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# Extended Loan Terms and Auto Loan Default Risk

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# Extended Loan Terms and Auto Loan Default Risk\*

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## Abstract

A salient feature of the \$1.2 trillion auto-loan market is the extension of loan maturity terms in recent years. Using a large, national sample of auto loans from the entire auto market, we find that the default rates on six- and seven-year loans are multiple times that of shorter five-year term loans. Most of the default risk difference is due to borrower risks associated with longer-term loans, as those longer-term auto borrowers are more credit and liquidity constrained. We also find borrowers' loan-term choice to be endogenous and that the endogeneity bias is substantial in conventional default model estimates. To mitigate this risk, we separately estimate instrumental variable regression and simultaneous equation models. Finally, we find evidence of adverse selection in borrowers' loan-term choices in the years when six- and seven-year loans first became widely used, which dissipates over time as lenders adjust to risks in the market.

*Keywords:* auto loans, credit risk, adverse selection

*JEL Classification Codes:* D14, D81, D82, G32

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## 1. Introduction

The post-crisis years have witnessed a thriving U.S. auto loan market. In 2015, auto loan balances hit the trillion-dollar mark for the first time ever, making them the third-largest asset class for consumers; by 2018, they exceeded \$1.2 trillion. A salient feature of the U.S. auto loan market in the new millennium is the extension of loan terms. As shown in Figure 1, in 2000, almost 80 percent of auto loans in the U.S. had terms of five years or less; by 2018, over half of all auto loans had terms *greater than* five years.<sup>1</sup> Meanwhile, the share of loans with even longer terms of seven-plus years grew from 5 percent in 2000 to 13 percent by 2018. The lengthening of maturity terms among observationally higher-risk borrowers has raised concerns of heightened default risk among policymakers and the popular press in the large and growing U.S. auto loan market.<sup>2</sup>

In theory, the extension of maturity terms could help mitigate default risk. Given the same loan amount, longer terms lead to a lower monthly payment burden for borrowers, potentially decreasing the probability of default, which we label the *payment reduction effect*. As we will see, monthly payments can be reduced even for larger balance loans with higher interest rates. On the other hand, extended loan terms prolong payment cycles, extending the time when borrowers pay off or owe less than their cars' value, potentially increasing default risk, which we label the *risk exposure effect*. On the intensive margin, with extended terms, borrowers could buy more expensive cars and take on more debt that stretch personal finances. On the extensive margin, consumers could be granted credit they would not have qualified for with shorter terms. Therefore,

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<sup>1</sup> In 2000, autos with terms of five years or less were 73 percent by balance; in 2018, autos with terms five years or less were 36 percent by balance. The difference between the balance count and loan count reflects the fact that longer-term auto loans on average had much larger balances.

<sup>2</sup>See, e.g., Brevoort et al., 2017; Guo, Zhang, and Zhao 2017; "Introducing the 97-Month Car Loan," *Wall Street Journal*, April 8, 2013; and "The Seven-Year Auto Loan: America's Middle Class Can't Afford Its Cars," *Wall Street Journal*, October 1, 2019.

it is an empirical question as to whether auto loans with extended terms impose bigger risks. Moreover, it is important to understand how much of the additional risk is due to the risks of the borrower versus the extended-term products.

In this paper, we use a novel database from a large, nationally representative sample of the entire U.S. auto loan market, excluding leases,<sup>3</sup> to explore these issues. Our data contain performance history of borrowers together with detailed loan and borrower information. The rich information in the data as well as its extensive coverage (i.e., more than 600,000 individual loans originated between 2006 and 2017), enable us to overcome several limitations we see in other studies.

The first challenge faced by existing studies is loan-term endogeneity. Borrowers' risk type is an important determinant of loan performance; however, at the same time, high-risk borrowers could self-select into certain types of terms (Hertzberg, Liberman, and Paravisini, 2018). Therefore, we face a classical endogeneity problem when we model the relation between default risk and loan terms. To overcome such identification difficulties, in this paper, we employ both an instrumental variable approach and a simultaneous-equation model. Our results demonstrate that endogeneity bias is significant.

Other major studies on the U.S. auto market have generally focused on particular segments of the market or a particular lender type. Argyle, Nadauld, and Palmer (2019) study payment targeting from a large service bureau, in which 98.5 percent of its lenders are credit unions. These membership-based financial institutions, which cover around a quarter of the auto lending market, have relationships with borrowers not found among other lenders, information we exploit to test for adverse selection among different types of lenders. Adams, Einav, and Levin (2009) examine

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<sup>3</sup> We do have a field in our database that identifies leases. Since most all leases are three-year terms, our sample naturally excludes them, giving us confidence we have successfully excluded all leases.

liquidity constraints and adverse selection at a single used-car subprime auto lender with originations from 2001 to 2004 and an astonishingly high default rate of 61 percent. Our study covers the entire car sales market and is therefore best suited to analyzing risks emanating from the substantial shift to longer-term auto loans in the overall trillion dollar-plus auto loan market that has generated much concerns from the popular press, policymakers, and even academics.<sup>4</sup>

A major advantage of our database of tradeline data from a major credit bureau is that we have long histories of borrowers' non-auto debts, some of which is not available to lenders when loan decisions are made.<sup>5</sup> With such private information, we are able to tie borrowers' loan-term choice and loan performance to their broader historical consumer debt condition, captured in such data as past credit scores and borrowers' historical credit-card utilization. In fact, we find that borrowers' other debt usage significantly affects auto-loan term choice and loan performance. Moreover, we are able to exploit the information contained in borrowers' credit-card utilization before and after booking the auto loan to test for adverse selection.

We show that borrowers who take out six- or seven-year loans face greater credit and liquidity constraints. They have lower credit scores, live in lower-income neighborhoods, and have significantly higher credit card utilization prior to booking their auto loan. They are also less likely to have a home equity line of credit (HELOC) that they can tap into. A simple calculation shows that, with a longer-term loan, borrowers are able to reduce their monthly payment by 13 percent

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<sup>4</sup> Argyle, Nadauld, and Palmer (2019) write, "We are not the first to sound an alarm about rising auto-loan maturities. ..."

<sup>5</sup> Up to now, lenders' loan origination systems could only obtain information on a current snapshot of borrowers' credit reports. Information missed in this snapshot, but known to borrowers, include past credit scores and credit utilization over time. More recently, Fannie Mae and other lenders have begun to work with credit bureaus to gather more information on borrowers' past credit reports from the three major credit bureaus.

to 24 percent. Taking a longer-term loan is therefore a means for borrowers to alleviate liquidity constraints, provided that lenders are more willing to provide the credit.

Given the profiles of longer-term borrowers, it is not surprising that their default rates are higher.<sup>6</sup> The two-year cumulative default rate of six-year loans is 1.67 times higher than five-year loans, while the default rate of seven-year loans is 3.34 times higher. In propensity score-matched samples, the default rate gaps shrink but remain significant at 18 percent and 92 percent, respectively.

In our baseline default probability model, we find longer terms to be associated with higher default risk after controlling for a battery of loan and borrower characteristics. However, in our instrumental variable regression that mitigates endogeneity, we find six-year loans to be *less* risky than five-year loans, *ceteris paribus*. This sharp contrast indicates that the endogeneity bias is significant. Further, a separately estimated simultaneous-equation model generates default results consistent with those of the instrumental variable regression and clearly indicates that higher-risk borrowers do self-select into longer-term loans.

For seven-year loans, after accounting for borrower differences and endogeneity in loan terms, the default risk gap between them and the shorter-term five-year loans shrinks from 234 percent to 60 percent. In other words, three-quarters of the default risk difference are explained by borrower differences. If we interpret the residual default risk difference as product risks of longer-term loans when we pool all loans originated between 2006 and 2016 together, our results suggest that the payment reduction benefit of a six-year loan outweighs its cost of increased credit exposure but that the opposite is true for seven-year loans.

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<sup>6</sup> *Default* is defined as loans becoming more than 90 days past due, having been charged-off, having a bankruptcy, or having been repossessed within the first 24 months after booking.

When we rerun our analysis by loan vintage, we find the residual default risk difference between longer-term loans and shorter-term loans changes over time. In both the six- and seven-year cases, the residual default risk difference is positive in the earlier vintages. For six-year loans, it turns negative for the post-2008 vintages, but it becomes insignificant for seven-year loans. These time-series patterns suggest that the residual default rate difference cannot be purely product risk; risk inherent to the product should be stable over time. A more plausible interpretation of the time-series patterns should be changing unobservable borrower risks because of adverse selection: In early years when lenders did not have enough experience with longer-term loans, they were adversely selected. Higher-risk borrowers self-select into longer-term loans, and thus, after controlling for observable borrower characteristics, the residual default risk difference was positive and significant. As lenders accumulate more experience over time with longer-term loans, they are able to manage risks better, and as a result, they become less adversely selected.

We conduct additional tests of adverse selection by comparing risks of longer-term loans made by different types of lenders. We find that credit unions face significantly lower risks than auto finance companies with their longer-term loans. This is consistent with the intuition that, due to closer lending relationships, credit unions are in a better position to develop “soft” information that they could use to underwrite those longer-term loans, suggesting credit unions are less adversely selected. We also study the pricing of auto loans in our sample and find less variation in the interest rate of longer-term loans with respect to borrower risk types, which is consistent with theoretical pricing results in a pooling equilibrium under adverse selection.

