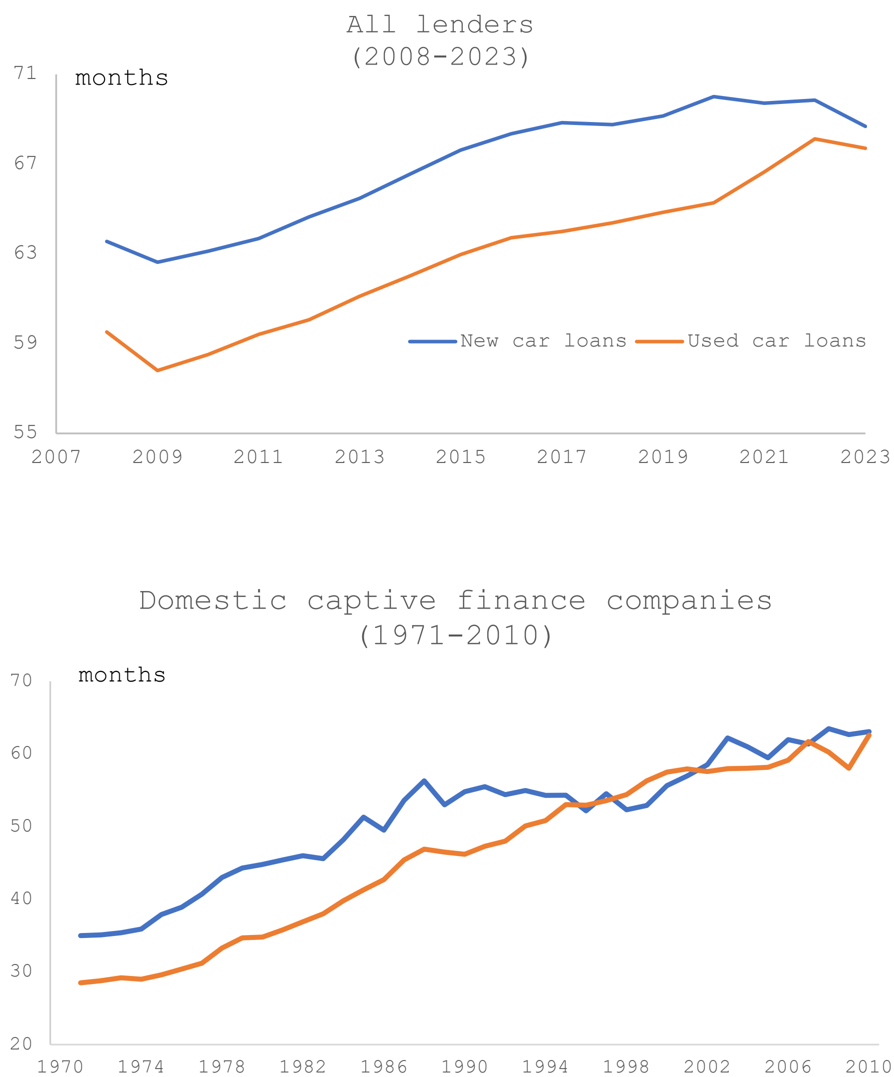
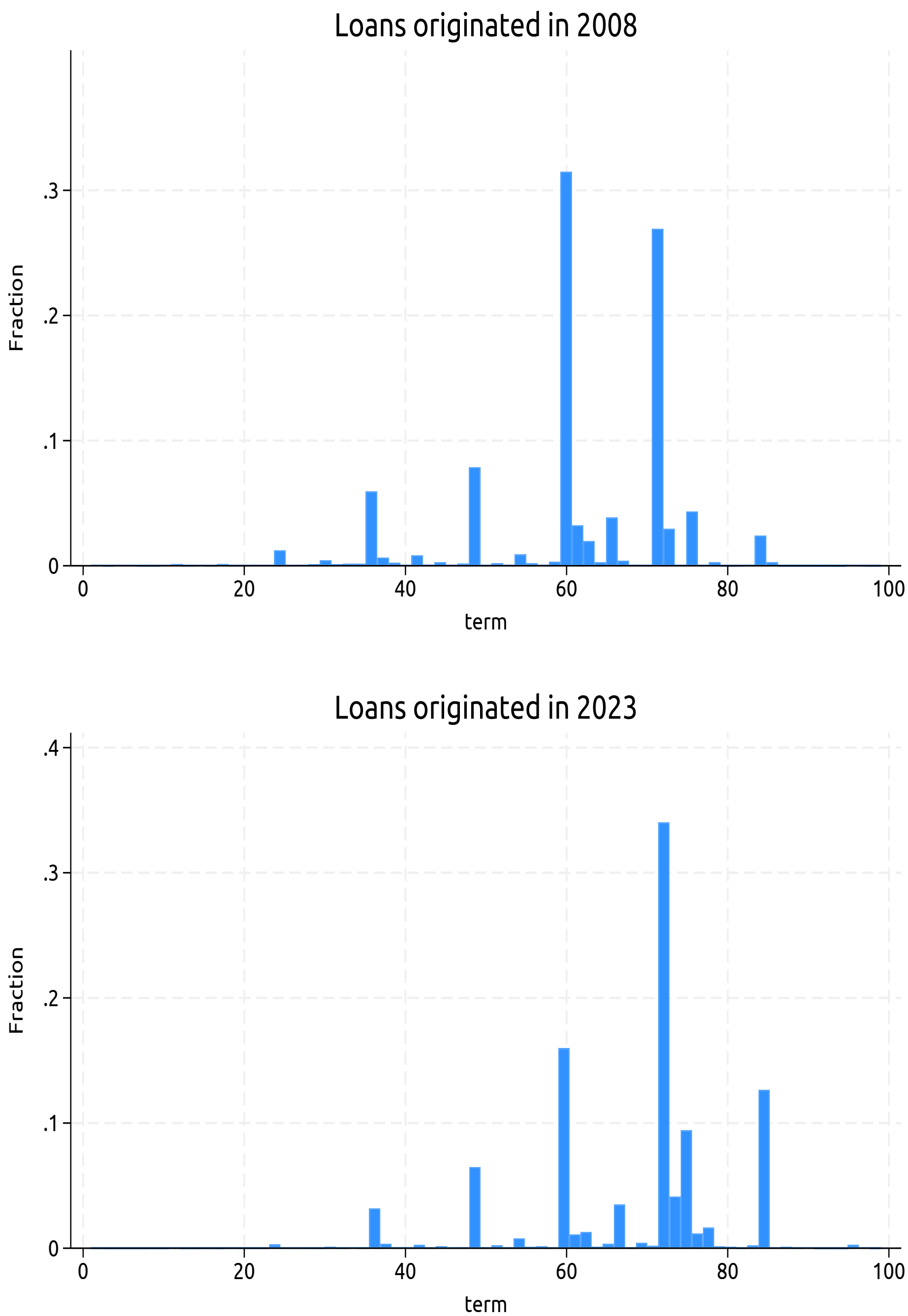
Figure 1: Recent Trend of Average Auto Loan Maturity



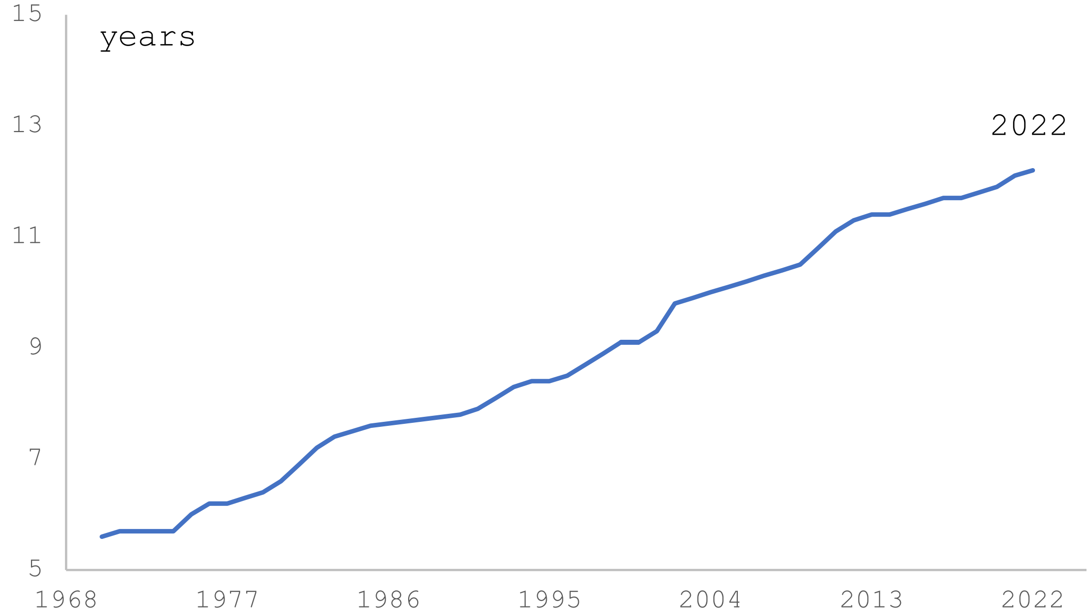
Note: The panels show the average auto loan maturity over time for new and used car loans. Source: For all lenders, Experian AutoCount data; for captive finance companies, Federal Reserve Board. Statistical Release G.20, "Finance Companies."

