Dislocated Credit:

Captive Lending as Liquidity Management*

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Abstract

A manufacturer who also provides loans to its customers can generate liquidity by adjusting credit terms and standards. For example, approving loans to risky borrowers it would have otherwise rejected, the manufacturer will boost revenue today at the cost of higher defaults in the future. Using a multi-country dataset on securitized car loans and quasi-exogenous variation from the Volkswagen emissions scandal, we show that manufacturers/lenders dislocate credit in response to a liquidity shock. Using a calibrated model for quantification, we find that credit dislocations increase the cash collected up front per vehicle by 16% at a cost lower than available alternatives. Our results imply that the direction, magnitude, and heterogeneity of financial shock transmission to consumers is altered when financial intermediation is internalized by manufacturers.

JEL codes: G21, G23, G50.

Keywords: Captive Finance, Vertical Integration, Liquidity, Fire Sales, Car Loans.

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1 Introduction

GM Financial is "inherently cash generative during a downturn."

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

The role played by consumer leverage in the purchase of durable goods in the global financial crisis resurfaced a long-standing academic debate on the mechanisms through which financial shocks are transmitted to the economy (Bernanke, 2018; Gertler and Gilchrist, 2018; Mian and Sufi, 2018). Most of the extant work focuses on evaluating how much of boom and bust in leverage and economic activity can be explained by innovations in stand-alone financial institutions, such as securitization and the liability maturity shortening (Keys et al., 2010; Gorton and Metrick, 2012). The analysis thus largely ignores that the crisis developed in the wake of another secular trend in the market for consumer credit: the internalization of financial intermediation by durable good manufacturers (Banner, 1958; Greenwood and Scharfstein, 2013; Bodnaruk et al., 2016).

Real estate (Stroebel, 2016), auto (Benmelech et al., 2017), and equipment (Murfin and Pratt, 2019) manufacturers have, over the last 50 years, created subsidiaries that perform bank-like activities - so called "captive lenders".[1] In the vertically integrated units, lending standards are set to maximize the joint profits of lending and manufacturing, which can change substantially the real implications of financial shocks. For example, while a cash-strapped stand-alone lender may reduce the supply of credit to risky borrowers, an integrated lender/manufacturer may relax lending standards to boost durable good demand, resulting in increased leverage by risky consumers during downturns.

[1]According 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`).

In this paper we assess empirically how vertically integrated durable good manufacturers/lenders propagate financial shocks to consumers. We show evidence that manufacturers use captive lending as a tool for liquidity management that is distinct from those studied in prior literature, such as inventory fire-sales (Shleifer and Vishny, 2011) or car price adjustments (Chevalier and Scharfstein, 1996; Gilchrist et al., 2017). Integrated manufacturer/lenders dislocate credit terms and standards to enhance the cash generated via sales of car inventory. For inframarginal buyers, reducing loan amount increases down-payments at the cost of lower future interest revenue. For marginal buyers, relaxing lending standards to risky borrowers boosts purchases (and down-payments), and the cost of higher future defaults.[2]

The use of captive lending as a tool for liquidity management has novel implications for how financial shocks affect manufacturers and propagate to consumers. For integrated manufacturer/lenders, the financial cost of liquidating car inventory—lower interest revenues and larger default losses—are only realized in the future and difficult to evaluate by outsiders. Instead, the direct cost of liquidating inventory (or any asset) at fire-sale prices is reflected immediately on the manufacturer's balance sheet. For consumers, changes in captive lending standards 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 induce an increase in the leverage of risky borrowers (relative to safe ones), an effect that would be difficult to reconcile with a standalone manufacturer fire-selling inventory or adjusting product prices, or with a standalone lender cutting credit supply.

To provide evidence of liquidity management through captive lending, we investigate how integrated manufacturer/lenders adjust their lending terms and standards in response to financial shocks, using a new multi-country dataset on over a million securitized used auto

[2]Anecdotal evidence during the Covid-19 Pandemic stresses the role of captive lenders for manufacturers 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).

loans in Europe. The European securitized used car loan market has four distinct features that are ideal for the empirical study of liquidity management through captive lending. First, traditional stand-alone banks are active players in the market for financing used vehicles sold by integrated lenders.[3] The credit terms offered by stand-alone lenders provide a useful benchmark 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. Third, manufacturer-owned dealerships are common in the European used car market during our sample period, which enables integrated manufacturer-lenders to generate liquidity through used car inventory.[4] Finally, securitization cannot generate cash immediately after issuing a loan (because car loans are securitized a year after issuance) and lenders internalize the financial costs of default (because lenders retain the equity tranche). As a result, auto-loan securitization is not a short-run substitute for captive credit dislocation, and it is unlikely to distort loan terms and lending standards through agency or asymmetric information considerations.

We begin our analysis by documenting how captive lenders adjust credit terms and standards—relative to terms offered by stand-alone banks, and to purchase the same model/make vehicle in the same location—when the their associated manufacturer faces a liquidity shock. We identify manufacturer liquidity shocks as concurrent increases in liquidity needs/demand (measured as the fraction of long term bonds maturing in a given month) and the cost of external funding (measured with high frequency variation in CDS prices). Before addressing the issue of endogeneity, we document stylized facts consistent with integrated manufacturers/lenders using captive lending as a tool for liquidity management, remaining agnostic on the source of the liquidity shocks.

The stylized facts, derived from specifications that include car-model × geographical

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

[4]For example, in 2014 Volkswagen owned the largest dealership network in Europe, with twice the size of the largest independent dealer network (See: `https://europe.autonews.com/article/20140914/ANE/140909885/european-automakers-reduce-company-owned-dealerships`). Moreover, according 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.

market × month fixed-effects, are as follows. In the intensive margin, captive lenders tighten loan terms (reduce loan amount and maturity, increase interest rates) relative to stand-alone banks when their associated manufacturer faces a liquidity shock. In the extensive margin, captive lenders increase the proportion of credit issued to buyers with lower income and without income verification. The apparent contraction of credit supply in the intensive margin and increase in the extensive margin can be reconciled through the logic of liquidity management: both adjustments increase the cash generated up front from the sale of used car inventory. Credit dislocations generate liquidity at a cost: changes in lending standards are associated with a significant and economically large increase in the probability of future repayment arrears, even after controlling for changes in observable borrower characteristics.

We then provide evidence of the causal impact of liquidity shocks on a manufacturer's captive lending behavior. We exploit the events surrounding the Volkswagen emissions scandal as a natural experiment that generated unexpected time series variation in car manufacturers' cost of external funding. 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 when the car was being tested, changing its performance to improve the test result.[5] The days following the discovery, Volkswagen's CDS price quadrupled, and that of all other manufacturers increased by 50% on average. For manufacturers *excluding* Volkswagen with a large fraction of bonds maturing in the quarter after the event (manufacturers with high liquidity needs), the Volkswagen scandal triggered an exogenous coincidence of an increase in liquidity needs and the cost of external financing, unrelated to firm fundamentals.[6] We use the auto manufacturers that also experienced a CDS price increase, but had a small fraction of bonds maturing in the quarter after the event (low liquidity needs manufacturers), as a counterfactual in a difference-in-difference analysis.[7] We estimate specifications that compare credit terms and standards offered by

[5] 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).

[6] We provide validating evidence that the fraction of bonds maturing during the Volkswagen event is purely coincidental, driven by borrowing decisions made well before the scandal unfolded and unrelated to unobservable firm characteristics that may interact with a change in the cost of external financing.

[7] The research design is close to Almeida et al. (2011) others?, who compare firms whose long-term debt

captive lenders relative to stand-alone banks, during the two months before and after the scandal. As in the initial analysis, the baseline estimation includes car-model × geographical market × month fixed-effects. The results are robust to comparing captive and stand-alone within narrower market definitions as well as controlling for unobservable characteristics of the cars with bins of car values.[8]

The findings from the causal analysis echo the stylized patterns. Integrated manufacturers/lenders with high liquidity needs after the shock make cash-generating adjustments to loan terms: the CDS price increase following the Volkswagen scandal (a 50 basis point increase) causes a 36 basis points increase in loan rates, and a decrease in loan maturity and amount of 8% and 10% respectively (relative to stand-alone lenders). Captive lenders also lower lending standards in response to the event: the fraction of loans with future arrears increases by 1.2 percentage points—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. Combined, the results on loan terms and credit standards imply that to gain one additional euro in cash today high-liquidity-need integrated manufacturers are willing to lose 7 cents in present value terms, or an opportunity cost of 1.8% annualized. Hence, by changing loan terms and standards, manufacturers that face a liquidity shock can raise cash at an opportunity cost that is lower than the average cost of financing in public debt markets.[9]

Since captive lending adjustments entails a contraction of credit to infra-marginal (safe) borrowers and an expansion of credit to marginal (risky) borrowers, captive credit disloca-

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was scheduled to mature early in 2007 (onset of the Financial Crisis) to matched firms whose debt was scheduled to mature after 2008.

[8]This is expected given the ex ante plausibility of the identifying assumption of the difference-in-differences estimation (that the fraction of loans maturing in September 2015 is uncorrelated with the unobserved quality of the cars sold by a manufacturer after the Volkswagen scandal). Nevertheless, we provide the results in a robustness analysis since our data do not include some car attributes, such as engine size or add-ons.

[9]For example, the month after the Volkswagen emissions scandal the cost of external funds for manufacturers, measured as the average car manufacturer 5-year CDS plus the 5-year swap rate, was almost 2.5%.

tions to generate liquidity unambiguously affect the car buyer risk composition. However, due to the opposing effects on lending to marginal and inframarginal buyers, captive credit dislocations have an ambiguous effect on the quantity of cars sold and financed. We use the Volkswagen events to verify these conjectures. After the Volkswagen emissions scandal, integrated manufacturers/lenders with high liquidity needs increase the share of originations to low income borrowers relative to stand-alone lenders (there is no such difference in the placebo group of manufacturers with low liquidity needs). Buyer income is positively correlated with loan repayment probability (conditional on car model, location and month), so the finding implies that the captive lenders reallocate credit towards risky borrowers. We obtain corroborating evidence using the internal credit score data for the captive arm of one high-liquidity need manufacturer and one stand-alone lender. In this subsample, the captive lender increases the share of loans to low credit score borrowers relative to the stand-alone lender by about 18% of the baseline fraction. In contrast to the results on the borrower risk composition, the increase in manufacturer CDS prices does not have a statistically significant differential impact on the total number of cars financed by high liquidity need and low liquidity need captive lenders (relative to stand-alone lenders).