Finally, leveraging the rich borrower credit data on borrowers’ other debt usage, we compare credit card utilization rates of longer-term borrowers with that of shorter-term borrowers.

We find borrowers who are choosing longer terms are more aggressive in their credit card utilization *after* they book their auto loans, which further supports our adverse selection argument.

The paper contributes to the literature in a number of ways. First, it advances our understanding of extended auto-loan terms and answers questions such as the characteristics of borrowers who take out longer terms, how to quantify default risk of these longer-term loans, how much of the risk comes from differences between borrowers versus the products they choose, and what the main risk drivers are. Along the way, we address an important endogeneity issue in modeling auto-loan default risk. Compared with studies in the growing literature on extended auto loan terms (see, e.g., Brevoort et al., 2017; Guo, Zhang, and Zhao, 2017; Argyle, Nadauld, and Palmer, 2019), we focus on modeling borrowers' term choice and default decisions jointly and find that loan term endogeneity could bias default model estimates significantly.

Second, the paper sheds light on loan-term choice and credit rationing in the auto loan market. Argyle, Nadauld, and Palmer (2019) stress the importance of payment targeting by auto-loan borrowers. Our results show that liquidity constraints identified in prior literature are still relevant in today's auto loan market (see, e.g., Gross and Souleles, 2002; Johnson, Parker, and Souleles, 2006; Adams, Einav, and Levin, 2009). We also confirm the conventional wisdom that as cars become more durable, lenders are more comfortable granting longer-term loans. Moreover, our findings about adverse selection help explain why there exists significant credit constraints even though the auto-lending market is relatively competitive<sup>7</sup> — credit rationing is an equilibrium outcome in the presence of adverse selection (see, e.g., Stiglitz and Weiss, 1981; Adams, Einav, and Levin, 2009).

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<sup>7</sup> Verma (2017) documents that there were 209 “major” auto lenders that made more than 10,000 loans or leases in the U.S. in 2015.



Finally, our paper has implications for risk management in auto lending. One of the factors that contributed to the recent housing and mortgage crisis was the excessive use of nontraditional loan products that lowered borrowers' monthly payments through features such as negative amortization, interest-only, and relatively low initial rates on hybrid adjustable-rate mortgages (ARMs) (see, e.g., Bernanke, 2007; Demyanyk and Van Hemert, 2011). Banks, regulators, and investors need to closely monitor the changes in loan terms and possible other loan features and ensure that the risks associated with those changes in the auto-lending market are appropriately accounted for.

This paper proceeds as follows. In Section 2, we explain our data. In Section 3, we present our default risk models and results. We present evidence of adverse selection in Section 4. Concluding remarks are in Section 5.

## **2. Data**

### *2.1. Data sources*

Our main sources of data are the Federal Reserve Bank of New York/Equifax Consumer Credit Panel (hereafter CCP)<sup>8</sup>, and, unique to our study, the auto-tradelines data supplement to the main CCP (hereafter, Equifax CCP Tradeline Data) that gives the loan-level detail of each loan through the auto tradelines.<sup>9</sup> The main CCP covers a 5 percent national sample of consumers. The data are refreshed on a quarterly basis from 1999 to the present and include more than 500 credit attributes, providing a comprehensive view of borrowers' consumer debts and related performance.

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<sup>8</sup> See [https://www.newyorkfed.org/medialibrary/interactives/householdcredit/data/pdf/Technical\\_Notes\\_HHDC.pdf](https://www.newyorkfed.org/medialibrary/interactives/householdcredit/data/pdf/Technical_Notes_HHDC.pdf).

<sup>9</sup> Since the CCP is at the borrower level, auto tradeline information is summed up to the borrower level, leaving out important information on individual auto loans we capture with the tradeline supplement.

The auto tradeline data cover the same 5 percent national sample of consumers for up to four open auto trades.<sup>10</sup> An *open trade* is defined as a loan with activity in the last six months and not closed with a zero balance. The auto tradeline panel starts in June 2000. It is refreshed semiannually in June and December of each year.<sup>11</sup> For each trade, Equifax provides up to 13 tradeline-level attributes. Of most interest for our study are loan terms, loan amounts, open dates, current balances, contractual monthly payment amounts, and delinquency status. Since lenders often report zero values in the loan-term field, we are able to use an amortization function to calculate the loan terms using the loan amount, balance, and contractual payment amount for most all the loans. For our analysis, we draw up to four auto tradelines associated with a 10 percent random sample of primary borrowers from the Equifax CCP Tradeline Data. We exclude all auto leases and a small portion of loans with small balances, missing contractual payment amounts, and borrowers with non-monthly payments.

We supplement our main auto data with the Internal Revenue Service (IRS) zip code-level adjusted gross income data and the Census Bureau's ZIP Codes Business Patterns (ZBP) data. The supplemental data are matched to the main data by zip code.

Our initial 10 percent sample from the Equifax CCP Tradeline Data contains over 2.6 million unique auto loans originated between 2000 and 2018. In Figure 1, we display the loan-term distribution for each vintage of auto loans in the sample. We classify loan terms into four categories: less than or equal to 4 years, 5 years, 6 years, and 7+ years.<sup>12</sup> In the second panel

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<sup>10</sup> Less than 0.1 percent of auto-loan consumers hold more than four auto trades at the same time, according to Equifax.

<sup>11</sup> Starting from 2017, tradeline data are updated every quarter on the same schedule with the main CCP data. To be consistent with the historical tradeline data, we continue to extract samples semiannually post-2017.

<sup>12</sup> For many of the loans, we use a combination of original balance, monthly payment, and interest rate to calculate loan terms as the loan-term field if the raw data are missing. For those loans, we round loan terms to whole year and check the robustness of our results with various rounding methods. For example, in one version, we exclude those with calculated terms that are more than three months away from a whole-year

(Figure 1, Panel B), the share of each category is weighted by loan amount. Loans with terms of five years or less accounted for 79 percent of the sample in 2000, but they were only 47 percent by 2018 (73 percent and 36 percent by balance). In contrast, there is a clear increase in the share of six-year loans. What is also significant is that the share of loans with terms of seven or more years rose from 5 percent in 2009 to 13 percent by 2018 (7 percent to 18 percent, by balance).

For the purpose of this study, we include loans with only terms of five, six, and seven years booked between 2006 and 2016. We include all loans with original balances between \$5,000 and \$99,999. We also exclude tradelines with an Equifax Origination Risk Score (hereafter Risk Score) of less than 500,<sup>13</sup> in which the Origination Score is the Equifax Risk Score from the last quarter prior to loan booking. Throughout the paper, we define *Default* as loans becoming more than 90 days past due, having been charged-off, having a bankruptcy, or having been repossessed within the first 24 months after booking. Our final sample includes 827,301 loans.

## 2.2. Borrower profile: longer- versus shorter-term loans

Our central research questions center around differences between longer-term and shorter-term loans. We define *longer-term loans* as those with a term at or beyond five years (which we define as an estimated 54 to 65 months in our sample), and we further distinguish six-year term loans (66 to 77 months) and seven-year term loans (78 to 89 months) as two separate groups. We compare six- and seven-year terms against five-year terms, which is our reference group.

The logic of separating our sample in this way is clear from univariate comparisons of the three subsamples in Table 1, as five-, six- and seven-year term auto loans show a clear monotonic

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mark. While the term distribution at a certain point in time changes depending on the rounding method, the trend remains. Regression results we show later remain robust when we change the rounding method.

<sup>13</sup> A vast majority (95 percent) of auto loans with original loan amount below \$5,000 have loan terms of less than five years. We also excluded auto loans with an original Equifax Risk Score below 500. All told, we only eliminated 4.8 percent of loans with five-, six- and seven-year terms.

pattern positively correlated with risk. Loan balances, interest rates, credit card utilization rates, and 24-month default rates are increasingly higher the longer the term. Average origination scores and zip code-level adjusted gross income (AGI) are lower the longer the term. Longer-term borrowers are more likely to rent rather than own, less likely to have a HELOC, and more likely to have a student loan. As we have detailed, comparisons like these have drawn concerns from the popular press, policymakers, and academics.

Longer-term loans are also clearly larger in size. An interesting first question is whether, after controlling for loan amount, significant differences remain between longer-term borrowers and shorter-term borrowers. In Table 2, we show results comparing longer-term loans with similarly sized five-year loans. We first match six- and five-year loans based on loan size and then compare the characteristics of the different maturity groups; we do the same for seven-year loans.<sup>14</sup> Results remain comparable to those in Table 1: Borrowers still show that longer-term borrowers have lower Risk Scores, live in lower-income neighborhoods, and have higher credit card utilization rates, with a lower likelihood of having a HELOC.

These bivariate tabulations highlight credit and liquidity constraints of longer-term borrowers. Adams, Einav, and Levin (2009) show that U.S. auto consumers are short-term liquidity constrained, as demand increases sharply during tax rebate season and purchases are highly sensitive to down-payment requirements. Here, we show that liquidity constraints are stronger for longer-term borrowers. They have less ability to borrow against their future income to finance present consumption or to smooth consumption across uncertain states of the economy; this is seen both in credit card unused limits and in less access to home equity lines.

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<sup>14</sup> Later we do propensity score matching across a large number of attributes. Here we match only loan size.

### *2.3. Payment reduction with longer-term loans*

Argyle, Nadauld, and Palmer (2019) discuss the importance of monthly payment targeting in auto borrowers' loan-term choice. In this regard, we want to understand by how much longer-term loans could help borrowers lower monthly payments.