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 estimated with a linear interpolation. 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

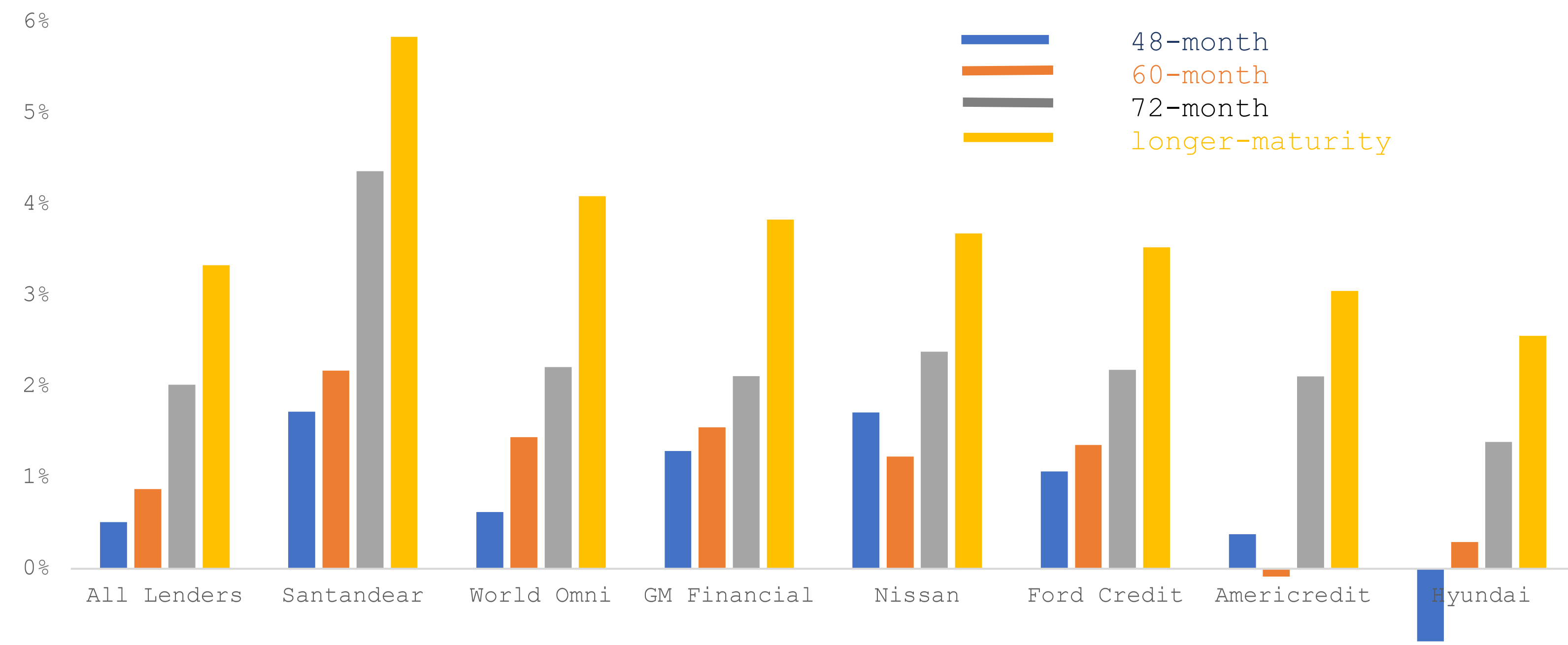
Credit Score (720+) | Credit Score (700-719) | Credit Score (680-699) | Credit Score (640-679)
Credit Score (600-639) | Credit Score (<600)

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

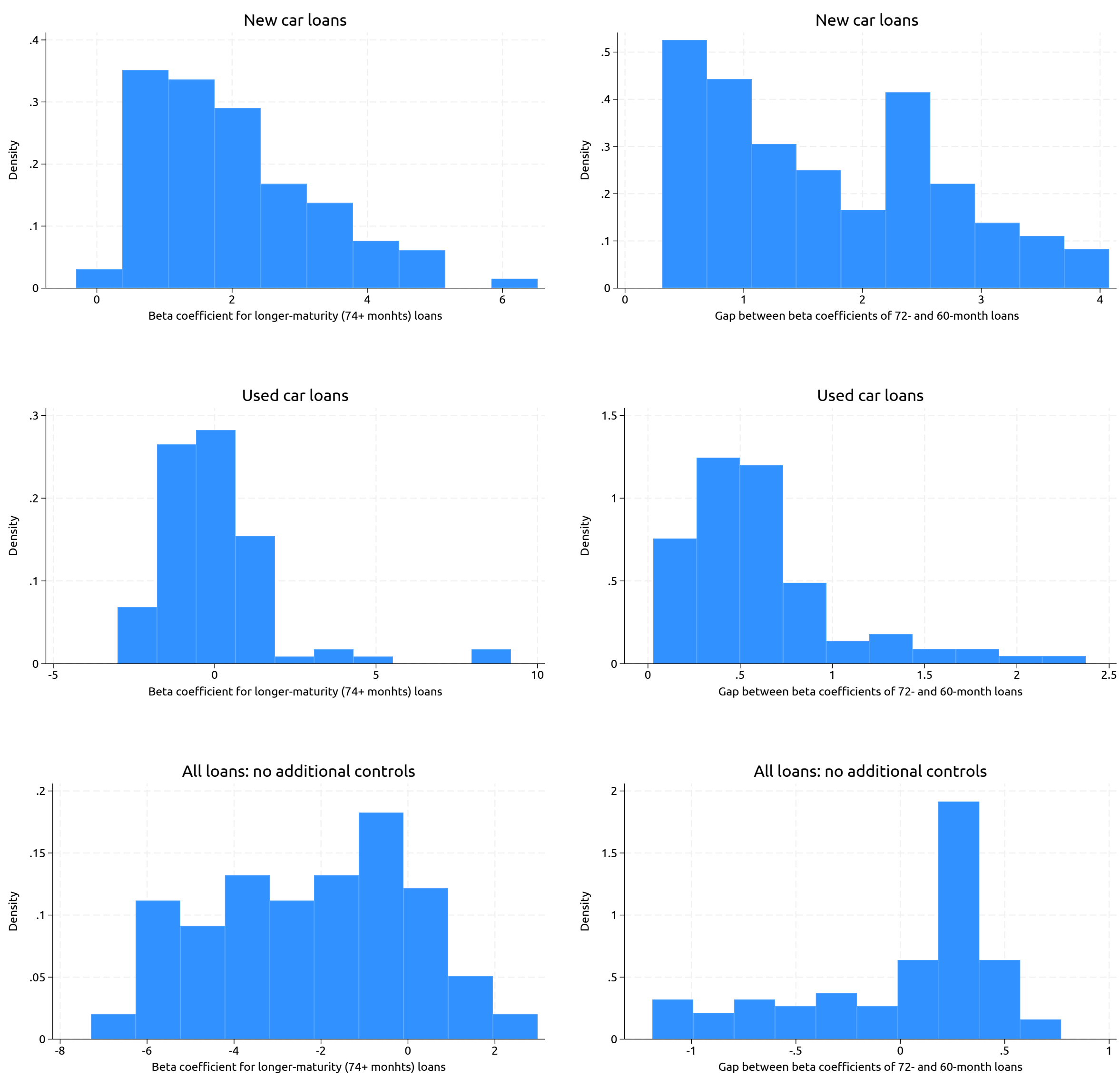
Note: The upper panel is retrieved from a large lender that originated about 300,000 auto loans in 2023, and the lower panel from a smaller lender that originated about 14,000 loans in the same year.

