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

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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.

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

[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).

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 micro level 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 micro level 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 captive dependence is associated with a 1.4 percentage point or 0.1 standard deviation decline in the growth in new car transactions over the 2009-2008 period. This point estimate implies that even with the unprecedented interventions aimed at unfreezing short term funding markets in 2008 and 2009, as well as the bailout of the US automakers and their financing arms, the liquidity shock to captive financing capacity might explain about 31 percent of the drop in car sales in 2009 relative to 2008. Conversely, without these interventions, illiquidity in funding markets could have precipitated an even steeper collapse in car sales.

Captives tended to serve lower credit quality borrowers—the very borrowers identified as most affected by the Great Recession. There is compelling evidence for example that these borrowers may have suffered the sharpest increases in unplanned leverage from the collapse in house prices, reducing their demand for automobiles and other durable goods (Mian and Sufi

(2014)). These borrowers are also more likely to face a contraction in their credit limits imposed by other lenders, such as credit card companies. And rather than reflecting the effects of diminished captive financing on account of illiquidity in short-term funding markets, these results could reflect a more general contraction in credit to more risky borrowers.

To address this challenge to causal inference, we show that our county-level results are robust to the inclusion of most common proxies for household demand: house prices; household leverage; household net worth, and even less specific measures like unemployment (Mian and Sufi (forthcoming)). We also find evidence of substitution: Sales financed by non captive 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.

Next, the richness of our data and, in particular, the availability of make-segment data allow us to address further county-level omitted variables concerns. That is, even within the same make, manufactures 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. And the effects of the Great Recession on the likely buyers of Chevrolets were probably very different than potential buyers of Cadillacs, even for those living in the same county. We can thus use county-segment fixed effects to non-parametrically control for differences in demand within a county across different model segments. Our results remain unchanged.

There are however limits to these non-parametric controls. And the level of aggregation at the county-level could still lead to biased estimates because of unobserved differences in borrower credit quality between captive financiers and other creditors. Therefore, we next use data from the Equifax panel for about three million individuals to gauge the robustness of these results. The Equifax panel includes the dynamic FICO score of the borrower along with age, automotive, mortgage and other credit usage measures. In the case of automotive debt, the dataset also identifies whether credit was obtained from a captive lender or other – non-captive – lenders. Therefore, while Equifax does not provide as a rich a set of information about the car purchase as the county level dataset, it directly address concerns about borrower credit quality,

credit access and latent demand among users of captive relative to other sources of automotive credit.

Holding constant FICO scores, homeownership status and other observables, we find significant evidence that for borrowers living in counties more traditionally dependent on captive financing, the probability of obtaining captive credit fell sharply over the 2008-2009 period, becoming zero in late 2009. Falsification tests reveal no similar pattern for either mortgage or revolving lines of credit. If anything, non-automotive credit access actually improved in these counties as the economy exited the recession in the second half of 2009. There is also no evidence of a significant decline in the pre-crisis period either.

Last, we hand merge our car sales data to the bank call to identify further how the supply of short-term funding might shape car sales. Notably, like captives, some large banks incurred sizable losses due to their ABCP conduits. And this use of the data allows us to study how these bank-level losses might have affected the supply of bank automotive credit at the extensive margin, without relying on the county-level variation in captive dependence. We find that car credit fell more sharply at those banks more exposed to these markets before the crisis. These effects are especially large after regulatory changes forced many banks to bring these exposures onto their balance sheets.

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 (2015; 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.[4] 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.

[4] 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.[10] Vertically integrated captives were also less encumbered by moral objections to consumer spending, especially on cars.[11] 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,

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

[11] 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.[12]

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

[12] 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.[13]

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

[13] 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).[14] 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.[15] 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

[14] 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).

[15] 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.*[16]

[16] 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.*[17]

> *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.*[18]

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 finance*

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

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

companies (including manufacturers' captive finance companies).[19]

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.[20]

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.[21] 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

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

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

[21] 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.

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, 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. Also, since the credit quality of borrowers might be important for car sales, we include the median credit score in the county in 2008 Q1 from Trans Union.

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; similarly, the correlation is also positive for counties with more creditworthy borrowers. 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). 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. The median credit score in the county, and the unemployment rate appear to be significantly related to the change in car sales over this period.

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 construct a measure of a county's dependence on captive financing. For most of the analysis, 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. 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. 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, this approach to measuring captive dependence could also more generally proxy for credit usage and income within a county. If high income households disproportionately self-finance their new car purchases, then the ratio of captive financed transactions to all transactions might be lower in higher income counties. Conversely, in counties where buyers are

poorer and rely more on automotive credit to help buy cars, the ratio of captive financed transactions to all retail transactions might be higher. But these less affluent counties were also hit harder by the recession and may have seen a steeper drop in demand. Thus, our baseline approach to measuring captive dependence could mechanically conflate the effects of the hypothesized captive credit shock with borrower demand.

The timing of our baseline measure of captive dependence could also affect inference. The earliest available data from Polk that contain lender information are for the first quarter of 2008. But since disruptions in short term funding markets had already begun at least two quarters earlier, a 2008 Q1 based measure of dependence could itself 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. Also, because the baseline dependence measure is based on Q1 2008 data, seasonality in the provision of credit across lenders could lead to inaccurate estimates of a county's captive dependence.

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 pre-crisis 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.

We obtain additional data from Equifax in order to supplement our Polk-based baseline county-level captive dependence measure. Equifax, one of the three major credit bureaus, collects data on the liabilities of individuals, including their car purchases, and in the version of the dataset available to us, it identifies whether the source of automotive credit is a captive financier along with the zip code of the borrower. These data available quarterly and extend back

to 2006 which enables us to construct measures of captive-dependence at least two years before the outset of the financial crisis.[22] We draw a 10 percent random sample from Equifax which yields a panel of about three million households. As Figure 5 demonstrates, the quarterly growth in car sales derived from either Polk or Equifax are very similar.

We aggregate the Equifax data at the county level and create two measures of captive dependence using the Equifax data. These measures include: (1) the ratio of captive financed transactions to all financed transactions in the county in 2008 Q1 which corresponds to the time period in the baseline Polk measure, and (2) the ratio of captive financed transactions to all finance transactions during 2006. Table 6A reports the summary statistics for the two Equifax-based measures of captive dependence (Columns 1 and 2); the baseline Polk derived variable (Column 3); and the ratio of captive to all financed transactions, derived from Polk (Column 4) along with a panoply of key control variables.

The basic summary statistics suggest that captive lessors account for about 40 percent of all auto purchases (Column 3), and for about 52 percent of all financed purchases (Column 4). The dependence measures derived from Equifax are also very similar to each other as well those obtained using Polk, although the average incidence of captive leasing appears to be a little smaller in 2006 compared to that observed in 2008 Q1. The cross-sectional variation in all four variables is very similar. Table 6B reports the coefficient from regressing separately the Equifax 2008 Q1 measure of dependence separately on the other three alternative dependence variables, controlling for state fixed effects. These point estimates are nearly identical, and echoing this similarity, the robustness section shows that our baseline estimates are relatively unchanged across the alternative measures of captive dependence. We now present the baseline regressions.

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 immediately after the financial crisis. We begin with a simple test of the credit shock hypothesis by estimating the relation between captive dependence and captive auto sales at the county level, controlling for the factors most likely to affect the demand for automotive credit in the county. We estimate variants of the following baseline regression specification:

[22] Equifax does not list the name of the credit supplier.

$$\log(cars\ financed)_{2009,i} - \log\left(cars\ financed\right)_{2008,i} = \alpha_0 + \alpha_1 dependence_i + X_i\beta + S_i + e_i \quad (1)$$

where the dependent variable is the change in the number of cars financed by captives and other similar non-bank financial intermediaries—captives—in county i between 2009 and 2008. Our main explanatory variable is the county's dependence on captive financing. Throughout the paper we measure *dependence* in a number of different ways, but our baseline specifications use Polk data and we define *dependence* as the ratio of retail sales financed by captives to all sales in the county, observed in 2008 Q1—the earliest date for which Polk data identifies captive transactions.

