Collateral Damage: Low-Income Borrowers Depend on Cash Flow-Based Lending

Mark Garmaise, Mark Jansen, and Adam Winegar*

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ABSTRACT

We study the relative importance of asset-backed lending (ABL) and cash flow-based lending (CFBL) in auto finance. We find that negative durability shocks generated by vehicle discontinuations lead to increased loan-to-value ratios and down payments. This result stands in stark contrast to the corporate lending market, and is also inconsistent with traditional models of ABL. Discontinued cars are less expensive and are purchased by lower-income borrowers, and yet we find that these purchases are markedly more likely, in the event of default, to result in a personal recovery. Finally, the heavy use of CFBL by lower-income borrowers suggests that their relative credit access may have declined with the securitization-driven rise of ABL.

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*Garmaise: UCLA Anderson School of Management, mark.garmaise@anderson.ucla.edu; Jansen: University of Utah, Eccles School of Business, mark.jansen@eccles.utah.edu; Winegar: BI Norwegian Business School, adam.w.winegar@bi.no. For helpful comments, we thank Ivo Welch, Vesa Pursiainen, Artashes Karapetyan, and the seminar participants at the University of Utah, the University of Texas at Austin, Brigham Young University, ESSEC-Cergy, and the 3rd Vaasa Banking Research Workshop.

1. Introduction

Two key forces animate the auto financing market: asset-based lending (ABL) linked to the physical collateral value of the vehicles (Assunçao et al., 2014; Argyle et al., 2020; Ratnadiwakara, 2021) and cash flow-based lending (CFBL) supported by a car buyer's income (Dewatripont and Tirole, 1994; Holmstrom and Tirole, 1997). In this paper we ask whether low-income borrowers rely relatively more on ABL or CFBL. A clear understanding of the parts played by ABL and CFBL in facilitating vehicle financing for disadvantaged consumers serves two functions. First, it provides insights into which financial innovations are most likely to aid low-income borrowers. Second, given that incomes and asset prices move according to varying dynamics, it helps in predicting the relative impact on low-income borrowers of different economic fluctuations. Our main finding is that CFBL is particularly important for low-income borrowers. This stands in stark contrast to the corporate lending market, in which it is well-understood that ABL is crucial for the financing of resource-constrained firms (Leeth and Scott, 1989; John et al., 2003; Jimenez et al., 2006; Lian and Ma, 2021).

ABL and CFBL are intertwined, which presents challenges when empirically assessing the importance of CFBL for auto finance across different types of borrowers. Car loan contracts do not explicitly assign weights to the ABL and CFBL components of the financing. To distinguish these two types of lending, we develop a theory showing that they respond differently to changes in the economic durability of the underlying physical asset: we describe an asset as declining in economic durability if it experiences both a lower price today and a quicker rate of price depreciation over time. In an ABL-only model a decrease in economic durability decreases the loan-to-value (LTV) ratio (Hart and Moore, 1994) and also decreases the borrower's down payment (Rampini, 2019), as the asset becomes both less capable of supporting debt and less expensive. By contrast, in a model that also incorporates CFBL, a decrease in economic durability may *increase* both the LTV and the down payment. LTV values may be higher for less durable assets because low-income borrowers can rely on CFBL to finance non-durable assets with low collateral values, thereby generating high LTV ratios. Down payments may be higher for less durable assets because they are purchased by low-income borrowers who have little future income to pledge to support borrowing today. It is an implication of the model that if non-durable assets have higher LTVs and down payments, then it must be the case that low-income borrowers depend more heavily than high-income borrowers on CFBL. The predictions of the model provide an opportunity to empirically assess the importance of CFBL for auto lending for different kinds of borrowers.

Testing these differing hypotheses requires a shock to economic durability. While cars may vary in their durability for a number of reasons (e.g., manufacturing, mileage), these sources of variation are also associated with differences along other dimensions (e.g., driving experience and amenities). We wish to identify the pure effect of a change in economic durability, so we seek shifts in durability that do not have an impact on current vehicle quality. We utilize model and make discontinuations on existing cars as shocks to durability. In the last twenty-five years 825 car models and eight car brands have been discontinued. Discontinuations may affect economic durability in two ways. First, it is likely that the physical durability of discontinued cars declines. Repair costs relative to vehicle value are of first-order importance in keeping a car on the road (Insurance Networking News, November 15, 2015) and discontinuation plausibly reduces vehicle durability of existing cars due to concerns about future parts and service expertise (Titman, 1984).[1] The inability to get replacement parts and increased servicing costs is frequently cited as a concern following the discontinuation of a car brand or model.[2] Second, discontinued cars may experience a loss

[1]While many internal components (e.g., transmission components) can be interchangeable across makes within the same car family (e.g., a Chevrolet part can be used in a GMC), it is not universally true for all components and it is especially problematic for external components (e.g., driver's side panels), which are mostly likely to be damaged in a collision. Moreover, even if third-party suppliers provide these non-interchangeable components, they will generally be more expensive due to their specialized nature.

[2]For instance, a 2001 article around the announcement of the discontinuation of Oldsmobile notes "There is no question they're going to take a serious hit in resale value. Anyone who buys an Oldsmobile has to understand that unless they keep it until it's dead, it's not going to be worth much."

of prestige, which should depress their current prices, which is one component of economic durability, though it is less clear whether this effect will also cause quicker value depreciation over time.

We begin our empirical analysis by showing that discontinuations do indeed reduce economic durability. We show that after the announcement of discontinuation, car values fall by about $278 or approximately three percent of the value. We further find that default recoveries (the value the lender receives from the vehicle liquidation after default over the vehicle's wholesale value at origination) decline by roughly 1.8 percentage points after discontinuations. These reduced recoveries are measured relative to the vehicles' already lower post-discontinuation prices. These findings provide clear evidence that discontinued vehicles have reduced economic durability. Consistent with our model, we also show that discontinued cars are more likely to be purchased by low-income borrowers.

Our empirical tests hold fixed the model-vintage year of the vehicle (and include dealer and corporate parent-transaction year fixed effects), so we effectively compare the same model-vintage year vehicle before and after a discontinuation announcement, while controlling for changes at the corporate parent and the dealership. While it is not a formal prediction of our stylized model, we further find that auto loans have shorter maturities after discontinuations, which supports the contention that they have reduced durability.

Discontinuation is a deliberate choice of the manufacturer, but it is not under the direct control of other auto market participants. Buyers, sellers and third-party financiers likely assign some probability to a possible future model discontinuation, but its actual occurrence (i.e., with certainty) must represent adverse news. Moreover, we find no evidence of increasing anticipation before the announcement; there is no observable pre-trend in vehicle price, down payment, or LTV before discontinuation. For used auto buyers, sellers and lenders, discontinuations appear to cause an unanticipated negative shock to economic durability.

We assess the relative importance of CFBL for high- and low-income borrowers by tracing the effects of discontinuation-driven durability shocks on down payments, LTVs and PTI (payment-to-income) ratios. First, we show that down payments are approximately \$88 higher after discontinuations (a 9% increase relative to the mean). A post-discontinuation increase in down payments only occurs in the theory if future income is sufficiently pledgeable. Low-income consumers are forced to purchase the asset with a larger down payment, as their low future income does not allow them to borrow a large amount today. If income is not pledgeable to a meaningful degree, then the lower price of a less-durable asset should lead it to be purchased with a lower down payment, which we do not observe.

Second, we show that discontinuation causes an increase of two percentage points in LTV ratios. This is a result that emerges in the model only if low-income borrowers make greater use of CFBL. If high-income borrowers rely more heavily on CFBL (or if only ABL lending is available), by contrast, the lower liquidation values produced by a discontinuation should lead to lower LTV ratios, which we do not find.

The model also predicts that if low-income borrowers are more reliant on CFBL, then discontinued vehicles will be financed at lower PTI ratios, and we find that to be true in the data as well. The uniform implication of the down payment, LTV and PTI results is that in the U.S. auto loan market income is highly pledgeable and low-income borrowers are relatively more dependent on CFBL.

In the model incorporating CFBL, lenders partially support their debt with a claim on the borrower's future income. In the event of default, do auto lenders actually make personal recoveries aside from the proceeds from vehicle repossession as this model predicts? We find that they do. For our sample of defaulted loans, we show that the average proceeds from the sales of repossessed vehicles are \$3,722 and the average cash recovery from the borrower is \$1,827. This indicates that in default physical assets and personal borrower resources supply 67% and 33%, respectively, of the total recovery proceeds.

We offer an additional test of the claim that low-income borrowers make relatively greater use of CFBL by analyzing post-default recoveries. We show that in the event of default, discontinued vehicles have physical collateral recoveries that are \$595 lower, which is not unexpected. What is more surprising, however, is that personal default recoveries are $286 higher for discontinued cars.

In fact, conditional on default, we find that after discontinuation there is a 6.7 percentage point increase in the probability that there will be a personal default recovery. Discontinued cars are less expensive and are purchased by lower-income borrowers, and yet we find that these purchases are markedly more likely, in the event of default, to result in a personal recovery. This perhaps counter-intuitive finding is rationalized by the model. The lower-income borrowers who purchase less durable assets rely more heavily on CFBL; given the low collateral value of these vehicles, if default occurs lenders seek personal recoveries.

It is clear that a key value of collateral lies in its providing an avenue for the lender to recoup potential losses after default. This theme has been explored in an influential theoretical literature (Bernanke and Gertler, 1989; Hart and Moore, 1994, 1998; Rampini and Viswanathan, 2010, 2013; Rampini, 2019; Demarzo, 2019) and has been extensively validated in empirical tests (Benmelech et al., 2005; Benmelech, 2009; Gan, 2007; Chaney et al., 2012; Cerqueiro et al., 2016; Jahan, 2020; Li and Tsou, 2020; Ioannidou et al., 2022). The CFBL-specific component of lending, by contrast, is tied to the profit or income generated by the borrower (Dewatripont and Tirole, 1994; Holmstrom and Tirole, 1997).

In the corporate setting, large and profitable borrowing firms have been shown to make extensive use of CFBL, while small and less-profitable borrowing firms firms depend almost exclusively on ABL (Lian and Ma, 2021). Consistent with these results, more resource-constrained and riskier firms are more likely to use collateral to support their borrowing (Leeth and Scott, 1989; John et al., 2003; Jimenez et al., 2006). By contrast, we show in the consumer auto loan market that CFBL is especially important for low-income borrowers. We argue that these divergent findings arise from the fact that small firms may be terminated and abandoned, which discourages CFBL. For defaulting consumers, however, the abandonment option is much more costly (as bankruptcies are reflected for at least seven years on credit reports), and it is often feasible for creditors to make CFBL collections from them in the form of wage garnishments and long-term bankruptcy payments.

As described above, our empirical findings are best explained by a model in which high-income borrowers make greater use of ABL while low-income borrowers depend to a greater degree on CFBL. A shift in financing markets that promotes ABL and disfavors CFBL is therefore likely to offer disproportionate benefits to wealthy consumers. In the post-financial crisis period, there has been a dramatic expansion in the securitization of collateralized assets such as equipment relative to the securitization of cash flow-based debt such as credit card receivables and student loans. Our analysis suggests that this change in securitization markets should facilitate auto lending especially for high-income borrowers, and we indeed observe that wealthier borrowers have come to account for an increasing proportion of car loan financing.

Access to auto financing is particularly valuable in the U.S., where vehicle ownership is often critical for employment opportunities and mobility (Gurley and Bruce, 2005; Baum, 2009; Gautier and Zenou, 2010; Moody et al., 2021). Recent empirical evidence from Brazil corroborates the finding that vehicular access increases formal employment rates and salaries (Doornik et al., 2021). Ensuring the ability of low-income consumers to borrow to purchase cars is therefore important for a broad set of policy goals.

Our results indicate that innovations that reduce the cost of monitoring borrower incomes (e.g., automated data links to borrower bank accounts) will likely promote the provision of financing via CFBL to lower-income auto purchasers. Our findings also make clear that, in periods in which auto asset values rise more quickly than incomes, vehicle lending to constrained borrowers is likely to decline disproportionately. These points may be helpful in providing guidance to ensure that credit markets serve, to the maximum extent possible, to protect the relative financial access of economically disadvantaged borrowers.

2. Theoretical Framework

To illustrate the effects of a durability shock on the consumer financing of asset purchases, we provide a simple model of financing. In this section we outline the model and describe the main results. The technical details are supplied in the Appendix.

We assume that there are two types of consumers with either high or low income. Consumers can purchase either durable or non-durable assets from sellers (i.e., car dealerships) who charge a markup on sales. Both types of assets have a current period price and a residual value next period. Our central interest is in *economic durability*: we define this term to mean that assets with higher economic durability have both higher prices today and slower rates of price depreciation over time. Formally, we have:

Definition 1.

a) Durable assets have a higher price than non-durable assets in the current period.

b) Durable assets have a higher ratio of residual value to current period price than non-durable assets.

Differences across assets in economic durability may arise from variation in either physical durability or rates of intangible quality degradation.

Lenders provide financing at competitive rates. Consumers prefer current over delayed consumption and thus seek to maximize their leverage. Borrowers can access financing by pledging both the residual value of the asset next period as well as their future income. We refer to the former as asset-based lending (ABL) and the latter as cash flow-based lending (CFBL). ABL and CFBL are both subject to limited pledgeability constraints which govern the degree to which lenders will provide financing for the given type of lending. For ABL, lenders may be able to seize the collateral at some cost. For CFBL, mechanisms for securing the partial pledgeability of future income could include wage garnishment or other lender claims that have recourse to borrower wealth other than the asset in question.

We focus on the interesting region of the parameter space by assuming that high-income consumers can afford the durable good if they borrow to their maximum feasible limit but that low-income consumers can only afford the non-durable asset. We further presume that the durable asset is more attractive than the non-durable asset to unconstrained borrowers. This generates the following result.

Result 1:

In equilibrium high-income borrowers purchase the durable good while low-income borrowers purchase the non-durable good.

Result 1 follows immediately from the assumed attractiveness of the durable good and the constraints faced by low-income borrowers. We next consider the implications of the model for the contrasting financing patterns of high- and low-income borrowers.

Result 2:

a) If income is sufficiently pledgeable, then the down payment is higher for low-income borrowers purchasing the non-durable asset than it is for high-income borrowers purchasing the durable asset.

b) Otherwise, the down payment is lower for low-income borrowers.

Result 3:

a) If low-income borrowers rely relatively more on CFBL than high-income borrowers, then the LTV ratio is higher for low-income borrowers purchasing the non-durable asset than it is for high-income borrowers purchasing the durable asset.

b) Otherwise, the LTV ratio is lower for low-income borrowers.

Results 2b and 3b echo the results in Rampini (2019) in which CFBL is not considered. The durable asset has a higher price. Result 2b follows from the fact that this higher price is not offset one-for-one with more debt due to limited asset pledgeability and relatively low income pledgeability, which leads to higher down payments for the durable good. Result 3b is driven by the feature that the durable asset purchased by high-income borrowers offers more pledgeable security; the component of the LTV ratio due solely to asset-backed lending is therefore higher for high-income borrowers. If high-income borrowers rely more heavily on CFBL than low-income borrowers, then the CFBL component of the LTV will also be higher for high-income borrowers.

