Auto Sales and Credit Supply

Kathleen Johnson, Karen Pence, and Daniel Vine

Board of Governors of the Federal Reserve System

September 2014

Abstract. Consumer purchases of motor vehicles fell more than 20 percent during the 2007-09 recession, and auto loan originations fell by a third. We show that swings in auto sales and credit availability are significant features of most business cycles. Using a novel measure of household perceptions of vehicle financing conditions, we show with both time-series and household-level data that the effects of credit conditions on auto sales are as large as those from factors such as unemployment and income. The results contribute to the literature validating the usefulness of survey measures of household perceptions for forecasting macroeconomic activity.

Author contact information: Kathleen.W.Johnson@frb.gov, Karen.Pence@frb.gov, Daniel.J.Vine@frb.gov. We thank Samuel Ackerman, Angus Chen, Andrew Loucky, Brett McCully, Meredith Richman, Mark Wicks, and Jessica Zehel for terrific research assistance. We thank our Federal Reserve colleagues, Moshe Buchinsky, and seminar participants at the NBER Summer Institute, the OCC and the Homer Hoyt Institute for helpful insights and conversations. We are grateful to Bob Hunt, Avi Peled, Sharon Tang, and Chellappan Ramasamy at the Philadelphia Fed for generously providing us with estimates from credit bureau data. 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

Real consumer purchases of new and used motor vehicles and the flow of consumer credit used to purchase them contracted considerably during the 2007-09 recession.[1] Real consumer purchases of motor vehicles dropped 22 percent between the end of 2007 and the first quarter of 2009, and loan originations for motor vehicles fell 33 percent. Factors that likely contributed to the drop in sales included the sharp rise in the unemployment rate, the plunge in household wealth, a spate of bankruptcies in the motor vehicle industry that depressed the value of trade-in vehicles for some brands, and the steep run-up in gasoline prices in the summer of 2008. In addition, the financial crisis constrained the ability of finance companies, banks, and even credit unions to originate auto loans. Auto lending conditions appeared to tighten considerably during this period, with average interest rate spreads on new car loans rising from about 2¼ percentage points in mid-2007 to more than 4¾ percentage points in the first quarter of 2009.

Although the decreases in consumer purchases of motor vehicles and consumer auto loans during the 2007-09 recession were quite large, these contractions are not unusual. Declines in purchases of motor vehicles typically account for almost two-thirds of the slowdown in growth of real durable goods consumption during recessions, even though vehicles represent only about a third of durable goods purchases. Part of this decline seems to stem from the fact that consumers may delay vehicle purchases when they are uncertain about their economic prospects, and part of the decline likely reflects the fact that the supply of credit often tightens during recessions and may reduce the affordability of a car

[1] Motor vehicles in this paper are defined as passenger cars and light trucks, which include vans, pickups, sports-utility and cross-utility vehicles. We use the terms "autos" and "cars" interchangeably with "motor vehicles."

purchase. This relationship between credit supply and vehicle purchases is the focus of our paper.

Identifying the effects of changes in credit conditions on real activity is a classic topic in macroeconomics. The traditional life-cycle framework suggests that in the absence of borrowing constraints, interest rates should be the only loan contract term that affects vehicle demand (see Chah, Ramey, and Starr, 1995, for one example). However, the vehicle demand of borrowing-constrained households depends on other contract terms besides the interest rate, such as the loan amount, the required down payment, and the loan maturity. Data on motor vehicle loan contracts suggest that many vehicle purchasers are borrowing constrained (Attanasio, Goldberg, and Kyriazidou, 2008). The sensitivity of vehicle purchases to changes in transitory income has also been presented as evidence of borrowing constraints, as shown in the context of tax refunds (Adams, Einav, and Levin, 2009; Souleles, 1999); economic stimulus payments (Parker, Souleles, Johnson, and McClelland, 2013); an increase in the minimum wage (Aaronson, Agarwal, and French, 2012); an increase in Social Security benefits (Wilcox, 1989); and expansions of health insurance (Leininger, Levy, and Schanzenbach, 2010). These papers suggest that this excess sensitivity may be concentrated among purchases of new cars by lower-income households that are presumably more likely to depend on credit to purchase vehicles. Similarly, Mian, Rao, and Sufi (2013) and Mian and Sufi (2014) show that the marginal propensity to purchase vehicles from changes in housing wealth—which appear to affect household borrowing constraints—is largest in zip codes with lower average income and higher ratios of mortgage debt to house values.

In this paper, we explore the role that auto lending conditions play in consumer purchases of motor vehicles. We first document the significant swings in auto sales, auto loans, and credit availability that typically occur over the

business cycle, including the recent 2007-09 recession. We then look for evidence of a causal link between credit supply and auto purchases. Two issues make this exercise challenging. First, it is difficult, if not impossible, to observe the credit supply conditions that apply to each consumer, as loan contract terms are observed only for households who purchase cars. Second, observed interest rates and other loan terms are partly endogenous, reflecting changes in the average credit quality of households and overall demand conditions. For example, the interest rates for new cars are often subsidized by the manufacturers' affiliated finance companies ("captive" financing companies). These subsidies, which are known as interest subvention, typically occur when vehicle sales are soft.

In our empirical work, we use household perceptions of financing conditions, as measured on the Reuters/University of Michigan Surveys of Consumers (herein, "Michigan survey") to explore the relationship between lending conditions and vehicle sales. These perceptions questions are asked of all households, including those who do not purchase vehicles. We assume that the household responses primarily reflect credit supply conditions, and, indeed, we show that these responses vary in sensible ways with other indicators of credit supply. To the best of our knowledge, the relationship between these subjective assessments of financing conditions and vehicle purchases has not been explored previously, and doing so is one of the contributions of this paper.

We estimate the relationship between financing conditions and vehicle sales both with a vector auto-regression (VAR) based on aggregate data and with logit regressions based on previously unexplored household-level data from the Michigan survey. In the VAR, the effects of credit conditions on motor vehicle purchases are measured with the response of purchases to shocks identified recursively with variable ordering. In the logit regressions, we measure the effect

of a household's assessment of auto finance conditions on the probability it buys a car, holding constant the detailed information we observe on the economic circumstances of each household. We measure these household assessments well in advance of the vehicle-purchase decision, and therefore avoid simultaneity bias.

The two models use different identification assumptions, estimation techniques, and source data, and yet both models suggest a relatively strong and causal relationship between credit supply and vehicle purchases. In both models, the effects of financing conditions on sales are as large, if not larger, than traditional determinants of vehicle purchases such as income and unemployment. The household-level model suggests that perceived financing conditions are particularly important for purchases of new cars by households who may be more likely to depend on credit for their purchases, such as those who do not own stock or have a college degree. This result is consistent with the studies referenced earlier that find excess sensitivity of new auto purchases to increases in income among lower-income households. The household-level model also suggests that consumers are a bit more likely to purchase cars when they anticipate that interest rates will rise in the next year. Overall, the relationships that we find between households' perceptions of vehicle finance conditions and their subsequent car purchases are consistent with other studies that show that measures of consumer perceptions and expectations can be useful in forecasting economic outcomes.[2]

In summary, we find that changes in credit conditions over the business cycle significantly affect vehicle sales. In the 2007-09 recession, as in previous recessions, credit conditions tightened, and loan originations and vehicle sales fell. We show that the changes in vehicle purchases and vehicle loans did not

[2] For recent examples, see French, Kelley, and Qi (2013) and van der Klauuw (2012).

look particularly unusual over this period despite the severity of the 2008 financial crisis. That said, some of the mechanisms by which credit tightened were different from previous business cycles, as the sources of funding for auto loans appear to have shifted over time. For example, the asset-backed commercial paper and asset-backed securities market came under significant strain during the financial crisis, and the shocks to these sectors appear to have affected motor vehicle sales (Ramcharan, van den Heuvel, and Verani, forthcoming; Benmelech, Meisenzahl, and Ramcharan, 2014).[3]

2. Motor Vehicle Spending and the Business Cycle

Real (inflation-adjusted) personal consumption expenditures (PCE) for motor vehicles—which includes both new and used vehicles—fell 22 percent during the 2007-09 recession, as shown in figure 1. The decline was the largest in several decades, but the declines in motor vehicle spending during recessions tend to be large; real spending on motor vehicles fell 28 percent during the 1969-70 recession and by 14 percent in the 1980 and 1990-91 recessions.

The other components of PCE shown in figure 1, which exclude purchases of motor vehicles, also fell during the 2007-09 recession.[4] In order to put the 2007-09 recession into historical context and to compare vehicle purchases with purchases of other durable goods, figure 2 plots the 6-quarter changes of real PCE for motor vehicles and real PCE for other durable goods. We chose six quarters to match the duration of the 2007-2009 recession. By this measure, the decline in real PCE for motor vehicles during the 2007-09 recession was large, but it was

[3] See Covitz, Liang, and Suarez (2013) for a discussion of the asset-based commercial paper market during the crisis, and Campbell, Covitz, Nelson, and Pence (2011) for a discussion of the asset-backed securities market.

[4] Computers and information processing equipment are excluded from Figure 1 because real spending in these categories has risen so much faster since 1967 than has spending for other durable goods; it is also not particularly cyclical.

not as large as the declines observed during the 1970, 1974-75, and 1980 recessions. In contrast, the decline in real PCE for other durable goods during the 2007-09 recession was the most severe decline on record for any 6-quarter period back to at least 1967.

Table 1 presents more formally the contribution of motor vehicles to the business cycle patterns in PCE for durable goods. Each numbered row of the table shows data for one U.S. business cycle episode, identified by the NBER dates of the peak and trough, and the memo line at the bottom of the table shows the average for the business cycles before the 2007-09 recession. In an average expansion, real PCE for durable goods grows 5.5 percent at an annual rate from peak to peak, and during an average recession, it falls 3.1 percent. The contribution of motor vehicles to the average change in growth from expansions to recessions, shown in the fourth column of the table, is -5.2 percentage points, or about 60 percent of the average overall change.[5] This contribution is about twice as large as the average share of vehicle purchases in overall durable goods consumption.

During the 2007-09 recession, real PCE for durable goods fell 9 percent at an annual rate after having risen 6 percent from 2001 to 2007 (row 7). The change in growth, at -15.1 percentage points, was about twice as large as the average decline observed during previous recessions. The contribution of motor

[5] The averages in the bottom row of table 1 include observations from the 1981-1982 and 2001 recessions, when—in contrast to the general pattern—purchases of durable goods and motor vehicles increased, and the changes in growth from expansion to recession were also positive. Real PCE for motor vehicles grew at a tepid pace during the 1981-1982 recession and had declined during the brief expansion following the 1980 recession. Motor vehicle spending surged temporarily during the last quarter of the 2001 recession, when the Detroit automakers offered zero-percent financing in effort to boost sales after the September 11 attacks. Another auto industry development that affects the table 1 calculations is the company-wide strike at GM in 1970, which held down auto sales at the end of that year and likely exaggerated the decline in vehicle spending during the 1969-1970 recession.

vehicles to this change, at -4.8 percentage points, was about in line with previous recessions.

