Credit and Oil Consumption

Arora, Vipin

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Vipin Arora[2]

Abstract

Credit greases the wheels of oil consumption—it is prevalent in purchases of cars, trucks, and even the construction of factories. But the traditional view is that it affects oil consumption only through economic activity and the price of oil. I argue that credit is important in its own right. To make my case, I first show that an association between credit and oil consumption growth exists across countries and time. I then give a nod to the traditional view, and conclude by showing that changes in credit alter oil consumption—even after accounting for economic activity and oil prices.

Keywords: credit; oil consumption; economic activity; VAR
JEL Classifications: E51, F39, Q47

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

[2] U.S. Energy Information Administration: 1000 Independence Ave. SW, Washington DC, 20585, USA. Email: vipin.arora@eia.gov.

Introduction

Few of us walk into a car dealership, throw a stack of $100 bills on the table, and drive off into the sunset. No, we buy on credit. Even after choosing the car, and then haggling with the salesman on price, most of us trudge to a different room and fill out still more paperwork to get a loan. We also tend to fuel that car using credit. Companies are no different: many finance the purchases of capital assets—such as vehicles—by taking on debt. In general, credit is an important factor in determining the amount of oil we buy. But when it comes to understanding or explaining oil consumption, credit is like marijuana—commonly used but rarely acknowledged.[3]

The typical suspects for such explanations are economic activity and oil prices. For longer-term trends you can throw in government policies such vehicle fuel economy standards or technological change like the development of electric cars. The implicit assumption in this traditional view is that the impact of credit on oil consumption is tied up with economic activity, and because credit growth tends to rise and fall with the economy there is no need to account for it separately.

On the face of it this makes sense: consumer vehicle purchases and firm investment also tend to move up and down with the economy. These are generally times when asset prices are high as well, which can further reinforce such consumption and investment. Yet there are other aspects of credit demand and supply that are not directly related to economic activity. For example, oil producers may take on debt to maintain or increase current production and to invest for the future. Either depends on the availability and price of credit—not solely economic activity. And these actions affect the oil price, which influences its consumption.

In some countries there is also a feedback loop, whereby credit flows from oil exporting countries fund oil consumption by allowing for cheaper and more wide-spread borrowing by domestic consumers and firms. This helps to push up oil prices, which then further increases capital flows and lowers the cost of credit because oil exporters push even more of their savings into the global financial system, and this again increases oil consumption, and so on. Finally, movements of financial capital across countries influence exchange rates, which alters the local price of oil in most countries, also leading to changes in oil consumption.

In this paper I show through various methods that credit helps in accounting for and understanding oil consumption—above and beyond its impact on economic activity or oil prices. I first use scatterplots and correlations to establish an association between credit and oil consumption growth across countries and over time, at both annual and quarterly frequencies. I then demonstrate that—depending upon model specification and frequency of the data—changes in credit can either predict oil consumption growth, or changes in real GDP growth, which then predict oil consumption growth. This is consistent with the traditional view of how credit impacts oil consumption.

I finish by showing that credit can account for changes in oil consumption directly, not just because it alters economic activity. To do so, I estimate a multivariate model that shows an unexpected increase in credit affects oil consumption, even after accounting for growth in real

[3] See Arora (2016) for related analysis.

GDP and the oil price. A 10% increase in credit in this model increases oil consumption by just over 1% over the first year, rising to slightly below 3% by the fifth.

Oil Consumption, Credit, and Economic Growth

The majority of oil consumed around the world—a bit less than 60%—is for the transportation of people or goods.[4] It fuels the cars we drive, the trucks that move our food and clothing, and the boats which deliver our electronics and commodities. The other big chunk—around 35%—is consumed by firms to produce goods. These are the plastics which seem to be in everything we use, fertilizers that aid farmers in growing fruits and vegetables, and also the asphalt which paves our highways and driveways.

Underlying these end-uses for oil are fundamental factors, sometimes called determinants, which help to make sense of observed and potential oil consumption. These include consumer preferences, government policies, the number of people that will consume oil, the state of the economy, the price of oil or oil products and any close substitutes, and the technologies available either for using oil or producing goods with it.