Results 2a and 3a emerge only if CFBL is sufficiently important and low-income borrowers rely relatively more on this type of borrowing. The intuition for Result 2a is that income must be sufficiently pledgeable for high-income borrowers to reduce their down payments by offering a large future income-based payment. Both high- and low-income borrowers pledge their future incomes as security for cash flow-based lending, but low-income borrowers have less to pledge. As a result, as long as the difference in income between the two types of borrowers is sufficiently large, then low-income borrowers receive smaller cash flow-based loans and therefore must supply a larger down payment to purchase the asset. When low-income borrowers rely relatively more on CFBL, then the larger loan offsets the lower residual value of their non-durable assets and yields Result 3a.

Contrasting Results 2a with 2b shows that higher down payments for low-income borrowers can only occur when income is sufficiently pledgeable. Moreover, it is clear from Results 3a and 3b that higher LTVs for the non-durable good purchased by low-income borrowers require that those borrowers make relative heavier use of CBFL.[3]

The model also has implications for borrowers' payment-to-income (PTI) ratios.

Result 4:

a) If low-income borrowers rely relatively more on CFBL than high-income borrowers, then the PTI ratio is lower for low-income borrowers purchasing the non-durable asset than it is for high-income borrowers purchasing the durable asset.

b) Otherwise, the PTI ratio is higher for low-income borrowers.

Result 4a arises from the fact that the promised payment for the non-durable good

[3]If parameters are chosen such that the high- and low-income borrowers both purchase the same asset, unlike in our main model, then low-income borrowers will have higher down payments and lower LTVs, as they can borrow less against their future income.

depends at least in part on its future residual value. If this future residual value for the non-durable asset is very low, which is the case when the low-income borrower is heavily reliant on CFBL, then the future payment must also be low.

There are parameters that simultaneously satisfy the conditions of Results 2a, 3a and 4a, as well as the other model assumptions. Thus the following implications arise from the model.

Model Implications. If

a) the down payment is higher for the non-durable asset,

b) the LTV ratio is higher for the non-durable asset,

and

c) the PTI ratio is lower for the non-durable asset

then

i) Income must be sufficiently pledgeable

and

ii) Low-income borrowers must rely relatively more heavily than high-income borrowers on CFBL.

Figure 1 presents a graphical illustration of the results. There are four regions describing the down payment, LTV, and PTI for the non-durable asset purchased by the low-income consumer relative to the durable asset purchased by the high-income consumer. As income pledgeability increases, CFBL becomes a relatively large portion of financing to purchase the asset. As the relative economic durability of the non-durable asset decreases, CFBL becomes relatively more important for the low-income borrower; when the residual value of the non-durable asset is low, the low-income purchaser of that asset has little ability to rely on ABL. When income pledgeability is relatively high and relative economic durability of the non-durable asset is low, the light blue region (I), the LTV and down payment are higher for the non-durable asset, and the PTI is lower. When income pledgeability is relatively low (i.e., below the dark red line), the lower price of non-durable assets combined with the dearth of CFBL for high-income borrowers leads to lower down payments for the non-durable asset, as depicted in the purple region (IV).

If relative economic durability of the non-durable asset is above a certain level, then low-income consumers rely relatively more on ABL and as a result their LTV is lower and their PTI is higher, as described in the dark blue (II) and orange regions (III).

3. Data

To explore the role of asset durability on consumer financing, we examine loan terms offered from a large independent automotive indirect-finance company.[4] The data include all loans that were purchased by the firm in 44 states between the early 1990s and 2021. In total, we observe key features of 291,493 loans that were originated at 3,929 dealerships located in 1,860 U.S. ZIP codes as described in Table 1, Panel A.[5]

The breadth and detail of our data distinguish our study from previous work. More specifically, we observe loan characteristics (e.g., purchase price and down payment) that are typically unavailable in aggregate data. For example, Experian Autocount data does not measure down payments and sale prices, limiting the construction of collateral measures. We also observe the price at which each loan is sold by the dealer to the lender, a value that may capture some otherwise unobservable loan or borrower attributes.

Table 1 presents summary statistics of the buyer, loan, and vehicle characteristics that were observable to the dealer at the time of origination for all loans in the sample where we observe complete origination data. In our sample, the median vehicle is two years old and has approximately 38,000 miles when sold. The median vehicle has a value of $13,075, and the median down payment is $800 (roughly 6% of the vehicle's value). The median loan in our sample has a term of 72 months (6-years) and an APR of approximately 19.5%.

[4]This firm is not one of the captive auto lenders studied by Benmelech et al. (2017) and Benetton et al. (2021).

[5]The raw data include approximately 343,000 loans. We exclude loans with incomplete origination data.

Note the higher APR reflects that the borrowers in the sample are subprime—the median reported credit score is approximately 530, with roughly 30% of borrowers having a reported bankruptcy (chapter 7 or 13) within seven years of loan origination.

4. Discontinuations

4.1. Background

To causally identify the impact of economic durability on financing, we require a source of exogenous variation in asset economic durability. Moreover, to separate any general effect of durability from other technological shocks in the time series (e.g., financial engineering or digital processing of applications), we require a shock that affects only some vehicles but that still allows for controls for vehicle age and manufacturer, and model, and the year the vehicle was sold. Ideally, we would randomly assign similar vehicles different economic durability. While this may not be feasible, we can take advantage of shocks to existing vehicles that affect their current and future resale values. Specifically, we utilize the discontinuation of makes and models of vehicles as a source of exogenous variation in vehicle economic durability in our data.

Importantly, this shock does not affect the current quality of a used car because no component of the car changes. In this sense the shock to quality is only forward looking, although it may, of course, be reflected in current prices. Prior to discontinuation, the car is made is in the same factories with the same materials. Moreover, by comparing car prices prior to discontinuation to the same model and year of car post-discontinuation, we can hold constant the car quality and use vehicles that were not shocked to control for the but-for depreciation curve.

One concern with this shock is that the decision to discontinue a make and model of car by the firm is an endogenous decision and there are many reasons a car manufacturer may choose to do so. For instance, a car manufacturer may choose to cut less profitable models during times of financial distress. However, in our specifications we can directly control for the parent car company and thus can compare cars of similar quality within the same car manufacturing family. Thus, any effect on durability due to potential future bankruptcy, as noted in Titman (1984) and shown to be empirically important in Titman and Wessels (1988) and Hortaçsu et al. (2013) among others, should affect all cars made by that manufacture. Additionally, in several of cases the discontinuation happened when the auto manufacturer was not under financial distress. Moreover, by comparing pre-trends of the vehicles, we can plausibly detect any movements in the resale or depreciation value of the vehicles prior to the shock.

4.2. Discontinuation Shocks

Among the 825 discontinued models, we identify 208 instances in which the manufacturer decides to maintain the make of the car (e.g., Chevrolet) but discontinues a specific model (e.g., Chevrolet Monte Carlo), and the model appears in our loan data.[6]. We supplement these model discontinuations with eight discontinuations of major US car brands (i.e., makes) during our sample period. A list of discontinued models, discontinued makes and discontinuation years is provided in the Appendix in Table IA.1 and Table IA.2.

4.3. Empirical Method

We use a difference-in-difference (DiD) approach to test the effect of our shock to depreciation. Specifically, for a transaction i, of model j, with dealer d, during period t, we run the following regression:

$$Y_{i,j,d,t,v} = \tau_t + \iota_{j,v} + \xi_d + \beta X_{i,j,d} + \phi_{j,t}\text{Treated}_{j,t} + \epsilon_{i,j,d,t}, \quad (1)$$

[6] More than half of the discontinued models that are discontinued include low volume production vehicles such as the Aston Martin Vantage GT and the Ferrari 248

where Y is an outcome such as vehicle price or financing term, τ is a transaction year fixed effect, ι is a car model x vintage year fixed effect, ξ is a dealer fixed effect, X are a series of vehicle, borrower, and dealer controls, and Treated is an indicator if the make of model j has been discontinued prior to time t. Thus, in the cross-section we are comparing cars within the same period, absorbing any non-time varying attributes related to the specific model, and dealer, as well as any linear effects of vehicle age. In all specifications we cluster by make.[7]

In additional specifications we include interactions of the fixed effects including the car make's parent company x transaction year fixed effects ($\phi_{j,t}$). Thus we are also absorbing any effects related to the financial condition of the parent company at the time of the transaction. Importantly, this isolates general effects that would apply to all makes of a given parent company (e.g., GM during the 2008-2009 Global Financial Crisis).

5. Results

5.1. *Discontinuation Shock and Economic Durability*

We propose to use the model and brand discontinuations described in Section 4 as a shock to vehicle economic durability. Parts availability and servicing expertise for discontinued vehicles are likely to degrade more quickly than for other vehicles. There may also be a loss of prestige that leads to lower current prices. From the perspective of the theoretical framework described in Section 2, this suggests that discontinuation may be viewed as a

[7] Several recent papers raise concerns of differential treatment timing in difference-in-difference regressions and raise the spectre of resulting bias when using higher dimensional fixed-effects if there is expected treatment effect heterogeneity (Callaway and Sant'Anna, 2021; Baker et al., 2022). We note several features of our analysis that should alleviate such concerns. First, we drop all observations where the vehicle age exceeds seven years. This reduces the potential for long-run effects to drive the results and for previously discontinued vehicles to act as future controls. Second, we note that 83% of our observations are never treated, reducing the likelihood of negative weights (Goodman-Bacon, 2021). Finally, we repeat our baseline specifications using the stacked regression approach of Gormley and Matsa (2011) and Cengiz et al. (2019), and find similar results.

shock that reduces the economic durability of a car.

We begin by empirically assessing the impact of discontinuation on economic durability. Definition 1a in Section 2 requires that durable assets must have higher prices, so if discontinuation reduces durability, then it should reduce the vehicle price. We test this implication by estimating equation (1) and regressing a vehicle's price on a post-discontinuation indicator, model-vintage year fixed effects, dealer fixed effects and corporate parent-contract year fixed effects. Our use of model-vintage year fixed effects allows us to contrast vehicles of the exact same model and vintage year before and after discontinuation. Dealer fixed effects control for any differences among dealers. Corporate parent-contract year fixed effects remove any impacts that influenced the corporate parent. It is plausible that corporations that discontinue a make or model may differ from those that do not. For example, it could be that corporate parents that discontinue a make or model may have weaker balance sheets and may therefore be less capable of guaranteeing future warranties. The corporate parent-contract year fixed effects control for any impacts of this kind. Taken together, this complement of fixed effects (which we refer to as the standard set of fixed effects) isolates the impact of discontinuation itself on the specific model that will no longer be manufactured.

We find, as shown in the first column of Table 2, that discontinued vehicles experience a drop in wholesale value of \$297.6 (t-statistic=-2.58). This is consistent with the claim that discontinuation reduces economic durability: less durable vehicles are less appealing to consumers and should trade for lower values. Including controls for borrower income and credit score, indicators for prior borrower chapter 7 or chapter 13 bankruptcy filings and an indicator for borrower homeowner status leaves the qualitative finding unchanged, as shown in the second column of Table 2. Including a control for vehicle mileage and dealer profit yields the result that discontinuation reduces wholesale value by \$277.88 (t-statistic=-2.57).

As a second measure of vehicle value we consider the scaled price, which is defined as the vehicle wholesale value divided by the average wholesale value of the given vehicle model and vintage when new. We show in the fourth column of Table 2 that the scaled price is

3.89 percentage points lower (t-statistic=-4.59) post-discontinuation. Figure 2 depicts the evolution of scaled price over time: there is no visible pre-trend before the discontinuation event, prices drop significantly one year after discontinuation and prices remained depressed for the following three years.

The result from the specification including borrower and vehicle mileage controls in the scaled price regression supports the conclusion that discontinuation reduces vehicle value, as shown in the fifth and sixth column of Table 2. The reduced price in the current period likely reflects both the impaired future physical durability of discontinued vehicles and the stigma associated with these cars.

The second key feature of non-durable assets, which is highlighted in Definition 1b in Section 2, is that they have a lower ratio of residual value to current period price. We define the recovery percent of a vehicle to be the value the lender receives from the vehicle's liquidation after default divided by the vehicle's wholesale value at origination. This is the empirical analogue of the ratio of residual value to current price.

As our second test for whether discontinuation can be viewed a negative durability shock, we therefore regress the recovery percent on the post-discontinuation dummy and the standard fixed effects. We note here for clarity that we assign the post-discontinuation indicator to a vehicle if it is purchased after discontinuation. As we showed in Table 2, these vehicles have lower current period prices when purchased. In the present test we explore whether their future recovery values are lower, as a fraction of their already reduced prices, relative to other vehicles.

We find, as shown in the first column of Table 3, that the recovery percent is 1.05 percentage points lower (t-statistic=-2.56) for post-discontinuation vehicles. This is a meaningful drop compared to the average recovery ratio of 28 percent. In the second column of Table 3, we show that including borrower, vehicle mileage, and dealer profit controls as well as a control for the time to default yields a coefficient of -1.99 percentage points (t-statistic=-5.70) on post-discontinuation. Including an additional fixed effect at the corporate parent-year of default level results in an estimated coefficient of -1.80 percentage points (t-statistic=-5.18), as shown in the third column of Table 3.

These results support the general conclusion that discontinued vehicles have lower residual values, even when viewing those residual values as a fraction of their lower current prices. The reduction in recovery percents likely reflects a decrease in physical durability, as it seems unlikely that the loss of prestige for discontinued cars would increase over time as a fraction of overall value. In any case, irrespective of the specific cause, Tables 2 and 3 make clear that the discontinuation shock reduces economic durability as described in Definition 1. Discontinued vehicles have lower prices and lower residual values, and we consequently view them as less-durable assets for the purpose of testing the theoretical predictions outlined in Section 2.

5.2. Durability and Consumer Income

Result 1 in the theoretical framework presented in Section 2 is that high-income borrowers will purchase more durable assets. The basic intuition is that economically durable assets are attractive but expensive. We test this prediction by regressing an indicator for whether a borrower had a bottom quartile income relative to all borrowers in that year on the post-discontinuation dummy and the standard fixed effects. We find, as shown in the first column of Table 4, that discontinuation increases the probability that the purchaser is in the bottom income quartile by 3.45 percentage points (t-statistic=2.92). This finding supports Result 1: low-income borrowers are more likely to buy the less-durable discontinued vehicles. Including controls yields a similar conclusion, as shown in the second column of Table 4. A regression of the log of borrower income on discontinuation yields a coefficient of -0.01 (t-statistic=-2.03), as displayed in the third column of Table 4. This result is robust to controlling for the vehicle mileage and dealer profits, and also emerges in specifications utilizing Poisson regressions as suggested by Silva and Tenreyro (2006) and Cohn et al. (2022), as shown in the columns four through six of Table 4. Discontinued vehicles are purchased by lower-income borrowers, and the the effect is especially pronounced for borrowers in the bottom income quartile.