3. The relationship between auto purchases and auto loans

About 70 percent of household purchases of new vehicles and 35 percent of household purchases of used vehicles are financed with auto loans.[6] Total auto loan originations for new and used cars fell from about 29.4 million before the onset of the 2007-09 recession to 19.8 million at the trough, a decline of about 33 percent (figure 3).[7] This decline somewhat exceeded the 22 percent drop in real consumer spending on new and used vehicles over the same period.

The decline in auto loan originations during the recession was concentrated among borrowers with lower credit scores (figure 4). Loans originated to borrowers with credit scores below 620—the traditional cutoff for a subprime credit rating—fell by 54 percent between the fourth quarter of 2007 and the second quarter of 2009, whereas loan originations to borrowers with credit scores greater than 780—traditionally considered "superprime" —were little changed. Subprime loan originations made up about 30 percent of all loan originations in 2006, so the contraction in this category had a significant effect on overall originations.

Because data on auto loan originations are available back to only the early 2000s, we cannot use these data to characterize the typical movements of auto loans and auto sales over the business cycle. However, data on auto loan balances, which are somewhat more difficult to compare with auto purchases but

[6] Staff calculation from data on the 2004, 2007, and 2010 Surveys of Consumer Finances.
[7] Calculated by staff at the Philadelphia Fed using anonymized credit bureau trade line data provided by Equifax. Units are measured at annual rate.

have a much longer history, suggest that auto loans are a bit more volatile than sales over the business cycle, although in general the two series move together.[8]

To see this, figure 5 shows the 4-quarter changes in vehicle loan balances (solid line) alongside the 4-quarter changes in the estimated collateral value of recently purchased vehicles (the dashed line).

The collateral value of recently purchased vehicles plotted in the figure is constructed as the discounted sum of nominal consumer vehicle purchases made during the past three years or so. The quarterly discount rate used in the calculation, which we estimate by comparing loan originations to the changes in loan balances from 2001 to 2007, captures the average pace at which outstanding loan balances are either paid off by borrowers or written off by lenders. We estimate this rate to be about 13 percent per quarter, which implies that loan balances should rise and fall in tandem with the discounted sum of auto purchases made during the past three years if the share of autos purchased with a loan is constant.[9]

The peaks and troughs of the two lines in figure 5 are generally well aligned, suggesting that our estimate of the collateral value of recently purchased vehicles is reasonable and based on assumptions that do not appear to have changed much over time. The figure also suggests that loan balances usually grow somewhat more rapidly than purchases during expansions, an observation

[8] Auto loan balances totaled $878 billion in the fourth quarter of 2013, accounting for almost 30 percent of total consumer credit outstanding. Total consumer credit outstanding includes most credit extended to individuals excluding loans secured by real estate. Auto loan balances do not include vehicle leases.

[9] To estimate the discount rate, we subtract originations in quarter *t* from loan balances at the end of quarter *t*. We regress this measure on loan balances at the end of quarter t-1, after first-differencing the data. The coefficient on the lagged loan balances is 0.87 and is significant at the 95% level. The estimate implies that 40 percent of open loan balances reflect loans originated within the past 1 year, 67 percent from the past 2 years, and 82 percent from the past 3 years.

that may reflect the cyclical increase during expansions of vehicle purchases by households that are more reliant on financing. Further, the decline in the growth rate of auto loan balances between expansions and recessions is somewhat larger than the decline in the growth rate of consumer vehicle purchases.

Changes in the cost and availability of auto loans during the business cycle

Many consumers use a loan to buy a car, and so changes in auto loan originations during the business cycle to a large extent just reflect the rise and fall of car purchases. However, changes in vehicle financing conditions also affect the affordability of a vehicle purchase and therefore vehicle sales. This effect is pro-cyclical, as lending conditions tend to loosen during expansions and tighten during recessions. In this regard, also, the 2007-09 recession was not too different from previous recessions: the deterioration in several measures of auto lending conditions was large but similar magnitudes of deterioration had been observed in previous recessions.

We show three measures to demonstrate the cyclicality of lending conditions. First, the spread between the rate charged on new auto loans and the funding benchmark for lenders—the two-year swap rate—generally widens in recessions (figure 6). This relationship holds for all the major suppliers of auto loans—commercial banks, credit unions, and finance companies—as well as for loans originated at dealerships, which could be financed by any of these types of institutions. The widening in spreads during the 2007-09 recession appears to be about in line with previous business cycles.

Second, the willingness of banks to make consumer installment loans, as measured by the Senior Loan Officer Opinion Survey, also declines in recessions (figure 7). Auto loans are the largest component of consumer installment loans.

The decline observed in this measure during the 2007-09 recession was matched only by the drop during the 1980 recession.

Third, respondents to the Michigan Survey are asked whether it is a good or bad time to buy a car, and if so, why. The answers to these questions will feature prominently in our empirical work. The index of respondents' assessments of auto credit conditions, defined as the share who cite low interest rates or easy credit conditions as a reason that it is a good time to buy a car less the share that cite high interest rates or tight credit conditions as a reason it is a bad time to buy a car, also moves with the business cycle (figure 8). The index is also affected at times by the much-publicized reduced-rate financing deals offered by the captive finance companies, such as in the mid-1980s and early 2000s. During the 2007-09 recession, this index fell to its lowest level since the 1981-82 recession.

4. The Role of Financing Conditions in Motor Vehicle Consumption

We now turn from describing patterns in auto sales and auto lending over the business cycle to estimating the statistical relationship between these patterns. One way to assess the causal relationship between lending conditions and vehicle purchases is to include measures of financing conditions along with the motor vehicle component of PCE and macro variables in a vector autoregression, as is shown in equation (1).

$$(1) \qquad Y_t = C + A(L)Y_{t-1} + U_t$$

C is a vector of constants, and the vector *Y* consists of real PCE for motor vehicles and five other variables: the real 2-year swap rate; the spread between the interest rate offered by the captive finance companies and the rate offered by banks—a proxy for interest subvention; an index constructed from consumer

assessments of auto credit conditions in the Michigan survey; the unemployment rate; and real disposable personal income.[10] *A(L)* is a matrix of polynomials in the lag operator *L*. The real variables in Y_t are in log differences, and the interest rates and index variables are in differences. The index of consumer assessments of auto credit conditions is the Michigan Survey measure shown in figure 8. We also include in the model three lags of each variable, and U_t is a vector of error terms.[11] The model is estimated on quarterly data from 1978:Q3 through 2007:Q4 to ensure that the estimated effects of financing conditions on real auto purchases are not unduly influenced by the outsized moves in some of the variables during the 2007-09 recession. As a robustness exercise, we estimate the model with data through 2013; except where noted, our results are unchanged when we estimate the regression for this longer time period.

Figure 9 plots the response of real PCE for motor vehicles to a one standard deviation shock to each equation. These shocks are identified recursively in the VAR with a standard Cholesky decomposition. We assume that motor vehicle consumption responds to shocks to real income and interest subvention in the same quarter and to changes in the unemployment rate, the real two-year swap rate, and auto credit sentiment with a one-quarter lag.[12]

---

[10] Real PCE for motor vehicles and real disposable personal income are from the National Income and Product Accounts; the 2-year swap rate is from Reuters limited; the unemployment rate is from the Bureau of Labor Statistics; and the rates offered on auto loans from banks and captive finance companies are from the G.19 and G.20 statistical releases from the Federal Reserve. The real rate of interest is calculated as the nominal rate of interest less the 12-month change in the PCE price index.

[11] We experimented with several other variables that we ultimately excluded from the model because they were not statistically significant: the aggregate LTV; the log of changes in real household wealth; gasoline prices; headline measures of consumer confidence; and forward-looking survey measures of expected unemployment.

[12] The variable ordering is similar to the recursive ordering used by Sims (1986) and assumes that real variables respond to the real 2-year swap rate with a lag. The ordering of the variables also implies that consumer sentiment toward car-buying credit conditions responds to the real swap rate shocks in the same period; as a result, shocks to credit sentiment are conditional on underlying

The solid line in each panel of figure 9 shows the response of the level of motor vehicle consumption to a one standard deviation shock to the listed explanatory variable, and the dashed lines define the 95 percent confidence interval around each point on the solid line. As shown in the top left panel, a one standard deviation increase to the growth rate of real DPI boosts motor vehicle consumption by about 1¾ percent after 4 quarters, a magnitude that is statistically different from zero. Shocks to interest subvention, shown in the top-right panel, boost motor vehicle consumption by about 1½ percent. The effect of an unemployment rate shock, shown in the middle-left, is not different from zero. A one standard deviation shock to the 2-year swap rate reduces motor vehicle consumption by about 2¼ percentage points after 4 quarters.[13] A one standard-deviation increase in consumer sentiment toward car-buying credit conditions, conditional on all of the other shocks, boosts motor vehicle consumption by 2 percent after about 4 quarters, a magnitude that is statistically different from zero.

We also estimated the VAR separately for new-car and used-car purchases. The results indicate that financing discounts affect new-car purchases but not used-car purchases; real interest rates likewise appear to have a larger effect on new-car purchases than on used-car purchases. The financing-discount result is reassuring, as these promotions are offered almost exclusively for new-car purchases. In contrast, auto credit sentiment has about the same effect on both

interest rates and the value of interest subvention. Moving the unemployment rate ahead of vehicle purchases in the ordering did not much alter the results.

[13] The response of vehicle purchases to changes in the real swap rate becomes insignificant (just barely) at most horizons if the end of the sample period is extended from 2007:Q4 to 2013:Q4. If we exclude the years before 1985, when high inflation was a central concern and interest rates were volatile, the response of purchases to the real swap rate decreases, although the response of purchases to financing discounts increases and the response to credit sentiment remains significant and becomes larger than the response of purchases to real income.

new-car and used-car purchases, although the response is more precisely estimated for used-car purchases.

The impulse responses from the main VAR suggest that consumer assessments of auto credit conditions play a large role in vehicle purchases even after controlling for underlying interest rates and interest subvention. To explore what these assessments capture, Table 2 presents the forecast error variance decomposition for this variable in the VAR. The exercise shows that the perceptions variable moves in a sensible way with interest rate conditions: about a quarter of the variance of consumer assessments of auto credit conditions after 4 quarters reflects shocks to the real interest rate and interest subvention. However, slightly more than half of the variance of car-buying credit sentiment is unexplained by the other variables in the system, as shown in the last column of the table.

These unexplained changes in the credit assessment index could reflect aspects of lending conditions not well-captured by the average interest rate; differences between consumer perceptions of lending conditions and actual lending conditions; or idiosyncratic factors that affect a household's ability to access credit at affordable terms. To assess whether the shocks to consumer credit sentiment partly reflect changes in other (non-interest rate) terms or standards of credit, we regress the orthogonalized residuals from the consumer assessments of auto credit conditions equation on the current and lagged values of the Senior Loan Officer Opinion Survey on Bank Lending Practices (SLOOS) index of the net increase in the willingness of banks to extend consumer credit.[14] The regression is shown in equation 2.

[14] Information on the SLOOS is available at http://www.federalreserve.gov/boarddocs/SnLoanSurvey/.