We conclude the analysis with a quantitative evaluation of the liquidity created by captive lenders through the dislocation of credit terms and standards. We calibrate to the microdata a stylized two-period model of borrowers' demand for cars and loans with stand-alone and captive lenders. With the calibrated parameters, captive lending leads to a relaxation of lending standards even in the absence of a liquidity shock, because the profits from marginal car sales outweigh the losses from marginal defaults. We then use the model to compute the cash generated by captive credit dislocations. We find that a stand-alone manufacturer can generate the same amount of cash than the average captive credit dislocation observed in the data with a fire sale of car inventory at a 8-12% discount from the equilibrium sale price. We then use the calibrated model to compare the financial cost of captive lending dislocations (lower interest revenue and higher losses due to defaults) to the cost of a fire sale (lower revenue per car sold at a discounted price). To generate the same amount of cash, liquidity management through captive credit dislocations is 60% cheaper than a traditional car 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 provide a new complementary explanation: liquidity management. Captive lenders enable manufacturers affected by an increase in the cost of, and the demand for, external funding to generate liquidity through a dislocation in lending terms and standards.

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 stand-alone manufacturer facing a cash shortage 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 shows that when the asset sale is bundled with financing there could be dislocation in *contract terms* beyond the price. In other words, the integration of manufacturing and financing broadens the set of contract terms that can be adjusted to create liquidity. As a result, the cost of credit dislocation —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 price dislocation.

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 captive finance liquidity management occurs through the dislocation of financing terms, they can be used to generate liquidity even if consumers have standard preferences. More importantly, captive finance credit dislocations also have potential macroeconomic implications, although not on prices.

Integrated manufacturers/lenders that face a liquidity shock may reallocate credit from safe to risky borrowers during economic downturns, potentially exacerbating aggregate leverage cycles.

Hence, our findings imply that vertical integration of production and financing fundamentally alters how liquidity shocks affect the supply of credit, 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 via banks (Almeida et al., 2011; Paravisini et al., 2014, 2015; Costello, 2020) as well as work on the growing role and different behavior of non-bank financial intermediaries (Buchak et al., 2018; Gopal and Schnabl, 2022).

Finally, our work also contributes 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-baked commercial paper market on auto sales, through illiquidity of nonbank lenders. We complement their work by showcasing the role of the captive lending unit of integrated manufacturers in generating cash when manufacturers face a liquidity shortage.

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 captive lending credit dislocation 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 borrowers' demand for cars and loans 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.[10] 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 used cars.[11] Second, in the used car market we can ignore car manufacturing costs and focus on the transformation of car inventory into cash.

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

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

[11] Our 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.

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 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.[12]

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 €5 thousand to €24 thousand.[13]

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 thou-

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

[13]The car value reported in our data is the sale price of the car.

sands 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.[14]

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 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.[15]

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 in a year (in a quarter) as a fraction of the total outstanding value is about 20% (5%). There are manufacturers-month pairs with no maturing bonds, and months in which a manufacturer has more than 10% of the value of outstanding bonds maturing in a quarter. 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.

[14]The 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 one stand-alone bank and for this reason we remove them from the analysis on arrears.

[15]For 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")."

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)	15.71	14.54	6.99	8.01	24.18	37
Panel E: Manufacturers						
CDS (%)	1.252	1.034	0.915	0.279	3.020	441
Maturing bonds - Next quarter (%)	4.785	4.289	4.41	0.00	10.58	441
Maturing bonds - Next year (%)	19.57	19.90	9.22	3.656	32.21	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 or year as a percentage of total outstanding bonds value at the beginning of the quarter or year. 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.

2.2 Captive Lenders VS Stand-alone Banks

To set the stage for our empirical analysis, 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. Figure 1 shows the share of loans made by two captive and two traditional lenders for 25 different brands. Traditional stand-alone lenders spread their loans across different brands. Bank A has no share greater than 30% in any brand, while bank B is even more diversified with no single brands accounting for more than 15% of the loans. On the other hand, the cars purchased with the loans granted by a given captive lender are part of the inventory of the car manufacturer that belongs to the same business group as the captive lender. Approximately 45% of PSA finance loans are for Citroen and 55% for Peugeot; more than 60% of Volskwagen finance loans goes to Volskwagen and Seat, which is also part of the group.

These different specialization patterns by captive lenders relative to stand-alone banks is reflected in contract terms and lending standards, as shown in Table 2. Loans granted by captive lenders have on average a significantly higher interest rate (6.8%) than loans by traditional banks (5.3%). Captive lenders also offer on average shorter maturities (48 months versus 55 months) and lower loan-to-values (65% 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).

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.[16] Finally, borrowers from captive lenders are about 1 percentage point more

[16] The 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).

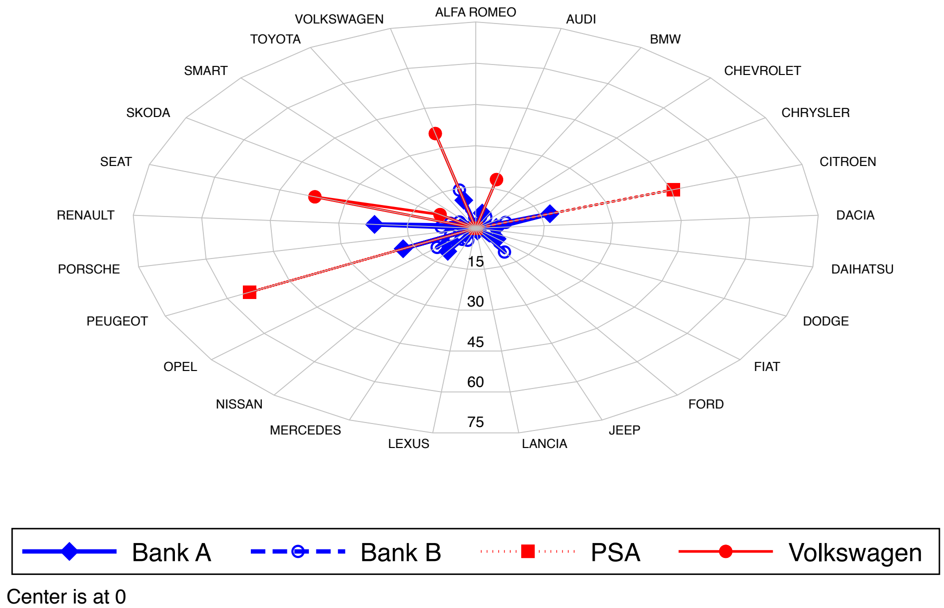


Figure 1: Specialization of Captive and Stand-alone Lenders Across Brands
Note: The figure shows the share of loans made by two captive and two stand-alone lenders for approximately 25 different brands. The captive lenders are PSA finance and Volskwagen Finance. The stand-alone lenders are not reported 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).

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.

Moreover, due to data protection, captive lenders may not be able to verify the income status of some borrowers. Potential difference in reporting between captive and stand-alone lenders are not a concern for our identification strategy, unless the reporting standards also change differentially for captive lenders when the parent manufacturer CDS and liquidity needs are high.

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.

3 Captive Lending Credit Dislocation: Facts

We provide in this section stylized evidence consistent with captive lending as a tool for liquidity management. In contrast to a stand-alone manufacturer, which can generate additional liquidity from a car sale only by adjusting the car price, an integrated manufacturer/lender can also adjust credit contract terms.[17] For example, the manufacturer/lender can reduce the price of the loan (instead of the price of the car) to sell more cars, at the cost

[17] Our focus in this paper is on internal liquidity creation. A manufacturer with increased need for liquidity can also acquire it externally borrowing or drawing down on credit lines. In the results section we compare the cost of raising liquidity internally versus the cost of raising it externally. A captive lender can also generate cash by securitizing its portfolio of auto loans. As noted earlier, securitization cannot be used to generate liquidity immediately after financing a car sale because car loans are securitized one year after sale.

of reducing future cash flows from interest. Also, the manufacturer/lender can reduce the loan amount—increase the down-payment cash flow at the time of the sale, at the cost of reducing future cash flows from interest and principal payment.[18] Similarly, reducing loan maturity brings forward cash repayments, at the cost of future interest rate revenue. Finally, the manufacturer/lender can also relax lending standards (approve loans to marginal, riskier, buyers) to increase car purchases, at the cost of future higher losses related to default.

The results in this section demonstrate that captive lenders adjust loan terms and lending standards (relative to stand-alone lenders) in the ways described above, when their parent manufacturers both have high liquidity needs and experience an increase in the cost of external financing. We first discuss empirical specification and measurement issues and then present the stylized evidence.

3.1 Empirical Specification

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

$$y_{ilbmt} = \alpha Manuf.ExtFinCost_{bt} \times Captive_l + \theta X_{ilt} + \gamma_l + \gamma_{bmt} + \epsilon_{ilbmt}, \tag{1}$$

where y_{ilbmt} is outcome of interest y (e.g., interest rate, maturity, loan amount, and borrower characteristics) for individual i borrowing from lender l and buying brand-model b in market m and period t; $Manuf.ExtFinCost_{bt}$ is a measure of the external financing cost of manufacturer b at the beginning of period t (we use manufacturer's CDS price as a measure and validate it in the next subsection); $Captive_l$ is a dummy equal to one if the lender is

[18] Data on trade-ins are not available. Trade-ins, which impact the final cash that the transaction generates (= car price - loan amount - trade-in value), are relatively infrequent in used car transactions. For example, aggregate statistics for the US market show that about 20% of all used-car sales involve a trade-in compared to more than 40% of new-car transactions (See: https://askwonder.com/research/cars-sold-trade-in-deals-us-qfro7n8la#:~:text=The%20National%20Automobile%20Dealers%20Association,sales%20include%20a%20trade%2Din.). Thus, for the median used car transaction in our analysis, we likely measure the true cash generated.

a captive firm; X_{ilt} are borrower and lenders controls; γ_l are lender fixed effects; and γ_{bmt} are interacted brand-model, market and time fixed effects.[19] The specification also includes lender fixed-effects, which capture time-invariant differences in loan terms between captive and stand-alone lenders. Thus, the estimation only uses variation over time and across manufacturers *interacted* with the type of car loan provider (captive versus stand-alone).[20]

The coefficient of interest, α, captures how variation in manufacturers' external cost of funding covaries with loan terms/standard by captive lenders *relative* to stand-alone banks. Our stringent set of fixed effects implies α is estimated from variation between loans originated by captive relative to stand-alone lenders for the same brand-model in the same market and time. We use this baseline specification to evaluate whether the relative changes in captive loan contract outcomes are related to liquidity creation. To do so, we evaluate how α changes in the cross section with ex ante measures of manufacturers' liquidity needs, which we discuss below.