5.3. Durability and Loan Maturity

The model we consider in our theoretical framework involves one period loan repayments, so it does not generate formal predictions for the impact of durability on loan maturity. It is intuitive, however, that less durable assets will be financed with shorter-term asset-backed debt, and this implication arises, for example, in the model of Hart and Moore (1994). Hart and Moore (1994) also argue that human capital cannot support long-term debt as it belongs only to its owner and may be withdrawn from use at any time. A reduction in durability that leads to greater use of cash flow-based financing should thus lead to shorter-term financing. Both asset-backed and cash flow-based models of financing therefore suggest that a decrease in asset durability will result in shorter-maturity debt.

We test this hypothesis by regressing the observed maturity in months of the auto loan on the post-discontinuation dummy and the standard fixed effects. We find that discontinuation reduces the maturity of the loan (coefficient=-0.82 and t-statistic=-5.64), as displayed in the first column of Table 5. The reduction of 0.82 months in loan maturity after discontinuation is a meaningful effect, though perhaps not very large compared to the mean loan maturity of 67.54 months. Overall, however, there is little observed variation in loan maturities (the interquartile range is 66 to 72 months), so it is notable that we find an effect of reasonable magnitude. As in Argyle et al. (2020), we find that cars with shorter expected lives receive loans with shorter maturities. Including borrower, vehicle, and dealer profit controls has little impact on the estimated coefficient, as we show in the second and third columns of Table 5.

5.4. Durability and Down Payments

The results described above in Section 5.5.1 serve to validate the use of discontinuation as a shock to economic durability. The results in Sections 5.5.2-5.5.3 support the implications of theory for the impact of a reduction in durability on borrower income and loan maturity.

The model offers conflicting predictions for the impact of economic durability on the dollar value of the borrower's down payment (i.e., the cash amount paid by the borrower on the transaction date). When income pledgeability is low, durable assets require larger down payments (Result 2b), while when income pledgeability is sufficiently high borrowers purchase non-durable assets with larger down payments (Result 2a).

We regress the down payment on the post-discontinuation indicator and the standard fixed effects. We find that discontinuation leads to larger down payments, as displayed in the first column of Table 6. Consistent with the implication in the model when income is sufficiently pledgeable, borrowers supply an additional \$85.3 (t-statistic=3.76) in down payments when purchasing non-durable discontinued vehicles. As shown in Figure 3, down payments climb significantly after discontinuation and do not exhibit any apparent pre-trend.

This down payment result is particularly surprising from the perspective of a model with only asset-based collateral, i.e., if income was not pledgeable. We showed above in Table 2 that discontinued vehicles are less expensive. This fact, along with the limited pledgeability of collateral emphasized in asset-backed models of lending, should lead discontinued autos to require lower down payments. Moreover, we demonstrate in Table 4 that these vehicles are purchased by lower-income borrowers who presumably have less cash in hand for a down payment. Despite these two compelling intuitions for a prediction that there will be lower down payments for non-durable assets, we find the opposite. This finding in the context of the model show that cash flow-based lending is a relatively important feature of auto lending. Given that low-income consumers have smaller future incomes against which to borrow, the low-income purchasers of non-durable assets need to provide larger down payments to close the transactions.

The positive impact of discontinuation on down payments continues to hold when controlling for borrower and vehicle characteristics, as detailed in the second column of Table 6. We show in the third column of Table 6 that in the cross-section more expensive vehicles with elevated book values generally require higher down payments. There are, however, many unobserved differences between vehicles of different prices. Our result that discontinuation shocks lead to higher down payments on vehicles of specific model-vintage years is somewhat stronger when controlling for this vehicle book value effect, as is displayed in the third column.

The higher down payments for non-durable assets that we find indicate that the empirically relevant regions of Figure 1 are restricted to region I (light blue) or region II (dark blue). Only for the high levels of income pledgeability that hold in those regions will low-income borrowers make the higher down payments that we observe. Regions III and IV are incompatible with the down payment results in Table 6.

5.5. Durability and LTV ratios

In this section, we consider the implications of the model for the LTV. Specifically, in the theory when CFBL is relatively unimportant for low-income borrowers, LTV increases with durability (Result 3b), but when CFBL is relatively important for low-income borrowers LTV decreases with durability (Result 3a).

We define the LTV to be the ratio of the loan balance to the wholesale value of the auto at the time of origination. We regress LTV on the post-discontinuation indicator and the standard fixed effects, and we find a positive and significant coefficient of 0.02 (t-statistic=3.63), as displayed in the first column of Table 7. This result shows that a discontinuation shock reducing vehicle durability leads to higher LTV ratios, which, as we describe in Section 2, arises only in the model when low-income borrowers depend heavily on CFBL. Figure 4 shows that LTV ratio exhibit no pre-trend before discontinuations and are higher afterwards.[8]

It is a general and robust feature of models of asset-backed financing that LTV increases with durability (Hart and Moore, 1994; Rampini, 2019). When the asset constitutes the entire collateral, as in a model without CFBL, more durable assets with higher liquidation values support larger loans relative to current values. We also find this implication in our model when CFBL is relatively less important for low-income borrowers (these are regions II and III in Figure 1). Our finding to the contrary indicates that in the auto loan market, cash flow-based lending must play a meaningful role and that it is especially important for low-income borrowers. Our model describes a setting in which borrowers can rely on their future income to purchase assets. Low-income borrowers, in particular, use their future income to purchase non-durable assets. If the price of the non-durable asset is relatively low, then low income borrowers will purchase it with a relatively high debt ratio, as the debt is secured by their incomes, not just by the physical collateral. This mechanism in the model is consistent with the finding that LTV *increases* after a decline in durability.

Including borrower controls has little impact on the estimated effect of the discontinuation shock on LTV, as shown in the second column of Table 7. In the third column of Table 7 we display the similar results when including the full set of vehicle and borrower controls (coefficient=0.02 and t-statistic=6.74). The general conclusion is unchanged: less durable autos are financed with higher LTV ratios, which emerges as a potential outcome in the model only when low-income borrowers are relatively more dependent on CFBL.

We have thus shown in Tables 6 and 7 that non-durable assets have both higher down payments and higher LTVs than durable assets. The only region in Figure 1 for which both these outcomes hold true is region I. The data thus indicate that in the U.S. auto loan market income is quite pledgeable and low-income borrowers rely relatively more heavily on CFBL.

[8] The post-discontinuation increase in LTV ratios does not reflect a shift in default risk; we find in unreported results that the latter does not change significantly with the discontinuation shock.

We further comment that the mean (and median) LTV for our auto borrowers is 129%.[9] In a model where income pledgeability was low (i.e., little CFBL) this high level of debt would be unexpected, as lenders can only seek repayment from the asset value. LTVs of above 100% can be supported, however, when income is sufficiently pledgeable, as the borrower's future income is also used to meet the required debt payments. This is also consistent with market parameters lying in region I of Figure 1.[10]

5.6. Durability and Payment-to-Income Ratios

Result 4 of the model predicts that the payment-to-income ratio will be lower for non-durable assets if low-income borrowers are more heavily dependent on CFBL (as is the case in region I of Figure 1). This provides an additional model implication that we test.

We test this prediction by regression the log of the borrower's payment-to-income (PTI) ratio on the post-discontinuation variable and the standard fixed effects. We find a negative and significant effect of discontinuation on the log of PTI (coefficient=-0.02 and t-statistic=-2.51), as displayed in the first column of Table 8. PTI ratios of the purchasers of these vehicles drop by 2 percent after discontinuation is announced.

Including borrower income decile fixed effects has little impact on the estimated negative coefficient on discontinuation, though it does increase the precision of the estimate, as shown in the second column of Table 8. Introducing borrower and vehicle controls, either with or without borrower income decile fixed effects, also yields similar estimates, as described in columns three and four of Table 8. Using the PTI ratio rather than the log as the dependent

[9] We further note that the mean LTV for prime auto borrowers (FICO score of 661 to 780) is 131%, while it exceeds 139% for subprime borrowers (Zabritski, 2019).

[10] At first glance it may seem surprising that discontinued vehicles have lower prices and higher down payments, yet carry higher LTV ratios. This can occur, however, when dealers charge markups and LTVs are calculated relative to the book values of the vehicles. For example, suppose a durable asset sells for 150, has a book value of 135 and is financed with 145 in debt and a down payment of 5. Suppose the non-durable asset sells for 130, has a book value of 115 and is financed with 124 in debt and a down payment of 6. In this case the non-durable asset has a lower price, a higher down payment and a higher LTV ratio.

variable yields similar directional results and significance but lower magnitudes, as displayed in columns five through eight of Table 8. This is due to a wide distribution in PTI that may skew the results. Figure 5 shows that borrower PTI drops after discontinuation, with no visible pre-trend.

The full set of findings across down payments, LTVs and PTIs offers consistent support for the argument that income is pledgeable and that low-income borrowers rely more heavily on CFBL, as described in region I of Figure 1.

5.7. Durability and Recovery in Default

In the discussion above we highlight the role of CFBL. For CFBL to be important, however, it must be that consumers are able to borrow against their future income and need not rely solely on the physical asset to serve as collateral. In this section we discuss the direct evidence on post-default lender collections. In particular, is it the case that lenders actually take recovery from the personal resources of borrowers?

We have data on the recovery proceeds from 79,012 defaulted loans. For many of these loans, the recovery is still in process at the close of our sample. Eliminating those censored observations leaves 38,183 defaulted loans with complete recovery information. For this sample, we find that the average proceeds from the sales of repossessed vehicles are $3,722. The average cash recovery from the borrower is $1,827. We thus find that in default, physical assets and personal borrower resources supply 67% and 33%, respectively, of the total recovery proceeds. These summary statistics show that in the auto loan market, a market in which vehicle collateral is generally deemed to serve a central role, borrower personal income pledges do perform a significant function.

5.8. *Cash flow-based Lending to Low-Income Consumers—Default Recoveries*

As outlined in the model developed in Section 2, the results in Table 6 showing that a reduction in durability leads to larger down payments demonstrate that income-based lending is important in the auto financing market. The empirical findings on LTV and PTI in Tables 7 and 8 establish that low-income borrowers rely more heavily than high-income borrowers on CFBL.

The vehicle default recovery data make possible an additional test of these implications. We show in Table 4 that discontinued vehicles tend to be purchased by low-income consumers. Under the model implications, we should therefore expect to observe lower vehicle recoveries and higher personal income recoveries from the purchasers of discontinued vehicles who default.

We test these predictions by regressing the ratio of the vehicle recovery to the defaulted loan balance on the post-discontinuation indicator, the standard fixed effects and an additional fixed effect at the level of the corporate parent-default year to control for any time-varying effects at the level of the manufacturer. We find, as shown in the first column of Table 9, that discontinued vehicles are worth \$601.5 less (t-statistic=2.74) in repossession. Less durable assets provide diminished physical recovery proceeds, as expected under the model. Including borrower, vehicle mileage, dealer profit, and time to default controls has little impact on the estimated coefficient on discontinuation, as detailed in the second column of Table 9.

A decrease in durability reduces not only the dollar amount recovered from the repossessed asset, but also the percentage of the loan balance recovered through liquidation. We find, as shown in the third column of Table 9, that that the percentage of the loan balance recovered through liquidation of the vehicle decreases (coefficient=-3.29 and t-statistic=-2.96) after discontinuation. The result for the specification including the full set of controls, outlined in the fourth column, is quite similar.

While it is perhaps unsurprising that vehicle recoveries are lower for discontinued vehicles, it is a novel implication of the model that personal income recovery should be higher for non-durable assets, as low-income borrowers rely more heavily on CFBL. We test this hypothesis by regressing the dollar amount of personal post-default payments on the post-discontinuation indicator and the fixed effects described above. We find, as displayed in the fifth column of Table 9, that the dollar amount increases (coefficient=241.8 and t-statistic=2.45) after discontinuation. A similar result holds in the specification with all the controls, as shown in the sixth column of Table 9.

The ratio of the personal borrower payments to the defaulted loan balance post-default payments also weakly increases after discontinuation (coefficient=1.51 and t-statistic=1.75), as we detail in the seventh column of Table 9. Including controls little alters this conclusion; the results are displayed in the eighth column of the table.

Further, we find that the probability of any post-default personal recovery is significantly higher (coefficient=5.90 and t-statistic=3.68) for discontinued vehicles, as shown in the ninth column of Table 9. This continues to hold when adding controls, as shown in the tenth column of the same table.

Taken together, these results provide convincing support for the contention that low-income borrowers rely more heavily than high-income borrowers on their income as a source of collateral. It is striking that purchasers of discontinued vehicles are more likely to have their personal resources pursued by a lender after default. These consumers have lower incomes and they buy less expensive vehicles. For both of these reasons, one might have expected them to be less likely to be subject to personal recovery in the event of a default, yet we find the opposite. The model supplies the intuition for our finding: purchasers of discontinued non-durable vehicles must pledge their own income, rather than the quickly depreciating physical asset, in order to receive a loan. In the event of default, a lender therefore will have to have recourse to their income, as the physical collateral does not have much value.

6. Discussion

6.1. CFBL for Consumers and Firms

We find that low-income borrowers depend heavily on CFBL, as demonstrated by the higher LTVs, lower PTIs and higher personal recoveries on discontinued vehicles. These low-income consumers who rely on CFBL typically have more consequential repayment outcomes than the high-income borrowers who make greater use of ABL. This feature of consumer credit contrasts starkly with the financing pattern in the corporate market. Leeth and Scott (1989), John et al. (2003), Jimenez et al. (2006) and Lian and Ma (2021) all show that better-resourced firms make greater use of CFBL, while riskier and more constrained small businesses are more likely to utilize collateral and ABL. What explains this sharp divergence in the risk profiles of CFBL borrowers in the two markets? The analysis in Section 2 makes clear that CFBL can only influence financing when income is sufficiently pledgeable. That is, lenders must have a credible claim on the income of the borrower. In the consumer lending market, this claim can take the form of wage garnishment, a bankruptcy payment plan or personal collections. Although defaulting consumers may be eligible for a Chapter 7 liquidation without repayment, that option carries significant long-term credit report consequences that are likely unappealing and costly.

For small businesses, by contrast, the default and abandonment option is much less expensive. Firms can file for bankruptcy and have their corporate lives terminated. The former owners may then go on to form new companies that are unburdened in a corporate sense by the bankruptcy history of their principals' previous ventures. The accessibility of this abandonment option for small firms makes their future cash flows less pledgeable and necessitates their reliance on ABL. For large corporations with ongoing business operations, the abandonment possibility is less of a concern, and lenders are therefore willing to supply them with CFBL.

6.2. Trends in Consumer CFBL

The dependence by low-income borrowers on CFBL that we document suggests that recent changes in securitization markets have potentially broad implications for the relative auto credit access of poor consumers. Specifically, Figure 7 displays total annual securitization issuances for autos, equipment, student loans, and credit cards. As is clear from the figure, in the post-financial crisis period (i.e., since 2008) there has been a significant increase in the securitization of ABL such as equipment relative to CFBL such as student loans and credit cards. One possible rationale for this shift is that it became apparent during the financial crisis that monitoring incentives were reduced for securitized debt (Keys et al., 2010), and such monitoring is likely more important for CFBL than for ABL. A second candidate explanation is that post-crisis Basel III risk weightings of bank loans adjusted to favor collateralized assets (Degryse et al., 2021), which may have led to both reduced originations and decreased securitizations of CFBL. Irrespective of the underlying cause, we argue that this change in securitization is important for auto financing, which, our study argues, is a composite of ABL and CFBL.

