The Real Effects of Liquidity During the Financial Crisis: Evidence from Automobiles[1]

Efraim Benmelech
Northwestern University
and NBER

Ralf R. Meisenzahl
Federal Reserve Board

Rodney Ramcharan
Federal Reserve Board

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Abstract

This paper shows that illiquidity in short-term credit markets during the financial crisis may have sharply curtailed the supply of non-bank consumer credit. Using a new data set linking every car sold in the United States to the credit supplier involved in each transaction, we show that the collapse of the asset-backed commercial paper market decimated the financing capacity of captive leasing companies in the automobile industry. As a result, car sales in counties that traditionally depended on captive-leasing companies declined sharply. Although other lenders increased their supply of credit, the net aggregate effect of illiquidity on car sales is large and negative. We conclude that the decline in auto sales during the financial crisis was caused in part by a *credit supply shock* driven by the illiquidity of the most important providers of consumer finance in the auto loan market: the captive leasing arms of auto manufacturing companies. These results also imply that interventions aimed at arresting illiquidity in credit markets and supporting the automobile industry might have helped to contain the real effects of the crisis.

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1. Introduction

Financial crises can have large adverse effects on real economic activity. Illiquidity in one corner of the financial system and large realized balance-sheet losses in the financial sector can lead to a contraction in the aggregate supply of credit and a decline in economic activity.[2] Consistent with these theoretical predictions, there is growing evidence from the 2007–2009 financial crisis that the balance-sheet losses incurred by traditional financial institutions—banks and credit unions—may have led to a fundamental post-crisis disruption in credit intermediation, contributing to the recession and the slow economic recovery (Ramcharan et al., 2013, forthcoming; Chodorow-Reich, 2014).[3]

However, non-bank financial institutions— such as finance and leasing companies—have historically been important sources of credit, especially for consumer durable goods purchases such as automobiles and appliances (Ludvigson, 1998). For example, non-bank institutions accounted for more than a half of all new cars bought in the United States before the crisis. Unlike most traditional banks, non-bank financial institutions are more closely connected to the shadow banking system, relying primarily on short-term funding markets, such as the asset-backed commercial paper (ABCP) market, for funding.

We investigate how runs in the ABCP market and the loss of financing capacity at non-bank institutions, such as the captive leasing arms of auto manufacturers, might have curtailed the supply of auto credit, led to the collapse in car sales, and exacerbated the financial difficulties of companies such as GM and Chrysler that were already on the verge of bankruptcy. Between 2007 and 2008, short-term funding markets in the United States came to a halt, as money market funds (MMFs) and other traditional buyers of short-term debt fled these markets (Covitz, Liang, and Suarez, 2013). Although the initial decline in 2007 was driven mainly by ABCP backed by mortgage-backed securities, the decline following the Lehman Brothers bankruptcy affected all ABCP issuers.

[2] See, e.g., Allen and Gale (2000), Diamond and Rajan (2005, 2011), Shleifer and Vishny (2010).

[3] The crisis may have also disrupted intermediation even at non-traditional lenders like internet banks (Ramcharan and Crowe, 2012).

By early 2009, growing illiquidity in the ABCP market—one of the major sources of short-term credit in the United States—made it difficult for many non-bank intermediaries to roll over debt or secure new funding (Campbell et al., 2011). This illiquidity in short-term funding markets coincided with the collapse of several large non-bank lenders. Chief among these lenders was the General Motors Acceptance Corporation (GMAC)—the financing arm of General Motors (GM) and one of the largest providers of auto financing in the world. At the same time, automobile sales fell dramatically in 2008 and 2009, and GM and Chrysler eventually filed for Chapter 11 bankruptcy protection.

In order to better understand the economic consequences of these disruptions in short-term funding markets, we use a proprietary microlevel data set that includes all new car sales in the United States. Our data set matches every new car to the sources of financing used in the transaction (for example, auto loan or lease) and identifies the financial institution involved in the transaction. The data, which are reported quarterly starting in 2002, also identify the county in which the car was registered, along with the car's make and model. This microlevel detailed information and the spatial nature of the data enable us to develop an empirical identification strategy that can help identify how captives' loss of financing capacity might have affected car sales in the United States.

Our identification strategy hinges on the notion that by the end of 2008, liquidity runs in the ABCP market and the dislocations in other short-term funding markets had decimated the financing capacity of the captive financing arms of automakers. We then show cross-sectionally that in counties that are historically more dependent on these captive arms for auto credit, sales financed by captive lessors fell dramatically in 2009. In particular, a one standard deviation increase in a county's dependence on captive financing before the crisis is associated with a 10% drop in sales financed by captive lessors after the second quarter of 2009.

Next, we show that our results are driven by a liquidity shortage in short-term credit markets, supplementing our cross-sectional evidence with panel regressions by adding a time-series dimension to our analysis. Money market funds were the main purchasers of ABCP, holding about 40% of commercial paper in mid-2007.[4] The bankruptcy of Lehman Brothers on

[4] Pozsar et al. (2010) survey the shadow banking system and highlight the crucial role that MMFs play for short-term credit and securitization.

September 15, 2008 triggered heavy outflows from MMFs and was a leading factor in the evaporation of liquidity in the commercial paper market.[5] Captive financing entities relied predominantly on MMFs to finance their commercial paper issuances. We argue that the collapse of the commercial paper market significantly reduced the funding available for leasing companies to finance their operations.

Consistent with this hypothesis, we find that the number of retail car sales financed by captive leasing arms declined as aggregate flows into MMFs dried up. The decline in auto sales was exacerbated in counties that are historically more dependent on captive lease financing. During a quarter when the growth in flows in MMFs was at the 25th percentile, a one standard deviation increase in captive dependency is associated with a 3% drop in captive sales growth. However, with the growth in flows into MMFs at the 75th percentile, a similar increase in captive dependence is associated with only a 0.3% drop in captive sales growth.

Whereas we find that captive leasing arms reduced credit supply to potential car buyers, we also find evidence for substitution in that sales financed by noncaptive lenders—those financial institutions more dependent on traditional deposits for funding—actually rose during this period in counties with higher dependency on captive financing. The evidence on substitution from captive leasing to other forms of financing suggests that our results are driven not by latent demand factors but rather by a credit supply shock. However, even with the substitution to other lenders, the aggregate effects of disruptions in the short-term credit markets on auto sales appear large. We find that regardless of the source of financing, aggregate car sales dropped more sharply after the second quarter of 2009 in counties that depend more on captive financing.

Next, the richness of our data and, in particular, the availability of make-level data allow us to alleviate county-level omitted variables concerns. More specifically, we use a different aggregation of the data in which the unit of observation is at the make-county level for the four largest automakers: Toyota, GM, Ford, and Honda. The make-county data aggregation enables us to control for county fixed effects as well as make fixed effects in our regression analysis. We find that the impact of captive dependence on captive financed sales remains negative and

[5] The day after Lehman's failure, the Reserve Primary Fund, a $62 billion MMF, announced that it had "broken the buck" (its share price had fallen below $1) because of losses on Lehman debt.

statistically significant at the 1% level after controlling for both county and make fixed effects.

The level of detail in the dataset also allows us to exploit the segmentation in car markets within makes and across models to further address these omitted variables concerns. Car makers use different models to appeal to different types of consumers at different price points. GM for example, markets Chevrolet towards nonluxury buyers, while Cadillac is aimed at wealthier consumers. We can thus use county-model fixed effects to non-parametrically control for differences in demand within a county across different model segments. Our results remain unchanged.

Last, we use some of the attempts to regulate the financial system after the crisis to identify further how the supply of short-term funding might shape car sales. Notably, large banks incurred sizable losses due to their ABCP conduits. Financial regulation after the crisis also drastically curtailed banks' ability to use short-term funding markets to fund their activities. In contrast, nonbank financial institutions, such as captive financiers, faced fewer barriers to operating in these markets. We find that after these regulatory changes, captive lessors may have garnered a sizable competitive advantage relative to large banks in retail automobile lending. All this suggests that financial regulation after the crisis might have pushed a greater share of intermediation into the shadow banking system.

Taken together, these results imply that funding disruptions in the short-term credit markets during the recent financial crisis had a significant negative impact on car sales. This evidence of a *credit supply shock* adds to our understanding of financial crises more broadly, and complements those papers that emphasize alternative mechanisms, such as the role of debt and deleveraging, that might shape post–credit boom economies (see Mian and Sufi, 2010, 2014a; Mian, Rao and Sufi, 2013; Rajan and Ramcharan, forthcoming). We argue that a credit supply channel was in particular important in the new car auto market during the crisis since more than 80% of new cars in the U.S. are financed by captive leases and auto loans from leasing companies and other financial institutions, and only less than 20% are bought for in all cash transactions.

Our evidence also tentatively suggests that the various Treasury and Federal Reserve programs aimed at arresting illiquidity in credit markets and supporting the automobile industry might have helped to contain the real effects of the crisis.

Our paper also adds to the broader literature on the effects of financial markets and bank lending on real economic outcomes.[6] But whereas previous studies of the financial crisis document the importance of short-term funding for *banks*' liquidity and lending, less is known about the real consequences of the collapse of short-term funding markets. Also less well understood is the importance of leasing companies in the provision of credit in auto markets and how these institutions might be connected to nontraditional sources of financing. We fill this void by documenting that the collapse of short-term funding reduced auto lending by financial institutions, which in turn resulted in fewer purchases of cars and reduced economic activity. We also provide evidence that illiquidity in the short-term funding markets may have played an important role in limiting the supply of *non-bank* consumer credit during the crisis, as the collapse of the ABCP market decimated the financing capacity of many captive financing companies.

The rest of the paper is organized as follows. Section 2 describes the institutional background of captives' ABCP funding and the data. We discuss identification concerns in Section 3. Section 4 provides text evidence from the financial reports of auto dealerships on the decline of credit by captive lessors. Section 5 discusses the data and the main summary statistics. Sections 6, 7 and 8 present the results from our regression analyses. Section 9 concludes.

2. Captive leasing and asset-backed commercial paper

Most new cars in the United States are bought on credit through either car loans or leasing. Auto credit peaked in 2006 at $785 billion, accounting for 32% of consumer debt. As Table 1 illustrates, although banks play an important role in automobile financing, about half of automotive credit in 2005 came from finance companies, mostly captive lessors—leasing companies set up by automakers to finance their own cars. One prominent captive lessor, for example, was General Motors Acceptance Corp (GMAC), the captive leasing arm of General Motors (GM), which provided credit to buyers of GM cars often at the point of sale through financing arrangements with GM car dealerships.

[6] See Acharya, Schnabl, and Suarez (2011); Ivanshina and Scharfstein (2010); Brunnermeier (2009); Gorton (2010); Gorton and Metrick (2012); Khwaja and Mian (2008); Cornett et al. (2011); and Acharya and Mora (2013).

Captive finance companies have long been central to automotive sales in the United States. As manufacturers sought to popularize the automobile in the 1910s, they realized that the automobile, with its unique combination of high cost, mass appeal, and independent dealership networks, required a new form of financing in order to expand distribution and sales. Commercial banks, however, were reluctant to use cars as collateral. Cars were still a relatively novel and difficult to value durable good, and outsiders such as commercial banks had less information about their depreciation path, especially given that the introduction of new models often led to a sharp drop in the resale value of outgoing models. As a result, interest rates on car loans were often close to the maximum legally allowed. Some bankers also thought it unwise for commercial banks to provide credit for a luxury good, in part because of moral concerns that credit for luxury goods may discourage thrift (Phelps, 1952). Car sales were also highly seasonal, and the reluctance of banks to provide automotive financing also affected the ability of dealers to finance their inventories (Hyman, 2011).

The organizational form of captives helped address some of these frictions. Captives such as GMAC, which was founded in 1919, were vertically integrated into the manufacturer and better able to overcome informational frictions surrounding the value of collateral; they knew, for example, the model release schedule well ahead of arms-length lenders.[7] Vertically integrated captives were also less encumbered by moral objections to consumer spending, especially on cars.[8] Captive credit, by providing medium or long-term credit to consumers to pay for car purchases, allowed dealers to receive cash on the sale of a car to a consumer. In some cases dealers were also allowed to intermediate captive credit and earn additional markups. Also, by providing floorplan financing, a form of credit collateralized by the dealer's auto inventory,

[7] Murfin and Pratt (2014) expand on these ideas within a theoretical model and provide evidence based on machine equipment.

[8] These points are echoed by William C. Durant in announcing the formation of GMAC in a letter dated March 15, 1919: "The magnitude of the business has presented new problems in financing which the present banking facilities seem not to be elastic enough to overcome. . . . This fact leads us to the conclusion that the General Motors Corporation should lend its help to solve these problems. Hence the creation of General Motors Acceptance Corporation; and the function of that Company will be to supplement the local sources of accommodation to such extent as may be necessary to permit the fullest development of our dealers' business" (cited in Sloan, 1964, p. 303).

captive credit relaxed financial constraints at the dealership level, enabling the automobile manufacturer to receive cash on the sale of a car to the dealer.

Branch banking deregulation in the 1980s and early 1990s increasingly allowed banks to operate nationally and to enter into new markets, including those previously dominated by captives. However, the rise of securitization, which was in part a response to new bank capital regulation, offered captive lessors new ways to tap into cheap funding and maintain their auto-lending business in the face of new competition (Calder, 1992; Hyman, 2011).

Indeed, asset-backed commercial paper (ABCP) became the main source of funding for captive lessors before the financial crisis. Table 2, based on non-public data collected by the Federal Reserve, demonstrates the importance of commercial paper as a source of funding for selected major automobile captives active in the United States. Given the nature of the data, we cannot disclose the identities of the captive lessors in the table and instead label them Captive 1 through Captive 4. As Table 2 shows, commercial paper was a major source of funding for three out of the four captive lessors. Although commercial paper accounted for just 10.2% of one lessor's liabilities (Captive 3), the other three captive lessors relied much more heavily on this form of short-term funding, with the share of commercial paper in their liabilities ranging from 45.9% (Captive 2) to 75.12% (Captive 4).

