New Vehicle Sales and Credit Supply Shocks: What Happened in 2008?

Kathleen Johnson, Karen Pence, and Daniel Vine

Board of Governors of the Federal Reserve System

June 2010

Abstract. Motor vehicle sales were one of the first casualties of the deepening financial crisis in 2008: vehicle spending declined 40 percent between the end of 2007 and mid-2009. This decline was much larger than could be explained by economic fundamentals such as unemployment and changes in income. Over the same period, the asset-backed securities (ABS) market that funds a large share of consumer vehicle loans shut down almost completely, and data from a variety of sources suggests that the sharp drop in vehicle sales reflected, in part, tight credit conditions that left many households unable to obtain vehicle loans at affordable terms. In March 2009, the Federal Reserve sought to restore the flow of credit to sectors dependent on ABS markets and launched the Term Asset-Backed Securities Loan Facility (TALF).

In this paper, we explore the link between vehicle financing conditions and vehicle sales. Using both aggregate and household-level data, we document that financing conditions play a significant role in explaining fluctuations in vehicle sales. Our estimates suggest that restoring the flow of credit to consumers through programs such as TALF may have helped stanch the free-fall in vehicle sales by spring 2009.

Author contact information: Kathleen.W.Johnson@frb.gov, Karen.Pence@frb.gov, Daniel.J.Vine@frb.gov. We thank Samuel Ackerman, Angus Chen, Meredith Richman, and Mark Wicks for wonderful research assistance. We thank our Federal Reserve colleagues and seminar participants at the OCC and the Homer Hoyt Institute for helpful insights and conversations. We are grateful to Jordan Pollinger, Beth Caviness, Jessica Leung, Kwaw de Graft-Johnson, Evan LeFlore, Andy Haughwout, and Donghoon Lee at the New York Fed for generously providing data and statistics. The views in this paper are the authors’ alone and do not necessarily reflect the views of the Board of Governors of the Federal Reserve System or its staff.
1. Introduction

Spending on motor vehicles fell by an extraordinary 40 percent between the end of 2007 and the spring of 2009. Vehicle financing conditions also deteriorated over this period—acutely so in late 2008. For example, the average interest rate on auto loans extended by the finance companies associated with the Detroit 3 automakers increased from 3.25 percent in July 2008 to over 8 percent in December 2008. Interest rates spiked partly because the asset-backed securities (ABS) market, a major source of funding for these companies, began to come under stress in late 2007 and froze almost completely by the end of 2008. Auto ABS issuance in the fourth quarter of 2008 was a mere $2.5 billion—approximately 13 percent of issuance during an average quarter.¹

The Federal Reserve and the U.S. Treasury responded to the ABS market shutdown with a targeted lending program, the Term Asset-Backed Securities Lending Facility (TALF). The program was announced in late November 2008 and launched in March 2009. TALF appears to have contributed significantly to the recovery of the auto ABS market and of auto lending more generally. A few months after the TALF launch, average interest rates at finance companies had retreated from their 2008 year-end highs to 3 to 4 percent, and the share of consumers reporting on the Thomson Reuters / University of Michigan Survey of Consumers (the Michigan survey) that “it is a bad time to buy a car because of credit conditions” reverted back towards the levels seen before the financial crisis. By the program’s end in March 2010, seventeen finance companies and banks had issued $42 billion in TALF-eligible auto ABS; these ABS financed over 2.8 million vehicle loans and leases to consumers. In turn, auto sales stabilized by spring 2009 and even began to show some signs of recovery early that summer.

In this paper, we explore the relationship between auto lending conditions and vehicle sales, and provide a rough estimate of the effect of lending conditions—influenced in part by the launch of TALF—on vehicle sales in 2008 and 2009. We begin with an analysis of a special module on vehicle financing that the Federal Reserve has run on the Michigan survey from 2003 to 2010. With these data, we establish that actual and perceived financing conditions affect household vehicle purchase decisions, and that borrowing constraints are a significant factor in this market. We then examine aggregate data on vehicle sales and financing conditions over the

¹ “Average quarter” measured from 2002:Q1 to 2008:Q2.
last three decades and find further evidence that financing conditions matter. In these data, both an increase in the average interest rate on auto loans and a deterioration in household perceptions of financing conditions suppress vehicle sales. We estimate the effect of credit tightening during the 2008 financial crisis with a simulation of vehicle sales from December 2007 to June 2009 in which we allow only shocks to auto loan interest rates and perceptions of auto financing conditions to affect vehicle sales. We find that financial shocks can explain a bit under forty percent of the decline in vehicle sales during this period.

2. Vehicle sales

Sales of new light motor vehicles are followed closely by many economists and the business press as a bellwether of consumer spending. These sales, shown on a per household basis in figure 1, are notoriously volatile and quite sensitive to the business cycle. Households and businesses are quick to delay the purchase of a motor vehicle when economic times are tough, and thus sales respond in an exaggerated fashion to many of the economic factors that affect overall consumer demand. Over the past seven recessions, vehicle sales fell, on average, 35 percent from peak to trough; sales fell 40 percent from the end of 2007 to spring 2009. In late 2008, the rate of sales was at a level not seen in over 50 years.

Table 1 illustrates the large influence that motor vehicles have on the quarter-to-quarter changes in headline personal consumption expenditures (PCE). The analysis includes data only through the end of 2007, before the subsequent plunge in auto sales. Goods purchases account for 41 percent of the level of PCE and 84 percent of its volatility. New motor vehicle purchases, a subcomponent of goods, account for 3 percent of the level of PCE, but 36 percent of its volatility.