In particular, a rise in ABL securitization relative to that of CFBL is likely to facilitate the availability of the former type of financing at lower prices. Given the importance of the CFBL component of auto debt to low-income borrowers, this suggests that an increasing fraction of vehicle lending will be directed to wealthier consumers. To explore the effects of changing market conditions, we examine the relationship between auto financing of consumers and the securitization of ABL relative to securitization of CFBL. Specifically, each year we calculate the ratio of securitized equipment lending, which is almost entirely ABL, to the sum of equipment, credit card, and student loan lending, where the latter two are almost entirely

CFBL.[11] We then plot the relationship across the highest and lowest income quartiles since the onset of the financial crisis in Figure 8.[12] As the ratio of equipment to total securitization increases, borrowers in the highest income quartile experience an increase in auto financing, while borrowers in the lowest income quartile experience a decrease. Although this figure depicts an association rather than a causal connection, it is consistent with the argument that the importance to low-income borrowers of CFBL, which has been relatively disfavored by securitization markets, may be acting to reduce their ability to purchase vehicles.

Vehicles play an important role in helping consumers access jobs and achieve mobility, and their prices have recently been increasing.[13] Restricted credit access for low-income borrowers arising from their reliance on CFBL may narrow their prospects. Financially constrained car purchasers receive no federal auto financing assistance, despite the darkening credit conditions for these consumers and the crucial part cars play in creating opportunity. This contrasts with mortgage financing where the U.S. government devotes significant resources to facilitating access, largely for the benefit of less-wealthy citizens.[14] Also, significant policy has been developed to move jobs to distressed communities, while little if any financial support to improve the mobility of poor borrowers.[15]

7. Conclusion

We study the roles of asset-backed lending (ABL) and cash flow-based lending (CFBL) in the $1.3 trillion U.S. automotive lending market. Using a simple theoretical framework, we

[11]To avoid any mechanical relationship, we exclude securitized auto lending.

[12]We present the regression underlying this analysis in the internet appendix.

[13]Source: https://fred.stlouisfed.org/series/CUSR0000SETA.

[14]Studies of home mortgages have emphasized that borrower incomes (i.e., CFBL) influences the terms and performance of lending (Archer et al., 1996; Diaz-Serrano, 2005; Piskorski and Tchistyi, 2010), though there is evidence that reported incomes are sometimes misstated (Blackburn and Vermilyea, 2012; Jiang et al., 2014; Ambrose et al., 2016; Mian and Sufi, 2017).

[15]For example, the Tax Cuts and Jobs Act of 2017 (TCJA) has been estimated to cost $16 billion in revenue over ten years (Source: Joint Committee on Taxation, "Estimated Budget Effects of the Conference Agreement for H.R. 1, The Tax Cuts and Jobs Act," JCX-67-17, Dec. 18, 2017.)

show that tracing the effects of a reduction in asset economic durability on financing allows us to assess the overall importance of CFBL and its relative usage by high- and low-income borrowers. Specifically, when income pledgeability is low (i.e., CFBL plays a small role) and low-income borrowers rely relatively less on CFBL, less durable assets have lower down payments and LTV ratios. By contrast, when income pledgeability is high and low-income borrowers rely relatively more on CFBL, less durable assets have higher down payments and LTV ratios. In our empirical analysis, we show that model and make discontinuations generate a negative economic durability shock for used cars: post-discontinuation, holding fixed the model-vintage year, we observe that discontinued vehicles have lower prices, lower liquidations values, and are purchased by lower-income consumers.

After discontinuation, down payments are higher by approximately \$88 and LTV ratios increase by about two percentage points. These two findings are consistent with a model of the auto market in which CFBL plays a meaningful part and low-income borrowers rely relatively more heavily on it. In a sample of defaulted loans, we find that roughly two-thirds of lender recoveries arise from the vehicle (which serves as the collateral for ABL) and the remaining one-third comes from the borrower personally (the source of the guarantee in CFBL). Post-discontinuation physical collateral recoveries are \$595 lower and personal default recoveries increase by \$286. The higher personal recoveries on discontinued vehicles may seem surprising given that their purchasers have lower incomes and buy less-expensive vehicles. The model supplies the explanation that low-income borrowers make greater use of CFBL and must therefore use their personal resources, rather than the collateral value of the vehicle, to cover missing payments in the event of default.

In the post-financial crisis period, securitization market issuances have increased relatively more for ABL than for CFBL forms of financing. This shift may limit relative credit access for the lower-income borrowers who rely on CFBL. A resulting restriction on the ability of less-wealthy consumers to purchase cars may have wide-ranging implications for their welfare. Our results indicate that innovations that aid lenders in monitoring borrower incomes are likely to be especially helpful for constrained consumers who seek auto financing.

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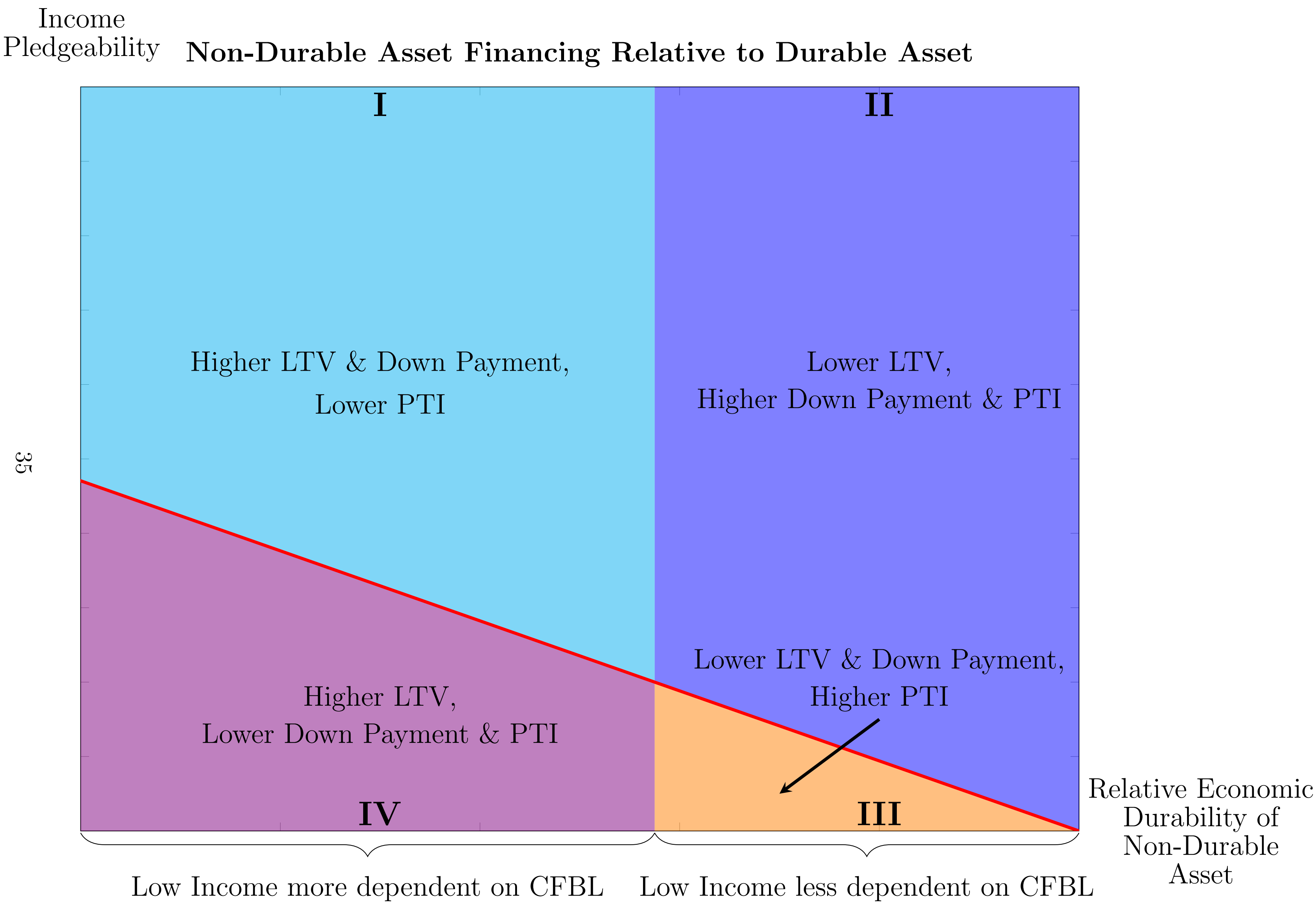

Figure 1: **Visualization of model equilibria - Non-Durable relative to Durable Asset.** This figure presents four potential equilibrium outcomes of the LTV, down payment, and PTI of the non-durable asset relative to the durable asset. The y-axis is income pledgeability (θ_I), the x-axis is the economic durability of the non-durable asset (δ). Model parameters are: $I_H = 2$, $I_L = 1.15$, $\theta_G = 0.6$, and $\gamma = 1$.

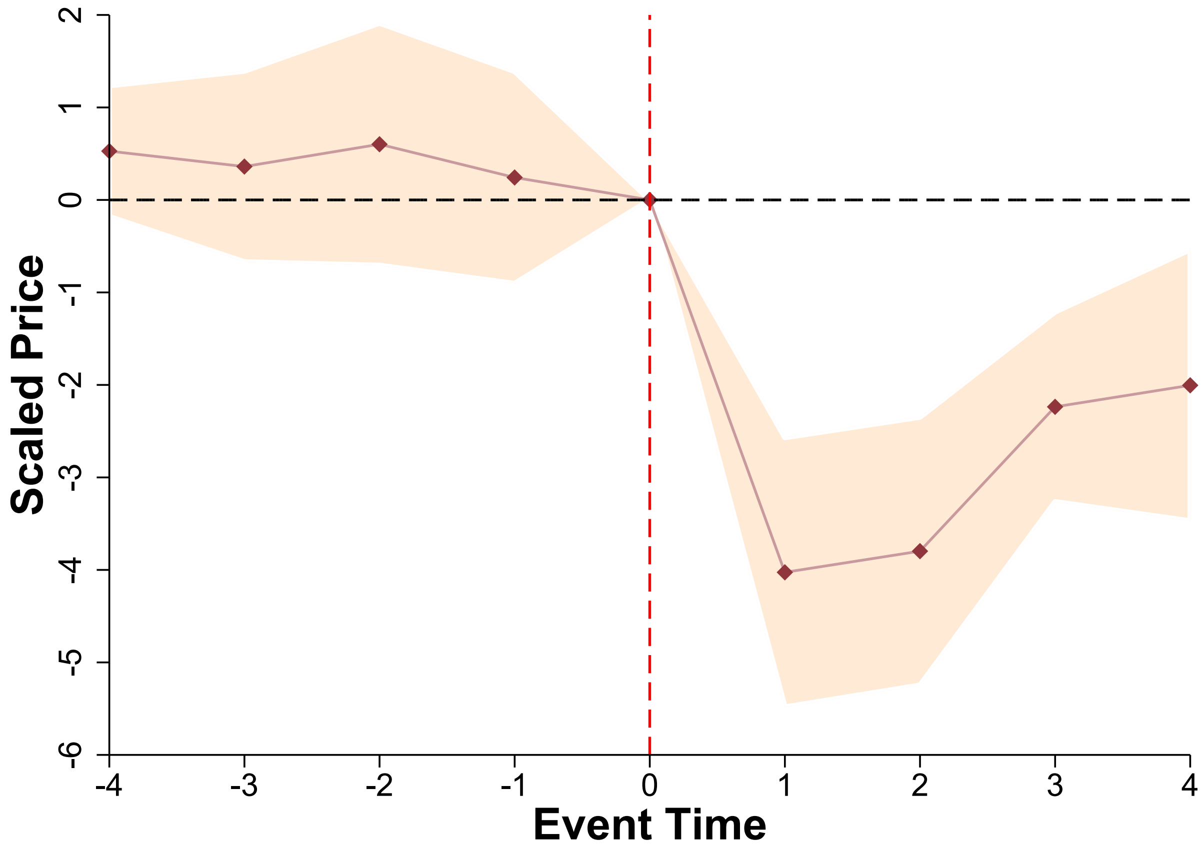

Figure 2: **Scaled Price against Event Time.** This figure presents differences in the scaled price across vehicles (models & makes) that were discontinued and those that were not. The plot is the regression coefficients for timing indicators around the year the model was discontinued (discontinuation year=0). The dependent variable is the wholesale value of the vehicle divided by the average wholesale value when new, as reported to the lender. Included fixed effects are Make/Model x Vintage Year, Dealership, and Contract Year x Parent Company.

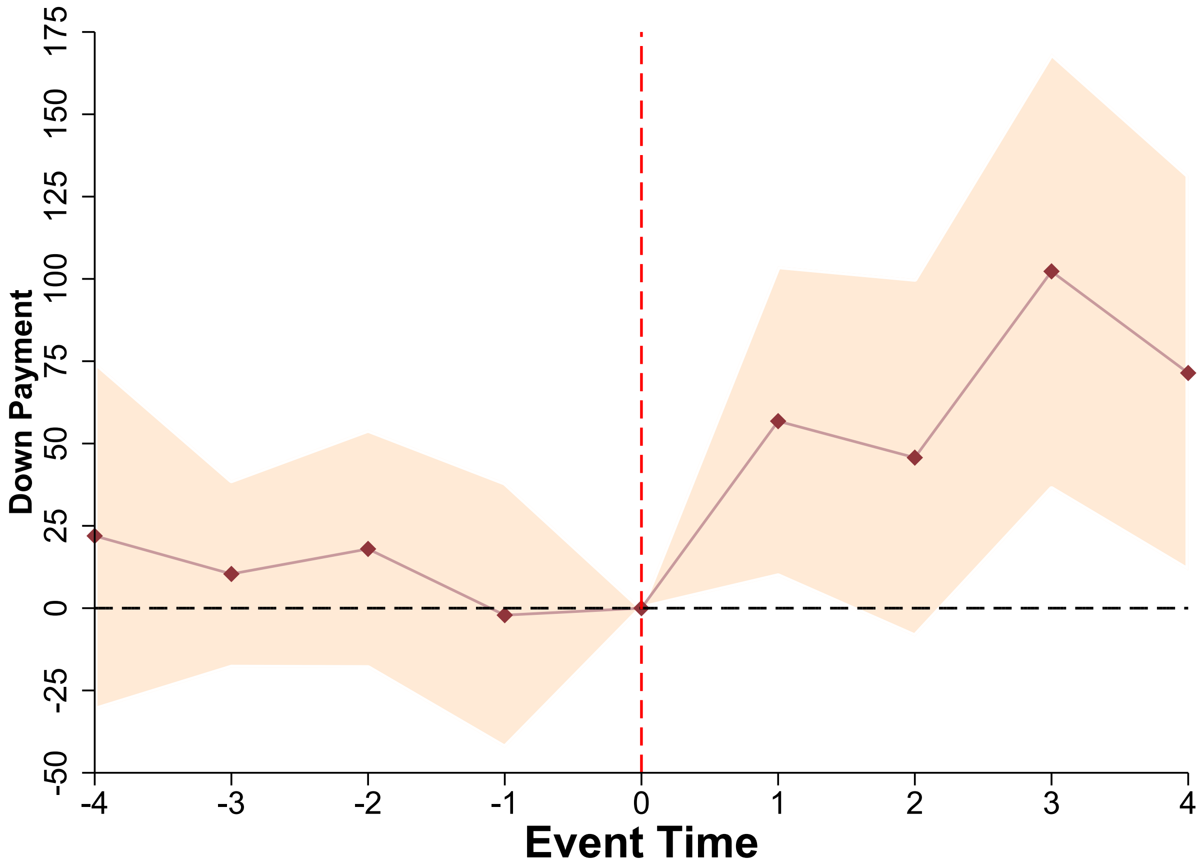

Figure 3: **Down Payment against Event Time.** This figure presents differences in the down payments across vehicles (models & makes) that were discontinued and those that were not. The plot is the regression coefficients for timing indicators around the year the model was discontinued (discontinuation year=0). The dependent variable is the down payment for the vehicle. Included fixed effects are Make/Model x Vintage Year, Dealership, and Contract Year x Parent Company.