In Table 3, we show some simple calculations. The key questions here are: If the longer-term borrowers had taken a shorter five-year loan, what would the payment be and how does it compare with the borrower's current payment? The difficulty here is that we do not observe the counterfactual interest rate on the same borrower. However, we know the interest rate of the current longer-term loan is an upper bound (given it has a longer term). We could also use the interest rate of the shorter five-year term loans as a lower bound. Therefore, in this exercise, we calculate two monthly payment numbers using the higher and the lower bounds of each loan. Using the average interest rate of the six-year loans, the monthly payment for an average balance of six-year loans with a five-year term would be \$499; using the average interest rate of the five-year loans, the monthly payment would be \$482. Compared with these two hypothetical five-year term loan payments, the current payment of \$420 for the longer six-year term represents payment reduction somewhere between 13 percent and 16 percent.

A similar calculation for seven-year loans shows that the payment reduction is between 17 percent and 24 percent. Payment reductions of this size could enable many liquidity-constrained borrowers who would not have been able to afford a shorter-term loan to afford a larger loans. Argyle, Nadauld, and Palmer (2019) document borrower preferences for these loans with lower monthly payments, detailing how such preferences for maturity is inconsistent with a consumer objective function that minimizes the net present value of total borrowing costs, termed NPV neglect by Shu (2013).

From a risk-management perspective, the combination of these bivariate comparisons raises concerns about longer-term maturities and default risk. Next, we examine their relationship to default risk in a multivariate setting, controlling for endogeneity and other identification issues.

### 3. Default Risk Models and Results

#### 3.1. Empirical strategy

The tabulation of our data in the previous section clearly indicates that borrowers taking longer-term auto loans are different from those taking shorter terms. Therefore, in understanding risks inherent in longer-term auto loans, it is important to understand the main risk drivers of longer-term loans, whether we can differentiate between the risk of the borrower and the risk in the longer-term loan products, and the stationarity of that risk over time.

We start our multivariate analysis with a standard default probability model of the following form:

$$y_i = f(\alpha + \gamma l_i + X_i \beta), \quad (1)$$

where  $y_i$  is an indicator of default defined above;  $l_i$  is an indicator of a longer-term loan;  $X_i$  is a vector of control variables, including loan and borrower characteristics and macroeconomic variables; and  $f$  is a linear, logit, or probit link function.

The challenge we face with such a model is endogeneity. In addition to market factors, loan default is driven by borrowers' risk type. However, at the same time, borrower risk type could be a driver of loan-term choice. Research shows that riskier, credit-constrained borrowers are more likely to choose longer-term loans (e.g., Hertzberg, Liberman, and Paravisini, 2018).

We first attempt to address such endogeneity concerns with instrumental variables. We first regress loan term  $l_i$  on our instruments,

$$l_i = \delta + W_i\varphi + \varepsilon_i, \quad (2)$$

and replace  $l_i$  with the imputed loan term  $\hat{l}_i$  in equation (1). The instruments we use are loan size and average loan terms in the borrower's zip code.

Alternatively, we run a simultaneous equation model to address endogeneity. In addition to equation (1), we simultaneously estimate a loan term-choice equation:

$$l_i = g(\mu + \sigma y_i + Z_i\theta). \quad (3)$$

Note that  $Z_i$  and  $X_i$  are different sets of control variables that satisfy the exclusion requirements. For example, we include neighborhood income and the borrower's possession of a home equity loan (or line of credit) as exogenous variable in  $Z_i$ , but not in  $X_i$ . In our tests, they are not significantly correlated with loan default and thus satisfy the exclusion requirements.

### 3.2. Model results

Figure 2 depicts the unconditional 24-month default rates of our three auto-loan term product groupings, excluding the 2017 and 2018 vintages that do not have 24 months of performance history. The two-year cumulative default rate of six-year loans is 2.62 percent, 67 percent higher than the 1.57 percent default rate of five-year loans. What is revealing is that the two-year cumulative default rate of seven-year loans, at 5.25 percent, is more than three times that of five-year loans.

Table 4 contains propensity-score matched sample comparisons. The variables used in the match include loan, borrower, and neighborhood characteristics. We match the longer-term loans with the shorter five-year term loans one-on-one using the closest propensity score. After the match, the default rate gaps shrink to 18 percent for six- versus five-year loans and 92 percent for seven- versus five-year loans. Therefore, a large portion of the default rate difference is explained by observable loan and borrower characteristics.

In Table 5, we report our model results. Panel A shows the six-year versus five-year term results. Our baseline model is equation (1) in linear form. Our dependent variable is an indicator of default within 24 months of loan origination. Our focus variable is the longer-term (here six-year) instrument, and our control variables include borrower Risk Scores (with spline functions) at loan origination, credit card utilization (with bins), number of credit cards owned by the borrower, whether there is a co-signer of the auto loan, the change in the unemployment rate (highest 24-month post-origination minus origination), and lender type. We also include state-fixed effects and vintage-fixed effects. Standard errors are clustered at the state level.

The control variable results largely conform to our expectations. For example, *ceteris paribus*, borrower Risk Score is shown to be negatively related to default, change in unemployment rate is positive, and borrowers with a co-signer have significantly lower default risk. The number of bankcards the borrower has is positive, while high credit card utilization is associated with higher auto-loan default probability.

*Ceteris paribus*, loans originated by credit unions have the lowest risk, followed by those originated by banks. Other types of lenders mainly include personal loan companies, auto dealers, and sales financing companies. Loans originated by them show the highest default risk.

Turning to our focus variable, the six-year term dummy is positive and significant. *Ceteris paribus*, six-year loans have a two-year cumulative default rate that is 0.29 percentage points higher. After controlling for loan, borrower and lender effects, the difference is down to 18.5 percent ( $0.29/1.57=18.5$  percent). This result is qualitatively consistent with our finding from the propensity score match, and the magnitude of the difference is also comparable.

However, as discussed previously, we need to control for endogeneity. Therefore, we turn to our instrumental variable regression and simultaneous equation model results in Table 5. Once



we mitigate endogeneity in our models, our focus variable coefficient flips sign. In both our instrumental variable regression and the simultaneous equation model results, six-year loans now demonstrate *lower* default risk after controlling for observable risk factors and accounting for endogeneity. The difference is -0.44 percentage points (-28 percent) in the instrumental variable model and -0.55 (-35 percent) in the simultaneous equation model.

We get very different results when we compare seven-year loans with our five-year reference group, shown in Panel B of Table 5. Similar to results in Panel A, the baseline model shows that seven-year loans have significantly higher default risk, *ceteris paribus*. The difference is 2.39 percentage points (152 percent higher). Once we mitigate endogeneity in our models, the difference becomes smaller, but it is still positive and significant. It is shown to be 1.11 percentage points (70 percent) in the instrumental variable regression and 0.94 percentage points (60 percent) in the simultaneous equation model. This compares with 92 percent difference in the propensity score-matched sample.

There are two major takeaways from these model results. First, the majority of the risk difference between longer-term loans and shorter-term loans can be explained by observable borrower risk characteristics. Taking five-year loans as a reference, the unconditional average default rates of seven-year loans is over three times higher. However, after accounting for borrower differences, the gap shrinks to around 60 percent higher. Thus, three-quarters of the default rate difference is explained by borrower differences. For six-year loans, observable borrower risks more than explain its default rate difference with five-year loans.

Second, borrowers self-select into different loan-term products. This is clearly demonstrated by our simultaneous equation model. In Appendix Table 1, we report the loan-term choice equation of our simultaneous equation model. We see that borrowers with higher default

risk are more likely to choose longer-term loans, indicated by the positive coefficient of the default variable on the right-hand side of the loan-term choice equation, in both the six-year and seven-year cases. In addition, we find a time trend toward longer terms in recent years, which is consistent with the intuition that lenders became more comfortable originating longer-term loans either because automobiles became more reliable and durable or because lenders gained more experience with longer-term products over time. In that regard, we test a specification with the average life of cars in the loan-term choice equation and find it to be positive and significant, which supports the hypothesis that lenders feel more comfortable granting longer-term loans in recent years as cars become more durable.<sup>15</sup>

Both our instrumental variable regression and simultaneous equation model results demonstrate that endogeneity bias in our default model could be large. This is evidenced by the significant change in the longer-term coefficient from our baseline model to the simultaneous equation model as shown in Table 5. In fact, as shown in Panel A of the table, for six-year loans, we indicate they are lower risk from a baseline default model after accounting for loan-term endogeneity.

### *3.3 Changing borrower risks*

The modeling discussed in the previous subsection can be viewed as a decomposition of risk differentials between longer-term and shorter-term loans. The unconditional default rate difference between those two groups of loans includes additional borrower risks associated with longer-term loans as well as additional product risks of longer-term loans. By including borrower characteristics in the regression, we account for observable borrower differences. The residual

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<sup>15</sup> Results available upon request.

default risk difference should include unobservable borrower differences and product risk differences.

In the previous subsection, we note that the residual default risk difference is positive for seven-year loans and negative for six-year loans. A possible explanation is that the product risk differs between six-year and seven-year loans. As we discussed previously, longer-term loans are paid off more slowly. Therefore, it takes longer to reach a point where borrowers owe less on a car than it is worth, and the borrower is exposed for a longer period of time during which adverse events, such as job loss and illness, could lead to default (previously defined as the *risk exposure effect*). On the other hand, longer terms help lower monthly payments, which is critical for borrowers who are at the margin of being able to service their debts. Therefore, longer terms potentially help decrease default risk (previously defined as the *payment reduction effect*). We can interpret the negative residual default risk difference between six-year and five-year loans as the payment reduction effect outweighing the risk exposure effect in six-year loans. However, the payment reduction effect seems to be outweighed by the risk exposure effect in seven-year loans.