(2)

$$u_t = \underset{(.002)}{0} + \underset{(.001)}{.005}^{**} \cdot sloos_t + \underset{(.002)}{.001} \cdot sloos_{t-1} + \underset{(.002)}{0} \cdot sloos_{t-2} + \underset{(.001)}{.003}^{**} \cdot sloos_{t-3} + \varepsilon_t$$

The sum of the coefficients on the SLOOS index terms is greater than zero, indicating an increasing willingness to lend boosts the consumer sentiment index, and are statistically significant as a group.[15] The R^2 from the regression indicates that about 12 percent of the variance of the shocks to consumer sentiment toward car-buying credit conditions may reflect restrictions in credit supply as measured by the SLOOS index.

The results presented here suggest that both actual interest rates, including the amount by which finance companies subsidize interest rates, and consumer assessments of financing conditions have an impact on real PCE for motor vehicles, even conditional on other macroeconomic variables that typically determine consumer spending. In addition, the response of vehicle purchases to changes in financing conditions is as large, or perhaps even larger, than its response to traditional macro factors, such as personal income.

5. The effects of financing conditions on household auto purchases

We next explore the relationship between vehicle purchases and financing conditions with household-level data, which have two key advantages relative to the macro data. First, by exploiting variation across households, we can control more thoroughly for factors such as employment and wealth that might be correlated with interest rates. Second, we can identify the types of households whose auto purchases are more likely to be sensitive to interest rates or other

[15] ** indicates statistical significance at the 5% level. An F test rejects the hypothesis that the coefficients on the SLOOS and its lags are zero; the F statistic is 4.1 with a p-value of .004.

terms of the loan contract, and thereby gain more insight into the mechanisms underlying the macroeconomic relationship.

Our household-level analysis is based on microdata from the Michigan survey, in which about 500 households are asked each month about their expectations for the economy; their assessment of current conditions; and their income, wealth, and assorted demographic characteristics. Among these variables, as noted earlier, is the household's assessment of vehicle-purchasing conditions. Households are interviewed twice for the survey, with the two interviews separated by six months. We supplement these data with a special module on vehicle purchases that the Federal Reserve has sponsored on the survey about three times per year since 2003. These data include an indicator for whether the household purchased a new or used car during the past six months.

We use these data to estimate logit regressions that relate a household's decision to purchase a vehicle to its beliefs about vehicle financing conditions and its personal financial situation. Our estimation takes advantage of the short-panel aspect of the survey. The dependent variable is an indicator of whether the household reported in the second interview that it had purchased an automobile in the previous six months. The independent variables are measured at the time of the first interview and include measures of financing conditions and a host of macroeconomic and demographic controls. By using responses from the first interview as the independent variables, we reduce the simultaneity problems that complicate identification of demand functions.

Our analysis focuses on two measures of financing conditions from the Michigan survey. First, survey respondents are asked whether "the next twelve months or so will be a good or bad time to buy a vehicle," and are then asked "If so, why?" These data are the household-level responses that underlie the index of

consumer assessments of auto credit conditions that was used in the VAR. We construct an indicator variable from these responses that denotes when a household says it is a good time to buy a car because credit conditions are favorable. As about 95 percent of such respondents cite low interest rates, we refer to this variable as "good time-rates."[16] [17] Second, respondents to the survey are also asked: "What do you think will happen to interest rates for borrowing money during the next 12 months—will they go up, stay the same, or go down?" We construct indicator variables from these responses to denote when a household says it expects rates to go up (we refer to this variable as "rates up") and when it says it expects rates to go down (we refer to this variable as "rates down").[18] We also included the two-year swap rate and a measure of interest subvention in the regressions, but the coefficients on these time-series variables are not significant, perhaps due to the shorter time span of these household-level data.[19]

---

[16] The Michigan Survey also codes reasons why households think that it is a bad time to buy a car. However, the share of all households reporting "bad time because of credit conditions-"is quite low (4 percent) compared with the share reporting "good time because of credit conditions" (20 percent), so we focus only on the "good time-rates" data in this section of the paper.

[17] Respondents to the Michigan Survey can supply two reasons for why now is a good time to buy a car. We set "good time–rates" equal to 1 if a household listed financing conditions as either the primary or the secondary reason, and "good time–other" equal to 1 if a household did not list financing conditions for either reason. As a result, "good time-rates" includes households who listed a non-credit reason first. However, we think that this choice is preferable to contaminating "good time-other" with households who noted interest rates as a factor. In practice, when we set "good time–rates" equal to 1 if a household listed financing conditions as the primary reason, and "good time–other" equal to 1 if a household listed a different factor for the primary reason, our results are largely unchanged.

[18] The moves in these measures of expected interest rate changes are fairly consistent with actual changes in the prime rate, as shown by the Surveys of Consumers (University of Michigan, 2014).

[19] For the empirical work with micro data, we use an interest subvention measure provided by J.D. Power and Associates. Because of the limited history of this measure, we were not able to use it in the macro data exercise. This subvention measure is the net present value of reduced-rate financing per vehicle sold, normalized by the average vehicle price. For example, when reduced-rate financing deals were at their peak in the early 2000s, interest subvention reduced average transaction prices by about 1¾ percent.

Our dataset consists of the survey responses of households whose second interview occurred when the vehicle module was conducted and whose survey was answered by the head of household or their spouse. Table 3 shows the months the module was conducted and the associated sample sizes. The dataset spans from 2003 to 2013 and includes 5,699 observations with 755 purchases of new and used vehicles.

The Michigan survey is designed to be nationally representative. However, a comparison of our sample with the Survey of Consumer Finances suggests respondents to the Michigan survey tend to have higher income and more education than respondents to the Survey of Consumer Finances, and are also more likely to own stocks or homes (table 4).[20] This pattern is even more pronounced for our panel sub-sample. For example, 43 percent of the households in our panel sample graduated from college, 66 percent own stock, and 80 percent are homeowners, compared with a college attendance rate of 36 percent, a stockownership rate of 51 percent, and a homeownership rate of 69 percent in the Survey of Consumer Finances (SCF). In the regression, we address concerns about the representativeness of the sample, at least in part, by including education, homeownership, and stockownership in the list of explanatory variables, and by estimating the models separately over these subgroups. Our main regressions are not weighted because the information used to construct the Michigan weights—the age and income of each household surveyed—are included as independent variables. However, we show the estimates from the weighted model as a robustness test. We show robust standard errors throughout.

[20] 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.

We begin with a simple logit model that estimates the marginal effects of a household's assessment of auto credit conditions and its predictions of the future path of interest rates on the probability it purchases a vehicle in the next six months. The first line of table 5 shows that households are nearly 8 percentage points more likely to purchase a car if they assess car-buying conditions as good because interest rates are low. The marginal effect is statistically significant, and it is large relative to the share of all households in these data that purchase a car in a given six-month period, which is 13 percent.

One concern about the "good time-rates" variable is that it might be picking up broader positive assessments of car-buying conditions rather than any factors specific to auto finance conditions. We construct another indicator variable, "good times-other," that measures whether the household believes that is a good time to buy a car for reasons other than financing conditions. About two-thirds of such households cite reasons related to car prices, such as "good buys are available;" the remainder cite car features ("new cars get better gas mileage") or the economy. Households that perceive car-buying conditions are good for other reasons are only 3 percentage points more likely to purchase a vehicle, a smaller effect than was estimated for "good time-rates." A χ^2 test indicates that we can reject at the 1 percent confidence level the hypothesis that the coefficients on "good time—rates" and "good time—other" are equal. We interpret this comparison as evidence that perceptions of financing conditions are particularly potent for vehicle purchases.

The second line of table 5 indicates that households who believe that general interest rates are likely to rise are 2 percentage points more likely to purchase a car during the next six months, and the coefficient is statistically significant. A belief that interest rates are likely to decline appears to have no effect on the car purchase decision. This result suggests that households may time

their car purchases in response to expected increases in interest rates. The marginal effect associated with this belief, however, is much smaller than that associated with "good time-rates."

We next add to the model an assortment of other variables that might be correlated with vehicle purchases. These variables include indicators of whether the respondent answers yes or no to the following statements: "I am better off financially than I was a year ago;" "I am worse off financially than I was a year ago;" "During the next 12 months, I expect my family income to be higher than during the past year;" "During the next 12 months, I expect my family income to be lower than during the past year;" "The current value of my house has increased compared with a year ago;" and "The current value of my house has decreased compared with a year ago." For demographics, we include the age, income, marital status, and race of the household, as well as indicators of whether the household head owned a home, owned stock, and graduated from college.[21] The marginal effects of all of the variables in the full specification are shown in table 6, and sample statistics for these variables are shown in table 7.

The estimates show that households are more likely to purchase a vehicle if they report that their financial condition has improved over the past year. Expectations of future income and reported changes in home values appear to be unrelated to vehicle purchases; data explorations suggest that the "better off than a year ago" variable appears to be capturing much of the same variation in the data. Households are more likely to buy a car if they are younger than 65 (and ages 18 to 34 particularly), their income exceeds $35,000, they are white, or they are

[21] Income is measured in bins because a fair number of households in the Michigan survey were only willing to provide a range for their income.

married. Households are less likely to buy a vehicle if they are college graduates (conditional on all other variables).

Even with these other variables in the model, households' assessments of auto credit conditions and their prediction of future interest rates have large and statistically significant effects on vehicle purchases. Households are 5 percentage points more likely to buy a car if they cite low interest rates as a reason that car-buying conditions are good. This marginal effect is bigger, by a statistically significant amount, than the effect from "good times—other," and it is also as large as most of the marginal effects of the other variables in the model.[22] The marginal effect of "rates-up" is a 2 percentage point increase in the probability of purchasing a car, about the same as in the simple model.[23]

In unreported specifications, we tried a variety of other variables in the model, such as the county-level changes in employment from the Quarterly Census of Employment and Wages; the county-level changes in house prices as measured by CoreLogic and Zillow; an indicator of whether a household's financial condition has changed relative to a year ago because he or she lost a job, gained a job, experienced a pay increase or a pay decrease; whether the respondent expected aggregate employment to increase or decrease; and whether the respondent expected his personal financial condition to improve. None of these variables, however, appeared to affect vehicle purchases in a statistically or economically significant way conditioning on the other variables already in the model.

[22] The marginal effect of "good time—rates" is statistically different at the 10 percent level from the marginal effect of "good times—other."
[23] This result differs from what we found in the VAR. We tried adding the index of consumer expectations about future changes in interest rates to the VAR (ordered after the 2-year swap rate), but its shocks did not significantly affect vehicle purchases.

To explore whether financing conditions have different effects on purchases of new or used cars, we estimated a multinomial logit model with three outcomes for making a vehicle purchase: (1) no car purchase, (2) purchase a new car, and (3) purchase a used car (table 5). The estimates from this model indicate that a household is 4 percentage points more likely to buy a new car during the next six months if it assesses car-buying conditions as favorable because interest rates are low; this effect is quite large relative to the 5 percent share of households who purchase a new car over a given six-month period (table 8). In contrast, purchases of used cars are not much affected by households' assessments of auto credit conditions, although they are affected by households' assessments of their financial situation relative to a year ago. As noted earlier, only about 35 percent of used cars, compared with 70 percent of new cars, are financed with credit, so perhaps this result is not surprising. However, these results differ from the VAR, which found an effect of the Michigan credit sentiment index on purchases of used cars.