All specifications also include state fixed effects (the vector $\boldsymbol{S}$) and most of our specifications also control for county-level economic and demographic variables that are included in the vector $\boldsymbol{X_i}$.[23] 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 variants of the model and displays standard errors (in parentheses) that are clustered at the state level; we also weight these county-level regressions by the population in the county circa 2009 {Autor:2013ca}.

Column (1) of Table 7 presents the results of regression (1) using only state fixed effects as controls in addition to the captive dependency measure based on Polk data. The coefficient on captive dependence is negative and significant at the 1% level, and suggests that the effect of captive financing dependence is economically sizable. A one standard deviation increase in captive dependence is associated with a 3.5 percentage points or 0.16 standard deviation decline in the growth in captive financed transactions. To put these magnitudes in further context, moving from a county at the 25th to the 75th percentile in captive dependence is associated with a 5 percentage drop in the growth of captive financed transactions during this period.

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

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

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.

Also, since captives might be more likely to serve lower credit quality borrowers, who in turn might have been more exposed to the Great Recession, we control for the median credit score in the county using data from Transunion. Because credit scores in a county might endogenously respond to any credit supply disruptions, as with the captive dependence variable, our baseline specification uses the median credit score observed in 2008 Q1—in the robustness section we show that these results are unchanged when using alternative measures of borrower credit quality.

Unobserved demand shocks are also potentially driven by the employment structure within a county. Most notably, in counties with strong employment links to the automotive sector, the demand for cars might endogenously vary with the health of that sector. At the same time, these counties might also have higher levels of captive dependence because of these automotive linkages. Figure 4 shows for example that 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, also have the largest share of captive-financed transactions in the United States. [25] We thus add the fraction of employment in the automotive sector as a control variable to the regression in Column 2.

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 increases somewhat in absolute value, from -0.35 to -0.53 and remains significant at the 1% level.[26] 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. Also, as one might expect, the credit quality of borrowers within a county is positively correlated with the growth in captive financed transactions. In unreported results – which are available upon request – we combine the 2005–2009 ACS with county-level data from

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

[26] The coefficient on captive dependence when estimating the regression in column 1 with the same sample as in column 2 is -0.35 (0.07).

the 2000 Census in order to compute the changes in median income, the poverty rate, population, and African American population within counties over time. Using the changes instead of the level of these socio-demographic control variables does not change the point estimate on the captive dependence variable.

We next incorporate household balance sheet control variables into our analysis. There is a burgeoning literature on the effect of home prices, household leverage and net worth on local demand and employment (see Mian and Sufi, forthcoming, 2011; and the broader discussion in Mian and Sufi, 2014b). Some of this literature has also directly connected car purchases to household level changes in debt service (DiMaggio, Kermani, and Ramcharan (2014), Keys et. al (2014)). And to the extent that our measure of captive dependence is correlated with the household balance-sheet driven demand channel, estimates of the dependence coefficient might be biased.

Column 3 of Table 7 adds the 2009 county-level unemployment rate as well the median debt to income ratio for households in a county in 2006, the latter variable kindly provided by Amir Sufi, to the control variables used in Column (2). These data are available for a smaller subsample of counties, reducing the sample size from 2,849 in Column (2) to 2,056 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 (2). Since unemployment and leverage might be highly correlated, in results available upon request, we include these variables in separate regressions; the results are unchanged.

House price dynamics was a chief catalyst behind the collapse in household demand, and 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. Including this variable further reduces the sample size, but as Column (4) of Table 7 demonstrates, our main finding is little changed. The house price change point estimate is positive, though imprecisely estimated, and suggests that a one standard deviation increase in house prices is associated with a 0.05 standard deviation increase in the growth in captive financed transactions. In results available upon request, we also include an interaction term between household leverage and house price changes in the county—our basic results remain unchanged.

Finally, we add the change in household net worth between 2006 and 2009 to the list of control variables in Column 5. Mian and Sufi (forthcoming) has shown that the deterioration in

household balance sheets, as measured by county-level changes in household net-worth, might have had a significant negative impact on local demand. Including this variable attenuates the sample size considerably, but our main results again remain unchanged. Having included a panoply of variables associated in the literature with the household demand channel, in what follows, we use the controls in Column 2 of Table 7 as part of our baseline specification.

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 8 using the same benchmark specification presented in Column (2) of Table 7.

Column (1) of Table 8 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 8 shows, the point estimate on captive dependence is now positive and statistically significant. In particular, a one standard deviation increase in captive dependence is associated with a 4.3 percentage point or 0.26 standard deviation increase in non-captive financed transactions in the county.

This change in sign—compared to the estimates for captive leasing in Table 7—suggests that as captives reduced their credit supply, other lenders may have provided alternative sources of credit. Some potential car buyers may have also used their own financial resources to substitute for the loss of captive credit, and column 2 uses as the dependent variable the growth in cash financed transactions in the county over this period. Consistent with a decline in the availability of captive credit, the captive point estimate is positive though imprecisely estimated (p-value=0.09), suggesting that disruptions in credit supply during the financial crisis may have also forced some car buyers to use cash outright.

This evidence for partial substitution from captive lessors to other financial intermediaries and self-financing 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 coefficients in Columns (1) and (2) would have been expected to be negative. Instead, the contrast in the sign of the captive dependence coefficients between Tables 7 and 8 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.

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 change in the number of all car sales in a county between 2009 and 2008, regardless of whether they were financed or the source of financing. As Column 3 of Table 8 demonstrates, the dependence coefficient is negative and statistically significant at the 1% level. A one standard deviation increase in captive dependence is associated with a 1.4 percentage point or 0.1 standard deviation decline in the growth in new car transactions over this period.

In order to gauge heuristically the economic impact of captive distress on aggregate car sales, for each county we multiply its dependence on captive financing by the captive dependence coefficient in Column 3. This product yields each county's predicted growth in total car sales, as determined by the county's degree of captive dependence. Multiplying this predicted growth rate by the level of sales in 2008 within the county gives the predicted change in units. Taking the sum across all counties suggests that the distress among captives might account for a drop of about 478,776 units in 2009 relative to 2008 sales; in our sample, 8.1 million cars were sold in 2008 and 6.5 million in 2009. This implies that even with the large scale federal interventions in short term funding markets in 2008 and 2009, as well as the bailout of the US automakers and their financing arms, the liquidity shock to captive financing capacity might explain about 31 percent of the drop in car sales in 2009 relative to 2008. Without these interventions to arrest illiquidity in funding markets, these estimates suggest that the collapse in car sales could have been even larger.

6.3.1 Captive dependence and aggregate auto sales--Robustness

In this subsection, we now consider a number of additional specifications to gauge the robustness of the negative relationship between captive dependence and aggregate car sales growth. These tests focus on alternative measures of captive dependence; alternative measures of

borrower credit quality; and also consider a number of different subsamples of counties.

We have noted that the ratio of captive financed transactions to all retail transactions in a county might proxy for a county's historic dependence on captive credit for automotive transactions. But this measure of dependence could also more generally proxy for credit usage and income within a county. We have of course controlled for both median income and the variance of income within a county, but to help purge this potential source of bias, we define dependence as the ratio of captive financed transactions to all financed transactions in the county; as before, we use Polk data for 2008 Q1. Not surprisingly given Table 6B, Column 1 of Table 9 suggests little change in the economic impact of captive dependence on sales: a one standard deviation increase in captive dependence is associated with a 1 percentage point or 0.08 standard deviation drop in total car sales.

Columns 2 and 3 use the Equifax derived measures of dependence. In Column 2, the ratio of captive finance to all financed transaction in the county is observed in 2008 Q1. This point estimate is a little larger than in Column 1: a one standard deviation increase in the Equifax derived measure of captive dependence is associated with a 1.5 percentage point or 0.12 standard deviation decline in total car sales. Column 3 considers this ratio computed through 2006. Data averaged over the entire year is less likely to be measured with error, and the effects appear larger. A one standard deviation increase in captive dependence is associated with a 2 percentage point drop or 0.16 standard deviation decline in the growth in total car sales.