---

2 Light vehicles are defined as passenger cars and light trucks, which include vans, pickups, sports-utility and cross-utility vehicles.
3 PCE goods are shown separately in the table in response to concerns raised by Wilcox (1992) about mixing the different methodologies used to construct various components of PCE. As a share of real PCE expenditures on goods, new motor vehicles purchases represent about 7 percent of the average level of spending and 50 percent of the variance of quarterly changes.
4 The contribution of new motor vehicle purchases to the variance of PCE falls from 36 percent to 27 percent if the spike in sales that resulted from the zero-interest financing incentives offered in the first quarter of 2001 is excluded.
5 A bit more than 96 percent of the variance in new motor vehicle purchases between 1990 and 2007 stemmed from fluctuations in unit transactions, leaving a small role for changes in the real average value per vehicle sold.
Roughly 65 percent of new vehicle sales and 40 percent of used vehicle sales are funded with auto loans. Not surprisingly, the growth in auto loans has generally followed vehicle sales and the broader business cycle (Figure 2). One exception to this pattern is the early 2000s, when the growth in auto loans declined while vehicle sales remained constant. The surge in alternative forms of vehicle finance such as leasing and home equity extraction may explain this divergence.

Auto loans appear to soften more than vehicle sales in recessions, suggesting that access to auto finance may be restricted during economic contractions. This relationship can be seen most clearly in the bottom panel of Figure 2, which scales the change in loans by nominal expenditures on motor vehicles. In 2009, the annual change in vehicle loans outstanding relative to sales stood at its lowest level since at least 1967.

As of June 2009, households owed about $760 billion in motor vehicle loans, representing about 7 percent of their disposable personal income. In comparison, total non-mortgage debt (including motor vehicle loans) represented 23 percent of disposable personal income and total mortgage debt represented 95 percent of disposable personal income.

3. Vehicle purchases and financing conditions – microeconomic evidence

What are the pathways by which auto financing conditions might affect auto demand? If a household is not borrowing constrained, the only loan term that affects its auto demand is the interest rate. A higher interest rate raises the user cost of purchasing a car and reduces auto demand, all else equal. In contrast, if a household is borrowing constrained, its auto demand is a function of the amount it is allowed to borrow. That amount primarily depends on the loan-to-value ratio and the maturity of the loan. Chah, Ramey, and Starr (1995) present a model of durable goods consumption and borrowing constraints that shows these points more formally.

Attanasio, Goldberg, and Kyriazidou (2008) present empirical evidence consistent with this framework. They find that the elasticity of auto loans with respect to maturity declines with income, while the elasticity with respect to interest rates increases. They summarize: “with the exception of high income households, consumers are very responsive to maturity [of vehicle

---

6 Authors’ tabulation from the Michigan survey.
7 Authors’ estimate from data underlying the G.19 consumer credit statistical release (http://www.federalreserve.gov/releases/g19/Current/), Flow of Funds Accounts of the United States (www.federalreserve.gov/releases/z1), and Survey of Current Business (www.bea.gov/scb/index.htm).
loans] and less responsive to interest rate changes." They interpret these results to imply that a large proportion of households in the auto loan market do not have ready access to auto loans.

We can also infer the extent of borrowing constraints from how vehicle purchases respond to changes in income. Borrowing-constrained households cannot purchase in anticipation of higher future income, but must wait for the income to arrive. However, households with ready access to credit will purchase as soon as they learn of the higher future income. Adams, Einav, and Levin (2009) find that the vehicle demand of low income households with poor credit histories is higher following the receipt of income tax refunds—a time when borrowers have the funds to make a significant down payment on a car. The authors also find that a $100 reduction in the required down payment increases vehicle demand by 9 percent.

In addition, borrowing constraints have an asymmetric effect on vehicle purchases (Altonji and Siow, 1987; Jappelli and Pistaferri, 2000). These constraints can restrain households from purchasing a vehicle when they receive news of higher income in the future, but cannot restrain households from forgoing a purchase when they receive news of lower income in the future.

In this paper, we provide new evidence from the Michigan survey that financing conditions and borrowing constraints play a significant role in vehicle purchase decisions. The Federal Reserve sponsored nineteen modules on vehicle purchase and financing from April 2003 to August 2010. The timing of these modules is particularly advantageous as they span the spikes in sales in the early and mid-2000s and the recent downturn. The Michigan survey also contains data on income expectations, so we can test for the presence of borrowing constraints. Equally importantly, we will exploit the rotating panel design of the Michigan survey to measure income expectations in advance of a vehicle purchase.

Our analysis centers on the “Did you buy a car in the previous six months?” question in the vehicle module. We worded the question in this manner because the Michigan survey interviews households twice, six months apart. Thus, we can link a household’s attitudes,

---

8 p. 401.
expectations, and demographic characteristics in the initial survey to whether the household bought a vehicle in the ensuing six months.

The Michigan survey interviews around 500 households each month. In any given month, about 60 percent of the respondents are being interviewed for the first time, and about 40 percent are being interviewed for the second time. We limit our sample to households whose second interview coincided with a month in which we asked the vehicle finance module. Our final dataset has 3,802 observations.

The Michigan survey is designed to be nationally representative. Although the age distribution in our sample appears representative, more educated and wealthier households appear to be over-represented in the data (Table 2). For example, 64 percent of the households in our sample attended college and 79 percent are homeowners, compared to a college attendance rate of 54 percent and a homeownership rate of 69 percent in the Survey of Consumer Finances (SCF).9 We considered whether our sample restriction that households must have responded to both waves of the Michigan Survey explains this difference. However, the demographic characteristics of all households in the Michigan Survey (the “cross-section” column in the table) are quite similar to the characteristics of the households that could be matched to their earlier interview (the “panel” column).

We explored the role of auto financing in vehicle purchases in two ways. First, we examined whether borrowing conditions significantly influence whether a household purchases a car. We measured borrowing conditions with whether a household believed at the beginning of the six month period that “it is a good time to buy a car because of interest rates or other credit terms.” Another measure is the average interest rate on new auto loans extended by the Detroit Three finance companies, measured at the beginning of the period. Second, we examined whether vehicle purchases are more sensitive to current income (and conversely, less sensitive to future income) for groups of households that are more likely to be borrowing constrained.