But such an interpretation relies on the assumption that we have perfect control of unobservable borrower risks, and thus the residual default rate difference purely reflects product risks. In the following analysis, we show that this is unlikely.

What we do is to rerun our simultaneous equation model by loan vintage and see how the residual default rate differences between longer-term loans and shorter-term loans change over time. In Figure 3, we plot the point estimates of the longer-term indicator coefficient and their confidence bands. Panel A shows the results for six-year versus five-year loans. In 2007 and 2008, the coefficient is positive and significant. We also see a clear trend of it turning from positive to negative. Panel B contains the results for seven-year versus five-year loans. Similarly, we see that

the coefficient is positive and significant in the early vintages. However, it becomes insignificant starting in 2009.

Changes in the coefficient over time indicates that the residual default risk difference cannot be purely product risk; risk inherent in the product should be stable over time. A more plausible interpretation of the time-series patterns should be changing unobservable borrower risks. In fact, this interpretation is intuitive: In early years, when lenders did not have enough experience with longer-term loans, they could have been adversely selected. Higher-risk borrowers self-select into longer-term loans, and thus, after controlling for observable borrower characteristics, the residual default risk difference was positive and significant. As lenders accumulate more experience with longer-term loans, underwriting can better captures risks, and as a result, they become less adversely selected. In addition, the payment reduction effect outweighs the risk exposure effect in six-year loans, which explains the stable negative coefficient in recent years. In the next section, we present additional evidence of adverse selection.

#### **4. Tests of Adverse Selection**

##### *4.1. Default risk by lender type*

Akerlof (1970) first discussed adverse selection in used car and insurance markets. Recent research shows it prevails in consumer loan markets (see, e.g., Adams, Einav, and Levin, 2009; An et al., 2015; Hertzberg, Liberman, and Paravisini, 2018). In the context of this research, borrowers who are higher risk can self-select into longer-term loans, and as a result, longer-term loans have additional (unobservable) default risk.

Note that adverse selection is based on information asymmetries between borrower and lender — the borrower knows his own risk type as private information. An advantage of our data

is that it includes loans originated by different types of lenders. Certain lenders are in a better or worse position to develop “soft” information about their borrowers, and thus information asymmetries between them and their borrowers is smaller. We exploit this variation to test whether adverse selection varies with respect to lender type.

Credit unions are probably in the best position to develop additional insights into borrowers’ creditworthiness, as they are membership based and members often have a close relationship with the credit union. Banks also have a relatively good chance of gathering soft information relative to non-credit union types, particularly for direct lending to borrowers who have other relationships with the bank. Auto finance companies are probably in the worst position to obtain soft information: They are generally transaction based and often fund through securitization markets. Therefore, we hypothesize that banks and credit unions are less adversely selected and face lower unobservable default risk in their longer-term loans.

We estimate an augmented version of our simultaneous equation default model where we interact the loan-term dummy with lender type in the default equation. Again, we estimate two separate models for six-year (versus five-year) loans and seven-year (versus five-year) loans. Given that we see residual default risk associated with longer terms is only significant in the 2006–08 vintages, we estimate a separate model using the 2006–08 vintage subsample in addition to the main model with all vintages of loans. We present our results in Table 6.

Table 6, column 1, shows the six-year term results with the 2006–08 vintages. Consistent with our prior findings, six-year term loans show higher default risk in those three vintages. However, bank and credit union loans have lower default risk. Longer-term loans originated by credit unions show the lowest default risk among all longer-term loans, as evidenced by the

significant and negative coefficient of the interaction term. This result is consistent with our hypothesis that credit unions faced the least adverse selection.

The next column shows the six-year term results with all the vintages. Six-year term loans now show lower default risk when we pool all the vintages together, consistent with what we saw previously. Bank and credit union loans still demonstrate lower default risk. Credit unions do not show an edge over auto finance companies in the longer-term loans they originate when we bring later vintages into the sample. This is consistent with our prior hypothesis that adverse selection diminishes over time as lenders get more familiar with these longer-term loan products.

Columns 3 and 4 of Table 6 show our seven-year term results. In general, seven-year loans demonstrate significantly elevated default risk, no matter if it is in the 2006–08 vintage subsample or in the full sample. Again, banks and credit unions loans have lower risks, *ceteris paribus*. Longer-term loans originated by credit unions show lower risks relative to longer-term loans originated by auto finance companies, which further supports the hypothesis that credit unions are less adversely selected and thus face lower residual risks. The only surprise here is that seven-year loans originated by other types of lenders show significant lower risk than banks and auto finance companies. This could be because some small lenders in the other types specialize in nontraditional lending such as the extra-long seven-year term loans.

#### *4.3. Evidence from loan pricing*

Stiglitz and Weiss (1981) and many others show that when faced with adverse selection, there could be a pooling equilibrium in which lenders charge the same (high enough) price on the borrowers they accept while rejecting other borrowers (so-called credit rationing). Therefore, if adverse selection really happens as we hypothesize in the previous subsection, we would expect to see more uniformity (less variation) in the price of longer-term loans than in the price of shorter-

term loans. Therefore, we study the variation in loan interest rates with respect to the risk of loans and compare such variation between longer-term and shorter-term loans.

Table 7 contains our regression results. Here our dependent variable is the interest rate on the auto loans. On the right-hand side, we have the default risk indicator — whether the loan falls into default within 24 months of origination. We also have longer-term (six-year and seven-year) indicators as well as the interaction between the default risk indicator and the longer-term term indicator. Again, we run the regressions with the 2006–08 vintages and with the full sample. Columns 1 and 2 of Table 7 show regression results without additional control variables, while columns 3 and 4 show results with additional control variables.

Not surprisingly, loans with higher risk and with longer terms are charged higher interest rates, *ceteris paribus*. For example, high-risk loans indicated by the default risk indicator in the model carry an almost 3 to 4 percentage points (276–386 basis points (bps)) higher interest rate, depending on the vintage. The six-year loans have a 74–130 bps higher interest rate, and the seven-year loans have a 289–355 bps higher interest rate, depending on the vintage. The interaction terms have negative coefficients in the specifications both with and without other control variables. Therefore, for example, among six-year loans, the variation in interest rate with respect to default risk type is 203 bps ( $276-73=203$ ) among six-year loans instead of 276 bps among five-year loans in the early vintages. Between seven-year and five-year loans, the variation in interest rate with respect to default risk type is 167 bps ( $276-109=167$ ) versus 276 bps.

Taken together, these results show that the interest rates charged vary with respect to the default risk of the loans; however, the variation is smaller among longer-term loans. These interest rate results support the idea that there is pooling in longer-term loans, and they are consistent with our adverse selection argument.

#### *4.2. Evidence from credit card utilization*

Another advantage of our data is that it contains detailed information about the auto borrower's other debts such as mortgages loans, HELOCs, credit cards, and personal loans, among which the credit card information is typically the most telling about the borrower. We are particularly interested in the borrowers' credit card usage before and after booking the auto loan. In this section, we design a difference-in-differences (DID) test to examine the relation between the borrowers' choice of longer-term auto loans and their credit-card usage.

Before we turn to the DID analysis, we make a simple comparison based on the propensity score-matched samples. Table 8 presents our comparison of the eight-quarter change in credit card utilization rates and Risk Scores. For borrowers with multiple credit cards, we combine all the accounts. Panel A shows the comparison between five- and six-year loans. We see that both five- and six-year auto borrowers experience some decline in credit card utilization eight quarters before booking the auto loan. This is consistent with the conventional wisdom that, before taking a large installment loan, borrowers try to manage their credit posture to build up their Risk Scores so they can qualify for the installment loan or get a lower interest rate. In fact, borrowers' Risk Score improvements shown in the table supports this view — borrowers had average Risk Score increases of 14 and 17 points in their Risk Scores before booking their loans. Note that the credit card utilization rate declines more among the longer-term auto loan borrowers prior to booking their loans. After loans are booked, credit card utilization rates increase by 0.54 percent for the five-year loans and increase 1.85 percent for six-year loans.

In Panel B, we see that prior to booking seven-year loans, these longer-term borrowers decrease their credit card utilization by 2.67 percent, and their Risk Scores improve by more than 19 points. However, after the loan is booked, the seven-year auto loan borrowers increase their



credit card utilization by 2.84 percent, even though a comparable group of five-year loan borrowers shows a much smaller increase of 0.30 percent. This comparison suggests that the seven-year auto loan borrowers are more aggressive in their spending after booking the longer-term loan.

Turning to our DID tests, our treatment event is the booking of the auto loan. Our treatment group is borrowers who take out six- or seven-year loans and the control group is borrowers who take five-year loans. The outcome variable is the eight-quarter change in the credit card utilization rate.

We report our DID results in Table 9. The left column shows the six-year versus five-year term results. Post-auto loan booking, credit card utilization increases for both our treatment group and our control group, and credit card utilization differs between the two groups; controlling for other factors, six-year term borrowers have higher utilization rates. The interaction terms, which is our focus here, show no difference in the six-year term case. However, in the right-hand column of Table 9, we see that our treatment group, the seven-year term borrowers, show a significantly higher growth in credit card utilization post-event.