Figure 5: Maturity-Interest Rate Relationship at Large Lenders



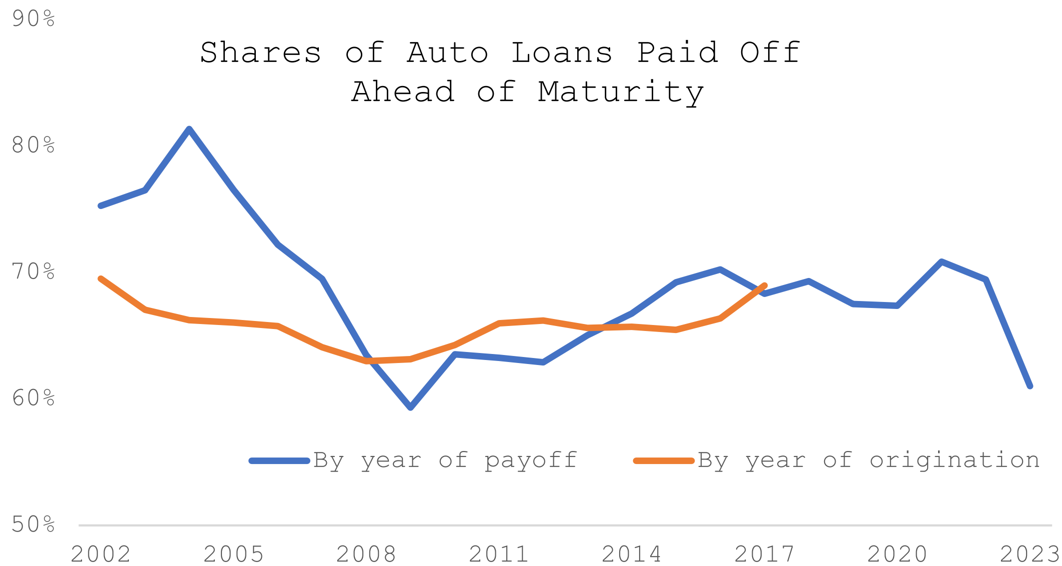
Note: The figure plots the estimated β coefficient of equation (2), adding vehicle make-model and vehicle-year fixed effects. The left-most set of bars plot the term-bin coefficients estimated using the entire sample, also controlling for lender fixed effects. The other sets of bars plot the lender-specific estimates for the seven largest lenders in our sample. Source: Authors' estimation using the ABS-EE data.

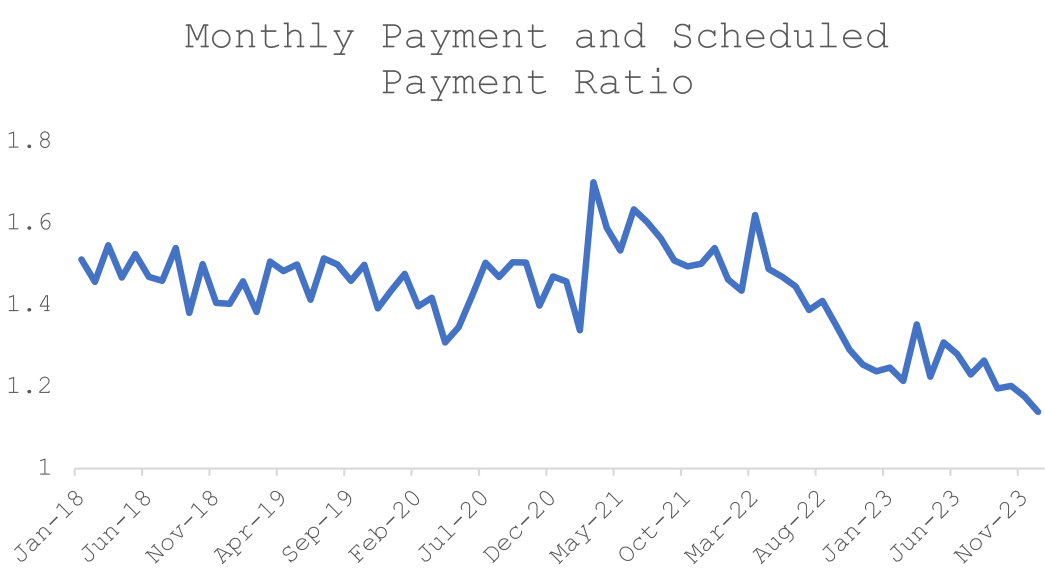
Figure 6: Comparison with Guo, Zhang, and Zhao Estimates



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 2) for new car loans, while the middle panels are for used car loans. The model is estimate for each year and credit score bucket defined in Guo et al. (2022) separately. 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.

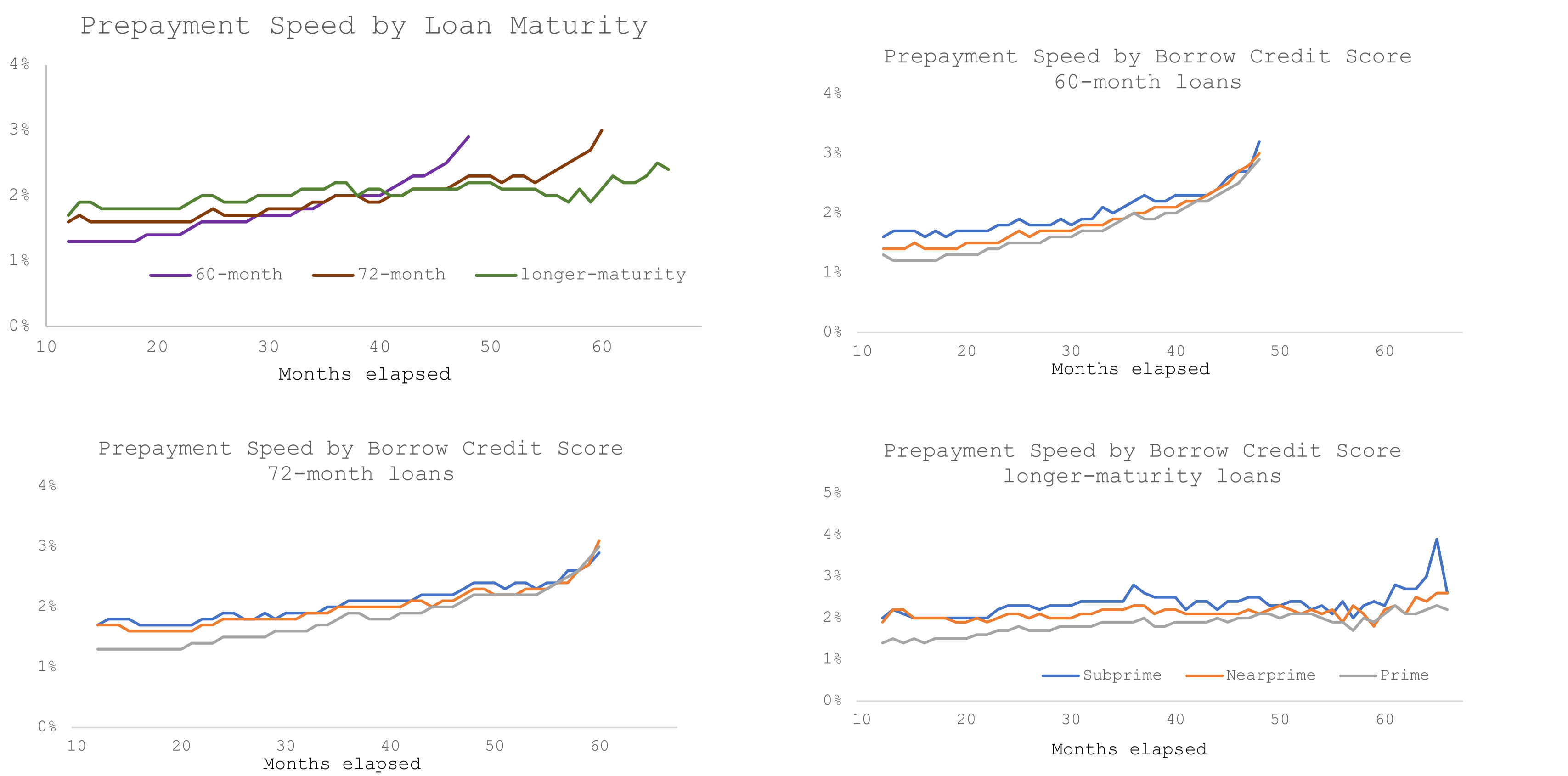
Figure 7: Trends of Prepayments of Auto Loans