3.2 Measurement

External financing cost. We measure the cost of external financing using the car manufacturers' credit default swaps (CDS). With this measure we intend to capture the cost of raising external cash, rather than direct or indirect costs of financial distress. In our sample period car manufacturers are nowhere near bankruptcy, as the CDS spread of car manufacturers never exceed 400 basis points, well below the levels reached by General Motors and Ford Motor Company in 2008 (see Hortaçsu et al. (2013) for auto manufacturer CDS spreads during the Great Recession). We use CDS prices instead of bonds yields because daily data for homogeneous and standardized 5-year maturity contracts are available across all manufacturers and all periods. While the parent manufacturer and the captive lending unit may have separate funding sources, we use the manufacturer's CDS as a measure of the

[19] The car-model × geographical market × month fixed-effects absorb, amongst other things, the average variation in loan terms/standards that can be explained by the external cost of financing.

[20] Note 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).

financing cost for the entire vertically integrated producers (i.e., the manufacturer plus the captive finance arm). Figure A1, Panel (a), 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.[21] We also find a very high correlation between the yields on comparable bonds issued by manufacturers and their captive unit. For example, Panel (b) of Figure A1 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 around 0.97.

Liquidity needs. We measure manufacturer liquidity needs using the fraction of maturing loans (see Almeida et al. (2011) for an early application of this approach). First, we compute for each manufacturer in each year the face value of manufacturer's expiring bonds over the total amount of its outstanding bonds at the beginning of the year. Second, we classify a car manufacturer as facing *high liquidity needs* if its fraction of maturing bonds is above the median of the distribution of this ratio. Based on this classification, all manufacturers in our sample belong to the high liquidity need group in at least one month. In the next Section we provide a detailed discussion of this variable's variation in the context of our causal estimation.

Unobservable car characteristics. We do not observe some relevant car characteristics such as engine type or year of manufacturing, which can affect the car resale value upon default among other things. For this reason, when we use contract characteristics as an outcome variable, we augment specification (1) with interactions with borrower income-quintiles (defined within geographical market and year) to capture the car unobserved quality within brand-model. We do not include the interaction with income bins when the dependent variables are capturing lending standards, since the pool of borrowers might change. We also present robustness results for all dependent variables capturing credit dislocation using bins of car values.

Lending terms and standards. We use as a dependent variable measures of lending

[21]For other car makers separate high frequency data on the CDS for both the parent manufacturer and the captive unit are not available.

terms reported in the data (loan amount, maturity, and interest rate). We measure credit standards indirectly 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 and low borrower income). Second we use the realized loan default rate.

3.3 Stylized facts

We present in Appendix Table A1 specification (1) estimates on the full sample. We find that when the car manufacturer's CDS increases, its captive lender increases the interest rate, shortens the maturity and decreases the loan amount (increases the down-payment) for car loans relative to stand-alone banks. Regarding lending standards, when the car manufacturer's CDS increases, the average loan recipient income, fraction with loan verification, and probability of loan repayment of captive loan recipients decrease relative to borrowers from stand-alone banks. The magnitudes are all economically significant. For example, 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 relative to loans originated by stand-alone lenders. Given a baseline default probability of approximately 5 percentage points, this represents approximately a 30% increase in the probability of future arrears.

To evaluate whether the observed average lending behavior by captive lenders is related to liquidity creation motives, we estimate the model separately in two subsamples defined by the fraction of maturing loans, as defined above. We expect the coefficient α in equation (1) in the high liquidity needs sample to capture the effect of captive lenders as liquidity providers when the manufacturer faces a liquidity shock. Table 3 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 have a larger magnitude and statistical significance when the fraction of maturing bonds is high. Following a 100-basis-points increase in the parent manufacturer's CDS, captive lenders increase rate by about 17 basis points when they have high liquidity needs, while the increase is about 5 basis point and not statistically significant when the manufacturer's liquidity needs are low. Both maturity and loan size 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 Table 3, columns (4) to (6), we look at how captive lending standards adjust with changes in the manufacturer's CDS price. The results in Panel A (high fraction of bonds maturing) are consistent with captive lenders relaxing lending standards when the integrated manufacturer/lender experience a high cost of and demand for external finance. When a manufacturer faces a 100 basis point increase in their CDS price concurrent with a high fraction of bonds maturing, the income of an average borrower taking a loan from captive lenders drops by about 2%, the fraction of borrowers from captive lenders with verified income drops by 7 percentage points, and the probability of future arrears of captive lender loans increases by about 2 percentage points (all relative to loans issued by stand-alone lenders). The results in Panel B (low fraction of bonds maturing) show that these results disappear (income, fraction of verified income) or are small in magnitude (arrears) when the manufacturer does not have high liquidity needs.

To summarize, the differential behavior of captive lenders relative to stand-alone lenders occurs predominantly when the parent manufacturers face simultaneously high external financing costs and high liquidity needs. These stylized facts are consistent with a dislocation of credit terms by captive lenders that face liquidity shocks. For robustness, we show in Appendix B that these facts are unchanged when controls for bins of car values are added. We also provide additional evidence on the lending standards margin looking at borrowers' credit score.

Table 3: Captive Lenders Liquidity Creation

	Credit Terms			Credit Standards		
	Rate	Maturity	Loan Size	Income	Income verified	Arrears
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: High liquidity need manufacturers						
Manuf. CDS × Captive Lender	0.176***	-0.016***	-0.026**	-0.017***	-0.069***	0.016***
	[0.049]	[0.005]	[0.013]	[0.006]	[0.010]	[0.005]
Avg Dep Var	6.622	3.887	8.903	9.988	.634	.065
R^2	0.823	0.461	0.564	0.442	0.814	0.297
Observations	300,247	300,247	300,247	452,842	452,842	330,054
Panel B: Low liquidity need manufacturers						
Manuf. CDS × Captive Lender	0.053	0.010	0.004	0.009	0.010	0.007*
	[0.074]	[0.012]	[0.013]	[0.008]	[0.010]	[0.004]
Avg Dep Var	5.649	3.849	8.976	10.127	.602	.035
R^2	0.788	0.442	0.541	0.499	0.960	0.296
Observations	310,861	310,861	310,861	453,243	453,243	286,692
Fixed effects:						
Model-Region-Time-Income	YES	YES	YES	NO	NO	NO
Model-Region-Time	NO	NO	NO	YES	YES	YES
Lender	YES	YES	YES	YES	YES	YES
Age	NO	NO	NO	NO	NO	YES
Additional controls:						
Lender-time	YES	YES	YES	YES	YES	YES
Borrower	YES	YES	YES	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 month we compute the ratio between the face value of manufacturer expiring bonds in the next year over its total amount of outstanding bonds in that month. We classify a car manufacturer as high liquidity needs, if it lies above the median of the distribution of this ratio in our sample. The dependent variables are the interest rate in percentage points, maturity in logs, loan size in logs, income in logs, 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.

4 Evidence from the Volkswagen Emission Scandal

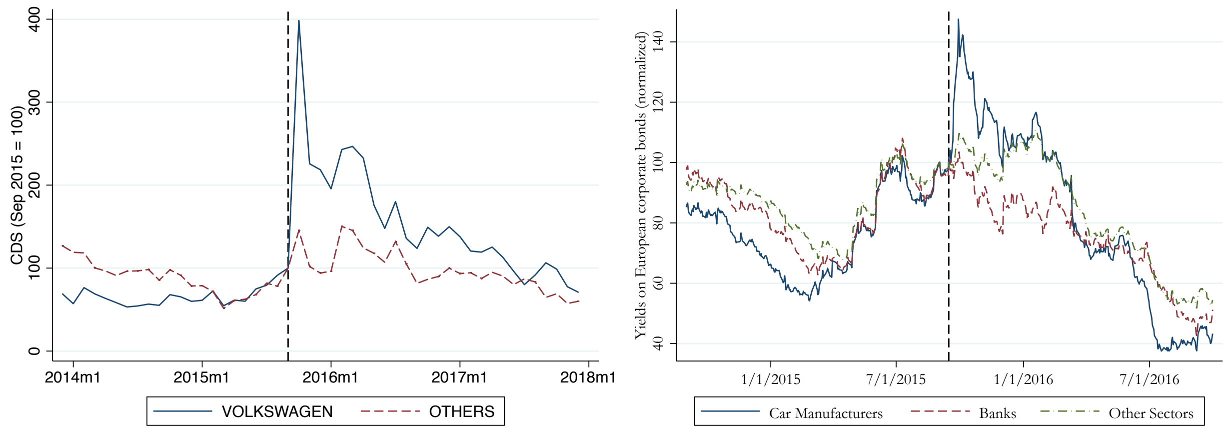
In this section we establish a causal link between liquidity shocks to manufacturers and the dislocations in credit terms and standards by captive lenders documented in the previous section. The goal is to isolate changes in captive lending terms and standards due to manufacturer funding needs when the cost of external finance increases, and distinguish them from those driven by demand shocks, changes in price discrimination or the value of collateral.

4.1 Empirical Strategy

In an ideal setting, identifying the effect of a liquidity shock on credit term dislocations by captive lenders requires: (i) observing the *same individual borrower* buying two *identical cars* using financing from both a captive lender and a stand-alone lender; (ii) exogenous variation in both manufacturers' CDS and liquidity needs, all else equal. Since we do not observe (i) in the data, we mitigate potential selection issues by including car-model $\times$ geographical market $\times$ month $\times$ income bin fixed-effects. This ensures our estimates are obtained exclusively from variation in car financing contracts across captive and stand-alone lenders, for the same car-model in the same market at the same time for borrowers with similar income. To achieve (ii) we exploit two sources of quasi-experimental variation induced by the Volkswagen emissions scandal: short-lived time-series variation in car manufacturers' funding costs, and cross-sectional variation in the fraction of bonds maturing in the quarter after the scandal.

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 when the car was being tested, changing the performance accordingly to improve results. Panel (a) of Figure 2 shows the CDS for Volkswagen and other car manufactures normalized to 100 in September 2015.[22] Before the scandal the different brands

[22]Figure A2 in Appendix B shows the CDS for Volkswagen and other car manufactures in level.