Taken together, these results suggest that the seven-year auto loan borrowers are more aggressive in their spending after booking the auto loan. One can interpret this result as the seven-year term loan borrowers are higher-risk types and that, even though the extra-long (i.e., seven-year) term reduces borrowers' monthly payments significantly, those borrowers use the additional room of debt service to consume more aggressively instead of keeping credit-card debt down. This credit card utilization result is consistent with our hypothesis of adverse selection.

## 5. Conclusions and Discussion

A salient feature of the large and growing \$1.2 trillion auto-loan market is the extension of loan terms beyond the historical norm of five years or less to six or more years today. The extension of auto-loan terms to more observationally risky borrowers has in recent years raised concerns about heightened risk among regulators, academics, and the popular press in much the same ways exotic affordability products in mortgages lowered monthly payments in the short term but ultimately contributed to much higher default rates.

We find that auto borrowers who took longer-term auto loans have lower Risk Scores, live in lower-income neighborhoods, and face higher liquidity constraints. By taking a six-year loan instead of a five-year loan, borrowers are able to lower their monthly payment substantially. While payment targeting is clearly evidenced in Argyle, Nadauld, and Palmer (2019), our results show that liquidity constraints identified in the prior literature are still relevant in today's auto-loan market (see, e.g., Adams, Einav, and Levin, 2009).

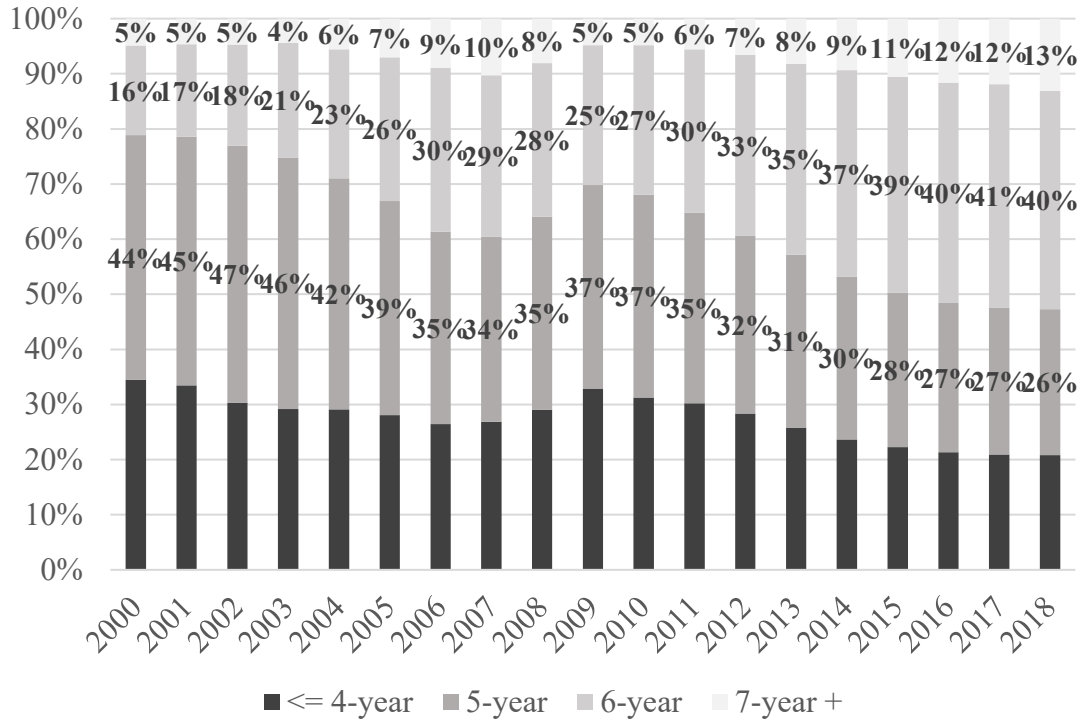
In terms of default risk, simple bivariate comparisons show that longer-term loans have significantly higher default rates (e.g., seven-year loans have a two-year cumulative default rate more than three times higher than five-year loans). After accounting for borrower differences and endogeneity in loan terms, the default risk gaps between longer-term six- and seven-year loans and shorter-term five-year loans shrink significantly, as three-quarters of the default rate difference between seven-year and five-year loans are explained by borrower differences. Meanwhile, we find evidence of adverse selection in the 2006–08 vintages: Borrowers with higher-default risk self-select into longer-term loans. The question for future research is whether lenders are compensated for the additional risk they take with the longer-term loans, especially when there is adverse selection.

Our paper has implications to auto-loan risk management. For example, lenders and investors need to closely monitor the changes in loan terms and possible other loan features and account for the (unobservable) risks associated with those changes in their pricing and loan decisions. From a modeling perspective, segmentation by loan terms could be important to avoid underestimation of risk for those longer-term loans.

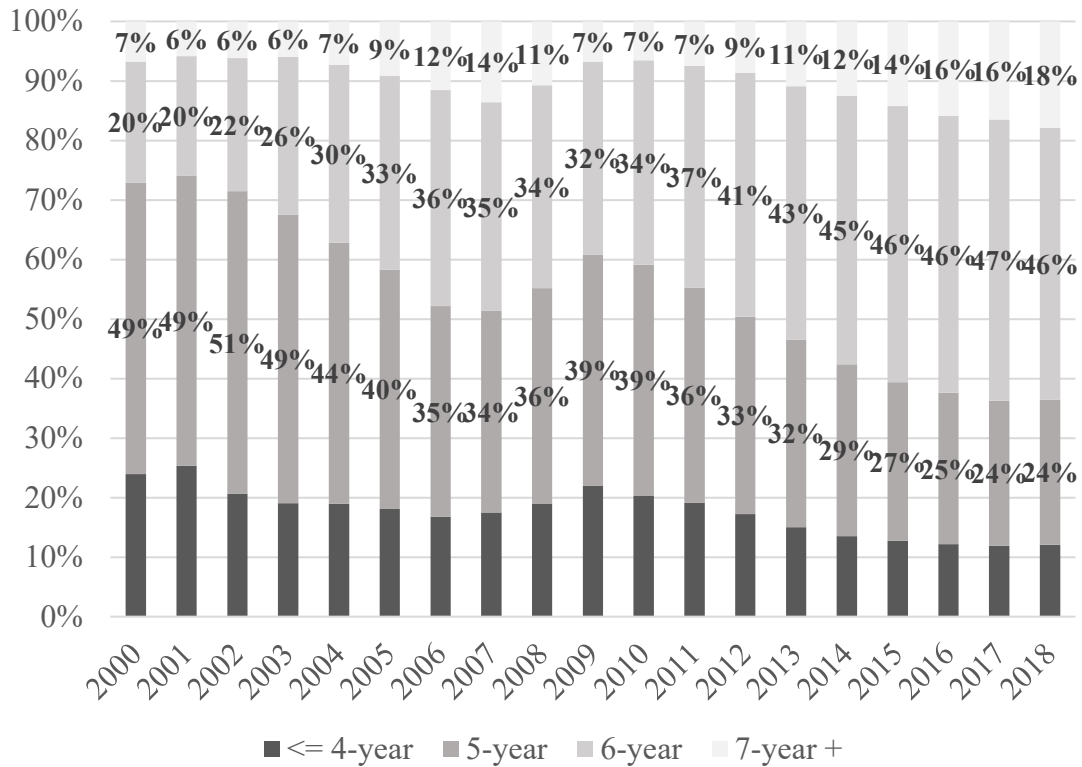
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**Figure 1: Loan Term Distribution**  
**Panel A: By Number of Loans**