Checks on robustness

We next explore the robustness of these results to some of our specification choices (table 5). First we tested whether the results are stable over time by estimating the logit model over sub-periods. The "good time-rates" coefficient increased a bit when we estimated the regression on data from 2003 to 2007, a period that preceded the 2007-09 recession and included aggressive financing campaigns that the captive finance arms of the Detroit automakers conducted in 2003 and 2004. The coefficient decreased a bit when we excluded these aggressive financing campaign years from the sample; while this estimate is still statistically different from zero at the 10 percent level, it is no longer

statistically different from the "good time-other" coefficient.[24] The "rates-up" coefficient is 2 percentage points in all time periods, but is not statistically significant when the regression is estimated over the 2003-07 period.

As a second robustness check, we include indicator variables for the month-year in which the survey is conducted. Including the variables means the marginal effect on vehicle purchases of assessments of auto credit conditions is identified only by the variation across households at a point in time. The results indicate that the probability of purchasing a vehicle in the next six months rises 4 percentage points if households perceive that it is a good time to purchase a vehicle because of favorable credit conditions, and it increases 2 percentage points if they believe that interest rates will rise. These marginal effects are close to those from the models without month-year controls.

Finally, we estimate the model with the sample weights provided by the Michigan Survey, which implicitly put more emphasis on the car purchase decisions of younger and lower-income households. Relative to the unweighted model, the marginal effect of "good time-rates" is about the same, whereas the marginal effect of "expect rates-up" is smaller and is statistically insignificant.

Effects of credit perceptions on auto sales for households with tighter access to credit

Next, we separate households based on characteristics that may proxy for more easy access to credit: college graduation; stock ownership; and home ownership. The relationship between these proxies and the likelihood that a household faces credit constraints is supported by tabulations from the Survey of

[24] However, we will later show that among subgroups whose purchases are particularly sensitive to interest rates, the "good time-rates" coefficient is generally large and statistically different in all time periods.

Consumer Finances, which show that households who did not graduate from college, or own houses or stocks, are about 50 percent more likely than their counterparts to have been turned down for credit in the previous five years, and are about twice as likely to have been late on loan payments during the past year (table 8). In addition, when these households buy a new car, they are more likely than their counterparts to take out a loan.

For households likely to have easier access to credit—those who graduated from college, owned stocks, or owned homes—"good time-rates" is associated with a 3 to 4 percentage point increase in the probability of purchasing a vehicle, and the marginal effect is not statistically different from the effect of "good time-other" (table 9). For households who likely have more tenuous access to credit—those who did not graduate from college, do not own stock, or do not own a home—"good time-rates" is associated with a 6 to 8 percentage point increase in the probability of buying a car. For all three groups with more-tenuous access to credit, the marginal effect of "good time-rates" is statistically different from the effect of "good time-other." The effect of "rates-up" is statistically significantly different from zero for some types of households, but the relationship between this variable and the likelihood of buying a vehicle does not vary in a systematic way with the likelihood of being credit constrained.[25]

Turning to new and used car purchases, all types of households—both those more and less likely to have easy access to credit— are about 4 percentage points more likely to purchase a new car if they cited favorable auto credit conditions as a reason that car-buying conditions are good six months earlier. However, scaling by the share of households in each group that typically buy a new car in a given six-month period—which is about 3 percent for households

[25] The only discernible pattern with this coefficient is that it is more likely to be statistically significant when estimated over larger subgroups.

with more-tenuous access to credit and 7 percent for households with easier access to credit—indicates that the purchases of households with more-tenuous access to credit are much more sensitive to perceptions of credit conditions. Used-car purchases for all groups appear to be unaffected by assessments of auto credit conditions.

As a robustness check, we excluded the 2003 and 2004 period from the subgroup regressions. We found that the marginal effect of "good time-rates" declined but remained large and significant for households who do not own stocks or houses; it was significantly different from the effect of "good time-other" for households who do not own stock. As another robustness check, we added month-date indicators to the models. This change resulted in only a small decrease in the magnitude and statistical significance of the "good time-rates" and "rates-up" coefficients (results not shown).

Discussion

Our analysis has assumed that variation in the "good time-rates" variable, after controlling for other factors in the VAR and micro data specifications, captures changes in the supply of auto credit. We showed that shocks to credit sentiment in the aggregate data move together with the SLOOS measure of lender willingness to extend credit, which is consistent with this interpretation.

Nonetheless, some of the changes in "good time-rates" that we have identified as supply shocks may pick up other factors that are correlated with car purchases. For example, households who are already inclined to purchase a vehicle may also be monitoring financing conditions more closely. We partly—but likely not completely—address this concern by measuring perceptions in advance of vehicle purchases and by including a full suite of control variables in the regression that capture some of the determinants of car purchases.

As an initial step towards exploring this possibility, we estimate a multivariate logit model in which the three outcomes are: good time to buy a car because of credit conditions; good time to buy a car for other reasons; and bad time to buy a car (table 10). The results indicate that "good time-rates" is correlated with supply conditions: households are more likely to report this answer when interest subvention is high. "Good time-rates" is also more prevalent among households who live in a county where house prices have increased over the past year.[26] This result holds even controlling for county-level employment growth and the household's perceived change in its own house price over the past year, and it is consistent with the Mian, Rao, and Sufi (2013) and Mian and Sufi (2014) findings that areas that saw the largest changes in house prices also appear to have experienced larger changes in their ability to access credit.[27]

However, households that report favorable car-buying conditions because of low interest rates are also more likely to have other characteristics that are associated with higher rates of purchasing vehicles. For example, they tend to be younger and to have higher income. They are more likely to report that they are better off financially than a year ago; that they expect higher income in the future; and that the value of their house has increased during the past year. Although we control for these variables in the regressions, these correlations raise the possibility that "good time-rates" is capturing, in addition to credit supply

[26] A one-standard deviation increase in interest rate subvention is 0.5 and in the one-year house price change is 0.10. In both cases, a one-standard deviation shock is therefore associated with a 5 percentage point increase in the probability that a household reports "good time-rates."
[27] The county-level change in employment is from the Quarterly Census of Employment and Wages; the county-level change in house prices is from CoreLogic. The regression has a smaller sample size because the county level variables are not available for all households in the survey.

changes, other differences across households that are associated with car purchases.

More generally, our results raise several questions about consumer perceptions of car-buying credit conditions and the relationship between this measure and vehicle purchases. For example, how do households form their perceptions of auto financing conditions, and how closely do these perceptions correspond with actual financing conditions? If perceptions and reality differ, which is more important for vehicle purchases? How do these differences vary across groups? Does the strong relationship between interest subvention and vehicle purchases reflect the effects of the advertising campaigns that generally accompany these promotions in addition to the effects of low interest rates?

6. Conclusion

Consumer purchases of motor vehicles fell considerably during the 2007-09 recession, and the decline in loan originations was even somewhat larger. In this paper, we showed that significant swings in auto sales, auto loans, and credit availability are a regular feature of the business cycle and that the drop in consumer vehicle purchases from 2007 to 2009, although the largest decline in a long while, was about average relative to previous recessions. We then demonstrated that changes in credit supply conditions are an important determinant of changes in vehicle sales. One consistent finding from our work is that households who say "it's a good time to buy a car because interest rates are low" are significantly more likely to buy a new car some months later. The effect is large and robust in both aggregate data and in household-level data, even though the models we estimate for each type of data use different identification assumptions, estimation techniques, and source data. The models are also

estimated over different time periods. The effect is large in both models relative to traditional determinants of car purchases such as income and employment.

The results of the models are less consistent on some other fronts. For example, the VAR estimates suggest a relationship between consumer perceptions of auto credit conditions and their purchases of used cars; the household-level estimates do not. The household-level estimates suggest a relationship between expectations of rising interest rates and car purchases; the VAR estimates do not.

In the household-level data, we found evidence that perceptions of auto credit conditions are particularly potent for the new vehicle purchases of households whose access to credit is more likely to be tenuous—households without a college degree or who do not own stocks or houses. This finding is consistent with the sharp decline in subprime loan originations during the 2007-09 recession and the subsequent rebound. We hesitate to draw too strong a linkage here, though, as these households also likely faced greater exposure to other adverse shocks during this period, such as unemployment.

REFERENCES

Aaronson, D., S. Agarwal, and E. French (2012). "The Spending and Debt Response to Minimum Wage Hikes." *American Economic Review*, 102(7): 3111-3139.

Adams, W., L. Einav and J. Levin (2009). "Liquidity Constraints and Imperfect Information in Subprime Lending." *American Economic Review*, 99(1): 49-84.

Attanasio, O., P. Goldberg and E. Kyriazidou (2008). "Credit Constraints in the Market for Consumer Durables: Evidence from Micro Data on Car Loans." *International Economic Review*, 49:2, 401-436.

Benmelech, E., R. Meisenzahl, and R. Ramcharan (2014). "Liquidity, Non-Bank Credit, and the Financial Crisis: Evidence from Automobiles." Working paper.

Campbell, S., D. Covitz, W. Nelson, and K. Pence (2011). "Securitization Markets and Central Banking: An Evaluation of the Term Asset-Backed Securities Loan Facility." *Journal of Monetary Economics*, 58(5):518-531.

Chah, E., V. Ramey and R. Starr (1995). "Liquidity Constraints and Intertemporal Consumer Optimization: Theory and Evidence from Durable Goods." *Journal of Money, Credit, and Banking*, 27:1, 272-287.

Covitz, D., N. Liang, and G. Suarez (2013). "The Evolution of a Financial Crisis: Collapse of the Asset-Backed Commercial Paper Market." *Journal of Finance,* 68:3, 815-848.

French, E., T, Kelley, and A. Qi (2013). "Expected Income Growth and the Great Recession." *Federal Reserve Bank of Chicago Economic Perspectives*, 37: 14-29.

Leininger, L., H. Levy, and D. Schanzenbach (2010). "Consequences of SCHIP Expansions for Household Well-Being." *Forum for Health Economics and Policy,* 13(1).

Mian, A., K. Rao, and A. Sufi (2013). "Household Balance Sheets, Consumption, and the Economic Slump." *Quarterly Journal of Economics*, 128(4): 1687-1726.

Mian, A., and A. Sufi (2014). "House Price Gains and U.S. Household Spending from 2002 to 2006." Fama-Miller working paper, University of Chicago.

Ramcharan, R., S. Van den Heuvel, and S.Verani (forthcoming). "From Wall Street to Main Street: The Impact of the Financial Crisis on Consumer Credit Supply." *Journal of Finance*.

Sims, C. (1986). "Are Forecasting Models Usable for Policy Analysis?" *Federal Reserve Bank of Minneapolis Quarterly Review*, Winter, 10(1): 2-16.

Souleles, N. (1999). "The Response of Household Consumption to Income Tax Refunds." *American Economic Review*, 89(4): 947-58.