Some of these determinants are difficult to quantify—particularly consumer preferences, government policies, and available technologies. Reliable data is unavailable in many countries for others, such as the price of oil products or close substitutes. This generally leaves the state of the economy and price of oil as variables which can be used to understand and/or forecast oil consumption. The variable which stands in for the state of the economy is usually inflation-adjusted, or real, gross domestic product (GDP), while some type of benchmark—Brent or West Texas Intermediate (WTI)—typically represents the oil price.

Of course these are general observations—specific analysts employ all different types of variables, explicitly or implicitly, in order to explain oil consumption. Some may use a different benchmark oil price, others might gather gasoline prices, and still others could use some type of industrial production index instead of real GDP. The details will vary based on data availability, country, and the time-frame under consideration. But it is very unusual to see any references to credit when accounting for oil consumption.

Why does credit matter for oil consumption? For starters, it eases the purchase of things that use oil. Consumers, firms, and even governments can purchase vehicles—car, trucks, boats, ships—on credit that might otherwise be unobtainable. The more vehicles that are sold, the greater oil consumption is likely to be. Companies or governments might also use credit to build factories that use oil as an input, such as chemical plants.

Growth in credit can also increase economic activity, which results in greater oil consumption because people and firms buy more vehicles with higher income, consumers tend to travel more as well, and firms need to transport a greater number of goods. There may also be a knock-on effect from credit growth to asset prices—real estate and equities in particular—and there is a well-known wealth effect where consumer purchases rise with asset prices (Shen et. al, 2015).

[4] See the International Energy Agency's energy statistics at http://www.iea.org/statistics/.

Another channel is through oil supply. The ability of oil producers—both private and public—to get loans will help to determine both current production and investment (Caruana, 2016). Some oil producers in the U.S. are currently relying on bank loans and bond sales to finance ongoing production; others are producing in the low-price environment at a loss to repay such loans. This additional supply, which would not be possible without such debt, helps to keep current prices down, pushing up consumption. And many state-owned oil companies have taken on debt in recent years as well, ostensibly to finance large investments in future production, which affects future oil prices and consumption (Caruana, 2016).

There is also the so-called commodity-credit feedback loop.[5] The basic idea here is that oil exporting countries have funds in excess of domestic needs to invest in foreign markets because of higher oil prices (petrodollars). These tend to bid up global asset prices, but also make credit more accessible in certain emerging markets (via lower interest rates, a smaller risk premium, etc.). Consumers and firms in these countries use such credit for purchases that increase oil consumption. This raises oil prices, and oil exporters then have even more funds to invest, which makes credit even easier, and so on.

A final channel is through exchange rates. Flows of capital across countries, which directly impact credit cost and availability, have an impact on exchange rates. And because oil is priced in dollars, such changes in currency values may alter oil consumption (Bruno and Shin, 2014).

These channels are nice, you may be thinking, but aren't changes in economic activity sufficient to account for any impacts credit has on oil consumption? I don't believe so, and provide specific evidence for that below. But I don't find this conceptually satisfactory either, as the relationship between credit and economic growth is not as straightforward as it might seem.

There are three general ways in which the financial sector and the so-called real economy impact each other: (i) through the assets and liabilities of consumers, which can affect purchases of goods and services; (ii) through the assets and liabilities of banks or other financial intermediaries, which can affect their supply of credit to consumers and firms; and (iii) through the ability of financial intermediaries and consumers to sell or buy assets without substantial changes in price, sometimes referred to as liquidity (BCBS, 2011).

Recent research has overwhelmingly supported the view that financial factors, through the channels outlined above, make an important contribution to changes in real GDP—across countries and time (Jorda et. al, 2012). But this research also emphasizes that credit and economic growth do not move together in lock-step, and it is unclear that one is fully driving movements in the other (Claessens et. al, 2012). Additionally, the impacts of credit on growth, or the reverse, can depend upon the country or countries being considered, particularly in terms of their policies on capital flows and stage of development (Garcia-Escribano and Han, 2015).