---

9 The SCF oversamples households likely to be wealthy. We obtain nationally representative statistics by weighting the SCF data with the x42001 weight. Because the household is the unit of observation in the SCF, we weight the Michigan data with the Michigan household weight. In our later regression analysis of the Michigan data, we use the household head weight recommended by the Survey of Consumers.
In addition to the borrowing conditions variables, we controlled for macroeconomic conditions with the federal funds rate and the aggregate unemployment rate, measured at the onset of the six-month period. We also include indicators for whether respondents believed at the start of the six-month period that it is a good time to buy a car for reasons other than credit terms; whether they are worse off financially than a year ago; and whether they expect their future incomes to increase. Finally, we controlled for demographic variables: age, marital status, race, income, education, stock ownership, and homeownership. Sample statistics for all variables are shown in Table 3.

Our main specification is a linear probability model (Table 4). We used this specification for simplicity; a probit model and a model with fixed-effects for the month in which the survey was conducted yielded very similar results. As recommended by the Survey of Consumers, we weighted the regression with the weight for the household head. By using this weight, we dropped 138 households in which someone other than the household head responded to the survey. The results are robust to not using the sample weights, except as noted.

Turning to our first test, financing conditions appear to play a significant role in vehicle purchases. A household who believes that it is a good time to buy a car because credit conditions are favorable is 5 percentage points more likely to buy a car over the next six months than a household without this belief. This coefficient is statistically significant at the 1 percent level. As the overall probability of buying a car over six months is 14 percent, a change in this variable represents a 35 percent increase in the probability that a household will buy a vehicle. The coefficient on “good time to buy a car for other reasons” is associated with only a 1.6 percentage point increase, and is statistically insignificant. The fact that the “good time—other reasons” coefficient is so small suggests to us that the large coefficient on “good time—financing” reflects optimism about financing terms rather than optimism about vehicle purchases more generally. An increase in the loan rate at finance companies is associated with a decrease in the probability of buying a vehicle, but the relationship is not statistically significant.10

10 We do not include the aggregate loan-to-value ratio of loans originated at finance companies as a regressor because the interpretation of this variable is difficult. Historically, this variable has been low both at times of tight credit supply and at times when vehicle sales promotions such as Cash for Clunkers or financing incentives attracted buyers who made a sizeable downpayment. The aggregate interest rate is less subject to this compositional concern.
The unemployment rate has a significant effect on the probability of purchasing a car. A one percentage point increase in this rate is associated with a 1.6 percentage point decrease in the probability of purchasing a car. Variables summarizing a household’s income prospects—whether a household is worse off than a year ago, expects higher income next year, or expects lower income next year—do not have a statistically significant effect in the sample overall, although their effects are in the expected direction.

Turning to the demographic characteristics, the probability of purchasing a car decreases with age, and increases with income. Middle-aged households are 5 percentage points more likely than the elderly to purchase a car, and households with income over $60,000 are around 6 percentage points more likely to purchase a car than those with income under $35,000. Those who attended college are 3 percentage points less likely to buy a car, and married households are 5 percentage points more likely—presumably because there are more adults in the home. Note that the “good time to buy—financing” coefficient is of comparable magnitude to most of these coefficients. Stock ownership, homeownership, and race are insignificant.

We now turn to our second test, and examine whether the sensitivity of vehicle purchases to current and future income differs by the likelihood that a household is credit-constrained. We split the sample along two lines: households with a head who attended at least some college and households whose head did not; households that own stock and households that do not (Table 5). We assume that households with a head who attended college and households that own stock have more financial resources and have greater access to credit than their counterparts.

We view the results as consistent with the presence of credit constraints. College attendees who expect higher income next year are 4 percentage points more likely to buy a car than college attendees who expect the same income next year. The purchases of households who did not attend college do not vary with future income expectations. However, consistent with the consumption literature, this sensitivity is asymmetric: college attendees who expect lower income in the future are not less likely than to buy a car than college attendees who expect the

11 If the specification is not weighted, the “future income” coefficient drops to 0.027 and is just a hair shy of significance at the 10 percent level. We have not yet determined why weighting makes a difference for this coefficient.
same income next year. This result suggests that college attendees have more latitude than those who did not attend college to shift their purchases across time, perhaps by borrowing.

However, the purchases of households who did not attend college are much more sensitive to current credit conditions than the purchases of college attendees. Those who did not attend college are ten percentage points more likely to buy a car if they believe that credit conditions are favorable, whereas college attendees are no more likely. When we pool the samples and interact the college and “good time to buy—credit conditions” variables, the interaction term is negative and statistically significantly different from zero, thereby suggesting that the responses of the two groups are different.

The results are similar, but less strong, when we split the sample by stockownership status. As before, the vehicle purchases of stockowners are more sensitive to future income and less sensitive to current credit conditions than the purchases of non-stockowners, but the difference between the coefficients is smaller than for the equivalent college / no-college groups. In addition, the “future income” coefficient is not statistically significantly different from zero for the stockowner group.

Taken together, we believe that the results from these two sets of specifications indicate that financing conditions play a non-trivial role in vehicle sales. Household perceptions of the availability of vehicle financing appear to play as large a role in the vehicle purchase decision as standard lifecycle variables such as age and income, and perhaps an even larger role than unemployment. These perceptions play an even more significant role in the vehicle purchase decisions of households that are more likely to be borrowing constrained.

4. Vehicle purchases and financing conditions – macroeconomic evidence

Evidence of a financing effect on vehicle sales is also apparent in aggregate data. Both the interest rate on new car loans and household perceptions of financing conditions influence aggregate sales of new motor vehicles. To gauge the magnitude of these influences, we estimated a vector autoregression (VAR). The VAR is specified as:

\[ Y_t = C + A(L)Y_{t-1} + U_t. \]
C is a vector of constants and the vector Y consists of six variables: The change in the average finance rate on new car loans at captive automobile finance companies, $\Delta AutoRate_t$; changes in the shares of respondents to the Reuters/Michigan survey that cited good or bad lending conditions, $\Delta Good_t$ and $\Delta Bad_t$; the change in the unemployment rate, $\Delta UnEmp_t$; the log change in real disposable income, $\Delta DPI_t$; and the log change in U.S. light vehicle sales, $\Delta S_t$. $A(L)$ is a matrix of polynomials in the lag operator L, and $U$ is a vector of disturbances. We include four monthly lags in the VAR and estimate its parameters with data through December 2007.