(a) CDS of Car Manufacturers

(b) Yields on Corporate Bonds

Figure 2: Volkswagen Emissions Scandal: CDS and Bond Yields

Note: Panel (a) 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 normalized to 100 in September 2015. Panel (b) shows the yields on European corporate bond indexes for car manufacturers, banks and other non-financial firms.

have a similar trend in CDS, with minor deviations and with Volkswagen having a lower average CDS than other manufacturers. During the month after the scandal, Volkswagen CDS price quadruples, and remains at more than double the pre-scandal level for several months. Other car manufacturers also experience large CDS price increases, approximately 50% higher relative to September 2015.

Figure 2, Panel (b), shows yields on European corporate bond indexes for car manufacturers, banks and other non-financial firms. Car manufacturer yields exhibit a sudden increase after September 2015. Such increase is not present among banks, indicating that stand-alone banks which are used as controls are not affected by the news about Volkswagen. The increase in yields is also not present among other non-financial firms, which implies that aggregate variation in risk-premia is not driving the increase in car manufacturer funding costs following the scandal.

Our identification strategy combines time-series variation in the CDS of car manufacturers *other* than Volkswagen, with cross-sectional variation in liquidity needs. We rank brands in our sample by liquidity needs during the Volkswagen scandal, using the fraction of bonds outstanding in September 2015 maturing in the quarter after the event. We consider the amount of bonds maturing in the quarter after September 2015, since the Volkswagen scandal had a short-lived impact on manufacturers CDS, which returned to pre-shock levels about three months after the event. We label the manufacturers above the median fraction of bonds maturing as *high liquidity needs* manufacturers (BMW, Mercedes, Renault, and Volkswagen). The remaining manufacturers are labeled *low liquidity needs* (Fiat, Ford, Opel, Peugeot and Toyota). In the main analysis we exclude loans for buying Volskwagen cars and other brands of the group (Audi, Porsche, Seat, and Skoda) to minimize the potential confounding effect of changes in demand due to the scandal.

To validate the fraction of maturing bonds as a measure of liquidity needs, we explore the number of bonds issuances by different manufacturers during the quarter after the Volkswagen emissions scandal. We find that the average number of issuances for the group with high liquidity needs is six, while the average number of issuances for the group with low liquidity needs is two. This observation corroborates firms tend to roll over expiring long term debt. Thus, the fraction of bonds expiring is a reasonable proxy for liquidity demand.

The average fraction of loans maturing in the quarter after the Volskwagen scandal is 4% for the carmakers with high liquidity needs, and 1% for the low liquidity need group. Despite the low number of observations, the difference between these two means is statistically different from zero. The difference between the two analogous means in the quarter before the event (4.2% and 4.2%, respectively) is not statistically different from zero. This suggests the manufacturer ranking by liquidity needs during the Volskwagen scandal is not driven by a fixed firm characteristic, driven, for example, by a propensity to issue short term debt.

Figure A3 in Appendix B validates the hypothesis that the fraction of bonds maturing during the Volkswagen event is purely coincidental, driven by borrowing decisions made well before the scandal unfolded. The figure plots for each month the ranking of manufacturers by liquidity needs from one (highest liquidity need) to nine (lowest liquidity need). The liquidity need is measured as the fraction of bonds outstanding at the end of month $t-1$ maturing in months t, $t+1$ and $t+2$. The grey vertical bar identifies the month after the Volskwagen emission scandal. The manufacturer ranking varies substantially month to month. Thus, liquidity needs during the quarter following the Volkswagen scandal is unlikely to be driven by unobservable differences between high- and low-liquidity need manufacturers, which is consistent with the identification hypothesis of our research design.

Figure 3 shows that manufacturers with high and low liquidity needs experience a very similar pattern 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.[23] The identical reaction of CDS prices to the scandal across the two groups of firms suggests the change in the CDS prices was caused by an industry-wide shock, and not a firm-specific one. Thus, for firms with a high fraction of debt maturing, the Volkswagen scandal constitutes the double coincidence of a high demand for liquidity and a sharp increase in the cost of external funding that is unrelated to firm fundamentals.[24]

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

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

where y_{ilbmt} is the outcome of interest y for individual i borrowing from lender l and buying brand-model b in market m and period t; $Post_t$ is a dummy equal to one after the Volkswagen emissions scandal (the sample period is two months before and two months after the month of the Volkswagen Emission Scandal, September 2015); and all other variables are as in equation (1). The coefficient of interest is α which captures the differential changes on

[23] Also in levels the two groups experience a similar change around 50 basis point.

[24] As discussed in the previous section, we measure changes in the cost of external financing using the high frequency variation in CDS spread. To verify the latter can be a good proxy for the evolution in the cost of funding around the Volkswagen scandal, Figure A4 in Appendix B shows the correlation at the daily level between CDS and bond spreads for car manufacturers during the period surrounding the scandal. The average correlation between the CDS and bond spreads for the nine bonds corresponding to the same number of manufacturers is 0.93. Importantly, the average basis, which is defined as the difference between the CDS and the bond spread, amounts to just 4% of the average of both spread. This means that not only the CDS and bond spreads are highly correlated, but also that their levels are very similar, consistent with no-arbitrage (Blanco et al., 2005; Mayordomo et al., 2014).

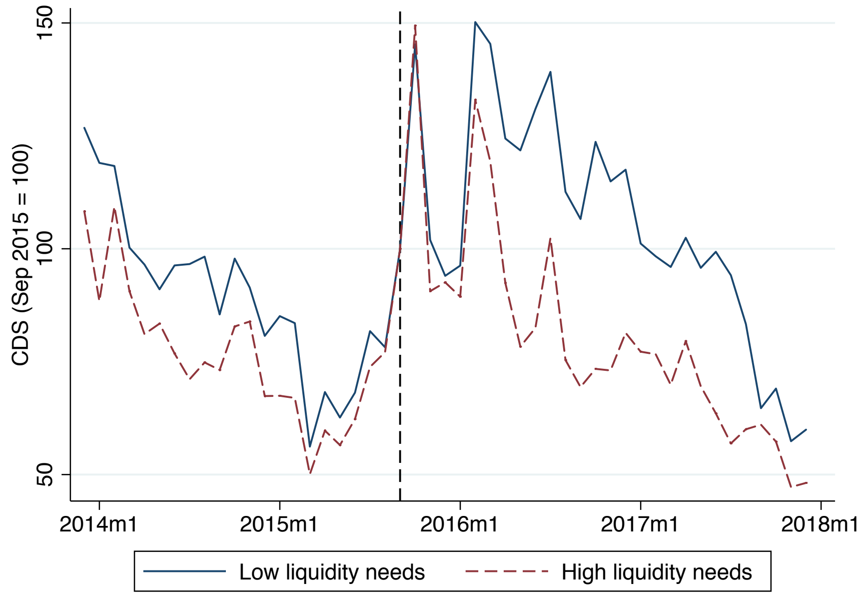


Figure 3: Volkswagen Emissions Scandal: CDS high and low liquidity manufacturers

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 Volskwagen 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.

loan terms and credit standards by captive lenders relative to stand-alone banks after the outbreak of the scandal. We expect the α estimates in the subsample of manufacturers with high liquidity needs to capture the impact of liquidity shocks on the terms and standards of captive lending. The α estimates in the subsample of manufacturers with low liquidity needs are used as a placebo.

4.2 Results

Main result. Table 4 shows the results. For manufacturers with high liquidity needs, the CDS price increase following the Volkswagen scandal (a 50 basis point increase) 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.

Lending standards also change in response to the liquidity shock. High liquidity needs manufacturers who experience a 50 basis points increase in CDS after the Volkswagen scandal 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. The difference between the high and low liquidity need manufacturer groups is statistically significant for loan rates, maturity, income verification and arrears, while it is not significant for loan amounts and income, where point estimates are noisier.[25]

On the one hand, the loan terms results suggest that the liquidity shock generates a response by captive lenders akin to a credit tightening by a traditional stand-alone lender: higher interest rates, lower loan amounts and shorter maturities. On the other hand, the lending standard results suggest that the liquidity shock induces a response by captive lenders akin to a credit supply expansion to risky buyers. The apparent contradiction in credit supply responses on loan terms and standards can be fully reconciled when we interpret captive lending through the lens of liquidity management. Both responses increase the cash flows the manufacturer generates through financed car sales today, at the cost of lower cash flows in the future. For infra-marginal buyers, less credit leads to higher down-payments and shorter maturity leads to earlier repayment, at the cost of future lower interest revenue. For marginal buyers, lax lending standards promote additional car sales, at the cost of higher future losses due to additional defaults.

To illustrate the trade-offs involved in liquidity management through captive lending, we provide a simple back-of-the-envelope calculation of the effects of credit terms and standards, *all else equal*. We compute the cost of generating an extra euro of cash today through a

[25] The p-value for the difference in relative changes in loan amounts between high and low liquidity need manufacturer groups is 0.12.

Table 4: CAPTIVE LENDING CREDIT DISLOCATION DURING THE VW EMISSION SCANDAL

	Credit Terms			Credit Standards		
	Rate	Maturity	Loan Size	Income	Income verified	Arrears
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: High liquidity need manufacturers						
Post × Captive Lender	0.359***	-0.088***	-0.096**	-0.025*	0.000	0.012**
	[0.094]	[0.022]	[0.045]	[0.013]	[0.000]	[0.006]
Avg Dep Var	5.931	3.755	8.865	9.987	.456	.039
R^2	0.867	0.428	0.484	0.466	1.000	0.366
Observations	21,811	21,811	21,811	31,157	31,157	17,161
Panel B: Low liquidity need manufacturers						
Post × Captive Lender	0.013	-0.022	-0.019	-0.006	0.037***	-0.005
	[0.080]	[0.016]	[0.024]	[0.014]	[0.013]	[0.006]
Avg Dep Var	5.716	3.916	8.918	10.104	.656	.064
R^2	0.763	0.409	0.540	0.463	0.781	0.439
Observations	28,549	28,549	28,549	41,888	41,888	18,686
Fixed effects:						
Model-Region-Time-Income	YES	YES	YES	NO	NO	NO
Model-Region-Time	NO	NO	NO	YES	YES	YES
Lender	YES	YES	YES	YES	YES	YES
Age	NO	NO	NO	NO	NO	YES
Additional controls:						
Lender-time	YES	YES	YES	YES	YES	YES
Borrower	YES	YES	YES	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 in 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, loan size in log, income in logs, 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.

decline in loan amount (an increase in down-payment) in terms of forgone net-present-value of future revenues from expected interest payments. Using the summary statistics in Table 1 and the estimates for high-liquidity need manufacturers from Table 4, we compute the additional cash, the new monthly payment and the expected net-present-value (see detailed calculation in Appendix C). High-liquidity-need manufacturers obtain approximately €820 in additional cash per car sold as a result of the larger down-payments. 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 €880 relative to the baseline. These numbers imply that to gain one additional euro in cash today, high-liquidity-needs manufacturers lose 7 cents in present value terms. Thus, managing liquidity by distorting captive lending terms allows the integrated manufacturer/lender to raise cash at an opportunity cost of about 1.8% annualized. We note that this back-of-the-envelope calculation does not consider extensive margin responses coming from either worse credit standards or different non-financial terms (e.g., car prices). We explore these margins next and postpone a full quantification of the costs and benefits of the dislocation in credit terms and standards to Section 5, where we also compare credit dislocations to price dislocations.