A key advantage of ABCP funding is that it enables captive lessors to turn relatively illiquid auto term loans into liquid assets that can be used to obtain funding for new loans. This is done by pooling auto loans together and placing them in a special purpose vehicle (SPV) that is bankruptcy remote from the originating captive lessor. The SPV in turn, issues short-term secured commercial paper (ABCP) to finance loans and markets the commercial paper—generally with a duration of no more than three months.[9]

Money market funds and other institutional investors seeking to invest in liquid and high-yield short-term assets are the main buyers of commercial paper, and in mid-2007, just before the turbulence in credit markets, MMFs held about 40% of outstanding commercial paper in the United States. The bankruptcy of Lehman Brothers on September 15, 2008 and the "breaking of the buck" at Reserve Primary Fund the next day triggered heavy outflows from MMFs, leading the Treasury to announce an unprecedented guarantee program for virtually all MMF shares. The

[9] For a detailed discussion of ABCP structures, see Acharya, Schnabl, and Suarez (2011).

Federal Reserve followed suit by announcing a program to finance purchases of ABCP—which were highly illiquid at the time—from MMFs. Despite these interventions, however, flows into MMF remained highly erratic, and MMFs significantly retrenched their commercial paper holdings. In the three weeks following Lehman's bankruptcy, prime MMFs reduced their holdings of commercial paper by $202 billion, a steep decline of 29%.

The reduction in commercial paper held by MMFs accounted for a substantial portion of the decline in outstanding commercial paper during this period and contributed to a sharp rise in borrowing costs for issuers of commercial paper. ABCP issuances also fell sharply amid the turmoil in short-term credit markets, and the sharp outflows of assets from MMFs in the third quarter of 2008 precipitated a run on many of these auto-related securitization pools. Figure 1 displays the outstanding amount of ABCP issued by SPVs associated with the captive leasing arms of the big three American automakers: GMAC, Chrysler Financial (CF), and Ford Motor Credit (FMC). Although the ABCP market began to weaken in 2007, automakers' issuance of ABCP began to collapse in the third quarter of 2008. Together, the big three captive lessors had about $40 billion worth of ABCP outstanding in 2006 before they largely collapsed by the end of 2009.[10]

3. The endogeneity concern

3.1. The endogeneity concern

We hypothesize that the decline in auto sales was caused in part by a *credit supply shock* driven by the illiquidity of captive lessors—the most important providers of consumer finance in the auto loan market. That is, we argue that runs in the ABCP market and the loss of financing capacity at the captive arms of the automakers curtailed the supply of auto credit, which in turn caused a drop in car sales. To identify the credit supply channel, we construct a measure of a

[10] Ford's financing arm, FMC, survived the crisis in part because of its continued access to the Federal Reserve's Commercial Paper Funding Facility (CPFF), which bought ABCP to alleviate liquidity pressures in the funding markets after the Lehman collapse. The Federal Reserve announced the CPFF to provide a liquidity backstop for US commercial paper issuers with high short-term credit ratings on October 14, 2008. Before losing access in January 2009, GMAC heavily relied on CPFF, selling a total of $13.5 billion ABCP to the facility. In contrast to GMAC and CF, FMC was able to maintain its short-term credit rating and never lost access to CPFF, from which it had raised almost $16 billion by summer 2009 and then began again to raise funds from private investors.

county's dependence on captive financing, defined as the ratio of the number of retail auto sales financed by captives to the number of all retail auto sales. We then estimate the relation between captive dependence and auto sales at the county level, controlling for the factors most likely to affect the demand for automotive credit in the county.

However, identifying a *credit supply* channel using a regression of auto sales on a measure of captive leasing is difficult because reliance on captive leasing is potentially correlated with underlying *demand side* factors. For example, one can argue that the demand for consumer credit from borrowers who rely on captive leasing may have fallen, too, since captive lessors are often seen as providers of credit to riskier borrowers (Barron, Chong, and Staten, 2008; Einav, Jenkins, and Levin, 2013).[11] And since some of these borrowers were also hit by the housing crisis, it is possible that the dramatic fall in car sales in 2009 might have also been driven by a demand shock.

3.2. Are our results driven by consumer demand?

Although the concern that auto sales financed by captive lessors plummeted because of lower demand by risky borrowers is a valid one, three pieces of evidence suggest that a credit supply shock was indeed an important factor in the decline of auto sales.

First, it is important to note that by the first quarter of 2007 only 15% of GMAC's US-serviced consumer asset portfolio was considered nonprime.[12] That is, the vast majority of those who relied on captive leasing were safer borrowers who had lower sensitivity to the housing cycle.

Second, a demand-side shock should lead to an overall decline in all types of credit regardless of the lender's identity. In contrast, we find that although lending by captive lessors fell dramatically during the crisis, sales financed by banks actually rose during this period—although not enough to offset the decline. We argue that it is hard to reconcile the declining

[11] Charles, Hurst, and Stephens (2010) document that minorities, in particular African Americans, are more likely to receive auto loans from financing companies and pay, on average, higher interest rates on those loans. One plausible explanation for this pattern is that minorities have, on average, lower credit scores and therefore are more likely to receive financing from captives. For a detailed analysis of subprime aut0-lending contracts, see Adams, Einav, and Levin (2009) and Einav, Jenkins, and Levin (2012).

[12] See GMAC LLC, 8-K, April 26, 2007, File No. 001-03754.

demand conjecture with the observed shift from captive leasing to bank financing during the crisis. The substitution from captive leasing to banks is well illustrated in Panel (B) of Table 1. The auto loan market share of finance companies—mostly captive lessors—was 51.3% in 2005 and declined to just 41.3% and 36.7% in 2009 and 2010, respectively. In contrast, the auto loan market share of banks, including both credit unions and commercial banks rose from 44.9% in 2005 to 56.2% and 61.1% in 2009 and 2010, respectively.

Third, though captive lessors are key players in the provision of consumer credit, they are also an important source of credit to auto dealerships. In particular, captive lessors provide floorplan financing—a form of credit collateralized by the dealer's auto inventory—that enable dealerships to purchase their car inventory. Although it is not easy to obtain dealership-level data on floorplan loans, we have read the financial reports of the largest publicly traded automotive dealerships in the United States to understand the challenges that auto dealerships faced during the great recession. In reading these reports we came across many instances in which these companies list lack of financing for both consumers and dealerships as a first-order reason for the decline in auto sales. That is, the illiquidity of captive lessors led to a decline in auto sales through a credit supply channel that affected not only consumers but also car dealerships.

Nevertheless, to alleviate concerns about the endogeneity of captured leasing, we use several identification strategies. We saturate our baseline specification with a battery of economic and demographic characteristics that have been used in the literature to measure the impact of housing and leverage on local demand. We also use the richness of the data to nonparametrically control for demand within counties. We include placebo tests based on auto cash sales as well as consumer expenditures on other goods and services, and we use the timing of MMF flows to measure how temporal variation in the financing capacity of captives might affect local sales. But before turning to the data and empirics, we first provide narrative-based evidence on the decline in captive financing.

4. The decline in credit supply by captive lessors: evidence from auto dealership companies

Before we move to the statistical analysis, we present narratives from the Form 10-Ks of the largest publicly traded dealership companies in the United States based on our reading of these 10Ks from 2006 to 2011. We collect and reproduce here those discussions that pertain to the role

of captive leasing in the automotive industry in general and during the financial crisis in particular.

4.1. AutoNation

By the end of 2006, AutoNation was the largest automotive retailer in the United States, owning and operating 331 new vehicle franchises out of 257 stores located in major metropolitan markets. AutoNation stores sold 37 different brands of new vehicles, primarily those manufactured by Ford, General Motors, DaimlerChrysler, Toyota, Nissan, Honda, and BMW. According to AutoNation' 2006 10K, the firm retailed approximately 600,000 new and used vehicles through their stores.

In 2006, AutoNation relied heavily on floorplan borrowing from captive lessors, with a total vehicle floorplan payable of $2,264.9 million, accounting for 74.7% of the company's current liabilities and 46.3% of its total liabilities. Similarly, in 2007, total vehicle floorplan was $2,181.8 million, accounting for 75.2% of current liabilities and 43.6% of total liabilities. Indeed, the importance of financing supplied by captive lessors for AutoNation as well as for its customers is echoed in their 2009 Form 10-K:

> *We obtain a significant amount of financing for our customers through the captive finance companies of automotive manufacturers, which companies were adversely impacted by the turbulence in the capital markets as well as the overall economic conditions in the United States. These conditions also adversely impacted other finance companies, including GMAC, which received extensive federal support and is now majority-owned by the U.S. Treasury. In 2009, the availability of automotive loans and leases through many of these finance companies declined significantly, forcing us to seek, at times unsuccessfully, alternative financing sources for our customers. We also rely on the captive finance companies of automotive manufacturers for floorplan financing to purchase new vehicle inventory. In 2009, many of these captive finance companies altered their floorplan financing programs to our detriment, providing additional restrictions on lending and increasing interest rates*.[13]

[13] AutoNation Form 10-K for the fiscal year ending December 31, 2009, pp. 22–23.

4.2. Lithia Motors

Another large auto dealership company that is highly dependent on floorplan financing from captive lessors is Lithia Motors, a NYSE publicly listed company. Operating in both new and used vehicles markets, in 2006 Lithia Motors offered 30 brands of new vehicles through 193 franchises in the western United States, with DaimlerChrysler, General Motors, Toyota, and Ford accounting for 41.0%, 19.4%, 10.9% and 7.3% of new vehicle sales, respectively. In its Form 10-K for the fiscal year ending in December 31, 2008 the company reports:

> *During 2008, overall macroeconomic issues have reduced consumers' desire and ability to purchase automobiles. An additional factor negatively impacting auto sales has been a reduction in available options for consumer auto loans. The manufacturers' captive financing companies have suffered additional pressure as the financial crisis has raised their cost of funds and reduced their access to capital. This and financial stress on manufacturers has prevented them from offering as many incentives designed to drive sales, such as subsidized interest rates and the amount of loan to value they are willing to advance on vehicles.*[14]

> *The tightening of the credit markets experienced in 2008 reduced the number of loans originated, restricted loans to more credit-worthy customers, reduced vehicle leasing programs and increased the overall cost of financing.*[15]

Lithia Motors again expresses concerns about tightening credit markets and their effects on both dealerships and customers in its 2009 annual report:

> *Credit markets continued to remain tight in 2009. . . . These constraints in financing resulted in fewer consumers in the market and less floor traffic at our stores. The financial crisis has increased the cost of funds and reduced the access to capital for*

[14] Lithia Motors Form 10-K for the fiscal year ending December 31, 2008, p. 4.

[15] Lithia Motors Form 10-K for the fiscal year ending December 31, 2008, p. 11.

finance companies (including manufacturers' captive finance companies).[16]

A lack of available credit continued to prove challenging to prospective purchasers of our stores. One of the primary problems was the lack of vehicle inventory floorplan financing, which is a basic requirement of the franchise agreement. Even for prospective purchasers with existing floorplan financing, obtaining mortgage financing on dealership real estate or committing to other significant capital investment proved exceedingly difficult.[17]

As these reports reveal, access to finance was a major concern in the US auto market in 2008 and 2009. Lack of financing posed a problem not only to consumers but also to large, publicly traded firms that relied heavily on floorplan financing from auto manufacturers' leasing companies. This widespread lack of credit was also listed as a key motivation for federal support of the automobile sector.[18] We turn now to the data and our empirical tests.

5. Data and summary statistics

We use a proprietary data set from R. L. Polk & Company (Polk) that records all new car sales in the United States. Beginning in 2002, for each new car purchased in the United States, the data set identifies vehicle make and model, such as Ford (make) Focus (model) or Toyota (make) Camry (model), and whether the car was purchased by a private consumer (a retail purchase), a firm (commercial purchase), or by the government. The data set also details the county, year, and quarter of vehicle registration. Because we are interested in identifying the effect of a credit supply shock on household consumption, we focus exclusively on retail purchases. Moreover, for each retail credit transaction starting in the first quarter of 2008, Polk

[16] Lithia Motors Form 10-K for the fiscal year ending December 31, 2009, p. 7.

[17] Lithia Motors Form 10-K for the fiscal year ending December 31, 2009, p. 126.

[18] In directly supporting GM and Chrysler, guaranteeing their new car warranties, and providing credit lines to downstream industry suppliers, the Automotive Industry Financing Program under TARP noted that "the recession has made credit less available, which may have limited the ability of auto manufacturers and suppliers to finance their businesses, consumers to purchase cars, and dealers to obtain loans to sustain their inventories." http://www.gao.gov/assets/290/288835.pdf, p. 8.

lists the name of the financial institution and type of financial services being provided, such as bank, credit union, or automaker's captive financing arm. We use this information to merge the Polk data with the Call Reports for banks.

5.1. The determinants of the collapse in retail car sales

Using the Polk data, we replicate the well-known observation that durable goods purchases—such as automobiles—declined sharply during and after the financial crises. Figure 2a plots the total number of automobiles sold annually from 2002 to 2013. Total car sales plummeted from a peak of 17 million units in 2006 to 11 million units in 2009 before rebounding slightly in 2010 and 2011. In 2012, auto sales had recovered to around 14 million units sold, and by 2013 sales approached precrisis levels. This pattern is driven largely by retail auto sales (Fig. 2b). We report the summary statistics of annual county-level retail auto sales in Table 3, demonstrating the dramatic decline in auto sales during the crisis. County-level mean sales dropped from 3,866 units in 2007 to 3,168 and 2,563 in 2008 and 2009, respectively. This pattern of dramatic decline is not driven by outlier counties and can also be observed by inspecting such sample order statistics as the median and the first and third quartiles. Figure 3 displays the spatial variation in the collapse of retail car sales, defined as the percentage change in retail automobile sales from 2008 to 2009 within a county. Counties in New England and parts of the Upper west experienced a relatively smaller drop in retail auto sales relative to the majority of counties in the South and West.