[5] This name comes from the FT Alphaville blog (subscription required), which has many excellent discussions of this topic and its potential ramifications. See specifically: http://ftalphaville.ft.com/2015/10/12/2141989/the-commodity-credit-feedback-loop/ and the links at the bottom.

I believe these caveats, along with the importance of credit for financing oil consumption outlined above, make a compelling case for assessing its usefulness in analyzing and accounting for oil consumption. I take this up in the next section.

Results

I use four different methods in this section to dive into the relationship between oil consumption and credit. I begin with scatterplots and correlations, move to statistical tests of predictability, and then estimate a multivariate model. Throughout the analysis I use two different panel data sets, one that is annual and the other quarterly. Appendix 1 fully details the countries in each panel and specifics on the data series.

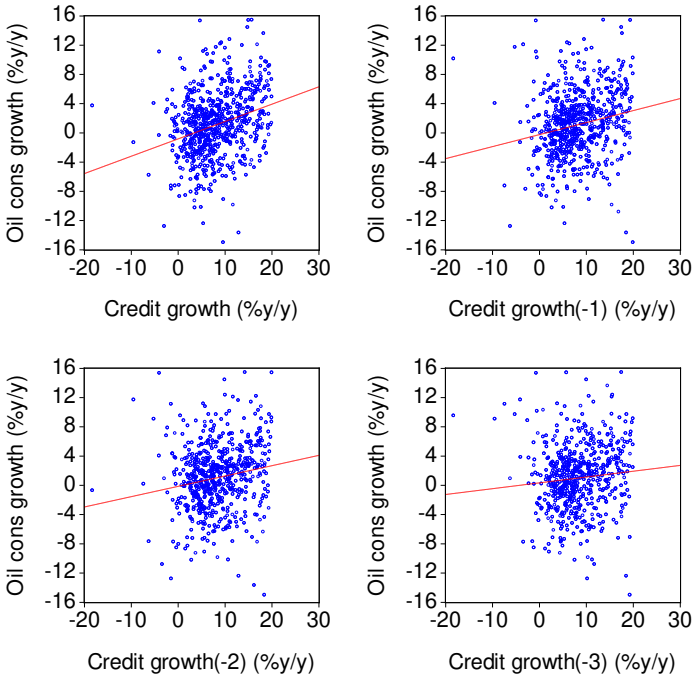
The annual panel covers 39 countries and includes a total of 738 observations between 1980 and 2014. The analysis uses only 652 observations because I have restricted the growth rates of each series to lie between -20% and 20% to minimize the impact of outliers. The quarterly panel includes a total of 1776 observations between 2002Q1 and 2015Q2 for 36 countries. As with the panel using annual data, I have restricted the growth rates in each series, in this case to lie between -25% and 25%, which leaves 1657 observations for the analysis.[6]

Associations

Figure 1 shows scatterplots of growth in oil consumption and credit based on the unbalanced panel of annual data. The central tendency across plots is a positive relationship: as credit growth rises oil consumption growth tends to as well. This relationship is strongest when both series are contemporaneous (top-left), and then weakens when credit growth is lagged by one (top-right), two (bottom-left), and three years (bottom-right).

[6] The upper and lower bounds are slightly higher than with the annual panel in order to increase the number of observations in individual countries.

Figure 1: Scatterplots of annual growth in oil consumption and lags of credit growth for the annual panel of 39 countries



Source: EIA, BIS, Author calculations

The best-fit lines associated with the scatterplots of the annual panel are consistent with correlations between the series (Table 1).[7] The contemporaneous correlation coefficient between the series is 0.30. This falls to 0.23 when credit growth lags by one period, is 0.20 when credit growth lags by two years, and drops to 0.19 when it is three years behind oil consumption growth.

