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Consumer Credit, Oil Prices, and the U.S. Economy

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Abstract. Have you paid cash to fill up your gas tank lately? Probably not and I argue this is one reason why the U.S. economy appears to have become less sensitive to changes in the price of oil. When gas prices rise drivers have increasingly been able to borrow and firms able to offer incentives making immediate reductions in the purchases of groceries, electronics, cars, and other goods smaller than in the past. This alters the relationship between oil prices and U.S. economic activity, but does not eliminate it the money must be paid back after all.
Keywords. oil price, economic activity, credit, consumption.
JEL. C00, E20, E51, E60, Q43.

1. Introduction

The Imagine -or remember- filling the tank of your Oldsmobile Cutlass Supreme after the Iranian revolution.Sure it only gave 13 miles to the gallon, but when it was fresh off the lot,gasoline cost less than 65 cents per galon the local Amoco charged over $1.25 in March of 1980. By 2008 you were filling up a Toyota Camry, and gasoline prices jumped from $2.25 to above $4.00 per gallon. Although the price increases were similar in percentage terms, many argue that the economic impact was less severe for the 2008 episode, and that in general changes in the price of oil have become less important for U.S. economic activity. Others disagree.

The reasons given for oil's declining importance ranging from the source of oil price changes to improvements in fuel efficiency are persuasive. But the patterns highlighted in Figure 1have been passed over. Over the past 30-35 years the availability and use of credit in the United States have risen substantially, while the costs have drifted lower. I argue these are important reasons why the U.S. economy appears to have become less sensitive to changes in the price of oil. I do not take a position on whether or not oil has become less important for the U.S. economy over time, but greater use of credit may be one reason that some studies find this result and others do not.

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The analysis and conclusions expressed here are those of the author and not necessarily those of the U.S. Energy Information Administration.

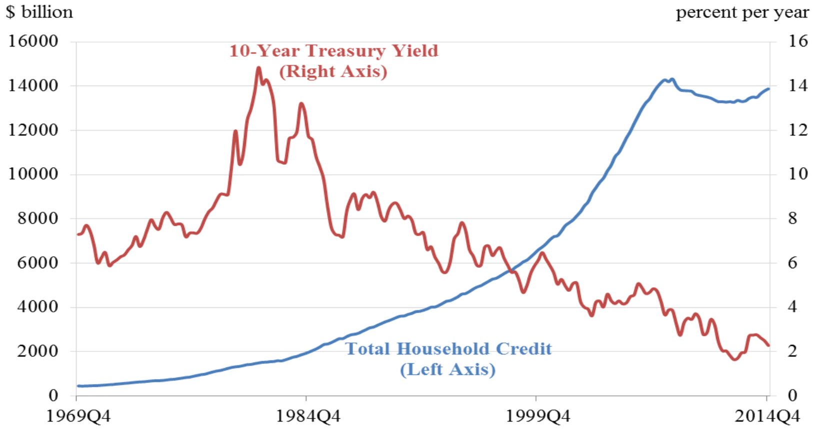

Figure 1. *Total U.S. Household Credit and 10-year Treasury Yields*
Source: Federal Reserve[i]

The logic is straightforward—when gasoline prices rise consumers can borrow instead of paying directly out of available income. Using credit cards allows for slower changes to purchases of groceries, clothing, and electronics than was possible in the past. And because firm access and costs for credit are lower as well, they can offer incentives and financingwhen oil becomes more expensive. This meanspurchases of longer lasting goods such as cars or furniture may not fall by as much as in the past. The logic also applies in reverse when oil prices fall, implying that consumer spending may not rise by as much as in the past due to declines in the price of oil.[ii]

In support of this contention I show that the association between consumer credit and gasoline spending in the United States has increasingly moved together. Time-varying scatterplots, correlations, and copulas all demonstrate that the association between credit and gasoline expenditures has gotten stronger since the 1970s. This is true using various types of time-variation, linear and non-linear correlations, and even when both series take on more extreme values away from their respective means.

The availability, use, and the cost of credit vary for many reasons -from monetary policy to changing consumer preferences- but they are also a factor in how oil price changes affect the U.S. economy. In the remainder of the paper I will review the debate on whether oil has become less important for U.S. economic activity; then document trends in credit use, availability, and cost; and finallyassociate changes in credit use with these trends.

2. Possible Explanations

The U.S. economy has changed so much since the 1970'sthat it seems intuitive oil is less important. Not only have vehicles become more efficient, but oil is now used scarcely in generating electricity, manufacturing accounts for a smaller share of overall goods production, and monetary policymakers tend to focus more on price indices that exclude oil.

Multiple studies support this conclusion.[iii] Blanchard & Gali (2010) estimate two different vector autoregression (VAR) models, one from 1960Q1-1983Q4 and the other from 1984Q1-2007Q3. Based on the model results they conclude that oil prices affected U.S. inflation and economic activity much more over the first time period than the second. Blanchard & Gali (2010) attribute this togreater wage flexibility, changes in monetary policy implementation, and declines in the share of U.S. expenditures on oil between the two time periods.

Edelstein & Kilian (2009) arrive at a similar conclusion by focusing on consumption instead of real GDP. They give specific attention to the demand for goods and services because earlier research summarized in Kilian (2008) points to changes in consumer expenditures on automobiles as an important way in which oil prices affect the U.S. economy. The Edelstein and Kilian (2009) model is also estimated between two different time periods, splitting at the end of 1987 (ending in 2006M7). The results show that consumption responds more to oil price changes in the period up to 1987 then after. Kilian (2008) offers several possible explanations: the declining value of energy relative to the total value of U.S. consumption expenditures over time; the possibility that oil price movements have become more demand-driven over time; and changes in the structure of the U.S. automobile industry.

Segal (2007) agrees that oil price movements have become less important for the U.S. economy over time, but argues this is because of monetary policy. Due to the factors cited by Blanchard & Gali (2010) greater flexibility in wages and more credible monetary policy higher oil prices are less likely to raise inflation than in the past. And this means monetary policymakers have less of a need to raise short-term interest rates, which Segal (2007) presumes would reduce economic growth, when oil prices rise.

These views are consistent with recent estimates of how summary measures such as price elasticities of demand have changed in the United States over time. Baumeister & Peersman (2013) find that the short run price elasticity of oil demand in the U.S. the response of U.S. oil demand to a change in the price over a few months fell from the mid-1980s through 2010.Similarly, Hughes, Knittel & Sperling (2008) calculate that the short-run price elasticity of U.S. gasoline demand fell between the 1975-1980 and 2001-2006 periods.

Others have a different perspective. Hamilton (2009) reconsiders the models in both Blanchard & Gali (2010) and Edelstein & Kilian (2009) and provides a different interpretation. He argues that the consequences for the economy of the run-up in oil prices through 2008 were similar to those in the past. And as before, consumption spending, particularly purchases of domestic automobiles, declined because of the higher oil prices.

Ramey & Vine (2011) center their attention on the U.S. motor vehicle industry, given the importance of consumption spending for transmitting oil price changes to the economy. After accounting for rationing of gasoline in the 1970s, which is not reflected in available price data, Ramey & Vine (2011) find stability in the response of real GDP to oil price changes over time. Furthermore, they argue that the motor vehicle industry responded to the oil price rise through 2008 in a similar manner as in the 1970s.

The research to date leaves us in a familiar place for macroeconomists complementary explanations over the same patterns in the data. However, I believe that credit can account for some of the differences.[iv] Because consumers and firms have greater access to credit there is less of an immediate adjustment in purchases after changes in oil prices, consistent with studies that find a declining impact. However, this may only delay the economic impact and not necessarily put it offbecause credit balances build up over time. This is more in-line with studies that find the economic effects of oil price changes have not varied much over time. I turn next to trends in credit.