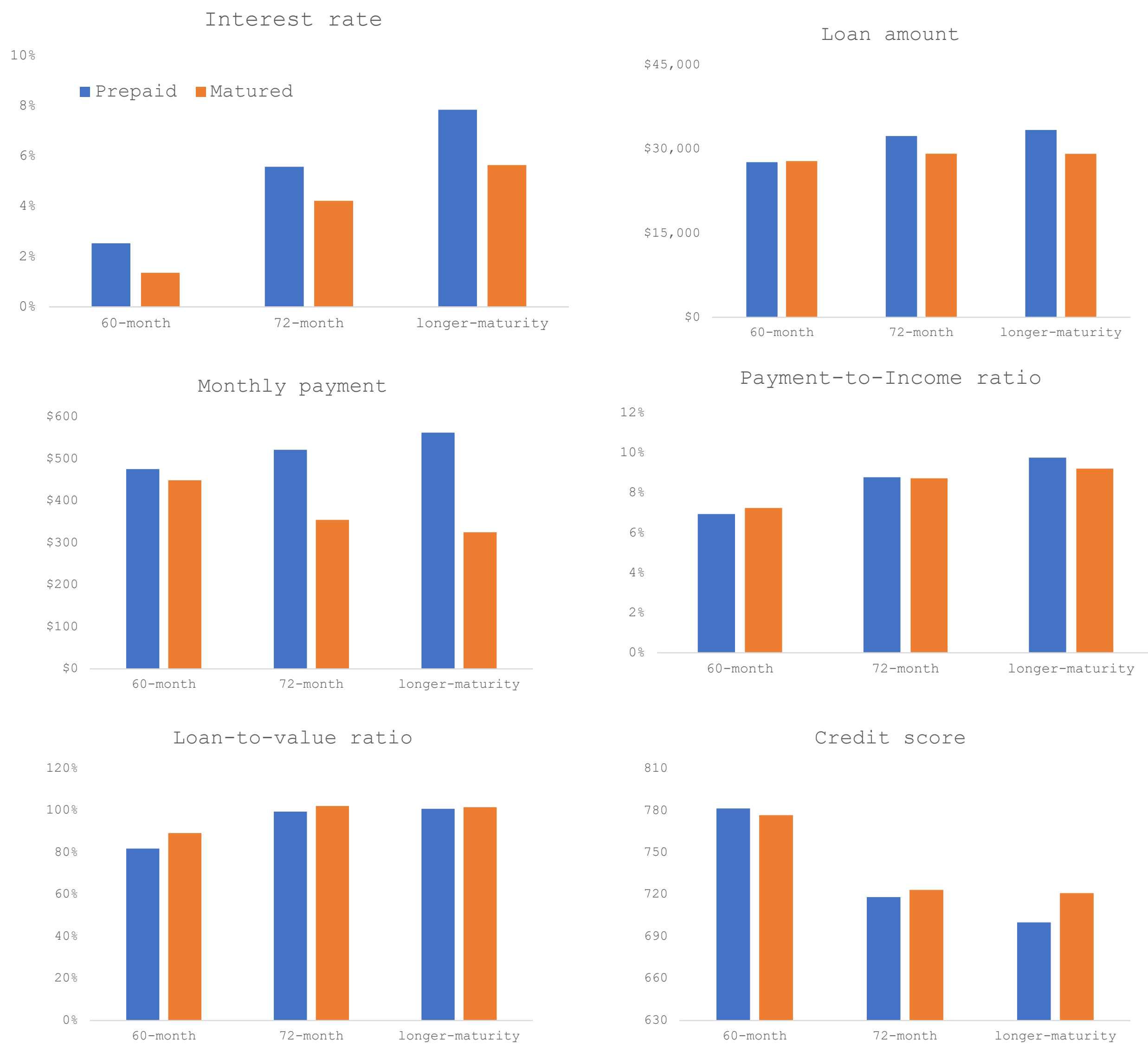
Note: In the upper panel, the blue series plots the share of loans that were prepaid among all loans paid off in a given year, and the orange series plots the share of loans that were eventually prepaid by year of origination. In the lower panel, the series plots the ratio between the actual and the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

Figure 8: 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. Source: Authors' estimation using the ABS-EE data.

Figure 9: Characteristics of Prepaid and Matured Loans (New Car Loans)

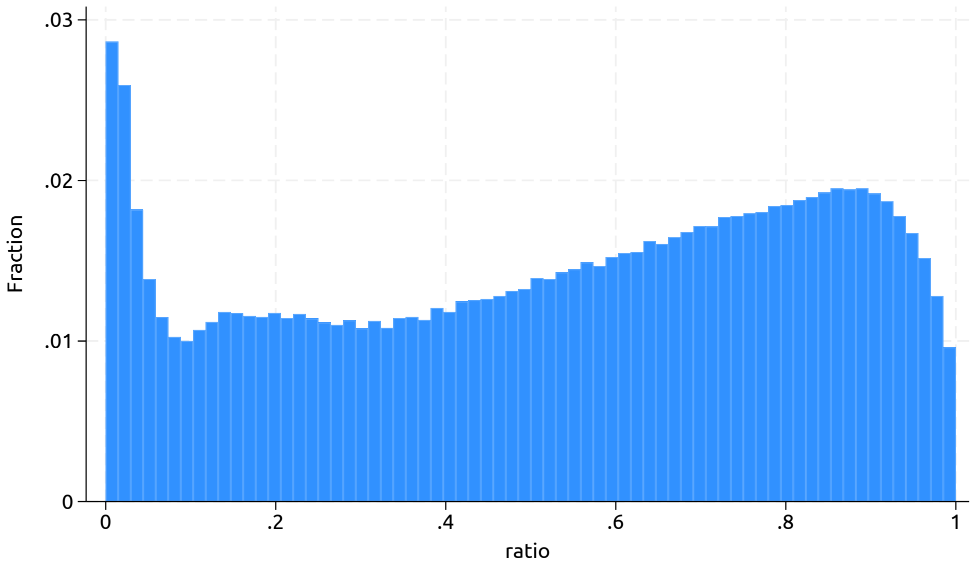


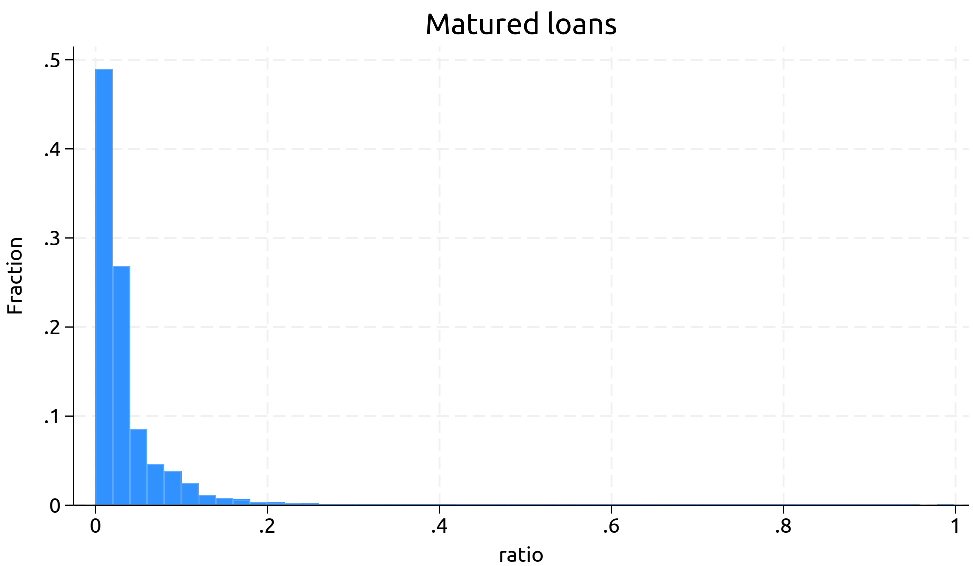
Note: The panels compare key characteristics between new car loans prepaid at least 6 months ahead of maturity (blue bars) and matured loans (orange bars). Source: Authors' estimation using the ABS-EE data.

Figure 10: Comparing Relative Risk Ratios between Prepayment and Default

Note: Authors' estimation using the ABS-EE data. The charts plot the coefficients and standard errors estimated from equation (3), a multinominal logit model. The blue series indicate how various characteristics are associated with prepayment risks, and the green series default risks.