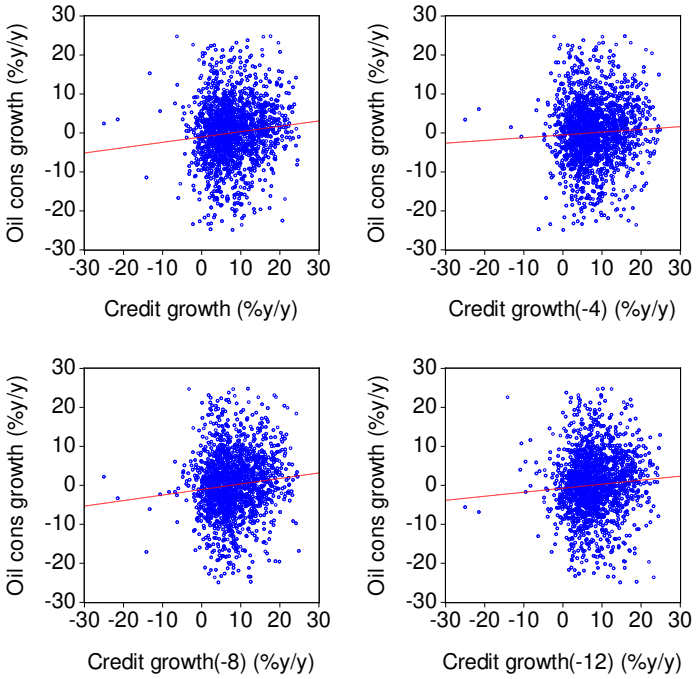
Table 1: Correlation coefficients between oil consumption and various lags of credit growth

	Contemporaneous	1 Year	2 Years	3 Years
Annual	0.30	0.23	0.20	0.19
Quarterly	0.11	0.07	0.11	0.12

The scatterplots based on the unbalanced quarterly panel show a similar pattern to the annual one (Figure 2). As before, the best-fit lines indicate a positive relationship between year-on-year growth in credit and oil consumption. In contrast to the annual data, however, the slope of the best-fit line remains about the same irrespective of whether credit growth is contemporaneous with oil consumption growth, or if it is lagged by two or three years. The line is slightly flatter when credit growth is lagged by one year.

[7] I use rank-based non-parametric (Spearman) correlations to better account for any non-linearities and remaining outliers in the relationship between the series.

Figure 2: Scatterplots of annual growth in oil consumption and lags of credit growth for the quarterly panel of 36 countries



Source: JODI, BIS, Author calculations

The correlations fit this arrangement as well, although they show less association between the series than equivalent values from the annual panel (Table 1). The contemporaneous correlation is 0.11, it falls to 0.07 when credit growth is lagged by one year, rises again to 0.11 when it is lagged two years, and is 0.12 when credit growth is three years behind oil consumption growth.

Granger Causality Tests

Another way to study the relationship between credit and oil consumption growth is to test whether changes in credit growth are able to predict changes in oil consumption growth. To do this, I use multivariate Granger Causality (GC) tests with both the annual and quarterly panels.[8] The results are summarized in Table 2 for three different model specifications.

Table 2: Does credit growth Granger Cause oil consumption growth?

	2 Variables	3 Variables	4 Variables
Annual	Yes	Yes	No
Quarterly	Yes	No	No

The first model, labeled 2 variables, tests whether credit growth can predict oil consumption growth when these are the only two variables in the model. The second model, 3 variables, conducts the same test but also adds real GDP growth to the specification. And the final model, four variables, adds growth in nominal oil prices on top of that.

[8] Based upon the Schwartz Criterion, I use 2 lags for the annual panel and 8 lags for quarterly.

The results with annual data—at the 90% confidence level—show that changes in credit are able to predict changes in oil consumption with either the two or three variables models, but not with the four variable one. However, changes in credit are able to predict both real GDP growth and oil price growth in the four variable model. The two and three variable models highlight the direct impact of credit on oil consumption, whereas the results from the four variable one show the importance of the traditional channel through economic activity and oil prices.

The quarterly results are slightly different. Here, credit growth only predicts oil consumption growth for the two variable model, and it only predicts real GDP growth for the three variable model. Credit growth also does not predict real GDP or oil price growth in the four variable model, but changes in oil prices are also unable to predict oil consumption growth in that particular specification. Although not as strong as with the annual panel, the quarterly GC tests still highlight the indirect impacts of credit on oil consumption.