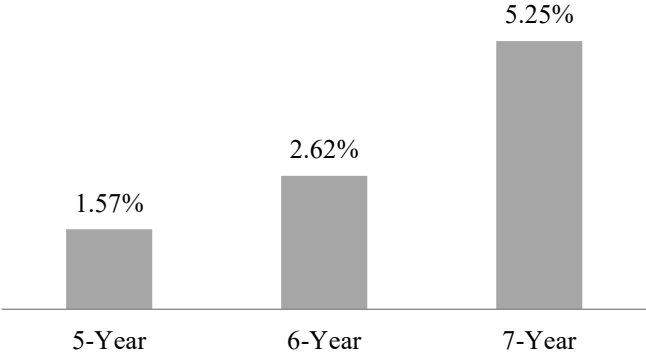


**Panel B: By Loan Amount**



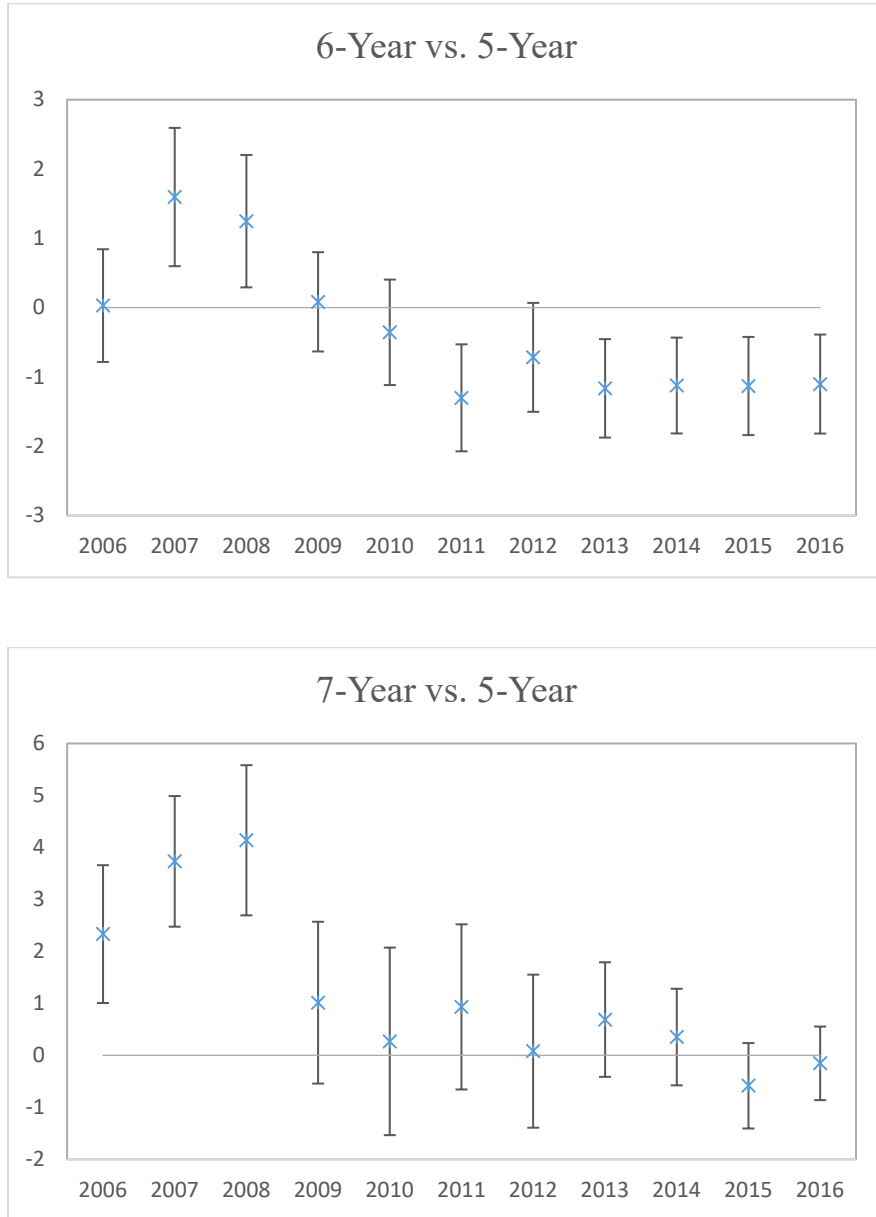
Source: Equifax CCP Tradeline Data

**Figure 2: Two-Year Cumulative Default Rates**



Notes: Data are from Equifax CCP Tradeline Data. Loans included are a 10 percent sample of primary borrowers booked between 2006 and 2016 with terms of five, six and seven years, with origination score  $\geq$  500 and loan amount between \$5,000 and \$99,999. *Origination Score* is the borrower’s Equifax Risk Score from the last quarter prior to loan origination. *Default* is defined as loans becoming more than 90 days past due, having been charged-off, having a bankruptcy, or having been repossessed within the first 24 months after booking.

**Figure 3: Estimates of the Residual Default Risk Differences Between Longer-Term and Shorter-Term Loans**



Notes: Data are from Equifax CCP Tradeline Data. The figures show plots of the longer-term indicator coefficients and their confidence bands from the simultaneous equation model of Equation 3, broken out by origination year for comparisons of 6-year versus 5-year and 7-year versus 5-year loans. The error bars show +/- 2 standard errors. Data sample and default are defined in Figure 2.

**Table 1: Comparison of 5-Year, 6-Year, and 7-Year Loans**

Variable	5-year			6-year			7-year		
	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.	Mean	Median	Std. Dev.
Original loan amount	20,273	18,366	9,685	24,766	22,961	10,056	28,303	26,433	11,371
Interest rate	6.31%	4.97%	5.27%	7.83%	6.42%	5.35%	10.61%	8.90%	6.51%
Origination Score	718	732	80	685	683	80	667	665	81
Joint Account	49%	0%	50%	51%	100%	50%	53%	100%	50%
Monthly Loan Payment	380	352	182	422	396	168	464	440	169
Monthly Total Payment	1,852	1,135	24,837	1,611	1,013	17,639	1,710	1,071	36,322
Zipcode AGI	63,396	53,819	38,657	57,944	50,714	31,207	55,479	49,648	26,766
Card Utilization	31.9%	17.9%	33.8%	43.7%	37.6%	36.3%	50.6%	50.5%	36.8%
Total Card Limit	24,572	16,400	26,386	18,042	10,000	22,378	15,270	7,926	19,929
Unused Card Limit	18,975	10,927	23,288	12,430	4,498	18,987	9,703	2,751	16,391
Number of Cards	2.62	2	2.27	2.31	2	2.19	2.17	2	2.14
Has Mortgage	49.0%	–	50.0%	42.9%	–	49.5%	41.6%	–	49.3%
Has HELOC	13.1%	–	33.7%	8.6%	–	28.0%	6.6%	–	24.8%
Has HELoan	6.3%	–	24.3%	6.1%	–	24.0%	6.4%	–	24.6%
Has Student Loan	14.8%	–	35.5%	17.1%	–	37.6%	17.1%	–	37.6%
Auto Financing Co.	43%	–	49.5%	48%	–	50.0%	35%	–	47.7%
Bank	28%	–	44.9%	29%	–	45.3%	22%	–	41.4%
Credit Union	26%	–	44.1%	20%	–	40.3%	36%	–	48.1%
Other Lender Types	2.6%	–	16.1%	2.8%	–	16.6%	6.5%	–	24.6%
Default Rate in 24m	1.57%	–	12.4%	2.62%	–	16.0%	5.25%	–	22.3%
Number of loans	374,268			371,902			81,131		

Notes: Data are from the Federal Reserve Bank of New York/Equifax Consumer Credit Panel (hereafter CCP) and Equifax CCP Tradeline Data. This table reports summary statistics on key variables of 5-, 6-, and 7-year auto loans. Loans include a 10 percent sample of primary borrowers from the CCP booked between 2006 and 2016 with term in 5, 6, or 7 years, with origination score  $\geq 500$  and loan amount between \$5,000 and \$99,999. Interest rate is derived from the loan amount, loan term, and monthly payment. *Origination Score* is the borrower’s Equifax Risk Score from the last quarter prior to loan origination. *Zip code-adjusted gross income (AGI)* was from IRS SOI Individual Income Tax ZIP Code Data. *Default* is defined as loans becoming more than 90 days past due, having been charged-off, having a bankruptcy, or having been repossessed within the first 24 months after origination. Other types of lenders mainly include personal loan companies, auto dealers, and sales financing companies.



**Table 2: Balance-Matched Comparison of 6-Year, 7-Year and 5-Year Loans**

Variable	5-Year		6-Year	
	Mean	Median	Mean	Median
Original loan amount	\$22,830	\$20,868	\$22,831	\$20,868
Origination Score	725	740	682	679
Debt-to-income ratio	56%	31%	57%	36%
Avg. zip code AGI	\$64,970	\$54,872	\$57,349	\$50,364
Credit card utilization	31%	17%	44%	38%
Has HELOC	14%	0%	8%	0%
Interest rate	5.60%	4.51%	8.26%	6.82%
Default rate in 24 months	1.37%	–	2.75%	–
Number of loans	289,522		289,522	

Variable	5-Year		7-Year	
	Mean	Median	Mean	Median
Original loan amount	\$28,264	\$26,404	\$28,266	\$26,402
Origination Score	734	751	667	665
Debt-to-income ratio	62%	35%	69%	48%
Avg. zip code AGI	\$68,872	\$57,046	\$55,475	\$49,640
Credit card utilization	29%	16%	51%	51%
Has HELOC	16%	0%	7%	0%
Interest rate	4.82%	3.91%	10.62%	8.91%
Default rate in 24 months	1.00%	–	5.26%	–
Number of loans	80,969		80,969	

Notes: Data are from the CCP and Equifax CCP Tradeline Data. This table compares summary statistics of key risk variables with a sample that matches *only* on loan balance comparing 5-year loans with 6- and 7-year loans. Data sample and default are defined in Table 1. *Origination Score* is the borrower’s Equifax Risk Score from the quarter prior to loan origination.

**Table 3: Calculation of Payment Reduction with Longer-Term Loans**

Variable	6-Year	7-Year
Loan Amount	24,766	28,303
Monthly Payment	422	464
Interest Rate	7.8%	10.6%
Reduced Interest Rate (Five-Year Avg.)	6.3%	6.3%
5-Year with Existing Int. Rate	500	610
5-Year with Reduced Int. Rate	482	551
Payment Drop w/Existing Int. Rate	16%	24%
Payment Drop w/Reduced Int. Rate	13%	16%

Notes: Data are from the Equifax CCP Tradeline Data. This table calculates the average payment reduction from longer-term loans using the average interest rate on the longer-term loans as an upper bound, and the average interest rate on the shorter-term loans applied to the longer-term loan balance as a lower bound. Reduced monthly payment for 6- and 7-year loan term groups are calculated using the average loan amount, average interest rate, and respective loan terms from Table 1.