Figure 11: Last Payment to Loan Amount Ratio

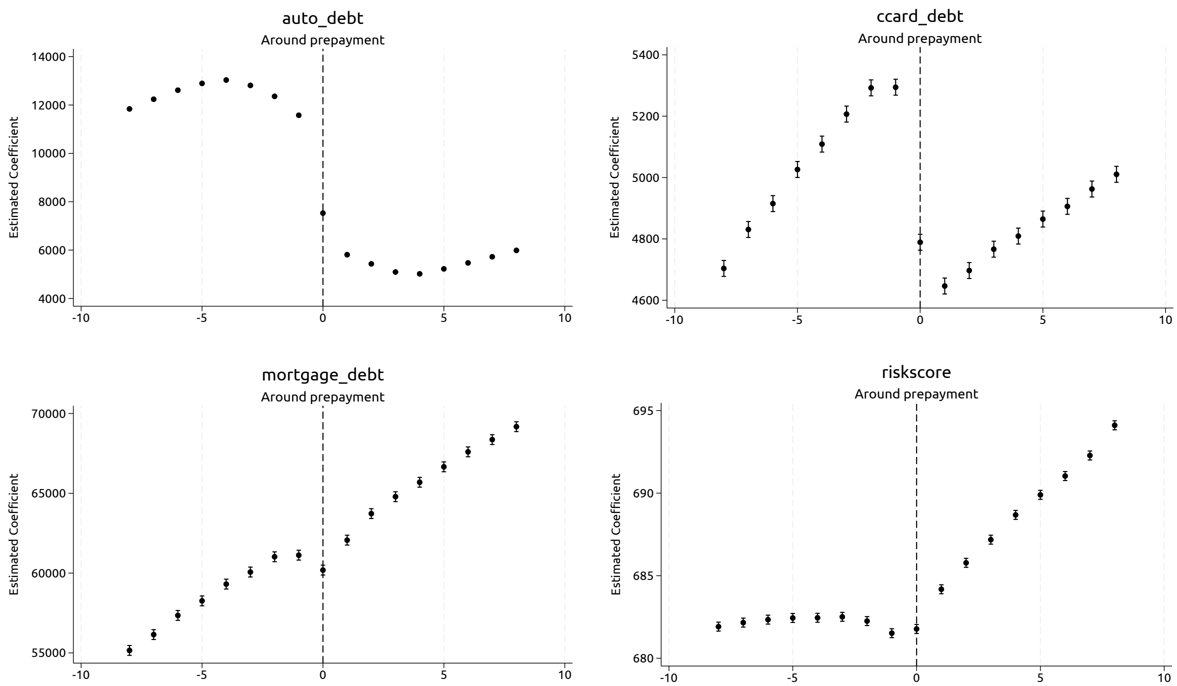




Note: The panels display the ratio between the last payment and the loan amount at origination for prepaid loans (top panel) and matured loans (bottom panel). Source: Authors' estimation using the ABS-EE data.

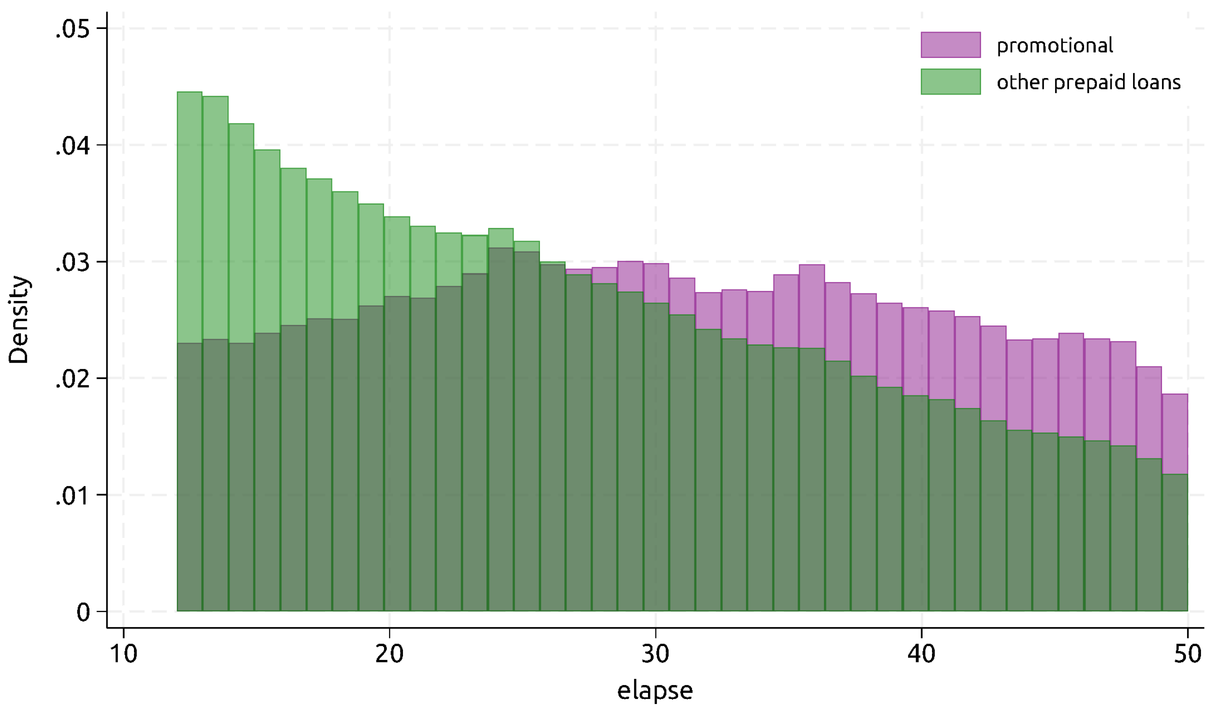
Figure 12: Loan Balances around the Time of Paying Off the Auto Loan

No replacement vehicle



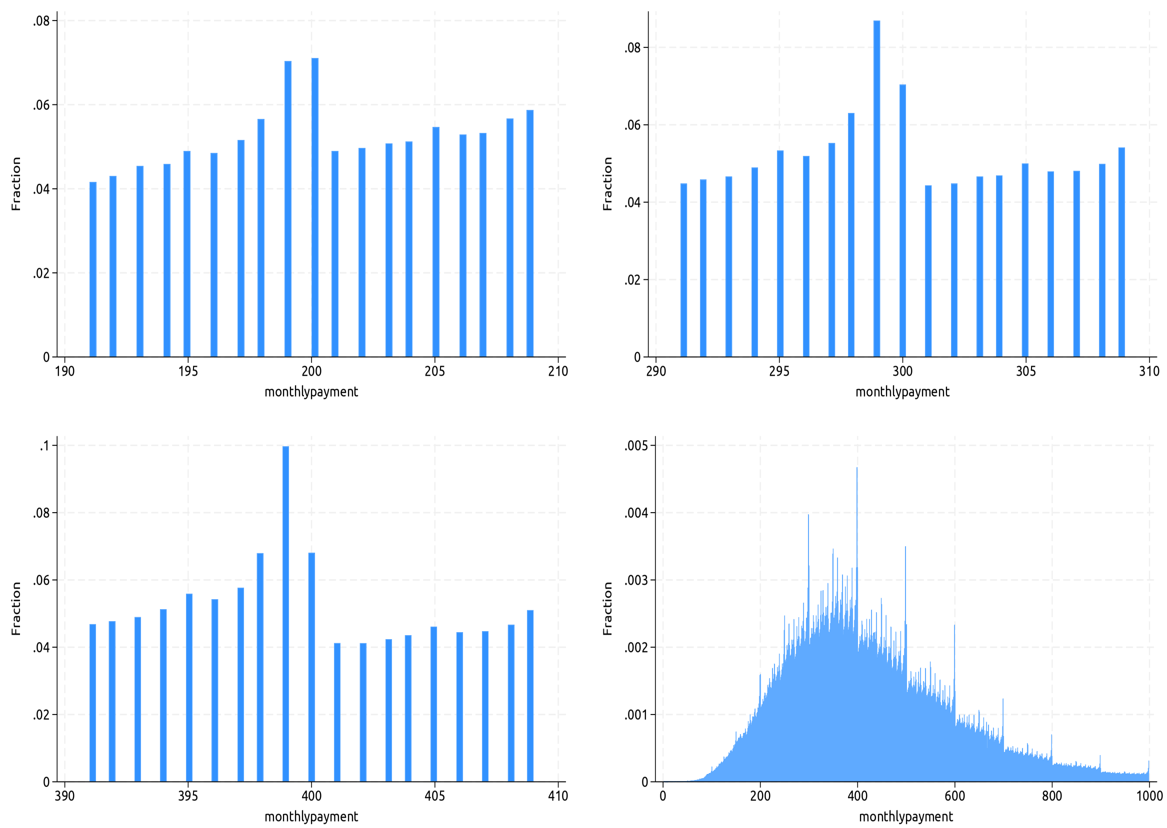
Note: The panels illustrate the dynamics of auto loan, credit card, and mortgage balances and borrower credit score 8 quarters before and after an auto loan was prepaid in quarter 0. Source: Authors' estimation using the FRBNY/Equifax Consumer Credit Panel data.