To measure the potency with which these explanatory variables affect monthly light vehicle sales, we compare the response of sales to a one standard deviation shock in each variable. Shocks to each equation in the VAR are identified by restricting the ways in which each variable can respond to the other variables within the same period. Identification is achieved for this exercise by using the variables in the same order as they are listed above. The ordering implies that interest rates on new vehicle loans at the finance companies respond to other variables only with a lag, while consumer sentiment responds to interest rates in the current period and to vehicle sales and the other variables only with a lag. Vehicle sales are ordered last and thus are determined by the contemporaneous values of each of the other variables in addition to the lagged values of all variables.

The impulse response plots are shown in figure 3. The solid line in each panel shows the cumulative response of sales to a one standard deviation shock to the listed explanatory variable, and the dashed lines define the two-standard-error confidence interval associated with each point on the solid line. As shown in the top left panel, a one standard deviation adverse shock to the average finance rate would reduce the level of sales 0.8 percentage point below its baseline after 12 months. Using an annual rate of sales of about 16.5 million units as a baseline rate, this response would be equivalent to reduction in sales of about 130,000 units. The response of sales to consumer sentiment shocks are shown in the top right and middle left panels: A shock to good credit sentiment boosts sales 0.5 percentage point after twelve months, but the effect at that

12 Because the vehicle purchases of borrowing constrained households have been shown to depend on the maturity and LTV, we initially included the aggregate LTV and maturity of auto loans originated by the captive finance companies of the Detroit Three automakers. However, these series vary little over time and were dropped from the model due to their statistical insignificance.
horizon is not precisely estimated. An increase in the prevalence of bad credit perceptions, on the other hand, reduces sales 0.7 percentage point after twelve months, and this effect is statistically significant.

For comparison, the other panels in the figure show the response of sales to one standard deviation innovations in the other error terms for the unemployment rate and real disposable personal income equations in the VAR, though the interpretation of these impulses as exogenous shocks is less clear. That said, a one standard deviation innovation to the unemployment rate error term reduces sales 1.0 percentage point after twelve months, as shown in the middle right panel. A one standard deviation innovation to the real DPI error term, shown in the bottom panel, raises sales 0.9 percentage point after twelve months.

The estimated VAR coefficients thus suggest that the financial variables can affect light vehicle sales by magnitudes that are comparable to macro variables that are widely considered fundamental determinants of vehicle demand. It is worth repeating, however, that light vehicle sales are notoriously volatile and the portion of a typical twelve-month change in sales that can be explained by any of these variables is quite modest. The typical twelve-month change in sales between 1978 and 2007 was about 1.1 million units, and one standard deviation shocks to our explanatory variables each account for movements in sales that are in the range of 60,000 to 170,000 units.

5. A shock to credit access - The financial crisis (summer 2007 to present)

The auto finance system came under significant strain during the financial crisis. In the middle of 2007, problems in the broader capital markets spilled into the asset-backed securities (ABS) market, which funds a significant amount of auto loans. The spread between yields on triple-A rated auto loan ABS and interest rate swaps rose from 2 basis points at the beginning of 2007 to 85 at year-end; this level was wider than at the time of the 2001 recession (figure 4). The market came under increasing strain over 2008 and collapsed entirely towards the end of that year. Issuance fell from a pre-financial crisis rate of around $7 billion a month to a low of $1 billion a month at the end of 2008 (figure 4). Spreads ballooned to 150 basis points in mid-2008 and to over 400 basis points by year end.
Finance companies were hit hard by the shutdown of the ABS market. These lenders, which accounted for 39 percent of outstanding auto loans in the second quarter of 2009 (Experian, 2009), are heavily reliant on securitization for funding.\(^{13}\) Finance companies account for about 85 percent of outstanding auto ABS, with commercial banks and thrifts accounting for the remainder.\(^{14}\) In contrast, credit unions, which accounted for 24 percent of outstanding loans in 2009:Q2, rely almost exclusively on deposits, whereas commercial banks (37 percent of loans) rely on deposits as well as securitization.

Historically, interest rates on new vehicle loans did not vary much by type of lender; in 1990 these rates were between 10 and 12 percent (figure 5). Since the late 1990s, however, interest rates offered by different types of lenders have varied considerably. While interest rates at banks and credit unions fell 4 to 5 percentage points from 1990 to the mid 2000s, rates at finance companies affiliated with the Detroit Three manufacturers fell by 6 to 7 percentage points and were substantially more volatile.

Finance companies were likely able to reduce their rates below those of banks and credit unions because the maturation of the securitization market in the mid-1990s enabled finance companies to access funding more cheaply than in the past. In addition, finance companies affiliated with manufacturers—the so-called “captive” finance companies—have agreements with the manufacturers to offer below-market interest rates to spur vehicle sales. This arrangement became increasingly important in the early 2000s, when several automakers responded to the slowdown in vehicle sales in the wake of the September 11\(^{th}\) attacks by introducing zero-percent financing on new car purchases. Vehicle sales surged in response to this financing promotion, and to similar, subsequent promotions in 2002, 2004, and 2006.

However, securitization also made finance companies more vulnerable during the financial crisis, as lenders with access to deposits were able to continue lending, whereas lenders that relied on capital markets and securitization encountered difficulty. As the financial crisis deepened between the third and fourth quarters of 2008, auto loan originations fell by 34 percent.

\(^{13}\) Data from the G.19 consumer credit release and from the Michigan survey of consumers produce the same estimates as Experian for the distribution of loans.

\(^{14}\) Authors’ estimate from data underlying the G.19 consumer credit statistical release.
at finance companies and by only 6 percent at depositories.\textsuperscript{15} In the subsequent quarter, originations fell a further 26 percent at finance companies and 5 percent at depositories. Chase, Wachovia, and Bank of America saw big increases in market share in the first half of 2009 compared to 2008, whereas Toyota, Ford, Honda, and GMAC had the largest decreases (Experian, 2009).