**Table 4: Default Rate Comparison with the Propensity Score-Matched Samples**

	No. of pairs	5-Year	6-Year
Propensity – 6-Year	242,920	0.499	0.499
Default Rate	242,920	1.94%	2.29%

	No. of pairs	5-Year	7-Year
Propensity – 7-Year	66,811	0.330	0.330
Default Rate	66,811	2.83%	5.43%

Notes: Data are from the Equifax CCP Tradeline Data. This table compares propensity-score matched samples for 5-year loans and 6- and 7-year loans. The variables used in the match include loan, borrower, and neighborhood characteristics. We match the longer-term loans with the shorter 5-year term loans one-on-one using the closest propensity score. Data sample and default are defined in Table 1.

**Table 5: Default Risk Model Results***Panel A: 6- versus 5-year*

Covariate	Value	Estimate (S.E.)		
		Baseline	Instrumental	Simultaneous Equation
Intercept		77.2644*** (2.051)	78.7319*** (1.880)	83.8153*** (1.5081)
6-Year/Instrument		0.2932*** (0.070)	-0.4424** (0.201)	-0.5459*** (0.1171)
Lender Type	Banks	-0.6449*** (0.028)	-0.6421*** (0.028)	-0.7210*** (0.0480)
	Credit Unions	-0.8606*** (0.054)	-0.9019*** (0.055)	-1.0608*** (0.0509)
	Other	2.2472*** (0.272)	2.2028*** (0.271)	2.4310*** (0.0607)
	Auto Financing			
Origination Score Spline	<=620	-0.0556*** (0.002)	-0.0555*** (0.002)	-0.0245*** (0.0005)
	621-660	-0.0374*** (0.002)	-0.0376*** (0.002)	-0.0538*** (0.0013)
	661-720	-0.0124*** (0.001)	-0.0126*** (0.001)	-0.0189*** (0.0010)
	721-760	-0.0099*** (0.001)	-0.0103*** (0.001)	0.0045** (0.0018)
	761+	-0.0013*** (0.000)	-0.0019*** (0.000)	-0.0284*** (0.0011)
Card Utilization Bucket	Missing	1.5304*** (0.116)	1.5013*** (0.115)	1.6205*** (0.0487)
	0-50%	0.0151 (0.086)	-0.0002 (0.087)	0.2298*** (0.0582)
	90%+	0.2179** (0.099)	0.2161** (0.098)	0.3438*** (0.0582)
	50%-90%			
Number of Cards		0.0451*** (0.012)	0.0432*** (0.012)	0.0268*** (0.0063)
Joint		-0.6908*** (0.059)	-0.6782*** (0.059)	-0.6376*** (0.0339)
Leading 24m. UR Chg.		0.0991** (0.040)	0.1030** (0.040)	0.0916*** (0.0085)
State FE		Yes	Yes	Yes

Vintage FE	Yes	Yes	Yes
Nobs	746,170	746,036	731,349
R-Squared	3.28%	3.29%	3.04%
RMSE	14.07	14.07	14.08

*Panel B: 7- versus 5-year*

Covariate	Value	Estimate (S.E.)		
		Baseline	Instrumental	Simultaneous Equation
Intercept		87.7060*** (2.390)	96.9980*** (2.478)	91.9198*** (1.7858)
7-Year /Instrument		2.3923*** (0.153)	1.1052*** (0.227)	0.9431*** (0.1690)
Lender Type	Banks	-0.7994*** (0.064)	-0.7283*** (0.064)	-0.8666*** (0.0639)
	Credit Unions	-1.3830*** (0.077)	-1.1871*** (0.091)	-1.5804*** (0.0639)
	Other	1.4577*** (0.278)	1.8043*** (0.266)	1.8736*** (0.0766)
	Auto Financing			
Origination Score Spline	621–660	-0.0569*** (0.003)	-0.0592*** (0.003)	-0.0299*** (0.0006)
	661–720	-0.0523*** (0.002)	-0.0564*** (0.002)	-0.0626*** (0.0014)
	721–760	-0.0120*** (0.001)	-0.0137*** (0.001)	-0.0172*** (0.0010)
	761+	-0.0125*** (0.002)	-0.0148*** (0.002)	-0.0066*** (0.0019)
	<=620	0.0006 (0.001)	-0.0021*** (0.001)	-0.0181*** (0.0011)
Card Utilization	Missing	1.6787*** (0.190)	1.6458*** (0.193)	1.8363*** (0.0644)
	0–50%	0.0814 (0.110)	0.0316 (0.112)	0.2193*** (0.0764)
	90%+	0.1305 (0.106)	0.1962* (0.107)	0.3072*** (0.0769)
	50%–90%			
Number of Cards		0.0615*** (0.013)	0.0473*** (0.014)	0.0376*** (0.0081)
Joint		-0.7280***	-0.6686***	-0.7175***

	(0.064)	(0.061)	(0.0445)
Unemp. Rate Chg. 24m.	0.0837**	0.0982***	0.0992***
	(0.036)	(0.037)	(0.0084)
State FE	Yes	Yes	Yes
Vintage FE	Yes	Yes	Yes
Nobs	455,399	455,321	446,627
R-Squared	4.46%	4.14%	4.18%
RMSE	14.41	14.44	14.43

Notes: Data are from the CCP and Equifax CCP Tradeline Data. This table reports estimates of results of default probability models as described in equations (1), (2) and (3). First, a baseline default model is shown in column 1, compared with the instrumental-variable model in column 2 and the simultaneous equation model in column 3. In Panel A, comparisons are made between 5- and 6-year loans, with Panel B comparing 5- and 7-year loans. Data sample and default are defined in Table 1. Origination Score is the borrower's Equifax Risk Score from the last quarter prior to loan origination. Unemp. Rate Chg. 24m. is the difference between the county unemployment rate (UR) at the origination month and the maximum UR over the next 24 months. Standard errors are clustered at the state level. \*\*\* for  $p < 0.01\%$ , \*\* for  $p < 0.1\%$ , and \* for  $p < 5\%$ .

**Table 6: Default Risk by Lender Type**

Covariate	Value	Estimate (S.E.) - 6-Year vs. 5-Year		7-Year vs. 5-Year	
		2006-2008	All Vintages	2006-2008	All Vintages
Intercept		86.2043*** (3.188)	76.9294*** (2.092)	90.4184*** (3.702)	83.5427*** (2.525)
Term (6/7-Year)		1.0061*** (0.173)	0.4033*** (0.119)	5.2537*** (0.420)	4.4050*** (0.248)
Lender Type	Banks	-0.5235*** (0.115)	-0.5638*** (0.068)	-0.5146*** (0.110)	-0.5172*** (0.060)
	Credit Unions	-0.9239*** (0.109)	-0.8299*** (0.080)	-0.9495*** (0.105)	-0.8019*** (0.076)
	Other	2.6218*** (0.469)	3.1584*** (0.493)	2.6309*** (0.467)	3.0452*** (0.496)
	Auto Financing				
Term *Lender Type	Banks	-0.4542* (0.261)	-0.1625 (0.136)	-1.8554*** (0.538)	-2.1470*** (0.233)
	Credit Unions	-0.4541*** (0.174)	-0.0509 (0.107)	-3.8013*** (0.379)	-3.3889*** (0.252)
	Other	-2.3615*** (0.553)	-1.7588*** (0.494)	-6.3205*** (0.827)	-5.4412*** (0.753)
	Auto Financing				
Other Controls		Yes	Yes	Yes	Yes
Vintage FE		Yes	Yes	Yes	Yes
State FE		Yes	Yes	Yes	Yes
NObs		199,993	746,170	131,026	455,399
R-Squared		3.37%	3.29%	4.58%	4.63%
RMSE		16.40	14.06	16.56	14.40

Notes: Data are from the CCP and Equifax CCP Tradeline Data. This table reports estimates of an augmented version of our simultaneous equation default model of equation (3) interacting the loan-term dummy with lender type in the default equation. We estimate two separate models for 6-year (versus 5-year) loans and 7-year (versus 5-year) loans. We also break out 2006–08 originations and compare with the full sample. Data sample and default are defined in Table 1. Standard errors are clustered at the state-level. \*\*\* for  $p < 0.01\%$ , \*\* for  $p < 0.1\%$ , and \* for  $p < 5\%$ .

**Table 7: Auto Loan Interest Rate Regression Results**

Covariate	Value	Model 1		Model 2	
		Vintage 2006– 2008	All Vintages	Vintage 2006– 2008	All Vintages
Intercept		7.8465*** ( 0.016)	6.1645*** ( 0.009)	11.5578*** ( 0.059)	10.4684*** ( 0.034)
Default		6.3830*** ( 0.106)	8.6506*** ( 0.071)	2.7568*** ( 0.085)	3.8646*** ( 0.054)
Term	6-Year	2.3788*** ( 0.023)	1.5047*** ( 0.013)	1.3021*** ( 0.019)	0.7432*** ( 0.010)
	7-Year	5.3776*** ( 0.037)	4.1572*** ( 0.021)	3.5496*** ( 0.031)	2.8883*** ( 0.017)
	5-Year				
Term * Default	6-Year	-2.1313*** ( 0.137)	-2.5558*** ( 0.090)	-0.7254*** ( 0.109)	-1.1106*** ( 0.068)
	7-Year	-3.0970*** ( 0.166)	-3.0989*** ( 0.110)	-1.0922*** ( 0.132)	-1.2665*** ( 0.083)
	5-Year				
Orig. Score	621–660			-3.1293*** ( 0.028)	-3.4129*** ( 0.016)
	661–720			-4.9035*** ( 0.027)	-5.3860*** ( 0.015)
	721–760			-5.7918*** ( 0.033)	-6.3964*** ( 0.018)
	761+			-6.0999*** ( 0.033)	-6.8483*** ( 0.018)
	<=620				
Lender Type	Banks			0.1414*** ( 0.021)	-0.5594*** ( 0.011)
	Credit Unions			-0.7360*** ( 0.023)	-0.9620*** ( 0.012)
	Other			2.8580*** ( 0.039)	3.5867*** ( 0.026)
	Auto Financing				
Card Utilization Bucket	Missing			1.8686*** ( 0.042)	1.6970*** ( 0.024)
	0–50%			0.0956*** ( 0.026)	0.1604*** ( 0.014)