Having established the decline in retail auto sales and its spatial distribution, we next analyze the determinants of the decline in auto sales during 2008–2009. Table 4a reports the simple correlation between the change in retail auto sales from 2008 to 2009 and a battery of county-level economic and demographic characteristics observed for the same period. Some of these variables are obtained from the 2005–2009 American Community Surveys (ACS) and include population density, median income, income inequality, poverty rate, and percentage of African American residents. Our county-level characteristics also include the unemployment rate as of 2009 and—in order to measure a county's potential economic links to the automotive sector before the crisis—the employment share in automobile manufacturing within a county in 2007. Labor and employment data are obtained from the Bureau of Labor Statistics' Quarterly Census of Employment and Wages.

Consistent with the notion that local economic conditions might be related to new cars sales during the crisis, Table 4a demonstrates that median income and the change in auto sales from 2008 to 2009 are positively correlated. Likewise, auto sales dropped more in counties with greater unemployment rates and higher rates of poverty. We also find that auto sales declined in counties with higher income inequality (as measured by the Gini coefficient) and a higher percentage of African American residents. Table 4b shows the results obtained from regression analysis of the correlation between the change on auto sales and economic and demographic county characteristics. Columns (1)–(7) present the coefficients from estimating univariate regressions, while Column (8) demonstrates the multivariate nature of the correlations reported in Table 4a. Median household income and the poverty rate remain negative and highly significant while the estimated coefficient on income inequality is insignificant.

5.2. Captive dependency and the collapse in retail car sales

We argue that the collapse in auto sales was driven in part by the collapse in captive financing capacity brought about by disruptions in the ABCP and other short-term funding markets. To analyze the role of captive financing capacity in the collapse of car sales, we begin by constructing a measure of a county's dependence on captive financing. We define captive dependence as the ratio of the number of retail auto sales financed by captives in the county to the number of all retail auto sales in the county in 2008 Q1.

Ideally, we would have liked to measure a county's preexisting captive dependence during a period that predates the crisis, for example, in early 2006. However, the earliest available data from Polk that contain lender information is for the first quarter of 2008. Since disruptions in the ABCP market had already begun at least two quarters earlier, this measure could be contaminated by the crisis. For example, to the extent that dealers and consumers may have begun substituting away from captive financing to other lenders during this period, this measure may already reflect the effects of this substitution, rather than a county's historic dependence on captive credit. Moreover, since dependence is constructed based on Q1 2008 data, any systematic seasonal variation in the provision of credit across lenders could also bias our measure.

While these measurement concerns are valid, the relationship-based nature of captive credit, especially at the wholesale level, suggests that the cross-county variation in captive

dependence is likely to be highly persistent, at least before the full onset of the financial crisis. Thus, the potential for measurement error might be limited. To illustrate this point, we collect data from Warren et al. (2010) on aggregate financing by GMAC—the largest captive to collapse during the crisis—for the years 2005 to 2009 and report summary statistics on its aggregate lending in Table 5. As the table shows, there is remarkable persistence in the precrisis aggregate leasing activity. For example, according to Column (1) of Table 5, GMAC financed about 80% of GM dealer floorplans from 2005 until 2008, dropping to 78% only in 2009. Likewise, Column (2) illustrates the persistence in the consumer side of GM auto retail transactions: the fraction of GMAC-financed GM cars sold to consumers ranges from 32% to 38% during 2005–2008, falling precipitously only in 2009.

Table 6 reports summary statistics for our county-level captive dependence measure as well as for other key independent variables that are used in our empirical analysis. As the table shows, captive lessors account, on average, for almost 40% of retail auto transactions and range from 0.08 to 1.0 with a median of 0.38, illustrating the important role that captive leasing plays in US auto purchases. Figure 4 plots county-level variation in captive dependence, as measured in the first quarter of 2008. Not surprisingly, Michigan—the headquarters of the three major domestic manufacturers and their respective captive-financing arms—has the largest share of captive-financed transactions in the United States. Moreover, in areas where other manufacturers have a longstanding presence and dealers have close relationships with captives, such as in Alabama and Tennessee, captives also appear to dominate credit transactions (Holmes, 1998).

To be sure, the spatial variation in captive dependence may be correlated with other factors that might shape the demand for cars. And these potentially latent demand factors could make it difficult to identify contraction in captive credit supply. However, as we argue in the previous section, our identification strategy enables us to rule out demand-based explanations and to focus on the notion that a credit supply shock led to a significant decline in auto sales during the financial crisis.

6. The collapse of auto sales and captive leasing

6.1. Baseline county-level regressions

Here we present our baseline results of the effect of the collapse of the auto captive lessors during and after the financial crisis. We begin with a simple test of the credit shock hypothesis

by estimating the relation between captive dependence and auto sales at the county level, controlling for the factors most likely to affect the demand for automotive credit in the county. We estimate different variants of the following baseline regression specification:

$$\log(cars\ financed)_{2009,i} = \alpha_o + \alpha_1 \times dependence_i + \alpha_2 \times \log(cars\ financed)_{2008,i} + X_i\beta + S_i + e_i \quad (1)$$

where the dependent variable is the log of cars financed by captive lessors in 2009 in county i. Our main explanatory variable is the county's dependence on captive financing in the first quarter of 2008—*dependence*—which is defined as the ratio of retail sales financed by captives to all sales in the county. All specifications also include state fixed effects (the vector ***S***) and the log of the number of captive-financed auto sales in 2008. Most of our specifications also control for county-level economic and demographic variables that are included in the vector $\boldsymbol{X_i}$.[19] Our main coefficient of interest is α_1, which measures the effect of dependence on captive leasing on car sales during the crisis. Table 7 presents the results from estimating different variants of the model and displays standard errors (in parentheses) that are clustered at the state level.

Column (1) of Table 7 presents the results of regression (1) using state fixed effects and the log of the number of captive financed auto sales in 2008 as controls in addition to a captive dependency measure. As can be seen, the coefficient on captive dependence is negative and significant at the 1% level. The effect of captive financing dependence is economically sizable. For example, it implies that moving from a county at the 25th percentile of dependence to a county at the 75th percentile is associated with an almost 9% drop in financed car sales in 2009 relative to 2008.

In Column (2) of Table 7 we add a number of demographic and economic county-level controls to the analysis. We control for log median income since the demand for cars might be higher in counties with higher household income. Similarly, we control for the number of African American and White residents, given the evidence that race might affect access to automotive credit (Hurst and Stephens, 2010). We also add income inequality, as measured by the Gini coefficient, the log area, and the population of the county as control variables in our regressions.

[19] Table 6 reports summary statistics for the explanatory variables used in these regressions.

We attempt to address concerns about omitted variable bias by controlling for the fraction of county-level employment in automobile manufacturing. As illustrated in Fig. 4, counties in Michigan—the headquarters of the "big three"— as well as counties in states where auto manufacturers have a longstanding presence such as Alabama, Indiana, Kentucky, and Tennessee, have the largest share of captive-financed transactions in the United States. The empirical concern is that in areas with strong employment links to the automotive sector, the demand for cars might endogenously vary with the health of that sector. We address this concern directly by controlling for the relative size of employment in automobile manufacturing within the county.[20]

The inclusion of these county-level variables, which are not available for every county in our data, results in a slightly smaller sample size: 2,849 in Column (2) compared to 3,082 in Column (1). As Column (2) shows, the point estimate on captive dependence declines by about 20% from -0.635 to -0.469 but remains significant at the 1% level, still suggesting that the loss of captive-financing capacity might have had a large, independent impact on car sales in this period. Among the sociodemographic variables, we find that both median income and the number of African American residents in the county are correlated with the number of car sales financed by captive lessors. Available on request are results that combine the 2005–2009 ACS with county-level data from the 2000 Census in order to compute the change in median income, the poverty rate, population, and African American population inside the county over the two periods. The point estimate on the captive dependence variable is unchanged.

Although the specification in Column (2) controls for a battery of economic and demographic characteristics, there is a burgeoning literature on the effect of home prices and household leverage during the boom on local demand and employment (see Mian and Sufi, forthcoming, 2011; and the broader discussion in Mian and Sufi, 2014b). As a result, to the extent that captive dependence is correlated with this demand channel, estimates of the dependence coefficient might be biased.

We address this concern in Column (3) of Table 7 by adding the 2009 county-level unemployment rate as well the median debt to income ratio for households in a county in 2006 to the control variables used in Column (2). These data are available for a smaller subsample of

[20] Appendix A provides a detailed description of variables construction and their sources.

counties, reducing the sample size from 2,849 in Column (2) to 979 counties in Column (3). Yet the negative impact of dependence remains robust, with statistical significance at the 1% level and a point estimate that is very close to the one obtained in Column (1). Interestingly, in these specifications that include captive dependence as the main explanatory variables and in contrast to some of the earlier studies we do not find an independent statistically significant effect of unemployment and household debt on car sales that are financed by captive lessors.

Recent research has identified housing price changes as a chief catalyst behind the collapse in household demand. In order to address further concerns about latent demand, Column (4) directly controls for the average change in home prices in a county from 2008 to 2009. As Column (4) of Table 7 demonstrates, the inclusion of housing price change—which, consistent with the literature, is positive and statistically significant—does not affect our main finding. The coefficient on captive dependence remains statistically significant and similar in magnitudes to the estimates obtained in Columns (1) and (3). The housing price change point estimate suggests that moving from a county at the 25th to the 75th percentile in this variable is associated with a 2% percent increase in car sales, suggesting that household net worth is an important factor in car sales. But in this subsample, a similar change in captive dependence is associated with an 8% drop in sales. In unreported results we also control for the median credit score in the county and obtain similar results for the captive dependence estimates in Table 7.

We now consider additional robustness tests using the regression reported in Column (2) as our baseline specification.

6.2. Placebo and robustness

One concern about our analysis is the endogeneity of captive-leasing dependence, where our measure of captive dependence captures an omitted demand factor. For example, it is possible that counties in which captive lessors are more prevalent are also counties that experienced a general decline in consumption of durable goods during the crisis. In order to address this concern, we supplement our analysis with a placebo exercise and report the results in Table 8.

We use the same regression specification as in Table 7, Column (2). However, we redefine the dependent variable to be the log number of cars that were bought for *cash* within a county in 2009. If captive dependence merely captures unobserved county-level demand, then, as in the estimates reported in Table 7, α_1, the coefficient of *captive dependence,* should be

negative and significant. In contrast, the results of the placebo test, reported in Table 8, Column (1), show that α_1 is very close to zero and is statistically not significant. That is, we find no effect of a county's dependence on captive leasing on overall cash sales of cars, and hence we can reject the notion that our measure of captives captures a general demand side factor. The fact that captives are associated with lower sales of financed cars but do not affect cash sales of automobiles reinforces our argument that our results are driven by a credit supply shock.

Furthermore, we obtain data from Nielsen on the dollar value of consumer expenditure at the county level. The Nielsen consumer expenditure data include purchases of apparel, education, electronic devices, food, furniture, major appliances, medical expenses, and personal care. If captive dependence merely proxies for latent demand, then counties with greater captive dependence should have also experienced a greater decline in other purchases during this period. In contrast, as Column 3 of Table 8 shows, the point estimate on captive dependence is both economically and statistically insignificant, suggesting that it unlikely that our measure of captive dependence captures latent demand.

We have already addressed the concern that captive dependence is higher in counties with a large automotive sector by directly controlling for the fraction of county-level employment in automobile manufacturing in Table 7. We refine this control in Columns (2) and (3) of Table 8 by splitting the sample between counties with and without auto industry employment and estimating specification (1) separately for each of the samples. These regressions focus on counties that—based on employment data—have no ties to the auto industry; hence, their dependence on captive leasing is unlikely to be specifically correlated with the state of the industry. Column (2) of Table 8 reports results that are based on the sample of 2,003 counties in which there is zero employment in the auto industry, while Column (3) coefficients are estimated with a sample of the 846 counties with strictly positive auto industry employment. As Column (2) shows, the point estimate of *captive dependence* in the zero auto employment is negative and statistically significant at the 1% level. As expected, the coefficient of *captive dependence* is higher in counties with links to the auto industry (-0.556 compared to -0.476). Nevertheless, the coefficient in Column (2) of Table 8 is almost identical to the estimate obtained in our baseline specification in Column (2) of Table 7 (-0.476 compared to -0.469). We conclude that our results are unlikely to be driven by local employment effects of the automotive industry.

6.3. Captive dependence and aggregate auto sales

The evidence in Table 7 shows that captive financed auto sales fell after the collapse of the ABCP market in those areas more heavily dependent on captive financing. However, other lenders such as banks could have stepped in as alternative sources of finance—substituting for the loss of captive-financing capacity. And this potential substitution effect—away from captive lenders—could partially or even fully mute the adverse effects of captive distress on car sales. We examine the substitution hypothesis and report results in Table 9 using the same benchmark specification presented in Column (2) of Table 7.

Column (1) of Table 9 uses the log number of *non*-captive financed transactions within a county in 2009 as the dependent variable: these transactions include all banks and financing companies that are not captive arms of the automakers. As Table 9 shows, the point estimate on captive dependence is now positive and statistically significant. In particular, moving from a county at the 25th percentile to the 75th percentile of captive dependence is associated with a 1.8% increase in *non*-captive financed sales. This change in sign—compared to the estimates for captive leasing in Table 7—suggests that as captives reduced their credit supply, other lenders were providing an alternative source of credit. These results remain robust if we also include the change in house prices and household leverage.

Moreover, this evidence for partial substitution from captive lessors to other financial intermediaries lends credence to the credit supply shock hypothesis and our identification strategy. If our captive dependence measure primarily proxies for weak demand within a county during the crisis, then even the number of non-captive transactions should have fallen as well, and hence the coefficient in Column (1) would have been expected to be negative. Instead, the contrast in the sign of the captive dependence coefficients between Tables 7 and 9 suggest that our results are unlikely to be driven by latent demand, but rather reflect the effects of diminished captive credit supply on auto sales in this period.