Lending terms tightened along with the drop in originations. In the fourth quarter of 2008, the spread on interest rates on new auto loans originated by finance companies rose by over 3 percentage points.\textsuperscript{16} In contrast, the spread on rates for loans originated by commercial banks and credit unions rose about 1 percentage point. At the same time, the average maturity on auto loans at finance companies declined from 67 to 60 months and the average LTV fell from 95 to 85 percent (figure 6); credit bureau data on all types of auto loans also show a drop in maturities, albeit a less dramatic one (Experian, 2009).\textsuperscript{17} The average credit score for a borrower with a new auto loan was nearly 20 points higher in the first half of 2009 than in the first half of 2008, whereas the average score of a borrower with a used car loan was 8 points higher (Experian, 2009).

If the deterioration in the economy made households with poor credit relatively less likely to buy a car, this drop in maturities and LTVs and rise in credit scores might reflect changes in borrower composition. However, statements by lenders suggest that these contract term changes also reflect tighter credit supply due to the turmoil in the capital markets. In an October 2008 press release, GMAC implemented “a more conservative purchase policy for consumer auto financing in the United States as a result of the lack of stability in the global capital and credit markets. The changes include limiting purchases to contracts with a credit score of 700 or above. Additionally, the company will restrict contracts with higher advance rates and longer terms.”\textsuperscript{18} In addition, in June 2009 ten issuers of TALF-eligible auto ABS looked back at the factors underlying the drop in their loan originations in previous months. Six

\textsuperscript{15} Estimate calculated by the Federal Reserve Bank of New York from Equifax data. Loan originations are dollar-weighted.
\textsuperscript{16} Spread measured relative to the yield on 5-year Treasury notes.
\textsuperscript{17} These data indicate that maturities on loans for the purchase of new and used cars were 1 to 2 months shorter in the first half of 2009 than in the first half of 2008, and the amount financed fell for new loans originated to borrowers with subprime or nonprime credit and for all categories of borrowers for used loans.
of these issuers pointed to a “lack of funding” as a very important factor in the drop in their loan originations over the previous months, and three labeled it a “somewhat important” factor.¹⁹

5.1. The effect of the financial crisis on vehicle sales

The financial crisis hit vehicle sales in earnest during the second half of 2008, and selling rates plunged to levels not seen since the early 1980s. The VAR estimated in section 4 suggests that vehicle sales were likely suppressed by the host of adverse shocks to households’ employment situations, incomes and available credit supply between the end of 2007 and the middle of 2009. The shocks to each of the six equations in the VAR are shown in figure 7. The graphs in the left-hand column show estimates of the shocks to each variable from July 1978 through April 2010, and the column to the right shows the same data in the more limited range of January 2007 through April 2010. To put the plots on comparable scales, the shocks have been normalized by their standard deviations.

As seen in the top panel of the figure, a series of large and positive shocks to the changes in interest rates for new vehicle loans were registered between August 2008 and December 2008. By the end of this period, interest rates on vehicle loans stood 7 standard deviations (or about 5 percentage points²⁰) above their expected level, given the histories of the variables in the system. Much of this cumulative residual was unwound in the spring of 2009.

Looking through the other variables, the next two panels plot shocks to the measures of consumer sentiment towards car buying credit conditions. Note that adverse credit shocks show up in these plots as negative “good” credit shocks as well as positive “bad” credit shocks. As seen in the figure, these measures registered magnitudes during the 2008 financial crisis that had not been seen since the 1980s, even conditional on the path of interest rates. Similarly, unexplained changes in the unemployment rate popped up several times in 2008 and 2009, as shown in the following page. Shocks to real personal income were influenced by fiscal stimulus spending and tax rebates at various times in 2008 and 2009, but real personal incomes were otherwise recording low values over much of this period, even conditional on employment.

¹⁹ Survey conducted by the Federal Reserve Bank of New York Markets Group.
²⁰ The standard deviation of the shocks to interest rate changes was 0.7 percentage point.
Changes to any single factor are unlikely to explain a significant share of the deterioration in new vehicle sales over this period. In fact, as seen in the bottom row of figure 7, the residuals to the vehicle sales equation were large and negative over most months between March 2008 and February 2009, a result that suggests that vehicle sales fell much more sharply over this period than could be explained by all of the variables included in the system.

How much of the decline in new vehicle sales between the end of 2007 and the middle of 2009 can be attributed to the deterioration in credit conditions? To answer this question, we used the VAR system estimated above and simulated a counter-factual path for vehicle sales in the 2008 financial crisis. The counterfactual path of sales is the level of sales that would have occurred if the only shocks allowed to affect the VAR system after December 2007 are the shocks to the three financial variables—the interest rates on new vehicle loans at finance companies and the two measures of consumer attitudes towards vehicle lending conditions.

Figure 8 shows the results of this exercise. The solid black line in the figure shows actual light vehicle sales, a measure that declined at an annual rate of 6.3 million units between December 2007 and June 2009. Vehicle sales popped up in July and August 2009, when the federal government introduced a temporary vehicle scrappage incentive program that offered households a rebate if they turned in old vehicles and purchased new vehicles. Sales during the rebate period are shown as the black dashed line in the figure, and to avoid the influence of this special event we terminated the VAR simulation in June 2009. The dashed red line in the figure plots the counter-factual path of sales that isolates the movements attributable to financial shocks. The counterfactual measure declined at an annual rate of 2.4 million units over the simulation period, a magnitude that accounts for about 38 percent of the actual decline that was observed over this period.

For comparison, the decline in vehicle sales predicted by the complete VAR model over the simulation period is also shown in figure 8 as the hollow line. This path corresponds to the level of sales that the VAR model would have predicted in December 2007 if accurate predictions for the paths for interest rates, consumer sentiment, the unemployment rate, and changes in real personal income were supplied for the coming 28 months. The fitted sales path fell 4.5 million units between December 2007 and June 2009, an amount that corresponds to about 70 percent of the decline that was actually observed. As mentioned above, the remaining
30 percent corresponds to the string of large and negative residuals to the vehicle sales equation in the VAR model.

In summary, the simulation exercise shows that a deterioration in vehicle lending conditions occurred between the end of 2007 and the end of 2008 that rivaled in magnitude the episodes of tight credit observed in the late 1970s and early 1980s. In the context of our VAR model, the deterioration in lending conditions can account for a bit more than a third of the plunge in vehicle sales between the end of 2007 and the middle of 2009, an amount that was almost as large as the decline accounted for by shocks to the unemployment rate. However, a significant portion of the drop in vehicle sales, almost 30 percent, is explained by factors not included in the model.