3. Trends in Consumer Credit Availability and Cost

Before looking at specific patterns in credit, try to think about the last time you paid for gasoline or groceries using cash. Has it been a while? Over time Americans have used less and less cash; non-cash payments now account for the majority of their purchases from Amazon to the car dealership, credit and debit cards and loans are the primary means of payment. And consumer credit has grown right along-side.

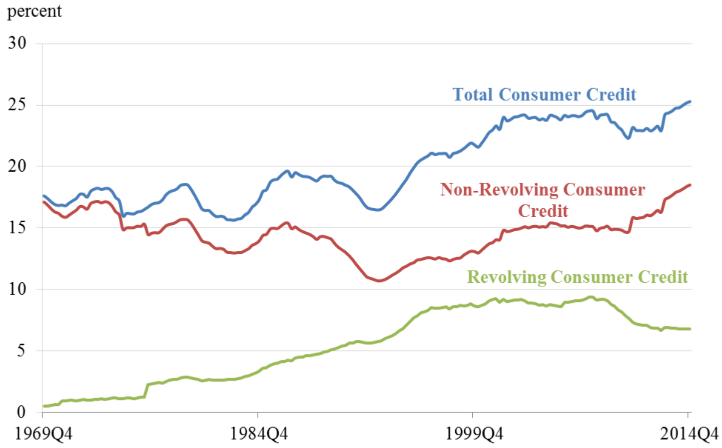

Figure 2. *U.S. Consumer Credit Relative to Disposable Income*
Source: Federal Reserve, BEA[v]

This is true irrespective of whether total creditincluding mortgages is considered, as in Figure 1, ifabsolute levels of consumer creditareshown, or if consumer credit is scaled relative to disposable income as in Figure 2.[vi]

Total consumer credit relative to disposable income has been rising since the early-1970s, slowly climbing through the mid-1990s before accelerating; the value stood around 26% of disposable income at the end of 2014. Through the 1970s and 1980s the primary driver of higher total credit appears to be revolving credit, the type associated with credit cards.

Revolving credit rose over most of the 1970-2008 time period compared with disposable income, growing fastestbetween the late-1970s and the late-1990s/early-2000s. By 2015 its value was almost 7% of disposable income, although the series peaked in 2008 close to 10% of disposable income.

After growth in revolving credit flattened out around 2000, increases in non-revolving credit began to drive those in total consumer credit. Non-revolving consumer credit is commonly associated with vehicle and student loans; it was almost 19% of disposable income at the end of 2014, and has a shape similar to that of total credit over the last 15 years.

The story behind these numbers is intuitive Americans have borrowed more relative to income for school and vehicle purchases, and they have also relied more on credit cards. After the 2008 recession however, many people began to pay down credit card balances, which led to a fall in the level of revolving consumer credit outstanding relative to disposable income.

The broad trends in credit outstanding show up in micro-level data on non-cash payments as well. Payments using an automated clearing house (ACH), credit cards (CC), debit cards (DC), or electronic benefits transfer (EBT) grew very quickly between 1979 and 2000 [Figure 3]. Checks accounted for 85% of retail payments in 1979, but fell to 60% by 2001 roughly half of the remaining retail payments were accounted for by credit cards (Federal Reserve, 2002).

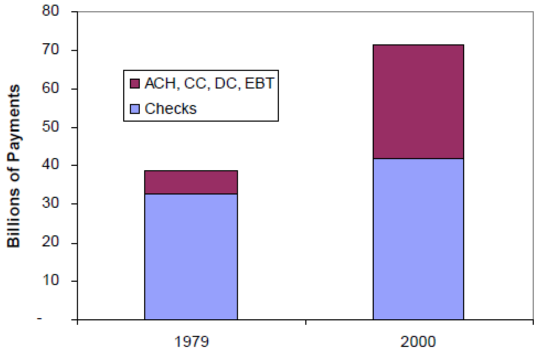

Figure 3. *Comparison of Non-Cash payments Volumes (1979 vs. 2000)*
Source: Federal Reserve (2002)[vii]

This trend has continued through 2012 the number of non-cash payments grew by 4.7% each year from 2003-2012, with credit cards growing roughly 3.7% annually over that period (Federal Reserve, 2013).

Broadly speaking, Figure 2 and Figure 3 show that credit use in the U.S. economy has grown over time: both credit outstanding and the number of credit card transactions has increased. It has generally become cheaper for both U.S. consumers and firms to borrow as well. Interest rates on most types of debt have fallen, including mortgages, automobile loans, credit card balances, and bond yields for firms [Figure 4].[viii] Does "no money down and 0% financing" sound familiar?

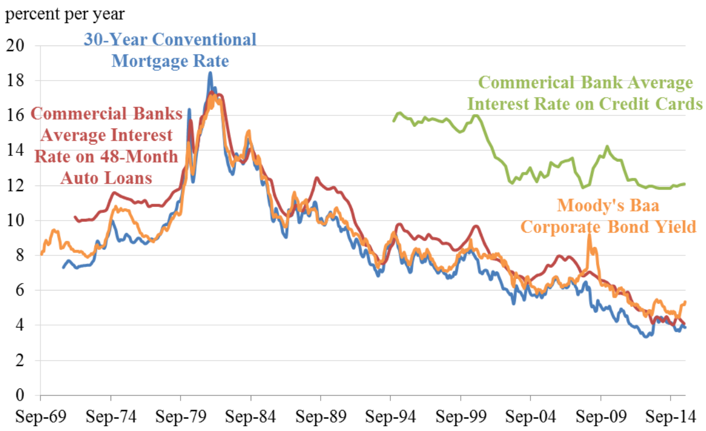

Figure 4. *Select U.S. Interest Rates*
Source: Federal Reserve Economic Data[ix]

At this point you may be thinking trends in credit are all good and well, but what does this have to do with the economic impacts of oil prices? I turn to this in the next section.

4. Associating Credit and Oil Shocks

To this point I have reviewed information on how U.S. credit use has varied over the past 45 years. While there are many reasons behind such changes, I believe one implication is that they change the relationship between oil prices and U.S. economic activity. My hypothesis is that increasing credit use allows consumers to defer or delay responses to changes in oil prices. As a result, higher gasoline costs don't affect overall purchases as much as in the past because goods can be paid for on credit, which means that that economic activity may not change with oil prices as it has previously.

If true, this implies that changes in gasoline expenditures and credit use should increasingly move together as credit has become a more important means of payment. While showing that associations have increased over time does not prove the hypothesis, it does provide support.

To demonstrate that the association between changes in credit and gasoline expenditures has risen over time I will use three different methods. The first are simple scatterplots over changing samples. Next are two different types of correlation coefficients over different sample periods. And the final method is by estimating tail coefficients from two different copulas, also over different sample windows.

One major component of my analysis is that I associatechanges in expenditures on gasoline not the price of gasoline with credit. There are two reasons for this. The first is that both prices and quantities are important; a high price does not mean much economically if there is little demand, and vice versa. Credit only becomes salient when expenditures change, not necessarily prices. Additionally, U.S. gasoline demand is relatively inelastic to price in the short-run, so expenditures effectively reflect movements in prices over one to two years (Hughes, Knittel & Sperling, 2008).

What has such spending on gasoline looked like historically? U.S. consumers have steadily spent more on gasoline since the early-1970s, with some major fluctuations after the early-2000s [Figure 5]. Gasoline expenditures grew around the oil price shocks in the late-1970s/early-1980s, were flat from the mid-1980s through the early-2000s before rising to a peak around 2008, and have bumped along since that time.