The evidence presented in the first column of Table 9 suggests that some financial intermediaries stepped in to fill the void left by captive lessors. We now turn to analyze the aggregate consequences of the contraction in captive credit supply. To do so, we redefine the dependent variable as the log of the number of all car sales in a county in 2009, regardless of whether they were financed or the source of financing. As Column 2 of Table 9 demonstrates,

the dependence coefficient is negative and statistically significant at the 1% level. Moving from a county at the 25th percentile to the 75th percentile of captive dependence is associated with 2.5% drop in overall car sales in 2009. Thus, substitution away from captive lessors into other lenders may have only partially muted the impact of captive distress on lending and auto sales. And as before, these findings are unchanged if we control for house price changes and household leverage and their interaction.

We argue that the main reason that banks could not fully substitute for the decline in credit supply by captive lessors is driven by informational frictions. As discussed in Section 2, the vertical integration of captive lessors into auto manufacturers enables them to overcome informational frictions surrounding collateral values. This informational advantage helps captive lessors in providing both floorplan credit to auto dealerships as well as credit in the form of leases and loans to consumers.[21]

6.4. The home price and household leverage channels in auto sales

The last column of Table 7 shows that changes in house prices are positively correlated with auto sales, and in Table 10, we investigate in greater detail how local home prices and household leverage might have shaped auto sales during this period (Mian and Sufi (2010, 2011) and Mian, Rao and Sufi (2013)).

The first column of Table 10 repeats the analysis presented in Column 4 of Table 7. The effect of captive dependence in this subsample is about four times higher than the home price effect, while household leverage has no effect on auto sales. We conjecture that household leverage does not seem to be an important determinant of auto sales in this subsample since the automobiles are financed through auto loans and leases and hence rely less on home equity. We next turn to estimate the importance of household leverage and house prices for cars bought with cash – where home equity and household leverage may play a bigger role. As Column 2 of Table 10 demonstrates, and consistent with the placebo results in Column 1 of Table 8, captive leasing is unrelated to car cash sales. In contrast, household leverage and house price changes are both statistically and economically significant in explaining cash car sales, confirming their

[21] See Pierce (2012) for evidence suggesting that captive lessors have informational advantage in predicting lease residual values—although these advantages may be mitigated by conflicting interests within the organization.

importance for cars that are not financed by captive lessors. The housing price change point estimate suggests that moving from a county at the 25th to the 75th percentile in this variable is associated with a 4% percent increase in car sales. Similarly, moving from the 25th to the 75th percentile in household leverage increases is associated with a 2 percent increase in car sales.

Finally, the last column of Table 10 reports the coefficients for aggregate car sales. While both captive dependence and housing prices are statistically significant at the one percent level, household leverage is only marginally significant. These estimates likely reflect the composition of the new car auto market in the U.S. in which more than 80% of the cars are financed by captive leases and auto loans from leasing companies and other financial institutions, and only 20% are bought for in all cash transactions.

6.5. Changes in aggregate financing capacity and local auto sales

The panel structure of our data can help in providing more direct evidence linking changes in captive-financing capacity to the local supply of credit and auto sales. The approach builds on the idea that because money market funds—mutual funds that invest in short-term securities—are the principal source of funding for many securitization conduits, we would expect that when net flows into MMFs are plentiful, these funds are likely to increase their demand for captive ABCP.[22] This in turn could lead captives to increase the supply of captive credit to dealers and households. Conversely, a sharp contraction in MMF net inflows would be expected to increase the cost of ABCP financing for captives, leading to a contraction in captive credit supply and slower captive-financed sales growth.

Using data from Flow of Funds, Fig. 5 plots the net inflows into MMFs during the crisis. Net inflows into funds that primarily serve retail investors were far less volatile during this period than flows into those funds that cater to institutional investors—the latter were the major buyers of ABCP during this period.

We would thus expect that the effects of MMF flows on the financing capacity of captives are likely to be more pronounced in those counties more dependent on captive financing. And we exploit the variation in both the cross-section of captive dependence and the

[22] MMF can be grouped by type of investments. Treasury MMF sole invest in Treasury securities. Non-Treasury MMF also buy commercial paper from non-financial firms and ABCP conduits.

time-series of flows into non-Treasury MMFs to investigate this hypothesis. Using quarterly car sales data over the period 2008–2009, we estimate the following specification:

$$\log(cars\ financed)_{i,q} =$$
$$\alpha_o + \alpha_1 \times dependence_i + \alpha_2 \times MMFs\ flows_q + \alpha_3 \times (dependence_i \times MMFs\ flows_q)$$
$$+\alpha_4 \times \log(cars\ financed)_{i,q} + X_i\beta + S_i + T_q + e_{i,q} \qquad (2)$$

where the unit of observation is at the county-quarter level for the period 2008 Q1: 2009 Q4. We use the same baseline specification as in Table 7 and add a measure of quarterly flows into MMFs and an interaction term between captive dependence (observed in 2008 Q1) and MMFs flows in each of the quarters from 2008 Q1 until 2009 Q4. All specifications also include state fixed effects (the vector ***S***), quarter fixed effects (the vector ***T***), the log of the number of captive-financed auto sales in 2008, and county-level economic and demographic variables that are included in the vector $\boldsymbol{X_i}$. Table 11 presents the results and reports standard errors (in parentheses) that are clustered at the state level.

As Table 11 demonstrates, sales of autos that are financed by captive lessors are higher in quarters when MMFs inflows are higher. In Column 1 of the table we interact captive dependency at the county level with aggregate flows into all types of MMFs. As in our previous results, the coefficient on *captive dependence* is negative and statistically significant at the 1% level. Moreover, after controlling for state fixed effects, quarter fixed effects, and the demographic controls that were included in the specification presented in Column (2) of Table 7, we find that the interaction term between captive dependency and MMFs flows is significant and positive.[23] The economic magnitude of the estimates imply that during a quarter when the growth in flows in MMFs is at the 25th percentile, a one standard deviation increase in captive dependency is associated with a 3.0% drop in captive sales growth. In contrast, in quarters in which the growth in flows into MMFs is at the 75th percentile, a similar increase in captive dependence is associated with only a 0.3% drop in captive sales growth.

[23] Note that the level of MMF flows is not included in the regressions as it is fully absorbed by the quarter fixed effects.

One concern about these results is that we are capturing some general trend in economic conditions rather than actual flows into MMFs. In order to address this concern, we conduct robustness tests in which we control for the S&P 500 index level, real GDP, State-level income as well as the interaction of these variables with *captive dependence*. Our results (which are omitted for brevity and are available upon request) are unaffected by the inclusion of these time-series economic indicators and their interactions with county-level *captive dependence*.

Next, we further split MMFs flows between institutional MMFs and retail MMFs. Not all MMFs invest in ABCP: while MMFs that primarily cater to retail investors tend to be more conservative and were less likely to invest in ABCP, institutional MMFs invested in riskier assets such as ABCP (Kacperczyk and Schnabl, 2013). As Columns (2) and (3) of Table 11 show, our results are driven by institutional MMF flows (point estimate of 0.023 significant at the 5% level in Column 2 compared to an insignificant 0.005% in Column 3). Taken together, the results in Table 11 suggest that shocks to the financing capacity provided by MMFs, mainly those funds focused on institutional investors, had a significant impact on the collapse in car sales during the financial crisis and the great recession.

6.6. Make heterogeneity and county fixed effects

We now turn to analyze the heterogeneity of the effect of captive leasing on auto sales. More specifically, we study the effect of captive leasing on sales within auto manufacturers.[24] In each of the columns of Table 12 we restrict our analysis to only one automaker in each regression and estimate specifications similar to Regression (1) with the same set of control variables as in Column (2) of Table 7. In each of the columns in the table *captive dependence* is defined as a county's dependence on the captive-financing arms of each of the automakers based on sales financed in 2008 Q1. The table reports results for the three largest automakers in the United States: GM, Columns (1)–(3); Ford, Columns (4)–(6); and Toyota, Columns (7)–(9).

The dependent variable in Column (1) of Table 12 is the change in GMAC-financed sales within a county from 2008 to 2009. As the table shows, the point estimate on GMAC dependence is negative and significant, suggesting that the collapse in GMAC-financed sales

[24] There is evidence that concerns about the long-term solvency of the automobile manufacturer could independently shape the demand for its cars (see Hortacsu, Matvos, Syverson, and Venkataraman, 2013).

was larger in those areas more dependent on GMAC for credit: a one standard deviation increase in dependence is associated with a 0.14 standard deviation drop in the change in GMAC sales. While Non-GMAC financed GM sales rose sharply in those areas where GMAC was more dominant (Column 2), the net aggregate impact on GM sales is negative despite the substitution away from GMAC-financed cars (Column 3).

In results available on request, we also use a change in GMAC's credit policy to connect further the availability of financing from short-term funding markets and captive credit supply. This test is motivated by the fact that in early October 2008, GMAC found it increasingly difficult to roll over its debt in the ABCP market and decided to strategically reallocate its remaining financing capacity away from borrowers with a credit score of less than 700 (Congressional Oversight Panel, 2013). The TARP injection in late December 2008 relieved some of these funding pressures, and GMAC lowered its credit score requirement to 620. Consistent with this credit supply narrative, we find evidence that those counties that are more dependent on GMAC for their GM car purchases and have a larger fraction of borrowers with credit scores below 700 suffered a steeper collapse in GM car sales in the fourth quarter of 2008 relative to those counties that relied on other lenders to supply car credit and had better credit scores.

The remaining columns of Table 12 repeat the basic specifications for the other two major makes in the United States: Ford and Toyota. The pattern is similar across the three largest automakers. It suggests that despite the variation in experiences across these firms, dependence on captive financing played a significant role in explaining some of the collapse in car sales.

Last, the richness of our data and in particular, the availability of make level data allow us to once more gauge the extent of biased estimates due to latent county-level unobservables that might both explain the demand for cars within a county and its dependence on captive financing. Specifically, we use a different aggregation of the data where the unit of observation is at the make-county level for the four largest automakers: Toyota, GM, Ford, and Honda.[25] The

[25] Together, these four makes accounted for about 55% of the US market in 2007, have a market presence across most geographic regions, and offer models in most segments. We exclude smaller makes, such as Nissan, the next largest car company in terms of market share in the Polk data, as these firms tend to operate in only a small number of counties and compete in only one or two segments. For example, while the Ford Taurus and various Buick

make-county data aggregation enables us to control for county fixed effects as well as make fixed effects in our regression analysis.

This specification thus absorbs any latent time invariant county- and make-level effects and offers a powerful robustness check. For example, a county's exposure to the "cash for clunkers" program, as determined by the preexisting fraction of "clunkers" in the county's automobile stock, could be correlated with both sales in 2009 and captive dependency (Mian and Sufi, 2012). Similarly, a county's industrial structure, such as the degree of employment in nontraded goods, or its indirect connections to the automobile sector not measured by BLS employment shares, could also drive demand and correlate with the captive dependency, leading to biased estimates.

More specifically, we estimate the following regression model:

$$\begin{aligned}\log(cars\ financed)_{2009,i,m} = {} & \alpha_o + \alpha_1 \times dependence_{i,m} + \alpha_2 \times \log(cars\ financed)_{2008,i,m} \\ & + \alpha_3 \times (market\ share)_{2008,i,m} + C_i + M_m + e_{i,m} \end{aligned} \quad (3)$$

where the unit of observation is at the county-make level. All specifications also include the log number of car sales financed by captives in 2008 Q1. And since we now disaggregate the data by make, we can include the market share of the make within a county in 2008 Q1, as well as county fixed effects (the vector ***C***) and make fixed effects (the vector ***M***). Table 13 presents the results and reports standard errors (in parentheses) that are clustered at the state level.

As Column (1) of Table 13 shows, the impact of captive dependence on captive-financed sales remains negative and statistically significant at the 1% level after controlling for both county and make fixed effects. While there is also evidence of substitution (Column 2), the coefficient is imprecisely estimated and is not statistically significant. Last, the net aggregate effect of captive dependency remains negative and significant after controlling for county fixed-effects (Column 3). Our main result thus holds within each county across different makes and controlling for make-specific effects.

The results presented in the first three columns of Table 13 are important in alleviating

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models compete in the "large sedan" segment, Nissan offers no models in that segment. Likewise, Subaru sells almost no new cars in the South and competes in only a handful of segments.

concerns about unobserved county and automaker invariant effects. However, the automobile market is highly segmented, and this segmentation suggests that even after controlling for county and make fixed effects, shocks to the demand for cars within a county could vary substantially across models, even for those sold by the same firm. For example, some manufacturers, such as GM, offer a large number of makes and models aimed at buyers with different income levels: Chevrolet, a major sub-make within GM, generally sells nonluxury models that are marketed toward lower- and middle-income buyers, while Buick and Cadillac, again both GM sub-makes, sell more luxurious models aimed at higher-income buyers.[26] As a result, the collapse in house prices and the rise in household leverage among lower-income borrowers could precipitate a drop in the demand for Chevrolet models within a county, whereas demand for Buick and Cadillac cars within the same county could be less affected. In contrast, housing price dynamics may have had a smaller impact on the net worth of these higher-income buyers. Thus, one can argue that our measure of captive leasing captures those households who traditionally bought nonluxury models and that were more affected by the drop in housing prices such as subprime borrowers.