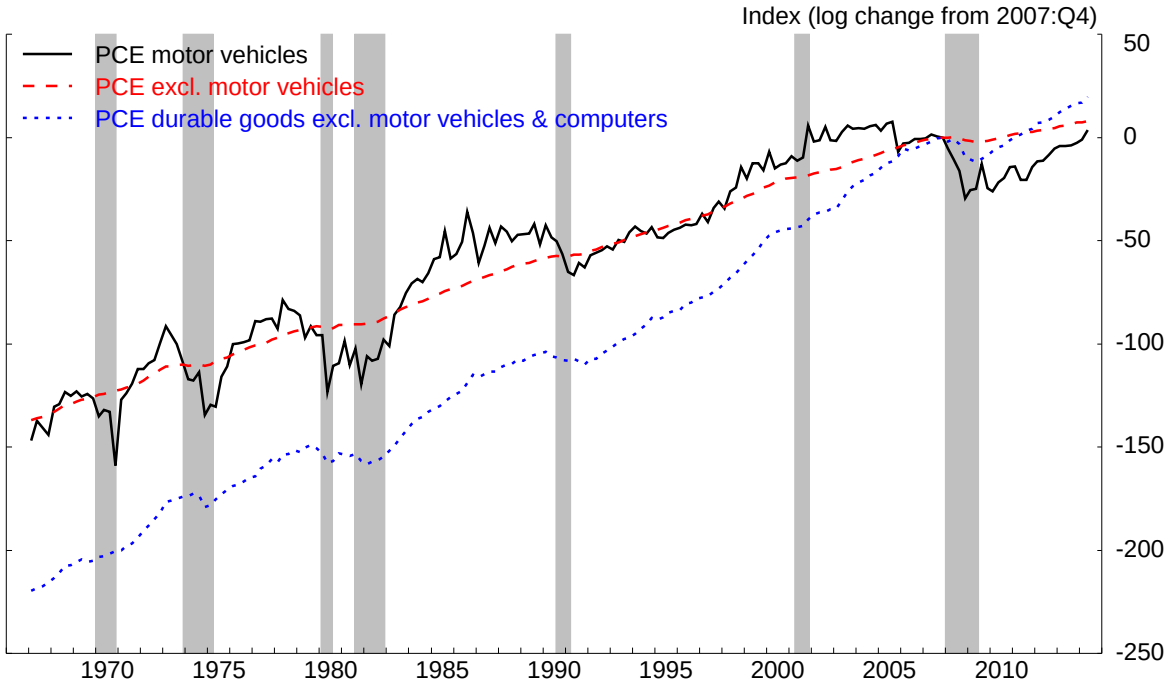
University of Michigan, Survey Research Center (2014). "Survey Description," available on the website of the Thomson Reuters/University of Michigan Surveys of Consumers at www.sca.isr.umich.edu/survey-info.php (accessed March 16, 2014).

Van der Klaauw, W. (2012). "On the Use of Expectations Data in Estimating Structural Dynamic Choice Models." *Journal of Labor Economics*, 30(3): 521-554.

Wilcox, D. (1989). "Social Security Benefits, Consumption Expenditures, and the Life Cycle Hypothesis." *Journal of Political Economy*, 97: 288-304.

Figure 1: Real Personal Consumption Expenditures (PCE)

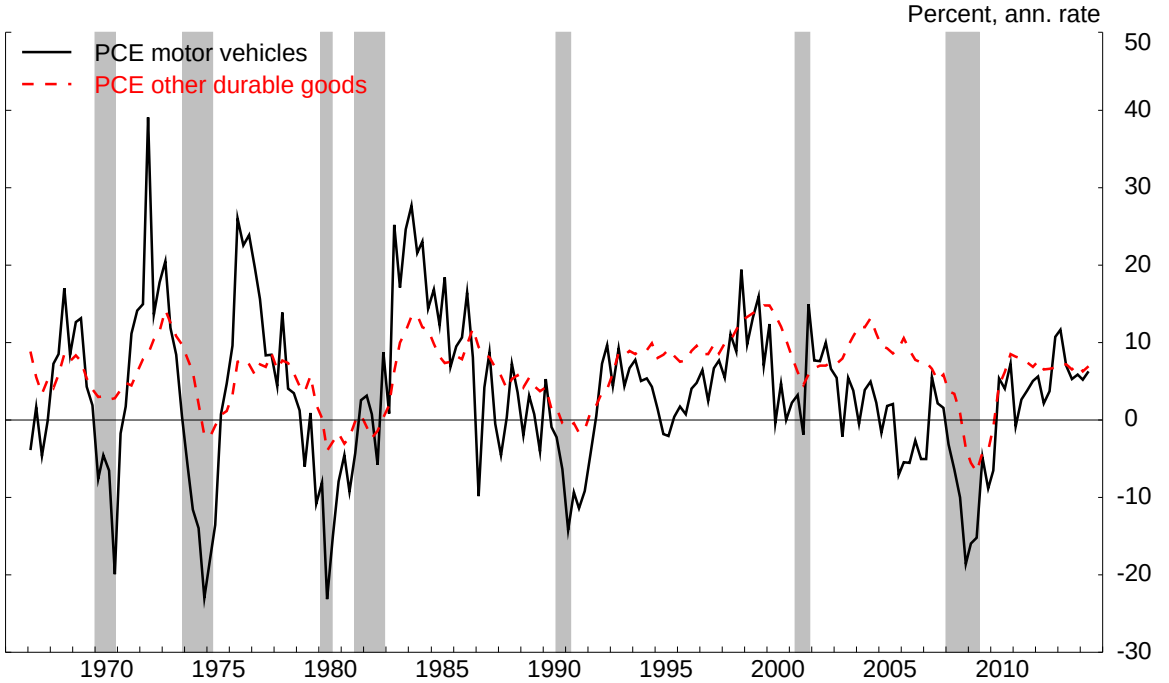
1967:Q1 through 2014:Q2



Notes. Data are from the National Income and Product Accounts. For each series x, the index is calculated as $100 \times [\log(x_t) - \log(x_{2007:Q4})]$.

Figure 2: Six-Quarter Changes in Real PCE for Durable Goods

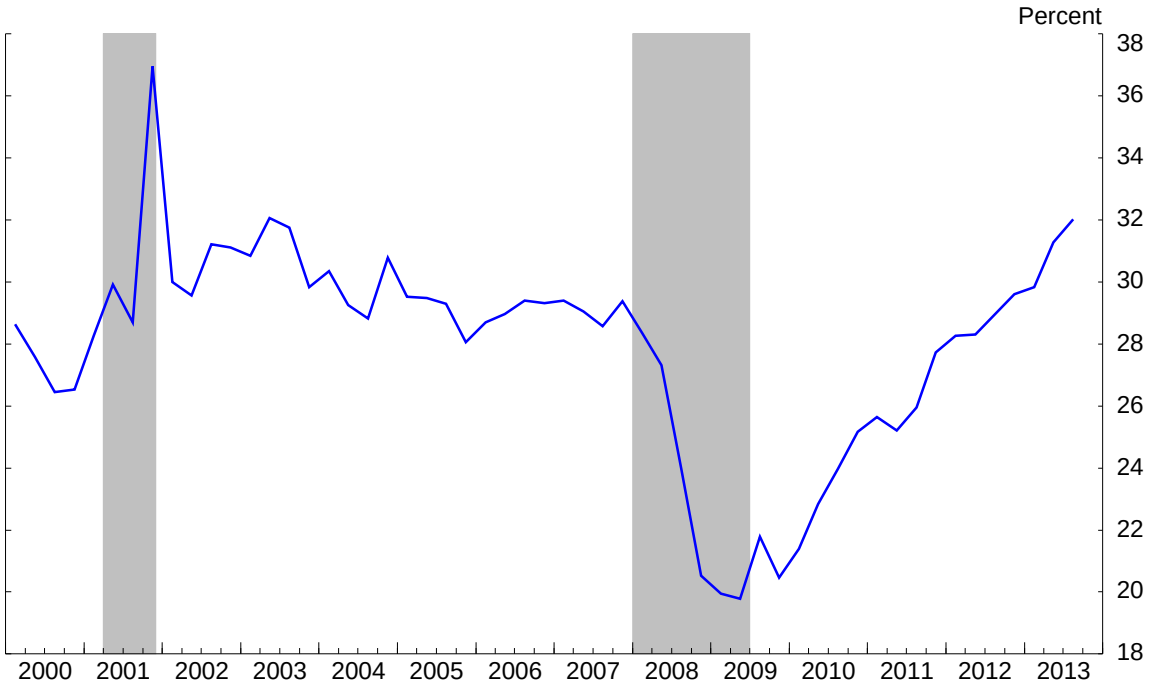
1967:Q1 through 2014:Q2



Notes. Data are from the National Income and Product Accounts. Six quarters is the duration of the 2007-2009 recession.

Figure 3: Auto Loan Originations

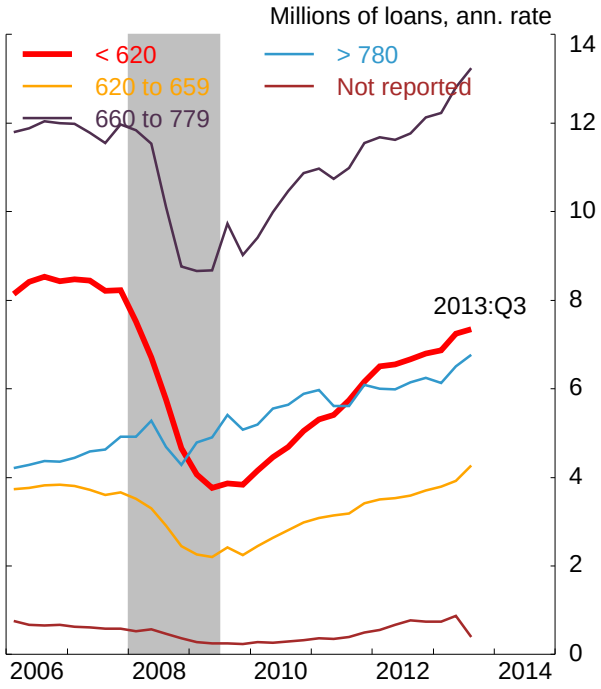
2000:Q1 through 2013:Q3



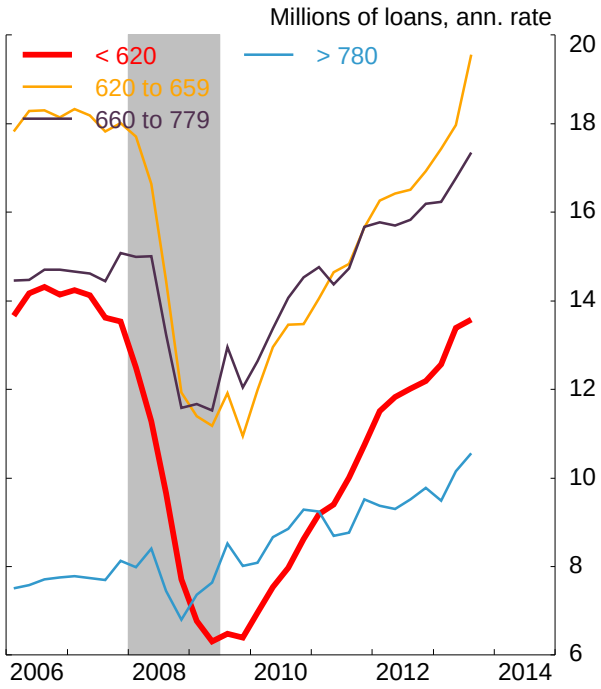
Notes. Data are from the Federal Reserve Bank of New York Consumer Credit Panel and from Equifax. Estimates were created by staff at the Federal Reserve Bank of Philadelphia and have been seasonally adjusted by the authors.