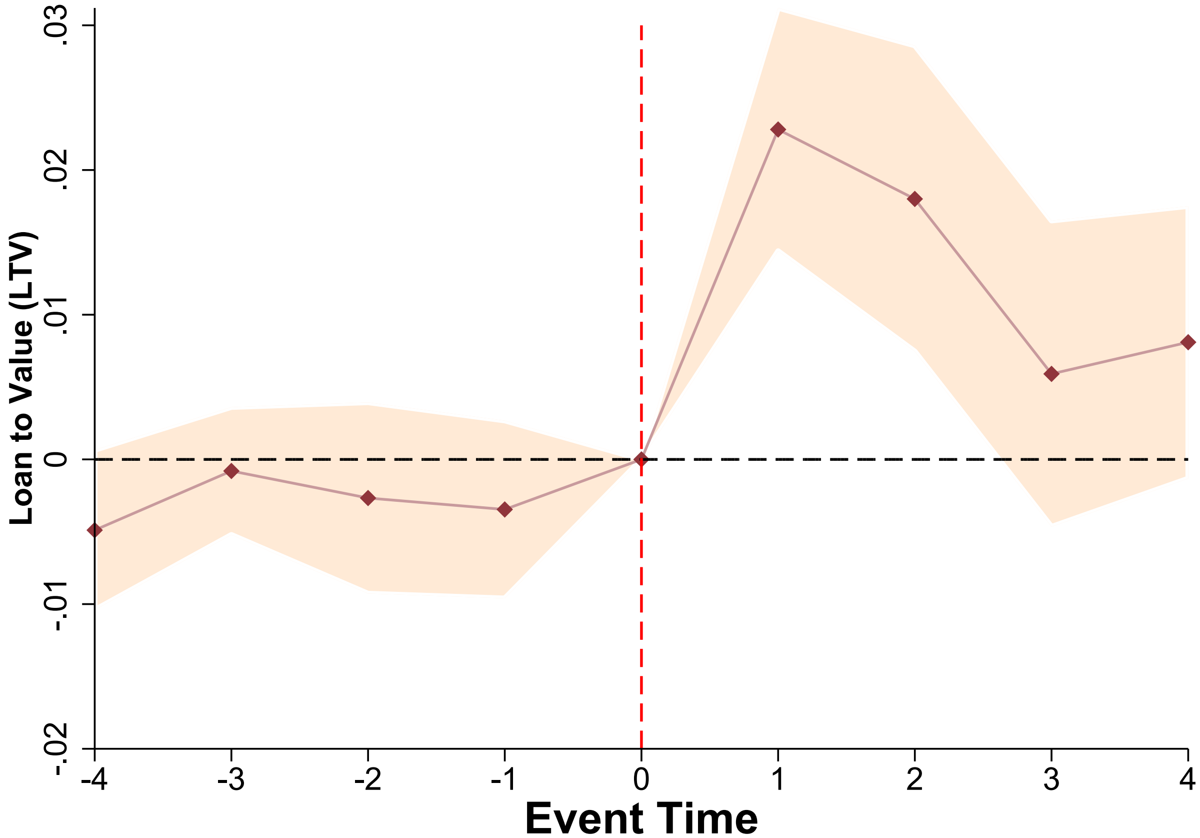

Figure 4: **LTV against Event Time.** This figure presents differences in the loan to value (LTV) across vehicles (models & makes) that were discontinued and those that were not. The plot is the regression coefficients for timing indicators around the year the model was discontinued (discontinuation year=0). The dependent variable is the loan amount divided by the reported vehicle value to the lender for the vehicle. Included fixed effects are Make/Model x Vintage Year, Dealership, and Contract Year x Parent Company.

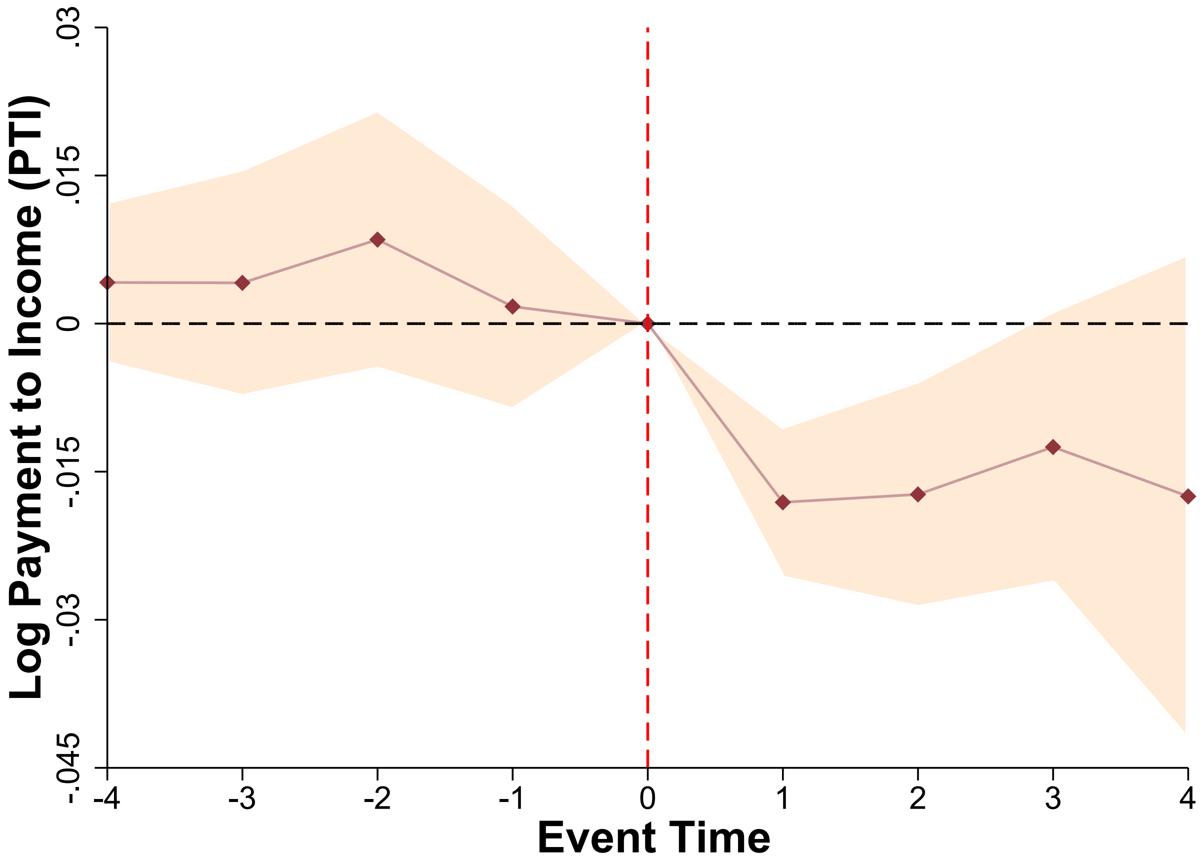

Figure 5: **PTI against Event Time.** This figure presents differences in the log of the payment to income ratio (PTI) across vehicles (models & makes) that were discontinued and those that were not. The plot is the regression coefficients for timing indicators around the year the model was discontinued (discontinuation year=0). The dependent variable is the log of the borrower's reported monthly payment to the borrower's reported monthly income. Included fixed effects are Make/Model x Vintage Year, Dealership, borrower income decile, and Contract Year x Parent Company.

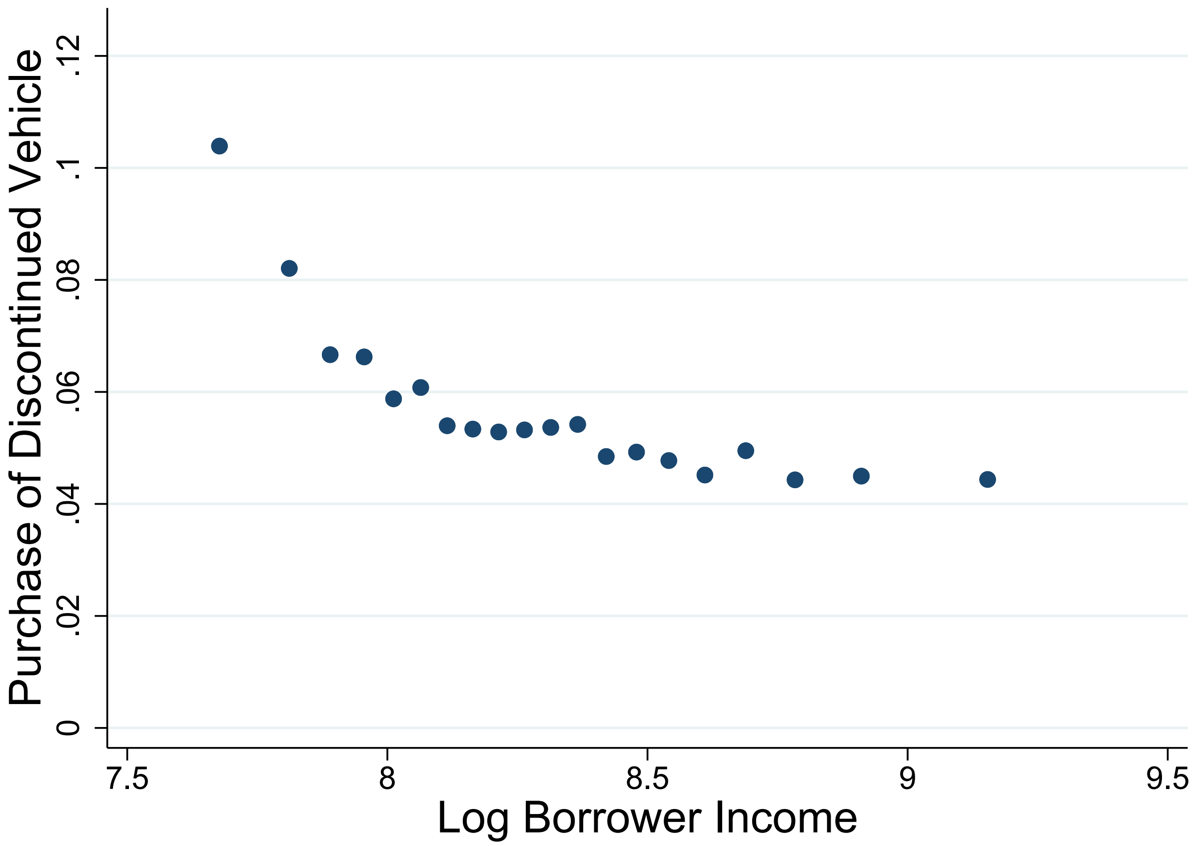

Figure 6: **Purchase of Discontinued Vehicle (=1) against Borrower Income.** This figure presents the average propensity for the borrower of a given log income bucket (20 buckets) to purchase a discontinued vehicle.

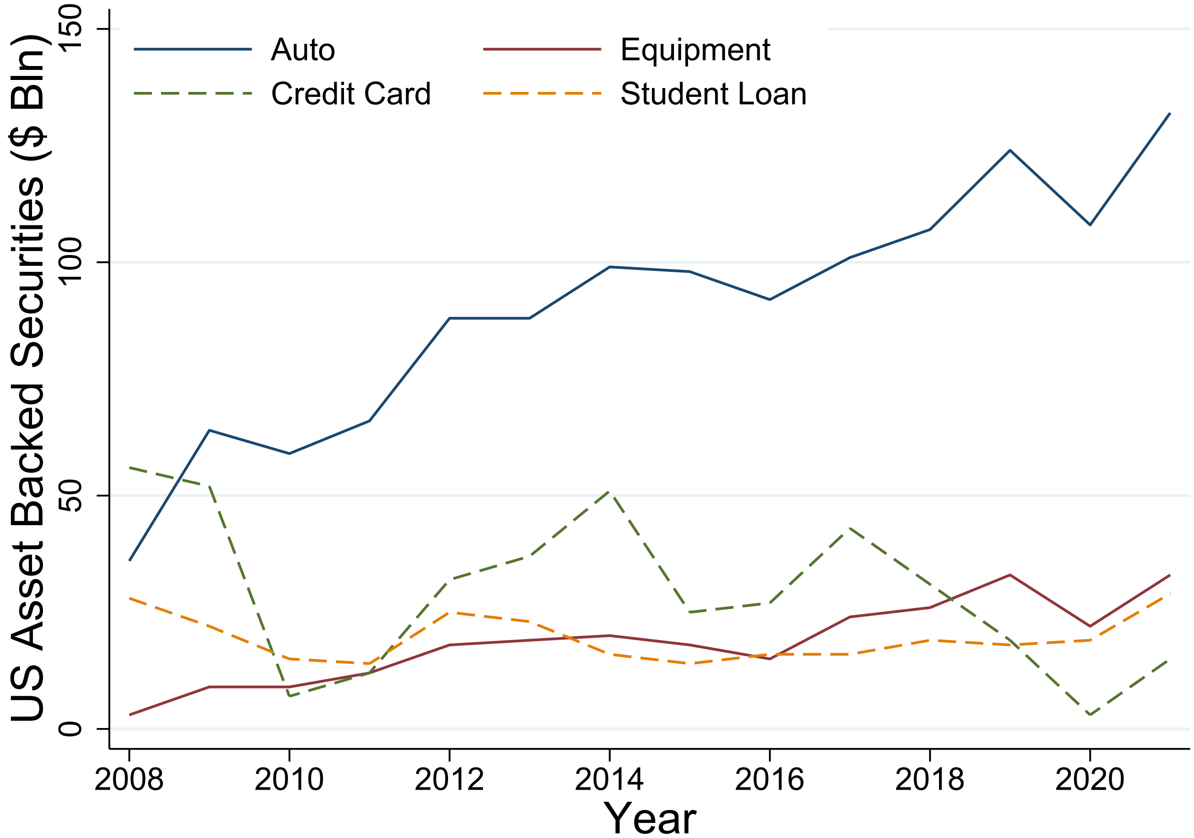

Figure 7: **US Asset Backed Securitization** This figure presents the total annual issuance of US Asset Backed Securities in the United States for four categories (auto, equipment, student loans, and credit cards). All amounts are billions of U.S. Dollars. All data is from Bloomberg, Dealogic, Thomson Reuters; www.sifma.org, March 28 2022.