Vector Autoregressive Models

I move next to a Vector Autoregressive (VAR) model in order to assess the impact of credit changes on oil consumption while accounting for both economic activity and the price of oil. As above, I use both the annual and quarterly panels, and my VAR model is estimated on the growth rates of four variables: oil consumption, credit, real GDP, and the oil price.[9]

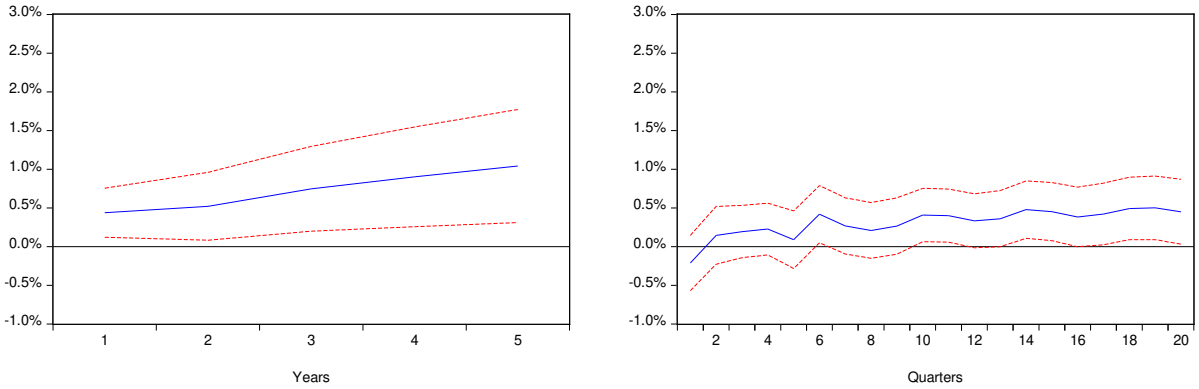
The two plots in Figure 3 show the response of oil consumption to an unexpected increase in credit over five years (the annual panel is to the left, quarterly to the right).[10] The responses are accumulated, meaning that the value in a given year is the total impact of the initial increase in credit on oil consumption up to that point. The solid lines are the estimated responses and the dashed lines surrounding them are confidence intervals.

For the annual panel, oil consumption rises after an unexpected increase in credit, and continues to increase over five years. Because the model accounts for GDP and the oil price when estimating this response, it is consistent with my contention that credit affects oil consumption directly, outside of its indirect importance for economic activity or oil prices. The plots in Figure 3 are responses of oil consumption to an increase in credit that has the magnitude of one standard deviation. In more meaningful terms, they imply that a 1% increase in credit raises oil consumption by 0.12% after one year, growing to 0.28% after five years.

[9] Based upon the Schwartz Criterion, I use 2 lags for the annual panel and 8 lags for quarterly.

[10] These are generalized impulse responses, which show the response of a variable to a one-time unexpected change in the error term associated with any of the equations in the VAR model. The impulses to each error term are constructed so that they are uncorrelated with each other and have a magnitude of one standard deviation (of the error term being changed). For more on generalized impulse responses see Pesaran and Shin (1998).

Figure 3: Response of oil consumption to a change in credit from the annual (left) and quarterly (right) VAR models based on each respective panel.



Source: EIA, JODI, BIS, Author calculations

The response of the VAR model based on the quarterly panel looks different to the annual one, but is actually quite similar. Here, oil consumption also increases after one year due to the initial rise in credit, and it continues to grow over the five year period. And the magnitudes are almost exactly the same: a 1% increase in credit results in a 0.13% increase in oil consumption after a year, rising to 0.27% after five years.

Conclusion

The scatterplots and correlations for both panels—annual and quarterly—indicate there is a positive association between credit and oil consumption growth across countries and time. The Granger Causality tests further reinforce this notion, and highlight the importance of the indirect channels through which credit affects oil consumption, namely via economic activity and oil prices. Finally, the VAR model shows that there is a direct channel from credit to oil consumption, even after accounting for real GDP and the price of oil.