Figure 4: Auto Loan Originations by Credit Score Bucket

A. Number of Loan Originations



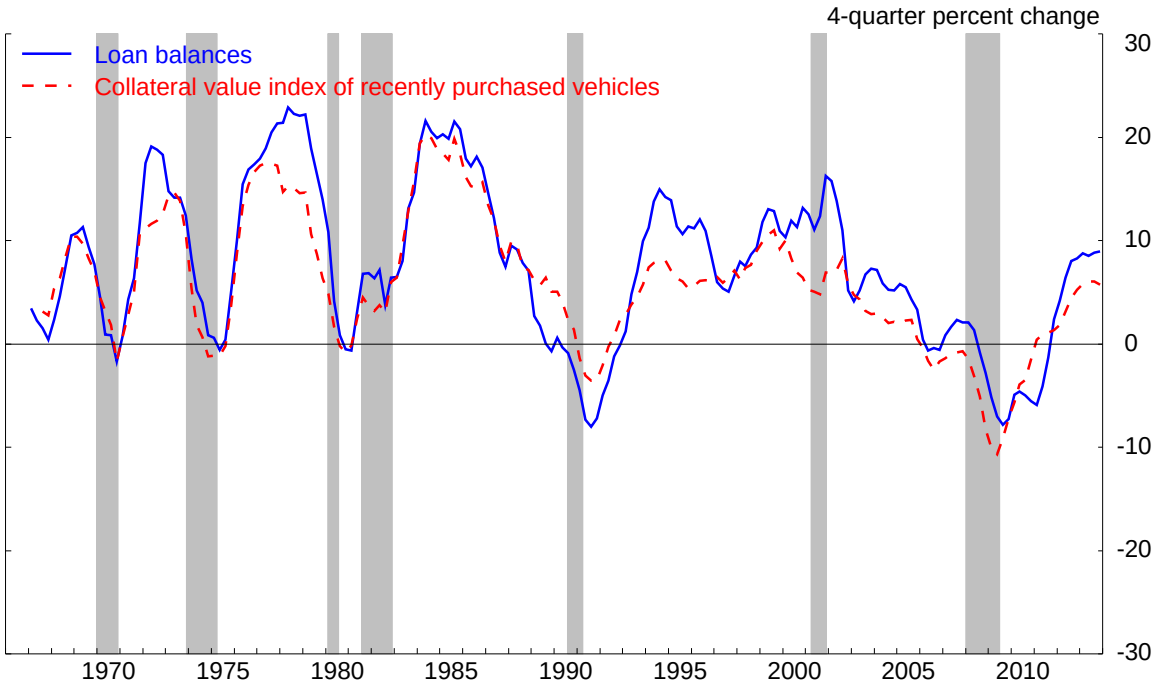
B. Loan Originations per 100 People



Notes. Data are from the Federal Reserve Bank of New York Consumer Credit Panel and from Equifax. Estimates were created by staff at the Federal Reserve Bank of Philadelphia and have been seasonally adjusted by the authors.

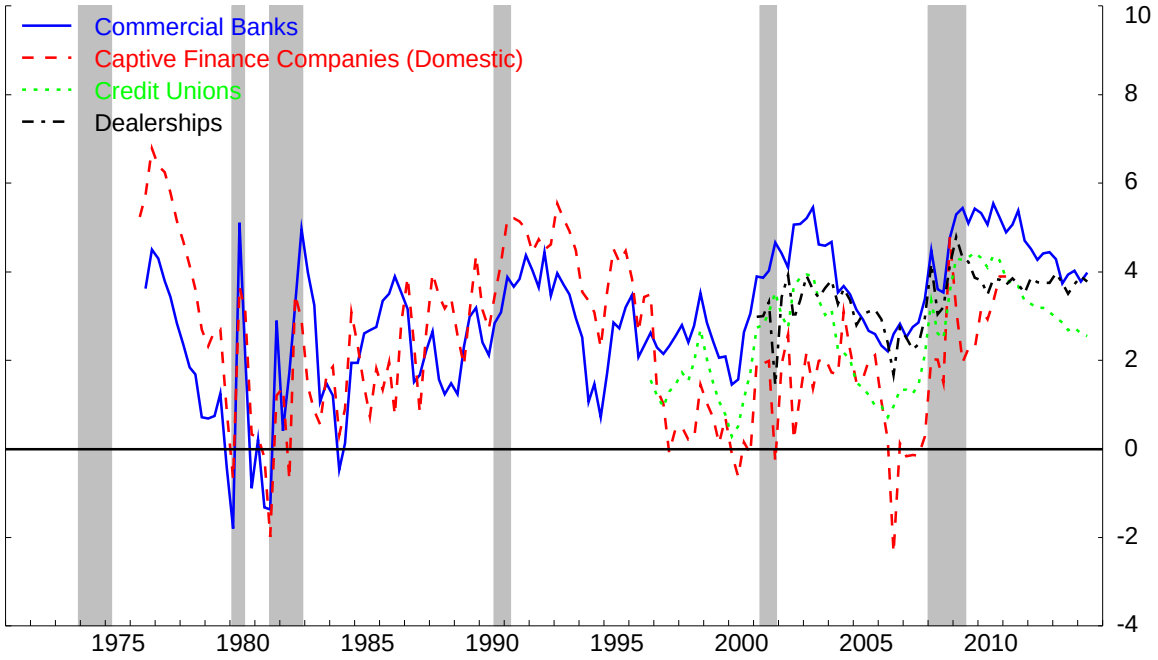
Figure 5: Auto Loan Balances and Vehicle Collateral Value Index

1967:Q1 through 2013:Q4



Notes. Auto loan balances are from the Federal Reserve's G.19 Consumer Credit release. The collateral value index of recently purchased vehicles is the discounted sum of nominal motor vehicle PCE in quarters leading up to and including the current date, assuming a 13 percent constant quarterly discount rate.

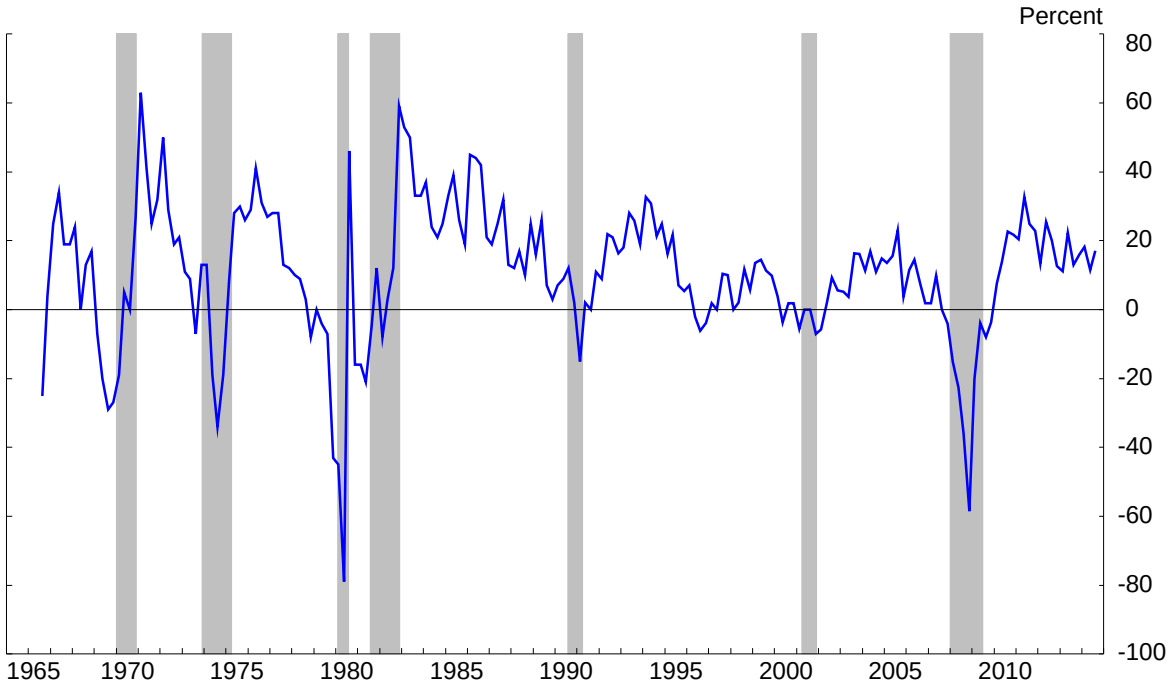
Figure 6: Interest Rate Spreads for New Vehicle Loans
1976:Q1 to 2014:Q2



Notes. Spread is relative to the 2-year Libor swap rate. The interest rate for the captive finance companies reflects the average rate on loans originated by the finance arms of Ford, GM and Chrysler, and interest rate for commercial banks reflects the average rate on 48-month loans originated during the middle month of each quarter; both series are from the G.19 Consumer Credit statistics release published by the Federal Reserve Board (data for the finance companies were discontinued in February 2011). The interest rate for credit unions is from the Credit Union National Association. The interest rate for dealerships reflects the average rate on loans originated at dealerships from all types of lenders and is from the Power Information Network at J.D. Power & Associates. The 2-year swap rate is extrapolated prior to 2000 using the yield on 2-year Treasury notes.

Figure 7: Willingness of Domestic Banks to Make Consumer Installment Loans

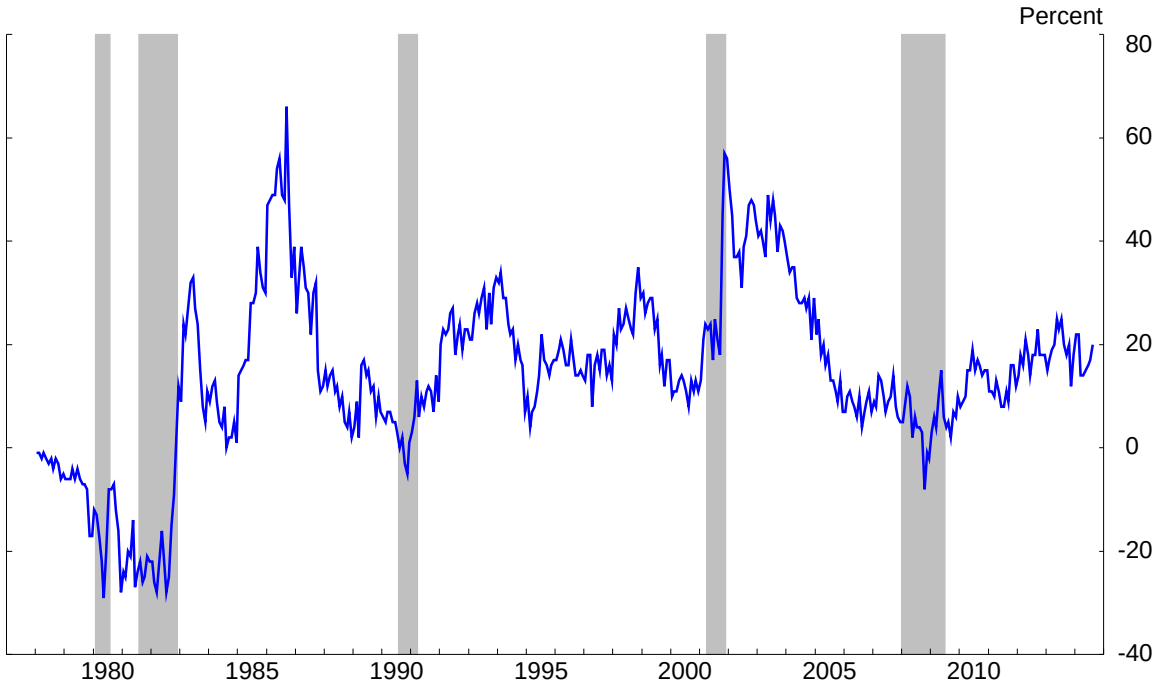
Senior Loan Officer Opinion Survey on Bank Lending Practices; 1966:Q3 to 2014:Q3



Notes. Figure shows the net percentage of domestic banks reporting an increased willingness to make loans.