We have seen that the negative impact of captive dependence on aggregate sales is robust to a number of plausible alternative measures of dependence. But a recurring challenge to causally interpreting these results center on the possibility that captives might disproportionately serve lower credit quality borrowers—the very borrowers likely to reduce their demand for durable goods during the Great Recession. We have controlled for the median credit score, based on all adults residing in the county with a credit history, using Transunion data. But Equifax provides the median credit score for those borrowers that actually obtained captive automotive credit in the county, potentially helping us to measure more accurately the credit quality of captive customers. In column 4, we control for borrower credit quality using this more targeted Equifax measure of credit score, observed in 2008 Q1. The point estimate on our Polk baseline measure of dependence is little changed, and the Equifax derived measure of borrower credit quality adds little additional information beyond the more general Transunion credit quality

variable.

Closely related to the concerns surrounding borrower credit quality is the fact that demand shocks operating through the labor market could also be a source of bias. Employees in the automotive industry may disproportionately rely on captives to finance their new car purchases. But the distress in the automotive sector during this period could have also reduced demand among these employees, leading to a spurious negative association between captive dependence and car sales. We already control for the share of labor employed in the automobile sector, but as a further check, we estimate the specification in column 3 of Table 8 separately for those counties with employment in the automotive sector and for those counties without any employment linkages to the sector. The point estimates across the two subsamples are virtually identical, though the standard errors are higher in the smaller subsample—those counties with some employment connection the automobile industry. We also repeat the specification in column 3 of Table 8 for broad geographic Census regions. Apart from the North East, where the small number of observations render the estimates unreliable, the point estimate on captive dependence is similar across these regions, and in the interest of concision, these results are available upon request.

6.6. Make heterogeneity and county fixed effects

We now 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.[28] In each of the columns of Table 10 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. *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 10 is the change in GMAC-financed sales within a county from 2008 to 2009. As the table shows, the point estimate on GMAC

[28] 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).

dependence is negative and significant, suggesting that the collapse in GMAC-financed sales 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 10 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 and model 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. We build on the fact that the automobile market is highly segmented, and 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.[29] 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, house 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 vehicles; and luxury utility vehicles.[30]

With information on county, make, and segment, we can include make fixed effects, county fixed effects, and county-segment fixed effects. 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 absorb county-specific time-invariant factors that affect sales of all cars equally within the county. For example, a county's exposure to the "cash for clunkers" program, as determined by the preexisting fraction of "clunkers" in the

[29] 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.

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

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. County-segment fixed effects however absorb invariant factors that affect sales of a particular segment that vary across segments, even within the same county.

As Column 10 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 10 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 captures latent demand for cars.

6.5. Changes in aggregate financing capacity and local auto sales

To understand the real effects of the liquidity disruptions during the crisis, we have focused on the collapse in car sales in 2009-2008. But 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. Although many automotive captives were forced to close their commercial paper SPVs in the first quarter of 2009, stresses in these markets began in late 2007, and tended to spike with large events like the collapse of Lehman brothers in the third quarter of 2008. The credit shock hypothesis would predict that car sales would be most sensitive to these aggregate fluctuations in short term financing conditions in those counties more dependent on captive credit.

To test this prediction, we regress the quarterly growth in new car sales within a county from the period 2006 Q1 through 2009 Q4. We include the baseline county level controls from before along with captive dependence. We also allow the coefficient on captive dependence to

vary by quarter over the sample period. This coefficient, along with the standard errors are plotted in Figure 6. Consistent with the idea that aggregate changes in captive financing capacity might affect captive credit supply, Figure 6 shows that in 2006, when captives generally had ample financing capacity, car sales were significantly faster in those counties more dependent on captive credit. The coefficient turns negative in the final quarter of 2007 when the asset backed commercial paper market became stressed, and again in the quarters around the collapse of Lehman Brothers. The coefficient is most negative in 2009 when the captive ABCP conduits were wound down.

Flows into money market funds provide another way to more directly connect changes in captive financing capacity to car 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.[31] 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. Figure 7 illustrates the considerable variation in these flows around the crisis.

The credit shock hypothesis would predict that the effects of disruptions in short term funding markets and MMF flows on the financing capacity of captives and car sales would be more pronounced in those counties more dependent on captive financing. And in results available upon request, we interact the cross-section of captive dependence with the time-series of flows into non-Treasury MMFs to more directly understand the impact of financing capacity on sales growth. As in our previous results, the coefficient on *captive dependence* is negative and statistically significant at the 1% level. And 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 non-treasury institutional MMFs flows is significant and positive.[32]

[31] 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.

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

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. Moreover, the interaction term when using only retail MMFs is not significant, as not all MMFs invest in ABCP: 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).

7. Individual-Level Evidence

We have used the cross-county variation in captive dependence to help identify the impact of illiquidity in short term funding markets on car sales. While these results appear robust to a number of alternative specifications, there is still a lingering concern that the county-level variation in captive dependence might reflect compositional differences in borrower credit quality and latent demand. For example, one can credibly argue that because of the differences in borrower credit quality between captive and non-captive borrowers, borrowers from captive leasing companies are more likely to face a contraction in their credit limits imposed by other lenders, such as credit card companies. And rather than reflecting the effects of diminished captive financing on account of illiquidity in short-term funding markets, these results might be an artifact of a more general contraction in credit to more risky borrowers.

To more directly address these concerns, in this subsection we turn to individual-level data from Equifax. This dataset records information about an individual's liabilities—automotive debt, mortgages, student loans and credit card debt and credit card borrowing limits—along with the individual's age, dynamic FICO score and zip code of residence. In the case of automotive debt, the dataset also identifies whether credit was obtained from a captive lender or other – non-captive –lenders. We observe the information in Equifax quarterly from 2006 through 2009 for a 10 percent random sample—a panel of about 3 million households.

Using this micro-level individual data, we can study how exposure to captive financing—the degree of captive dependence in the county—might have affected an individual's likelihood of obtaining captive automotive credit and other outcomes. By including the individual's FICO

score, age, homeownership status and even credit card balances we can directly control for key measures of borrower credit quality, thereby limiting the potential for biased estimates that might arise from latent demand and unobserved differences in the composition of borrowers between captives and other sources of automotive credit that might affect the more aggregate county-level evidence.

In Column 1 of Table 11 we use a simple linear probability model to study the probability that an individual obtains captive automotive credit in a given quarter over the period 2008-2009. Building on the earlier panel level results (Figure 6) which showed that captive financing capacity changed substantially over this period, we allow the coefficient on captive dependence at the county level to vary by quarter. And in addition to the household level controls, we include state, along with year by quarter fixed effects and cluster standard errors at the state level.

The evidence in Column 1 suggests that holding constant an individual's FICO score, age, credit card balance and mortgage status, individuals are more likely to obtain captive automotive credit when living in a county with a greater dependence on captive credit. Strikingly however, the impact of captive dependence on the probability of obtaining captive credit changes considerably over the sample period. The coefficient drops by about 28 percent from the first quarter of 2008 to the final quarter of that year. It rebounds a little in the beginning of 2009, but drops sharply towards the end of the year, almost by factor of 8 relative to its 2008 Q1 peak, becoming insignificant in the third quarter of 2009. Also, these results are little changed, and available upon request, if we model the persistence in car buying behavior with a lagged dependent variable.

Column 2 focuses on aggregate car sales. The dependent variable is the probability that an individual obtains automotive credit, regardless of the source of financing—excluding of course self-financing, as Equifax has no information on cash purchases. Mirroring the decline in the captive dependence coefficient in Column 1, for individuals living in more captive dependent counties, the likelihood of obtaining automotive credit fell sharply at the end of 2009. In particular, the captive dependence coefficient declines by about 33 percent in 2009 Q3 compared to its 2008 Q1 peak. This decline is less than the seven fold drop observed in Column 1, as other sources of automotive financing may have substituted for the loss of captive financing.