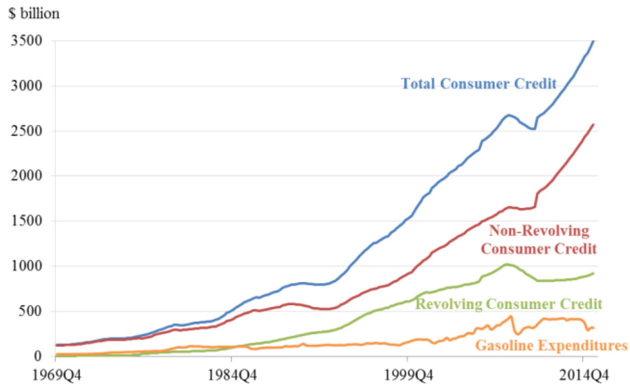

Figure 5. *Expenditures on Gasoline and Other Energy Goods and Various Measures of Consumer Credit*
Source: Federal Reserve, BEA[x]

Can we see any relationship between these expenditures and the levels of consumer credit plotted in Figure 5? There is a dip in all four series around the 2008 U.S. recession, but nothing else really stands out other than the fact that the measures of credit appear to grow much faster than spending on gasoline over the sample period. While the levels do not show a clear relationship, we are interested in whether changes in the series move together. Before looking at this in detail, I would like to discuss the data used for the analysis.

4.1. Data

The gasoline expenditures series I use comes from the BEA—it is personal consumption expenditures on gasoline and other energy goods. This series, while it includes slightly more than gasoline, is preferable to calculations based on average gasoline prices and quantities for a couple of reasons. One is that it has a relatively long history, dating back to the 1950s. The second is that it directly measures what we are interested in over that time period; other series, such as product supplied from EIA, may not do so directly.

The most relevant credit data are those of consumer credit from the Federal Reserve's monthly G.19 release. I include the three major consumer credit aggregates in the analysis: total, non-revolving, and revolving. Non-revolving credit includes student loans because separate data is unavailable before 2006.

For ease of display, I have shown all of the credit and expenditure series up to this point at seasonally adjusted annual rates. However, I will subsequently use quarterly series that have not been seasonally adjusted. They will be quarterly because the gasoline expenditures are unavailable at a higher frequency. And I use seasonally unadjusted data to avoid alterations that might change associations between the series.

Using such unadjusted values is also consistent with total credit series published by the Bank for International Settlements (BIS).[xi] The BIS use end of quarter values, not quarterly averages, and I do the same. When looking for associations I will use year-on-year growth rates, which have the advantage of accounting for seasonality in addition to being a growth rate. Finally, the analysis begins in 1969Q4 because information on revolving consumer credit becomes available in 1968, and it ends in 2014 because that is when non-seasonally adjusted gasoline expenditures data ends.[xii]

4.2. Scatterplots

Figure 6, Figure 7, and Figure 8 show scatterplots of annual growth in gasoline expenditures versus annual growth in total, non-revolving, and revolving consumer credit over different sample windows. Each sub-plot on the top-left of the figure shows a scatterplot for the 1969Q4-2014Q4 period, the next sub-plot to the right (the top-middle in the figure) has a sample that runs from 1974Q4-2014Q4, and each subsequent sub-plot moves the starting date of the sample forward by five years.

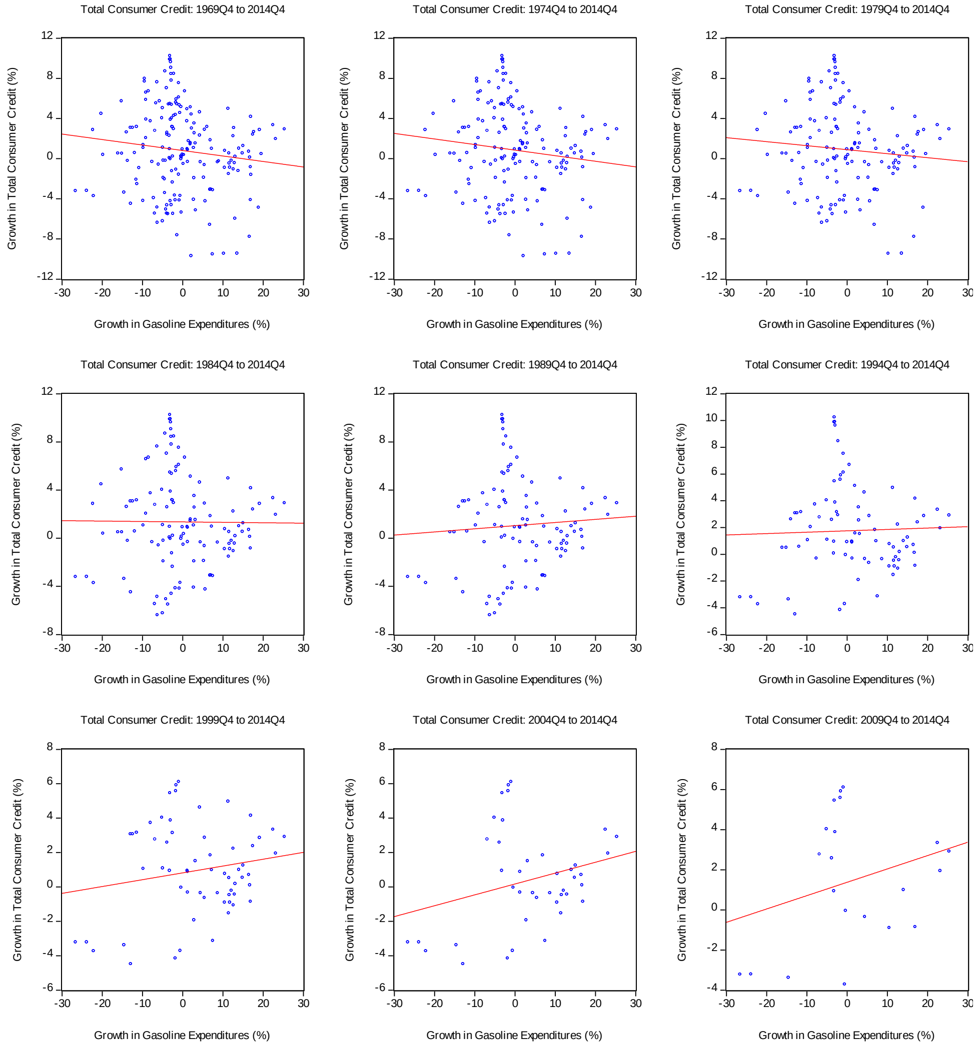

Figure 6. *Scatterplots of Annual Growth in Gasoline Expenditures and Total Consumer Credit over Various Sample Periods*
Source: Author Calculations based on BEA and Federal Reserve Data

There is a clear change in the slope of the best fit linebetween total consumer credit and spending on gasoline as the sample start date is moved forward. Over the entire sample the line has a slight downward trend, but this starts to moderate, and then has a slight upward slope when the sample begins in 1989Q4. The slope of the best-fit line subsequently gets steeper as the sample start date moves forward past 1989Q4.

This same pattern is repeated in the relationship between gasoline expenditures and non-revolving consumer credit [Figure 7]. There is also a slightly negative slope to the best fit line over the full sample that begins to turn as the sample start date is moved forward. The change comes earlier for non-revolving credit than for total credit, with the sample that begins in 1984Q4; the best-fit line continues to get steeper here with later sample starting dates as well.