Using the detailed model and make data from Polk, along with information on model types from Wards Automotive, one of the standard purveyors of intelligence on the automotive industry, we augment our analysis to utilize within-make within-county within-segment heterogeneity. Wards Automotive identifies the market segment in which each car model competes, and we use this information to construct a county-make-segment panel: the number of cars that each make sold within each county in each market segment. The market segmentation in the industry can be highly detailed, and Ward's lists 30 segments. This level of granularity can, however, lead to a large number of missing observations in our data set, as specialized models, such as the Chevrolet Corvette, tend to have a small number of sales in a limited geographic area. We thus collapse the 30 segments in Wards into eight broad market segments that correspond to the Insurance Institute for Highway Safety's classification: small cars; mid-sized cars; large cars; luxury cars; small utility vehicles; mid-sized utility vehicles; large utility

[26] Even within some sub-makes such as Chevrolet, some models, such as the Corvette, are aimed at richer buyers. Bricker, Ramcharan, and Krimmel (2014) and the references contained discuss cars, status, and the marketing of cars in the United States.

vehicles; and luxury utility vehicles.[27]

With information on county, make, and segment, we can include make fixed effects, M_m, county fixed effects, C_i, and county-segment fixed effects, μ_{is}. As before, make fixed effects allow us to absorb any shocks to make-level sales that affects all counties and segments, such as the potential insolvency of a make, while county fixed effects continue to absorb county-specific time-invariant factors that affect sales of all cars equally within the county. The addition of county-segment fixed effects now absorbs invariant factors that affect sales of a particular segment that vary across segments, even within the same county. Our modified regression specification is:

$$\log(cars\ financed)_{2009,i,m,s} = \alpha_o + \alpha_1 \times dependence_{i,m,s} + \alpha_2 \times \log(cars\ financed)_{2008,i,m,s} + \alpha_3 \times (market\ share)_{2008,i,m,s} + C_i + M_m + \mu_{i,s} + e_{i,m} \quad (4)$$

As Column (4) of Table 13 demonstrates, our basic results remain the same when controlling for county-segment fixed effects. A one standard deviation increase in captive dependence measured is associated with about a 1.2% drop in sales in 2009. In results available upon request, we replicate this exercise at the more aggregate MSA level, including all mainstream makes and models—our basic results are unchanged. In summary, the combined evidence in Table 13 renders it unlikely that our results are driven by omitted county or automaker factors. More important, the last column of the table shows that our results hold when we compare cars that are sold within county and auto segment, and thus it is unlikely that our captive dependence measure is capturing latent demand for cars.

7. Banks and the collapse of auto sales

After presenting evidence on the collapse of the ABCP market and its effect on captive lessors and car sales, we now turn to analyze the effect of ABCP on bank auto loans. Some banks were heavily exposed to the ABCP market, incurring losses either directly through their sponsorship of automobile-related conduits or indirectly via an increase in funding costs (Acharya and Mora, 2013). Bank-level data thus allow us to test further how disruptions in these markets might have affected the availability of automotive credit, which led to a decline in car sales.

[27] Appendix B provides more details on how the Wards data are merged to Polk.

To this end, we hand matched the credit supplier names from Polk with the income and balance sheet data available in banks' Call Reports. In cases where a bank is part of a bank holding company, we aggregate the Call Report data up to the bank holding company level and collectively refer to both stand-alone banks and bank holding companies as banks. The names of banks in the Polk data set do not always correspond to the legal names of the banks as recorded in the Call Report—especially for the smaller banks. Our Call Reports–Polk-matched sample has about 1,500 banks that are, on average, larger than the entire population of banks.[28]

Similar to Acharya and Mora (2013), we use two proxies for a bank's reliance on short-term wholesale funding. First, we construct a bank's unused commitments ratio: the ratio of unused loan commitments to the sum of loans and unused commitments. Unused loan commitments are the parts of credit lines that have not been drawn down and include, for example, support to ABCP program conduits that the banks were not required to consolidate on their balance sheets before the crisis. Banks with a higher precrisis unused commitments ratio are thus more heavily active in short-term markets and as a result are more exposed to stresses in these markets. The second proxy is the net wholesale funding ratio—liabilities excluding core deposits—divided by total assets. Banks that are less reliant on core deposits—a stable source of funding—are likely to have been more exposed to the disruptions in short-term funding markets during the crisis.

Table 14 reports results from *bank*-level regressions. For the 1,534 banks in our cross-section, we regress the log number of cars financed in 2009 on our two measures of a bank's exposure to short-term funding markets, observed in 2006. We also control for the log number of cars financed in 2008 by the bank, along with a number of bank-level characteristics from 2006, such as: bank assets (log), the ratio of Tier 1 capital to assets, the loans to assets ratio, and the share of real estate loans on the bank's balance sheet. As the table demonstrates, the estimated coefficient on the wholesale funding ratio is negative and significant at the 10% level. A one standard deviation increase in dependence on wholesale funding in 2006 is associated with a 6% drop in total cars financed in 2009. The point estimate on the unused commitments ratio is also negative but is not statistically significant. Last, and not surprisingly, there is also evidence that

[28] For example, the average bank in our sample had around $45 billion in assets in 2007, while the average for the full sample of banks in the Call Reports is $32 billion.

those banks more exposed to the real estate sector during the boom contracted automotive credit more sharply.

Our central thesis is that contraction in aggregate credit supply affects economic activity adversely and that this was the case during the financial crisis of 2008–2009. The adverse effects were not confined only to the time of the crisis, however. Some of the large-scale changes in financial regulation that followed the crisis made it more expensive for banks, especially the larger banks, to engage in many forms of securitization and to access wholesale funding markets.

In particular, in 2009, the Financial Accounting Standards Board modified accounting standards so that transfers of assets by banks to SPVs would no longer be recognized as a sale. Instead, these new rules required banks, beginning in 2010, to consolidate the assets and liabilities of any supported SPVs into the balance sheet of the bank holding company for regulatory and financial reporting purposes, thereby broadening the range of assets subject to capital requirements and decreasing the attractiveness of off-balance sheet securitization (FASB Statement Nos. 166 and 167). [29] Concurrently, banking regulators also announced a sizable expansion in capital and liquidity requirements, especially for the larger banks.[30] Non-bank lenders such as Ford Motor Credit are largely exempt from many of these capital and liquidity requirements, while many smaller banks face relatively lower requirements.[31] All this suggests that banks more connected to these markets would be expected to contract automotive credit more sharply, especially after these regulatory changes.

If these results reflect the effects of a loss of financing capacity stemming from the disruptions in the ABCP and other short-term funding markets, then the aforementioned 2009–2010 regulatory changes would be expected to engender an even sharper contraction in credit

[29] Summaries of these statements can be found here: http://www.fasb.org/cs/ContentServer?pagename=FASB%2FPronouncement_C%2FSummaryPage&cid=1176156241369.

[30] The regulatory agencies' amendment of their bank capital adequacy frameworks in response to the FASB rule on the consolidation of ABCP programs can be found here: http://www.fdic.gov/news/board/DEC152009no2.pdf. Other regulatory changes pertaining to securitization also focus on risk retention, the role of credit agencies, and the Volcker Rule. A general survey of the various US and international changes to bank capital and liquidity requirements and other regulations after the crisis is here: http://www.stlouisfed.org/federal-banking-regulations/.

[31] To be sure, the Dodd-Frank Act of 2010 allows the Federal Reserve to regulate non-bank financial institutions if they are deemed systemically important.

supply for those banks more dependent on these markets in the boom.

Column (2) of Table 14 uses the total number of cars financed 2010–2013 as the dependent variable, controlling for the standard suite of bank-level controls, as well as the log number of cars financed in 2009. As Column (2) shows, both the wholesale funding ratio and the unused commitments variables are significant at the 1% level. The point estimates are also much larger. A one standard deviation increase in the former is associated with an 11.5% drop in car sales. In the case of the latter, a similar increase is associated with a 9% drop in sales over the 2010–2013 period. Thus, the disruptions in short-term markets and some of the postcrisis regulatory changes intended to make banks less reliant on short-term credit markets might have curtailed the supply of credit, resulting in a prolonged contraction.

8. Captive leasing in the post-crisis years

These aforementioned post crisis changes in financial regulation aimed at banks relative to non-banks offer yet another way to gauge the importance of captive financing capacity on car sales.[32] Funding in ABS securitization markets in the post crisis period have become increasingly stable and cheap funding, yet banks face higher costs to securitization relative to the pre-crisis regulatory environment. Table 15 thus investigates the extent to which captives relative to other intermediaries might have used ABS securitization markets to gain market share from the traditional banking system.

Using a quarterly panel for the period 2010-2013, column 1 regresses the growth in aggregate sales in a county on captive dependence. Captive dependence is also interacted with the spread between the A-rated tranche of auto ABS over the corresponding two-year interest rate swap. The interaction term is negative and significant. This suggests that captive credit supply tends to decline in periods when the cost of funding in these markets rise, disproportionately affecting sales in those counties more dependent on captive financing. Column 2 shows the supply of bank credit is however relatively insensitive to the cost of funding in these markets: the interaction term is not significant. Column 3 replicates these results using

[32] In comparison to the larger number of new regulations aimed at banks that have emerged after the passage of the Dodd-Frank Act, non-bank automotive finance companies have only recently attracted the attention of federal regulators: http://www.consumerfinance.gov/newsroom/cfpb-proposes-new-federal-oversight-of-nonbank-auto-finance-companies/

the BBB spread. The coefficients are more precisely estimated but similar in magnitude to the previous results, suggesting that the relative calm in securitization markets post-crisis, along with the various changes in regulation aimed at banks, may have increased the financing capacity of captives relative to other lenders.

9. Conclusion

There is now considerable evidence that balance-sheet shocks to traditional financial institutions may have limited the availability of credit to the real economy. Our paper contributes to this literature in two ways. First, we show the real consequences of credit supply by linking shocks to short-term funding markets to credit supply by captive leasing companies and auto sales. Second, we provide evidence that illiquidity in the short-term funding markets played an important role in limiting the supply of non-bank consumer credit during the financial crisis. The collapse of the ABCP market decimated the financing capacity of many captive financing companies as well as some large banks. Our paper documents the importance of leasing companies in the provision of credit in the auto markets and the consequential real effects that credit supply had on auto purchases during the financial crisis and the great recession.

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Appendix A: Variable Description and Construction

For reference, the following is a list of variables used in the paper, their sources, and a brief description of how each variable is constructed.

i. *African American Population:* Number of African Americans in a county. (Source: American Community Survey)
ii. *Assets:* Total bank assets. (Source: FR Y9-C, FFIEC 031)
iii. *Captive Dependence:* Share of county-level retail car sales financed by captive financing companies. (Source: Polk)
iv. *Captive Financed Sales:* County-level retail car sales financed by captive financing companies. (Source: Polk)
v. *County Area:* Size of a county in square miles. (Source: American Community Survey)
vi. *Employment in Automobile Manufacturing*: Divides the number of employees in the automobile sector by total employment. (Source: Quarterly Census of Employment and Wages)
vii. *Gini Coefficient*: Measures income inequality in a county. (Source: American Community Survey)
viii. *House Price Change:* Annual change in the local house price index. (Source: CoreLogic)
ix. *Household Leverage:* County-level household debt-to-income ratio. (Source: Federal Reserve of New York)
x. *Leverage Ratio:* Divides Tier 1 eligible equity capital by total bank assets. (Source: FR Y9-C, FFIEC 031)
xi. *Loans/Assets*: Total bank loans divided by total bank assets. (Source: FR Y9-C, FFIEC 031)
xii. *Median Household Income* (Source: American Community Survey)
xiii. *Money Market Fund Flows:* Quarterly net flows to (from) money market funds. (Source: Flow of Funds, Federal Reserve Board)
xiv. *Non-Captive Financed Sales:* County-level retail car sales not financed by captive financing companies. (Source: Polk)
xv. *Percent African American:* African American population divided by population. (Source: American Community Survey)
xvi. *Population:* Number of people in a county. (Source: American Community Survey)
xvii. *Population density*: Population divided by area. (Source: American Community Survey)
xviii. *Poverty Rate:* Number of people living below the poverty line divided by population. (Source: US Census)

xix. *Real Estate Loans/Assets:* Total real estate loans divided by total bank assets. (Source: FR Y9-C, FFIEC 031)

xx. *Retail Car Sales:* The sum of retail purchases and retail leases. (Source: Polk)

xxi. *Unemployment Rate:* county-level labor force divided by the number of unemployed. (Source: BLS)

xxii. *Unused Commitments Ratio:* Total unused commitments divided by the sum of total unused commitments and total loans. (Source: FR Y9-C, FFIEC 031)

xxiii. *White Population:* Number of Caucasians in a county. (Source: American Community Survey)

xxiv. *Wholesale Deposits/Assets:* Total uninsured deposits divided by total bank assets. (Source: FR Y9-C, FFIEC 031)

Appendix B: Auto Segment Construction

The eight auto segments used in make-county regression (Table 11) include the following models:

i. **Small Cars (WARD categories: lower small and upper small)**
BMW 128, BMW 135, Chevrolet Aveo, Chevrolet Cobalt, Dodge Caliber, Ford Focus, Honda Civic, Honda Fit, Hyundai Accent, Hyundai Elantra, Kia Rio, Kia Forte, Kia Soul, Kia Spectra, Mazda 3, Mini Cooper, Mitsubishi Lancer, Nissan Cube, Nissan Sentra, Nissan Versa, Pontiac G3, Pontiac Vibe, Saab 93, Saturn Astra, Saturn Ion, Subaru Impreza, Suzuki Aerio, Suzuki Forenza, Suzuki Reno, Suzuki SX4, Toyota Corolla, Toyota Yaris, Volkswagen GLI, Volkswagen Golf, Volkswagen Jetta, Volkswagen R32, Volkswagen Rabbit, Volvo V50.

ii. **Mid-sized Cars (WARD categories: lower middle and upper middle)**
Buick Lacrosse, Chevrolet Impala, Chevrolet Malibu, Chrysler Sebring, Dodge Avenger, Ford Fusion, Honda Accord, Honda FCX, Honda Insight, Hyundai Azera, Hyundai Sonata, Kia Optima, Mazda 6, Mercury Mila, Mercury Montego, Mercury Sable, Mitsubishi Galant, Nissan Altima, Pontiac G6, Pontiac G8, Pontiac Grand Prix, Saturn Aura, Subaru Legacy, Suzuki Kizashi, Toyota Camry, Volkswagen CC, Volkswagen Passat, Volvo V70.

iii. **Large Cars (WARD category: large)**
Buick Lucerne, Chrysler 300, Dodge Charger, Dodge Magnum, Ford Crown Victoria, Ford Five Hundred, Ford Taurus, Kia Amanti, Mercury Grand Marquis, Mercury Monterey.