We now consider a number of robustness tests. To check whether captive dependence might more generally proxy for credit conditions inside the county, Column 3 uses the

probability that the individual buys a home in the quarter as the dependent variable. If the captive dependence variable reflects more general local credit conditions, such as the supply of mortgage financing, then the captive dependence coefficients should also evince a similar pattern to that observed in Columns 1 and 2. The estimates in Column 3 show no such pattern. They suggests that homeownership might on average be less likely in counties with greater captive dependence, but this general tendency is virtually static over the sample period.

To check further whether captive dependence might proxy for other types of binding credit constraint at the individual level, Columns 4 and 5 use the log level of the individual's credit limit and credit balance respectively. If anything, the captive dependence point estimate becomes less negative over time as the economy exited the recession in the second half of 2009. Finally, we replicate the specification in Column 1 using the 2007 sample. Unlike 2008-2009, the captive dependence coefficient is relatively stable for most of this period.

7. Banks and the collapse of auto sales

We have considered a number of different tests to understand the impact of illiquidity in short term funding markets on car sales. However, these tests also rely on the cross-county variation in captive dependence, and can be biased on account of latent demand. In this subsection then, we can consider a final set of tests that do not rely on the spatial variation in captive dependence. These tests build on the fact that some banks were also 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). And instead of relying on the cross-county variation in captive dependence, we can use the pre-crisis variation across banks in their exposure to short term funding markets to understand further the impact of illiquidity in these markets on car sales.

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.[34]

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 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

[34] 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.

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). [35] Concurrently, banking regulators also announced a sizable expansion in capital and liquidity requirements, especially for the larger banks.[36] 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.[37] 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 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

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

[36] 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/.

[37] 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.

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 post crisis 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.

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.

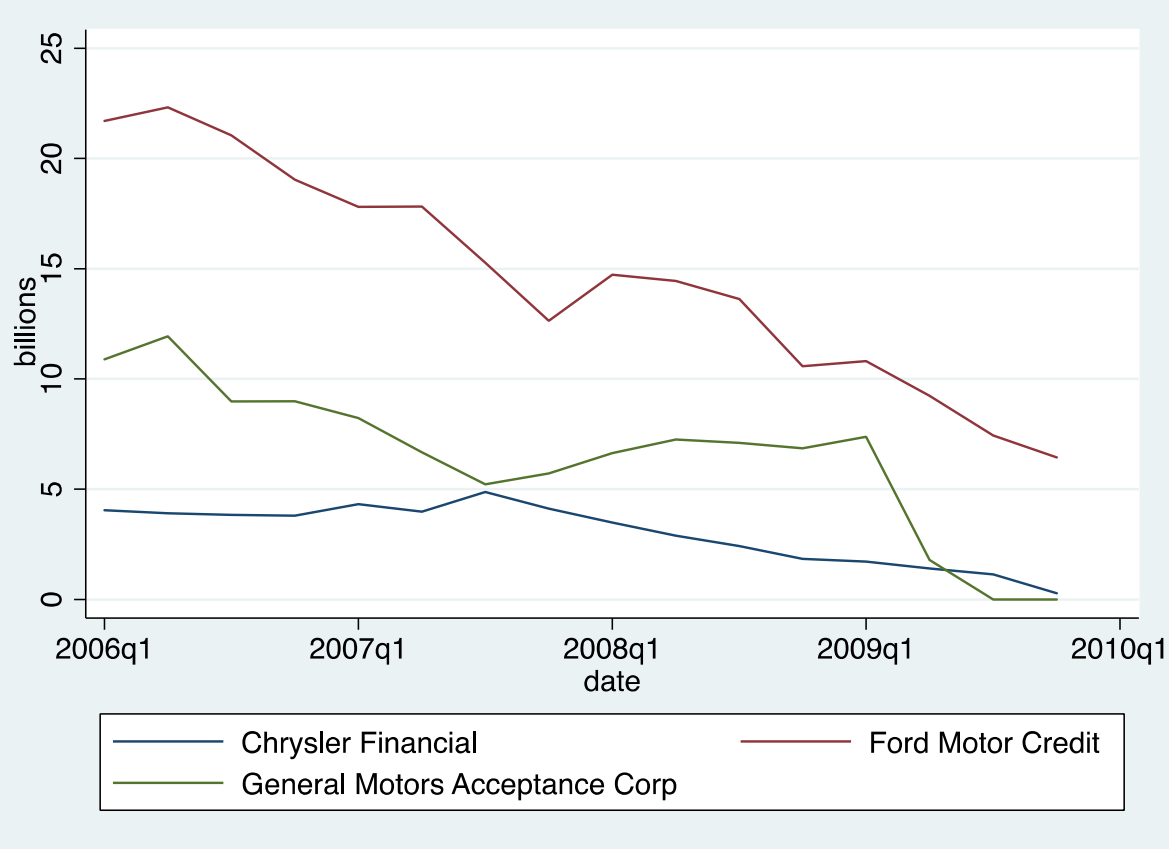

Figure 1. Outstanding Issuances of Asset-Backed Commercial Paper. Outstanding stock asset-backed commercial paper issued by three captive finance companies, 2006 Q1–2009 Q4. Source: Moody's Investor Services.

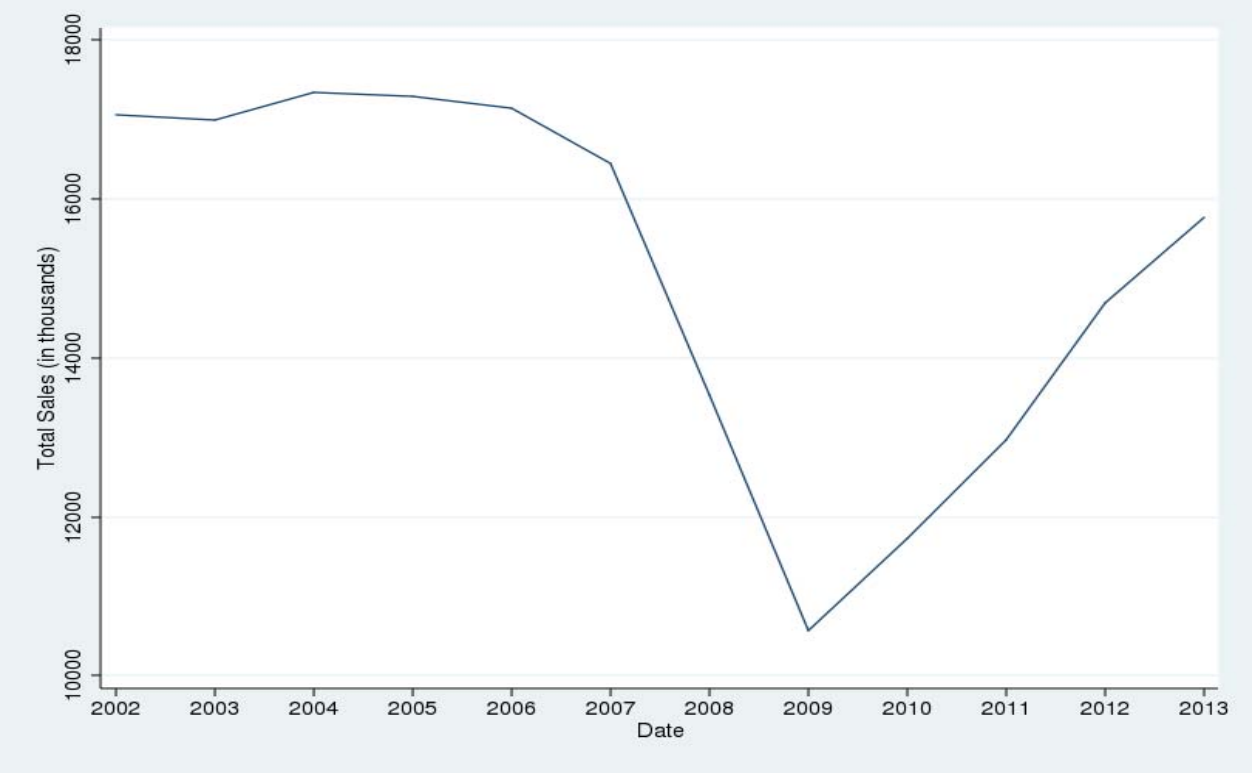

Figure 2a. Total Car Sales, 2002–2013. Total annual car purchases in Polk.

