

Credit Fire Sales: Captive Lending as Liquidity in Distress*

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Abstract

We study the role of captive finance in the car loan market when manufacturers' liquidity demand increases. Using a new multi-country dataset on securitized car loans, we show that captive lending enables a liquidity constrained integrated manufacturer to increase the cash collected from car sales via a *credit fire sale*: reducing loan amounts in the intensive margin and relaxing lending standards in the extensive margin increases car sale down-payments, at the cost of future losses. We exploit quasi-exogenous variation in manufacturers' liquidity cost and need following the Volkswagen emissions scandal to identify the channel. A simple calibrated model shows that a stand-alone manufacturer would have to decrease car prices by 12% to generate the same liquidity of a credit fire sale.

JEL codes: G21, G23, G50.

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1 Introduction

GM Financial is “inherently cash generative during a downturn.”

Dhivya Suryadevara, General Motors CFO (CNBC, May 11th 2020)

Over the last 50 years an increasing number of industrial firms have internalized financial intermediation by creating units that perform bank-like activities - so called “captive lenders” (Banner, 1958; Greenwood and Scharfstein, 2013; Bodnaruk et al., 2016). This phenomenon has been particularly pronounced for durable good industries such as real estate (Stroebel, 2016), cars (Benmelech et al., 2017), and equipment (Murfin and Pratt, 2019).¹ Given the central role durable goods played in the global financial crisis (Bernanke, 2018; Gertler and Gilchrist, 2018; Mian and Sufi, 2018), a natural question arises: does the vertical integration of manufacturing and credit provision affect how shocks to manufacturers/lenders propagate to consumer credit and durable good consumption?

In this paper we uncover a new channel through which captive lending affects the propagation of shocks from durable-good manufacturers to consumers. Captive lending enables manufacturers to convert car inventory into cash by changing jointly credit terms and standards, a behavior that we label a *credit fire sale*. Instead of fire-selling assets (Shleifer and Vishny, 2011) or adjusting product prices (Chevalier and Scharfstein, 1996; Gilchrist et al., 2017), we show that an integrated manufacturer/lender can increase the cash generated via car sales by: 1) lowering loan amount and maturity, which brings forward cash payments by inframarginal buyers, and 2) relaxing lending standards to risky borrowers, which boosts purchases and cash down-payments from marginal buyers.²

¹According to Benmelech et al. (2017) before the crisis nonbank lenders financed more than half of all new cars bought in the United States. General Motors used to run one of the nation’s largest banks, General Motors Acceptance Corp, which “contributed the bulk of the auto maker’s profits, leading critics to label General Motors a bank that happened to sell cars.” (See: <https://www.wsj.com/articles/gm-finance-arm-is-a-profitable-cushion-against-slowing-car-sales-1528023601>). In 2019 captive lenders account for about 28% of total car financing in the United States (See: <https://www.experian.com/content/dam/marketing/na/automotive/quarterly-webinars/credit-trends/q1-2019-safm-final-v2.pdf>)

²Anecdotal evidence during the Covid-19 Pandemic stresses the role of captive lenders for manu-

Credit fire sales have novel implications for how financial shocks affect manufacturers and consumers. The costs of a credit fire sale of car inventory—lower interest revenues and larger default losses—are only realized in the future and difficult to evaluate by outsiders. Instead, the cost of liquidating inventory (or any asset) at fire-sale prices is reflected immediately on the manufacturer’s balance sheet. Also, a credit fire sale shifts car purchases and credit from infra-marginal (safe) borrowers to marginal (risky) borrowers. This implies that the integrated manufacturer’s response to a liquidity shortage may result in an increase in the leverage of risky borrowers (relative to safe ones) that would not occur if a stand-alone manufacturer fire-sells inventory or adjusts product prices, nor if a stand-alone lender cuts credit supply.

Using a new multi-country dataset on over a million securitized used auto loans in Europe, we show that integrated manufacturers/lenders engage in credit fire sales when their cost of external funds increases and liquidity needs are high. The European securitized used car loan market has four distinct features that are ideal for the empirical study of credit fire sales. First, traditional stand-alone banks are active players in the market for financing used vehicles sold by integrated lenders.³ Thus, the credit terms offered by stand-alone lenders provide a useful counterfactual in the empirical analysis. Second, in the used car market we can ignore car manufacturing costs and focus on the transformation of car inventory into cash, the core mechanism behind credit fire sales. Third, credit fire sales of used cars represent an important liquidity management tool for car manufacturers, as exclusive dealing is prevalent in most European countries.⁴ Finally, lenders internalize the bulk of the financial costs of default, since securitized auto loans in Europe are heavily seasoned (securitization

facturers cash management. For example, Ford Chief Operating Officer Jim Farley said Ford Credit “has been indispensable” during the pandemic, while GM’s Suryadevara said GM Financial is “inherently cash generative during a downturn”. In the first quarter of 2020, GM received a \$400 million dividend from GM Financial, while Ford Credit distributed \$275 million to its parent company (See: <https://www.cnbc.com/2020/05/11/coronavirus-detroits-automakers-have-enough-cash-to-last-the-year-without-a-bailout.html>).

³According to a study by Roland Berger in 2016 the captive market share is around 36% in France, Italy and Spain, and 45% in Germany.

⁴According to Nurski and Verboven (2016), who study the impact of exclusive dealing on entry in the European car market, around 70% of European car dealers practice exclusive dealing.

occurs only a year after the loan has been issued) and lenders retain the equity tranche. This implies that agency or information frictions in the securitization market are an unlikely source of confounding variation on loan terms and lending standards.

We begin our analysis by documenting how captive lenders adjust credit terms and standards, *relative* to terms offered by stand-alone banks to purchase the same model/make vehicle in the same location, when their associated manufacturer experiences an increase in CDS price (our measure of manufacturer distress following [Hortaçsu et al. \(2013\)](#)). We find that captive lenders tighten loan terms, increasing down-payments and interest rates, and reducing loan maturity. In the extensive margin, captive lenders increase the proportion of credit issued to buyers without income verification or stable sources of income (e.g., students, self-employed, unemployed). The financial cost of the standard relaxation generates a significant and economically large increase in the probability of future repayment arrears, even after controlling for changes in observable borrower characteristics. All these stylized facts are robust to alternative specifications (e.g., comparing captive and stand-alone within narrower market definitions) and sample sub-periods (e.g., with or without large CDS price changes). Most notably, we show that our results on loan terms tightening and credit standard relaxation are stronger for manufacturers with larger liquidity needs, as measured by a high fraction of outstanding bonds maturing in a given month. Overall, our results are consistent with integrated manufacturers/lenders using credit fire sales as a tool for liquidity management, and difficult to reconcile with alternative interpretations.

Having established these facts, we then provide evidence of a causal link between manufacturer liquidity needs and credit fire sales. To do so we exploit the funding shock to manufacturers resulting from the coincidence of a large fraction of maturing long-term bonds with the unexpected and temporary increase in manufacturers' CDS prices triggered by the Volkswagen emissions scandal.⁵ We posit that for manufacturers *excluding* Volkswagen, the

⁵On September 18, 2015, the U.S. Environmental Protection Agency (EPA) found that approximately 500,000 Volkswagen diesel-engine vehicles sold in the US contained a defeat device that could detect when the car was being tested, changing the performance accordingly to improve results. A number of recent papers study the Volkswagen emission scandal and its implication for example for health outcomes ([Alexander and Schwandt, 2019](#)) and collective reputation ([Bachmann et al., 2019](#)). The shock generated a vast press

coincidence constitutes a purely idiosyncratic funding shock, uncorrelated to demand or any other determinant of the credit terms offered by the associated captive lender. We estimate difference-in-difference specifications comparing credit terms and standards of the captive lenders relative to stand-alone banks, during the two months before and after the scandal. As in the initial analysis, we include car-model \times geographical market \times month fixed-effects.⁶ To evaluate if the Volkswagen shock had any effect on demand that may confound the interpretation, we use manufacturers that did not have a large fraction of bonds maturing (but also experienced an increase in CDS prices following the scandal) as a placebo.⁷

The findings from the causal analysis are qualitatively and quantitatively similar to the stylized aggregate patterns. For integrated manufacturers with high liquidity needs, the increase in the CDS price following the Volkswagen emissions scandal (which corresponds to about 50 basis points) leads to an increase in loan rates by 36 basis points, and a decrease in maturity and loan amount by almost 8% and 10% respectively (relative to stand-alone lenders). Regarding lending standards, the fraction of loans with future arrears increases by 1.2 percentage points (or about a third relative to the mean arrears) relative to loans issued by stand-alone banks, even after controlling for observable borrower characteristics. In contrast, placebo integrated manufacturers with low liquidity needs barely change credit terms or standards despite experiencing the same increase in funding costs. Combining the results on loan terms and credit standards, our estimates show that to gain one additional euro in cash today high-liquidity-need integrated manufacturers are willing to lose 15 cents in present value terms. Hence, credit fire sales allow raising cash at an opportunity cost of 3.8% annualized.

coverage and immediate effects, with the CDS of Volkswagen quadrupling in a few days.

⁶We do not observe some relevant cars characteristics such as engine type or year of manufacturing. For this reason, when studying the effect on contract characteristics, we also add an additional interaction with the quintile of borrowers income which will likely be related to the car unobserved quality within car model. We do not include the additional interaction with income bins when the dependent variables are capturing lending standards as the pool of borrowers will change.

⁷In our high liquidity need group we have BMW, Mercedes and Renault, while in our low liquidity need group we have Toyota, Fiat, Opel, Peugeot and Ford. We check the number of bonds issued in the two months after the Volkswagen emissions scandal and we find that the average number of issuance for the high liquidity group is five, while the average number of issuance for the low liquidity group is 1.2.

While our data and identification approach prevent us from studying aggregate patterns, we look at the total number of cars financed in our sample and the share to low income borrowers in each market and month, for each brand-model by captive and stand-alone lenders. After the Volkswagen emissions scandal, we find that manufacturers with high liquidity needs do not differentially decrease the number of cars financed relative to stand-alone lenders and manufacturers with low liquidity needs, but they increase the share of originations to low income borrowers. This result is suggestive that lax lending standards (and the induced increase in demand from marginal risky borrowers) allow captive lenders to offer worse loan contract terms to infra-marginal borrowers without sacrificing overall volumes. Taken together, the results indicate that liquidity creation through credit fire sales is an important feature of the vertical integration of car manufacturers with auto lenders, with implications for the transmission of shocks to consumers with different risk profiles.

In the last part of the paper we evaluate quantitatively the liquidity created by credit fire sales using a simple two-period model of borrowers' demand for cars and loans with stand-alone and captive lenders. In the stylized model calibrated to the micro-data, we find that captive lending can lead to a relaxation of lending standards even if the integrated manufacturer is not liquidity constrained, because the profits from marginal car sales outweigh the losses from marginal defaults. We then use the model to compute the cash generated by a credit fire sale and its "car fire sale equivalent" for a stand-alone manufacturer. In our baseline calibration, we find that the average credit fire sale observed in the data generates the same amount of cash as a €1,000-1,600 reduction in car sale price by a stand-alone manufacturer, which corresponds to approximately a 12% discount from the equilibrium car value. Through the lens of the model, we also compare the cost of credit fire sales *relative* to car fire sales. The latter is captured by the lower revenues on the cars that would have been sold absent the price decrease; the former is due to: 1) expected losses from lending to risky marginal borrowers; 2) lower interest rate revenues from inframarginal borrowers. Our calibrated model shows that to generate the same amount of cash a credit fire sale is about 60% cheaper than a traditional fire sale for the average manufacturer.

Related literature. Our work is related to the literature on captive finance, which has proposed different explanations for the existence of captive lenders: price discrimination (Brennan et al., 1988); asymmetric information (Stroebel, 2016); commitment problems and the Coase conjecture (Murfin and Pratt, 2019). In this paper we show that captive lending adds a new tool for liquidity management for manufacturers in distress.

Thus our work is related to the vast literature on liquidity shocks and financial frictions. This literature has proposed two alternative mechanisms through which a financially distressed stand-alone manufacturers can raise internal liquidity. The first is a traditional fire sale (Pulvino, 1998; Benmelech and Bergman, 2008; Campbell et al., 2011). Shleifer and Vishny (2011) define a *fire sale* as “a forced sale of an *asset* at a dislocated *price*”. Our paper extends this traditional definition: a *credit fire sale* is a forced sale of an *asset bundled with financing* at dislocated *contract terms*. The integration of manufacturing and financing broadens the set of contract terms that can be adjusted to create liquidity. The cost of credit fire sales—due to lower revenues from interest payments and increased risk-taking in lending—accrue in the future and can be substantially lower than the immediate and certain losses of a traditional fire sale.

The second mechanism, proposed by work in macroeconomics to explain why prices increase during recessions, argues that manufacturers can generate internal liquidity by raising product prices when consumers face switching costs or have preferences with habit formation (Chevalier and Scharfstein, 1996; Gilchrist et al., 2017). Since credit fire sales occur through the dislocation of financing terms, they can be used to generate liquidity even if consumers have standard preferences. More importantly, credit fire sales also have potential macroeconomic implications, although not on prices. Large scale credit fire sales by distressed integrated manufacturers/lenders can lead to a reallocation of credit from safe to risky borrowers during economic downturns, potentially exacerbating aggregate leverage cycles.

Hence, our findings imply that vertical integration between production and financing fundamentally alters the credit responses to financing shocks relative to the case in which

the two functions are performed by separate entities. Existing literature documents how stand-alone lenders that face a liquidity shock tighten credit supply, especially to high-risk borrowers (Khwaja and Mian, 2008; Paravisini, 2008; Ivashina and Scharfstein, 2010; Amiti and Weinstein, 2011). This paper demonstrates that a liquidity shock to a captive lender may lead to the exact opposite: an expansion in credit to high-risk borrowers. These findings imply that the integration of manufacturing and financial intermediation can change the sign, magnitude, and timing of the real effects of liquidity shocks to lenders and manufacturers. These new insights complement existing work on the transmission of financing shocks to the real economy (Almeida et al., 2009; Paravisini et al., 2014, 2015; Costello, 2020).

Finally, our work also contribute to the literature that studies car finance (Attanasio et al., 2008; Adams et al., 2009; Argyle et al., 2017, 2018, 2019; Melzer and Schroeder, 2017). While most previous work has focused on the demand for car loans, we focus on the supply side. Thus, our paper is related to Salz et al. (2020) who study with a quantitative model the effects of dealers discretion when prime borrowers have different demand-side elasticities to rate and car prices. We complement their work focusing on discretion by vertically integrated manufacturers/lenders, when borrowers are heterogeneous on the risk dimension and manufacturers experience liquidity shocks. Hence, our paper is very related to the work by Benmelech et al. (2017) who study the effect of the collapse of the asset-backed commercial paper market on auto sales, through illiquidity of nonbank lenders. We complement their work by looking at how captive lenders can instead provide liquidity in the presence of shocks to the manufacturers. In this way, our paper is also related to Hortaçsu et al. (2013), who show that financial distress can decrease demand for the distressed firm products, thus affecting cash flows. We show how integrated car manufacturers manage cash flows in response to increase in external financing costs through their captive lending units.

Overview. The remainder of the paper is organized as follows. Section 2 describes the data sources and summary statistics for traditional banks and captive lenders. Section 3 shows stylized evidence on credit fire sales and in support of the liquidity creation channel. Section 4 discusses the identification strategy and presents the results from the Volkswagen

emission scandal. Section 5 presents a simple model of a car and loan market with stand-alone and captive lenders, and show the results of the quantitative exercise. Section 6 concludes.