iv. **Luxury Cars (WARD categories: small luxury, middle luxury, and large luxury)**
Acura RL**,** Acura TL, Acura TSX, Audi A3, Audi A4, Audi A6, Audi S4, Bentley Continental, BMW 328, BWM 335, BW 525, BMW 528, BMW 530, BMW 535, BMW 550, BMW M3, BMW M5, Cadillac CTS, Cadillac DTS, Cadillac STS, Chevrolet Monte Carlo, Hyundai Genesis, Infiniti G35, Infiniti G37, Infiniti M35, Infiniti M45, Jaguar S-Type, Jaguar X-Type, Lexus ES, Lexus GS, Lexus HS250H, Lexus IS, Lincoln MKS, Lincoln MKZ, Lincoln Town Car, Mercedes-Benz C-Class, Mercedes-Benz CLK-Class, Mercedes-Benz E-Class, Nissan Maxima, Toyota Avalon, Volvo S40, Volvo S60, Volvo S80.

v. **Small Utility Vehicles (WARD categories: small cross/utility and small sport/utility)**
Chevrolet HHR, Chrysler PT Cruiser, Dodge Nitro, Honda Element, Hyundai Tucson, Jeep Compass, Jeep Liberty, Jeep Patriot, Jeep Wrangler, Kia Sportage, Land Rover LR2, Mercury Mariner, Saab 95, Suzuki Grand Vitara.

vi. **Mid-Sized Utility Vehicles (WARD categories: middle cross/utility and middle sport/utility)**
Chevrolet Equinox, Chevrolet Trailblazer, Dodge Journey, Ford Edge, Ford Escape, Ford Explorer, GMC Envoy, GMC Terrain, Honda CR-V, Honda Crosstour, Honda Pilot, Hyundai Santa Fe, Hyundai Veracruz, Isuzu Ascender, Jeep Commander, Jeep Grand Cherokee, Kia Borrego, Kia Rondo, Kia Sorento, Land Rover LR3, Mazda 5, Mazda CX-7, Mazda Tribute, Mitsubishi Endeavor, Mitsubishi Outlander, Nissan Murano, Nissan Pathfinder, Nissan Rogue, Nissan Xterra, Pontiac Torrent, Saturn Vue, Subaru B9 Tribeca,

Subaru Forester, Subaru Outback, Suzuki XL7, Toyota 4 Runner, Toyota FJ Cruiser, Toyota Highlander, Toyota RAV4, Toyota Venza, Volkswagen Tiguan.

vii. **Large Utility Vehicles (WARD categories: large cross/utility and large sport/utility)**
Buick Enclave, Chevrolet Suburban, Chevrolet Tahoe, Chevrolet Traverse, Chrysler Aspen, Dodge Durango, Ford Expedition, Ford Flex, Ford Freestyle, Ford Taurus X, GMC Acadia, GMC Envoy XL, GMC Yukon, Mazda CX-9, Mitsubishi Montero, Nissan Armada, Saturn Outlook, Toyota Sequoia.

viii. **Luxury Utility Vehicles (WARD categories: small luxury cross/utility, middle luxury cross/utility, large luxury cross/utility, luxury middle sport/utility, and luxury large sport/utility)**
Acura MDX, Acura RDX, Acura ZDX, Audi Q5, Audi Q7, BMW X3, BMW X5, BMW X6, Buick Rainier, Buick Rendezvous, Cadillac Escalade, Cadillac SRX, Chrysler Pacifica, Hummer 4-PSGR Wagon, Hummer H2, Hummer H3, Infiniti EX, Infiniti FX35, Infiniti FX45, Infiniti FX50, Infiniti QX56, Land Rover LR4, Land Rover Range Rover, Lexus GX, Lexus LX, Lexus RX, Lincoln MKT, Lincoln MKX, Lincoln Navigator, Mercedes-Benz G-class, Mercedes-Benz GL-class, Mercedes-Benz GLK, Mercedes-Benz M-class, Mercedes-Benz R-class, Mercury Mountaineer, Porsche Cayenne, Saab 9-7X, Subaru Tribeca, Toyota Land Cruiser, Volkswagen Touareg, Volvo XC60, Volvo XC70, Volvo XC90.

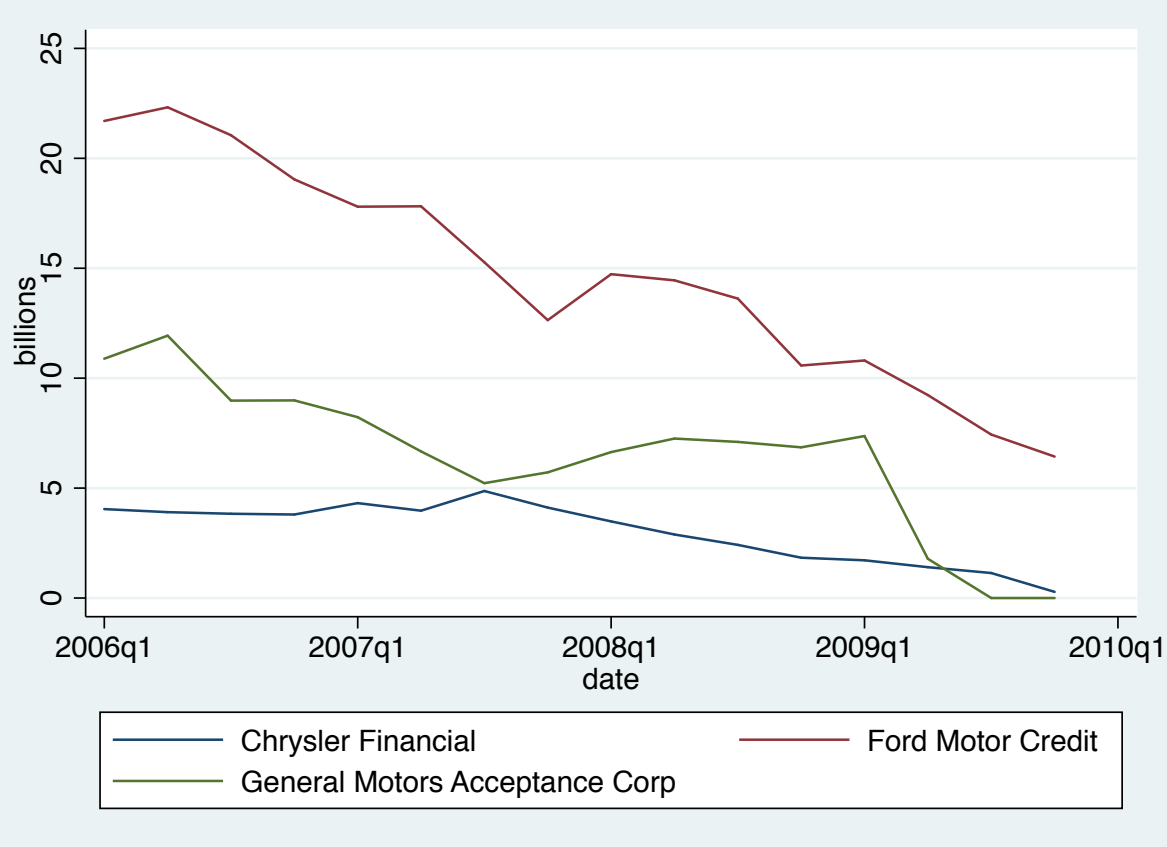

Figure 1. Outstanding Issuances of Asset-Backed Commercial Paper. Outstanding stock asset-backed commercial paper issued by three captive finance companies, 2006 Q1–2009 Q4. Source: Moody's Investor Services.

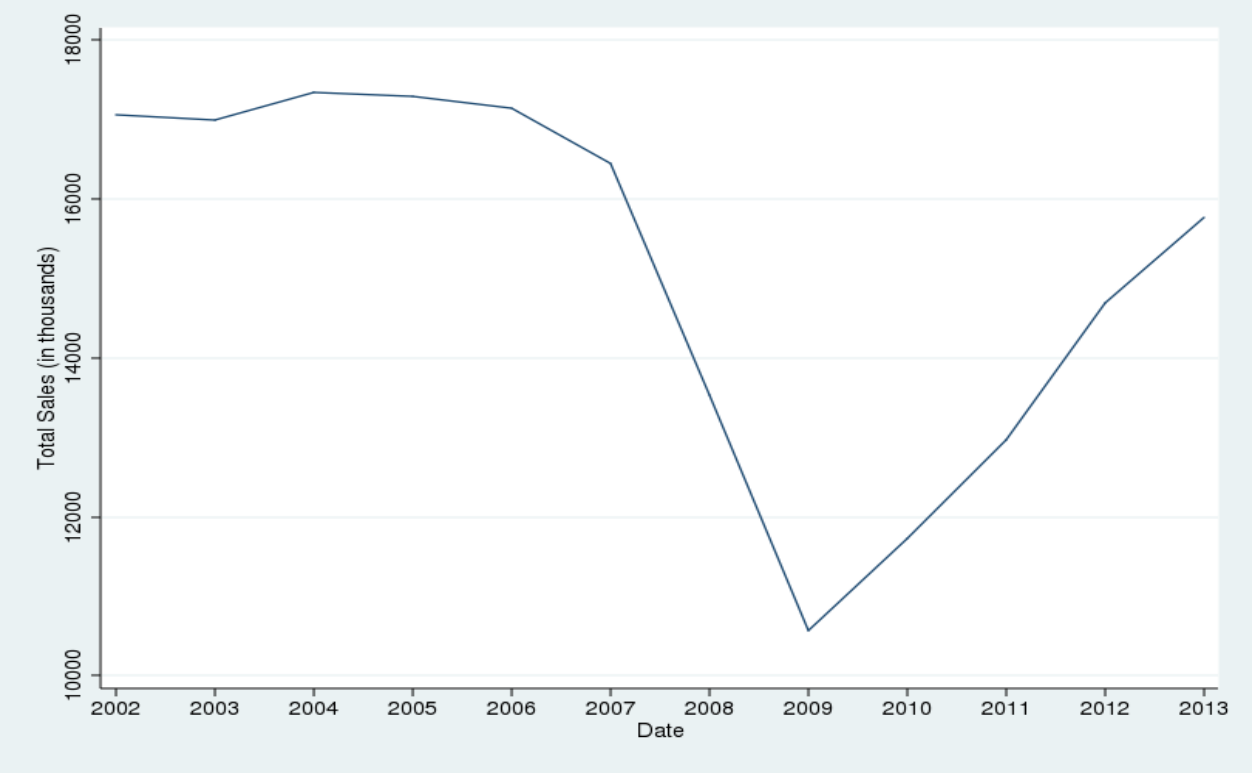

Figure 2a. Total Car Sales, 2002–2013. Total annual car purchases in Polk.

Figure 2b: Total Retail Car Sales, 2002–2013. Retail car sales are the sum of retail leases and retail purchases in Polk.

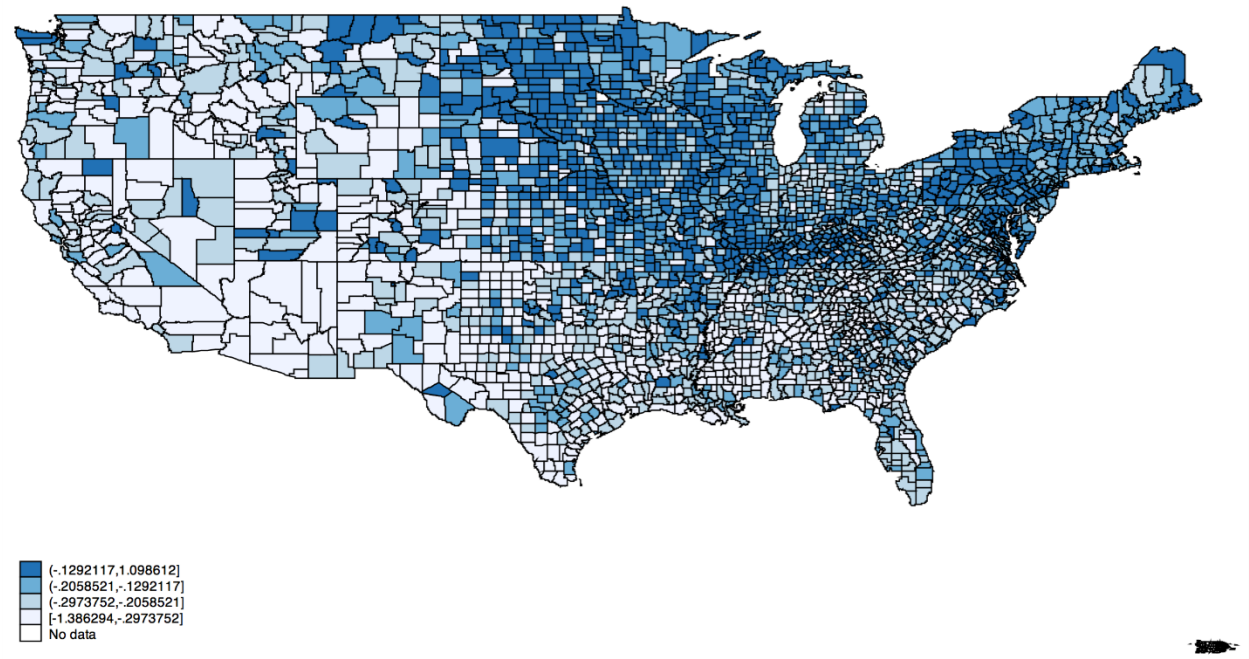

Figure 3: County-Level Change in Retail Car Sales, 2009–2008. Retail car sales are the sum of retail leases and retail purchases in Polk.