5.2. Response to the crisis: The Term Asset-Backed Securities Lending Facility (TALF)

In late November 2008, the Federal Reserve Board, the Federal Reserve Bank of New York, and the U.S. Treasury announced a lending facility (the Term Asset-Backed Securities Lending Facility, or TALF) designed to ease conditions in the ABS market and, by extension, facilitate new lending to consumers. Under TALF, the Federal Reserve Bank of New York extended loans to investors to purchase highly rated ABS. Investors were required to put up some of their own funds to purchase the securities (the “haircut”). For ABS with fixed-rate coupons, such as auto loan ABS, the TALF loan interest rate was 100 basis points over the equivalent-maturity Libor swap rate. The TALF loan spread was well below the spread prevailing in late 2008 but well above the spread on highly rated ABS during “normal” times, so that investors would cease to use the program as spreads returned to normal levels. The loans to investors are non-recourse, meaning that if the investor defaults on the TALF loan, the Federal Reserve Bank of New York receives the ABS and the investor loses only the haircut. Loans collateralized by auto loan ABS were extended from March 2009 to March 2010.

TALF was well-received by ABS investors and issuers. Over the life of the program, seventeen automobile lenders issued thirty-four TALF-eligible ABS. As the program gathered steam, spreads on auto ABS dropped from around 300 basis points in March 2009 to about 20

---

21 Shocks to the unemployment rate accounted for 3.1 million units of the decline in sales over this period.
22 Information on TALF is available at http://www.newyorkfed.org/markets/talf.html.
basis points in March 2010. This drop in spreads translated into substantially more favorable funding costs for issuers. In a June 2009 survey, three out of eleven issuers of TALF-eligible auto ABS estimated that participating in the TALF program reduced their cost of funds by 200 to 400 basis points, and five estimated a reduction in their cost of funds of 100 to 200 basis points.

Auto lenders appear to have passed along at least some of this decreased cost of funds to borrowers. In a follow-up survey in February 2010, issuers of TALF-eligible ABS provided data on their auto loan interest rates. The median change in the interest rates from the fourth quarter of 2008—the peak of the crisis—to the fourth quarter of 2009 was a drop of 162 basis points.\(^{23}\) This decrease is commensurate with declines shown in other data sources over this period: rates dropped by 135 basis points for loans extended by auto dealerships; by 362 basis points for loans extended by the Detroit 3 finance companies; and by 51 basis points for loans offered by commercial banks.\(^{24}\) Over the same period, average LTVs for loans extended by finance companies rose by 5 percentage points, and maturities increased by 1.5 months (figure 6).

Factors other than TALF clearly contributed to this improvement in auto financing conditions. Risk premiums declined in a variety of financial markets over 2009, and government assistance to GMAC and Chrysler Financial provided direct support to the auto industry. Nonetheless, auto lenders identified TALF as a significant factor in the decline in their loan rates. In the same February 2010 survey, four out of nine issuers identified the availability of TALF financing as the “dominant factor” or “a very important factor” in the change in their retail loan rates over the previous year, and an additional four labeled TALF financing a somewhat important factor. Changes in macroeconomic conditions and changes in the availability of other funding sources were cited as other important influences on their rates. Multiple accounts in the popular press also attributed much of the loosening of credit terms to TALF (Brannigan, 2010; Levin 2010; Strumpf and Durbin, 2010).

In total, TALF-eligible ABS financed over 2.8 million consumer vehicle loans and leases—approximately 20 percent of the auto loans and leases originated over this period.\(^{25}\) In

\(^{23}\) Estimate based on issuers of ABS collateralized by prime auto loans.

\(^{24}\) Data on loans extended by auto dealerships are provided by J.D. Power and Associates. Rates at finance companies and banks are taken from the G.19 consumer credit release: [http://www.federalreserve.gov/releases/g19/](http://www.federalreserve.gov/releases/g19/).

\(^{25}\) Number of loans and leases financed by TALF-eligible ABS tabulated by the New York Fed Markets Group from ABS prospectuses. Total number of loan and lease originations estimated by the New York Fed from Equifax data.
addition, by the fourth quarter of 2009, the market had improved enough so that many auto ABS were marketed outside of the TALF program. By improving liquidity and facilitating price discovery in the ABS market, TALF likely supported the issuance of these ABS and the funding of the underlying loans as well.

Vehicle sales have improved moderately since the summer of 2009 but remain at levels that are still quite weak. Between June 2009 and April 2010, sales moved up about 1½ million units (annual rate), retracing a quarter of the decline that had occurred over the preceding 18 months. According to the VAR simulation exercise used earlier, about 40 percent of the recent increase in sales reflects improvements in the financial conditions for auto lending, including more favorable loan rates at the captive auto finance companies and more upbeat consumer sentiment toward auto lending.

6. Conclusion

We find that conditions in the vehicle finance market significantly affect vehicle sales in general and contributed importantly to the slump in sales that began in 2008. Regressions based on household-level data from the Michigan survey suggest that actual and perceived financing conditions play a major role in vehicle purchases, and that a significant share of households are not able to access credit as easily as they would like. Households with a college education—a group less likely to be borrowing constrained—are more likely to purchase a car when they expect higher income in the future. The purchases of borrowing-constrained households, in contrast, are sensitive to current credit conditions but not to expected future income. The importance of financing conditions is also evident in aggregate data. We find that a one-standard-deviation adverse shock to the share of households who believe it is a bad time to buy because of credit conditions would reduce sales 120,000 units below its baseline. Aggregate vehicle sales are also quite sensitive to change in the average interest rate – falling about 130,000 units below its baseline for every one-standard deviation upward shock to the interest rate.