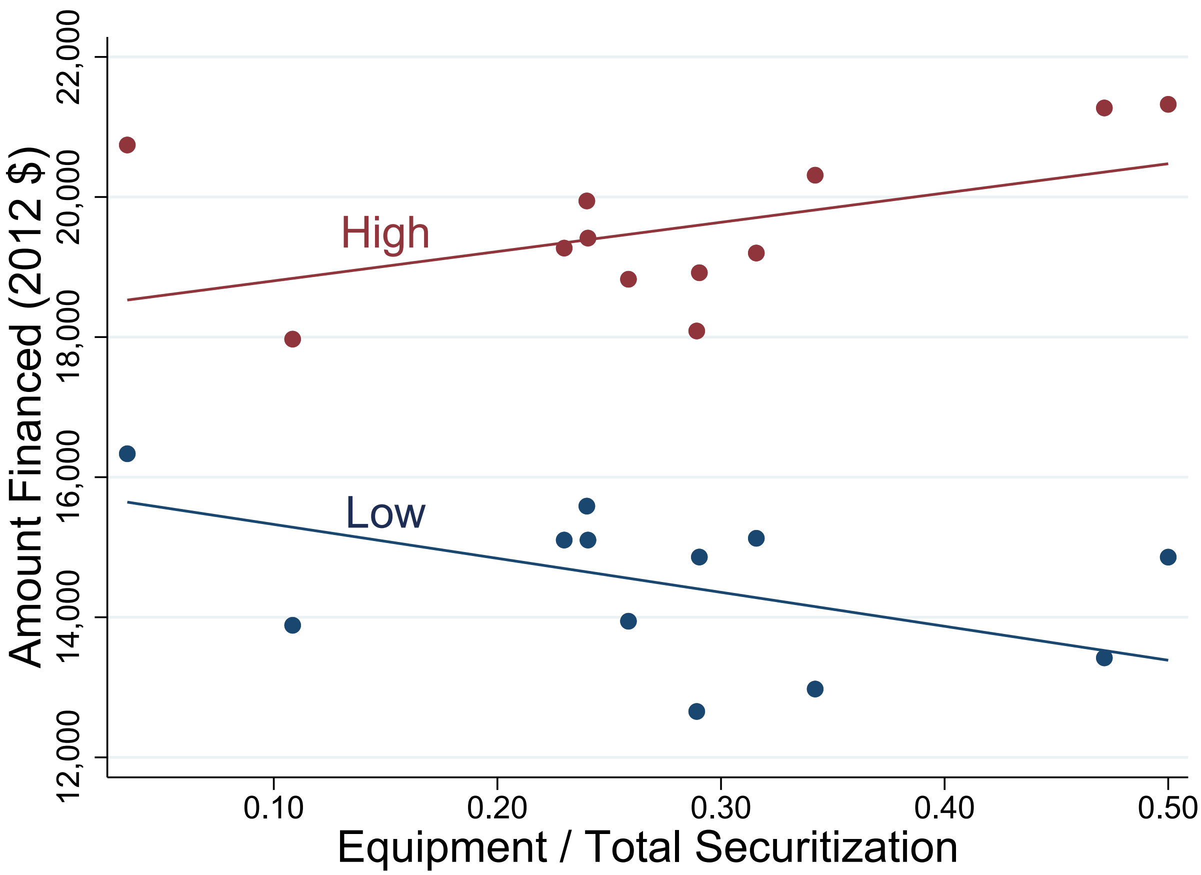

Figure 8: **Amount Financed to Asset Based Securitization.** This figure presents the average amount financed for borrowers for a given bucket of the ratio of equipment based securitization over the sum of credit card, student loan, and equipment based securitization across the lowest and highest borrower income quartiles based on the year of the transaction from 2008 to 2021. Amount financed is deflated to 2012 dollars using the GDP deflator from the St. Louis Federal Reserve. All securitization data is from Bloomberg, Dealogic, Thomson Reuters; www.sifma.org, March 28 2022.

Table 1: **Summary Statistics.** This table reports summary statistics for the variables used in the analysis. *Post-Discontinuation* is an indicator for all years after the transaction year for which the brand or model of the vehicle was discontinued. *Wholesale Value* is the vehicle's wholesale value at the time of the sale. *Mileage* is the vehicle's mileage at the time of the sale. *Scaled Price* is the ratio of the vehicle's value at the time of the sale to the vehicle's make, model, and vintage when new (new=100). *Dealer Profit* is the sale price less the wholesale value at origination and other costs associated with transaction closing. *Down Payment* is the cash amount that the borrower paid at loan origination. *LTV* is the dollar amount of the loan at origination relative to the vehicle wholesale value. *APR* is the actual annualized APR of the loan at origination (in % terms). *Term* is the term of the loan (in months) at origination. *Log PTI* is the log of the borrower's estimated monthly payment over the borrower's reported monthly income (the Payment-to-Income ratio). *Low Income* is an indicator if the borrower is in the lowest income quartile for the transaction year. *Log Income* is the gross monthly income for the borrower. *Credit Score* is the credit score of the borrower. *Default* is an indicator variable if the borrower eventually defaults. *Ch. 7 Bankruptcy* and *Ch. 13 Bankruptcy* are indicators if the borrower had a bankruptcy on their record prior to origination. *Homeowner* is an indicator if the borrower owned their home. All continuous variables are winsorized at the 1st and 99th percentile.

	Mean	S.D.	25th Pctile	Median	75th Pctile	Obs
Vehicle						
Post Discontinuation (=1)	0.05	0.22	0.00	0.00	0.00	342619
Wholesale Value ($)	13636	4385	10696.00	13075	15900	342611
Mileage	38864	21801	24500	38077	52782	339387
Scaled Price (%)	0.72	0.18	0.60	0.70	0.83	291493
Dealer Profit ('000 $)	4.31	2.47	2.60	4.20	6.03	342589
Loan						
Down Payment ($)	1024.29	1136.20	0.00	800.00	1500.00	342350
LTV	1.29	0.18	1.18	1.29	1.42	342488
APR (%)	19.34	2.82	17.95	19.49	21.00	342619
Term (Months)	67.57	7.32	66.00	72.00	72.00	342611
Log PTI	-2.33	0.40	-2.53	-2.24	-2.05	299771
Default (=1)	0.25	0.43	0.00	0.00	1.00	342619
Borrower						
Low Income (=1)	0.25	0.43	0.00	0.00	0.00	299769
Income	4426	1811	3101	3984	5296	299769
Credit Score	532	50.12	497	531	566	325715
Ch. 7 Bankruptcy (=1)	0.22	0.41	0.00	0.00	0.00	342619
Ch. 13 Bankruptcy (=1)	0.08	0.28	0.00	0.00	0.00	342619
Homeowner (=1)	0.06	0.23	0.00	0.00	0.00	342619

Table 2: **Vehicle Wholesale Value and Model Discontinuation.** This table reports estimates from panel regressions of the vehicle's reported value on model discontinuation. In columns (1) to (3), the dependent variable is the vehicle *Wholesale Value*, the wholesale value of the vehicle reported to the lender at loan origination. In columns (4) and (5), the dependent variable is the vehicle's *scaled price*, the vehicle wholesale value reported to the lender at origination over the average of the given vehicle model and year wholesale value when new. *Post-Discontinuation* is an indicator for all years after the transaction year for which the brand or model of the vehicle was discontinued. *Log Income* is the log of the gross monthly income for the borrower. *Credit Score* is the credit score of the borrower. *Ch. 7 Bankruptcy* and *Ch. 13 Bankruptcy* are indicators if the borrower had a bankruptcy on their record prior to origination. *Homeowner* is an indicator if the borrower owned their home at origination. *Dealer Profit* is the dealer's profit at origination. *Log Mileage* is the log of one plus the vehicle's mileage at origination. Fixed effects are as described in the table. Parent fixed effects relate to the parent company of the make and model. Robust standard errors are clustered by vehicle make. The t-statistics are shown in parentheses below the coefficient estimates. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Dep. Var.	Vehicle Wholesale Value ($)			Scaled Price (%)		
	(1)	(2)	(3)	(4)	(5)	(6)
Post Discontinuation (=1)	-297.56**	-371.27***	-277.88**	-3.89***	-3.88***	-3.16***
	(-2.58)	(-3.52)	(-2.57)	(-4.59)	(-4.65)	(-6.35)
Log Income		1205.65***	1178.17***		5.99***	5.63***
		(27.56)	(22.00)		(28.79)	(23.56)
Credit Score		1.16***	1.36***		0.01***	0.01***
		(6.24)	(5.81)		(5.05)	(4.78)
Ch. 7 Bankruptcy (=1)		119.93***	165.67***		0.54***	0.80***
		(8.33)	(17.43)		(7.93)	(16.67)
Ch. 13 Bankruptcy (=1)		-139.91***	-171.88***		-0.72***	-0.81***
		(-4.20)	(-4.48)		(-4.68)	(-4.38)
Homeowner (=1)		-49.33**	-30.52*		-0.37***	-0.27***
		(-2.61)	(-1.84)		(-3.76)	(-3.10)
Log Mileage			-636.79***			-3.53***
			(-22.88)			(-24.14)
Dealer Profit ('000 $)			-124.56***			-0.60***
			(-10.37)			(-8.84)
Vehicle Model x Vintage FEs	Yes	Yes	Yes	Yes	Yes	Yes
Dealer FEs	Yes	Yes	Yes	Yes	Yes	Yes
Parent x Contract Year FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations	332337	278938	278259	289778	252979	252422
Adjusted R^2	0.771	0.758	0.816	0.673	0.684	0.777

Table 3: **Default Recovery and Model Discontinuation.** This table reports estimates from panel regressions of proxies of the vehicle's residual value. The dependent variable is the *Percent recovery* of the lender conditional on default. It is value the lender receives from the vehicle liquidation after default over the vehicle's wholesale value at origination. All observations are conditional on default and non-zero recovery. Column (3) contains fixed effects for both the year of the transaction as well as the year of the default interacted with the parent company of the vehicle. *Post-Discontinuation* is an indicator for all years after the transaction year for which the brand or model of the vehicle was discontinued. *Log Income* is the log of the gross monthly income for the borrower. *Credit Score* is the credit score of the borrower. *Ch. 7 Bankruptcy* and *Ch. 13 Bankruptcy* are indicators if the borrower had a bankruptcy on their record prior to origination. *Homeowner* is an indicator if the borrower owned their home at origination. *Dealer Profit* is the dealer's profit at origination. *Log Mileage* is the log of one plus the vehicle's mileage at origination. *Time to Default* is the time (in months) between the transaction and the report of default. Fixed effects are as described in the table. Parent fixed effects relate to the parent company of the make and model. Robust standard errors are clustered by vehicle make. The t-statistics are shown in parentheses below the coefficient estimates. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Recovery Percent (%)	(1)	(2)	(3)
Post Discontinuation (=1)	-1.05**	-1.99***	-1.80***
	(-2.56)	(-5.70)	(-5.18)
Log Income		-0.01	-0.05
		(-0.02)	(-0.16)
Credit Score		0.01***	0.01***
		(4.70)	(5.55)
Ch. 7 Bankruptcy (=1)		0.11	0.14
		(0.58)	(0.70)
Ch. 13 Bankruptcy (=1)		-0.36	-0.45
		(-1.18)	(-1.48)
Homeowner (=1)		-0.11	-0.47***
		(-0.53)	(-2.75)
Log Mileage		0.10*	0.09
		(1.76)	(1.55)
Dealer Profit ('000 $)		0.56***	0.57***
		(18.44)	(18.33)
Time to Default (Months)		-0.71***	-0.81***
		(-44.61)	(-42.99)
Vehicle Model x Vintage FE	Yes	Yes	Yes
Parent x Contract Year FE	Yes	Yes	Yes
Dealership FE	Yes	Yes	Yes
Parent x Default Year FE	No	No	Yes
Observations	54496	47510	47488
Adjusted R^2	0.168	0.521	0.548

Table 4: **Borrower Income and Model Discontinuation.** This table reports estimates from panel regressions of borrower income. The dependent variable in columns (1-2) is *Low Income* = 1 an indicator for whether the borrower was in the bottom quartile of income for borrowers in that year. The dependent variable in columns (3-4) is the *Log Income* of the borrower reported to the lender at the time of the origination. The dependent variable in columns (5-6) is the borrower income, and the regression is estimated via Poisson pseudo-likelihood regression. *Post Discontinuation* is an indicator for all years after the transaction year for which the brand or model of the vehicle was discontinued. *Dealer Profit* is the dealer's profit at origination. *Log Mileage* is the log of one plus the vehicle's mileage at origination. Fixed effects are as described in the table. Parent fixed effects relate to the parent company of the make and model. Robust standard errors are clustered by vehicle make. The reported R^2 in columns (5-6) is the pseudo-R^2 from the Poisson regression. The t-statistics are shown in parentheses below the coefficient estimates. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Bottom Quartile (=1)		Log Income		Income (Poisson)	
	(1)	(2)	(3)	(4)	(5)	(6)
Post Discontinuation (=1)	3.45***	3.57***	-0.01**	-0.01*	-0.02***	-0.02***
	(2.93)	(3.05)	(-2.03)	(-1.96)	(-2.60)	(-2.59)
Log Mileage		2.59***		-0.03***		-0.03***
		(11.86)		(-21.68)		(-21.86)
Dealer Profit ('000 $)		-4.06***		0.03***		0.03***
		(-21.44)		(31.55)		(28.97)
Vehicle Model x Vintage FE	Yes	Yes	Yes	Yes	Yes	Yes
Parent x Contract Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Dealership FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	290435	289733	290435	289733	290435	289733
Adjusted R^2	0.141	0.183	0.241	0.281	0.251	0.282

Table 5: **Loan Maturity and Model Discontinuation.** This table reports estimates from panel regressions of the maturity of the loan at origination. The dependent variable *Loan Maturity* is the original maturity of the loan at origination (in months). *Post Discontinuation* is an indicator for all years after the transaction year for which the brand or model of the vehicle was discontinued. *Log Income* is the log of the gross monthly income for the borrower. *Credit Score* is the credit score of the borrower. *Ch. 7 Bankruptcy* and *Ch. 13 Bankruptcy* are indicators if the borrower had a bankruptcy on their record prior to origination. *Homeowner* is an indicator if the borrower owned their home at origination. *Dealer Profit* is the dealer's profit at origination. *Log Mileage* is the log of one plus the vehicle's mileage at origination. Fixed effects are as described in the table. Parent fixed effects relate to the parent company of the make and model. Robust standard errors are clustered by vehicle make. The t-statistics are shown in parentheses below the coefficient estimates. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Loan Maturity (Months)	(1)	(2)	(3)
Post Discontinuation (=1)	-0.82***	-0.79***	-0.81***
	(-5.64)	(-4.83)	(-5.18)
Log Income		-0.08***	-0.63***
		(-2.91)	(-17.92)
Credit Score		0.00***	0.00
		(4.08)	(0.25)
Ch. 7 Bankruptcy (=1)		0.13***	0.09**
		(3.16)	(2.33)
Ch. 13 Bankruptcy (=1)		-0.76***	-0.55***
		(-23.96)	(-18.70)
Homeowner (=1)		0.17***	0.15***
		(3.87)	(3.47)
Log Mileage			-0.26***
			(-6.25)
Dealer Profit ('000 $)			0.33***
			(19.30)
Vehicle Model x Vintage FEs	Yes	Yes	Yes
Dealer FEs	Yes	Yes	Yes
Parent x Contract Year FEs	Yes	Yes	Yes
Observations	332340	278941	278259
Adjusted R^2	0.579	0.369	0.385