2 Data and Setting

2.1 Data

Sources. Our main dataset comprises car loans securitised by European banks and captive lenders over the period December 2013 to December 2017. These data are available through the European Data Warehouse (EDW) and are reported according to the Asset Backed Security (ABS) template used by ECB within the framework of the 100 percent transparent policy on securitized loans. EDW collects information on all outstanding car loan securitizations from 2013. We focus on loans originated between December 2013 and December 2017 for buying used cars.⁸ For our analysis the advantage of focusing on used cars is twofold. First, the coverage of new cars is poor for diversified lenders. In the final sample, only 6% of the loans for the purchase of new cars are granted by diversified lenders, whereas this fraction is 41% for the used cars.⁹ Second, in the used car market we can ignore car manufacturing costs and focus on the transformation of car inventory into cash, the core mechanism behind credit fire sales.

Our final sample consists of about 1.2 million car loans granted by stand-alone banks (Banco Santander, Bank Deutsches Kraftfahrzeuggewerbe, Bank 11, BNP Paribas, Socram Banque) and captive lenders from nine large parent manufacturers (BMW, Fiat Chrysler, Ford, Mercedes, Opel/GM, Peugeot, Renault, Toyota and Volkswagen) over the period December 2013 to December 2017 to individuals domiciled in France, Germany, Italy and Spain. These loans are part of the pool of 37 securitizations and are granted for the purchase of

⁸In Appendix A we discuss in detail how we build the final dataset used in main analyses.

⁹Our identification strategy requires that for a brand-model in a market at a certain time we always observe at least a loan issued by a captive and a loan issued by a diversified lender. This requirement is even stronger in the several sample splits that we implement to understand the joint role of manufacturers' liquidity cost and need.

25 different brands and 272 different models made by the nine manufacturers mentioned above. All the loans that form our final sample are fixed-rate loans with a monthly payment frequency. In terms of coverage, for three captive lenders in our sample that operate in Spain we collected data from the Spanish credit register from January 2016 onward. For this subset of lenders, our initial sample of securitized loans represents more than 65% of the total amount of loans granted by the three captive lenders.¹⁰

Our analysis combines the previously described dataset and three additional ones. The information on the lender’s balance sheet is obtained from SNL (at branch or subsidiary level) and include proxies for size (logarithm of total assets), risk (equity over total assets) and profitability (ROA). CDS prices for the underlying lenders’ debt securities are obtained from Reuters. We use Dealogic to conduct the analysis based on the financing needs of manufacturers. More specifically, we use information on all individual debt securities issued by the parent firm or its subsidiaries (issuance and maturity dates and amount issued) to define the liquidity needs of manufacturers.

Summary statistics. Table 1 shows the main variables used in the analysis. Panel A shows the main contract characteristics. The average car loan in the sample has an interest rates of 6.2%, a maturity of 51 months and a loan-to-value of 73%. There is lots of variation in all contract dimensions with rates ranging from 3 to 10%, maturities from 14 to 84 months and loan-to-value from about 20 to more than 110%. The average car value is about €13 thousand and car values go from about €4 thousand to €25 thousand.

Panel B and C of Table 1 show borrowers characteristics and performances, respectively. The average annual gross income is about €36 thousands and it goes from about €7 thousands to more than €60 thousands. About 81% of borrowers are paid employee, 6% are self-employed, 1% student or unemployed and 11% pensioners. Income is verified in about 62% of loans. Finally, about 5% of loans are in arrears.¹¹

¹⁰Additionally, the maturity in our sample (51 months) is almost identical to the one for the universe of loans in the credit register (53 months).

¹¹The arrears dummy is defined combining four variables contained in our dataset. The arrears dummy is equal to one if after one year from origination the loan has been in arrears at any time, the number of months in arrears is higher than zero, the arrears balance at the cutoff date is positive or the loan is in default. Some of these variables are missing for one captive lender and two stand-alone banks and for this

Table 1: SUMMARY STATISTICS

	Mean	Median	SD	P5	P95	N
Panel A: Loan terms and car value						
Interest (%)	6.18	6.00	2.21	3.00	10.00	1,155,450
Maturity (Months)	50.95	49.00	18.79	14.00	84.00	1,155,450
Size (euro)	9,216	8,269	5,640	2,125	19,599	1,155,450
Car value (euro)	13,192	12,387	6,281	4,707	24,440	1,155,450
LTV (%)	72.79	80.00	30.37	17.65	112.36	1,155,450
Panel B: Ex - ante risk measures						
Income (euro)	35,855	24,000	7,192,142	7,200	63,000	1,113,559
Paid-employed (0/1)	0.81	1	0.39	0	1	1,155,450
Self-employed (0/1)	0.06	0	0.24	0	1	1,155,450
Unemployed (0/1)	0.01	0	0.12	0	0	1,155,450
Student (0/1)	0.01	0	0.08	0	0	1,155,450
Pensioner (0/1)	0.11	0	0.31	0	1	1,155,450
Verified (0/1)	0.62	1	0.49	0	1	1,155,450
Panel C: Ex - post risk measures						
In arrears (0/1)	0.05	0.00	0.22	0.00	1.00	708,470
Panel D: Security						
Avg seasoning (Months)	15	15	5	1	22	37
Panel E: Manufacturers						
CDS (%)	1.252	1.034	0.915	0.279	3.020	441
Maturing bonds (%)	11.205	9.719	9.357	0.000	30.486	441
Panel F: Lenders						
ROA (%)	0.919	0.910	0.692	0.000	1.970	763
Equity / TA (%)	11.070	10.550	8.789	6.750	13.730	763
Log(TA)	16.597	16.902	1.273	14.487	18.414	763

Note: Summary statistics for the main variables used in the analysis. Panel A shows the main contract characteristics. The interest rate is in percentage points; maturity is in months; the size of the loan and the car value is in euros; the loan-to-value is in percentage points. Panel B shows borrowers characteristics. Income is in euros; paid-employed, self-employed, unemployed, student, pensioner are dummies for the status of the borrower; verified is a dummy equal to one if the income in the application has been verified by the lender. Panel C shows the ex-post performances. Arrears is a dummy equal to one if the loan is late payment starting one year after origination. Panel D reports the average seasoning in months at the securitization level. Panel E reports the characteristics for the manufacturers. CDS is the credit default swap of the manufacturer the first day of each month t ; maturing bonds is the face value of maturing bonds in each quarter as a percentage of total outstanding bonds value at the beginning of the quarter. Panel F reports the characteristics for the lenders. ROA is return on assets; TA is total assets. The tables reports the mean, the standard deviation, the median, and 5th and 95th percentile in the full sample. N is the number of observations.

Panel D shows the average seasoning at the securitization level. The average seasoning is approximately 15 months. Hence there is a lag greater than a year between the date

reason we remove them from the analysis on arrears.

the loan is originated and the date the loan is added to the security pool. Additionally, while we do not observe in the data what fraction of the securitization is retained by the issuer, we used the International Securities Identification Number (ISIN) to manually check the securitization prospectus. For all securitization in our sample for which we found an available prospectus the issuing lender retained a material net economic interest which is never less than 5% in accordance with regulatory requirements.¹²

Panel E and F of Table 1 show manufacturers' and lenders' variables, respectively. The average CDS in the sample is 120 basis points, but there is a lot of variation with CDS as high as 300 basis points. The average value of maturing bonds as a fraction of the total outstanding value is about 11%. There are manufacturers-month pairs with no maturing bonds, and months in which a manufacturer has more than 30% of the value of outstanding bonds maturing. Finally, we report lenders controls that we use in our regressions. Lenders average return on assets is about one, while the ratio of equity over total assets is around 11%. The average lenders' (log) total assets are around 16 millions, ranging from one to more than 18 millions.

2.2 Captive Lenders VS Stand-alone Banks

To set the stage for our empirical strategy, in this section we provide stylized facts of the difference in car loan terms and lending standards between captive lenders and traditional stand-alone banks.¹³ Table 2 shows the main variables used in the analysis by lender type.

Loans granted by captive lenders have on average a significantly higher interest rate

¹²For example the prospectus of one of the securitization in our sample reads: "The Seller will retain for the life of the Transaction a material net economic interest of not less than 5 per cent in accordance with Article 405 of Regulation (EU) No 575/2013 of the European Parliament and of the Council of 26 June 2013 on prudential requirements for credit institutions and investment firms and amending Regulation (EU) No 648/2012 (the "CRR")."

¹³Figure A1 in Appendix B shows the share of loans made by two captive and two traditional lenders for approximately 25 different brands. Captive lenders fully specialize in their brands: approximately 45% of PSA loans are for Citroen and 55% for Peugeot; more than 60% of Volkswagen finance loans goes to Volkswagen and Seat, which is also part of the group. Diversified lenders spread their loans across different brands. Bank A has no share greater than 30% in any brand, while lender B is even more diversified with no single brands accounting for more than 15% of the loans.

(6.8%) than loans by traditional banks (5.2%). Captive lenders also offer on average shorter maturities (48 months versus 55 months) and lower loan-to-values (64% versus 85%) than traditional banks. The LTV difference comes, both, from captive lenders financing on average relatively more expensive cars (€13.7 versus 12.4 thousands) and lending smaller amounts (€8.5 versus 10.2 thousands).

Table 2: SUMMARY STATISTICS BY LENDER TYPE

	Captive lenders			Diversified banks			Difference
	Mean	SD	N	Mean	SD	N	
Panel A: Loan terms and car value							
Interest (%)	6.81	2.17	681,633	5.26	1.94	473,817	1.55***
Maturity (Months)	47.98	17.38	681,633	55.22	19.89	473,817	-7.24***
Size (euro)	8,508	5,304	681,633	10,235	5,945	473,817	-1,727***
Car value (euro)	13,711	6,094	681,633	12,445	6,469	473,817	1,265***
LTV (%)	65.22	30.41	681,633	85.13	25.71	473,817	-20.90***
Panel B: Ex - ante risk measures							
Income (euro)	36,352	9,479,542	640,971	35,180	69,096	472,588	1,172
Paid-employed (0/1)	0.82	0.38	681,633	0.80	0.40	473,817	0.03***
Self-employed (0/1)	0.04	0.19	681,633	0.10	0.30	473,817	-0.06***
Unemployed (0/1)	0.02	0.14	681,633	0.00	0.05	473,817	0.02***
Student (0/1)	0.01	0.09	681,633	0.01	0.07	473,817	0.00***
Pensioner (0/1)	0.11	0.31	681,633	0.10	0.30	473,817	0.01***
Verified (0/1)	0.35	0.48	681,633	1.00	0.02	473,817	-0.6***
Panel C: Ex - post risk measures							
In arrears (0/1)	0.06	0.23	452,497	0.05	0.21	255,973	0.01***

Note: Summary statistics for the main variables used in the analysis. Panel A shows the main contract characteristics. The interest rate is in percentage points; maturity is in months; the size of the loan and the car value is in euros; the loan-to-value is in percentage points. Panel B shows borrowers characteristics. Income is in euros; paid-employed, self-employed, unemployed, student, pensioner are dummies for the status of the borrower; verified is a dummy equal to one if the income in the application has been verified by the lender. Panel C shows the ex-post performances. Arrears is a dummy equal to one if the loan is late payment starting one year after origination. The tables reports the mean and the standard deviation for captive and diversified lenders in the full sample. N is the number of observations. The last column reports the difference in means between the means for captive and diversified lenders. *, **, and *** denote significance at the 10%, 5% and 1% levels, respectively.

In Panel B of Table 2 we look at borrowers characteristics at origination. Borrowers from captives and banks have similar income level. Captive lenders are more likely to lend to unemployed borrowers and pensioners, while diversified lenders are more likely to lend to self-employed borrowers. All loans issued by traditional banks have the borrower's income verified at origination, while only 35% of the loans issued by captive lenders have income

verification.¹⁴ Finally, borrowers from captive lenders are about 1 percentage point more likely to be in default than borrowers from banks, 6% relative to 5% respectively.

To summarize, captive lenders offer relatively worse financing conditions (higher rate, lower maturity, lower loan-to-value) and target a segment of the buyer population that is less likely to obtain bank credit. These differences are consistent with a segmented market for auto loans, where captive lenders have some market power over customers with high shopping costs, as captives provide a convenient one-stop shop alternative, and higher risk, as captives seem to be willing to lend without income verification. The existence of market power and segmentation implies that captive lenders can adjust loan terms and lending standard to create liquidity following shocks to their parent manufactures, which is the main object of our analysis.

3 Credit Fire Sales: Stylized Evidence

A stand-alone manufacturer without a captive lender can generate liquidity internally via a fire sale, which implies adjusting the car sale price.¹⁵ When the manufacturer also provides captive finance, the possibility of a credit fire sale arises. The manufacturer/lender can adjust an array of credit contract terms to increase the cash flows received at the time of the car purchase. First, the manufacturer/lender can reduce the price of the loan (instead of the price of the car) to sell more cars. Second, the manufacturer/lender can reduce the loan amount, which increases the cash flow from the down payment at the time of the sale, at the cost of reducing future cash flows from interest and principal payment.¹⁶ Third, the manufacturer/lender can adjust the extensive margin directly by relaxing lending standards, which increases car purchases through the loan approval rate of prospective buyers seeking

¹⁴The difference can be partly due to a technological advantage of stand alone lenders, who have access to other information about their customers (e.g., mortgage borrowing, cash account balance and activity). Moreover, due to data protection, captive lenders cannot verify the income status of some borrowers.

¹⁵Our focus in this paper is on internal liquidity creation. The manufacturer can also acquire liquidity externally by borrowing or drawing down on credit lines, if these options are available.

¹⁶Figure A2 in Appendix B shows the cash flows for an hypothetical one-period car loan in two cases: (a) with only traditional stand-alone lenders; (b) with captive lenders.

financing.¹⁷ Relaxing standards comes at the cost of future higher losses related to default. Finally, the manufacturer/lender can reduce the time until repayment by shortening loan maturity.

This section provides stylized evidence consistent with credit fire sales being used as a tool for liquidity management. We begin by discussing our manufacturers’ distress measure and empirical framework. Then we show how captive lenders adjust loan terms and lending standards relative to stand-alone lenders when the parent manufacturer experiences distress. Finally, we show that captive lending liquidity creation through a credit fire sale is more prevalent for manufacturers facing high financing costs when liquidity needs are high.

3.1 Measures and Empirical Specification

We follow [Hortaçsu et al. \(2013\)](#) and measure financial distress using the car manufacturers credit default swaps (CDS).¹⁸ While the parent manufacturer and the captive lending unit may have separate funding sources, we use the manufacturer CDS as a measure of distress for the entire vertically integrated producers (i.e., the manufacturer plus the captive finance arm). Panel (a) of Figure [A3](#) in Appendix [B](#) shows the CDS separately for Ford and Ford Motor Credit. The two CDSs are almost identical with a correlation of about 0.98.¹⁹

We use the following baseline empirical model to evaluate how car loan contract terms change with manufacturer distress differentially between loans financed by captive lenders and those financed by stand alone banks:

$$y_{ilbmt} = \alpha \text{Manuf.CDS}_{bt} \times \text{Captive}_l + \theta X_{ilt} + \gamma_l + \gamma_{bmt} + \epsilon_{ilbmt}, \quad (1)$$

where y_{ilbmt} is outcome of interest y (e.g., interest rate, maturity, loan amount, car value, and

¹⁷In Section [5.1](#) we sketch a simple model to explore this important dimension.