Car prices and sales. We estimate how the liquidity shock affects car prices and total car sales. The effect on car prices is of interest because provides information on whether credit dislocations are a complement or a substitute for the price dislocation in a traditional inventory fire sale. And measuring the effect on total car sales is empirically interesting, because the direction of the effect is in theory ambiguous (the credit dislocation increases credit to marginal buyers and decreases credit to inframarginal ones).

Columns (1) and (2) of Table 5 show the results on car prices using the same specification for lending terms given by (2). All estimates on the effect on car prices are not significantly different from zero, but these are noisily estimated. The result on car value is consistent with the dislocation in lending terms and standards being a tool for internal liquidity management, which may complement traditional price adjustment. Although noisily estimated, the point estimate for high-liquidity-needs manufacturers implies a decrease in car value of around 6%, which suggests integrated manufacturers/lenders may combine the dislocation of credit terms with a dislocation of car prices (a traditional fire sale). A downward car price adjustment would offset the negative effect that more expensive credit may have in the demand for cars, and could possibly generate liquidity itself (traditional fire sale of inventory).

Columns (3) and (4) of Table 5 report the results of the estimates using the (log) total car financed as the dependent variable (for low- and high-liquidity-needs manufacturers respectively). We find no significant effect of the liquidity shock on the number of cars financed by captive relative to stand-alone lenders (holds for both captives whose parent manufacturer has high and low liquidity needs). Hence, despite the worsening of financing terms (e.g., higher rates and larger down payment), car quantities financed by integrated manufacturer/lenders do not drop relative to stand-alone lenders.

A possible explanation is car buyers are insensitive to financing terms. However, this explanation is not fully consistent with existing evidence on the sensitivity of car demand to financing terms. While Salz et al. (2020) find consumers are less sensitive to changes in loan rates than car prices, Adams et al. (2009) find subprime car buyers are highly sensitive to down payment requirement.

Consumer heterogeneity. A complementary explanation for the last finding is that relaxing lending standards boost sales to marginal buyers that offset the sales lost to inframarginal buyers. To explore how the credit dislocation affects differentially marginal and inframarginal car buyers, we evaluate the heterogeneity of the liquidity shock effect on the composition of buyers along measure related to their ex ante riskiness. We report the estimates using the share of low income borrowers as the dependent variable in Table 5, columns (5) and (6). We find that captive lenders with high liquidity needs increase the share of low income buyers they finance, relative to stand-alone lenders (there is no significant change for low-liquidity-needs manufacturers). The estimated 2.5 percentage point increase is large in magnitude, and consistent with the results in Table 4.

We provide additional evidence on the change in the composition of borrowers using the share of low credit score borrowers as the dependent variable (results reported on Table 5, column 7). This estimate is obtained using data from one captive lender and one stand-alone lender from which we could obtain information on the internal credit score for borrowers. The captive lender is associated with a high-liquidity-needs manufacturer, so we cannot provide a placebo estimate for this result. Also, since the two lenders rank borrowers on a different scale, for comparability we create a dummy variable equal to one for borrowers with a low credit score.[26] 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, a significant effect both statistically and economically. Given an average share of low credit score borrowers of 15%, our estimates imply an increase by almost 20%.

Robustness. Overall, the findings from the causal analysis are qualitatively and quantitatively similar to the stylized aggregate patterns. Higher leverage and durable consumption by ex-ante riskier individuals is a direct consequence of the dislocation of credit terms and standards by integrated manufacturers/lenders' hit by a negative liquidity shock. Taken together, the results indicate that liquidity creation through captive lending credit dislocation 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. We end this section with a summary of robustness test results for these findings (reported in Appendix B).

First, we address the possibility that our classification of manufacturers between high- and low-liquidity needs based on the proportion of loans maturing right before the VW event is not coincidental, but a reflection of unobserved heterogeneity across manufacturers. Figure A3 in Appendix B shows that manufacturer ranking based on liquidity need varies substantially month to month. Also, the outcome variables of interest (e.g., loan rates) had similar trends before the event for high and low liquidity need manufacturers (see Table A4). We cannot reject the null hypothesis of parallel trends for all dependent variables, except income for high liquidity need manufacturers. If anything, in the month before the

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

Table 5: Effects on Car Prices, Sales and the Share of Risky Borrowers

	Car Value (log)		Number of Cars (log)		Low income borrowers (%)		Low credit score borrowers (%)
Manufacturer liquidity need	Low	High	Low	High	Low	High	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Post × Captive Lender	0.003	-0.063	0.028	0.019	0.004	0.025*	0.028**
	[0.017]	[0.044]	[0.023]	[0.020]	[0.014]	[0.015]	[0.011]
Fixed effects:							
Model-Region-Time-Income	YES	YES	NO	NO	NO	NO	NO
Model-Region-Time	NO	NO	YES	YES	YES	YES	NO
Lender	YES	YES	YES	YES	YES	YES	YES
Model-Time	NO	NO	NO	NO	NO	NO	YES
Region-Time	NO	NO	NO	NO	NO	NO	YES
Additional controls:							
Lender-Time	YES	YES	YES	YES	YES	YES	YES
Borrower	YES	YES	NO	NO	NO	NO	YES
Avg Dep Var	9.280	9.379	.998	1.052	.484	.466	.158
R^2	0.635	0.649	0.681	0.711	0.601	0.625	0.209
Observations	28,549	21,811	11,755	7,393	11,755	7,393	10,781

Note: Columns (1) and (2) in this Table contain the results obtained from the estimation of equation (2) but using as the dependent variable the logarithm of car value. Colums (3) - (7) show the results obtained from a variation of equation (2) but the dependent variables are: the logarithm of the total number of cars financed (columns (3) and (4)), the share of low income borrowers (columns (5) and (6)), 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 (7)). The results in the last column are estimated using information from one captive lender and one stand-alone lender for which we have credit score information. All columns are estimated 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 the face high or low liquidity needs. This is done based on the fraction of bonds maturing in the quarter after the event relative to the outstanding amount in 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. 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.

Volkswagen scandal captive lenders of manufacturers in the high liquidity need group lend to higher income borrowers relative to standalone lenders. Most notably, the difference in the interaction term between the high and low liquidity need manufacturer groups is statistically insignificant for all variable of interest.

Second, we address the possibility that unobserved car heterogeneity is driving the results. As discussed in Section 3, we do not observe some relevant car characteristics such as engine type or year of manufacturing. To address this limitation we control for car type with brand-model interacted with income bins fixed effects in all our baseline specifications studying loan terms. However, there could be unobservable characteristics that vary systematically between captive and traditional lenders and are correlated with both financing terms and manufacturers' external financing costs. To mitigate the concern about omitted characteristics we re-estimate our difference-in-difference specification from equation (2) controlling within each brand-model for quartiles of the car value.[27] Table A5 shows the estimates of this robustness exercise. Our main results are robust to additional granular controls based on car values.

5 Captive Lending Credit Dislocation: Quantification

We have shown that captive lenders hit by a liquidity shock decrease loan amounts and relax lending standards relative to stand-alone lenders to generate liquidity for the parent manufacturers. We did not find statistically significant evidence of captive lenders adjusting car values relative to stand-alone lenders. The dislocation of credit terms and standards by captive lenders thus generates liquidity for a cash-strapped manufacturing company.

In this section we develop and calibrate a simple model of borrowers' demand for car loans with stand-alone and captive lenders, to gauge quantitatively the importance of credit dislocation as a source of liquidity for manufacturers, and compare it to generating liquidity through the well-known mechanism of an inventory fire sale.

[27] In this case we do not interact the car-model × geographical market × 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.

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:

$$\Pi_j(p_1, ..., p_N) = (p_j - \kappa)D_j(p_1, ..., p_N) - K, \tag{3}$$

where $D_j(p_1, ..., p_N)$ 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 car j is given by:

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

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:

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

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):

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

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

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

they would not lend, is obtained by setting the per-dollar profits given by equation (5) to zero at the maximum interest rate $\bar{i}$:

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

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:

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

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

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

Note that if $\frac{p-\kappa}{l} > 0$ then $P(L|\bar{s}_j) < P(L|\bar{s}_b)$, 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:

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

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. $p_j = p \ \forall j = 1, ..., N$ (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:

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

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

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

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

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

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 Captive Credit Dislocation VS Car Price Dislocation

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

We calibrate the model leveraging the richness of our micro data. Table A8 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.

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 in Section 4.[30]

Table 6 shows the results for several variables of interest in a representative month. 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 profits from car sales by

[29] Adding 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 captive credit dislocation 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.

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

Table 6: Captive Credit Dislocation VS Car Price Dislocation

	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: Captive Lending Credit Dislocation			
Δ liquidity creation (%)		5.5	9.1
Marginal borrowers (%)		100	70
Inframarginal borrowers (%)		0	30
Dislocated car price equivalent (euros)		-990	-1636
Dislocated car price equivalent (% car price)		-7.5	-12.4
Cost of captive credit relative to car price dislocation		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 A8. 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 A8, 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 captive credit dislocation. 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 dislocated car price equivalent equivalent represents the decrease in car price that would generate the same cash flow as the captive lending credit dislocation expressed in euros and as a percentage of the car price. Finally, the cost of captive credit relative to car price dislocation 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 the captive adjusting loan terms and lending standards.

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 6 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 5.5% in extra liquidity each month for the average manufacturer. We can then calculate the change in car prices that would generate the same amount of liquidity for the manufacturer as the captive lending. 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 four (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 though the lens of our model is captured by the following expression:

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

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 $(1-\theta)$.[31]

[31] We repeat the calculation assuming that price changes occur in cars financed by, both, captive and stand-alone lenders. As expected, this requires a smaller car price decline to generate the same amount of liquidity as captive lending. However, in terms of revenue losses, which we discuss below, the results are

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 captive credit dislocation can be calculated by setting (14) equal to the amount of liquidity and solving for Δp, as follows:

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

Table 6 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.