In 2007, financial markets entered a period of crisis that eventually shut down ABS markets, an important source of funding for new vehicle loans. Through its effect on conditions in the vehicle financing market, this crisis contributed importantly to the slump in vehicle sales. Spending on motor vehicles fell by an extraordinary 40 percent between the end of 2007 and the
spring of 2009; we find that 38 percent of this decline can be explained by shocks to the interest rate on new vehicle loans and to consumer perceptions of financing conditions. This result suggests that actions taken by the Federal Reserve and the U.S. Treasury to bolster the flow of credit to car buyers may have played a role in supporting vehicle sales and the U.S. economy more broadly.
REFERENCES


### Table 1

**Fluctuations in Real Personal Consumption Expenditures (PCE)**

1990 through 2007

<table>
<thead>
<tr>
<th>Share of PCE</th>
<th>Standard deviation (quarterly percent change, annual rate)</th>
<th>Share of PCE volatility (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goods and services</td>
<td>100</td>
<td>1.8</td>
</tr>
<tr>
<td>. . Goods</td>
<td>41</td>
<td>3.6</td>
</tr>
<tr>
<td>. . . New motor vehicles</td>
<td>3</td>
<td>29.5</td>
</tr>
</tbody>
</table>

Data are from the *National Income and Product Accounts*. Share of PCE volatility attributable to each component is calculated as 100 less the variance of growth contribution of PCE excluding each component relative to the variance of total PCE. Components are excluded from PCE using a formula that accounts for chain weights.
<table>
<thead>
<tr>
<th>Age Group</th>
<th>Survey of Consumer Finances</th>
<th>Michigan Survey (cross-section)</th>
<th>Michigan Survey (panel)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age 18-24</td>
<td>0.06</td>
<td>0.06</td>
<td>0.05</td>
</tr>
<tr>
<td>Age 25-34</td>
<td>0.16</td>
<td>0.15</td>
<td>0.14</td>
</tr>
<tr>
<td>Age 35-44</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>Age 45-54</td>
<td>0.21</td>
<td>0.20</td>
<td>0.21</td>
</tr>
<tr>
<td>Age 55-64</td>
<td>0.16</td>
<td>0.16</td>
<td>0.16</td>
</tr>
<tr>
<td>Age 65+</td>
<td>0.21</td>
<td>0.22</td>
<td>0.24</td>
</tr>
<tr>
<td>Married</td>
<td>0.51</td>
<td>0.56</td>
<td>0.56</td>
</tr>
<tr>
<td>White</td>
<td>0.74</td>
<td>0.79</td>
<td>0.81</td>
</tr>
<tr>
<td>Attended college</td>
<td>0.54</td>
<td>0.64</td>
<td>0.64</td>
</tr>
<tr>
<td>Stockowner</td>
<td>0.51</td>
<td>0.62</td>
<td>0.64</td>
</tr>
<tr>
<td>Homeowner</td>
<td>0.69</td>
<td>0.78</td>
<td>0.79</td>
</tr>
</tbody>
</table>

**Notes.** SCF data are from the 2004 and 2007 waves. SCF estimates are weighted with the x42001 weight and Michigan estimates are weighted with the household weight. Reuters/Michigan (cross-section) refers to all households interviewed in months when the vehicle financing module was conducted. Reuters/Michigan (panel) refers to the subset of these households that could be matched with an earlier interview.
### Table 3

**Michigan Sample Summary Statistics**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bought a car in the past six months</td>
<td>0.14</td>
<td>0.35</td>
</tr>
</tbody>
</table>

**Financing conditions**
- Good time to buy a car because of credit conditions | 0.20  | 0.40               |
- Finance company vehicle loan rate                  | 4.86  | 0.96               |
- Fed funds rate                                     | 2.37  | 1.88               |

**Economic conditions**
- Personal financial circumstances are worse than a year ago | 0.40  | 0.49               |
- Unemployment rate                                    | 6.16  | 1.78               |
- Good time to buy a car for other reasons             | 0.43  | 0.50               |
- Expect higher family income next year               | 0.55  | 0.50               |
- Expect lower family income next year                | 0.18  | 0.39               |

**Demographics**
- Age 18-24                                          | 0.04  | 0.20               |
- Age 25-34                                          | 0.10  | 0.30               |
- Age 35-44                                          | 0.18  | 0.39               |
- Age 45-54                                          | 0.23  | 0.42               |
- Age 55-64                                          | 0.19  | 0.40               |
- Age 65+                                            | 0.25  | 0.44               |
- Income less than $35,000                            | 0.25  | 0.43               |
- Income $35,000 - $60,000                            | 0.23  | 0.42               |
- Income $60,000 - $100,000                           | 0.25  | 0.43               |
- Income greater than $100,000                        | 0.23  | 0.42               |
- Income missing                                      | 0.04  | 0.20               |
- White                                              | 0.84  | 0.37               |
- Married                                             | 0.69  | 0.46               |
- Attended college                                    | 0.67  | 0.47               |
- Own stock                                           | 0.83  | 0.38               |
- Own home                                            | 0.69  | 0.46               |