	90%+		0.4104***	0.2955***
			( 0.034)	( 0.018)
	50%–90%			
Has Mortgage			-0.3412***	-0.4231***
			( 0.019)	( 0.010)
Has HELOC			-0.2339***	-0.1772***
			( 0.028)	( 0.016)
Has HELoan			-0.0053	-0.0218
			( 0.030)	( 0.019)
Has Student Loan			-0.3987***	-0.4585***
			( 0.026)	( 0.013)
Has Card			0.1000**	-0.4466***
			( 0.041)	( 0.023)
Joint			-0.2848***	-0.3971***
			( 0.017)	( 0.009)
State FE			Yes	Yes
Vintage FE			Yes	Yes
R-Squared	0.137	0.089	0.459	0.488

Notes: Data are from the CCP and Equifax CCP Tradeline Data. This table compares the variation in loan interest rate, our dependent variable, with respect to risks in loans and compares variation between 5-year loans and 6- and 7-year loans. Columns 1 and 2 of Table 7 show regression results without additional control variables, while columns 3 and 4 show results with additional control variables. We also break out 2006–2008 originations and compare with the full sample. Data sample and default are defined in Table 1. Origination Score is the borrower’s Equifax Risk Score from the last quarter prior to loan origination. Standard errors are clustered at the state level. \*\*\* for  $p < 0.01\%$ , \*\* for  $p < 0.1\%$ , and \* for  $p < 5\%$ .

**Table 8: Credit Card Utilization Comparison for Propensity Score-Matched Sample***Panel A: 5-Year v. 6-Year*

	<i>5-Year</i>		<i>6-Year</i>	
	<i>Freq.</i>	<i>Mean</i>	<i>Freq.</i>	<i>Mean</i>
Propensity – 6-Year	243,033	0.499	243,033	0.499
8-Quarter Card Utilization Rate Change Prior to Loan Booking	158,457	-1.37%	157,579	-2.49%
8-Quarter Card Utilization Rate Change Post-Loan Booking	175,867	0.54%	172,721	1.85%
8-Quarter Risk Score Change Prior to Loan Booking	225,341	14.2	226,954	17.3
8-Quarter Risk Score Change Post-Loan Booking	240,491	5.6	240,092	1.0

*Panel B: 5-Year v. 7-Year*

	<i>5-Year</i>		<i>7-Year</i>	
	<i>Freq.</i>	<i>Mean</i>	<i>Freq.</i>	<i>Mean</i>
Propensity – 7-Year	66,511	0.331	66,511	0.331
8-Quarter Card Utilization Rate Change Prior to Loan Booking	38,012	-0.34%	37,704	-2.67%
8-Quarter Card Utilization Rate Change Post Loan Booking	44,165	0.30%	40,295	2.84%
8-Quarter Risk Score Change Prior to Loan Booking	61,337	13.9	62,731	19.5
8-Quarter Risk Score Change Post Loan Booking	65,803	6.2	65,478	-10.1

Notes: Data are from the CCP and Equifax CCP Tradeline Data. This table compares eight-quarter changes in credit-card utilization rates and Risk Scores for our propensity-score matched samples. Panel A reports results comparing 5-year loans with 6-year loans, while Panel B compares results of 5-year loans with 7-year loans. The variables used in the match are as described in Table 4. The data sample is defined in Table 1.

**Table 9: Credit Card Utilization Difference-in-Differences Results**

Covariate	Value	Estimate (S.E.)	
		6-Year	7-Year
Intercept		13.9349*** (1.300)	13.3767*** (1.503)
Post-Booking Dummy		2.8836*** (0.082)	2.8917*** (0.086)
6-Year		0.4434*** (0.086)	
7-Year			0.2784 (0.174)
Post Booking * 6-Year		-0.1723 (0.121)	
Post Booking * 7-Year			1.3496*** (0.299)
Origination Score	621–660	-0.7240*** (0.191)	-0.8822*** (0.232)
	661–720	-1.3469*** (0.117)	-1.6678*** (0.166)
	721–760	-1.9113*** (0.162)	-2.1405*** (0.171)
	761+	-2.2328*** (0.140)	-2.6020*** (0.189)
	<=620		
Orig. Qtr. Card Bal.	0–999	-3.3438*** (0.270)	-2.8630*** (0.344)
	1000–4999	-3.3979*** (0.291)	-2.8349*** (0.354)
	5000–9999	-2.6601*** (0.265)	-2.3722*** (0.326)
	10000–29999	-1.6307*** (0.260)	-1.1766*** (0.289)
	30000+		
Orig. Qtr. Card Limit	0–999	-2.0480*** (0.198)	-2.3322*** (0.281)
	1000–4999	-1.3760*** (0.132)	-1.4019*** (0.167)
	5000–9999	-0.7601***	-0.6604***

		(0.085)	(0.132)
	10000–29999	-0.2604***	-0.2173**
		(0.067)	(0.090)
	30000+		
Lender Type	Banks	0.1418**	-0.0457
		(0.072)	(0.080)
	Credit Unions	-0.0594	-0.1707*
		(0.073)	(0.088)
	Other	0.1136	0.1691
		(0.236)	(0.269)
	Auto Financing		
Log Loan Amount		-0.8591***	-0.8212***
		(0.089)	(0.090)
Log Zip Code AGI		-0.4102***	-0.4017***
		(0.074)	(0.107)
Missing Payment		0.2962	-2.3617**
		(0.930)	(1.068)
All Pmt. 0–500 Spline		0.5252	0.4103*
		(0.346)	(0.245)
All Pmt. 500–10K Spline		0.2284***	0.2751***
		(0.037)	(0.038)
State FE		Yes	Yes
Vintage FE		Yes	Yes

Notes: Data are from the CCP and Equifax CCP Tradeline Data. This table compares borrowers' credit card usage before and after booking an auto loan using a difference-in-differences (DID) test to examine the relationship between the borrowers' choice of longer-term auto loans and their credit-card usage. Our treatment event is the booking of the auto loan. Our treatment group is borrowers who take out 6- or 7-year loans, and the control group is borrowers who take out 5-year loans. The outcome variable is the 8-quarter change in the credit card utilization rate. *Origination Score* is the borrower's Equifax Risk Score from the last quarter prior to loan origination. Standard errors are clustered at the state level. \*\*\* for p<0.01%, \*\* for p<0.1%, and \* for p<5%.

**Appendix Table 1: Simultaneous Equation Model Loan Term Choice Equation Results**

Covariate	Value	Estimate (S.E.)	
		6-year vs. 5-year	7-year vs. 5-year
Intercept		-1.8915*** (0.0259)	-2.0401*** (0.0257)
Default		0.0508*** (0.0012)	0.0482*** (0.0008)
Log Loan Amount		0.3428*** (0.0024)	0.2776*** (0.0026)
Std. Vintage		0.0573*** (0.0010)	0.0372*** (0.0012)
Std. Vintage Squared		0.0110*** (0.0013)	0.0265*** (0.0014)
Log Zip Income		-0.1048*** (0.0016)	-0.0678*** (0.0014)
Lender Type	Banks	0.0774*** (0.0029)	0.0784*** (0.0035)
	Credit Unions	0.0325*** (0.0032)	0.1785*** (0.0035)
	Other	-0.1074*** (0.0053)	0.0741*** (0.0044)
	Auto Financing		
Origination Score	621–660	0.0693*** (0.0032)	0.0418*** (0.0026)
	661–720	0.0819*** (0.0047)	0.0692*** (0.0040)
	721–760	0.0316*** (0.0056)	0.0527*** (0.0049)
	761+	-0.0292*** (0.0063)	0.0338*** (0.0058)
	<=620		
Card Utilization	Missing	-0.0908*** (0.0037)	-0.0873*** (0.0038)
Bucket	0–50%	-0.0359*** (0.0034)	-0.0270*** (0.0039)
	90%+	-0.0028 (0.0037)	0.0137*** (0.0041)
	50%–90%		

Number of Cards	-0.0078*** (0.0004)	-0.0071*** (0.0004)
Has_HELOC	-0.0369*** (0.0018)	-0.0245*** (0.0018)
Has_HELoan	0.0164*** (0.0023)	0.0155*** (0.0020)
Joint	0.0525*** (0.0022)	0.0516*** (0.0024)

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Notes: Data are from the CCP and Equifax CCP Tradeline Data. This table displays the loan-term choice model part of the simultaneous equation model in equation (3). Separate models are estimated for the 5-year versus 6-year loans and 5-year versus 7-year loans. *Data* and *Default* are defined in Table 1. *Origination Score* is the borrower's Equifax Risk Score from the last quarter prior to loan origination. *Unemp. Rate Chg. 24m.* is the difference between county unemployment rate (UR) at the origination month and the maximum UR over the next 24 months. Standard errors are clustered at the state level. \*\*\* for p<0.01%, \*\* for p<0.1%, and \* for p<5%.