Finally, the third column of Table 6 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. Lending to marginally risky buyers and asking for a larger down payment generate about 9% extra liquidity each month for the average manufacturer.[32]

We decompose the increase in liquidity into the additional cash from the change in contract terms, and the cash generated though the change in lending standards. A 5-percentage-points lower loan-to-value increases monthly cash from inframarginal borrowers financed by the captive unit, accounting for 30% of the increase in liquidity. The additional cash coming from higher down payment is a likely upper bound to the cash generated via the intensive margin, as the lower loan-to-value (higher down payment) may discourage some inframarginal purchases.[33] The extensive margin accounts for about 70% of the increase in

similar (because the smaller price decline is multiplied by a larger number of fire-sold vehicles).

[32]This increase corresponds to approximately €5 millions in extra liquidity each month for the average manufacturer. This estimate pertains only the cash generated via the credit dislocation for used cars that are financed by a captive lender and then securitized. An estimate of the total amount of cash that a captive credit dislocation can generate to an integrated manufacturer/lender requires extrapolating our results to non-securitized used car loans and captive financed new cars, which requires stronger assumptions.

[33]In reality the fraction of borrowers financing a car and going to a captive lender (α) could be a complex function of (relative) car prices, financial contract characteristics such as interest rate, loan-to-value, and

liquidity and it is also higher than in the baseline case. The reason for the increase is 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, to generate the same cash of a captive lending credit dislocation, the manufacturers would have to decrease the price of the car by about €1600, or about 12.5% of its equilibrium value. In the last row of Table 6 we also report a measure of the cost of captive credit dislocation *relative* to car price dislocation. 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 captive credit dislocation comes from: 1) expected losses from lending to risky marginal borrowers; 2) lower interest rate revenues from inframarginal borrowers.[34] Using this simple measure, our calibration shows that to generate the same amount of captive credit dislocation is about 60% cheaper than a traditional car price dislocation for the average manufacturer.

6 Conclusions

In this paper we study the role of captive finance in the car loan market as a liquidity management tool when the parent manufacturing company faces a liquidity shock. Using a new multi-country dataset on securitized car loans, we show that captive lending enables cash-strapped 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 quantify the mechanism by exploiting a funding shock to manufacturers resulting

maturity, as well as other factors (e.g., proximity to a stand-alone bank brand relative to a exclusive dealer). While existing work has made significant progress in understanding car buyers' elasticities to down payment requirements (Adams et al., 2009), maturity and interest rates (Argyle et al., 2019), and car prices and interest rates (Salz et al., 2020), a comprehensive analysis of borrowers elasticities in segmented markets with multi-dimensional contracts would be an interesting area for future research.

[34] To 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.

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 the dislocation of credit terms and standards 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. Specifically, a liquidity shock to integrated durable good manufacturers leads to an increase in leverage and consumption by low-income/high-risk buyers.

Finally, while our paper focuses on the auto market, the economics of credit dislocations as a tool for liquidity management apply in theory to any setting in which sellers provide financing to purchase the products they sell. Exploring whether the mechanisms that we have uncovered in this work apply in other settings where sales and financing are bundled together, such as trade credit, is a promising avenue for future research.

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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.[35]

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.[36] Second, in the used car market we can ignore car manufacturing costs and focus on the transformation of car inventory into cash.

For the main analyses, we apply the following filters. First, we restrict our sample to

[35] We 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.

[36] Our 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.

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.[37] 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.[38]

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.[39] These loans are part of the pool of 37 securitizations and are granted for the

[37]We 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.

[38]These 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.

[39]Note 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 fur 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-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

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.

S.A. Niederlassung Deutschland), Toyota (TKG), Volkwagen (Volkswagen Bank GmbH, Volkswagen Bank Branch Italy, Volkswagen Finance S.A.).

B Additional Tables and Figures

In this Appendix we report the results of additional analyses and robustness checks.

First, Table A1 reports the estimates of equation (1) on the full sample. We find that when the car manufacturer's CDS increases, its captive lender 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 is associated with a 13 basis points increase in the captive loan rate (relative to stand-alone), or about 2% of the average loan rate. This increase possibly 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.[40] At the same time, captive lenders shorten maturity and decrease loan amount relative to standard banks when the car manufacturer CDS increases. Columns (4) to (6) of Table A1 reports the estimates when we also include income bins to the car-model × geographical market × month fixed-effects to 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, but the magnitudes are similar.

Columns (7) to (9) of Table A1 report the results for lending standards. The results for demographics variables at origination suggest a relaxation of lending standard by the captive lender when the parent company's CDS price increases. 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. At the same time, captive lender of a manufacturing company with a high external financing cost 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

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

captive lender by 5 percentage points, or 15% of the unconditional income verification rate by captive lenders. Finally, 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 relative to loans originated by stand-alone lenders. Given a baseline default probability of approximately 5 percentage points, this represents approximately a 30% increase in the probability of future arrears.

Second, in the baseline analysis we control for car type with brand-model interacted with income bins fixed effects. However, there could be unobservable characteristics that vary systematically between captive and traditional lenders and are correlated with both financing terms and manufacturers' liquidity shock. To lower the concern about omitted characteristics we re-estimate our model (1) controlling within each brand-model for quintiles of the car value.[41] Table A2 shows the estimates of this robustness exercise. Our main results are robust to additional granular controls based on car values.

Third, we also provide additional evidence on the lending standards margin 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 variable equal to one for borrowers with a low credit score.[42]. 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 A3 shows the result. We find that when the car manufacturer CDS increases by 100 basis

[41]In this case we do not interact the car-model × geographical market × 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.

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

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 the manufacturer's CDS is statistically insignificant and small in magnitude when the manufacture's liquidity needs are low.

Fourth, one possible concern with the results in Table 4 is that high liquidity need manufacturers and low liquidity need manufacturers are different for some unobservable reasons and these differences lead to different changes in contract terms and lending standards over time, irrespective of the change in CDS due to the Volkswagen scandal. We provide evidence that the outcome variables of interest (e.g., loan rates) had similar trend before the event for high and low liquidity need manufacturers. Most notably, we estimate equation (2) replacing the interaction term $Post_t \times Captive_l$ with interactions $Month_t \times Captive_l$, and using a sample period of two months before the month of the Volkswagen Emission Scandal (September 2015). Table A4 shows the results. We cannot reject the null hypothesis of parallel trends, with the coefficient on the interaction term being insignificant for all dependent variables for the low liquidity need manufacturers and all dependent variables except income for high liquidity need manufacturers. If anything, in the month before the Volkswagen scandal captive lenders of manufacturers in the high liquidity need group lend to higher income borrowers relative to standalone lenders. Most notably, the difference in the interaction term $Month_t \times Captive_l$ between the high and low liquidity need manufacturer groups is statistically insignificant for all variable of interest.

Fifth, Table A5 shows the results of the difference-in-difference specification from equation (2) controlling within each brand-model for quartiles of the car value. In this case we do not interact the car-model × geographical market × month fixed-effects also with the income bins because this will significantly drop the number of observations. As we discussed above in relation to Table A2, 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. Our main results exploiting variation from the Volkswagen scandal are robust to additional granular controls based on car values.

Finally, Table A6 shows the results of the difference-in-difference specification from equation (2) including loans for buying Volskwagen cars and other brands of the group (Audi, Porsche, Seat, and Skoda). Again the results are robust to include Volkswagen, which based on its expiring bonds belongs to the group of manufacturers with high liquidity needs.

Table A1: Captive lending credit dislocation: Credit terms and standards

	Credit Terms						Credit Standards		
	Rate	Maturity	Loan size	Rate	Maturity	Loan size	Income	Income verified	Arrears
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Manuf. CDS × Captive Lender	0.133***	-0.008**	-0.019**	0.130**	-0.008	-0.013	-0.008	-0.053***	0.014***
	[0.049]	[0.004]	[0.008]	[0.051]	[0.005]	[0.010]	[0.005]	[0.013]	[0.004]
Fixed effects:									
Model-Region-Time-Income	NO	NO	NO	YES	YES	YES	NO	NO	NO
Model-Region-Time	YES	YES	YES	NO	NO	NO	YES	YES	YES
Lender	YES	YES	YES	YES	YES	YES	YES	YES	YES
Age	NO	NO	NO	NO	NO	NO	NO	NO	YES
Additional controls:									
Lender-time	YES	YES	YES	YES	YES	YES	YES	YES	YES
Borrower	YES	YES	YES	YES	YES	YES	NO	YES	YES
Avg Dep Var	6.134	3.868	8.940	6.134	3.868	8.940	10.058	.618	.051
R^2	0.780	0.334	0.464	0.819	0.451	0.554	0.478	0.887	0.300
Observations	906,085	906,085	906,085	611,108	611,108	611,108	906,085	906,085	616,748

Note: The Table shows the results from equation (1). The dependent variables are the interest rate in percentage points, maturity in log, and loan size 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 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: Stylized evidence controlling for bins of car value

	Credit Terms			Credit Standards		
	Rate	Maturity	Loan Size	Income	Income verified	Arrears
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: High liquidity need manufacturers						
Manuf. CDS × Captive Lender	0.187***	-0.006	-0.018***	-0.013*	-0.077***	0.019***
	[0.063]	[0.004]	[0.006]	[0.007]	[0.012]	[0.005]
Avg Dep Var	6.622	3.887	8.903	9.988	.634	.065
R^2	0.821	0.459	0.599	0.524	0.851	0.394
Observations	329,034	329,034	329,034	329,034	329,034	233,642
Panel B: Low liquidity need manufacturers						
Manuf. CDS × Captive Lender	-0.001	0.001	-0.013	-0.003	0.007	0.007
	[0.072]	[0.008]	[0.009]	[0.010]	[0.012]	[0.005]
Avg Dep Var	5.649	3.849	8.976	10.127	.602	.035
R^2	0.803	0.476	0.645	0.574	0.971	0.397
Observations	330,558	330,558	330,558	330,558	330,558	203,947
Fixed effects:						
Model-Region-Time-CarValue	YES	YES	YES	YES	YES	YES
Lender	YES	YES	YES	YES	YES	YES
Age	NO	NO	NO	NO	NO	YES
Additional controls:						
Lender-time	YES	YES	YES	YES	YES	YES
Borrower	YES	YES	YES	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 month we compute the ratio between the face value of manufacturer expiring bonds in the next year over its total amount of outstanding bonds in that month. We classify a car manufacturer as facing high liquidity needs, if it lies above the median of the distribution of this ratio in our sample. The dependent variables are the interest rate in percentage points, maturity in log, loan size in log, income in logs, 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 quartiles 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 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: Additional stylized evidence with borrowers credit scores

	Low credit score borrowers (%)	
Manufacturer liquidity needs	High	Low
	(1)	(2)
Manuf. CDS × Captive Lender	0.021**	0.003
	[0.010]	[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.