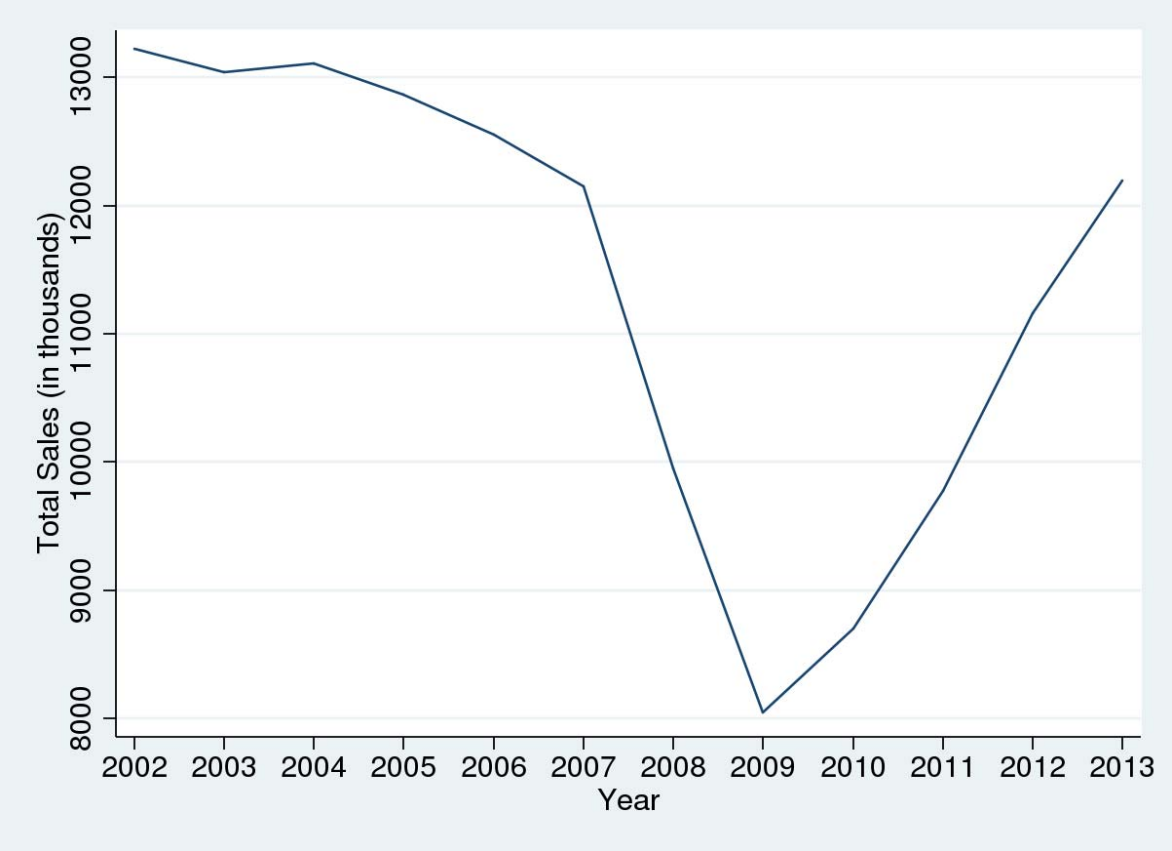

Figure 2b: Total Retail Car Sales, 2002–2013. Retail car sales are the sum of retail leases and retail purchases in Polk.

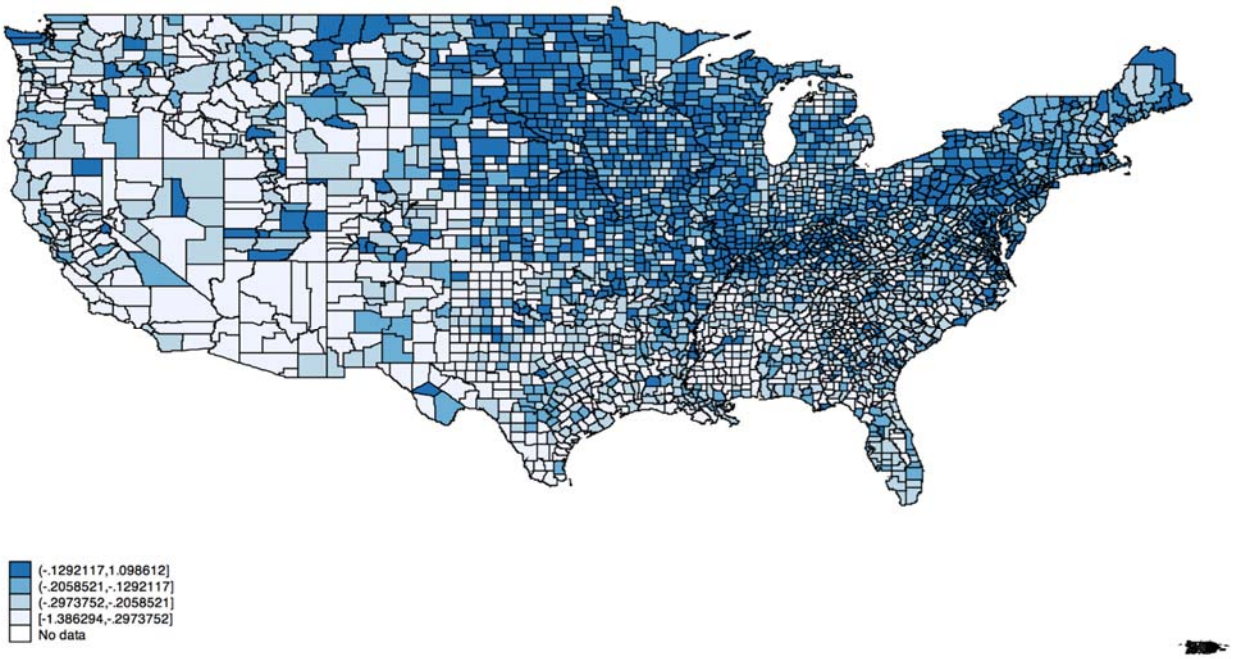

Figure 3: County-Level Change in Retail Car Sales, 2009–2008. Retail car sales are the sum of retail leases and retail purchases in Polk.

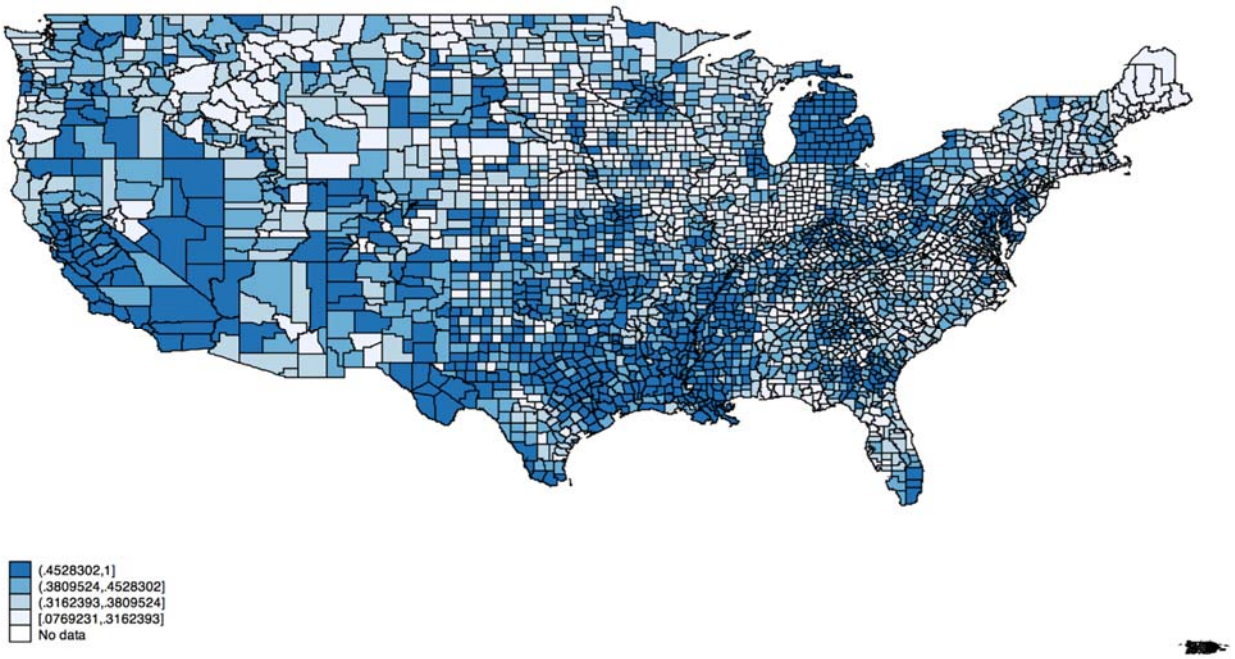

Figure 4. County-Level Share of Retail Cars Financed by Captives in 2008Q1. Retail car sales are the sum of retail leases and retail purchases in Polk. The share is defined relative to all retail transactions in the county, regardless of the source of financing.