¹⁸Throughout the paper we use the term financial distress and high financing costs interchangeably.

¹⁹For other car makers separate high frequency data on the CDS for both the parent manufacturer and the captive unit are not available. However, we also check the yields on comparable bonds issued by manufacturers and their captive unit and find on average a very high correlation. For example, Panel (b) of Figure [A3](#) shows the yields on a bond issued in March 2014 by Renault and on a bond with the same maturity issued in the same month by RCI (Renault Credit International). The yields are very similar with a correlation of about 0.97.

borrower characteristics) for individual i borrowing from lender l and buying brand-model b in market m and period t ; $Manuf.CDS_{bt}$ is the manufacturer’s CDS at the beginning of period t ; $Captive_l$ is a dummy equal to one if the lender is a captive firm; X_{it} are borrower and lenders controls; γ_l are lender fixed effects; and γ_{bmt} are interacted brand-model, market and time fixed effects. The coefficient of interest is α which captures the effect of variation in manufacturer CDS on loan terms and lending standard by captive lenders *relative* to stand-alone banks.

Our ideal experiment would be to observe the *same individual borrower* buying two *identical cars* using financing from both a captive lender and a stand-alone lenders in the *same period* (and we need this ideal experiment for different levels of the manufacturers’ CDS). Needless to say, this ideal experiment is unlikely to be observable in reality. We include in equation (1) car-model \times geographical market \times month fixed-effects to capture for several factors that can affect loan terms and lending standards. Our stringent set of fixed effects allow us to focus on variation between loans originated by captive relative to stand-alone lenders for the same brand-model in the same market and time.

We do not observe some relevant cars characteristics such as engine type or year of manufacturing, which can affect the resale value upon default among other things. For this reason, when studying the effect on contract characteristics, we also add an additional interactions with the quintile of borrowers income which will likely be related to the car unobserved quality within brand-model. Our quintiles of borrowers income are defined within geographical market and year. We do not include the additional interaction with income bins when the dependent variables are capturing lending standards as the pool of borrowers might change. Finally, equation (1) includes lenders’ fixed effects, thus removing time-invariant differences in loan terms between captive and stand-alone lenders. Thus we only use the variation over time and across manufacturers in financial distress *interacted* with the type of car loan provider (captive versus stand-alone) in the estimation.²⁰

²⁰Note that the use of lender fixed effects captures not only time-invariant differences between captive and stand-alone lenders, but also time-invariant differences across captive lenders of different manufacturers (and across different stand-alone lenders). Also, the car-model \times geographical market \times month fixed-effects absorb the direct effect of manufacturers CDS on loan terms and lending standards.

3.2 Results: Captive Contract Terms and Lending Standards

The estimation results using loan terms as the dependent variable are presented in Table 3. We find that when the car manufacturer CDS increases captive lenders increases the interest rate for car loans relative to stand-alone banks. Our basic specification indicates that a 100 basis point increase in a manufacturer’s CDS spread increases the relative rate by captive lender by 13 basis points, or about 2% of the average loan rate. This increase very likely reflects the passthrough of the higher financing costs faced by the manufacturer to borrowers. If the manufacturer/lender is using lower interest rates to spur car purchases, the effect is second order relative to the impact of the cost of capital. Additionally, lower interest rates may not be the most effective way to promote sales if consumer are less sensitive to interest rates than to car prices.²¹

At the same time, captive lenders shorten the maturity and decrease the loan amounts relative to standard banks when the car manufacturer CDS increases. The decline in maturity is statistically significant, but small in magnitude around 0.8%, while loan size declines by almost 2%. These results are consistent with a credit fire sale when the manufacturer parent company is in distress. Finally, we do not find evidence of differential changes in the price of the car between captive lenders and traditional banks when the CDS of the manufacturers increase. This does not imply the absence of a traditional fire sale, only that traditional fire sales do not occur more prevalently amongst cars financed by captive lenders than among car financed by stand-alone banks.

Columns (5) to (8) of Table 3 report the estimates when we include income bins to the car-model \times geographical market \times month fixed-effects to better control for unobservable car characteristics which may be correlated with borrower income. The estimates for interest rates are not affected, while the effects on maturity and loan size become statistically insignificant (even if the magnitudes are similar). This suggest that our stricter set of fixed effects could capture differential changes between captive and stand-alone in the type of

²¹For example, [Salz et al. \(2020\)](#) find that consumers are substantially more sensitive to changes in car prices than loan rates in the US.

Table 3: DISTRESS AND CAPTIVE LENDING: CONTRACT TERMS

	CONTRACT TERMS							
	Rate	Maturity	Loan size	Car value	Rate	Maturity	Loan size	Car value
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Manuf. CDS \times Captive Lender	0.133*** [0.049]	-0.008** [0.004]	-0.019** [0.008]	-0.006 [0.008]	0.130** [0.051]	-0.008 [0.005]	-0.013 [0.010]	-0.000 [0.009]
Fixed effects:								
Model-Region-Time	YES	YES	YES	YES	NO	NO	NO	NO
Model-Region-Time-Income	NO	NO	NO	NO	YES	YES	YES	YES
Lender	YES	YES	YES	YES	YES	YES	YES	YES
Additional controls:								
Lender-time	YES	YES	YES	YES	YES	YES	YES	YES
Borrower	YES	YES	YES	YES	YES	YES	YES	YES
Avg Dep Var	6.177	3.868	8.940	9.372	6.177	3.868	8.940	9.372
R^2	0.780	0.334	0.464	0.586	0.819	0.451	0.554	0.662
Observations	906,085	906,085	906,085	906,085	611,108	611,108	611,108	611,108

Note: The Table shows the results from equation (1). The dependent variables are the interest rate in percentage points, maturity in log, loan size in log and car value in log. Manuf. CDS is the CDS of the manufacturer of the car. Captive is a dummy equal to one if the lender originating the loan is a captive lender. Model, region and time fixed effect are interacted fixed effects for the brand-model, the region where the car was sold and the month and year in which it was sold. Model, region, time and income fixed effect include an additional interaction with income quintiles defined within geographical market and year. Region is defined as NUTS2. Lender-time controls are ROA, Equity as a fraction of total assets and the logarithm of total assets. Borrowers controls are income, employment status dummy and dummy for verified income. Standard errors are double clustered at brand-model and region-lender levels. *, **, and *** denote significance at the 10%, 5% and 1% levels, respectively.

borrowers they finance when the manufacturer is in distress. Additionally, Table 3 pools together manufacturers with different liquidity needs, which could have very different incentives in engaging in credit fire sales. We explore changes in lending standards next and the role of manufacturers' liquidity needs in Section 3.3.

Since we do not have data on loan approvals, we adopt an indirect approach to measure how lending standards change when the manufacturer is in distress. We exploit the fact that relaxing lending standards must lead, at least weakly, to a riskier loan portfolio. We measure the riskiness of auto loans in two ways. First, we use loan and borrower observable characteristics that can be associated with higher repayment risk (e.g., lack of income verification, low borrower income, borrower is unemployed, etc.). Second we use the realized loan default rate.

We estimate equation (1) with these risk measures as dependent variables. Table 4 shows the results. The results for demographics variables at origination suggest a relaxation of lending standard by the captive unit when the parent company is in distress. The average income of captive loan recipients decreases relative to traditional bank loan recipients, for the same brand-model in the same market, but the effects are imprecisely estimated. Also, the fraction of loans to unemployed, self-employed, students and pensioners by captive lenders increases, relative to stand-alone banks. The estimates are statistically significant and large in magnitude. A 100 basis points increase in the manufacturer’s CDS spread can be associated with a 2 percentage point increase in the fraction of unemployed and self-employed captive auto loan recipients.

Table 4: DISTRESS AND CAPTIVE LENDING: LENDING STANDARDS

	LENDING STANDARDS			
	Income	Other employment	Income verified	Arrears
	(1)	(2)	(3)	(4)
Manuf. CDS × Captive Lender	-0.008 [0.005]	0.021*** [0.005]	-0.053*** [0.013]	0.017*** [0.006]
Fixed effects:				
Model-Region-Time	YES	YES	YES	YES
Lender	YES	YES	YES	YES
Age-Time	NO	NO	NO	YES
Additional controls:				
Lender-time	YES	YES	YES	YES
Borrower	NO	NO	YES	YES
Avg Dep Var	10.058	.188	.615	.053
R^2	0.478	0.330	0.887	0.308
Observations	906,085	906,085	906,085	567,860

Note: The Table shows the results from equation (1). The dependent variables proxy for ex-ante risk are the borrower income in log, a dummy for borrowers who are student, pensioner, unemployed or self-employed, and a dummy for verified income. The dependent variable for ex-post risk is a dummy equal to one if the loan is late payment starting one year after origination. Manuf. CDS is the CDS of the manufacturer of the car. Captive is a dummy equal to one if the lender originating the loan is a captive lender. Model, region and time fixed effect are interacted fixed effects for the brand-model, the region where the car was sold and the month and year in which it was sold. Region is defined as NUTS2. Lender-time controls are ROA, Equity as a fraction of total assets and the logarithm of total assets. Borrowers controls are income, employment status dummy and dummy for verified income. Standard errors are double clustered at brand-model and region-lender levels. *, **, and *** denote significance at the 10%, 5% and 1% levels, respectively.

Column (3) of Table 4 shows the estimation result using an indicator for verified income

as the dependent variable. The sign of the estimate indicates that the captive lender of a manufacturing company in distress decreases the share of verified income loans relative to diversified banks. The point estimate implies that a 100 basis points increase in a manufacturer's CDS spread decreases the relative share of verified income by captive lender by 5 percentage points, or 15% of the unconditional income verification rate by captive lenders.

Overall, the results on verified income and borrowers characteristics at origination suggest a relation of lending standards by captive lenders relative to traditional banks when the car manufacturing company experience an increase in CDS. We confirm this behavior by looking at ex-post loan performance. Column (4) of Table 4 shows that loans originated by captive lenders when manufacturer's CDS spread increases by 100 basis points are 1.7 percentage points more likely to be in arrears over the course of the loan than loans originated by stand-alone lenders. Given a baseline default probability of approximately 5 percentage points, our results represent approximately a 30% increase in the probability of future arrears.

Our analysis thus far provides two main findings about the propagation of shock to manufacturers when production and financing are vertically integrated. First, the loan terms results imply that a shock to manufacturers generates a response by captive lenders akin to a credit tightening by a traditional stand-alone lender: captive lenders increase rates, lower loan amounts and shorten maturities. Additionally, the larger down payment and shorter maturity generate a reallocation of cash flows toward the present when liquidity is more costly, potentially avoiding the need to draw down liquidity or restore to fire sales. Second, the lending standard results imply that a shock to manufacturers generates a response by captive lenders that is the opposite of a credit tightening by traditional stand-alone lenders. Captive lenders relax lending standards to promote sales and increase liquidity in the short term, at the cost of uncertain higher losses in the longer term. Both the loan terms and lending standard adjustments are consistent with the integrated manufacturer maximizing current liquidity. In Section 3.3 we explore further the mechanism.

3.3 Channel: Captive Lenders Liquidity Creation

We have shown so far how captive lenders differentially adjust loan terms and lending standards when the parent manufacturing company is in financial distress. The results are consistent with captive lenders adjusting lending standards to push demand for the car manufacturer good, by lending to riskier borrowers. At the same time, the evidence is consistent with captive lenders adjusting loan terms to increase the car manufacturer current liquidity, with or without increasing demand. As an example, we find that when the CDS are high a captive lender requires larger down payments. All else equal, larger down payment requirements increase the liquidity today for the manufacturers, but without increasing demand along the extensive margin, all else equal. A larger down payment requirement may even reduce overall demand if more constraint borrowers cannot afford it and delay buying the good or move to a competitor. Is this therefore the combination of the loan terms adjustment and lending standards that allow the manufacturers through the captive unit to extract liquidity from inframarginal buyers, without losing (or even increasing) marginal buyers.²²

To understand the importance of liquidity creation when manufacturers experience financial distress, we construct a measure of liquidity needs for car manufacturers. If the differential behavior of captive lenders relative to stand-alone lenders when the manufacturing company is in financial distress is driven by a liquidity creation motive, we expect our results to be stronger when the manufacturer needs liquidity relative to when the manufacturer has enough liquidity. Our measure is based on the fraction of expiring bonds. In practice, we estimate our baseline empirical model given by equation (1), separating the full sample into two subgroups based on the manufacturers' liquidity needs. First, we compute for each manufacturer in each quarter the face value of manufacturer b expiring bonds over its total amount of outstanding bonds at the beginning of the quarter. Second, we classify a car manufacturer as facing high liquidity needs, if it lies in the top quartile of the distribution of this ratio in our sample. Based on this classification, we check that all manufacturers in

²²By extending loans to ex-ante riskier borrowers the captive unit can offer worse financing terms without sacrificing overall volumes. We explore this trade-off further in both Sections 4 and 5.

our sample belong to the high liquidity need group in at least one month.²³ We expect the coefficient α in equation (1) in the high liquidity needs sample to capture the effect of captive lenders as liquidity providers in distress.

Table 5 shows the results. Panel A reports the results obtained for the periods in which the car manufacturer has a high relative need of liquidity, while Panel B contains the results for the period in which the car manufacturer has relatively low liquidity needs. We find that the differential adjustment of loan terms by captive lenders when the manufacturer's CDS is high are more likely to be significant and stronger in magnitude when the average value of maturing bonds as a fraction of the total amount outstanding is high. Following a 100-basis-points increase in the parent manufacturer's CDS, captive lenders increase rate by about 30 basis points when they have high liquidity needs, while the increase is about 11 basis point when the manufacturer's liquidity needs are low. Both maturity and loan-to-value decrease by a significant and large amount when the manufacturers needs liquidity, while the effects are not significant and small in magnitude when liquidity needs are low.

In columns (5) to (8) of Table 5 we look at how captive lending standards adjust during financial distress for different manufacturers' liquidity needs. When the manufacturer is in distress and has high liquidity needs, captive lenders extend more loans to borrowers with relative lower income than stand-alone lenders. The effect is large in magnitude, as borrowers' income decline by about 4%. Furthermore, the income is less likely to be verified. When the car manufactures' CDS and liquidity needs are high, captive lenders reduce the relative share of verified income by 11 percentage points, while the decrease is about 4 percentage points when the manufacturers liquidity needs are low. Finally, when the car manufactures' CDS increases by 100 basis points and liquidity needs are high, we find that loans originated by captive lenders have a 3 percentage points higher probability of future arrears, while when the CDS increases but liquidity needs are low the increase in arrears is not significant and

²³For a given manufacturer to be considered it should have at least three outstanding bonds, to discard that a manufacturer with just one or two outstanding bonds that mature in a given month are classified as high liquidity needs. Results are identical if we do not impose this constraint and robust if we require that the manufacturer has at least five outstanding bonds instead of three. Table A1 in Appendix B reports the results when we impose that manufacturers should have at least five outstanding bonds.