Table A4: Testing the parallel trend assumption

	Credit Terms			Credit standards		
	Rate	Maturity	Loan Size	Income	Income verified	Arrears
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: High liquidity need manufacturers						
Month × Captive Lender	0.009	-0.017	-0.022	0.045**	0.000	0.020
	(0.072)	(0.030)	(0.037)	(0.019)	(0.000)	(0.015)
R^2	0.85	0.43	0.49	0.47	1.00	0.37
Observations	11,060	11,060	11,060	15,741	15,741	8,462
Panel B: Low liquidity need manufacturers						
Month × Captive Lender	0.082	0.011	-0.006	0.007	-0.008	-0.006
	(0.070)	(0.016)	(0.028)	(0.020)	(0.007)	(0.015)
R^2	0.77	0.41	0.54	0.46	0.80	0.44
Observations	14,648	14,648	14,648	21,367	21,367	9,268
Fixed effects:						
Model-Region-Time-Income	YES	YES	YES	NO	NO	NO
Model-Region-Time	NO	NO	NO	YES	YES	YES
Lender	YES	YES	YES	YES	YES	YES
Age	NO	NO	NO	NO	NO	YES
Additional controls:						
Lender-time	YES	YES	YES	YES	YES	YES
Borrower	YES	YES	YES	NO	YES	YES

Note: The Table shows the results from equation (2) replacing the interaction term $Post_t \times Captive_l$ with interactions $Month_t \times Captive_l$, and using a sample period of two months before 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 or low liquidity needs. This is done based on the fraction of bonds maturing in the quarter after the event relative to the outstanding amount in 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, loan size in log, income in logs, 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. Month is a dummy equal to months before 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.

Table A5: Captive lending credit dislocation controlling for bins of car value

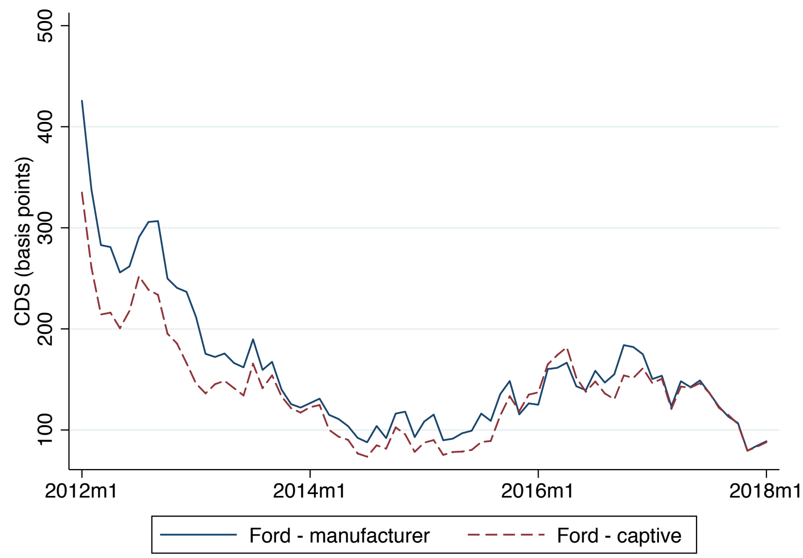
	Credit Terms			Credit Standards		
	Rate	Maturity	Loan Size	Income	Income verified	Arrears
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: High liquidity need manufacturers						
Post × Captive Lender	0.411***	-0.064***	-0.067***	0.009	-0.000	0.023***
	[0.065]	[0.015]	[0.023]	[0.024]	[0.000]	[0.006]
Avg Dep Var	5.931	3.755	8.865	9.987	.456	.039
R^2	0.864	0.421	0.528	0.549	1.000	0.356
Observations	23,719	23,719	23,719	23,719	23,719	18,456
Panel B: Low liquidity need manufacturers						
Post × Captive Lender	0.067	-0.015	-0.020	0.001	0.033**	-0.000
	[0.083]	[0.015]	[0.016]	[0.019]	[0.013]	[0.009]
Avg Dep Var	5.716	3.916	8.918	10.104	0.656	0.064
R^2	0.775	0.484	0.676	0.552	0.830	0.412
Observations	30,432	30,432	30,432	30,432	30,432	20,394
Fixed effects:						
Model-Region-Time-CarValue	YES	YES	YES	YES	YES	YES
Lender	YES	YES	YES	YES	YES	YES
Age	NO	NO	NO	NO	NO	YES
Additional controls:						
Lender-time	YES	YES	YES	YES	YES	YES
Borrower	YES	YES	YES	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, loan size in log, income in logs, 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 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 quartiles 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 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.

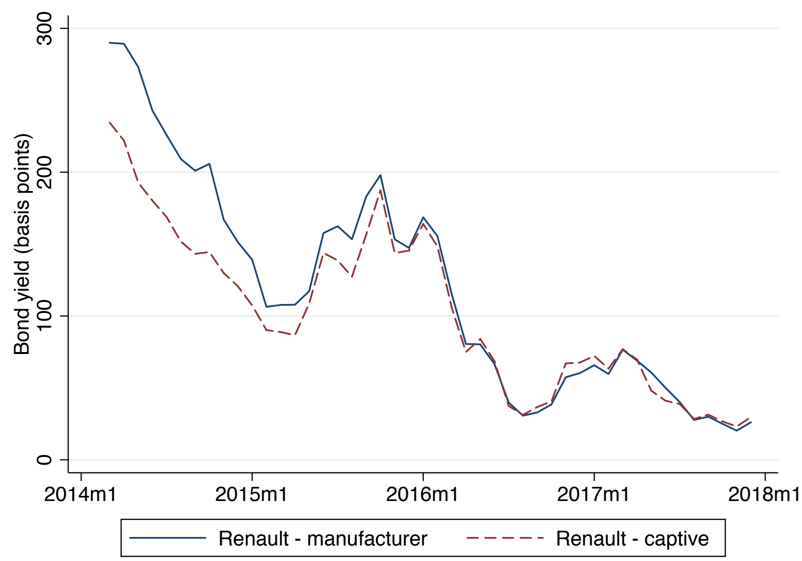
Table A6: Captive lending credit dislocation including Volkswagen

	Credit Terms			Credit standards		
	Rate	Maturity	Loan Size	Income	Income verified	Arrears
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: High liquidity need manufacturers						
Post × Captive Lender	0.285***	-0.071***	-0.083**	-0.021*	0.000	0.014**
	[0.097]	[0.021]	[0.040]	[0.012]	[0.000]	[0.007]
Avg Dep Var	6.171	3.822	8.980	10.029	.631	.043
R^2	0.877	0.445	0.528	0.473	1.000	0.297
Observations	30,201	30,201	30,201	44,420	44,420	33,657
Panel B: Low liquidity need manufacturers						
Post × Captive Lender	0.013	-0.022	-0.019	-0.006	0.037***	-0.005
	[0.080]	[0.016]	[0.024]	[0.014]	[0.013]	[0.006]
Avg Dep Var	5.716	3.916	8.918	10.104	.656	.064
R^2	0.763	0.409	0.540	0.463	0.781	0.315
Observations	28,549	28,549	28,549	41,888	41,888	29,449
Fixed effects:						
Model-Region-Time-Income	YES	YES	YES	NO	NO	NO
Model-Region-Time	NO	NO	NO	YES	YES	YES
Lender	YES	YES	YES	YES	YES	YES
Age-Time	NO	NO	NO	NO	NO	YES
Additional controls:						
Lender-time	YES	YES	YES	YES	YES	YES
Borrower	YES	YES	YES	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 included in this robustness analysis. The dependent variables are the interest rate in percentage points, maturity in log, loan size in log, income in logs, 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 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 quartiles 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 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.



(a) CDS Ford



(b) Bond yields Renault

Figure A1: 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).

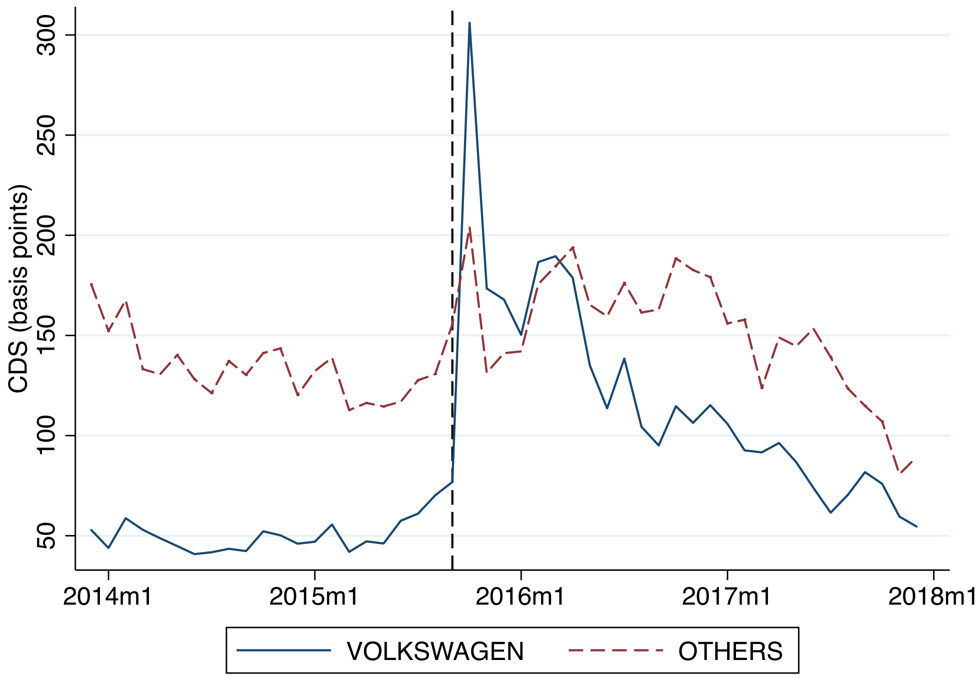


Figure A2: Volkswagen Emissions Scandal: CDS car manufacturers

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.