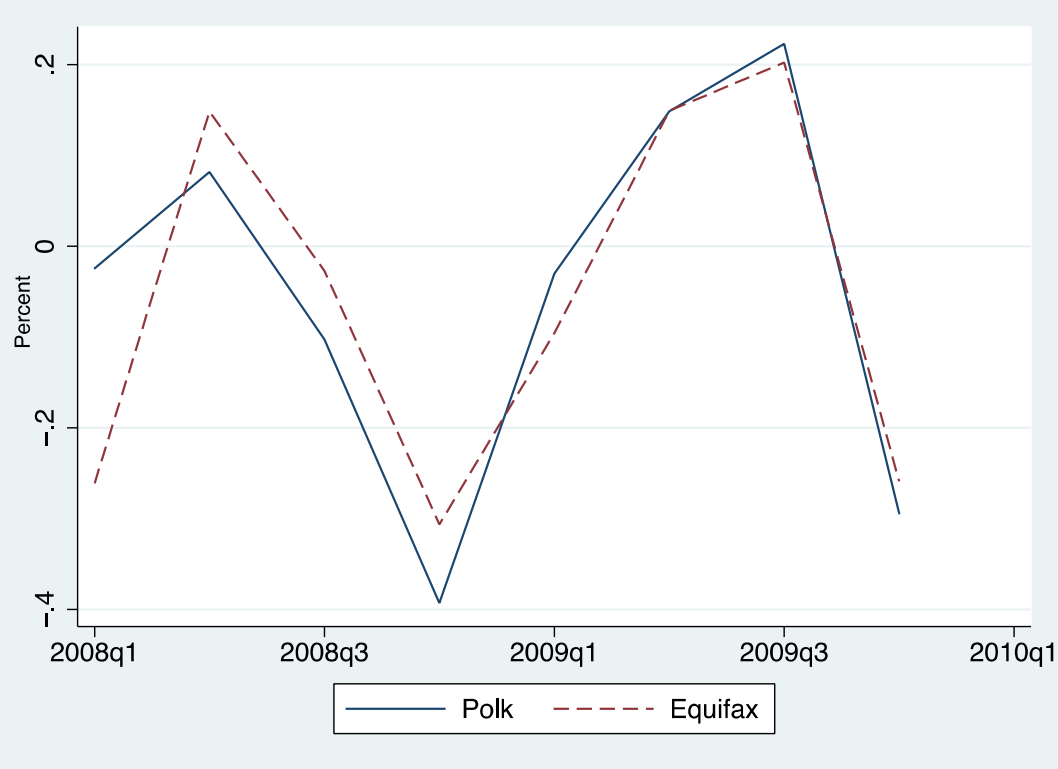

Figure 5. Quarterly Growth in New Car Sales—Comparing Polk and Equifax. The figure plots the quarter on quarter growth in car sales, as reported by Polk and Equifax.

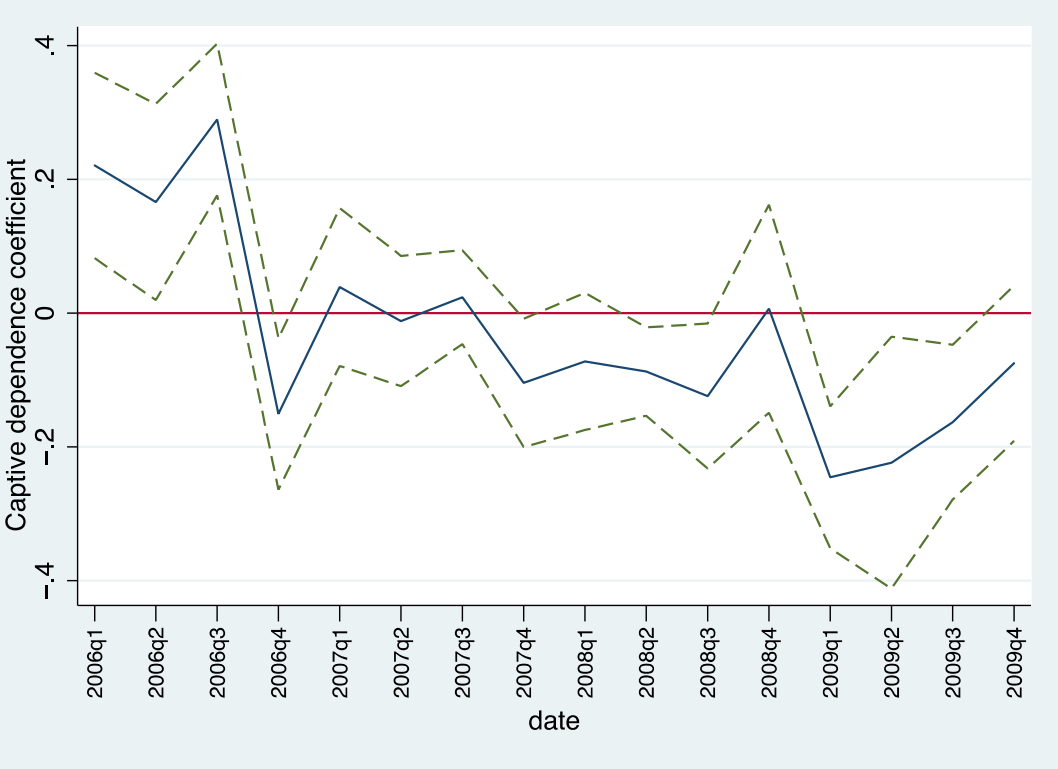

Figure 6. Captive Dependence and Car Sales, 2006 Q1-2009 Q4. The Figure plots the coefficient—solid line—along with the 95 percent confidence band—dashed line—from regressing the quarterly growth in aggregate car sales—at the county level—on captive dependence (Polk), and the baseline controls from column 2 of Table 7, along with year-quarter fixed effects. The captive dependence coefficient is allowed to vary by quarter over the sample period.