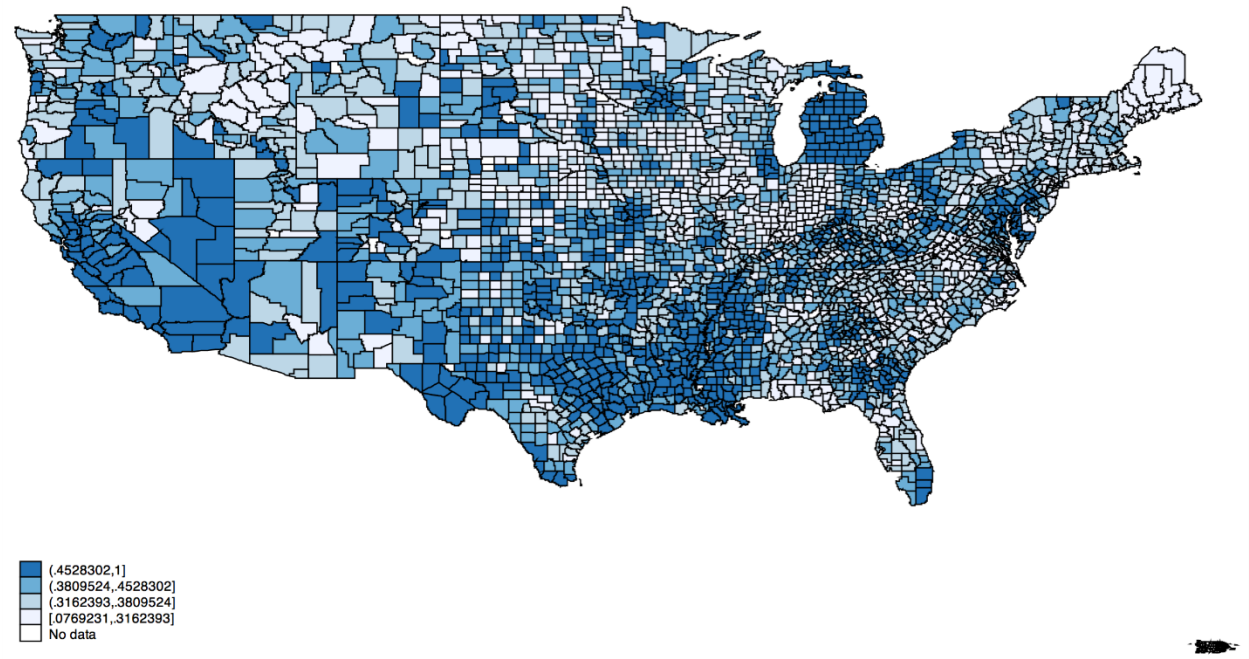

Figure 4. County-Level Share of Retail Cars Financed by Captives in 2008Q1. Retail car sales are the sum of retail leases and retail purchases in Polk.

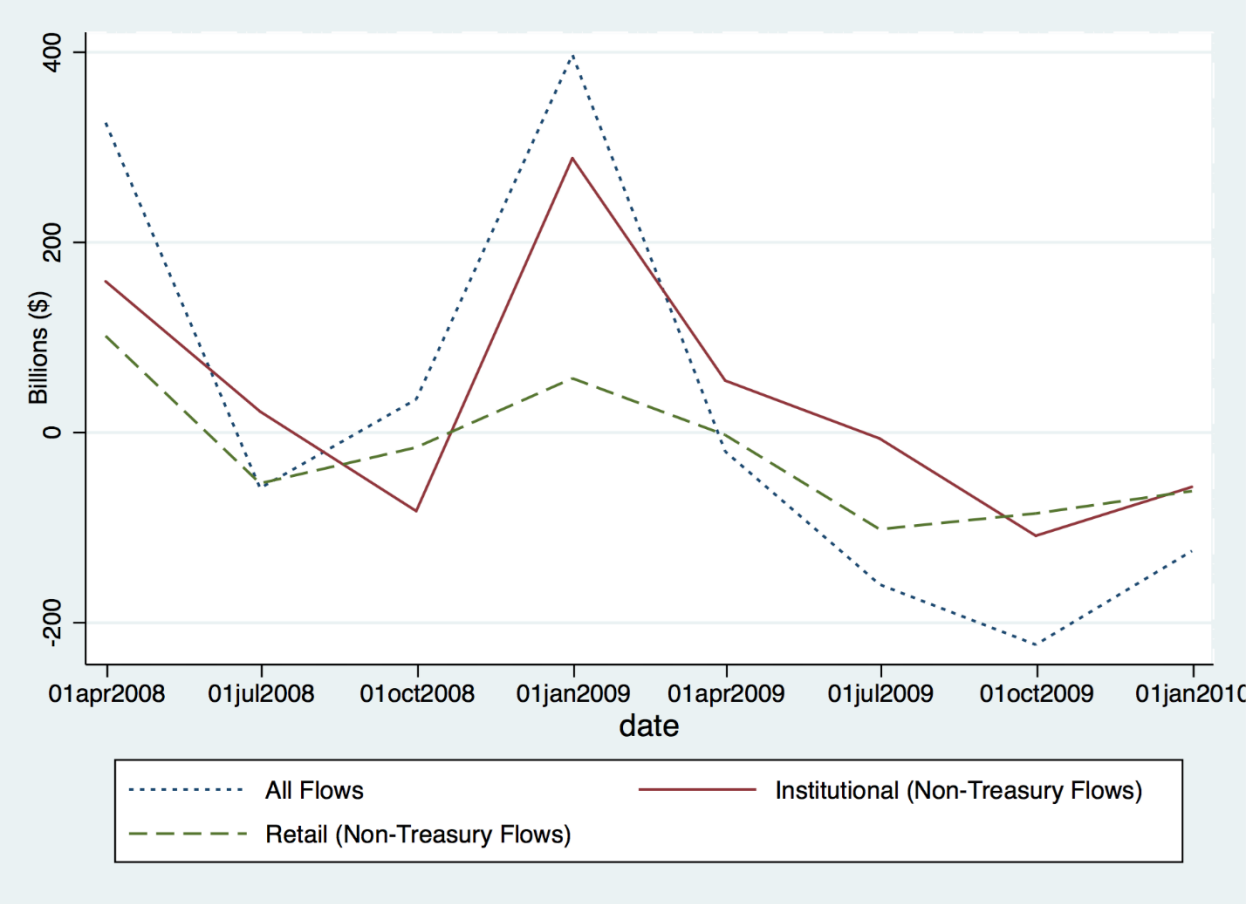

Figure 5. Quarterly Net Flows to Money Market Funds, 2008–2009. Flows are calculated using data from Flow of Funds.

Table 1. Market Share of the Financial Intermediaries in the Supply of Consumer Credit

This table lists the market share of various sources of consumer credit before, in, and after the financial crisis. Panel A reports the market shares for total installment credit. Panel B reports the market share for the subset of auto loans. Consumer credit data are taken from the Flow of Funds.

A. Total Consumer Installment Credit (%)

	By holder			By originator		
	2005	2009	2010	2005	2009	2010
Credit Unions	13.9	12.9	12.2	13.9	12.9	12.2
Commercial Banks	27.4	31.4	33.2	28.3	32.1	33.2
Finance Companies	47.8	45.2	38.1	41.8	37.9	35.5

B. Auto Loan Market Share (%)

	2005	2009	2010
Credit Unions	20.8	23.6	24.1
Commercial Banks	24.1	32.6	37.0
Finance Companies	51.3	41.3	36.7

Table 2. Automobile Captives and Commercial Paper, 2005

This table lists the percentage of commercial paper in all liabilities (bank loans, notes, bonds, and debentures, debt due to parent firm, and other liabilities excluding equity and retained earnings) in 2005 for four major automobile captives operating in the United States. The data are supervisory and non-public.

Captive	1	2	3	4
Share of Commercial Paper	66.67	45.91	10.23	75.12

Table 3. Summary Statistics of County-Level Retail Sales

This table presents the summary statistics for retail car sales across all counties for each year. Retail sales are the sum of retail purchases and retail leases in Polk. The sample period is 2002 to 2013.

Year	Mean	Standard Deviation	Min	25th Percentile	Median	75th Percentile	Max
2002	4,210	14,323	2	343	886	2,464	420,627
2003	4,251	13,945	1	340	868	2,485	420,561
2004	4,173	14,269	1	347	875	2,508	443,374
2005	4,096	14,343	2	331	845	2,405	456,466
2006	3,996	14,082	2	327	820	2,360	443,677
2007	3,866	13,331	1	321	808	2,332	409,445
2008	3,168	10,651	3	273	678	1,931	314,265
2009	2,563	8,334	2	219	528	1,553	235,562
2010	2,771	9,115	1	237	565	1,664	259,567
2011	3,113	10,045	3	280	667	1,926	287,269
2012	3,553	11,945	3	313	746	2,191	367,536
2013	3,881	13,342	3	329	795	2,343	417,487

Table 4a. Correlations between Car Sales Changes and County Characteristics.

This table reports the simple correlations between the county-level changes in car sales observed between 2009 and 2008 and county characteristics. Population Density is measured as county population dividend by county area in square miles. Percentage African American is the total African American population divided by total population. Employment in automobile sector is number of employees in the automobile sector divided by total employment. Population, county area, median household income, Gini coefficient, poverty rate, African American population, and White population are taken from the American Community Survey. County-level unemployment rates are taken from the BLS. Employees in automobile sector and total employment are taken from the Quarterly Census of Employment and Wages (QCEW).

Correlation with 2009–2008 changes	
Population Density	0.04**
Log(Median Household Income, log	0.11***
Gini Coefficient	-0.08***
Poverty Rate	-0.18***
Percentage African American	-0.14***
Employment in Automobile Manufacturing	0.02
Unemployment Rate (2008)	-0.05*

***, **, * denotes significance at the 1%, 5%, and 10% levels, respectively.

Table 4b. Car Sales Changes and County Characteristics.

This table reports the regression results of regression county-level car sales changes observed between 2009 and 2008 on county characteristics. Population Density is measured as county population dividend by county area in square miles. Percentage African American is the African American population divided by population. Employment in automobile sector is number of employees in the automobile sector divided by total employment. Population, county area, median household income, Gini coefficient, poverty rate, African American population, and White population are taken from the American Community Survey. County-level unemployment rates come from the BLS. Employees in automobile sector and total employment are taken from the Quarterly Census of Employment and Wages (QCEW).

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Population Density	3.04e-06*							2.95e-06**
	(1.60e-06)							(1.42e-06)
Median Income, log		0.062***						-0.0857***
		(0.012)						(0.0252)
Poverty Rate			-0.004***					-0.00606***
			(0.0005)					(0.00118)
Percentage African American				-0.141***				-0.102***
				(0.0166)				(0.0259)
Gini Coefficient					-0.325***			0.133
					(0.0898)			(0.125)
Employment in Automobile Manufacturing						0.213*		0.107
						(0.129)		(0.140)
Unemployment Rate (2008)							-0.004**	0.00263
							(0.0017)	(0.00186)
Observations	3,108	3,108	3,108	3,108	3,108	3,103	2,550	2,546
R-squared	0.001	0.011	0.032	0.020	0.007	0.000	0.003	0.043

***, **, * denotes significance at the 1%, 5%, and 10% levels, respectively.

Table 5. GMAC Financing

This table presents the market shares of GMAC in retail and wholesale financing of GM car sales. Column (1) reports the percent of dealer floor plan financing supplied by GMAC. Column (2) reports the percent of GM sales—in units—financed by GMAC. The financing shares are taken from GMAC 10-Ks.

Year	GMAC Floorplan Financing—Percentage of GM Dealers	GMAC Consumer Automobile Financing—Percentage of GM Sales
2005	82	36
2006	80	38
2007	82	35
2008	81	32
2009	78	20

Table 6. Summary Statistics

This table presents the summary statistics for county characteristics used in the empirical analysis. Captive dependence is the market share of captive finance companies in a county as of 2008:Q1. Population, county area, median household income, Gini coefficient, poverty rate, African American population, and White population are taken from the American Community Survey. Employees in automobile sector and total employment are taken from the Quarterly Census of Employment and Wages (QCEW).

Variable	Mean	Standard Deviation	Min	25th Percentile	Median	75th Percentile	Max
Captive Dependence	0.39	0.1	0.08	0.32	0.38	0.45	1
County Area, log	6.42	1	0.69	6.04	6.4	6.82	11.89
Population, log	10.25	1.45	4.36	9.32	10.16	11.06	16.09
Median Income, log	10.64	0.29	9.33	10.49	10.64	10.79	11.65
African American Population, log	6.78	2.59	0	4.92	6.95	8.71	14.11
White Population, log	10.04	1.45	3.04	9.12	9.99	10.92	15.42
Gini Coefficient	0.43	0.04	0.21	0.41	0.43	0.46	0.65
Employment in Automobile Sector, share	0.004	0.01	0	0	0	0.0003	0.19

Table 7. Captive Dependence and Captive Sales

This table reports the regression results of estimating Eq. (1). The dependent variable is the log number of cars financed by captives in 2009 as reported in Polk (columns 1-4). The dependent variable in column 5 is the log value of non-durable goods consumption. Captive dependence is the market share of captive finance companies in a county as of 2008:Q1. Population Density is measured as county population dividend by county area in square miles. Percentage African American is the African American population divided by population. Employment in automobile sector is number of employees in the automobile sector divided by total employment. Population, county area, median household income, Gini coefficient, poverty rate, African American population, and White population are taken from the American Community Survey. County-level unemployment rates are taken from the BLS. Employees in automobile sector and total employment are taken from the Quarterly Census of Employment and Wages (QCEW). Household leverage is the debt-to-income ratio (Federal Reserve Bank of New York). House price change is the change in the house price index (CoreLogic). All variables are defined in Appendix A.

	(1)	(2)	(3)	(4)
Variables	No controls	Economic and demographic controls	Unemployment and leverage	House prices
Captive dependence	-0.635***	-0.469***	-0.620***	-0.603***
	(0.0630)	(0.0905)	(0.0997)	(0.103)
Log number of cars financed in 2008	1.003***	0.902***	0.963***	1.009***
	(0.0039)	(0.0905)	(0.0209)	(0.0290)
County area, log		-0.00165	-0.0123	-0.0120
		(0.00534)	(0.00788)	(0.00809)
Population, log		0.126***	0.0789*	0.0784*
		(0.0318)	(0.0445)	(0.0451)
Median income, log		0.0982***	0.0999**	0.0912**
		(0.0242)	(0.0409)	(0.0405)
African American population, log		0.0108***	0.00733	0.00820
		(0.00347)	(0.00586)	(0.00600)
White population, log		-0.0330	-0.0862**	-0.0900***
		(0.0300)	(0.0322)	(0.0317)
Gini Coefficient		0.378***	0.467***	0.456***
		(0.138)	(0.138)	(0.133)
Employment in automobile sector, share		-0.334	-0.431*	-0.391*
		(0.269)	(0.235)	(0.233)
Unemployment rate			0.000129	-0.000246
			(0.00431)	(0.00416)
Household leverage, 2006			-0.00361	0.00353
			(0.0139)	(0.0129)
House price change				0.252**
				(0.109)
State Fixed Effect	Yes	Yes	Yes	Yes
Observations	3,082	2,849	979	958
R-squared	0.986	0.988	0.994	0.994

Standard errors are clustered at the state level. ***, **, * denotes significance at the 1%, 5%, and 10% levels, respectively.