Figure 13: Prepayment Speed of Loans with and without Promotional Interest Rate



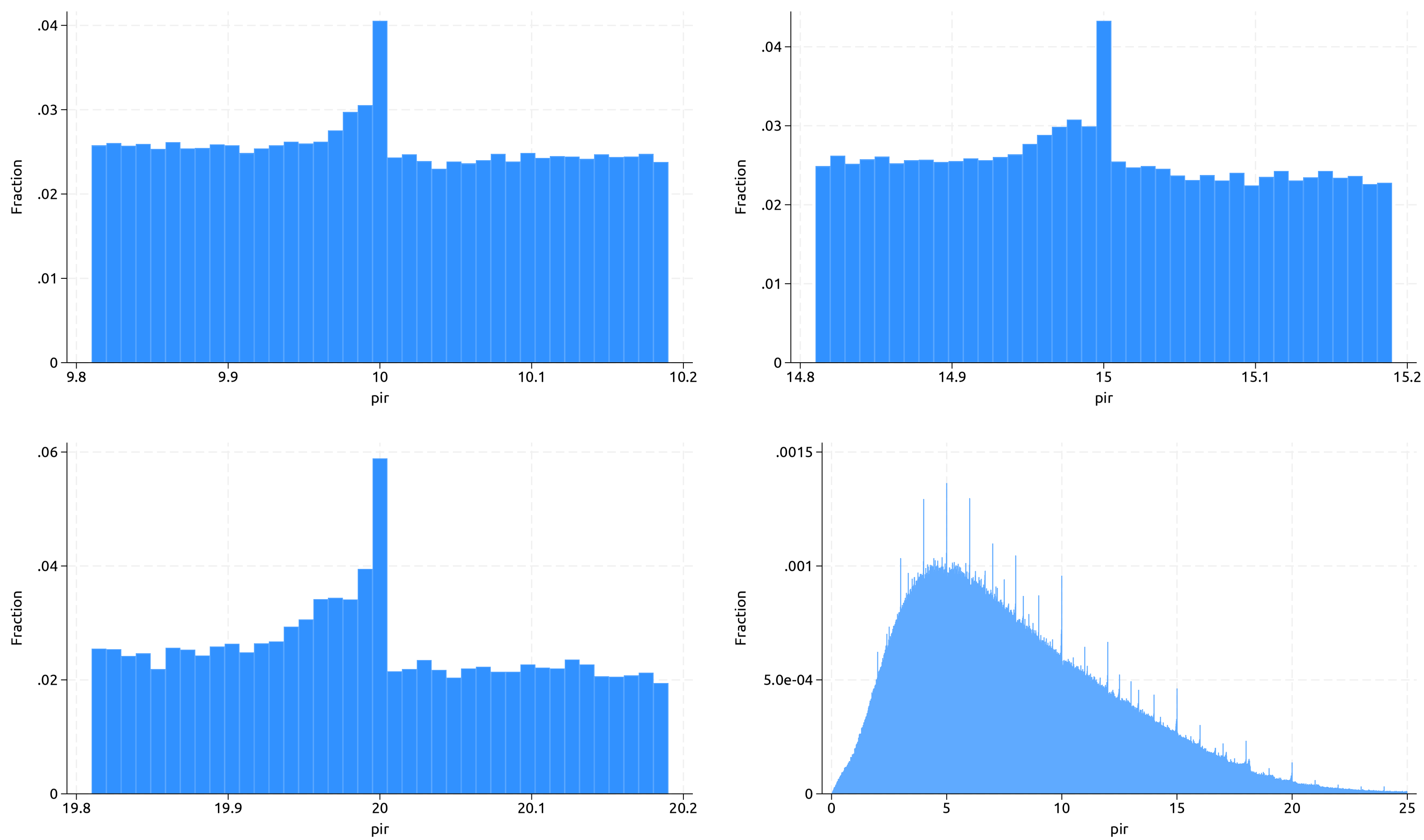
Note: The chart compares the distribution of pay-off timing of prepaid loans with promotional rates (purple) and those without (green). Source: Authors' estimation using the ABS-EE data.

Figure 14: Distributions of Monthly Payments
around Key Integers and the General Distribution



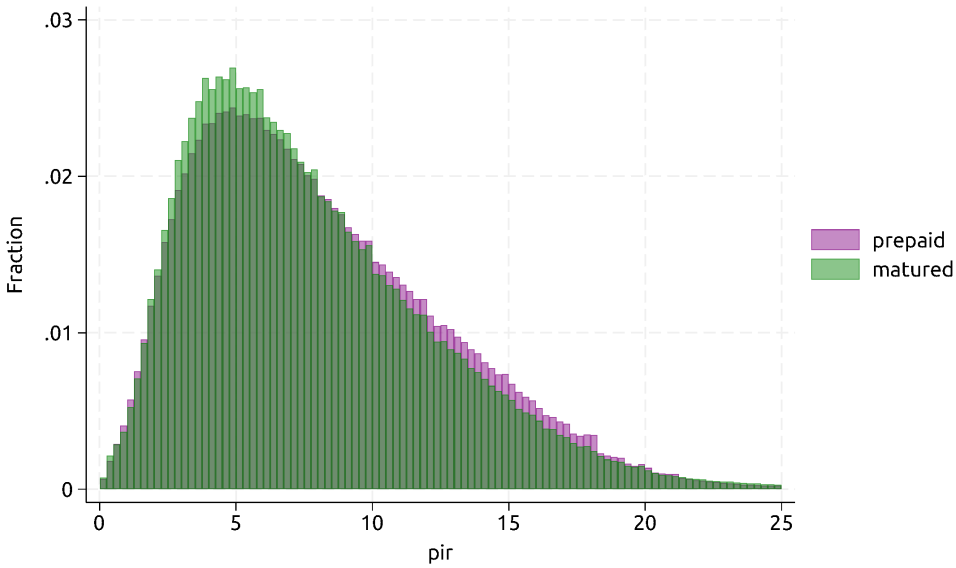
Note: The panels illustrate significant bunching at integer monthly payment levels. However, these loans account for a minor share of all loans (lower right panel). Source: Authors' estimation using the Experian AutoCount data.

Figure 15: 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 16: 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	0.613***	0.200***	0.488***	0.879***	1.023***
	(0.002)	(0.003)	(0.004)	(0.003)	(0.023)
60-month	0.781***	0.610***	0.602***	0.862***	0.926***
	(0.002)	(0.003)	(0.003)	(0.002)	(0.019)
72-month	2.121***	1.401***	1.111***	2.633***	3.841***
	(0.002)	(0.003)	(0.003)	(0.003)	(0.019)
longer-maturity	2.445***	1.516***	1.519***	4.121***	2.254***
	(0.002)	(0.003)	(0.003)	(0.003)	(0.019)
R-Squared	0.508	0.525	0.453	0.396	0.641
N	73,378,559	28,161,105	12,291,640	29,382,774	3,543,040
			Used car loans		
48-month	0.661***	0.514***	0.175***	0.900***	1.506***
	(0.002)	(0.003)	(0.003)	(0.007)	(0.006)
60-month	0.679***	0.351***	0.089***	0.479***	2.228***
	(0.002)	(0.003)	(0.003)	(0.006)	(0.006)
72-month	1.455***	0.928***	0.387***	2.060***	3.481***
	(0.002)	(0.003)	(0.003)	(0.006)	(0.006)
longer-maturity	1.041***	0.509***	0.415***	1.938***	0.410***
	(0.002)	(0.003)	(0.003)	(0.008)	(0.010)
R-Squared	0.666	0.532	0.407	0.467	0.341
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 (2), 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. *** 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	0.331***	-0.095***	0.291***	0.566***	0.981***
	(0.002)	(0.003)	(0.004)	(0.003)	(0.023)
60-month	0.347***	0.127***	0.238***	0.422***	0.817***
	(0.002)	(0.003)	(0.003)	(0.002)	(0.019)
72-month	1.514***	0.729***	0.596***	2.032***	3.586***
	(0.002)	(0.003)	(0.003)	(0.003)	(0.019)
longer-maturity	1.728***	0.711***	0.892***	3.443***	1.884***
	(0.002)	(0.003)	(0.003)	(0.003)	(0.019)
R-Squared	0.508	0.525	0.453	0.396	0.641
N	73,378,559	28,161,105	12,291,640	29,382,774	3,543,040
			Used car loans		
48-month	0.429***	0.284***	-0.040***	0.682***	1.248***
	(0.002)	(0.003)	(0.003)	(0.007)	(0.006)
60-month	0.247***	-0.100***	-0.310***	0.047***	1.784***
	(0.002)	(0.003)	(0.003)	(0.006)	(0.006)
72-month	0.871***	0.313***	-0.154***	1.473***	2.903***
	(0.002)	(0.003)	(0.003)	(0.007)	(0.006)
longer-maturity	0.368***	-0.204***	-0.213***	1.267***	-0.226***
	(0.002)	(0.003)	(0.003)	(0.008)	(0.010)
R-Squared	0.666	0.532	0.407	0.467	0.341
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 (2), 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. *** 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