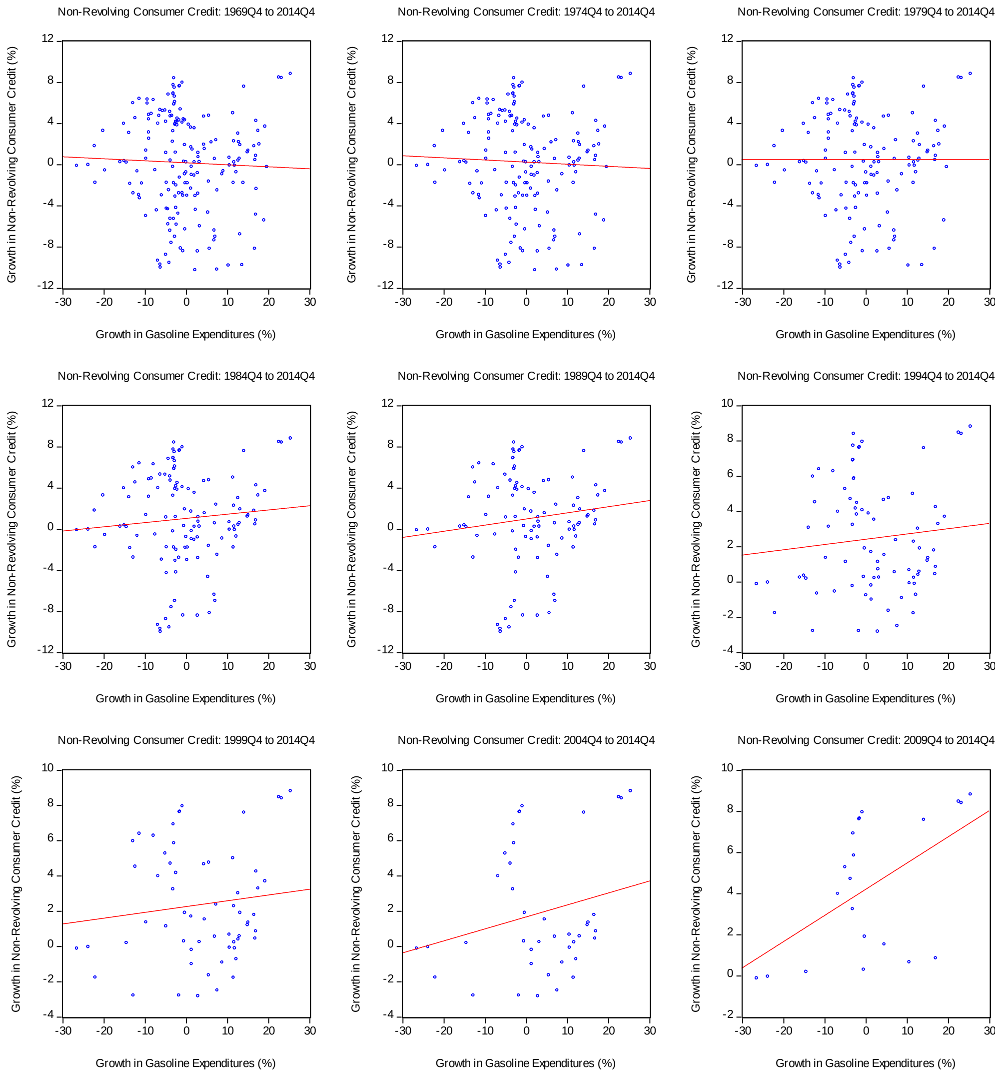

Figure 7. *Scatterplots of Annual Growth in Gasoline Expenditures and Non-Revolving Consumer Credit over Various Sample Periods*
Source: Author Calculations based on BEA and Federal Reserve Data

The association between growth in revolving credit and gasoline expenditures is more idiosyncratic [Figure 8]. While it also begins with a downward trend in the best-fit line over the entire sample period and begins to move up with the sample start date, it takes much longer: there is not an upwards slope to the best-fit line until the sample begins in 1999Q4. And it turns back negative in the last five years of the sample [2009Q4-2014Q4].

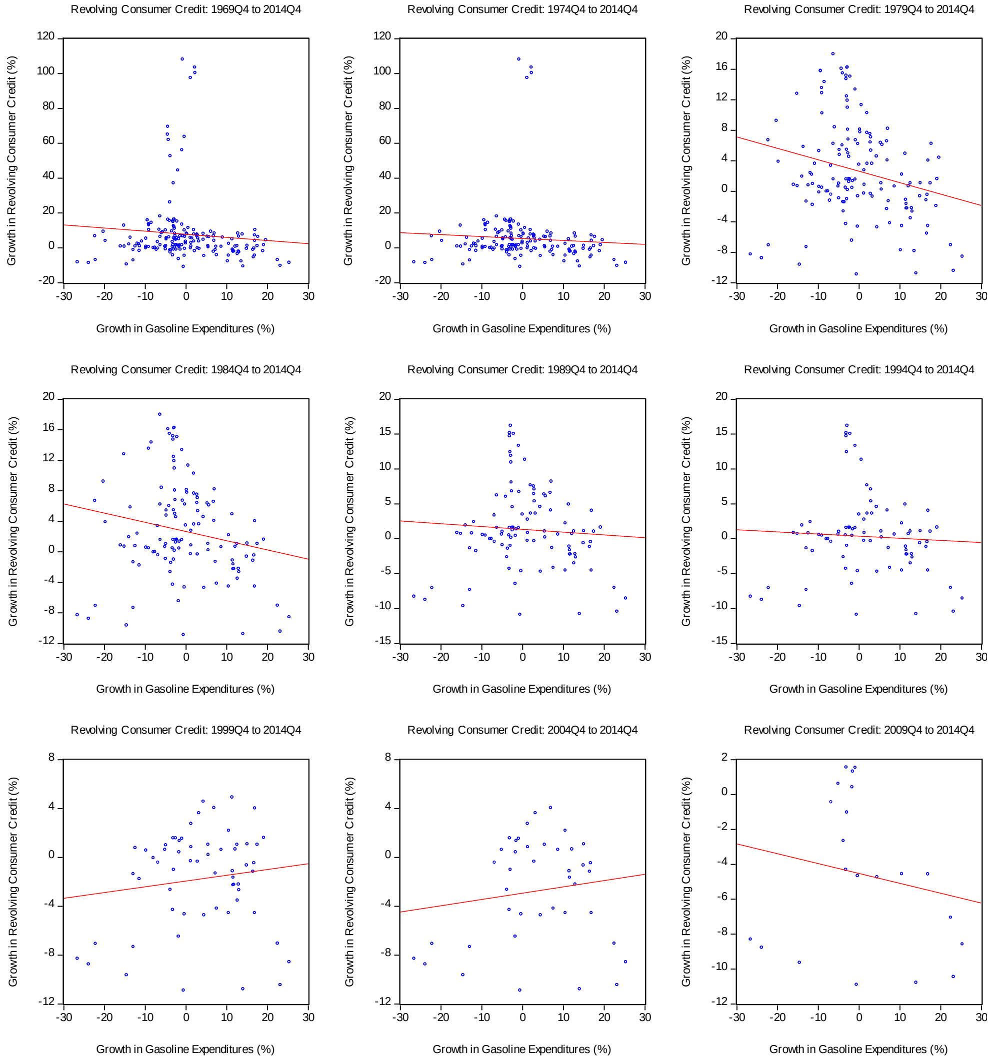

Figure 8. *Scatterplots of Annual Growth in Gasoline Expenditures and Revolving Consumer Credit over Various Sample Periods*
Source: Author Calculations based on BEA and Federal Reserve Data

Moving the sample start date forward is one way to see how the relationship between growth in the credit series and gasoline expenditures has changed over time using rolling windows is another. Figure 13-Figure 15 in the appendix reproduce the scatterplots with five-year rolling windows: the sub-plot in the top left covers the period from 1969Q4-1974Q4; the sub-plot to its right [top-middle in the figure] covers 1974Q4-1979Q4; and so on until the bottom-right sub-plothas a sample period of 2009Q4-2014Q4. Although there is more variation in these sub-plots, the movements in best-fit lines are similar to those shown for each of the credit series above.

Taken together, the various scatterplots show that the association between annual growth in gasoline spending and total, non-revolving, and revolving credit has changed over time. In particular, increases in gasoline expenditures have become more strongly associated with increases in consumer credit, and the reverse. These changes are more pronounced for non-revolving than revolving credit.

4.3. Correlations

All well and good you are probably thinking, but best-fit lines can be deceiving. And besides, there are a million other factors that could be driving those co-movements. Fair enough the scatterplots are only one way to consider association, correlations are another. Figure 9 and Figure 10 plot two different types of correlation over time between the credit and gasoline expenditure series: standard Pearson correlations and rank-based Spearman ones. As with the scatterplots, the start date of the sample is moved forward; the first correlation on each figure represents the correlation coefficient over the 1969Q4-2014Q4 period, the next one is over 1970Q1-2014Q4, and so on until the last covers 2009Q4-2014Q4.