Figure 8: Household Assessments of Auto Credit Conditions

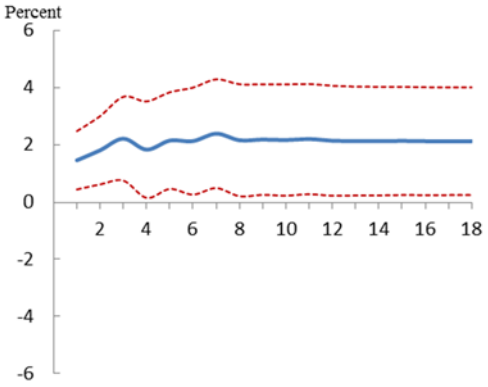
Reuters/University of Michigan Survey of Consumers; Jan. 1978 to Aug. 2014



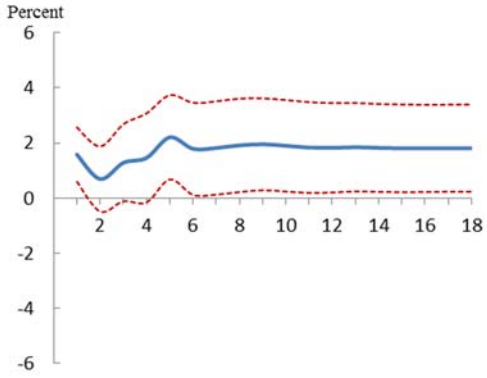
Notes. Figure shows percentage of respondents to the Reuters/University of Michigan Survey of Consumers that cite low interest rates as reason that car-buying conditions are good less the percentage that cite high interest rates or tight credit conditions as reasons that car-buying conditions are bad.

Figure 9: Response of Real PCE for Motor Vehicles to Model Shocks
Based on vector auto-regression; 1977:Q3 to 2007:Q4

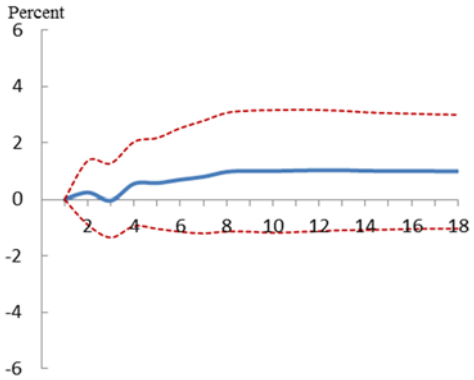
Shock to real disposable personal income



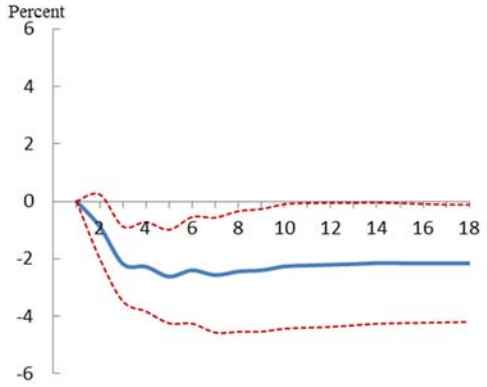
Shock to interest subvention



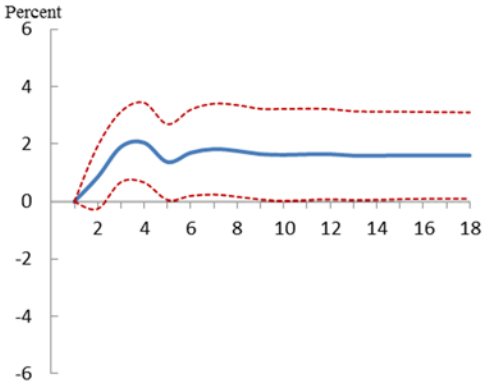
Shock to unemployment rate



Shock to Real 2-year Swap Rate



Shock to Car-buying Credit Sentiment



Notes. Impulses are 1 standard deviation to the change in each explanatory variable. Responses in sales are cumulative sums of first differences. Dashed lines are 95% confidence bands.

Table 1: Growth of Real PCE for Durable Goods during Business Cycles

Recessions (peak - trough)	Real PCE Durable Goods			Contribution of vehicle spending to the change (Pct. points)
	Preceding peak-to-peak (Pct. change, a.r.)	Recession (Pct. change, a.r.)	Change (Pct. points)	
1. 1969:4 - 1970:4	6.2	-6.7	-12.9	-12.8
2. 1973:4 - 1975:1	6.9	-7.1	-14.0	-6.8
3. 1980:1 - 1980:3	3.0	-13.2	-16.1	-11.5
4. 1981:3 - 1982:4	-1.5	1.0	2.5	3.1
5. 1990:3 - 1991:1	5.9	-10.6	-16.5	-11.5
6. 2001:1 - 2001:4	6.8	12.8	6.1	5.8
7. 2007:4 - 2009:2	6.0	-9.0	-15.1	-4.8
Memo: **Average 1967:1 -- 2007:4**	**5.5**	**-3.1**	**-8.7**	**-5.2**

Notes. Data are from the National Income and Product Accounts. Recession dates are from the National Bureau of Economic Research.

Table 2: Variance Decomposition for Consumer Sentiment Toward Car-buying Credit Conditions

Forecast horizon (Quarters)	Forecast standard error	Variance Decomposition (Percentage Points)					
		Interest subvention	*Interest rate*	*DPI*	*PCE motor vehicles*	*Unempl. rate*	*Credit sentiment*
1	0.70	15	2	0	6	1	75
4	0.78	10	17	1	12	7	52
8	0.80	10	17	2	13	8	50

Notes. The table reports the percentage of the variance of the error made in forecasting auto credit sentiment at the horizons shown in each row that is due to shocks to the variable listed at the top of each column.

Table 3: Michigan Survey Sample Sizes by Month

Dates of auto purchase and financing module	Number of households	Number of households who purchased autos
August 2003	204	31
February 2004	201	28
September 2004	203	43
April 2005	202	33
August 2005	200	31
December 2005	194	30
April 2006	200	26
August 2006	192	26
December 2006	196	24
April 2007	205	25
August 2007	193	33
December 2007	197	30
December 2008	196	20
February 2009	191	26
April 2009	195	24
August 2009	191	32
December 2009	195	22
February 2010	197	20
April 2010	196	16
August 2010	202	27
December 2010	194	23
April 2011	197	23
August 2011	202	25
December 2011	188	22
April 2012	206	23
August 2012	191	23
December 2012	187	25
April 2013	191	24
August 2013	193	20
Total	5,699	755

Note. Dataset derived from the Thomson Reuters / University of Michigan Survey of Consumers. Households in the sample are those in the given month who were also interviewed six months earlier. Households in which the respondent is someone other than the household head or spouse are excluded from the sample.

Table 4: Means of Selected Demographic Variables
Michigan Survey and the Survey of Consumer Finances

	Survey of Consumer Finances	Michigan Survey (cross-section)	Michigan Survey (panel)
Age 18-24	.05	.06	.05
Age 25-34	.16	.14	.12
Age 35-44	.19	.20	.19
Age 45-54	.21	.21	.21
Age 55-64	.17	.17	.18
Age 65+	.22	.22	.26
Income less than $35K	.40	.30	.30
Income $35K-$60K	.23	.21	.22
Income $60K-$100K	.20	.22	.23
Income more than $100K	.18	.20	.23
Income missing	--	.06	.03
Married	.51	.57	.59
White	.73	.80	.82
Completed college	.36	.42	.43
Stockowner	.51	.64	.66
Homeowner	.69	.79	.80

Notes. SCF data are from the 2004, 2007, and 2010 waves. SCF estimates are weighted with the x42001 weight and Michigan estimates are weighted with the household weight. Michigan (cross-section) refers to all households interviewed in months in which a vehicle financing module was conducted. Michigan (panel) refers to the subset of these households that had been interviewed six months earlier.

Table 5: The Effect of Selected Financing Conditions on the Probability of a Car Purchase
Dependent variable: Bought a car in the past six months

	Good time to buy—rates	Good time to buy—other	Prob. of rejecting "Rates" ="other"	Better off than a year ago	Expect rates up	Expect rates down	N
"Good time" only	.076*** (.015)	.028*** (.011)	.00	--	--	--	5,699
"Rates up" only	--	--	--	--	.023** (.010)	.006 (.017)	5,699
Better off" only	--	--	--	.054*** (.010)			5,699
All covariates	.046*** (.014)	.023** (.010)	.08	.024** (.012)	.020** (.009)	.009 (.016)	5,699
New cars	.040*** (.011)	.022*** (.007)	.07	.004 (.007)	.007 (.005)	-.003 (.010)	5,502
Used cars	.006 (.010)	.000 (.008)	.41	.022** (.010)	.015** (.007)	.014 (.013)	5,502
2003-07	.051** (.021)	.002 (.017)	.01	.028 (.020)	.020 (.015)	-.034 (.027)	2,387
2008-13	.031* (.018)	.037*** (.012)	.59	.020 (.017)	.019* (.011)	.032 (.020)	3,312
2005-13	.028* (.015)	.026** (.010)	.94	.018 (.013)	.021** (.010)	.022 (.018)	4,889
Date dummy variables	.040*** (.014)	.022** (.010)	.17	.021* (.012)	.021** (.009)	.008 (.016)	5,699
Weighted	.045*** (.015)	.021** (.011)	.08	.020 (.013)	.014 (.010)	.006 (.017)	5,699

Notes. Dataset derived from the Thomson Reuters / University of Michigan Survey of Consumers. Each row shows selected marginal effects from a logit regression in which the dependent variable is "bought a car in the past six months," with robust standard errors in parentheses. "Prob of reject rates=other" shows the confidence level at which we can reject the hypothesis that the "good time-rates" and "good time-other" coefficients are equal (based on a χ^2 test). "New cars" and "used cars" show the marginal effects from a multinomial logit regression in which "buy a new car," "buy a used car," and "buy no car" are the outcomes. The sample size is smaller for this regression because the type of car question was not asked in the February 2010 survey. Significant at the *** 1 percent level, ** 5 percent level, * 10 percent level.