	Promotional rates		Credit score range			LTV quartiles			
	Regular rates	Prob(Promo.)	Low	Middle score	High	Bottom	Lower middle	Upper middle	Top
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
48-month	0.374***	-0.101***	1.854***	0.986***	0.627***	0.447***	0.403***	0.302***	0.294***
	(0.002)	(0.000)	(0.032)	(0.009)	(0.001)	(0.002)	(0.005)	(0.009)	(0.014)
60-month	0.570***	-0.095***	1.083***	0.901***	0.902***	0.624***	0.547***	0.405***	0.123***
	(0.002)	(0.000)	(0.027)	(0.007)	(0.001)	(0.002)	(0.004)	(0.007)	(0.011)
72-month	1.610***	-0.207***	4.447***	3.223***	1.801***	1.439***	1.781***	2.004***	2.121***
	(0.002)	(0.000)	(0.027)	(0.007)	(0.001)	(0.002)	(0.004)	(0.007)	(0.011)
longer	1.906***	-0.207***	4.338***	3.450***	2.553***	1.681***	2.075***	2.282***	2.527***
	(0.002)	(0.000)	(0.028)	(0.007)	(0.001)	(0.003)	(0.004)	(0.007)	(0.011)
R-Squared	0.512	0.145	0.350	0.253	0.356	0.427	0.544	0.549	0.464
N	68,121,415	73,378,559	7,044,776	21,670,349	44,663,434	16,749,706	16,469,779	15,898,614	15,381,703

Note: The table reports the β coefficients of equation (2). The dependent variable is the loan interest rate. *** denotes statistical significance at the 99.9 percent level. Source: Authors' estimation using the Experian AutoCount data.

Table 4: Share of Loans Prepaid by Contract Maturity and Loan Age

	Prepayment share (percent)		
	60-month	72-month	longer-maturity
Months after orig.	(1)	(2)	(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 the 36th month		
	60-month	72-month	longer-maturity
Months after orig.	(1)	(2)	(3)
Credit score bin			
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 5: 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)	1% (2)	2% (3)	0% (4)	1% (5)	2% (6)
	Moderate interest rate environment 5 percent for maturity shorter than 36 months					
60-month (+0.9%)	1,570	916	298	1,783	1,104	478
72-month (+3.2%)	3,138	2,383	1,669	4,086	3,185	2,352
longer-maturity (+3.4%)	3,402	2,592	1,827	4,586	3,556	2,605
	High interest rate environment 7 percent for maturity shorter than 36 months					
60-month (+1.1%)	2,580	1,891	1,240	2,902	2,168	1,491
72-month (+4.5%)	5,001	4,194	3,432	6,537	5,540	4,619
longer-maturity (+4.3%)	5,089	4,231	3,421	6,875	5,752	4,714

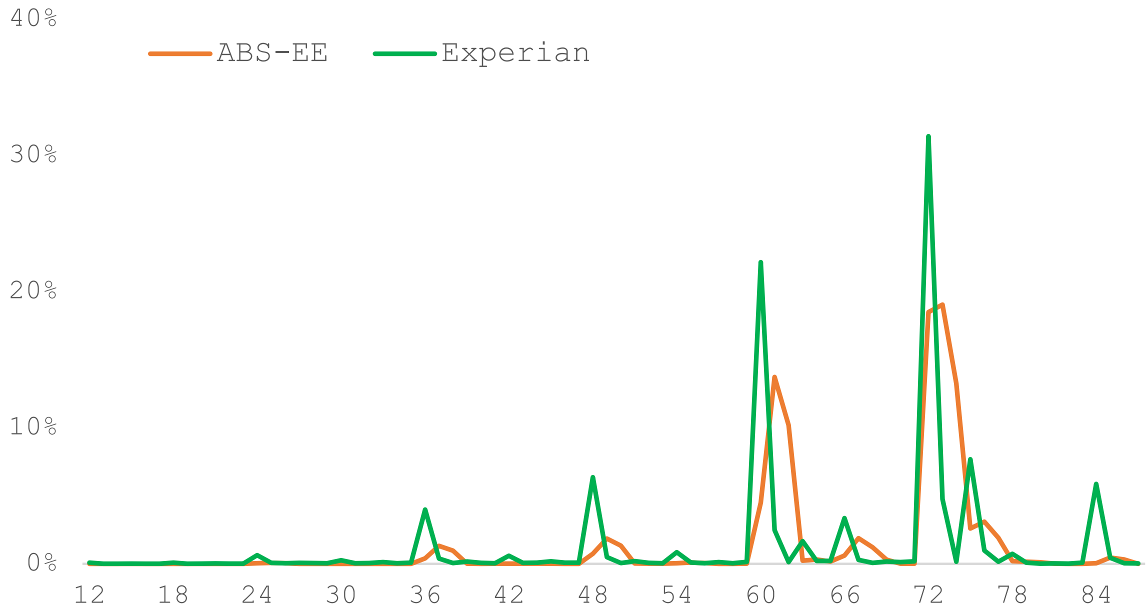
Note: Results based on simulations. The upper and lower panels of the table simulate the experience of middle- and low-score borrowers with a $35,000 loan and an interest rate of 5 and 7 percent, respectively, for shorter-maturity loans, which is set for both 24- and 36-month loans for simplicity. The 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 6: 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

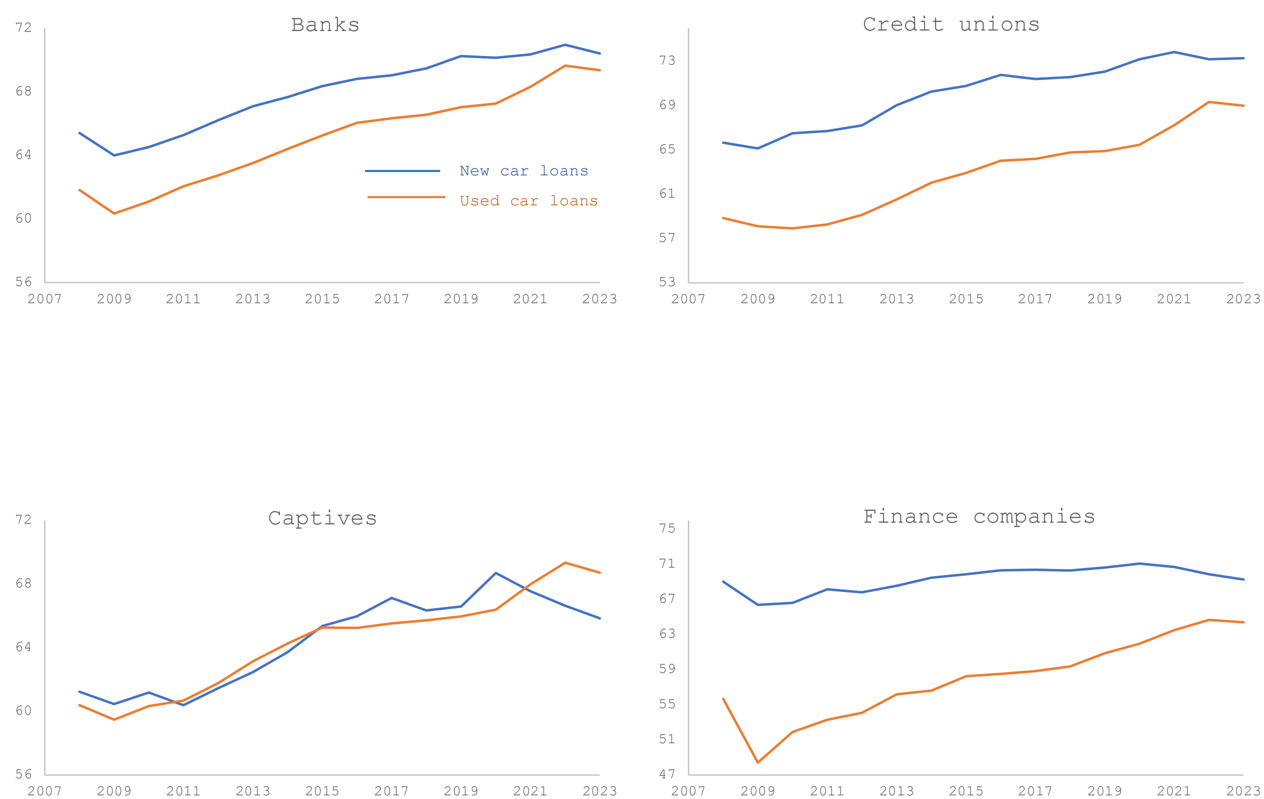
Note: Authors' calculation using the Experian AutoCount data.