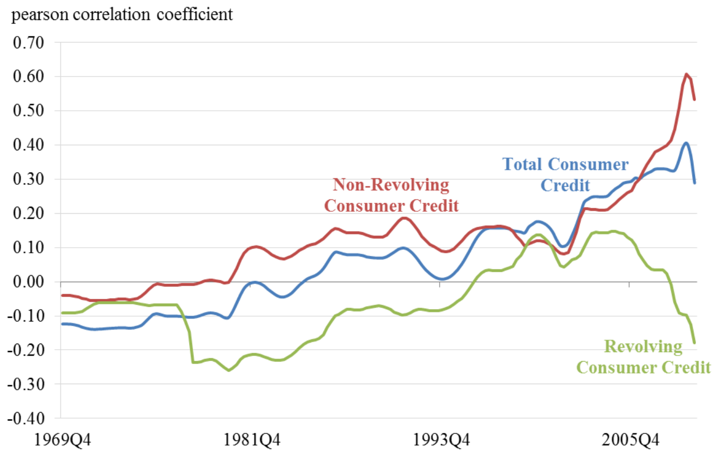

Figure 9. *PearsonCorrelations betweenAnnual Growth in Gasoline Expenditures and Consumer Credit over Various Sample Windows*
Source: Author Calculations based on BEA and Federal Reserve Data

There is a clear upward trend in Pearson correlations for all three credit series over most of the sample period [Figure 9]. The time-varying correlations between total credit and gasoline expenditures rise over the entire sample; the correlations between non-revolving credit and gasoline expenditures rise at first, flatten in the mid-1980s through the mid-1990s, and then rise again; and the correlations between revolving credit and gasoline expenditures rise from around 1980 through the mid-2000s, then drop off.

This behavior is consistent with the scatterplots above: both revolving and non-revolving credit appear to drive the increasing correlations in total credit through most of the sample period, but non-revolving credit increasingly does so towards the end as the association with revolving credit falls off. The Pearson correlations also provide support for the contention that associations between growth in credit and spending on gasoline have increased over time.

As with any measure, the Pearson correlation coefficient has limitations. One particularly important one in our context is that it is a linear measure of association and the relationship between credit and gasoline expenditures may be non-linear (Reboredo, 2012). To account for this I turn to Spearman correlation coefficients non-linear dependence measures in Figure 10.

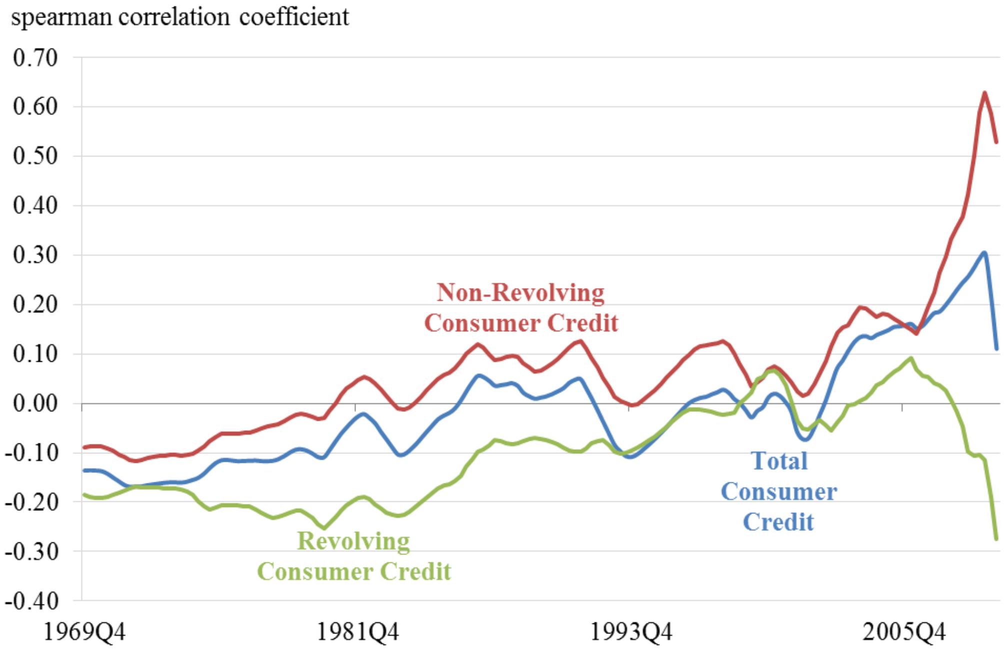

Figure 10. *Spearman Correlations betweenAnnual Growth in Gasoline Expenditures and Consumer Credit over Various Sample Windows*
Source: Author Calculations based on BEA and Federal Reserve Data

Although the values of the Spearman correlation coefficients are different, the pattern for each of the series is almost exactly the same as in Figure 9: increases through the mid-2000s before revolving consumer credit falls off, and the other two series subsequently jump up.

The trends in either correlation coefficient are not sensitive to the way in which I move the sample start date forward. Figure 16 and Figure 17 in the appendix show that there is still upward movement in each measure of correlation over time with 5-year rolling windows, though the values are more volatile.

The results of correlation analysis are the same as the scatterplots: there appears to be a growing association between growth in various measures of credit and gasoline expenditures over time.

4.4. Copulas

Fine you might say, but there is another concern: all measures of correlation are symmetric (Reboredo, 2012). They cannot distinguish between different types of association—some variables may move up together but not down, others the reverse, and correlation cannot account for such behavior. To look closer at such asymmetric dependence I turn to copulas, and specifically coefficients of tail dependence.

Copulas move one step beyond correlations and characterize the distribution of observations for multiple variables, the so-called joint distribution. The modeler specifies an underlying distribution for each individual variable, the type of copula distribution, and then estimates key parameters of the joint distribution (Dowd, 2008). Two of those key parameters are the coefficients of upper and lower tail dependence.

These parameters only available for specific copula distributions quantify the extent to which variables move up or down together in their tails, i.e. in those areas of the distribution that are far from the mean. Thus the coefficients of tail dependence quantify more extreme movements than correlations. Here, I estimate the upper and lower tail coefficients that characterize tail dependence for two different copulas: one based on a Gumbel distribution and the other based on a Clayton.[xiii]

The Gumbel copula is only upper tail dependent meaning its lower tail coefficient is zero and has an upper tail coefficient that ranges between zero and one; the higher its value the greater is the likelihood that variables move upwards together when far from their mean values. The Clayton copula is only lower tail dependent meaning its upper tail coefficient is zero and has a lower tail coefficient that ranges between zero and one;the higher its value the greater is the likelihood that variables move downwards together when far from their mean values (Aas, 2004).

Figure 11and Figure 12 plot the upper and lower tail coefficients from Gumbel and Clayton copulas between annual growth in gasoline expenditures and the various credit series over different sample windows. As with the correlation plots, the sample starting point moves forward by a quarter when going left to right.