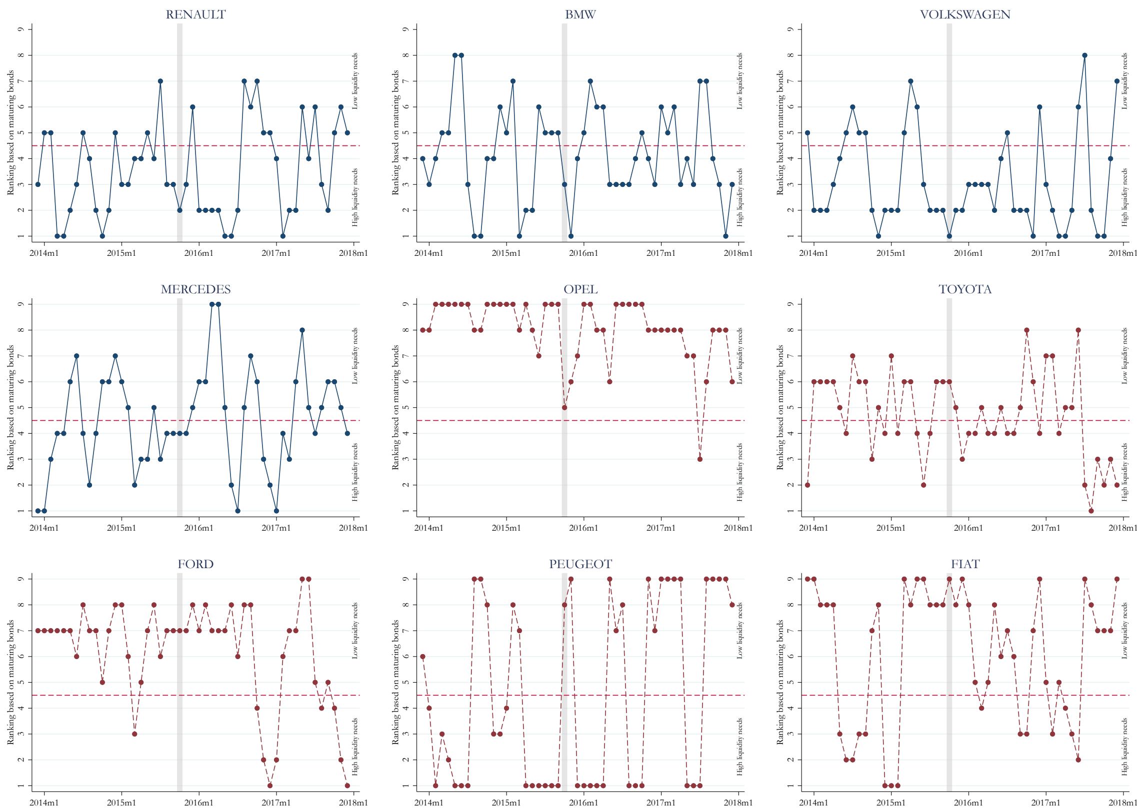


Figure A3: Ranking of Manufacturers by Liquidity Needs Over time

Note: The figure shows for each month the ranking of manufacturers by liquidity needs from one (highest liquidity need) to nine (lowest liquidity need). The liquidity need is measured as the fraction of bonds maturing in the current and subsequent two months relative to the outstanding amount at the end of the previous month. The grey vertical bar identifies the month after the Volskwagen emission scandal which we use for our classification of liquidity need in our identification strategy.

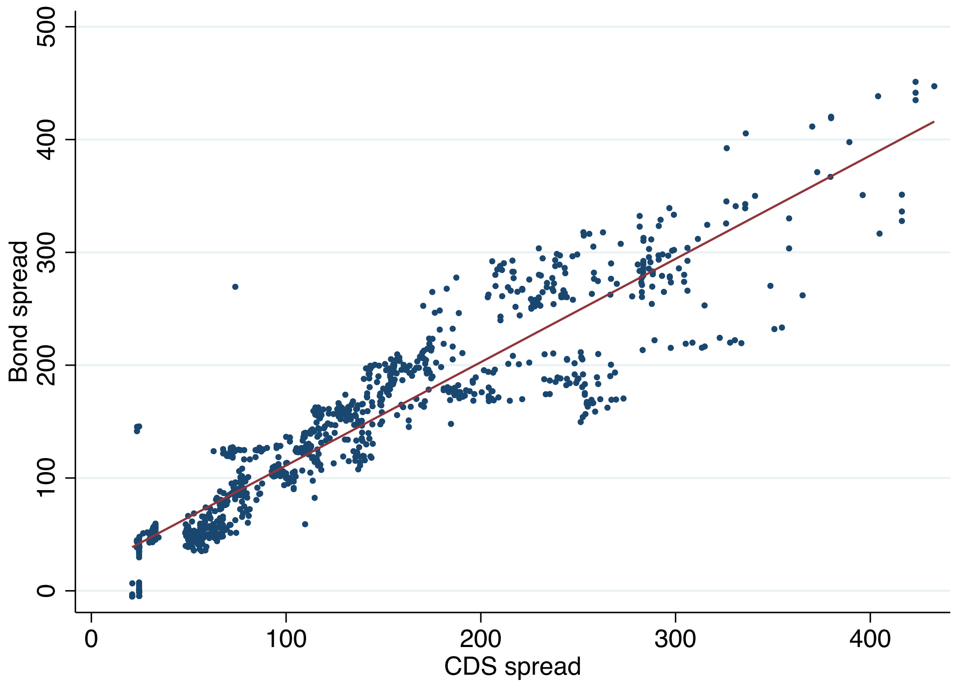


Figure A4: Correlation CDS and Bond Spread

Note: The figure shows the relationship at the daily level between CDS and bond spreads for car manufacturers for the period July, 1, 2015 - November, 30, 2015. Bond spreads are obtained as the bond yield minus a reference rate with a maturity similar to the bond considered for each manufacturer. More specifically, for each manufacturer we select one bond with a maturity between four and six years as of September 2015, with fixed coupon, and with the same currency as the CDS contract. The reference rate is the swap rate with the same maturity as the bond in each day. To this aim we use a linear interpolation between the two closest maturities for which we have information (4-, 5-, or 6-year maturity). Both CDS abd bond spreads are in basis points.

C Additional Derivations

C.1 Back-of-the-envelope Calculation

I have rewritten this section In this Appendix we discuss the calculation behind the back-of-the-envelope numbers that we present in Section 4. Table A7 reports the key inputs of and steps for the calculation. Credit terms and standards in column (1) are the average for captive lenders (See Panel A of 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 4 in the main text). Using the coefficients in column (2) and the baseline levels in column (1) we compute the credit 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 Volskwagen emission scandal for the manufacturers in our sample (See Figure A2). 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 expected present value of revenues on the loans declines by about €880 relative to the baseline. The present value of revenues in each scenario is computed as follows:

$$E\left[\text{PV loan}\right] = (1 - \text{Arrear}) \times (\text{PV monthly payments}) + \text{Arrear} \times \text{Recovery rate} \times \text{Car value}, \tag{16}$$

discounting the revenues from the monthly payments – including principal and interest – using the manufacturers cost of funds. We use a recovery rate of 90% of the car value in the

Table A7: Back-of-the-envelope calculation

	Baseline	High-liquidity needs		Difference
		Coefficient	Level	
	(1)	(2)	(3)	(4)
Credit 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	7,691	-817
Credit 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)	9,535		8,653	-882
Expected NPV loss for 1 euro of cash (euro)				0.07
Annualized rate (%)				1.84

Note: Column (1) shows averages for captive lenders (See Panel A of 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 4 in the main text). Column (3) shows averages for high liquidity need manufacturers following the Volkswagen emission scandal combining columns (1) and (2), 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.

case of arrears, which we obtain by computing for loans in arrears the total value of monthly payments before arrears plus the sale proceed upon default over the car value. The number is based based on a limited number of observation in our data for captive lenders who report information on loss given default.

The absolute value of the ratio of additional cash over lower expected present revenues is about 0.93. Hence, our estimates show that to gain one additional euro in cash today high-liquidity-need manufacturers loose 7 cents in present value terms. Given a four year average loan maturity, captive lending dislocation allows raising cash at an opportunity cost of about 1.8% annualized.

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:

$$D_j(p_1, ..., p_N) = M \int \left[F(p - p_j + v)\right]^{N-1} f(v)dv. \tag{17}$$

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

$$p_j = \kappa - \frac{D_j(p_1, ..., p_N)}{\frac{\partial D_j(p_1,...,p_N)}{\partial p_j}}. \tag{18}$$

We focus on a symmetric equilibrium where all manufacturers set the same price, i.e. $p_j = p \ \forall j = 1, ..., N$ (Perloff and Salop, 1985). Thus, each manufacturer receive a fraction $\frac{1}{N}$ of approved buyers. Combining (18) with (17) and using the symmetric equilibrium assumption, we get the optimal price:

$$p = \kappa + \frac{M \int \left[F(v)\right]^{N-1} f(v)dv}{(N-1)M \int \left[F(v)\right]^{N-2} f(v)^2 dv} = \kappa + \frac{1}{N(N-1) \int \left[F(v)\right]^{N-2} f(v)^2 dv}, \tag{19}$$

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

$$\frac{M}{N}(p - \kappa) - K = 0 \ \rightarrow \ N^* = \frac{M(p - k)}{K}. \tag{20}$$

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:

$$A(\bar{s}_b) = \gamma(1 - G_L(\bar{s}_b)) + (1 - \gamma)(1 - G_H(\bar{s}_b)). \tag{21}$$

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:

$$A(\bar{s}_b)\frac{M}{N}(p - \kappa) - K = 0 \;\rightarrow\; N = \frac{A(\bar{s}_b)M(p - k)}{K}. \tag{22}$$

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 (19) with the new number of manufacturers from equation (22).

Calibration. Table A8 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.[43] 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

[43] Given 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.

we proxy the cost of funds using the average car manufacturer 5-year CDS plus the 5-year swap rate. We use the swap-rate to proxy for the default-free interest rates because it is not exposed to taxation treatment, repo special or scarcity premium and they are available in unlimited quantities and are quoted on a constant maturity basis. In addition, it is the benchmark for pricing and trading corporate bonds, loans and mortgages and it enables us to use the same reference rate for all car manufacturers, no matters the country where they are domiciled.

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.

Table A8: 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.