Table 5: CAPTIVE LENDERS LIQUIDITY CREATION CHANNEL

	CONTRACT TERMS				LENDING STANDARDS			
	Rate	Maturity	Loan Size	Car value	Income	Other employment	Income verified	Arrears
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: High liquidity need manufacturers								
Manuf. CDS \times Captive Lender	0.292*** [0.069]	-0.032** [0.014]	-0.040* [0.023]	-0.002 [0.018]	-0.042*** [0.009]	0.020* [0.012]	-0.117*** [0.031]	0.030*** [0.010]
Avg Dep Var	6.18	3.867	8.895	9.422	9.983	.185	.564	.060
R^2	0.808	0.476	0.548	0.666	0.442	0.319	0.836	0.313
Observations	144,407	144,407	144,407	144,407	220,563	220,563	220,563	118,476
Panel B: Low liquidity need manufacturers								
Manuf. CDS \times Captive Lender	0.113*** [0.043]	-0.004 [0.006]	-0.012 [0.010]	-0.003 [0.009]	0.005 [0.005]	0.021*** [0.006]	-0.040*** [0.008]	0.005 [0.006]
Avg Dep Var	6.124	3.868	8.954	9.349	10.083	.181	.636	.052
R^2	0.824	0.442	0.554	0.659	0.486	0.334	0.904	0.319
Observations	465,375	465,375	465,375	465,375	682,679	682,679	682,679	449,309
Fixed effects:								
Model-Region-Time-Income	YES	YES	YES	YES	NO	NO	NO	NO
Model-Region-Time	NO	NO	NO	NO	YES	YES	YES	YES
Lender	YES	YES	YES	YES	YES	YES	YES	YES
Age-Time	NO	NO	NO	NO	NO	NO	NO	YES
Additional controls:								
Lender-time	YES	YES	YES	YES	YES	YES	YES	YES
Borrower	YES	YES	YES	YES	NO	NO	YES	YES

Note: The Table shows the results from equation (1). Panel A reports the case when manufacturers face high liquidity needs; Panel B reports the case when manufacturers face low liquidity needs. For each manufacturer in each quarter we compute the ratio between the face value of manufacturer expiring bonds over its total amount of outstanding bonds at the beginning of the quarter. We classify a car manufacturer as high liquidity needs, if it lies in the top quartile of the distribution of this ratio in our sample. The dependent variables are the interest rate in percentage points, maturity in logs, car value in logs, loan size in logs, income in logs, a dummy variable denoting the employment situation (student, pensioner, unemployed or self-employed), a dummy variable denoting if the income is verified and a dummy equal to one if the loan is late payment starting one year after origination. Manuf. CDS is the CDS of the manufacturer of the car. Captive is a dummy equal to one if the lender originating the loan is a captive lender. Model, region and time fixed effect are interacted fixed effects for the brand-model, the region where the car was sold and the month and year in which it was sold. Model, region, time and income fixed effect include an additional interaction with income quintiles defined within geographical market and year. Region is defined as NUTS2. Lender-time controls are ROA, Equity as a fraction of total assets and the logarithm of total assets. Borrowers controls are income, employment status dummy and dummy for verified income. Standard errors are double clustered at brand-model and region-lender levels. *, **, and *** denote significance at the 10%, 5% and 1% levels, respectively.

small in magnitude.

To summarize, our results show that the differential behavior of captive lenders relative to stand-alone lenders when the parent manufacturers experience distress is driven by liquidity needs. Both the loan terms adjustments and the relaxation of lending standards are stronger when the integrated manufacturer liquidity needs are higher.

3.4 Robustness and Additional Results

In Appendix B we report the results of additional analyses and robustness checks which we only briefly discuss here. First, while we control for car type with brand-model interacted with income bins fixed effects, there can be unobservable characteristics that vary systematically between captive and traditional lenders and are correlated with both financing terms and manufacturers' distress. To lower the concern about omitted characteristics we re-estimate our model (1) controlling within each brand-model for quintiles of the car value.²⁴ Table A2 shows the estimates of this robustness exercise. Table A3 reports an additional robustness test which excludes the month of the Volkswagen Emission Scandal (September 2015) and the two months after. Our main results are robust to additional granular controls based on car values and the exclusion of extreme changes in manufacturers CDS.

Finally, we provide additional evidence on the lending standards margin of credit fire sales looking at borrowers' credit score. For one captive lender and one stand-alone lender we obtained additional comparable information on the internal credit score for borrowers. Different lenders adopt different scoring systems (unobservable) which yield different ranks (observable) for borrowers' risk. In our context, the stand-alone lender classifies borrowers on a scale from 0 (highest risk) to 9 (lowest risk); while the captive lender classifies borrower on a scale from 1 (lowest risk) to 3 (highest risk). For comparability we create a dummy

²⁴In this case we do not interact the car-model \times geographical market \times month fixed-effects also with the income bins because this will significantly drop the number of observations. The car value bins represent a more direct way to control for unobservable characteristics, but relative to the income bins that we use in our baseline specification they are endogenous and could in principle respond to the shocks and incentives that we analyze.

variable equal to one for borrowers with a low credit score.²⁵ We estimate our baseline model from equation (1) using as dependent variable the share of borrowers with low credit score and a slightly different set of fixed effects given the more limited sample based on only two lenders.

Table A4 in Appendix B shows the result. We find that when the car manufactures CDS increases by 100 basis points and liquidity needs are high, the captive lender increases its share of low credit score borrowers by about 2 percentage points. Given an average share of low credit score borrower of 15%, our estimates implies an increase by about 13%. The differential response by captive relative to stand-alone lenders to an increase in manufacturers' CDS is statistically insignificant and small in magnitude when manufactures' liquidity needs are low.

4 Evidence from the Volkswagen Emission Scandal

Using variation in the full sample in manufacturers' financial distress and liquidity needs and a rich set of fixed effects, we have provided evidence that captive lenders adjust loan terms and relax credit standards to increase the cash paid upfront. In this section, we establish a causal link between manufacturer financial distress, liquidity needs, and the documented credit fire sale behavior. The goal is to isolate changes in captive lending terms and standards due to manufacturer funding needs, and distinguish them from those driven by demand shocks, changes in price discrimination or the value of collateral.

4.1 Empirical Strategy

We exploit as a source of time-series quasi-experimental variation the short-lived effect of the Volkswagen emissions scandal on car manufacturers' funding costs. On September 18, 2015, the U.S. Environmental Protection Agency (EPA) found that approximately 500,000 Volkswagen diesel-engine vehicles sold in the US contained a defeat device that could detect

²⁵Low credit score is defined as 1 to 7 for the stand-alone lender and 2 to 3 for the captive lender.

when the car was being tested, changing the performance accordingly to improve results. Figure A4 in Appendix B shows the CDS for Volkswagen and other car manufactures. We show both the level of CDS and a version normalized to 100 in September 2015. Before the scandal the different brands have a similar trend in CDS, with minor deviations and with Volkswagen having a lower average CDS than other manufacturers. After the onset of the scandal, we observe a huge increase in the CDS of Volkswagen, which quadruples in the month of September and remain more than twice higher than before the event for several months. Other car manufacturers also experienced large increases in their CDS although to a lower extent relative to Volkswagen.

Our main identification strategy combines time-series variation in the CDS of manufacturers *other* than Volkswagen with cross-sectional variation in liquidity needs. Most notably, we divide the brands in our sample into high and low liquidity needs based on the fraction of bonds maturing in the quarter after the event relative to the outstanding amount in September 2015. This is our ex-ante measure of cross-sectional exposure to the shock. We then rank carmakers according to their liquidity needs and split them into two groups: manufacturers with high liquidity need are BMW, Mercedes, Renault, and Volkswagen, while Fiat, Ford, Opel, Peugeot and Toyota have low liquidity needs. In our exercise we exclude on purpose loans for buying Volkswagen cars and other brands of the group (Audi, Porsche, Seat, and Skoda), given the largely different change in CDS, and to minimize direct demand effects.

To illustrate the liquidity needs of these carmakers we look at the average ratio of the bonds maturing in the quarter after the Volkswagen over the total amount of bonds outstanding in September 2015. The average ratio for the three carmakers with high liquidity needs is 10.1% whereas it is equal to 5.5% for the low liquidity need group. Despite the low number of observations, the difference between these two means is statistically different from zero. Importantly, the difference between the two analogous means for the pre-event period (6.5% and 6.8%, respectively) is not statistically different from zero. We also check the number of bonds issued in the quarter after the Volkswagen emissions scandal. We find that the average number of issuances for the group with high liquidity needs is seven, while

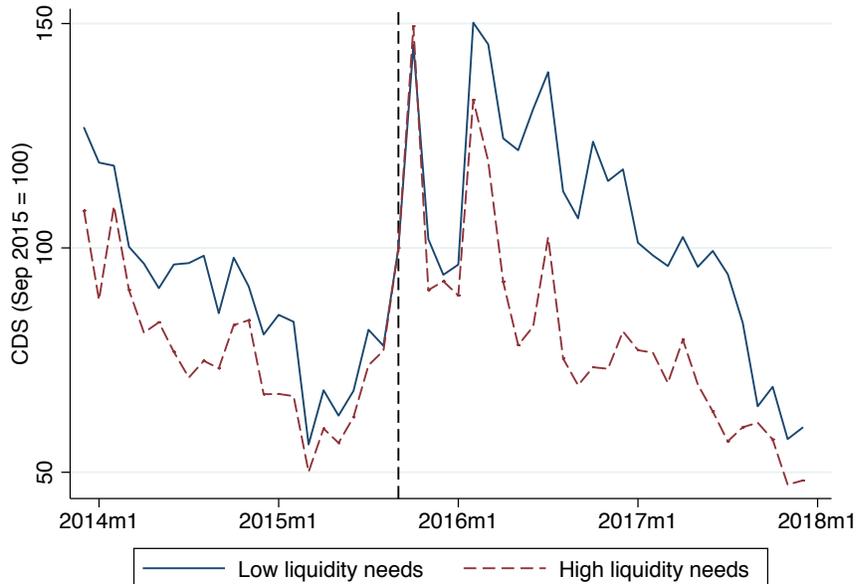


Figure 1: VOLKSWAGEN EMISSIONS SCANDAL: CDS HIGH AND LOW LIQUIDITY MANUFACTURERS

Note: The figure shows the CDS for two groups of manufacturers which we classify based on their liquidity needs. We divide the brands in our sample into high and low liquidity needs based on the fraction of bonds maturing in the quarter after the event relative to the outstanding amount in September 2015 and we exclude on purpose loans for buying Volkswagen cars and other brands of the group (Audi, Porsche, Seat, and Skoda). BMW, Mercedes, Renault are in the high liquidity need group, while Fiat, Ford, Opel, Peugeot and Toyota are in the low liquidity need group. The figure plots the monthly averages of daily CDS from December 2013 to December 2017. The CDS values are normalized to 100 in September 2015.

the average number of issuances for the group with low liquidity needs is one.

Figure 1 shows that manufacturers with high and low liquidity needs face a very similar pattern in terms of changes in CDS as a result of the scandal. The average CDS price of both groups increased by 50% on the date of the Volkswagen scandal, and returned to the pre-scandal level after a few months.²⁶

Thus, we estimate a difference-in-difference empirical model separately for the high liquidity needs (treated) and low liquidity needs (control) manufacturers:

$$y_{ilbmt} = \alpha Post_t \times Captive_l + \theta X_{ilt} + \gamma_l + \gamma_{bmt} + \epsilon_{ilbmt}, \quad (2)$$

where y_{ilbmt} is the outcome of interest y for individual i borrowing from lender l and buying

²⁶Also in levels the two groups experience a similar change around 50 basis point.

brand-model b in market m and period t ; $Post_t$ is a dummy equal to one after the Volkswagen emissions scandal; and all other variables are as in equation (1). The coefficient of interest is α which captures the differential changes on loan terms and credit standards by captive lenders relative to stand-alone banks after the outbreak of the scandal. Our key estimates of interest are the α s for the manufacturers which are mostly exposed to the increase in CDS due to a high fraction of expiring bonds.

4.2 Results

Table 6 shows the results. Consistent with credit fire sales being used as a tool for liquidity management (and with our results for the full sample), we find that the action is driven by captive lenders of manufacturers which have higher liquidity needs during distress. For manufacturers with high liquidity needs, a 50 basis points increase in the CDS price leads to an increase in loan rates relative to stand-alone lenders by more than 35 basis points, a decrease in maturity by more than 9%, and in loan amounts by almost 10%. Low-liquidity-needs manufacturers, despite experiencing a similar increase in CDS, do not change loan terms relative to stand-alone lenders.

With respect to lending standards, we find that manufacturers which experience a 50 basis points increase in CDS with high liquidity needs originate loans to lower income borrower, who ex-post are 1.2 percentage points more likely to default relative to loans originated by stand-alone lenders. In contrast, placebo manufactures with low liquidity needs barely change credit terms or standards despite experiencing the same increase in CDS. If anything, placebo manufacturers increase significantly the share of borrowers with verified income relative to stand-alone lenders.

We combine the results on loan terms and credit standards in Table 6 to compute a measure of the cost to generate an extra euro of cash today in terms of the net-present-value of future revenues from expected interest payments. Using the summary statistics in Table 1 and the statistically significant estimates for high-liquidity need manufacturers from Table 6, we compute the additional cash, the new monthly payment and the expected net-present-

Table 6: CREDIT FIRE SALES DURING THE VW EMISSION SCANDAL

	CONTRACT TERMS				LENDING STANDARDS			
	Rate	Maturity	Loan Size	Car value	Income	Other employment	Income verified	Arrears
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: High liquidity need manufacturers								
Post × Captive Lender	0.359*** [0.094]	-0.088*** [0.022]	-0.096** [0.045]	-0.063 [0.044]	-0.025* [0.013]	0.003 [0.015]	0.000 [0.000]	0.012** [0.006]
Avg Dep Var	5.716	3.916	8.918	9.279	9.987	.118	.453	.034
R^2	0.867	0.428	0.484	0.649	0.466	0.273	1.000	0.283
Observations	21,811	21,811	21,811	21,811	31,157	31,157	31,157	25,531
Panel B: Low liquidity need manufacturers								
Post × Captive Lender	0.013 [0.080]	-0.022 [0.016]	-0.019 [0.024]	0.003 [0.017]	-0.006 [0.014]	0.009 [0.009]	0.037*** [0.013]	-0.003 [0.007]
Avg Dep Var	5.716	3.916	8.918	9.279	10.104	.195	.647	.052
R^2	0.763	0.409	0.540	0.635	0.463	0.266	0.781	0.318
Observations	28,549	28,549	28,549	28,549	41,888	41,888	41,888	30,811
Fixed effects:								
Model-Region-Time-Income	YES	YES	YES	YES	NO	NO	NO	NO
Model-Region-Time	NO	NO	NO	NO	YES	YES	YES	YES
Lender	YES	YES	YES	YES	YES	YES	YES	YES
Age-Time	NO	NO	NO	NO	NO	NO	NO	YES
Additional controls:								
Lender-time	YES	YES	YES	YES	YES	YES	YES	YES
Borrower	YES	YES	YES	YES	NO	NO	YES	YES

Note: The Table shows the results from equation (2) using a sample period of two months before and two months after the month of the Volkswagen Emission Scandal (September 2015). We divide the car manufacturers in our sample in two groups depending on whether they face high (Panel A) or low (Panel B) liquidity needs. This is done based on the fraction of bonds maturing in the quarter after the event relative to the outstanding amount if September 2015. High liquidity needs manufacturers include BMW, Mercedes, Renault and Volkswagen whereas Fiat, Ford, Opel, Peugeot and Toyota represent the groups with low liquidity needs. Volkswagen cars are excluded on purpose in this analysis. The dependent variables are the interest rate in percentage points, maturity in log, car value in log, loan size in log, income in logs, a dummy variable denoting the employment situation (student, pensioner, unemployed or self-employed), a dummy variable denoting if the income is verified and a dummy variable that is equal to one if the loan is in arrears starting one year after origination. Post is a dummy equal to one after the Volkswagen Emission Scandal. Captive is a dummy equal to one if the lender originating the loan is a captive lender. Model, region and time fixed effect are interacted fixed effects for the brand-model, the region where the car was sold and the month and year in which it was sold. Model, region, time and income fixed effect include an additional interaction with income quintiles defined within geographical market and year. Region is defined as NUTS2. Lender-time controls are ROA, Equity as a fraction of total assets and the logarithm of total assets. Borrowers controls are income, employment status dummy and and dummy for verified income. Standard errors are double clustered at brand-model and region-lender levels. *, **, and *** denote significance at the 10%, 5% and 1% levels, respectively.

value.²⁷ High-liquidity-need manufacturers obtain approximately €820 in additional cash as a result of the larger down payment. Despite the significantly higher interest rate, the monthly payment for high-liquidity-need manufacturers decreases and the present value of expected revenues declines by about €950 relative to the baseline. Putting together these numbers, our estimates show that to gain one additional euro in cash today, high-liquidity-needs manufacturers lose 15 cents in present value terms. Overall, credit fire sale allows raising cash at an opportunity cost of 3.8% annualized.