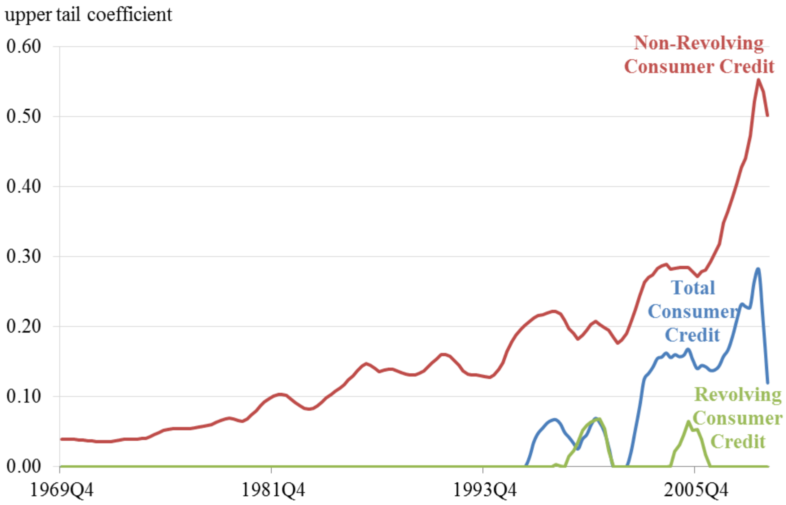

Figure 11. *Upper Tail Parameter of Gumbel Distribution Based Copula betweenAnnual Growth in Gasoline Expenditures and Consumer Credit over Various Sample Windows*
Source: Author Calculations based on BEA and Federal Reserve Data

The upper tail coefficients for non-revolving and total consumer credit grow over time particularly strongly for non-revolving consumer credit [Figure 11]. There are slight increases in the upper tail coefficient for revolving consumer credit later in the sample, but it remains relatively flat. It appears that the relationship between non-revolving credit and spending on gasoline is driving changes in the upper-tail coefficient between total consumer credit and gasoline expenditures, particularly after the mid-1990s.

All of the lower tail coefficients appear to change substantially over the sample period as well [Figure 12]. Here, total consumer credit shows the largest changes over time. This appears to be driven by consumer credit beginning in the mid-1980s through the mid-2000s, and then by non-revolving credit. The lower tail coefficient for non-revolving consumer credit and gasoline expenditures starts to grow in the early-2000s, and jumps after 2005. The coefficient for revolving credit grows gradually after the mid-1980s, but declines after 2005.

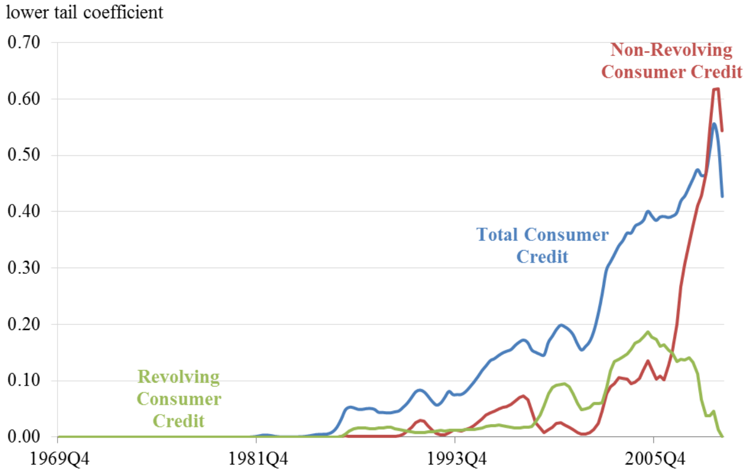

Figure 12. *Lower Tail Parameter of Clayton Distribution Based Copula betweenAnnual Growth in Gasoline Expenditures and Consumer Credit over Various Sample Windows*
Source: Author Calculations based on BEA and Federal Reserve Data

Figure 18 and Figure 19 in the appendix show the upper and lower tail coefficients using 5-year rolling windows instead of the forward-moving sample above. The results for these are much more volatile in both tails, but generally get larger over time as well.

The copula parameters upper and lower tail coefficients show that extreme co-movements between the growth of total and non-revolving consumer credit and gasoline spending, both up and down, have increased over time. Such co-movement between extreme changes appears to have increased for revolving consumer credit and gasoline expenditure only downwards.

4. 5. Summary

So where are we? I have used three different methods to show that the association between credit growth and changes in gasoline spending in the United States has changed over time. Each of these methods scatterplots, correlations, and copulas demonstrate an increase in various types of association between consumer credit and gasoline expenditures.

The scatterplots and correlations show that both linear and non-linear movements between credit and gasoline spending around the mean have increased their co-movement. The upper and lower tail coefficients from Gumbel and Clayton copulas show this is also true with larger movements away from the mean values.

While this supports my hypothesis about the importance of credit for the transmission of oil price, I am not claiming that it proves anything if such proof is even possible given all the factors that influence credit and gasoline spending. But it does fit with the larger story that Americans have changed the ways in which they pay for gasoline and other goods, and that this has an effect on the relationship between oil prices and the economy.

5. Conclusion

American consumers just don't buy things like they used to: not only has credit card use grown tremendously over the past 50 years, but so has the use of loans to buy cars and boats, to take vacations, and for other purposes as well. I argue that such changes have affected the relationship between oil prices and economic activity, and can explain why some researchers find that oil prices are less important for the U.S. economy than in the past.

Why? When gasoline prices change most people no longer pay with cash, meaning other purchases don't have to vary by as much as in the past. As a result, higher gasoline prices don't necessarily translate directly into reduced purchases of other goods, nor do lower prices automatically mean we buy more.

While this changes the relationship between oil prices and the U.S. economy, especially in how oil prices affect the economy over time, the ultimate economic effects may in fact be similar. As Benjamin Franklin once said, "Creditors have better memories than debtors," and this borrowing eventually has to be repaid.

Appendix

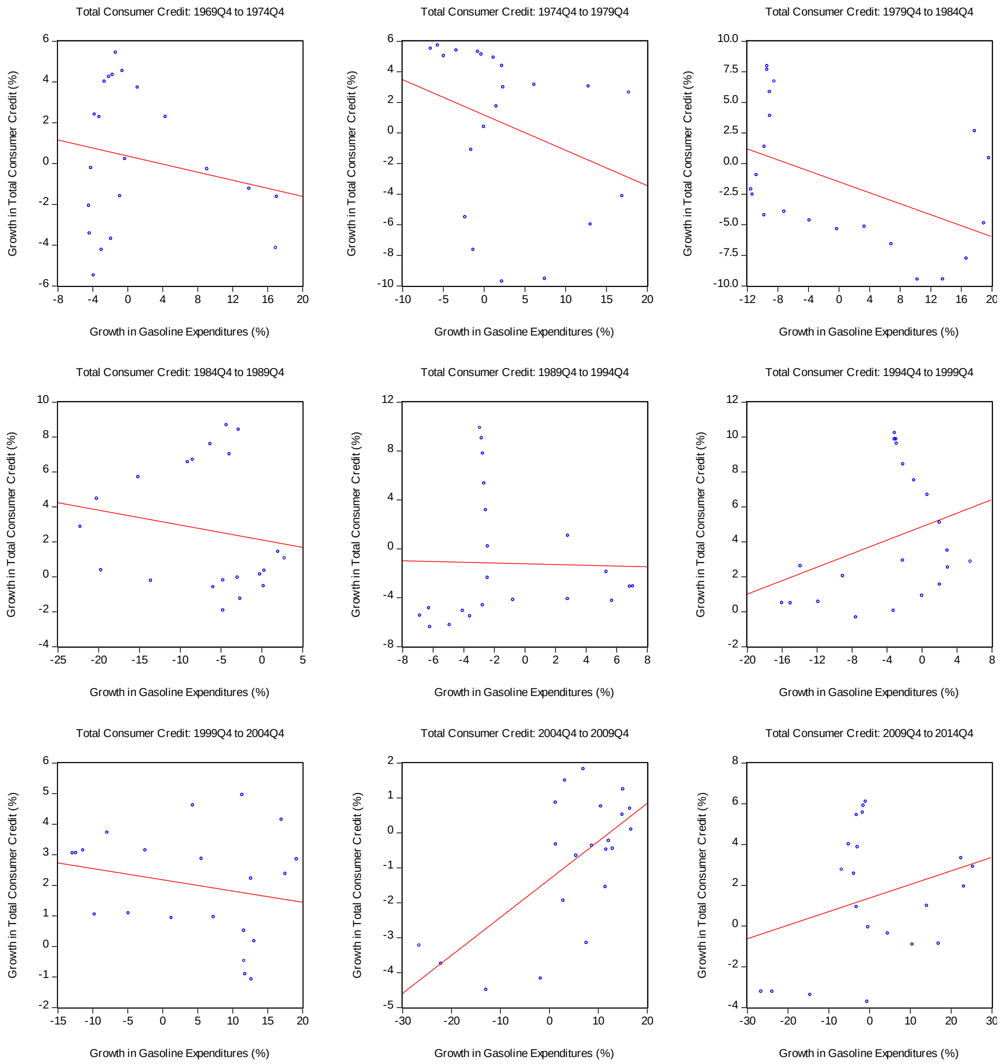

Figure 13. *Scatterplots of Annual Growth in Gasoline Expenditures and Total Consumer Credit over 5-Year Rolling Windows*
Source: Author Calculations based on BEA and Federal Reserve Data