Table 6: **Down payment and Model Discontinuation.** This table reports estimates from panel regressions of the vehicle's down payment at origination. The dependent variable is the winsorized vehicle's *Down Payment*, the cash amount that the borrower pays at loan origination. *Post Discontinuation* is an indicator for all years after the transaction year for which the brand or model of the vehicle was discontinued. *Wholesale Value* is the vehicle's collateral value to the loan provider at sale. *Log Income* is the log of the gross monthly income for the borrower. *Credit Score* is the credit score of the borrower. *Ch. 7 Bankruptcy* and *Ch. 13 Bankruptcy* are indicators if the borrower had a bankruptcy on their record prior to origination. *Homeowner* is an indicator if the borrower owned their home at origination. *Dealer Profit* is the dealer's profit at origination. *Log Mileage* is the log of one plus the vehicle's mileage at origination. Fixed effects are as described in the table. Parent fixed effects relate to the parent company of the make and model. Robust standard errors are clustered by vehicle make. The t-statistics are shown in parentheses below the coefficient estimates. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Down Payment ($)	(1)	(2)	(3)
Post Discontinuation (=1)	85.28***	68.76**	88.34***
	(3.76)	(2.31)	(3.30)
Log Income		-192.18***	-275.07***
		(-18.99)	(-22.80)
Credit Score		-0.07	-0.17*
		(-0.93)	(-1.93)
Ch. 7 Bankruptcy (=1)		-300.48***	-312.14***
		(-34.78)	(-34.28)
Ch. 13 Bankruptcy (=1)		209.56***	221.66***
		(16.79)	(14.95)
Homeowner (=1)		7.55	9.71
		(0.93)	(1.27)
Log Mileage		-74.03***	-29.22***
		(-10.14)	(-4.20)
Dealer Profit ('000 $)		76.21***	84.97***
		(19.86)	(18.12)
Wholesale Value ($)			0.07***
			(26.77)
Vehicle Model x Vintage FEs	Yes	Yes	Yes
Dealer FEs	Yes	Yes	Yes
Parent x Transaction Year FEs	Yes	Yes	Yes
Observations	332078	277997	277997
Adjusted R^2	0.208	0.226	0.239

Table 7: **Loan to Value (LTV) and Model Discontinuation.** This table reports estimates from panel regressions of the loan to value (LTV) ratio. The dependent variable in columns (1) to (3) is the *Loan-to-Value* (LTV) ratio, which is the amount financed over the reported wholesale vehicle value. *Post Discontinuation* is an indicator for all years after the transaction year for which the brand or model of the vehicle was discontinued. *Log Income* is the log of the gross monthly income for the borrower. *Credit Score* is the credit score of the borrower. *Ch. 7 Bankruptcy* and *Ch. 13 Bankruptcy* are indicators if the borrower had a bankruptcy on their record prior to origination. *Homeowner* is an indicator if the borrower owned their home at origination. *Dealer Profit* is the dealer's profit at origination. *Log Mileage* is the log of one plus the vehicle's mileage at origination. Fixed effects are as described in the table. Parent fixed effects relate to the parent company of the make and model. Robust standard errors are clustered by vehicle make. The t-statistics are shown in parentheses below the coefficient estimates. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Loan-to-Value (LTV)	(1)	(2)	(3)
Post Discontinuation (=1)	0.02***	0.02***	0.02***
	(3.63)	(4.06)	(6.74)
Log Income		0.07***	0.00**
		(45.19)	(2.51)
Credit Score		0.00***	-0.00***
		(12.00)	(-3.44)
Ch. 7 Bankruptcy (=1)		0.00*	-0.00*
		(1.95)	(-1.81)
Ch. 13 Bankruptcy (=1)		-0.06***	-0.04***
		(-20.44)	(-13.35)
Homeowner (=1)		0.00	-0.00
		(1.53)	(-1.23)
Log Mileage			0.01***
			(22.90)
Dealer Profit ('000 $)			0.05***
			(107.28)
Vehicle Model x Vintage FEs	Yes	Yes	Yes
Dealer FEs	Yes	Yes	Yes
Parent x Contract Year FEs	Yes	Yes	Yes
Observations	332236	278884	278204
Adjusted R^2	0.352	0.349	0.717

Table 8: **Payment to Income (PTI) and Model Discontinuation.** This table reports estimates from panel regressions of the payment to income ratio of the borrower. The dependent variable is the natural log of the *Payment-to-Income* ratio (PTI) in columns (1-4), which the is borrower's estimated monthly payment over the borrower's reported monthly income, and the PTI ratio in columns (5-8), multiplied by 100 for readability. *Post Discontinuation* is an indicator for all years after the transaction year for which the brand or model of the vehicle was discontinued. *Log Income* is the log of the gross monthly income for the borrower. *Credit Score* is the credit score of the borrower. *Ch. 7 Bankruptcy* and *Ch. 13 Bankruptcy* are indicators if the borrower had a bankruptcy on their record prior to origination. *Homeowner* is an indicator if the borrower owned their home at origination. *Dealer Profit* is the dealer's profit at origination. *Log Mileage* is the log of one plus the vehicle's mileage at origination. Fixed effects are as described in the table. Parent fixed effects relate to the parent company of the make and model. Income decile fixed effects are indicators for the borrower's income decile in the transaction year. Robust standard errors are clustered by vehicle make. The t-statistics are shown in parentheses below the coefficient estimates. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Log(PTI)				PTI			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post Discontinuation (=1)	-0.02**	-0.02***	-0.03***	-0.02***	-0.18***	-0.24***	-0.27***	-0.24***
	(-2.51)	(-5.26)	(-6.29)	(-5.36)	(-2.76)	(-6.05)	(-7.64)	(-6.41)
Log Income			-0.92***				-8.40***	
			(-403.87)				(-292.32)	
Credit Score			-0.00***	-0.00***			-0.00***	-0.00***
			(-31.07)	(-27.37)			(-25.39)	(-23.54)
Ch. 7 Bankruptcy (=1)			-0.01***	-0.01***			-0.08***	-0.06***
			(-4.88)	(-3.36)			(-4.18)	(-2.71)
Ch. 13 Bankruptcy (=1)			-0.06***	-0.07***			-0.31***	-0.46***
			(-18.83)	(-19.71)			(-17.50)	(-22.04)
Homeowner (=1)			-0.01***	-0.01***			-0.07***	-0.12***
			(-3.98)	(-4.97)			(-5.92)	(-8.22)
Log Mileage			-0.02***	-0.02***			-0.22***	-0.21***
			(-16.23)	(-15.70)			(-16.09)	(-14.99)
Dealer Profit ('000 $)			0.02***	0.02***			0.19***	0.19***
			(33.20)	(33.25)			(37.09)	(35.68)
Vehicle Model x Vintage FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Parent x Contract Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dealership FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Income Decile FE	No	Yes	No	Yes	No	Yes	No	Yes
Observations	290437	290435	278259	278259	290437	290435	278259	278259
Adjusted R^2	0.042	0.528	0.567	0.546	0.054	0.638	0.672	0.660

Table 9: **Recovery and Model Discontinuation.** This table reports estimates from panel regressions of the recovery on defaulted loans. The dependent variable is the: dollar value of the recovered vehicle net of fees (columns (1) and (2));percent of the balance of a defaulted loan recovered via repossession of the vehicle net of fees (columns (3) and (4)); dollar value of the income recovery amount net of fees (columns (5) and (6)); percent of the balance of a defaulted loan recovered via the income of the borrower net of fees (columns (7) and (8)); and an indicator (=1) if there was any positive income recovery, coefficients are multiplied by 100 for exposition (columns (9) and (10)). *Post-Discontinuation* is an indicator for all years after the transaction year for which the brand or model of the vehicle was discontinued. *Log Income* is the log of the gross monthly income for the borrower. *Credit Score* is the credit score of the borrower. *Ch. 7 Bankruptcy* and *Ch. 13 Bankruptcy* are indicators if the borrower had a bankruptcy on their record prior to origination. *Homeowner* is an indicator if the borrower owned their home at origination. *Dealer Profit* is the dealer's profit at origination. *Log Mileage* is the log of one plus the vehicle's mileage at origination. *Time to Default* is the time (in months) between the transaction and the report of default. Fixed effects are as described in the table. Parent fixed effects relate to the parent company of the make and model. Robust standard errors are clustered by vehicle make. The t-statistics are shown in parentheses below the coefficient estimates. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Dep. Var.	Veh. Recov. ($)		Veh. Recov. (%)		Inc. Recov. ($)		Inc. Recov. (%)		Inc. Recov. (=1)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Post Discontinuation (=1)	-601.51***	-595.12**	-3.29***	-3.50**	241.81**	286.19***	1.51*	1.77*	5.90***	6.73***
	(-2.74)	(-2.50)	(-2.96)	(-2.44)	(2.45)	(2.85)	(1.75)	(1.82)	(3.68)	(4.59)
Log Income		192.93***		0.32		181.60***		1.41**		2.52**
		(4.87)		(1.06)		(3.30)		(2.59)		(2.22)
Credit Score		-0.16		0.00		0.08		0.01**		0.01
		(-0.26)		(0.46)		(0.21)		(2.34)		(0.55)
Ch. 7 Bankruptcy (=1)		-64.27		-0.60*		120.10**		1.08**		3.81***
		(-1.20)		(-1.82)		(2.60)		(2.28)		(4.41)
Ch. 13 Bankruptcy (=1)		-173.07***		-0.19		-96.27***		-0.07		-1.24
		(-2.83)		(-0.50)		(-3.18)		(-0.23)		(-1.38)
Homeowner (=1)		259.18*		1.80*		-110.82**		-0.48		-4.29***
		(1.95)		(1.85)		(-2.16)		(-1.00)		(-3.60)
Log Mileage		-195.05***		-0.47***		-23.32*		0.03		-0.13
		(-8.79)		(-3.97)		(-2.00)		(0.34)		(-0.55)
Dealer Profit ('000 $)		70.19***		-0.14**		6.26		-0.06		0.46**
		(9.66)		(-2.74)		(0.85)		(-0.73)		(2.66)
Time to Default (Months)		-48.80***		-0.22***		-16.58***		-0.10***		-0.39***
		(-12.21)		(-8.50)		(-7.63)		(-4.24)		(-6.20)
Vehicle Model x Vintage FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Parent x Contract Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dealership FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Parent x Default Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	23578	22221	23574	22217	25757	24336	25752	24331	25757	24336
Adjusted R^2	0.246	0.259	0.138	0.141	0.034	0.039	0.038	0.040	0.035	0.040

Internet Appendix: "Collateral Damage:
Low-Income Borrowers Depend on Cash Flow-Based Lending"

Table IA.1: **Discontinuation of Models.** This table reports the years of model discontinuations. All dates are from JD Power Associates for the discontinuation for a given model.

Vehicle Make	Vehicle Model	Year	Vehicle Make	Vehicle Model	Year
Acura	CL	2003	Chevrolet	Cruze	2019
Acura	Integra	2001	Chevrolet	HHR	2011
Acura	RL	2012	Chevrolet	Lumina	2001
Acura	RSX	2006	Chevrolet	Metro	2001
Acura	TL	2014	Chevrolet	Monte Carlo	2007
Acura	TSX	2014	Chevrolet	Prizm	2002
BMW	325	2006	Chevrolet	SSR	2006
BMW	328	2016	Chevrolet	Tracker	2004
BMW	525	2007	Chevrolet	Uplander	2008
BMW	535	2016	Chevrolet	Venture	2005
BMW	550	2016	Chrysler	200	2017
BMW	Z3	2002	Chrysler	300M	2004
Buick	Cascada	2019	Chrysler	Aspen	2009
Buick	Century	2005	Chrysler	Concorde	2004
Buick	LeSabre	2005	Chrysler	Crossfire	2008
Buick	Lucerne	2011	Chrysler	PT Cruiser	2010
Buick	Park Avenue	2005	Chrysler	Sebring	2010
Buick	Rainier	2007	Chrysler	Town & Country	2016
Buick	Rendezvous	2007	Dodge	Avenger	2014
Buick	Terraza	2007	Dodge	Caliber	2012
Buick	Verano	2017	Dodge	Dakota	2011
Cadillac	ATS	2019	Dodge	Dart	2016
Cadillac	CTS	2019	Dodge	Intrepid	2004
Cadillac	Catera	2001	Dodge	Magnum	2008
Cadillac	DTS	2011	Dodge	Neon	2005
Cadillac	DeVille	2005	Dodge	Nitro	2011
Cadillac	SRX	2016	Dodge	Ram Van	2003
Cadillac	STS	2011	Dodge	Ramcharger	1993
Cadillac	Seville	2004	Dodge	Stratus	2006
Cadillac	XTS	2019	Fiat	500	2019
Chevrolet	Astro	2005	Ford	E150	2014
Chevrolet	Avalanche	2013	Ford	Excursion	2005
Chevrolet	Aveo	2011	Ford	Fiesta	2019
Chevrolet	Cavalier	2005	Ford	Five Hundred	2007
Chevrolet	Cobalt	2010	Ford	Flex	2019