Finally, Table 7 provides additional evidence on the lending standards channel of credit fire sales following the Volkswagen emission scandal. We compute the total number of cars financed (columns (1) and (2)) and the share of low income borrowers (columns (3) and (4)) in each market and month, for each brand-model by captive and stand-alone lenders. We find that after the Volkswagen emissions scandal captive lenders neither increase nor decrease the number of cars financed relative to stand-alone lenders. This result holds for both captives whose parent manufacturer has high and low liquidity needs. While the total number of cars does not change between captive and stand-alone lenders, we find that captive lenders with high liquidity needs increase their share of low income borrowers relative to stand-alone lenders. The higher overall lending to low income borrower is only marginally significant and large in magnitude for manufacturers with high liquidity needs, consistent with the results in Table 6. This result is suggestive that lax lending standards (and the induced increase in demand from marginal risky borrowers) allow captive lenders to offer worse loan contract terms to infra-marginal borrowers without sacrificing overall volumes.

The last column of Table 7 looks at the fraction of borrowers with low credit scores. In this case, we cannot distinguish between manufacturers with high and low liquidity needs, as we only have data on borrower credit scores for one captive lender (which in our case is in the group with high liquidity need). We can, however, study if when the parent manufacturer experiences financial distress as a result of the Volkswagen emissions scandal, the captive

²⁷Notice that for high-liquidity-needs manufacturers (the treated group) focusing on the significant coefficients is basically allowing all financial contract terms to change and keeping the car value unchanged. We discuss the calculation in detail in Appendix C.

Table 7: ADDITIONAL EVIDENCE ON LENDING STANDARDS

	NUMBER OF CARS (LOG)		LOW INCOME BORROWERS (%)		LOW CREDIT SCORE BORROWERS (%)
	Low (1)	High (2)	Low (3)	High (4)	(5)
Manufacturer liquidity need					
Post × Captive Lender	0.028 [0.023]	0.019 [0.020]	0.004 [0.014]	0.025* [0.015]	0.028** [0.011]
Fixed effects:					
Model-Region-Time	YES	YES	YES	YES	NO
Lender	YES	YES	YES	YES	YES
Model-Time	NO	NO	NO	NO	YES
Region-Time	NO	NO	NO	NO	YES
Additional controls:					
Lender-Time	YES	YES	YES	YES	YES
Borrower	NO	NO	NO	NO	YES
Avg Dep Var	.998	1.052	.484	.466	.158
R^2	0.681	0.711	0.601	0.625	0.209
Observations	11,755	7,393	11,755	7,393	10,781

Note: The Table shows the results from a variation of equation (2) using a sample period of two months before and two months after the month of the Volkswagen Emission Scandal (September 2015). The dependent variables are the logarithm of the total number of cars financed (columns (1) and (2)), the share of low income borrowers (columns (3) and (4)), which are those whose income is below the median in the region and month when they purchase the car, and the share of low credit score borrowers (columns (5)). The last column only refers to the one captive lender and one stand-alone lender for which we have credit score information. We divide the car manufacturers in our sample in two groups depending on whether the face high (Panel A) or low (Panel B) liquidity needs. This is done based on the fraction of bonds maturing in the quarter after the event relative to the outstanding amount if September 2015. High liquidity needs manufacturers include BMW, Mercedes, Renault and Volkswagen whereas Fiat, Ford, Opel, Peugeot and Toyota represent the groups with low liquidity needs. Volkswagen cars are excluded on purpose in this analysis. Post is a dummy equal to one after the Volkswagen Emission Scandal. Captive is a dummy equal to one if the lender originating the loan is a captive lender. Brand-model, region and year-month fixed effect are interacted fixed effects for the brand-model, the region where the car was sold and the month and year in which it was sold. Region is defined as NUTS2. Lender-time controls are ROA, Equity as a fraction of total assets and the logarithm of total assets. Borrowers controls are income, employment status dummy and and dummy for verified income. Standard errors are double clustered at brand-model and region-lender levels. *, **, and *** denote significance at the 10%, 5% and 1% levels, respectively.

unit relaxes lending standard relative to a stand-alone lender financing similar cars. We find that the captive lender with high liquidity needs increases the share of loans to low credit score borrowers relative to the stand-alone lender by almost 3 percentage points. The effect are significant and also larger in magnitude than the effect we documented in Section 3.3 using the full sample. Given an average share of low credit score borrowers of 15%, our estimates imply an increase by almost 20%.

Overall, the findings from the causal analysis are qualitatively and quantitatively similar to the stylized aggregate patterns. Taken together, the results indicate that liquidity creation

through credit fire sales is an important feature of the vertical integration of car manufacturers with auto lenders, with implications for the transmission of shocks to consumers with different risk profiles.

5 Quantification of Credit Fire Sales

We have shown that captive lenders decrease loan amounts and relax lending standards relative to stand-alone lenders to generate liquidity for the parent manufacturers, when the latter experience financial distress and liquidity needs are high. Additionally, we do not find differential effects on car values financed by captive lenders relative to stand-alone lenders. Thus, credit fire sales generate liquidity for the manufacturing company, without the need to adjust product prices.

In this section we develop a simple model of borrowers' demand for car loans with stand-alone and captive lenders, to gauge the importance of the new channel we document and compare it to more traditional asset fire sales. We then calibrate the model using our micro-data and perform a counterfactual analysis to quantify the effect of credit fire sales on manufacturers' liquidity.

5.1 A Simple Model with Stand-alone and Captive Lenders

Car market. We model the car loan market following [Perloff and Salop \(1985\)](#). There are N differentiated cars producers indexed by j . We assume each manufacturer produces only one brand-model for simplicity. Manufacturers produce cars at common marginal cost k and incur a fixed cost K , and they set a price p_j for the car they sell. Manufacturer's j profits from selling the car are then given by:

$$\Pi_j(p_1, \dots, p_N) = (p_j - \kappa)D_j(p_1, \dots, p_N) - K, \quad (3)$$

where $D_j(p_1, \dots, p_N)$ is the expected demand for manufacturer j .

Demand comes from M potential buyers indexed by i . We assume consumer i valuation for car j is given by v_{ij} , which is drawn from a distribution $F(v)$ with density $f(v)$. Consumer net surplus from purchasing car j is given by $b_{ij} = v_{ij} - p_j$. Consumer i will buy car j over car k if $b_{ij} > b_{ik}$ or $v_{ij} - p_j + p_k > v_{ik}$, which has a probability given by $F(v_{ij} - p_j + p_k)$. We assume valuations are independent and identically distributed across consumers. Thus, the fraction of consumer buying product j is given by:

$$Pr(b_{ij} \geq \max_{k \neq j} b_{ik}) = \int \prod_{k \neq j} [F(p_k - p_j + v)] f(v) dv. \quad (4)$$

Loan market. We assume that consumers need a loan to buy the car along the lines of [Barron et al. \(2008\)](#). A fraction γ of consumers is low risk (L), while a fraction $1 - \gamma$ is high risk (H). We assume that low risk consumers will always repay, while high risk will always default.

We make two simplifying assumptions on the supply side of car loans to avoid additional complications that are not central to the main channel we document in the empirical analysis. First, loans are provided in competitive markets by stand-alone banks and captive lenders. Second, a given fraction α of buyers goes to captive lenders and a fraction $1 - \alpha$ seeks a loan from stand-alone banks. In other words, credit markets are segmented.

We assume that all lenders borrow at rate r and incur a processing cost c per dollar loan. Lenders set an interest rate $i \leq \bar{i}$ based on the signal s from the consumer, which is below the maximum interest rate allowed in the car loan market \bar{i} .²⁸

Lenders observe a signal about borrowers' type that is drawn from a normal distribution $G_L \sim N(\mu_L, \sigma)$ for low risk consumers, and $G_H \sim N(\mu_H, \sigma)$ for high risk consumers. We assume that $\mu_L > \mu_H$, i.e. low risky consumers generate higher signals on average. The per dollar profits from lending to consumer i an amount $l = \theta p$, where θ is the loan-to-value, are given by:

²⁸Usury limit are common in automobile lending, see for example [Melzer and Schroeder \(2017\)](#).

$$\pi_b(s_b) = P(L|s)(i - r) + (1 - P(L|s))(d - r) - c, \quad (5)$$

where $P(L|s)$ is the probability that the consumer is low risk given the signal and d is what the lender gets from the collection of the salvage value of the collateral.

Equilibrium. In Appendix C we solve the equilibrium of the model under different assumptions on the loan market. Most notably, we discuss the case when buyers do not require financing (i.e., only cash buyers); and the case when only stand-alone banks operate in the car loan market. In the main text we focus on the general case with both stand-alone and captive lenders, which is the baseline model that we calibrate with our data. First, we discuss lending standards of stand-alone banks and captive lenders. Then, we solve for the equilibrium car price and number of manufacturers.

The equilibrium interest rate is obtained by setting to zero the per-dollar profits for stand-alone banks given by equation (5):

$$i(s) = \frac{(r + c) - (1 - P(L|s))d}{P(L|s)}. \quad (6)$$

Note that if there are only low risk borrowers ($P(L|s) = 1$) we obtain the standard equation of price equal to marginal costs ($i = r + c$). Consumers with a better signal pay lower interest rates (i.e. $\frac{\partial i(s)}{\partial s} < 0$). The equilibrium signal threshold for stand-alone banks \bar{s}_b , below which they would not lend, is obtained by setting the per-dollar profits given by equation (5) to zero at the maximum interest rate \bar{i} :

$$P(L|\bar{s}_b) = \frac{c + r - d}{\bar{i} - d}. \quad (7)$$

The equilibrium signal threshold for captive lenders is obtained by looking at the joint profit from the car and loan sale, which are given by:

$$\underbrace{(p - \kappa)}_{\text{Profits from sales}} + l \underbrace{[P(L|s)(\bar{i} - r) + (1 - P(L|s))(d - r) - c]}_{\text{Per dollar financing profits: } \pi_j(s_j)}. \quad (8)$$

Setting equation (8) equal to zero at the maximum interest rate \bar{i} , gives the optimal cutoff signal for the captive lender:

$$P(L|\bar{s}_j) = \frac{c + r - d - \frac{p-\kappa}{l}}{\bar{i} - d} \quad (9)$$

Note that $P(L|\bar{s}_j) < P(L|\bar{s}_b)$, where the latter is given by equation (7). Thus the captive lender has a lower signal threshold than the stand-alone lender $\bar{s}_j < \bar{s}_b$. The motivation behind the laxer lending standard is that the captive lender internalizes the profits from selling the car ($\frac{p-\kappa}{l}$).

The total fraction of buyers approved in the loan market is then given by:

$$(1 - \alpha) \overbrace{[\gamma(1 - G_L(\bar{s}_b)) + (1 - \gamma)(1 - G_H(\bar{s}_b))]}^{A(\bar{s}_b): \text{ Approval rate stand-alone lender}} + \alpha \overbrace{[\gamma(1 - G_L(\bar{s}_j)) + (1 - \gamma)(1 - G_H(\bar{s}_j))]}^{A(\bar{s}_j): \text{ Approval rate captive lender}}, \quad (10)$$

and the effective market size is $((1 - \alpha)A(\bar{s}_b) + \alpha A(\bar{s}_j))M$, which is strictly lower than M unless both stand-alone and captive lenders approve all buyers.

In the car market, we focus on a symmetric equilibrium where all manufacturers set the same price, i.e. $p_j = p \forall j = 1, \dots, N$ (Perloff and Salop, 1985). Thus, each manufacturer receive a fraction $\frac{1}{N}$ of approved buyers. The total profits of manufacturer j are then given by:

$$\Pi(s_j) = \frac{M}{N} \overbrace{[(1 - \alpha)A(\bar{s}_b) + \alpha A(\bar{s}_j)](p - \kappa)}^{\text{Total profits from sale}} + \alpha \frac{M}{N} \overbrace{(A(\bar{s}_j) - A(\bar{s}_b))(l\pi_j(\bar{s}_j))}^{\text{Losses from financing risky consumers}} - K = 0. \quad (11)$$

The equilibrium number of lender N is obtained by setting total profit given by equation (11) equal to zero:

$$N = \frac{[(1 - \alpha)A(\bar{s}_b) + \alpha A(\bar{s}_j)] M(p - \kappa)}{K} + \frac{\alpha M(A(\bar{s}_j) - A(\bar{s}_b))(l\pi_j(\bar{s}_j))}{K}. \quad (12)$$

Finally, under the Bertrand-Nash assumption that each manufacturer chooses price to maximize its expected profits, the FOC from equation (11) is:

$$p = \kappa + \frac{1}{N(N-1) \int [F(v)]^{N-2} f(v)^2 dv} + \frac{\frac{\alpha(A(\bar{s}_j) - A(\bar{s}_b))}{\alpha A(\bar{s}_j) + (1-\alpha)A(\bar{s}_b)} \pi_j(\bar{s}_j)}{N(N-1) \int [F(v)]^{N-2} f(v)^2 dv}, \quad (13)$$

where the three terms on the right side represent the marginal costs of producing a car, the mark-up due to product differentiation, and the expected losses on the riskier buyers that captive lenders approve, respectively.

5.2 Credit Fire Sales VS Car Fire Sales

Our model is very stylized and leaves out several real world complexities. However, it allows us to highlight the key mechanism of the credit fire sales channel that we identify empirically. Most notably, through the lens of the model we quantify the effect of credit fire sales on manufacturers' liquidity, decompose the role of marginal and inframarginal borrowers, and compare our channel to a traditional car fire sale.

We calibrate the model leveraging the richness of our micro data. Table A6 in Appendix C shows the main parameters that we observe in the data or calibrate, as well as the endogenous outcomes of the model that we also observe in the data and use as target moments for our calibration. Our simple model can match quite closely the average price of the car and the number of manufacturers. We over-predict arrears, which are in the model higher on average than in the data. This result is driven by the simplifying assumption that all risky borrowers default, while in the data only a fraction of ex-ante risky borrowers end up in arrears.²⁹ Additionally, our simple model is able to generate a positive differential in arrears between captive and stand-alone lenders which is the main object of interest from our empirical specifications.

²⁹Adding a probability of default conditional on the borrower type (safe or risky) would complicate the model without providing additional insights. If in reality safe borrowers almost never default and risky borrowers may also end up not defaulting, our estimates of the liquidity generated by credit fire sales represent a likely lower bound, as captive lenders have an even higher incentive to lend to risky borrowers who may not default than to risky borrower who always default.