**Note.** Dataset derived from the Thomson Reuters / University of Michigan Survey of Consumers. Statistics are unweighted.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter</th>
<th>Standard error</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Financing conditions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good time to buy because of credit conditions</td>
<td>0.049***</td>
<td>0.018</td>
</tr>
<tr>
<td>Good time to buy for other reasons</td>
<td>0.016</td>
<td>0.013</td>
</tr>
<tr>
<td>Finance company vehicle loan rate</td>
<td>-0.012</td>
<td>0.008</td>
</tr>
<tr>
<td>Fed funds rate</td>
<td>-0.008</td>
<td>0.006</td>
</tr>
<tr>
<td><strong>Economic conditions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unemployment rate</td>
<td>-0.016***</td>
<td>0.006</td>
</tr>
<tr>
<td>Personal financial condition worse than year ago</td>
<td>-0.010</td>
<td>0.012</td>
</tr>
<tr>
<td>Expect higher family income next year</td>
<td>0.021</td>
<td>0.014</td>
</tr>
<tr>
<td>Expect lower family income next year</td>
<td>-0.008</td>
<td>0.016</td>
</tr>
<tr>
<td><strong>Demographics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age 18-24</td>
<td>0.082</td>
<td>0.055</td>
</tr>
<tr>
<td>Age 25-34</td>
<td>0.055**</td>
<td>0.023</td>
</tr>
<tr>
<td>Age 35-44</td>
<td>0.047**</td>
<td>0.020</td>
</tr>
<tr>
<td>Age 45-54</td>
<td>0.064***</td>
<td>0.017</td>
</tr>
<tr>
<td>Age 55-64</td>
<td>0.022</td>
<td>0.017</td>
</tr>
<tr>
<td>Income $35,000 - $60,000</td>
<td>0.027</td>
<td>0.017</td>
</tr>
<tr>
<td>Income $60,000 - $100,000</td>
<td>0.060***</td>
<td>0.019</td>
</tr>
<tr>
<td>Income greater than $100,000</td>
<td>0.055***</td>
<td>0.021</td>
</tr>
<tr>
<td>Income missing</td>
<td>0.013</td>
<td>0.026</td>
</tr>
<tr>
<td>White</td>
<td>0.021</td>
<td>0.016</td>
</tr>
<tr>
<td>Married</td>
<td>0.047***</td>
<td>0.013</td>
</tr>
<tr>
<td>Attended college</td>
<td>-0.028*</td>
<td>0.014</td>
</tr>
<tr>
<td>Own stock</td>
<td>-0.001</td>
<td>0.014</td>
</tr>
<tr>
<td>Own home</td>
<td>0.006</td>
<td>0.016</td>
</tr>
<tr>
<td>Intercept</td>
<td>0.189</td>
<td>0.076</td>
</tr>
</tbody>
</table>

R-squared: 0.035

N: 3,664

**Notes.** Dataset derived from the Thomson Reuters / University of Michigan Survey of Consumers. Eicker-White robust standard errors are shown. Significant at the *** 1 percent level, ** 5 percent level, * 10 percent level. Data are weighted with the household head survey weights.
Table 5

Regression Estimates over Subgroups

Dependent variable: bought a car over the past six months

<table>
<thead>
<tr>
<th></th>
<th>Attended college</th>
<th>Owns stock</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Good time to buy because of credit conditions</td>
<td>0.024</td>
<td>0.102***</td>
</tr>
<tr>
<td>Finance company vehicle loan rate</td>
<td>-0.015</td>
<td>-0.006</td>
</tr>
<tr>
<td>Personal finance conditions worse than a year ago</td>
<td>-0.003</td>
<td>-0.025</td>
</tr>
<tr>
<td>Unemployment rate</td>
<td>-0.012*</td>
<td>-0.025**</td>
</tr>
<tr>
<td>Expect higher income over the next year</td>
<td>0.042**</td>
<td>-0.015</td>
</tr>
<tr>
<td>Expect lower income over the next year</td>
<td>0.006</td>
<td>-0.021</td>
</tr>
</tbody>
</table>

R-squared 0.037 0.064 0.038 0.035
N 2,479 1,185 2,544 1,120

Note. Dataset derived from Thomson Reuters / University of Michigan Survey of Consumers. Eicker-White robust standard errors are shown. Significant at the *** 1 percent level, * 5 percent level, * 10 percent level. Data are weighted with the household head survey weight.
Figure 1

Light Vehicle Sales per 1000 Households

Seasonally adjusted; January 1960 through May 2010

Note: Light vehicles are defined as cars and light trucks, which include vans, pickups, sports utility and cross-utility vehicles. Data come from the Bureau of Economic Analysis and the U.S. Bureau of the Census. 2009 population estimates were used for January and February 2010. Shaded regions denote NBER recessions. The trough of the recession that began December 2007 is shown here as September 2009, though, as of this writing, the date has yet to be determined.
Figure 3
Response of Light Vehicle Sales to Model Shocks
Based on vector autoregression; July 1978 to December 2007

Note: Impulses are 1 standard deviation to the change in each explanatory variable. Responses in sales are cumulative. Dashed lines are 2 standard deviation confidence bands. Standard errors based on monte carlo simulations.
Figure 4

Spread on auto ABS
2007-2010

Issuance
July 1997 through May 2010

Note. Data on ABS are from Inside MBS/ABS, Merrill Lynch, Bloomberg. Spread data is an indicative quote of the level at which a high-quality triple-A three-year auto ABS would trade in the secondary market. Spreads are relative to swaps.
Figure 5

Average Interest Rates and Spreads for New Car Loans

March 1972 through April 2010

Interest rates

Spreads

Note. Interest rates at finance companies are reported monthly in the G.19 Statistical Release at the Federal Reserve Board. Interest rates at commercial banks are reported at mid-quarter. Interest rates at credit unions are from the Credit Union National Association. Spreads are relative to the yield on 5-year Treasury notes.
Figure 6
Vehicle Financing Conditions at Finance Companies
July 2008 to April 2010

Source. G.19 Consumer Credit release.
Figure 7

Residuals from the equations in the vector autoregression

Standard deviations; July 1978 to April 2010

Note: Shocks are identified from the vector autoregression shown in equation (2). The shocks have been normalized by their standard deviation for comparability across variables. The charts in the right-hand column zoom-in on the period January 2007 through April 2010.
Figure 7 (continued)

Shocks to the variables in the vector autoregression

Standard deviations; July 1978 to April 2010

Note: Shocks are identified from the vector autoregression shown in equation (2). The shocks have been normalized by their standard deviation for comparability across variables. The charts in the right-hand column zoom-in on the period January 2007 through April 2010. The dashed lines in the “Auto sales” panels reflect periods in which sales were directly affected by the “Cash for Clunkers” program.
Figure 8

Effects of Financial Shocks on New Vehicle Sales

VAR simulation; December 2007 to April 2010

Note: Simulation is based on the VAR estimated in equation (2). The solid black line shows actual light vehicle sales. The dashed red line shows the counterfactual path of sales that would have occurred between December 2007 and April 2010 if the only shocks allowed to affect the VAR system after December 2007 were shocks to the three financial variables in equation (2). The double blue line shows the path of vehicle sales predicted by VAR model when the actual shocks to all five variables in equation (2) other than vehicle sales are allowed to affect the system.