Ford	Focus	2018
Ford	Freestar	2007
Ford	Freestyle	2007
Ford	Taurus	2019
Ford	Thunderbird	2005
Ford	Windstar	2003
GMC	Envoy	2009
GMC	Safari	2005
GMC	Sonoma	2004
Geo	Metro	1997
Geo	Prizm	1997
Geo	Tracker	1997
Honda	Crosstour	2015
Honda	Element	2011
Honda	Prelude	2001
Honda	S2000	2009
Hyundai	Azera	2017
Hyundai	Equus	2016
Hyundai	Genesis	2016
Hyundai	Tiburon	2008
Hyundai	Veracruz	2012
Infiniti	EX35	2012
Infiniti	EX37	2013
Infiniti	FX35	2012
Infiniti	FX37	2013
Infiniti	G20	2002
Infiniti	G25	2012
Infiniti	G35	2008
Infiniti	G37	2013
Infiniti	I30	2001
Infiniti	I35	2004
Infiniti	M35	2010
Infiniti	M37	2013
Infiniti	M45	2010
Infiniti	Q40	2015
Infiniti	Q70	2019
Infiniti	QX30	2019
Infiniti	QX56	2013
Infiniti	QX70	2017
Isuzu	Ascender	2008
Isuzu	Axiom	2004
Isuzu	Rodeo	2004
Isuzu	Trooper	2002
Isuzu	VehiCROSS	2001
Jaguar	XJ12	1996
Jaguar	XJ6	1997
Jaguar	XJ8	2009
Jeep	Commander	2010
Jeep	Liberty	2012
Jeep	Patriot	2017
Kia	Amanti	2009
Kia	Borrego	2009
Kia	Rondo	2010
Kia	Sephia	2001
Kia	Spectra	2009
Lexus	ES 300	2003
Lexus	ES 330	2006
Lexus	GS 300	2019
Lexus	GX 470	2009
Lexus	IS 250	2015
Lexus	LS 430	2006
Lexus	LS 460	2017
Lexus	RX 300	2003
Lexus	RX 330	2006
Lincoln	LS	2006
Lincoln	MKC	2019
Lincoln	MKS	2016
Lincoln	MKT	2019
Lincoln	MKX	2018
Lincoln	Mark LT	2008
Lincoln	Town Car	2011
Lincoln	Zephyr	2006
Mazda	626	2002
Mazda	CX-7	2012
Mazda	MPV	2006
Mazda	Millenia	2002
Mazda	Protege	2003
Mazda	Tribute	2011
Mercury	Cougar	2002
Mercury	Grand Marquis	2011
Mercury	Mariner	2011
Mercury	Milan	2011
Mercury	Montego	2007
Mercury	Monterey	2007
Mercury	Mountaineer	2010
Mercury	Sable	2009
Mercury	Villager	2002

Mitsubishi	Eclipse	2012	Volvo	C30	2013
Mitsubishi	Endeavor	2011	Volvo	C70	2013
Mitsubishi	Galant	2012	Volvo	S40	2011
Mitsubishi	Lancer	2017	Volvo	S80	2016
Mitsubishi	Montero	2006	Volvo	V40	2004
Mitsubishi	Montero Sport	2004	Volvo	V50	2011
Mitsubishi	Raider	2009	Volvo	V70	2010
Nissan	Cube	2014			
Nissan	Juke	2017			
Nissan	Xterra	2015			
Saab	9-7X	2009			
Saturn	Aura	2009			
Saturn	LS	2010			
Saturn	Outlook	2010			
Saturn	Relay	2007			
Saturn	SC	2002			
Saturn	SL	2002			
Saturn	Sky	2009			
Scion	FR-S	2016			
Scion	iA	2016			
Scion	iM	2016			
Scion	iQ	2015			
Subaru	B9 Tribeca	2007			
Subaru	Baja	2006			
Suzuki	Aerio	2007			
Suzuki	Forenza	2008			
Suzuki	Grand Vitara	2013			
Suzuki	Kizashi	2013			
Suzuki	Reno	2008			
Suzuki	SX4	2013			
Suzuki	Verona	2006			
Toyota	Camry Solara	2008			
Toyota	Celica	2005			
Toyota	Corolla iM	2018			
Toyota	FJ Cruiser	2014			
Toyota	MR2	2005			
Toyota	Matrix	2013			
Volkswagen	Beetle	2019			
Volkswagen	CC	2017			
Volkswagen	Cabrio	2002			
Volkswagen	Eos	2016			
Volkswagen	GTI	2014			
Volkswagen	Rabbit	2009			
Volkswagen	Touareg	2017			

Table IA.2: **Discontinuation of Makes.** This table reports the discontinuation dates for US automotive brands since 1995. All dates are from Factiva and represent the press release date.

Brand	**Parent**	**Discontinuation**
Geo	General Motors	December 1997
Eagle	Chrysler	September 1998
Plymouth	Daimler-Chrysler	June 2001
Oldsmobile	General Motors	April 2004
Saturn	General Motors	October 2010
Pontiac	General Motors	October 2010
Mercury	Ford	January 2011
Saab	Saab	December 2011

Table IA.3: **Amount Financed relative to Asset Based Securitization.** This table reports estimates from panel regressions of the amount financed. In columns (1) and (3), the dependent variable is the amount financed by the borrower. In columns (2) and (4), the dependent variable is the log of the amount financed. *Eq/Total* is the dollar value of securitization of equipment loans over the total of credit card, student, and equipment loan securitization. *Q2 Income*, *Q3 Income*, *Q4 Income* are indicators for the 2nd, 3rd, and 4th quartiles of income for the borrower in the year of the vehicle purchase. *Log Borrower Income* is the log of the monthly borrower income. *Post-Crisis* is an indicator =1 if the transaction took place after 2010. The sample period begins in 2003. Robust standard errors are clustered by transaction year. The t-statistics are shown in parentheses below the coefficient estimates. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Post-2007		Full-Sample		Post-2007		Full Sample	
	Amt. Fin.	Log(Amt. Fin.)	Amt. Fin.	Log(Amt. Fin.)	Amt. Fin.	Log(Amt. Fin.)	Amt. Fin.	Log(Amt. Fin.)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Q2 Income	882.89***	0.05***	986.83***	0.06***				
	(8.38)	(5.76)	(11.23)	(8.05)				
Q3 Income	1149.31***	0.06***	1442.24***	0.08***				
	(7.08)	(5.18)	(12.67)	(9.37)				
Q4 Income	1377.68***	0.07***	1834.26***	0.10***				
	(7.25)	(5.02)	(14.65)	(9.06)				
Q2 Income x EQ/Total	1103.04**	0.11***	978.74	0.10**				
	(2.77)	(3.32)	(1.67)	(2.18)				
Q3 Income x EQ/Total	2440.84***	0.18***	2331.01**	0.17**				
	(3.70)	(3.92)	(2.38)	(2.71)				
Q4 Income x EQ/Total	2796.49***	0.19***	2882.08**	0.20**				
	(3.82)	(3.79)	(2.55)	(2.85)				
Post-Crisis x Q2 Income			-61.23	-0.01				
			(-0.48)	(-1.21)				
Post-Crisis x Q3 Income			-260.82	-0.02				
			(-1.13)	(-1.62)				
Post-Crisis x Q4 Income			-493.43	-0.04*				
			(-1.65)	(-2.01)				
Log Income					1342.06***	0.06***	2011.61***	0.11***
					(5.57)	(3.66)	(16.71)	(9.74)
Log Income x EQ / Total					3060.37***	0.22***	3526.45***	0.25***
					(3.64)	(3.93)	(3.25)	(3.85)
Post-Crisis x Log Income							-839.19**	-0.06***
							(-2.69)	(-3.07)
Vehicle Model x Vintage FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dealer FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Parent x Contract Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	228638	228638	290420	290420	228638	228638	290420	290420
Adjusted R^2	0.69	0.69	0.71	0.71	0.69	0.69	0.71	0.71

Appendix A. Theoretical Setup

To illustrate the effects of a durability shock on the consumer financing of asset purchases, we provide a simple model of financing. The key difference between our model and others that examine the effects of durability (e.g., Rampini, 2019), is that we allow for both asset based lending (ABL) as well as cash flow based lending (CFBL). We show that the addition of a sufficient level of CFBL combined with lower income borrowers depending relatively more on CFBL is central to explaining our empirical results. The model consists of two-periods and three agents (consumers, sellers, and lenders). All agents are risk neutral.

Appendix 1.1. Consumers and Goods

There are two types (low and high income) of consumers $i \in \{L, H\}$. Both consumer types have income in each period, but differ in the level of their incomes, where $I_H > I_L > 0$. We further assume that the difference in incomes is not too large, so $2I_L > I_H$. Consumers can purchase one of two types of goods $G \in D, ND$, which we denote durable and non-durable. Durable goods have value $2\gamma > 0$ in the first period if resold, and value γ in the second period. Non-durable goods have value $(1 + \delta)\gamma$ in the first period and value $\delta\gamma$ in the second period, where $\delta \in (0, 1)$ represents the residual value of the non-durable good relative to the durable good. The only difference between the goods is their degree of depreciation. The seller (e.g., a car dealership) of the good earns some profit κ on the sale, meaning the combined price of a good is κ plus its value.

Consumers face no shocks, information is full, and consumers prefer current consumption over delayed consumption. Note the latter assumption is valid if, for example, the lender is more patient than the consumer or if the lender has more diversified income. Moreover, both consumer types would always prefer the more durable good if they can afford it. This assumption holds if the consumer gets the same marginal utility from each good, meaning the benefit is relatively cheaper given the fixed margin κ that the seller of the asset charges. We further presume that purchasing the non-durable good is attractive relative to purchasing nothing, even accounting for consumers' subjective preference for first period consumption.

Appendix 1.2. Pledgeability of Physical and Human Capital

Consumers can borrow from a competitive set of lenders to finance their purchase. As in Rampini (2019), due to the limited pledgeability of assets, lenders require collateral. The consumer can pledge the goods' value in the second period (i.e., ABL) as well as their income in the second period (i.e., CFBL). The pledgeability of physical and human capital is denoted by $\{\theta_G, \theta_I\}$, where both are bounded between $[0, 1)$, which represent the fraction of the asset and income, respectively, that can be pledged as collateral. Naturally, as the pledgeability of human capital θ_I (physical capital θ_G) tends towards 0, the financing will increasingly consist of ABL (CFBL). For simplicity, we assume that the risk-free rate is 0. Consumers face no sanction or cost from defaulting other than the loss of any pledged income or the good.

To examine the interesting parameter space of the model, we assume that high (low)-income consumers can (cannot) afford the durable good if they borrow their maximum feasible limit

$$\theta_I I_L + \theta_G \gamma + I_L < 2\gamma + \kappa < \theta_I I_H + \theta_G \gamma + I_H. \tag{A1}$$

Low income consumers, however, can afford the non-durable good,

$$\theta_G \delta\gamma + \theta_I I_L + I_L > (1 + \delta)\gamma + \kappa. \tag{A2}$$

We assume that κ is such that equations A1 and A2 hold.

Appendix 1.3. Analysis

We now solve for the loan characteristics of low income and high income consumers. Specifically, we examine the (1) down payments, (2) loan-to-value ratios, and (3) payment-to-income ratios of the two types of consumers and then examine the effects of allowing the pledgeability of income θ_I and the degree of depreciation δ to vary.

Appendix 1.3.1. Down Payments

Given the pledgeability constraints and the markup, consumers need to pay for some portion of the good in period 1 using their first period income I_i. Under the assumption that consumers prefer to maximize first period consumption, the consumer will seek to minimize their down payment and maximize their borrowing. We examine the down payments for consumers who purchase the durable and non-durable good separately.

The down payment for the consumer who purchases the durable good is

$$\kappa + 2\gamma - \gamma\theta_g - I_i\theta_I. \tag{A3}$$

The down payment for the consumer who purchases the non-durable good is

$$\kappa + (1+\delta)\gamma - \gamma\delta\theta_g - I_i\theta_I. \tag{A4}$$

If income is sufficiently pledgeable, specifically if

$$\theta_I > \frac{\gamma(1-\delta)(1-\theta_g)}{I_H - I_L}, \tag{A5}$$

then the down payment is greater for the non-durable good, otherwise the down payment will be greater for the durable good. This condition states that the income pledgeability constraint weakens when the difference between the non-pledgeable value of the assets is smaller than the difference in the borrower incomes. As the residual value of the non-durable good δ increases, it becomes relatively more expensive and thus requires a higher down-payment, matching the intuition of Rampini (2019). However, holding the residual value constant, when income pledgeability is high, the down payment of higher income borrower is lower since they can pledge more of their income when borrowing. Thus whether the down payment of the non-durable good is higher depends on the relative difference in the non-pledgeable portion of the assets to the difference in the incomes.

The intuition is that if the residual value is too small, then the *price effect* (i.e., the lower price and down payment from the difference in depreciation) will dominate *the income pledgeability effect* (i.e., lower income supporting smaller cash flow based loan and therefore a higher down payment).

Appendix 1.3.2. Loan-to-Value (LTV) Ratio

We now turn to the loan-to-value (LTV) ratios. The collateral value of the durable and non-durable good to the lender, i.e., the value of the good they can collect on next period, is γ or $\delta\gamma$.

Again, we examine the LTVs for the purchase of the durable and non-durable goods when both ABL and CFBL are available. The LTV for the high-income consumer who purchases the durable good is

$$\frac{\gamma\theta_g + I_H\theta_I}{\gamma}. \tag{A6}$$

The LTV for the low-income consumer who purchases the non-durable good is

$$\frac{\gamma\delta\theta_g + I_L\theta_I}{\delta\gamma}. \tag{A7}$$

If low-income borrowers are more dependent on cash flow based lending, specifically if

$$\delta < \frac{I_L}{I_H}, \tag{A8}$$

then the LTV is higher for the non-durable good, otherwise the LTV is higher for the durable good. This condition is equivalent to saying that the ratio of CFBL to ABL for low-income borrowers is higher than that for high-income borrowers, i.e.,

$$\frac{\theta_I I_L}{\theta_G\delta\gamma} > \frac{\theta_I I_H}{\theta_G\gamma}. \tag{A9}$$

The intuition, for the condition is that the cash flow portion of the financing must be more important for the low-income borrower. If CFBL is relatively more important for the low-income borrower, then their higher CFBL dependence will outweigh the relatively smaller amount they get from borrowing against a lower-valued asset.

The existence of constraints on both the pledgeability of income and the importance of the cash flow based lending provide key implications for empirical tests. Specifically, if less durable goods have higher LTVs, higher downpayments, and are purchased by lower-income consumers, then a key implication of the model is that the lower-income consumers are more dependent on cash flow based lending and that it most be relatively important for auto-lending.

Figure 1 presents a graphical illustration of the results. There are four regions which relate to where the down payment, LTV, and PTI for the non-durable asset purchased by the low-income consumer are relative to the durable asset purchased by the high-income consumer. As income pledgeability θ_I increases, CFBL becomes a relatively large portion of financing to purchase the asset. As δ decreases, CFBL becomes relatively more important for the low-income borrower as the residual value of the non-durable asset is declining, reducing the ability to rely on ABL. When θ_I is relatively high and δ is low, the light blue region (I), the LTV and down payment are higher for the non-durable asset, and the PTI is lower. The level of θ_I to support higher down payments for the non-durable asset, dark blue line, must increase to offset the lower price of the non-durable asset, otherwise the down payment is lower, the red region (IV). If δ is above a certain level, then low-income consumers rely relatively more on ABL and in return the LTV is lower and the PTI is higher, the orange (II) and green regions (III).

Appendix 1.3.3. Payment-to-Income (PTI) Ratio

The payment to income ratio is always lower for the low-income purchaser as long as the low-income purchases is more dependent on cash flow based lending, which is satisfied by equation A8 above. It does not depend on the degree of the pledgeability constraints.[16]

The overall restrictions for δ and θ_I for the down payment, LTV, and PTI results are then

$$1 > \theta_I > \frac{\gamma(1-\delta)(1-\theta_g)}{I_H - I_L} \tag{A10}$$

$$0 < \delta < \frac{I_L}{I_H}. \tag{A11}$$

[16]Note that the payment to income ratio for both types of consumers will be higher with more CFBL (higher θ_I), but since income is in the numerator and denominator of the ratio, the relative level of PTI only depends on the degree of residual value relative to the ratio of incomes.