We then simulate the calibrated model in the baseline and two alternative scenarios. First, we calculate the equilibrium in the car loan market without captive lenders simply by setting the fraction of borrowers going to captive lenders (α) equal to zero. Second, we consider a counterfactual in which manufacturers have high liquidity needs. We proxy this case by lowering the loan-to-value (θ) for car loans originated by captive lenders by 5 percentage points, which is in line with our empirical estimates from the Volkswagen Emission Scandal.³⁰

Table 8 shows the results for several variables of interest. Notice that the number of manufacturers and the price of the car exhibit only small variation across different scenarios, consistent with our empirical results that the action is taking place on the loan market. stand-alone banks' behavior is the same across scenarios, as the only difference is the exogenous fraction of borrowers that finance their cars purchases from them ($1 - \alpha$). stand-alone banks approve about 70% of borrowers, and approximately 5.7% of them end up in arrears.

First, we compare the baseline scenario to the case without captive lenders. Captive lenders have an approval rate of about 91%, or about 20 percentage points higher than stand-alone lenders. The key intuition is that captive lenders internalize the profit from the sell of the car by the parent manufacturing company. As a result of the higher approval rate, captive lenders experience higher average default rates at about 10%. The average loss for the defaulting high risky loans is however small given the low loan-to-value. The higher approval rate leads to almost 4.2 thousands more originations.

In Panel C of Table 8 we compute the cash that is generated by captive lenders. Given the average price of the car and the average loan-to-value by captive, the extra liquidity is computed as the down payment in euros by the buyers approved by captive lenders, who would not have been approved by stand-alone lenders. Lending to marginally riskier buyers generates approximately €3.2 million in extra liquidity each month for the average manufacturer. We can then calculate the car fire sale that would generate the same amount

³⁰We obtain the loan-to-value counterfactual with high liquidity need by using the significant change in (log) quantity from column (3) of Table 5 and the price baseline price of the car (given the insignificant effect on car value in column (4) of Table 5). Hence in this second scenario we set $\theta = 0.60 < 0.65$.

Table 8: CREDIT FIRE SALES VS CAR FIRE SALES

	NO CAPTIVE LENDERS	BASELINE	HIGH LIQUIDITY NEED
Panel A: Car market			
Car price (euros)	13,180	13,166	13,166
Number of manufacturers	6	6	6
Panel B: Loan market			
Approved Buyers	24,817	29,012	29,052
Traditional Banks			
Fraction approved (%)	71	71	71
Number approved	24,817	10,423	10,423
Fraction default (%)	5.7	5.7	5.7
Captive lenders			
Fraction approved (%)		91	92
Number approved		18,589	18,692
Fraction default (%)		10.5	10.7
Average loss on high-risk loan (euros)		99	93
Δ approval rate captive - traditional		20	21
Extensive margin		4195	4298
Panel C: Credit fire sales			
Liquidity creation (M euros)		3.21	5.34
Marginal borrowers (M euros)		3.21	3.76
Inframarginal borrowers (M euros)		0.00	1.57
Car fire sale equivalent (euros)		-990	-1636
Car fire sale equivalent (% car price)		-7.5	-12.4
Cost of credit fire sale relative to car fire sale		0.37	0.35

Note: The Tables shows the several variables in three different scenarios. The Baseline scenario represents the full model described in Section 5 and calibrated using the parameters from Table A6. The “No captive lenders” assumes that in the model all borrowers go to stand-alone lenders (i.e. $\alpha = 0$). The details are discussed in Appendix C. The “High liquidity need” scenario represents the full model described in Section 5 and calibrated using the parameters from Table A6, but setting the loan-to-value by captive lenders to 0.60, rather than the baseline value of 0.65. Panel A shows the equilibrium car price in euros and number of manufacturers. Panel B shows the variables in the loan market. The total number of approved borrowers, and the fraction approved, number approved and fraction in default for stand-alone and captive lenders, respectively. Panel B also shows the average loss in euros for captive lenders on risky loans, that stand-alone lenders would not have approved. Panel C shows several variables related to the loan fire sale channel. The difference in approval rates between stand-alone and captive lenders and the extensive margin which is the extra number of borrowers approved by the captive lenders. The cash generated by the captive lenders through relaxing lending standard to marginal borrowers and changing loan-to-values to inframarginal borrowers. The car fire sale equivalent to a credit fire sale represents the decrease in car price that would generate the same cash flow as the loan fire sale expressed in euros and as a percentage of the car price. Finally, the cost of credit fire sale relative to car fire sale is the cost in terms of foregone revenues for creating the same amount of cash either by lowering the price of the car or by a credit fire sale.

of liquidity for the manufacturer as the credit fire sale. A decline in car price would increase liquidity for the manufacturers via additional sales, but also decrease the liquidity because of the lower price paid by buyers who would have bought at the original (higher) price. To obtain the change in sales as a result of a percentage change in prices we borrow from previous works in the IO literature, which find a demand elasticity around 4 (Goldberg, 1995; Goldberg and Verboven, 2001; Salz et al., 2020). Differently from the traditional case of cash buyers, the change in cash is the full price of the car when financed by a stand-alone lender, while it is only given by the down payment when financed by the captive lender.

The well-known trade-off through the lens of our model is captured by the following expression:

$$\overbrace{\Delta p \times \frac{M}{N} \alpha A(\bar{s}_j)(1 - \theta)}^{\Delta p \times q: \text{ Losses from inframarginal buyers}} \quad \overbrace{-\epsilon \times \Delta p \times \frac{M}{N} \alpha A(\bar{s}_j)(1 - \theta)}^{\Delta q \times p: \text{ Gains from marginal buyers}}, \quad (14)$$

where the second term is obtained by inverting the formula for the demand elasticity; and $\frac{M}{N} \alpha A(\bar{s}_j)(1 - \theta)$ is the demand financed by captive lenders, which generate cash only through the fraction of the price that is paid upfront $(1 - \theta)$.

Thus, the change in car price for cars financed by captive lenders needed to generate the same amount of liquidity that is obtained through a loan fire sale can be calculated by setting (14) equal to the amount of liquidity and solving for Δp , as follows:

$$\Delta p = \frac{\text{Liquidity from credit fire sale}}{(1 - \epsilon) \times \frac{M}{N} \alpha A(\bar{s}_j)(1 - \theta)}. \quad (15)$$

Table 8 shows that the price of the car would have to decrease by about €990 to generate the same liquidity that captive lenders generate only via lending to marginally riskier borrower. This decline in price is equivalent to approximately 7.5% of the equilibrium car value.

In the last row of Table 8 we report a measure of the cost of a credit fire sale *relative* to a car fire sale. The cost of lowering the price of the car is captured by lower revenues on the cars that would have been sold absent the price decrease. The cost of a credit fire sales

comes from: 1) expected losses from lending to risky marginal borrowers; 2) lower interest rate revenues from inframarginal borrowers.³¹ Using this simple measure, our calibration shows that to generate the same amount of cash a credit fire sale is about 60% cheaper than a traditional fire sale for the average manufacturer.

Finally, the third column of Table 8 shows the case in which manufacturers have high liquidity needs. Relative to the baseline, the captive lenders approved a slightly higher number of consumers. The intuition is that the lower loan-to-value decrease the losses on the risky borrowers, who end up defaulting. Indeed we find that the average loss on high-risk loans decrease from €99 to €93. Lowering the loan-to-value generates an additional margin to create liquidity, which is now also operating via inframarginal borrowers. A 5-percentage-points lower loan-to-value increase monthly cash by about €1.6 millions from inframarginal borrowers financed by the captive unit. The extensive margin is also higher than in the baseline case, relative to the case with no captive lenders. The reason for the increase in twofold. First, captive lenders are approving more borrowers than in the baseline, even if only slightly so (by about one percentage point). Second, each marginal borrower is borrowing less due to the lower loan-to-value, thus generating more liquidity upfront. Overall, lending to marginally risky buyers and asking for a larger down payment generate more than €5 millions in extra liquidity each month for the average manufacturer. To generate the same cash of a credit fire sale, the manufacturers would have to decrease the price of the car by about €1600, or about 12.5% of its equilibrium value.

6 Conclusions

In this paper we study the role of captive finance in the car loan market when the parent manufacturing company's liquidity cost (CDS price) and need (large fraction of outstanding bonds expiring) are high. Using a new multi-country dataset on securitized car loans, we

³¹To compute the missed interest revenues in our simple one-period model we take a maturity of 4 years and an interest rate of 7% for loans originated by captive lenders consistent with our summary statistics in Table 2.

show that captive lending enables distressed manufacturers to create liquidity, at the cost of future losses, by lowering loan amounts to all borrowers and relaxing lending standards to high-risk borrowers relative to stand-alone lenders. We label this mechanism a *credit fire sale*.

We quantify the mechanism by exploiting a funding shock to manufacturers resulting from the coincidence of a large fraction of maturing long-term bonds with the unexpected and temporary increase in manufacturers' CDS prices triggered by the Volkswagen emissions scandal. Taken together, the results indicate that liquidity creation through credit fire sales is an important feature of the vertical integration of car manufacturers with auto lenders.

Our mechanism has novel implications for the transmission of shocks to durable consumption and household leverage. Most notably, our findings imply that the integration of manufacturing and financial intermediation can change the sign, magnitude, and timing of the real effects of liquidity shocks to lenders and manufacturers. Finally, while our paper focuses on the auto market, our novel extended definition of fire sales may apply to many other settings where assets sales and financing are bundled together.

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Online Appendix

The appendix is structured as follows. Section [A](#) discusses in detail how we construct our main dataset. Section [B](#) provides supplementary figures and tables with additional results and robustness checks. Section [C](#) provides additional derivations for the back-of-the-envelope calculation of Section [4](#) and the model of Section [5](#) in the main text.

A Data Construction

In this Appendix we discuss how we construct our main dataset. It comprises car loans securitised by European banks and captive lenders over the period December 2013 to December 2017. These data are available through the European Data Warehouse (EDW) and are reported according to the Asset Backed Security (ABS) template used by ECB within the framework of the 100 percent transparent policy on securitized loans. EDW collects information on all outstanding car loan securitizations from 2013. However, the information available in the first (and successive) reports of each securitization does not necessarily include all loans that were part of the pool of the securitization at origination, unless the first report is the one corresponding to the origination date. For instance, non-performing loans and loans maturing before the first reporting date could have been excluded. To avoid any bias due to this issue, we restrict our initial sample to those securitizations for which we observe the whole pool of securitized car loans over the entire life of the securitization (i.e., up to December 2017). Thus, we use information on all data reports (usually on a quarterly basis) corresponding to securitizations originated between December 2013 and December 2017.³²

We focus on loans originated between December 2013 and December 2017 for buying used cars. For our analysis the advantage of focusing on used cars is twofold. First, the coverage of new cars is poor for diversified lenders. In the final sample, only 6% of the loans for the purchase of new cars are granted by diversified lenders in our data, whereas this fraction is 41% for the used cars.³³ Second, in the used car market we can ignore car manufacturing costs and focus on the transformation of car inventory into cash, the core mechanism behind credit fire sales.

³²We screen all the reports available for each securitization given that new loans are added to the pool over time whereas some others disappear. Moreover, if any information is updated for any of the loans coming from a previous report, we use the new information to replace missing observations.

³³Our identification strategy requires that for a brand-model in a market at a certain time we always observe at least a loan issued by a captive and a loan issued by a diversified lender. This requirement is even stronger in the several sample splits that we implement to understand the joint role of manufacturers' liquidity cost and need.

For the main analyses, we apply the following filters. First, we restrict our sample to amortizing car loans, which means that we discard leasing, balloon loans and any other type of non-standard car loans. Second, we consider just customers with the legal form of individuals such that we do not consider public and limited companies, partnerships, government entities and any other type of customers. Third, we restrict our sample to all loans for which we have information on the interest rate, the maturity, the amount granted at origination, the value of the car, and the car model. We also discard loans without information on borrower characteristics such as income, employment status, and region in which his/her domicile is located (i.e., NUTS codes). Fourth, our sample is winsorized at 0.1 and 99.9% levels for the car value of each specific model and the following loan characteristics: interest rate, maturity, and size. Fifth, we exclude duplicated loans given that although each loan and borrower has a unique identifier in each securitization, they could appear in more than one securitization of the same lender.³⁴ Sixth, we discard motorbikes, caravans, trucks; car models that appear less than 100 times and loans with a LTV below 10% at origination. Finally, we exclude from our sample brands of manufacturers without a captive lender in the group.³⁵

Our final sample consists of about 1.2 million car loans granted by stand-alone banks (Banco Santander, Bank Deutsches Kraftfahrzeuggewerbe, Bank 11, BNP Paribas, Socram Banque) and captive lenders from nine large parent manufacturers (BMW, Fiat Chrysler, Ford, Mercedes, Opel/GM, Peugeot, Renault, Toyota and Volkswagen) over the period December 2013 to December 2017 to individuals domiciled in France, Germany, Italy and Spain.³⁶ These loans are part of the pool of 37 securitizations and are granted for the

³⁴We consider that a loan is duplicated when there is more than one loan granted by the same lender at the same date for the same interest rate, amount, down-payment, and maturity; to individuals that buy the same car model at the same price and who are domiciled in the same region, with the same employment status, and the same income.

³⁵These brands could belong to manufacturers with captive lenders not operating in Europe (e.g, Japanese brands) or not issuing Asset-backed securities (ABS) for financing.

³⁶Note that within each group there are different subsidiaries and branches that operate in different countries: Banco Santander (Santander Consumer EFC, Santander Consumer Bank AG, Santander Consumer Bank S.p.A.), Bank Deutsches Kraftfahrzeuggewerbe GmbH, Bank11 für Privatkunden und Handel GmbH, BNP Paribas Personal Finance, Socram Banque, BMW Bank, Fiat Chrysler (FCA Bank Deutschland GmbH, FCA Bank S.p.A., FCA Capital Espana, FGA Capital S.p.A.), Ford (FCE Bank German Branch), Mercedes-

purchase of 25 different brands and 272 different models made by the nine manufacturers mentioned above. All the loans that form of our final sample are fixed-rate loans with a monthly payment frequency.

Benz Bank, Opel/GM (GMAC Bank GmbH, Opel Bank GmbH), PSA (Banque PSA Finance, Banque PSA Finance Espana, BPF Italy, PSA Bank Deutschland GmbH, Credipar), Renault (RCI Banque, RCI Banque S.A. Niederlassung Deutschland), Toyota (TKG), Volkswagen (Volkswagen Bank GmbH, Volkswagen Bank Branch Italy, Volkswagen Finance S.A.).