My analysis is subject to numerous caveats and leaves open many avenues for future research. The most important of these is that I have used panel data and there is always the chance that a few countries have dominated the results. An extension to the country level would be welcome. I also made several decisions on model specification—the number of lags, the cut-off points for outliers, and the like—which have an impact on results. Finally, I have relied exclusively on linear frameworks that are parametric in nature. A non-linear/non-parametric analysis would be another useful extension.

Still, taken together, the associations, tests of predictability, and multivariate model demonstrate that there is a role for credit in explaining changes in oil consumption that goes above and beyond credit's impact on economic activity or oil prices. But that importance has to be recognized, or as the author Jack Canfield says, 'you can't heal what you don't acknowledge.'

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Appendix 1: Data

The data on credit are all from the Bank for International Settlements (BIS), specifically their series on total credit to the non-financial sector.[11] The values are available for 39 countries from varying starting points through the second quarter of 2015 (the last update to the data used in the analysis was in December 2015). The quarterly values are converted to annual by taking an average of the end-of-quarter stocks for each year; annual series are available through 2014. The specific series used are the market value of credit for all non-financial sectors in billions of local currency at current prices, adjusted for breaks.

The data on oil consumption are taken from two different sources. Annual series are from the U.S. Energy Information Administration's (EIA) international energy statistics.[12] These are available in thousands of barrels per day. The quarterly numbers are from the Joint Organisations Data Initiative (JODI), and are converted to thousands of barrels per day.[13] EIA series begin in 1980, JODI in the first quarter of 2002.

Real GDP for each of these countries are from Oxford Economics, and available in millions of local currency for the year 2010 (not seasonally adjusted). The oil price is the spot price of Brent Crude in current dollars, and comes from EIA.

Table 3 lists the countries included in the analysis, the frequencies for which data is available, and starting dates for the BIS series (EIA are available from 1980, JODI from 2002Q1). For calculations with annual data only those series with the full year available are included.

Table 3: Countries, frequencies, and BIS starting dates

Country	Frequency	BIS starting date
Argentina	Quarterly and Annual	1992Q4
Australia	Quarterly and Annual	1988Q2
Austria	Quarterly and Annual	1999Q1
Belgium	Quarterly and Annual	1998Q4
Brazil	Quarterly and Annual	1998Q1
Canada	Quarterly and Annual	1991Q1
China	Quarterly and Annual	1995Q4
Czech Republic	Quarterly and Annual	1998Q4
Denmark	Quarterly and Annual	1998Q4
Finland	Quarterly and Annual	1998Q4
France	Quarterly and Annual	1998Q4
Germany	Quarterly and Annual	1998Q4
Greece	Quarterly and Annual	1999Q1
Hong Kong	Annual	1998Q3
Hungary	Quarterly and Annual	1998Q4
India	Quarterly and Annual	1981Q1
Indonesia	Quarterly and Annual	2001Q4

[11] See http://www.bis.org/statistics/totcredit.htm.
[12] See http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm.
[13] See https://www.jodidata.org/.

Ireland	Quarterly and Annual	1998Q4
Italy	Quarterly and Annual	1999Q1
Japan	Quarterly and Annual	1997Q4
Korea	Quarterly and Annual	1990Q4
Luxembourg	Annual	2002Q1
Malaysia	Quarterly and Annual	1967Q1
Mexico	Quarterly and Annual	1990Q4
Netherlands	Quarterly and Annual	1998Q4
Norway	Quarterly and Annual	1995Q3
Poland	Quarterly and Annual	1999Q1
Portugal	Quarterly and Annual	1998Q4
Russia	Quarterly and Annual	1999Q4
Saudi Arabia	Quarterly and Annual	1999Q4
Singapore	Annual	1990Q1
South Africa	Quarterly and Annual	1965Q1
Spain	Quarterly and Annual	1995Q1
Sweden	Quarterly and Annual	1999Q1
Switzerland	Quarterly and Annual	1995Q4
Thailand	Quarterly and Annual	1997Q1
Turkey	Quarterly and Annual	2001Q1
UK	Quarterly and Annual	1999Q1
US	Quarterly and Annual	1952Q1