Figure A1: Loan Maturity Distribution in the Experian and ABS-EE Data



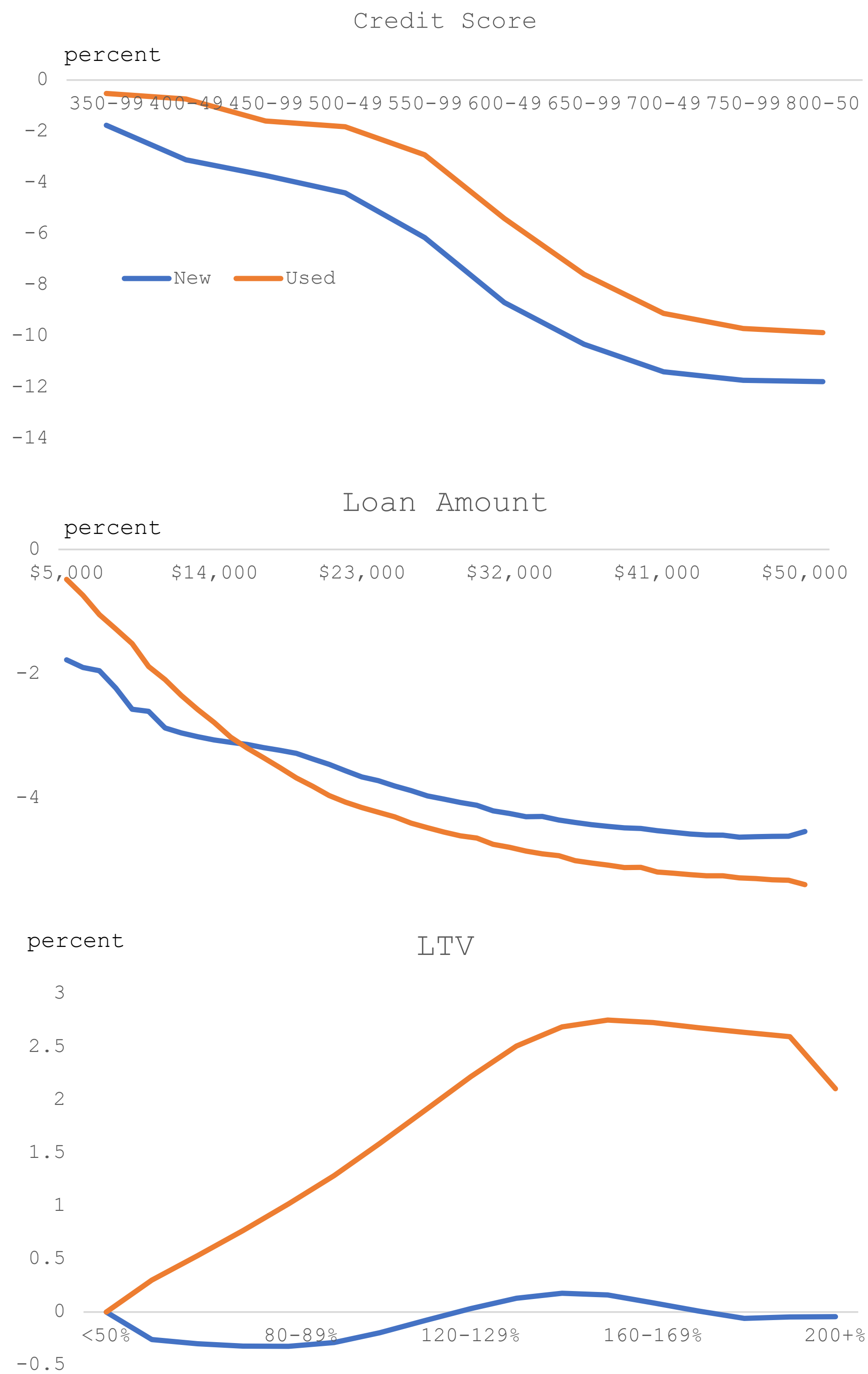
Note: The Experian AutoCount and ABS-EE data.

Figure A2: Loan Maturity by Lender Type



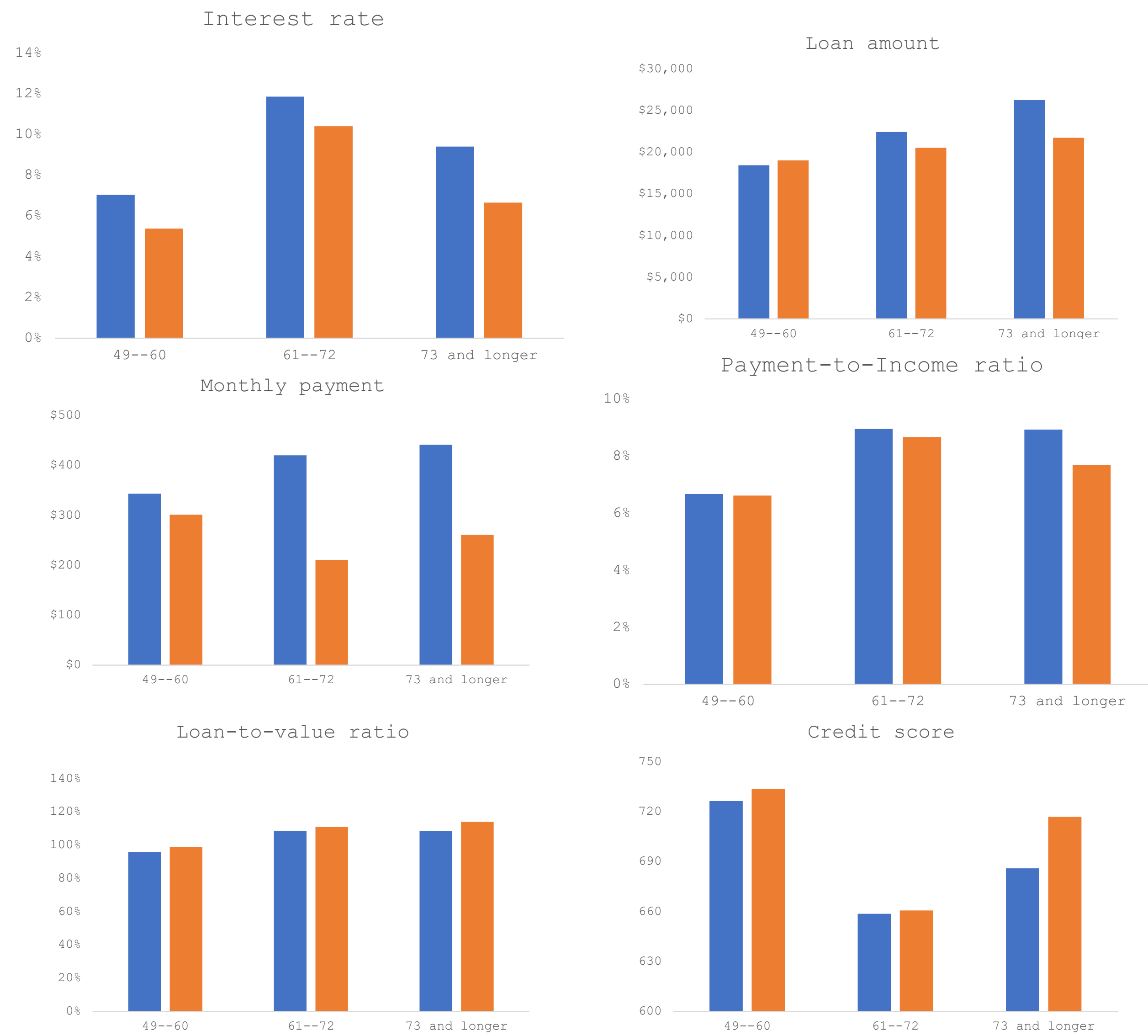
Note: The Experian AutoCount data.

Figure A3: Other Characteristics and Loan Interest Rates



Note: Authors' estimation using the Experian AutoCount data. The charts illustrate the coefficients estimated from equation (2) for credit score, loan amount, and LTV control bins.

Figure A4: Characteristics of Prepaid and Matured Loans (new car loans)



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

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

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 in Different Subsample Periods

	2008–10 (1)	2011–15 (2)	2016–19 (3)	2020-23 (4)
48-month	1.260***	0.474***	0.359***	0.466***
	(0.005)	(0.004)	(0.005)	(0.004)
60-month	1.446***	0.389***	0.336***	1.180***
	(0.004)	(0.003)	(0.004)	(0.004)
72-month	3.084***	1.922***	1.516***	2.074***
	(0.004)	(0.003)	(0.004)	(0.004)
longer-maturity	3.428***	1.802***	2.013***	2.726***
	(0.005)	(0.003)	(0.004)	(0.004)
R-Squared	0.480	0.509	0.527	0.504
N	10,125,275	24,817,808	19,783,358	18,652,118

Note: Authors' estimation using the Experian AutoCount data. The table reports the β coefficients of equation (2), 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.