B Additional Tables and Figures

Table A1: LIQUIDITY CHANNEL WITH AT LEAST 5 OUTSTANDING BONDS

	CONTRACT TERMS				LENDING STANDARDS			
	Rate	Maturity	Loan Size	Car value	Income	Other employment	Income verified	Arrears
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: High liquidity need manufacturers								
Manuf. CDS \times Captive Lender	0.285*** [0.066]	-0.032** [0.014]	-0.040* [0.023]	-0.002 [0.018]	-0.042*** [0.009]	0.020* [0.012]	-0.117*** [0.031]	0.030*** [0.010]
Avg Dep Var	6.233	3.863	8.882	9.420	9.984	.183	.575	.061
R^2	0.771	0.476	0.542	0.666	0.443	0.320	0.829	0.313
Observations	139,769	139,769	139,769	139,769	213,229	213,229	213,229	114,097
Panel B: Low liquidity need manufacturers								
Manuf. CDS \times Captive Lender	0.024 [0.046]	-0.004 [0.006]	-0.006 [0.010]	-0.002 [0.010]	0.005 [0.006]	0.023*** [0.006]	-0.019*** [0.005]	0.005 [0.006]
Avg Dep Var	6.134	3.865	8.956	9.345	10.083	.179	.631	.052
R^2	0.831	0.441	0.553	0.659	0.487	0.335	0.910	0.319
Observations	454,677	454,677	454,677	454,677	666,200	666,200	666,200	449,309
Fixed effects:								
Model-Region-Time-Income	YES	YES	YES	YES	NO	NO	NO	NO
Model-Region-Time	NO	NO	NO	NO	YES	YES	YES	YES
Lender	YES	YES	YES	YES	YES	YES	YES	YES
Age-Time	NO	NO	NO	NO	NO	NO	NO	YES
Additional controls:								
Lender-time	YES	YES	YES	YES	YES	YES	YES	YES
Borrower	YES	YES	YES	YES	NO	NO	YES	YES

Note: The Table shows the results from equation (1) restricting to the sample with at least five outstanding bonds. Panel A reports the case when manufacturers face high liquidity needs; Panel B reports the case when manufacturers face low liquidity needs. For each manufacturer in each quarter we compute the ratio between the face value of manufacturer expiring bonds over its total amount of outstanding bonds at the beginning of the quarter. We classify a car manufacturer as facing high liquidity needs, if it lies in the top quartile of the distribution of this ratio in our sample. The dependent variables are the interest rate in percentage points, maturity in log, car value in log, loan size in log, income in logs, a dummy variable denoting the employment situation (student, pensioner, unemployed or self-employed), a dummy variable denoting if the income is verified and a dummy equal to one if the loan is late payment starting one year after origination. Manuf. CDS is the CDS of the manufacturer of the car. Captive is a dummy equal to one if the lender originating the loan is a captive lender. Model, region and time fixed effect are interacted fixed effects for the brand-model, the region where the car was sold and the month and year in which it was sold. Model, region, time and income fixed effect include an additional interaction with income quintiles defined within geographical market and year. Region is defined as NUTS2. Lender-time controls are ROA, Equity as a fraction of total assets and the logarithm of total assets. Borrowers controls are income, employment status dummy and and dummy for verified income. Standard errors are double clustered at brand-model and region-lender levels. *, **, and *** denote significance at the 10%, 5% and 1% levels, respectively.

Table A2: LIQUIDITY CHANNEL CONTROLLING FOR BINS OF CAR VALUE

	CONTRACT TERMS				LENDING STANDARDS			
	Rate	Maturity	Loan Size	Car value	Income	Other employment	Income verified	Arrears
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: High liquidity need manufacturers								
Manuf. CDS \times Captive Lender	0.309*** [0.074]	-0.027** [0.013]	-0.041** [0.018]	-0.008 [0.007]	-0.065*** [0.014]	0.005 [0.011]	-0.131*** [0.035]	0.056*** [0.015]
Avg Dep Var	6.18	3.867	8.895	9.422	9.983	.185	.564	.06
R^2	0.815	0.496	0.944	0.594	0.528	0.431	0.871	0.427
Observations	145,337	145,337	145,337	145,337	145,337	145,337	145,337	75,346
Panel B: Low liquidity need manufacturers								
Manuf. CDS \times Captive Lender	0.110** [0.055]	-0.003 [0.005]	-0.015** [0.007]	-0.007* [0.004]	-0.003 [0.007]	0.023*** [0.007]	-0.039*** [0.009]	0.007 [0.007]
Avg Dep Var	6.124	3.868	8.954	9.349	10.083	.181	.636	.052
R^2	0.836	0.483	0.652	0.947	0.575	0.452	0.927	0.427
Observations	461,719	461,719	461,719	461,719	461,719	461,719	461,719	290,917
Fixed effects:								
Model-Region-Time-CarValue	YES	YES	YES	YES	YES	YES	YES	YES
Lender	YES	YES	YES	YES	YES	YES	YES	YES
Age-Time	NO	NO	NO	NO	NO	NO	NO	YES
Additional controls:								
Lender-time	YES	YES	YES	YES	YES	YES	YES	YES
Borrower	YES	YES	YES	YES	NO	NO	YES	YES

Note: The Table shows the results from equation (1). Panel A reports the case when manufacturers face high liquidity needs; Panel B reports the case when manufacturers face low liquidity needs. For each manufacturer in each quarter we compute the ratio between the face value of manufacturer expiring bonds over its total amount of outstanding bonds at the beginning of the quarter. We classify a car manufacturer as facing high liquidity needs, if it lies in the top quartile of the distribution of this ratio in our sample. The dependent variables are the interest rate in percentage points, maturity in log, car value in log, loan size in log, income in logs, a dummy variable denoting the employment situation (student, pensioner, unemployed or self-employed), a dummy variable denoting if the income is verified and a dummy equal to one if the loan is late payment starting one year after origination. Manuf. CDS is the CDS of the manufacturer of the car. Captive is a dummy equal to one if the lender originating the loan is a captive lender. Model, region, time and car-value fixed effect are interacted fixed effects for the brand-model, the region where the car was sold, the month and year in which it was sold, and quintiles of car value. Region is defined as NUTS2. Lender-time controls are ROA, Equity as a fraction of total assets and the logarithm of total assets. Borrowers controls are income, employment status dummy and dummy for verified income. Standard errors are double clustered at brand-model and region-lender levels. *, **, and *** denote significance at the 10%, 5% and 1% levels, respectively.

Table A3: LIQUIDITY CHANNEL EXCLUDING VOLKSWAGEN EMISSION SCANDAL MONTHS

	CONTRACT TERMS				LENDING STANDARDS			
	Rate	Maturity	Loan Size	Car value	Income	Other employment	Income verified	Arrears
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: High liquidity need manufacturers								
Manuf. CDS \times Captive Lender	0.298*** [0.079]	-0.032** [0.014]	-0.040* [0.023]	-0.000 [0.018]	-0.037*** [0.010]	0.022* [0.013]	-0.118*** [0.031]	0.031*** [0.009]
Avg Dep Var	6.17	3.865	8.896	9.423	9.982	.184	.561	.058
R^2	0.808	0.475	0.548	0.666	0.441	0.320	0.842	0.311
Observations	141,618	141,618	141,618	141,618	216,042	216,042	216,042	115,226
Panel B: Low liquidity need manufacturers								
Manuf. CDS \times Captive Lender	0.105 [0.083]	-0.004 [0.011]	-0.017 [0.016]	-0.012 [0.013]	0.013 [0.008]	0.035*** [0.008]	-0.060*** [0.012]	0.004 [0.007]
Avg Dep Var	6.151	3.869	8.954	9.349	10.085	.184	.637	.052
R^2	0.824	0.442	0.557	0.661	0.488	0.339	0.902	0.319
Observations	424,216	424,216	424,216	424,216	622,731	622,731	622,731	408,106
Fixed effects:								
Model-Region-Time-Income	YES	YES	YES	YES	NO	NO	NO	NO
Model-Region-Time	NO	NO	NO	NO	YES	YES	YES	YES
Lender	YES	YES	YES	YES	YES	YES	YES	YES
Age-Time	NO	NO	NO	NO	NO	NO	NO	YES
Additional controls:								
Lender-time	YES	YES	YES	YES	YES	YES	YES	YES
Borrower	YES	YES	YES	YES	NO	NO	YES	YES

Note: The Table shows the results from equation (1) excluding the month of the Volkswagen Emission Scandal (September 2015) and the two months after. Panel A reports the case when manufacturers face high liquidity needs; Panel B reports the case when manufacturers face low liquidity needs. For each manufacturer in each quarter we compute the ratio between the face value of manufacturer expiring bonds over its total amount of outstanding bonds at the beginning of the quarter. We classify a car manufacturer as facing high liquidity needs, if it lies in the top quartile of the distribution of this ratio in our sample. The dependent variables are the interest rate in percentage points, maturity in log, car value in log, loan size in log, income in logs, a dummy variable denoting the employment situation (student, pensioner, unemployed or self-employed), a dummy variable denoting if the income is verified and a dummy equal to one if the loan is late payment starting one year after origination. Manuf. CDS is the CDS of the manufacturer of the car. Captive is a dummy equal to one if the lender originating the loan is a captive lender. Model, region and time fixed effect are interacted fixed effects for the brand-model, the region where the car was sold and the month and year in which it was sold. Model, region, time and income fixed effect include an additional interaction with income quintiles defined within geographical market and year. Region is defined as NUTS2. Lender-time controls are ROA, Equity as a fraction of total assets and the logarithm of total assets. Borrowers controls are income, employment status dummy and and dummy for verified income. Standard errors are double clustered at brand-model and region-lender levels. *, **, and *** denote significance at the 10%, 5% and 1% levels, respectively.

Table A4: ADDITIONAL EVIDENCE WITH BORROWERS CREDIT SCORES

Manufacturer liquidity needs	LOW CREDIT SCORE BORROWERS (%)	
	High (1)	Low (2)
Manuf. CDS \times Captive Lender	0.021** [0.010]	0.003 [0.002]
Fixed effects:		
Model-Time	YES	YES
Region-Time	YES	YES
Lender	YES	YES
Additional controls:		
Lender-Time	YES	YES
Borrower	YES	YES
Avg Dep Var	.153	.149
R^2	0.179	0.234
Observations	44,650	106,714

Note: The Table shows the results from a variation of equation (1) using a captive lenders and a stand-alone lender for which we obtained data on internal credit scoring for borrowers. The dependent variable is the fraction of low credit score borrowers. For the car manufacturer in each quarter we compute the ratio between the face value of manufacturer expiring bonds over its total amount of outstanding bonds at the beginning of the quarter. We classify the car manufacturer as facing high liquidity needs, if it lies in the top quartile of the distribution of this ratio in our sample. Manuf. CDS is the CDS of the car manufacturer. Captive is a dummy equal to one if the lender originating the loan is a captive lender. Brand-model and year-month fixed effect are interacted fixed effects for the brand-model and the month and year in which it was sold. Region and year-month fixed effect are interacted fixed effects for the region where the car was sold and the month and year in which it was sold. Region is defined as NUTS2. Lender-time controls are ROA, Equity as a fraction of total assets and the logarithm of total assets. Borrowers controls are income, employment status dummy and and dummy for verified income. Standard errors are double clustered at brand-model and region-lender levels. *, **, and *** denote significance at the 10%, 5% and 1% levels, respectively.

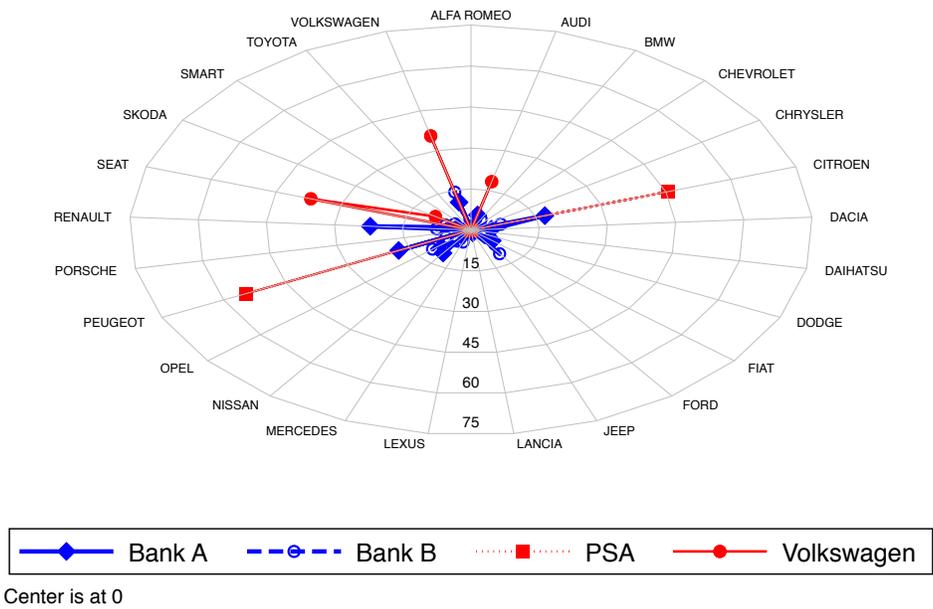


Figure A1: SPECIALIZATION BY BRANDS

Note: The figure shows the share of loans made by two captive and two stand-alone lenders for approximately 25 different brands. The captive lenders are PSA finance and Volkswagen Finance. The stand-alone lenders are not reported to preserve confidentiality. The data comes from securitized loans issued by the four lenders between December 2013 and December 2017 in four European Countries (Spain, France, Germany and Italy).