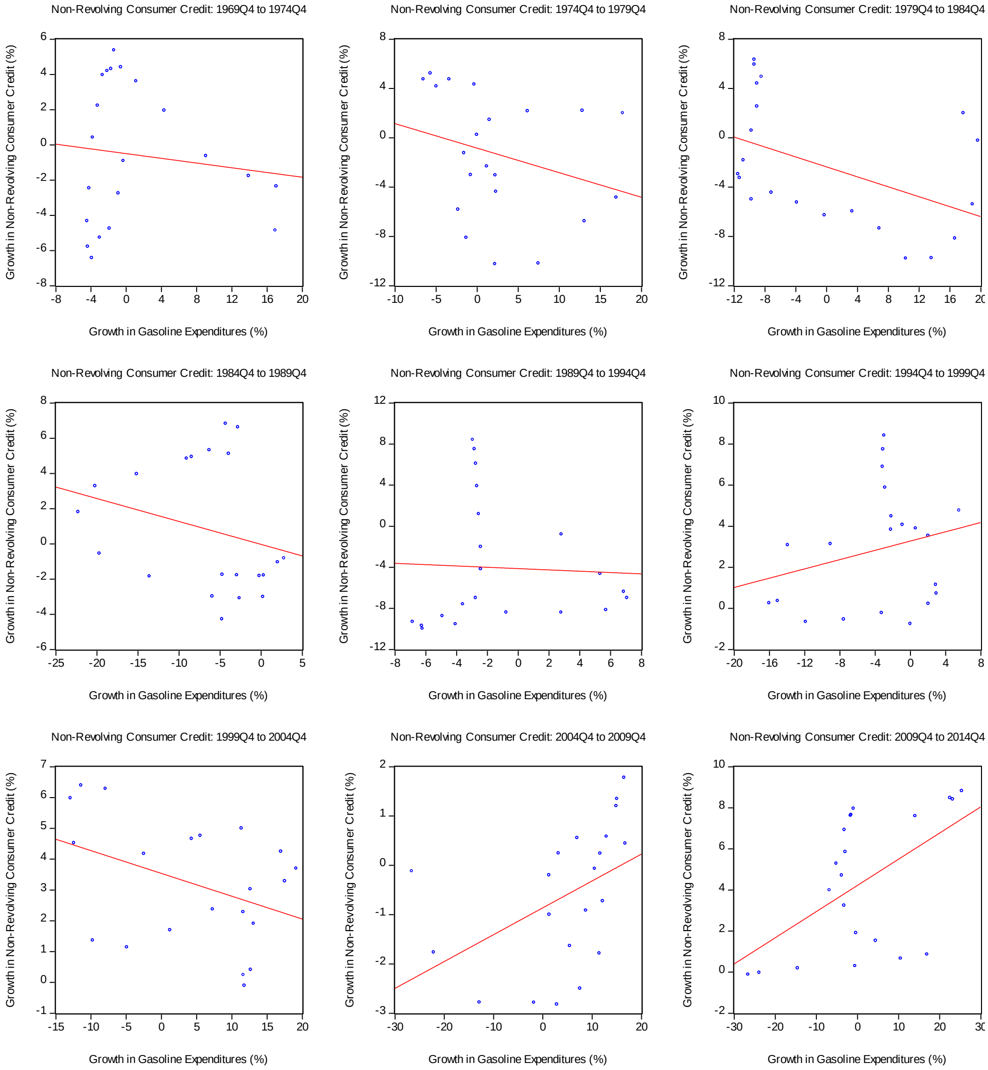

Figure 14. *Scatterplots of Annual Growth in Gasoline Expenditures and Non-Revolving Consumer Credit over 5-Year Rolling Windows*

Source: Author Calculations based on BEA and Federal Reserve Data

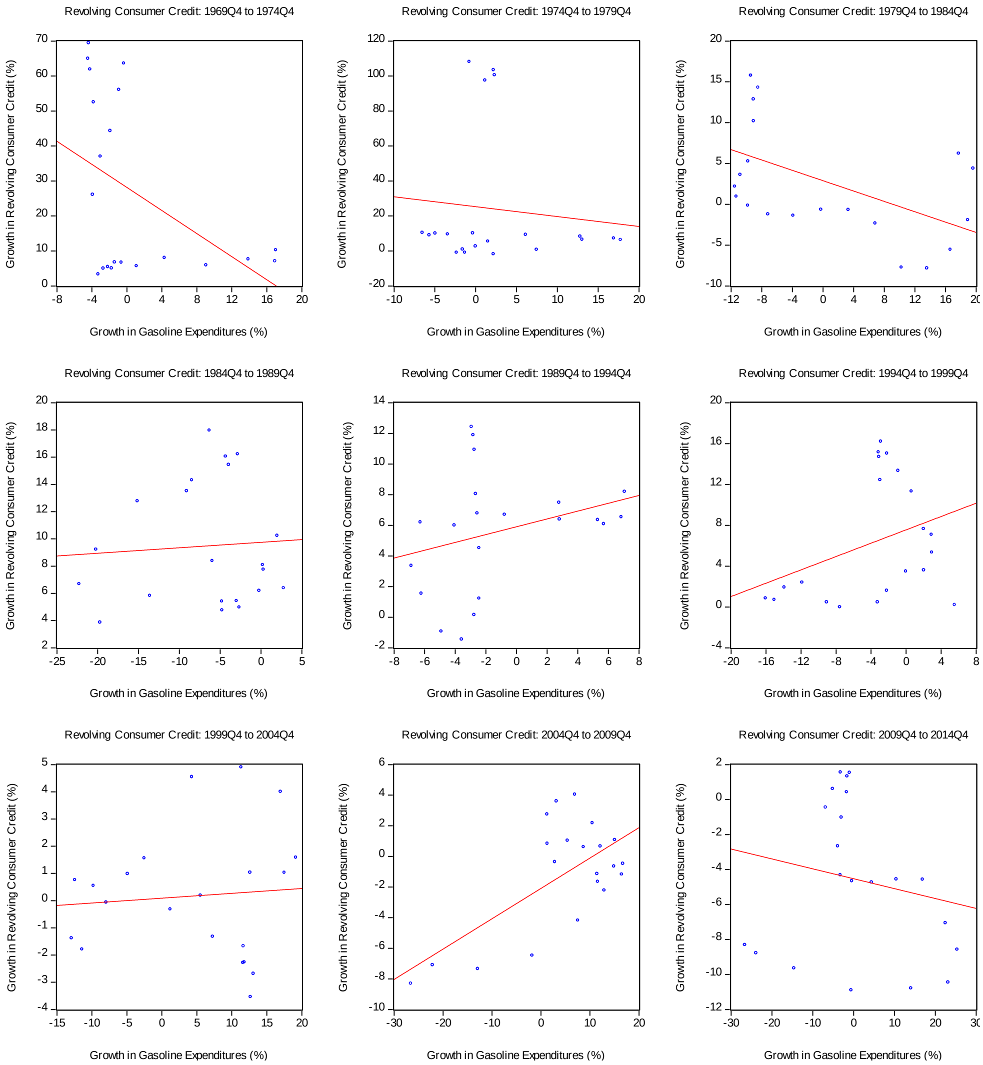

Figure 15. *Scatterplots of Annual Growth in Gasoline Expenditures and Revolving Consumer Credit over 5-Year Rolling Windows*