Table 6: Marginal Effects Estimates from the Main Logit Specification
Dependent variable: bought a car in the past six months

Variable	Marginal effect	Standard error
Financing conditions		
Good time to buy because of credit conditions	.046***	.014
Good time to buy a car for other reasons	.023**	.010
Expect rates to go up	.020**	.009
Expect rates to go down	.009	.016
Two-year Libor swap rate	-.001	.006
Interest rate subvention	-.005	.021
Economic conditions		
Better off financially than a year ago	.024**	.012
Worse off financially than a year ago	.005	.011
Expect higher family income--next 12 months	.003	.011
Expect lower family income--next 12 months	-.014	.012
Current house value is higher relative to a year ago	.004	.011
Current house value is lower relative to a year ago	-.001	.012
Demographics		
Age 18-34	.095***	.025
Age 35-44	.067***	.020
Age 45-54	.078***	.017
Age 55-64	.043***	.016
Income $35,000 - $60,000	.038**	.017
Income $60,000 - $100,000	.052***	.018
Income greater than $100,000	.043**	.019
Income missing	.004	.028
White	.027**	.011
Married	.052***	.010
Attended college	-.018*	.009
Own stock	-.008	.011
Own home	.005	.014
R-squared	.04	
N	5,699	

Notes. Dataset derived from the Thomson Reuters / University of Michigan Survey of Consumers. Robust standard errors are shown. Significant at the *** 1 percent level, ** 5 percent level, * 10 percent level.

Table 7: Michigan Sample Summary Statistics

Variable	Mean	Standard Deviation
Bought a car in the past six months	0.13	0.34
Financing conditions		
Good time to buy a car because of credit conditions	0.20	0.40
Good time to buy a car for other reasons	0.43	0.50
Expect rates to go up	0.53	0.50
Expect rates to go down	0.10	0.30
Two-year Libor swap rate	2.44	1.74
Interest rate subvention	1.14	0.50
Economic conditions		
Better off financially than a year ago	0.30	0.46
Worse off financially than a year ago	0.42	0.49
Expect higher family income--next 12 months	0.50	0.50
Expect lower family income--next 12 months	0.20	0.45
Current house value is higher relative to a year ago	0.29	0.45
Current house value is lower relative to a year ago	0.26	0.44
Demographics		
Age 18-34	0.10	0.30
Age 35-44	0.17	0.37
Age 45-54	0.23	0.42
Age 55-64	0.22	0.41
Age 65+	0.28	0.45
Income less than $35,000	0.26	0.44
Income $35,000 - $60,000	0.22	0.41
Income $60,000 - $100,000	0.25	0.43
Income greater than $100,000	0.24	0.43
Income missing	0.04	0.19
White	0.84	0.36
Married	0.62	0.49
College graduate	0.46	0.50
Own stock	0.69	0.46
Own home	0.83	0.37

Notes. Dataset derived from the Thomson Reuters / University of Michigan Survey of Consumers. Statistics are unweighted.

Table 8: Selected Means by Subgroup

	All	College graduate	Non-graduate	Stock-owner	Non-stock-owner	Home-owner	Renter
			Survey of Consumer Finances				
Turned down for credit	.28	.20	.33	.14	.31	.21	.44
Ever late on a loan payment	.18	.13	.21	.10	.20	.15	.26
… 60 days late	.07	.05	.08	.03	.08	.05	.10
Purchased a car	**.17**	**.17**	**.17**	**.18**	**.17**	**.18**	**.15**
… new car	.06	.08	.04	.09	.05	.07	.02
… … w/a loan	.70	.66	.74	.52	.77	.68	.82
… used car	.12	.09	.13	.09	.13	.11	.13
… … w/a loan	.35	.38	.34	.34	.35	.37	.32
			Michigan Survey of Consumers				
Purchased a car	**.13**	**.15**	**.12**	**.15**	**.12**	**.13**	**.11**
… new car	.05	.07	.04	.06	.04	.06	.02
… used car	.08	.08	.08	.08	.08	.08	.08

Notes. The SCF means are calculated with data from the 2004, 2007, and 2010 waves of the Survey of Consumer Finances and are weighted. A household is considered "turned down for credit" if, at any point in the past five years, it was turned down for credit; did not get as much credit as requested; or did not apply because of a concern of being rejected for the loan. "Ever late on a loan payment" and "60 days late" refer to the household's experience in the previous year. In the SCF data, the car purchase variables are the share of households who purchased a car in the previous 9 months or so. In the Michigan data, the car purchases refer to the previous 6 months. The Michigan estimates are weighted and are based on all households surveyed in the months in which the vehicle module was conducted.

Table 9: The Effect of Selected Responses on the Probability of a Car Purchase
Dependent variable: Bought a car in the past six months

	Good time to buy—rates	Good time to buy—other	Prob. of rejecting "rates"= "other"	Better off than a year ago	Expect rates up	Expect rates down	N
College graduates							
All	.034* (.021)	.025 (.016)	.63	.020 (.018)	.008 (.014)	-.005 (.025)	2,612
New car	.037** (.017)	.028** (.011)	.64	.008 (.012)	.003 (.009)	-.015 (.015)	2,521
Used car	-.004 (.012)	-.008 (.011)	.71	.012 (.014)	.009 (.011)	.018 (.020)	2,521
2005-13	.026 (.023)	.023 (.016)	.95	.017 (.020)	.005 (.016)	.001 (.026)	2,241
Non-college graduates							
All	.057*** (.019)	.020 (.013)	.04	.028* (.017)	.031 (.012)	.023 (.022)	3,087
New car	.043*** (.014)	.016** (.008)	.03	.000 (.008)	.011* (.006)	.005 (.012)	2,981
Used car	.015 (.013)	.006 (.010)	.40	.029** (.015)	.019* (.010)	.014 (.018)	2,981
2005-13	.030 (.020)	.027** (.013)	.95	.018 (.018)	.034*** (.013)	.042* (.025)	2,648
Stockowner							
All	.033** (.016)	.023* (.013)	.52	.028* (.015)	.030** (.012)	.036 (.023)	3,939
New car	.042*** (.014)	.027*** (.010)	.28	.008 (.010)	.012 (.008)	.010 (.016)	3,788
Used car	-.004 (.010)	-.002 (.009)	.91	.020* (.012)	.022** (.009)	.029* (.018)	3,788
2005-13	.012 (.017)	.023* (.013)	.46	.027 (.017)	.030** (.013)	.043* (.024)	3,404
Non-stockowners							
All	.080*** (.028)	.017 (.015)	.01	.020 (.020)	.001 (.014)	-.033* (.018)	1,760
New car	.038** (.016)	.009 (.007)	.03	.000 (.007)	-.001 (.006)	-.017*** (.006)	1,714
Used car	.021 (.014)	.001 (.008)	.09	.018 (.012)	.000 (.008)	-.009 (.010)	1,714
2005-13	.079** (.034)	.026* (.015)	.09	-.001 (.020)	.002 (.015)	-.018 (.022)	1,485

Table 9, continued

	Good time to buy—rates	Good time to buy—other	Prob. of rejecting "rates" = "other"	Better off than a year ago	Expect rates up	Expects rates down	N
Homeowners							
All	.042*** (.015)	.024** (.011)	.19	.023* (.014)	.019* (.010)	.016 (.019)	4,745
New car	.039*** (.012)	.025*** (.008)	.24	-.001 (.008)	.008 (.006)	-.004 (.011)	4,572
Used car	.004 (.010)	-.003 (.008)	.42	.026** (.012)	.014* (.008)	.020 (.015)	4,572
2005-13	.022 (.016)	.023** (.012)	.88	.016 (.015)	.019* (.011)	.023 (.020)	4,127
Renters							
All	.070** (.034)	.017 (.020)	.08	.034 (.028)	.022 (.020)	-.019 (.030)	954
New car	.036** (.018)	.003 (.009)	.02	.024 (.016)	.003 (.008)	.001 (.012)	930
Used car	.017 (.018)	.008 (.011)	.56	.002 (.014)	.012 (.011)	-.011 (.016)	930
2005-13	.072** (.045)	.032 (.020)	.37	.032 (.032)	.026 (.022)	.013 (.042)	762

Notes. Each row shows selected marginal effects from a logit regression in which the dependent variable is "bought a car in the past six months," with robust standard errors in parentheses. "Prob of reject rates=other" shows the confidence level at which we can reject the hypothesis that the "good time-rates" and "good time-other" coefficients are equal (based on a χ^2 test). "New cars" and "used cars" show the marginal effects from a multinomial logit regression in which "buy a new car," "buy a used car," and "buy no car" are the outcomes. The sample size is smaller for this regression because the type of car question was not asked in the February 2010 survey. Significant at the *** 1 percent level, ** 5 percent level, * 10 percent level.

Table 10: Characteristics of Households by Car-Buying Attitudes
(Marginal Effects from a Multinomial Logit)
Dependent variable: Is it a good time to buy a car?

Variable	Good time to buy a car-interest rates	Good time to buy a car-other reason	Bad time to buy a car
Macro finance conditions			
Two-year Libor swap rate	-.076 (.082)	-.012 (.011)	.019* (.011)
Interest rate subvention	.102*** (.028)	-.102*** (.038)	-.000 (.037)
County-level change in house prices	.459*** (.069)	-.327*** (.094)	-.132 (.091)
County-level change in employment	-.071 (.217)	-.486* (.286)	.557** (.277)
Household economic conditions			
Current house value is higher than a year ago	.038** (.017)	.013 (.021)	-.025 (.020)
Current house value is lower than a year ago	-.028* (.015)	-.009 (.021)	.019 (.020)
Better off financially than a year ago	.047*** (.016)	.027 (.020)	-.021 (.020)
Worse off financially than a year ago	-.004 (.014)	-.054*** (.018)	.058*** (.018)
Expect higher family income--next 12 months	.024* (.014)	-.009 (.018)	-.033* (.018)
Expect lower family income--next 12 months	-.036** (.016)	.041* (.021)	.077*** (.021)
Expect rates to go up	-.000 (.012)	-.025 (.016)	.026 (.016)
Expect rates to go down	.014 (.021)	-.059** (.026)	.045* (.026)
Demographics			
Age 18-34	.078*** (.027)	-.132*** (.027)	.055* (.030)
Age 35-44	.091*** (.023)	-.133*** (.023)	.042* (.025)
Age 45-54	.069*** (.020)	-.110*** (.021)	.040* (.022)
Age 55-64	.034* (.019)	-.060*** (.021)	.027 (.021)
Income $35,000 - $60,000	.046** (.021)	.002 (.024)	-.048** (.021)
Income $60,000 - $100,000	.047** (.022)	.038 (.025)	-.085*** (.023)

Variable	Good time to buy a car-interest rates	Good time to buy a car-other reason	Bad time to buy a car
Income greater than $100,000	.057**	.044	-.100***
	(.024)	(.027)	(.025)
Income missing	-.045	.024	.021
	(.031)	(.042)	(.040)
White	.046***	-.019	-.027
	(.014)	(.021)	(.020)
Married	.001	-.015	.014
	(.013)	(.021)	(.017)
Attended college	-.009	.033**	-.024
	(.012)	(.016)	(.020)
Own stock	.050***	.019	-.068***
	(.014)	(.019)	(.018)
Own home	.015	-.002	-.013
	(.018)	(.025)	(.017)
R-squared	.05		
N	4,913		

Notes. The table shows marginal effects from a multinomial logit regression in which the dependent variable is "Is it a good time to buy a car?" Each column shows the results for a different outcome value. The sample size is smaller than in the other regressions because county-level data are not available for all households. Dataset derived from the Thomson Reuters / University of Michigan Survey of Consumers. Robust standard errors are shown. Significant at the *** 1 percent level, ** 5 percent level, * 10 percent level.