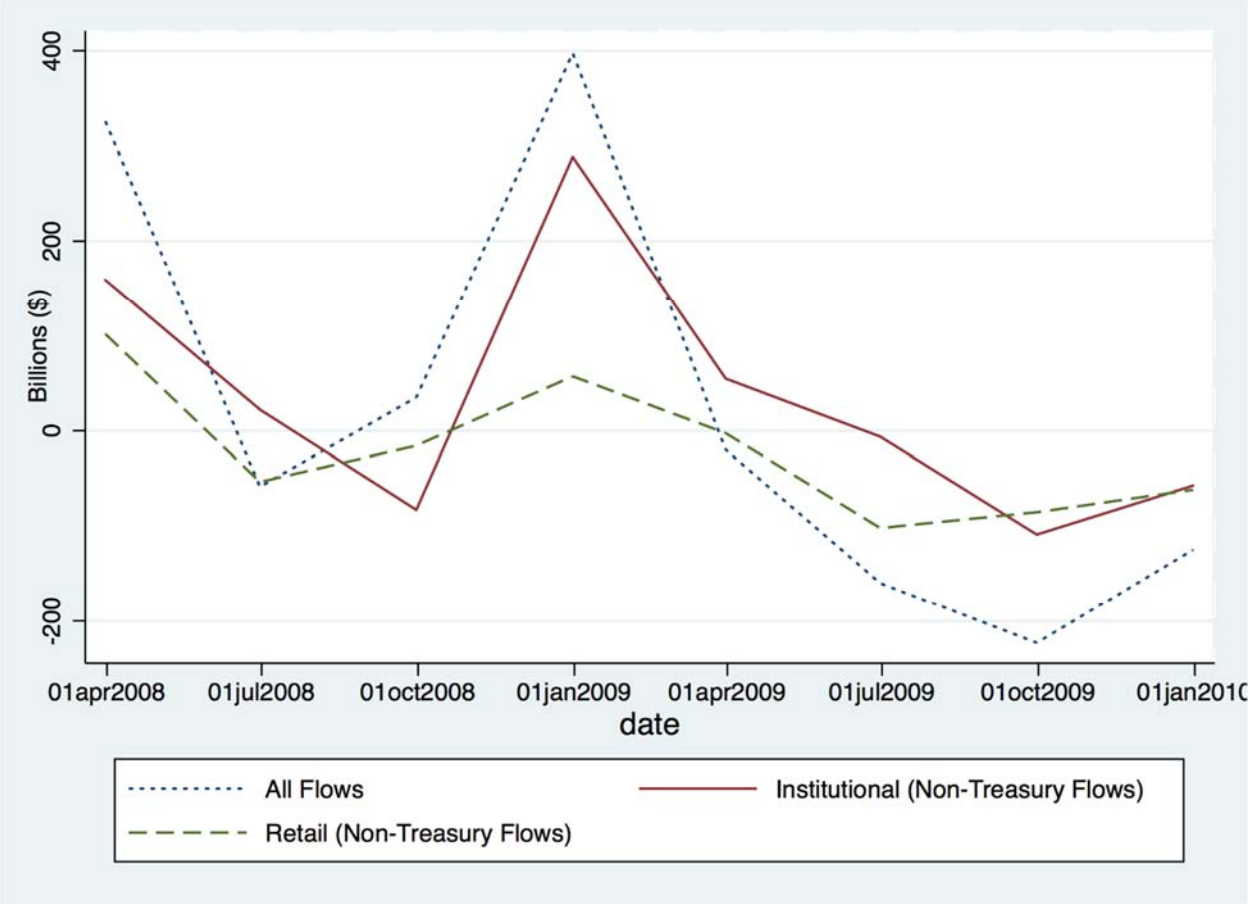

Figure 7. Quarterly Net Flows to Money Market Funds, 2008–2009. Flows are calculated using data from Flow of Funds.

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***
Median credit score, 2008 Q1 (Trans union)	0.36***
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 regressing 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. The socio-economic variables are taken from the American Community Survey. County-level unemployment rates come from the BLS. Employees in automobile sector are taken from the Quarterly Census of Employment and Wages (QCEW).

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Median Income, log	0.0166								-0.0296
	(0.0163)								(0.0349)
Population Density		6.11e-07							-7.93e-07
		(1.31e-06)							(6.27e-07)
Gini Coefficient			0.188						0.0883
			(0.113)						(0.162)
Employment in Automobile Manufacturing				-0.0678					-0.0113
				(0.128)					(0.140)
Median credit score, 2008 Q1 (Trans union)					0.0006***				0.0007***
					(0.0001)				(0.0001)
Unemployment Rate (2008)						-0.006***			-0.004**
						(0.001)			(0.00161)
Percentage African American							0.0186		0.136***
							(0.0272)		(0.0404)
Poverty Rate								-0.000919	0.00106
Observations	3,108	3,108	3,108	3,103	3,108	2,550	3,108	3,108	2,546
R-squared	0.300	0.300	0.302	0.299	0.323	0.292	0.300	0.301	0.316

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

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 6A. Summary Statistics

This table presents the summary statistics for county characteristics used in the empirical analysis. In column 1, captive dependence is the ratio of captive financed transactions to all financed transactions in a county as of 2008:Q1 and reported in Equifax. Column 2 defines captive dependence similarly, but taken over all of 2006. Column 3 defines captive dependence as the ratio of captive financed transactions to all sales in the county, including self-financed transactions, as of 2008:Q1 and reported in Polk. Column 4 defines captive dependence as the ratio of captive financed transactions to all financed transactions in a county as of 2008:Q1 and reported in Polk. 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).

	Captive Dependence											
	Equifax 2008 Q1	Equifax 2006	Polk 2008 Q1	Polk 2008 Q1 Financed	County Area, log	Population, log	Median Income, log	African American Population, log	White Population, log	Gini Coefficient	Employment in Automobile Sector, share	Median credit score, 2008 Q1 (Trans union)
Mean	0.49	0.45	0.39	0.52	6.47	10.25	10.66	6.78	10.06	0.43	0.42	675.74
Median	0.5	0.45	0.38	0.52	6.42	10.15	10.65	6.95	9.99	0.43	0	679
25^{th} percentile	0.38	0.35	0.32	0.44	6.06	9.32	10.5	4.9	9.12	0.41	0	634
75^{th} percentile	0.6	0.56	0.45	0.6	6.82	11.09	10.79	8.73	10.94	0.45	0.04	717
Min	0.1	0	0.08	0.14	0.69	4.39	9.86	0	4.17	0.21	0	507.5
Max	0.88	1	1	1	9.91	16.1	11.65	14.11	15.42	0.64	18.66	811
Standard Deviation	0.15	0.18	0.1	0.12	0.87	1.45	0.25	2.61	1.44	0.04	1.44	54.66

Table 6B. Captive Dependence

The dependent variable is captive dependence defined as the ratio of captive financed transactions to all financed transactions in a county over 2006 and reported in Equifax. All regressions include state fixed effects, are weighted by the population in the county, and standard errors are clustered at the state level; ***, **, * denotes significance at the 1%, 5%, and 10% levels, respectively.

Variables	(1)	(2)	(3)
captive dependence, 2006 (equifax), financed transactions	0.815***		
	(0.0441)		
captive dependence, 2008 Q1 (polk)		0.821***	
		(0.0778)	
captive dependence, 2008 Q1 (polk), financed transactions			0.762***
			(0.0854)
Observations	2,342	2,342	2,342
R-squared	0.685	0.535	0.554

Table 7. Captive Dependence and Captive Sales

This table reports the regression results of estimating Eq. (1). The dependent variable is the change in number of cars financed by captives in 2009 relative to 2008 as reported in Polk. Captive dependence is the market share of captive finance companies in a county as of 2008:Q1. 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). Household net-worth is from Mian and Sufi (forthcoming). All variables are defined in Appendix A.

Variables	(1) no controls	(2) economic and demographic controls	(3) unemployment and leverage	(4) house prices	(5) Household net worth
captive dependence (Polk)	-0.354***	-0.532***	-0.551***	-0.577***	-0.545***
	(0.0731)	(0.118)	(0.132)	(0.155)	(0.152)
county area,log		-0.0160*	-0.0171**	-0.0197*	-0.0198*
		(0.00814)	(0.00840)	(0.0103)	(0.0106)
population, log		0.0960***	0.0940***	0.0955***	0.0909***
		(0.0319)	(0.0321)	(0.0336)	(0.0331)
median income, log		0.0401	0.0353	0.0520	0.0681
		(0.0338)	(0.0335)	(0.0429)	(0.0414)
African-American population, log		0.00833**	0.00863**	0.00611	0.00634
		(0.00385)	(0.00426)	(0.00459)	(0.00431)
White population, log		-0.0951***	-0.0936***	-0.0871***	-0.0812***
		(0.0264)	(0.0276)	(0.0282)	(0.0280)
Gini Coefficient		0.280*	0.313**	0.260	0.169
		(0.152)	(0.144)	(0.159)	(0.183)
Employment in automobile, share		-0.339	-0.356	-0.417	-0.492
		(0.259)	(0.247)	(0.312)	(0.341)
median credit score, 2008 Q1 (trans union)		0.000504**	0.000464**	0.000355	0.000415
		(0.000201)	(0.000212)	(0.000280)	(0.000277)
house price change				0.133	
				(0.102)	
unemployment rate			0.00443	0.00306	
			(0.00394)	(0.00381)	
household leverage, 2006			0.0239 (0.0225)	0.0389 (0.0276)	
change in household net worth, 2006-2009					-0.0152
					(0.0898)
Observations	3,082	2,849	2,056	958	932
R-squared	0.725	0.775	0.798	0.854	0.855

All regressions are weighted by the county population and include state fixed effects. Standard errors are clustered at the state level. ***, **, * denotes significance at the 1%, 5%, and 10%

Table 8. Captive Dependence and Aggregate Effects.