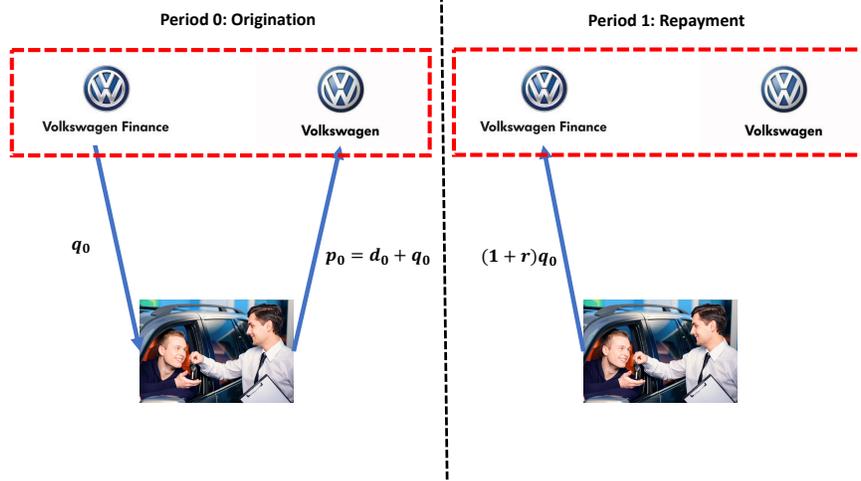
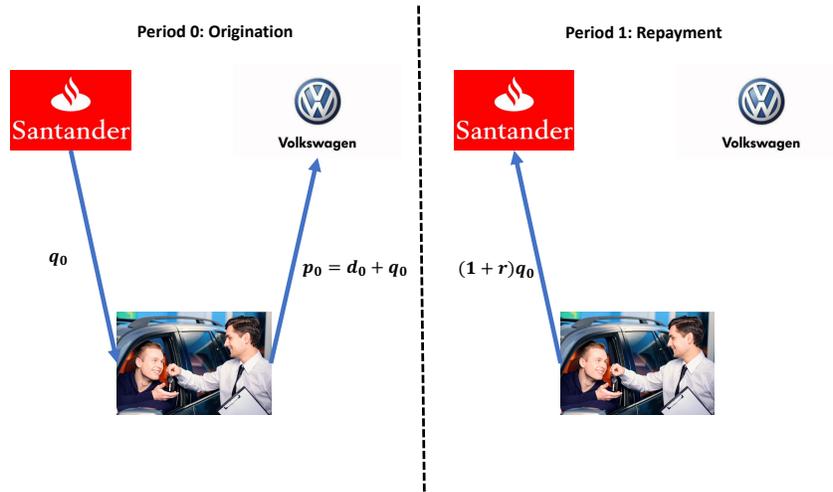
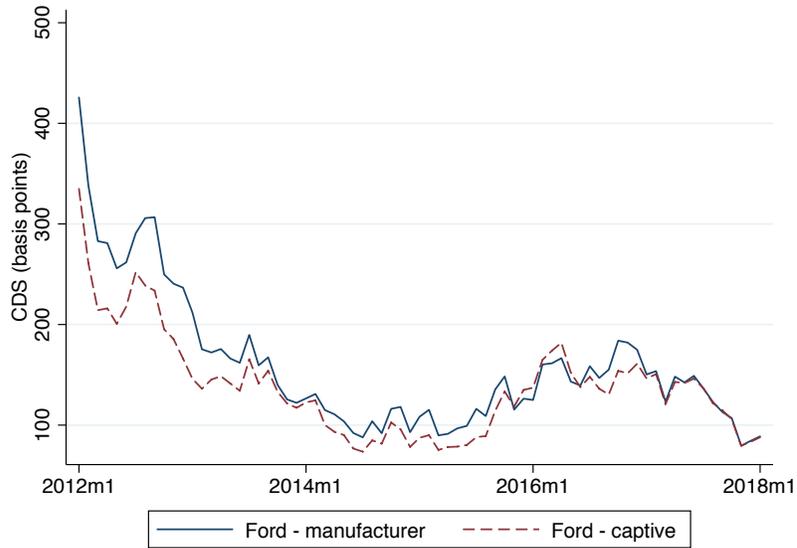
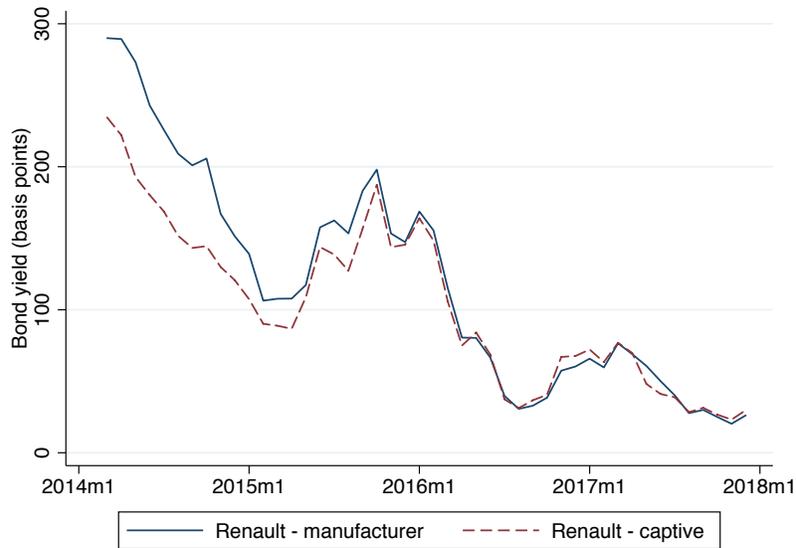


Figure A2: CASH FLOWS WITH TRADITIONAL BANK AND CAPTIVE LENDERS

Note: The figure shows the key flow and contract terms for a car purchase with financing at origination and repayment (assuming a one period contract). q_0 is the original loan amount, p_0 is the car value, d_0 is the down payment and r is the interest rate. Panel (a) shows the case with traditional bank financing, while panel (b) shows the case with captive financing. The red dotted line that circles the car maker and the captive lender indicates that they are part of the same group.



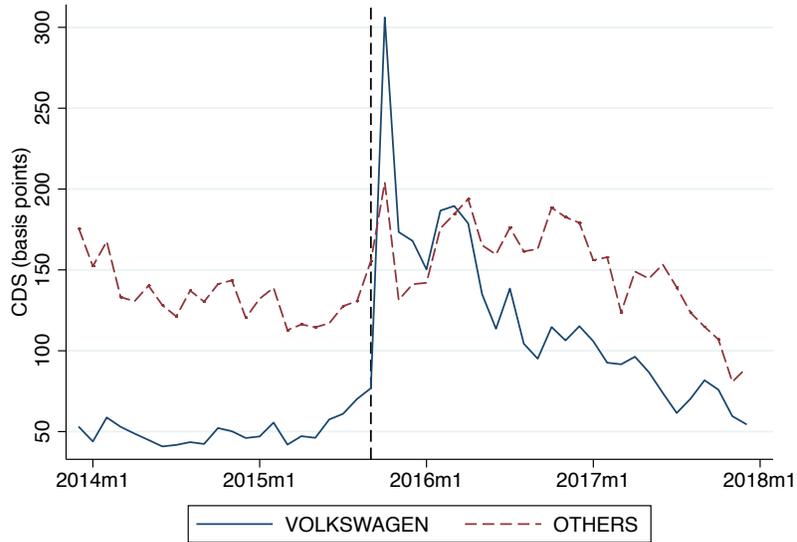
(a) CDS FORD



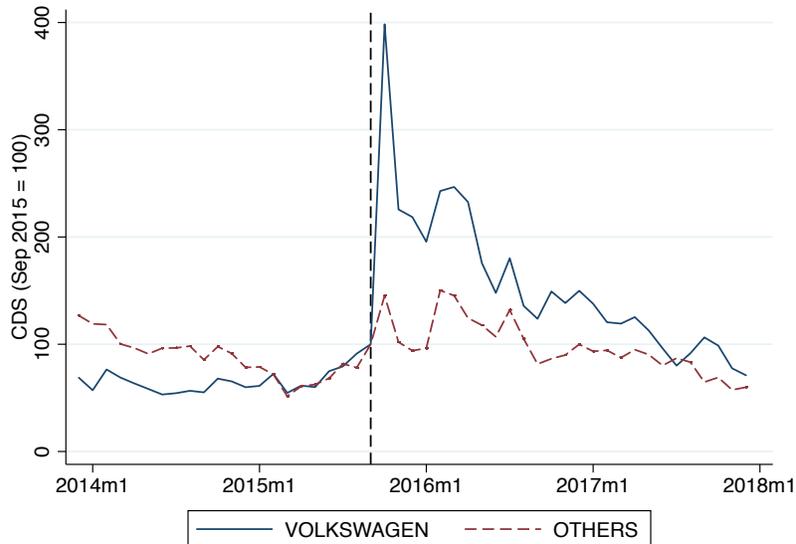
(b) BOND YIELDS RENAULT

Figure A3: FINANCING OF MANUFACTURER AND CAPTIVE UNIT

Note: Panel (a) shows the CDS in basis points for Ford and Ford Motor Credit from December 2013 to December 2017. Panel (b) shows the yields on a bond issued in March 2014 by Renault and on a bond with the same maturity issued in the same month by RCI (Renault Credit International).



(a) CDS LEVEL



(b) CDS NORMALIZED

Figure A4: VOLKSWAGEN EMISSIONS SCANDAL: CDS CAR MANUFACTURERS

Note: The figure shows the CDS for Volkswagen and the median across all other manufacturers. The figures plots the monthly averages of daily CDS from December 2013 to December 2017. The CDS values are in basis points in panel (a) and normalized to 100 in September 2015 in panel (b).

C Additional Derivations

C.1 Back-of-the-envelope Calculation

In this Appendix we discuss the calculation behind the back-of-the-envelope numbers that we present in Section 4. Table A5 reports the key inputs of and steps for the calculation. Contract terms and lending standards in column (1) are the average for captive lenders (See Table 2 in the main text). The coefficients in column (2) are the estimates for high liquidity need manufacturers following the Volkswagen emission scandal (See Panel A of Table 6 in the main text). Using the statistically significant coefficients in column (2) and the baseline levels in column (1) we compute the contract terms and fraction in arrears for high liquidity need manufacturers following the Volkswagen emission scandal, which we report in column (3).

We proxy the cost of funds as the sum of the average car manufacturer CDS plus the sovereign yield in our sample period. This gives a cost of funds of about 2%, which increases by about 50 basis points in the months following the Volkswagen emission scandal for the manufacturers in our sample (See Figure A4). We can then compute the cash manufacturers get upfront from the initial down payment and the expected net present value (NPV) of future revenues from expected interest payments both in the baseline scenario and in the high liquidity needs (and high CDS) scenario. High-liquidity-need manufacturers obtain approximately €820 in additional cash as a result of the larger down payment. Despite the significantly higher interest rate, the monthly payment for high-liquidity-need manufacturers decreases and the present value of expected revenues declines by about €950 relative to the baseline. Putting together these numbers, our estimates show that to gain one additional euro in cash today high-liquidity-need manufacturers lose 15 cents in present value terms. Overall, credit fire sale allows raising cash at an opportunity cost of 3.8% annualized.

Table A5: BACK-OF-THE-ENVELOPE CALCULATION

	BASELINE	HIGH-LIQUIDITY NEEDS	DIFFERENCE	
	(1)	COEFFICIENT	LEVEL	
	(1)	(2)	(3)	
			(4)	
Contract terms:				
Interest (%)	6.81	0.359***	7.17	0.36
Maturity (Months)	47.98	-0.088***	43.76	-4.22
Size (euro)	8,508	-0.096**	5.34	-817
Car value (euro)	13,711	-0.063	13,711	0
Lending standards:				
In arrears (0/1)	0.06	0.012**	0.07	0.01
Cost of funds (%)	2.00		2.50	0.50
Cash today (euro)	5,203		6,020	817
Expected NPV (euro)	5,853		4,911	-943
Expected NPV loss for 1 euro of cash (euro)				0.15
Annualized rate (%)				3.86

Note: Column (1) shows averages for captive lenders (See Table 2 in the main text). Column (2) shows the estimates for high liquidity need manufacturers following the Volkswagen emission scandal (See Panel A of Table 6 in the main text). Column (3) shows averages for high liquidity need manufacturers following the Volkswagen emission scandal combining columns (1) and (3), and column (4) shows the differences between column (3) and (1). The interest rate is in percentage points; maturity is in months; the size of the loan and the car value is in euros. Arrears is a dummy equal to one if the loan is late payment starting one year after origination. Cost of funds is in percentage points. Cash today is the difference between the car value and the loan amount. Expected NPV is the expected net present value of future revenues from expected interest payments.

C.2 Model derivation and calibration

In this Appendix we also discuss the solutions of the model presented in Section 5.1 in two simpler cases. First, focusing only in the car market under the assumption that all buyers can purchase the car. Second, looking at both the car market and the loan market, when only stand-alone lenders offers financing.

Car market only (i.e., all cash buyers). The endogenous variables in the car market are the number of manufacturers N and the price of the cars p_j . Given a market size M and using (4), we can compute demand for manufacturer j as follows:

$$D_j(p_1, \dots, p_N) = M \int [F(p - p_j + v)]^{N-1} f(v) dv. \quad (16)$$

Under the Bertrand-Nash assumption that each supplier chooses price to maximize its expected profits, then the FOC from (3) is:

$$p_j = \kappa - \frac{D_j(p_1, \dots, p_N)}{\frac{\partial D_j(p_1, \dots, p_N)}{\partial p_j}}. \quad (17)$$

We focus on a symmetric equilibrium where all manufacturers set the same price, i.e. $p_j = p \forall j = 1, \dots, N$ (Perloff and Salop, 1985). Thus, each manufacturer receive a fraction $\frac{1}{N}$ of approved buyers. Combining (17) with (16) and using the symmetric equilibrium assumption, we get the optimal price:

$$p = \kappa + \frac{M \int [F(v)]^{N-1} f(v) dv}{(N-1)M \int [F(v)]^{N-2} f(v)^2 dv} = \kappa + \frac{1}{N(N-1) \int [F(v)]^{N-2} f(v)^2 dv}, \quad (18)$$

and the number of manufacturers is given by the zero profits conditions (3):

$$\frac{M}{N}(p - \kappa) - K = 0 \rightarrow N^* = \frac{M(p - \kappa)}{K}. \quad (19)$$

Loan market with only stand-alone banks. We now assume that in order to buy a car consumers need financing which is provided by stand-alone banks. The endogenous variables are now the number of manufacturers N and the price of the cars p_j as above, and also s_b , which is the optimally chosen lending signal threshold for stand-alone banks. The latter is obtained by setting lenders' profit to zero at the highest interest rate in the market as shown in (7). The approval rate by stand-alone banks is then given by:

$$A(\bar{s}_b) = \gamma(1 - G_L(\bar{s}_b)) + (1 - \gamma)(1 - G_H(\bar{s}_b)). \quad (20)$$

Note that an increase in the signal threshold reduce the approval rate. Because now

consumers who are denied a loan cannot buy the good, the effective market size becomes: $A(\bar{s}_b)M$. The latter is strictly lower than M unless stand-alone lenders approve all potential buyers. The new equilibrium number of manufacturers N is then given by:

$$A(\bar{s}_b)\frac{M}{N}(p - \kappa) - K = 0 \rightarrow N = \frac{A(\bar{s}_b)M(p - \kappa)}{K}. \quad (21)$$

Unless traditional banks approve all consumers, we have a lower number of manufacturers than in the case in which all buyers can purchase a car irrespective of financing. And the new equilibrium price p is given by (18) with the new number of manufacturers from equation (21).

Calibration. Table A6 shows the main parameters that we observe in the data or calibrate, as well as the endogenous outcomes of the model that we also observe in the data and use as target moments for our calibration. Panel A shows the parameter of the model that we observe directly in our micro-data, namely the fraction α of borrowers going to captive lenders, the maximum rate \bar{i} , and the average loan-to-value by captive lenders θ .³⁷ We also observe in the data for a captive and a stand-alone lender the fraction of borrowers with a low credit score which we use to fix the proportion of low risk borrowers. Finally we proxy the cost of funds using the average car manufacturer CDS and the sovereign yield in our sample period.

Panel B shows the parameters that we have calibrated using the targeted endogenous outcomes of the model that we observe in the data and are reported in Panel C. To allow more flexibility in calibrating the model to the data, we allow processing cost c and collection rates upon default d to vary between stand-alone and diversified lenders.

³⁷Given the assumption that loans are provided in competitive markets by stand-alone banks and captive lenders, we only need the loan-to-value by captive lenders. The latter is used to compute the losses on the risky loans approved by captive lenders, which would not have been approved by stand-alone lenders.

Table A6: CALIBRATION

	VARIABLES	DATA	MODEL
Panel A: Parameters from the data			
Proportion of borrowers going to captive	α	0.58	0.58
Maximum loan rate	\bar{i}	0.13	0.13
Loan-to-value (captive)	θ	0.65	0.65
Proportion of low risk borrowers	γ	0.85	0.85
Cost of funds	r	0.02	0.02
Panel B: Parameters calibrated			
Marginal cost of producing car	κ		13,000
Fixed cost of producing car	K		800,000
Potential Buyers (monthly)	M		35,000
Support for uniform density function of car valuation	$f(v)$		15,000-16,000
Net collection rate upon default (standalone-captive)	d		0.01-0.02
Cost of processing loan (standalone-captive)	c		0.09-0.08
Panel C: Comparison data - model			
Car value	p	13,000	13,166
Number of car manufacturers	N	9	6
Arrears rate standalone	$\delta(s_b)$	0.05	0.06
Arrears rate captive	$\delta(s_j)$	0.06	0.10
Approved buyers (monthly)	$(1 - \alpha)A(\bar{s}_b) + \alpha A(\bar{s}_j)$	30,000	29,012

Note: Panel A shows the parameters of the model that we observe directly in our micro-data. Panel B shows the parameters that we have calibrated. Panel C shows endogenous outcomes of the model that we also observe in the data and use as target to calibrate the parameters of the model.