Table 8. Robustness: Cash Sales Placebo and Auto Industry Employment

This table reports the regression results of estimating Eq. (1). The dependent variable in Column (1) is the log number of cars bought with cash in 2009 as reported in Polk. The dependent variable in Column (2) is the log of the dollar amount of aggregate consumer expenditure at the county level in 2009 calculated by Nielsen. The dependent variable in Columns (3) and (4) is the log number of cars financed by captives in 2009 as reported in Polk. Captive dependence is the market share of captive finance companies in a county as of 2008:Q1. Population density is measured as county population dividend by county area in square miles. Percentage African American is the African American population divided by population. Employment in automobile sector is number of employees in the automobile sector divided by total employment. Population, county area, median household income, Gini coefficient, poverty rate, African American population, and White population are taken from the American Community Survey. Employees in automobile sector and total employment are taken from the Quarterly Census of Employment and Wages (QCEW).

	(1)	(2)	(3)	(4)
Dependent Variable	Cash Sales	Nielsen Consumer Expenditure	Captive Sales Counties without auto industry employment	Captive Sales Counties with auto industry employment
Captive dependence	-0.00627	-0.00200	-0.476***	-0.556***
	(0.0729)	(0.0217)	(0.0928)	(0.132)
Log Number of Sales 2008	0.802***	0.000769	0.887***	0.967***
	(0.0285)	(0.00281)	(0.0293)	(0.0308)
County area, log	-0.00373	0.0160	-0.000987	-0.00348
	(0.0105)	(0.0158)	(0.00597)	(0.00853)
Population, log	0.121**	-0.0392***	0.130***	0.0861*
	(0.0521)	(0.0119)	(0.0401)	(0.0497)
Median income, log	0.153***	0.00396*	0.0726**	0.139***
	(0.0432)	(0.00230)	(0.0284)	(0.0352)
African American population, log	-0.00392	-0.0163	0.0105**	0.00941
	(0.00426)	(0.0139)	(0.00432)	(0.00690)
White population, log	0.0813**	-0.0532	-0.0257	-0.0608
	(0.0391)	(0.0544)	(0.0331)	(0.0447)
Gini Coefficient	0.282	0.106	0.324*	0.584***
	(0.205)	(0.125)	(0.173)	(0.162)
Employment in automobile, share	-0.146	-0.00200		
	(0.162)	(0.0217)		
State Fixed Effect	Yes	Yes	Yes	Yes
Observations	2,848	2,370	2,003	846
R-squared	0.986	0.989	0.975	0.994

Standard errors are clustered at the state level. ***, **, * denotes significance at the 1%, 5%, and 10% levels, respectively.

Table 9. Captive Dependence and Aggregate Effects.

This table reports regression results of estimating Eq. (1). The dependent variable in Column (1) is the log number of cars financed by non-captives in 2009. The dependent variable in Column (2) is the log number of cars sold inside the county in 2009. Captive dependence is the market share of captive finance companies in a county as of 2008:Q1. The demographic controls are as the same as in Column (2) of Table 7. All variables are defined in Appendix A.

	(1)	(2)
Dependent variable	Substitution	Aggregate
Captive Dependence	0.149**	-0.193***
	(0.0631)	(0.0533)
Log Number of Cars Financed in 2008	0.859***	0.892***
	(0.0281)	(0.0229)
Demographic Controls	Yes	Yes
State Fixed Effects	Yes	Yes
Observations	2,848	2,849
R-squared	0.992	0.994

Standard errors are clustered at the state level. ***, **, * denotes significance at the 1%, 5%, and 10% levels, respectively.

Table 10. Cash Sales Versus Financed Cars: A Decomposition of the Home Price and Household Leverage Channels.

This table reports regression results of estimating Eq. (1). The dependent variable in Column (1) is the log number of cars that were financed by captives and sold inside the county in 2009. Column (2) is the log number of cars bought with cash in 2009 as reported in Polk. The dependent variable in Column (3) is the log number of cars sold inside the county in 2009. Captive dependence is the market share of captive finance companies in a county as of 2008:Q1. The demographic controls are as the same as in Column (4) of Table 7. All variables are defined in Appendix A.

	(1)	(2)	(3)
Dependent Variable	Financed cars	Cash sale Cars	Aggregate sales
Captive dependence	-0.603***	0.0637	-0.249***
	(0.103)	(0.127)	(0.0530)
Log number of cars financed	1.009***		
in 2008		0.887***	0.951***
	(0.0290)	0.0637	(0.0246)
Unemployment rate	-0.000246	-0.00536	-0.00194
	(0.00416)	(0.00696)	(0.00237)
Household leverage, 2006	0.00353	0.0298**	0.0131*
	(0.0129)	(0.0128)	(0.00742)
House price change	0.252**	0.489***	0.366***
	(0.109)	(0.139)	(0.0672)
Demographic Controls	Yes	Yes	Yes
State Fixed Effect	Yes	Yes	Yes
Observations	958	958	958
R-squared	0.994	0.991	0.997

Standard errors are clustered at the state level. ***, **, * denotes significance at the 1%, 5%, and 10% levels, respectively.

Table 11. Money Market Flows, Captive Dependence, and Car Sales

This table reports the results of estimating Eq. (2). The dependent variable is the quarterly growth in the number of captive-financed transactions in county over the period 2008 Q2: 2009 Q4. Captive dependence is defined as the fraction of retail car purchases financed by captive in 2008 Q1. Money market fund (MMF) flows are net inflows to the respective fund category. Quarterly money market fund flow data are taken from the Flow of Funds. The demographic controls are as the same as in Column (2) of Table 7.

	(1)	(2)	(3)
Variables	All MMFs	Non-Treasuries Institutional MMF Flows	Non-Treasuries Retail MMF Flows
Captive Dependence	-0.296***	-0.238***	-0.247***
	(0.0482)	(0.0232)	(0.0335)
Captive Dependence * All MMF Flows	0.0366*		
	(0.0211)		
Captive Dependence * Institutional MMF Flows		0.0227**	
		(0.00927)	
Captive Dependence * Retail MMF Flows			0.00480
			(0.00452)
MMF flows	Yes	Yes	Yes
Demographic Controls	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes
Quarter Fixed Effect	Yes	Yes	Yes
State Fixed Effect	Yes	Yes	Yes
Observations	19,883	19,883	19,883
R-squared	0.451	0.432	0.444

Standard errors are clustered at the state level. ***, **, * denotes significance at the 1%, 5%, and 10% levels, respectively.

Table 12. Within-Make Effects of Captive Financing on Auto Sales

This table presents the regression results of Eq. (1) for GM, Ford, and Toyota, respectively. The dependent variable in Column (1) is the change in GMAC-financed GM sales. Column (2) is the change in non-GMAC-financed GM sales. Column (3) is the change in all GM sales. In Column (4), the dependent variable is the change in Ford Motor Credit (FMC)-financed Ford sales. Column (5) is the change in non-FMC-financed Ford sales. Column (6) is the change in all Ford sales. The dependent variable in Column (7) is the change in all Toyota Motor Credit (TMC)-financed Toyota sales. Column (8) is the change in all non-TMC-financed Toyota sales. Column (9) is the change in all Toyota sales. GMAC dependence, FMC dependence, and TMC dependence are the 2008:Q1 market shares of GMAC, FMC, and TMC, respectively, in a particular county. In all cases, the share of the make in total county sales is included as a regressor along with the demographic controls in Column (2) of Table 7. All changes are defined as the percentage change in 2009 over 2008.

Variables	(1) GMAC Financed Sales	(2) Substitution: GMAC	(3) All GM Sales	(4) FMC Financed Sales	(5) Substitution: FMC	(6) All Ford Sales	(7) TMC Financed Sales	(8) Substitution: TMC	(9) All Toyota Sales
GMAC Dependence	-0.119***	0.0618***	-0.0133*						
	(0.0309)	(0.0145)	(0.00744)						
FMC Dependence				-0.0969***	0.0974***	-0.0244*			
				(0.0200)	(0.0244)	(0.0127)			
TMC Dependence							-0.0511**	-0.0299	-0.0350**
							(0.0235)	(0.0213)	(0.0136)
Make Market Share	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,811	2,814	2,808	2,767	2,771	2,764	2,579	2,717	2,754
R-squared	0.244	0.312	0.228	0.243	0.338	0.247	0.230	0.165	0.163

Standard errors are clustered at the state level. ***, **, * denotes significance at the 1%, 5%, and 10% levels, respectively.

Table 13. Make-County Panel Regressions

This table reports the results of estimating Eq. (3). The makes are Ford, GM, Honda, and Toyota. The dependent variable in Column (1) is the log number of cars financed by the automaker's captive arm in 2009 within a county, and Column (1) controls for the log number of cars financed by the automaker's captive arm in 2008 within the county. The dependent variable in Column (2) is the log number of cars not financed by the automakers' captive arms, and Column (2) controls for the log number of cars not financed by the automaker's captive arm in 2008. Column (3) is the log number of all sales inside the county in 2009, and Column (3) controls for the log number of all sales in 2008. The dependent variable in Column (4) is the log number of all sales by a make in each of eight segment (small cars; mid-sized cars; large cars; luxury cars; small utility vehicles; mid-sized utility vehicles; large utility vehicles; and luxury utility vehicles; for details on the segments, see Appendix B) within a county in 2009; the log number of sales in 2008 are included as a control variable. Market share is the fraction of cars sold by the make in 2008:Q1 in the county. Column (4) measures market share as the fraction of cars sold by the make within the segment in the county.

Variables	(1) captive transactions	(2) substitution: non-captive transactions	(3) all transactions	(4) all transactions segments
Captive Dependence	-0.306***	0.0357	-0.0189*	-0.0165**
	(0.0323)	(0.0325)	(0.0101)	(0.007)
Log Number of Cars Financed in 2008	Yes	Yes	Yes	Yes
Market Share	Yes	Yes	Yes	Yes
Make Fixed Effect	Yes	Yes	Yes	Yes
County Fixed Effect	Yes	Yes	Yes	No
County-Segment Fixed Effect	No	No	No	Yes
Observations	11,526	11,546	11,624	33,844
R-squared	0.363	0.486	0.408	0.94

Standard errors are clustered at the state level. ***, **, * denotes significance at the 1%, 5%, and 10% levels, respectively.

Table 14. Bank Funding and Auto Loan Growth

This table presents the results of bank-level auto loan growth regressions. The dependent variable in Column (1) is the log number of cars financed by a particular bank in 2009. The dependent variable in Column (2) is the log average annual number of cars financed by a particular bank between 2010 and 2013. Log number of cars financed is the log of all cars financed by a particular bank. Assets is total bank assets. Wholesale deposits are total uninsured deposits. Loans is total loans. Real estate loans are total loans backed by real estate. Unused commitments ratio is total unused commitments divided by total commitments (total unused commitments and total loans). Leverage ratio is tier 1 equity divided by total assets.

	(1)	(2)
Variables	2009	2010-2013
Log Number of Cars Financed in 2009		0.809***
		(0.0243)
Assets, log	0.0477**	0.343***
	(0.0235)	(0.0356)
Wholesale Deposits/Assets, 2006	-0.397*	-0.774***
	(0.231)	(0.218)
Loans/Assets, 2006	0.176	0.135
	(0.138)	(0.167)
Real Estate Loans/Loans, 2006	-0.251*	-1.549***
	(0.129)	(0.173)
Unused Commitments Ratio, 2006	-0.456	-1.228**
	(0.351)	(0.502)
Leverage Ratio, 2006	-0.161	0.685*
	(0.292)	(0.382)
Log Number of Cars Financed in 2008	Yes	Yes
Observations	1,534	1,534
R-squared	0.765	0.700

Heteroskedasticity-robust standard errors in parentheses. ***, **, * denotes significance at the 1%, 5%, and 10% levels, respectively.

Table 15. The Recovery and Securitization, Quarterly growth in sales, 2010-2013

This table reports the results of estimating Eq. (2). The dependent variable is the quarterly growth in the number of captive-financed transactions in county over the period 2010 Q1: 2013 Q4. Captive dependence is defined as the fraction of retail car purchases financed by captive in 2008 Q1. Big bank dependence is the fraction of retail purchases financed by the 20 largest banks—in terms of asset size—in 2008 Q1. Small bank dependence is the fraction of retail purchases financed by all other banks in 2008 Q1. The A (BBB) spread is the spread between the A(BBB)-rated tranche of auto ABS over the corresponding two year interest rate swap. The demographic controls are as the same as in Column (2) of Table 7.

	(1)	(2)	(3)
Variables	captives	captives and banks	captives and banks: BBB spread
captive dependence	0.0604**	0.0607*	0.0878***
	(0.0280)	(0.0319)	(0.0266)
captive dependence*A spread	-0.000475*	-0.000457	
	(0.000254)	(0.000285)	
big bank dependence		-0.0113	-0.0183
		(0.0445)	(0.0380)
big bank dependence*A spread		0.000208	
		(0.000385)	
small bank dependence		0.0186	0.0279
		(0.0511)	(0.0590)
small bank dependence*A spread		-0.000125	
		(0.000458)	
captive dependence*BBB spread			-0.000398***
			(0.000131)
big bank dependence*BBB spread			0.000154
			(0.000191)
small bank dependence*BBB spread			-0.000118
			(0.000292)
Observations	45,672	45,672	45,672
R-squared	0.132	0.132	0.139