This table reports regression results of estimating Eq. (1). The dependent variable in Column (1) is the change in the number of cars financed by non-captives in 2009 relative to 2008. The dependent variable in Column (2) is the change in the number of self financed cars sales in 2009 relative to 2008. Columns (3) uses the change in all car sales in 2009 relative to 2008. Captive dependence is the market share of captive finance companies, relative to all retail sales, 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.

Variables	(1) non-captive financed transactions	(2) cash transactions	(3) all transactions
captive dependence (Polk)	0.461**	0.339*	-0.138**
	(0.182)	(0.202)	(0.0584)
Observations	2,849	2,849	2,849
R-squared	0.710	0.809	0.684

All regressions are weighted by the county population and include state fixed effects. 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, Robustness

The dependent variable is the change in all car sales in 2009 relative to 2008. The demographic controls are the same as in Column (2) of Table 7. Captive dependence in column 1 is the ratio of captive financed transactions to all financed transactions in 2008:Q1, as reported by Polk. Columns 2 and 3 use the same definition of captive dependence but for data from Equifax in 2008:Q1 (column 2) and averaged over 2006 (column 3). Column 4 includes the median credit score in the county for car buyers using captive financing in 2008 Q1. Captive dependence in column 4 is the baseline measure: captive financed transactions to all retail transactions in 2008:Q1, as reported by Polk.

	(1)	(2)	(3)	(4)
Variables	Polk: Captive to All Financed	Equifax 2008 Q1	Equifax 2006	Credit quality, Redux
captive dependence, 2008 Q1 (polk), financed transactions	-0.0906*			
	(0.0517)			
captive dependence, 2008 Q1 (equifax), financed transactions		-0.102***		
		(0.0218)		
captive dependence, 2006 (equifax), financed transactions			-0.123***	
			(0.0255)	
captive dependence (Polk)				-0.140**
				(0.0597)
median credit score, 2008 Q1 (Equifax, captives)				6.38e-05
				(5.50e-05)
median credit score, 2008 Q1 (Trans union)				0.00128***
				(0.000159)
Observations	2,849	2,287	2,827	2,498
R-squared	0.681	0.705	0.687	0.695

All regressions are weighted by the county population and include state fixed effects. Standard errors are clustered at the state level. ***, **, * denotes significance at the 1%, 5%, and 10% levels, respectively.

Table 10. Within-Make Effects of Captive Financing on Auto Sales

The dependent variable in Column (1) is the change in all GM sales in 2009 relative to 2008. Column (2) is the change in GMAC-financed GM sales. Column (3) is the change in all non-GMAC financed GM sales. Columns 4-9 follow a similar pattern for Ford and Toyota sales. Captive dependence is defined as 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. Column 10 stacks the data by make: GM, Ford, Toyota and Honda; county and model segment. Column 10 includes county and brand fixed effects, along with county-segment fixed effects.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Variables	All GM Sales	GMAC Financed GM Sales	Substitution: Non-GMAC financed GM sales	All Ford Sales	FMC Financed Ford Sales	Substitution: Non-FMC financed Ford sales	All Toyota Sales	TMC Financed Toyota Sales	Substitution: Non-TMC Financed Toyota Sales	County, Make-Segment fixed effects
Captive dependence	-0.0419*	-0.425***	0.0814***	-0.0371**	-0.146***	0.299***	-0.0202*	-0.233***	0.192***	-0.0262*
	(0.0228)	(0.0537)	(0.0288)	(0.0182)	(0.0266)	(0.0295)	(0.0117)	(0.0613)	(0.0264)	(0.0145)
Observations	2,857	2,854	2,857	2,857	2,856	2,856	2,855	2,837	2,851	32,872
R-squared	0.377	0.407	0.509	0.389	0.369	0.583	0.289	0.328	0.271	0.718

All regressions are weighted by the county population and include state fixed effects. Standard errors are clustered at the state level. ***, **, * denotes significance at the 1%, 5%, and 10% levels, respectively.

Table 11. Captive Dependence and Car Buying, Individual Level Evidence

The dependent variable in columns 1 and 5 equals 1 if an individual financed a car purchase in the quarter through a captive, and 0 otherwise. The dependent variable in column 2 equals 1 if an individual financed a car in the quarter, regardless of the credit source, and 0 otherwise. The dependent variable in column 3 equals 1 if the individual obtained a mortgage in the quarter and 0 otherwise. The dependent variable in column 4 is the log of the indivdual's credit limit. In all columns, the data are quarterly, and for columns 1-4, observed from 2008:Q1- 2009: Q4; column 5 includes data from 2007:Q1-2007:Q4.

Variables	(1) captives	(2) all sales	(3) mortgage	(4) credit card limit	(5) 2007 Captives
FICO score, log	-0.0144***	-0.00621***	0.558***	4.564***	-0.0227***
	(0.000852)	(0.000853)	(0.0194)	(0.252)	(0.00125)
Credit Card Balance, log	-4.49e-05	-3.24e-05	0.0327***		-4.78e-05
	(3.99e-05)	(7.00e-05)	(0.00123)		(3.98e-05)
Age	0.134***	0.397***	2.731***	-50.88***	0.178***
	(0.0114)	(0.0166)	(0.447)	(1.690)	(0.0134)
Homeowner indicator	0.00767***	0.0180***		2.209***	0.0102***
	(0.000307)	(0.000700)		(0.0554)	(0.000411)
Captive dependence (Polk)	0.00771***	-0.00937**	-0.0570*	-1.610***	0.00538**
	(0.00191)	(0.00423)	(0.0328)	(0.195)	(0.00245)
Captive dependence (Polk)* 2008 Q2	-0.00164**	-0.00562***	-0.00337	-0.0706***	
	(0.000654)	(0.00170)	(0.00214)	(0.0189)	
Captive dependence (Polk)* 2008 Q3	-0.000941	-0.00372***	-0.00320	-0.00217	
	(0.000690)	(0.00123)	(0.00229)	(0.0478)	
Captive dependence (Polk)* 2008 Q4	-0.00215**	-0.00206	0.00102	0.0737	
	(0.000991)	(0.00187)	(0.00420)	(0.0683)	
Captive dependence (Polk)* 2009 Q1	-0.000726	0.00182	0.00839	0.247***	
	(0.00129)	(0.00193)	(0.00755)	(0.0878)	
Captive dependence (Polk)* 2009 Q2	-0.00140	-0.00230	0.00792	0.276***	
	(0.00129)	(0.00226)	(0.00766)	(0.0985)	
Captive dependence (Polk)* 2009 Q3	-0.00657***	-0.00978***	0.00626	0.266**	
	(0.00181)	(0.00318)	(0.00681)	(0.104)	
Captive dependence (Polk)* 2009 Q4	-0.00243	-0.00231	0.00476	0.264***	
	(0.00163)	(0.00268)	(0.00821)	(0.0971)	
Captive dependence (Polk)* 2007 Q2					4.44e-05
					(0.000762)
Captive dependence (Polk)* 2007 Q3					0.00133
					(0.00260)
Captive dependence (Polk)* 2008 Q4					-0.00138
					(0.00222)
Observations	23,665,802	23,665,802	23,665,802	23,665,802	11,896,155
R-squared	0.003	0.005	0.054	0.171	0.006

Table 12. 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.