Source: Author Calculations based on BEA and Federal Reserve Data

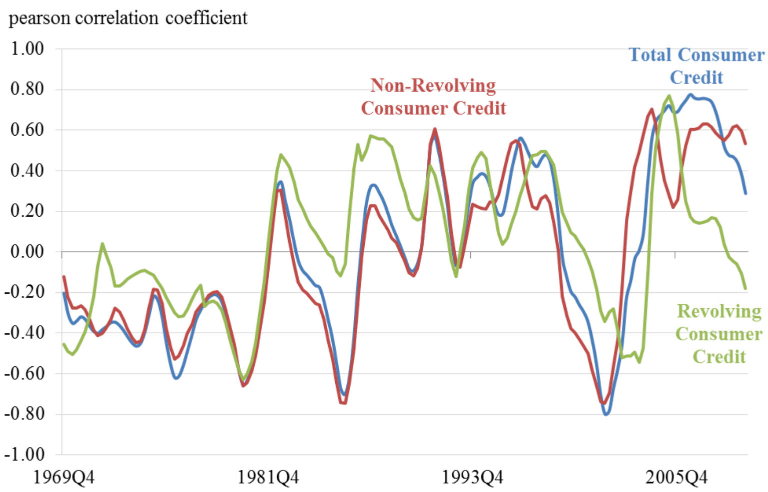

Figure 16. *Pearson Correlations between Annual Growth in Gasoline Expenditures and Consumer Credit over 5-Year Rolling Windows*

Source: Author Calculations based on BEA and Federal Reserve Data

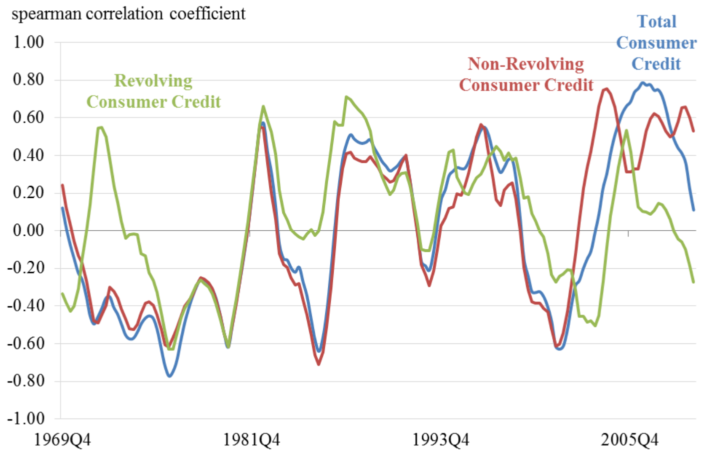

Figure 17. *Spearman Correlations between Annual Growth in Gasoline Expenditures and Consumer Credit over 5-Year Rolling Windows*

Source: Author Calculations based on BEA and Federal Reserve Data

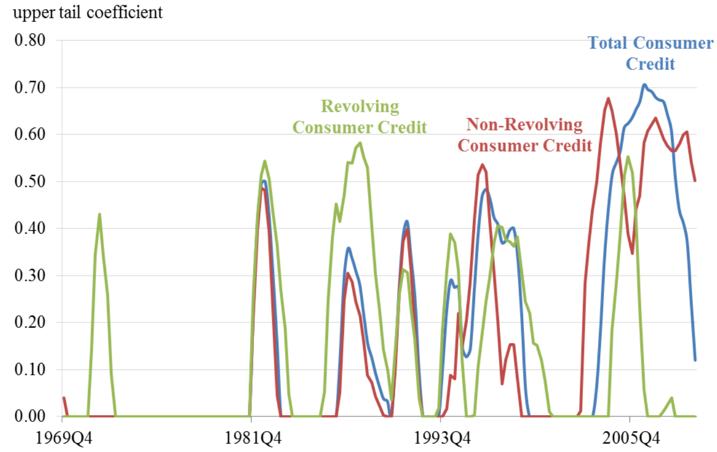

Figure 18. *Upper Tail Parameter of Gumbel Distribution Based Copula between Annual Growth in Gasoline Expenditures and Consumer Credit over 5-Year Rolling Windows*

Source: Author Calculations based on BEA and Federal Reserve Data

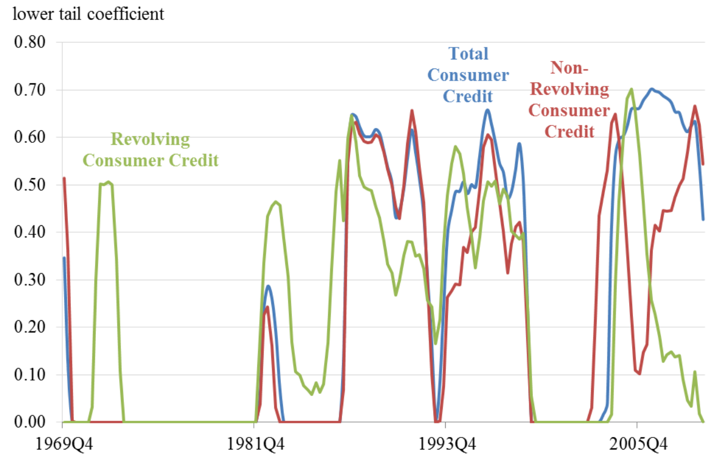

Figure 19. *Lower Tail Parameter of Clayton Distribution Based Copula between Annual Growth in Gasoline Expenditures and Consumer Credit over 5-Year Rolling Windows*

Source: Author Calculations based on BEA and Federal Reserve Data

Notes

[i] See https://research.stlouisfed.org/fred2/series/CMBDEBT and https://research.stlouisfed.org/fred2/series/GS10.

[ii] The rising importance of U.S. oil production also matters. For more on this see Arora (2015).

[iii] The general approach taken in these papers is to estimate a statistical model over two different time periods usually separating around 1984 and then compare the coefficient values.

[iv] In emphasizing the role of credit I am explicitly focusing on the monetary side of the economy; most other explanations for oil's declining association with economic activity are centered on the real side [i.e. Borio & Disyatat (2012)].

[v] See https://research.stlouisfed.org/fred2/series/TOTALSL, https://research.stlouisfed.org/fred2/series/REVOLSL, https://research.stlouisfed.org/fred2/series/NONREVSL, and https://research.stlouisfed.org/fred2/series/DPI.

[vi] See http://www.federalreserve.gov/releases/g19/about.htm.

[vii] See p. 21 of https://www.frbservices.org/files/communications/pdf/research/RetailPaymentsResearchProject.pdf.

[viii] The declining mortgage rates also reflect a similar pattern in refinancing rates, although loans secured by real estate are not included in the consumer credit measures shown above. Through at least 2008, consumers were increasingly able to refinance their mortgages for amounts greater than needed to pay off the mortgage. The additional money could help deal with higher gasoline prices, pay off credit card bills, finance home improvements, etc.

[ix] See https://research.stlouisfed.org/fred2/series/MORTG, https://research.stlouisfed.org/fred2/series/TERMCBAUTO48NS, https://research.stlouisfed.org/fred2/series/TERMCBCCALLNS, and https://research.stlouisfed.org/fred2/series/BAA.

[x] See https://research.stlouisfed.org/fred2/series/TOTALSL, https://research.stlouisfed.org/fred2/series/REVOLSL, https://research.stlouisfed.org/fred2/series/NONREVSL, and https://research.stlouisfed.org/fred2/series/DGOERC1Q027SBEA.

[xi] See http://www.bis.org/statistics/totcredit.htm.

[xii] I convert this annual gasoline expenditure series to quarterly by cubic interpolation. Interpolation from annual to quarterly is not ideal, but I prefer this approximation to seasonal adjustment of the series.

[xiii] I use a non-parametric estimate for the marginal distributions and estimate the copula parameters using semi-parametric maximum likelihood estimation.

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