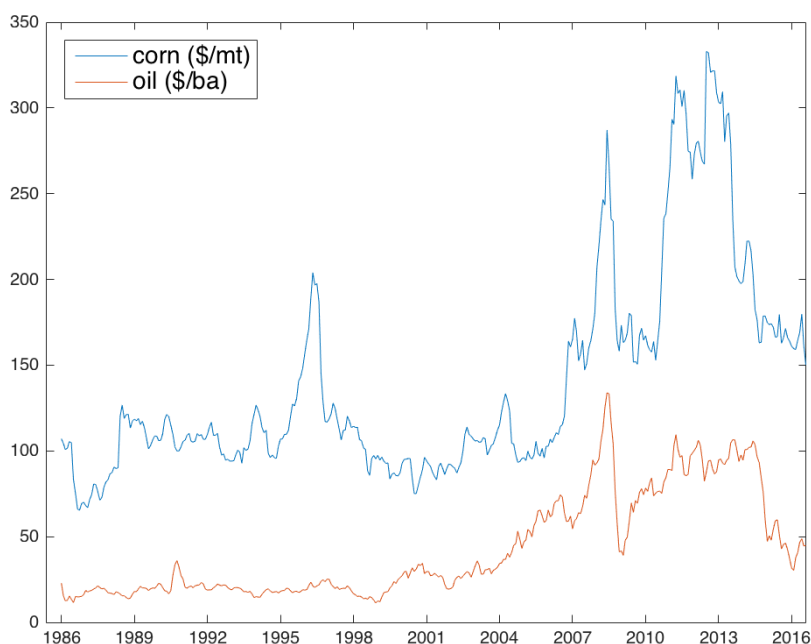


Problem 3 (19 Points)

Gasoline and Ethanol are both used as fuel for automobiles. Gasoline is derived from petroleum (crude oil). Corn is the main feedstock used for producing ethanol fuel in the U.S. In this exercise, we look at the relationship between the price of corn and crude oil. The **FRED** database at the Federal Reserve Bank of St. Louis contains data on **global corn prices**¹ and **West Texas Intermediate (WTI) crude oil prices**^{2,3}.

1. Download *monthly* data on global corn prices and WTI crude oil prices from **Jan. 1986** to **Aug. 2016**. Plot the two time series together. (5 Points)



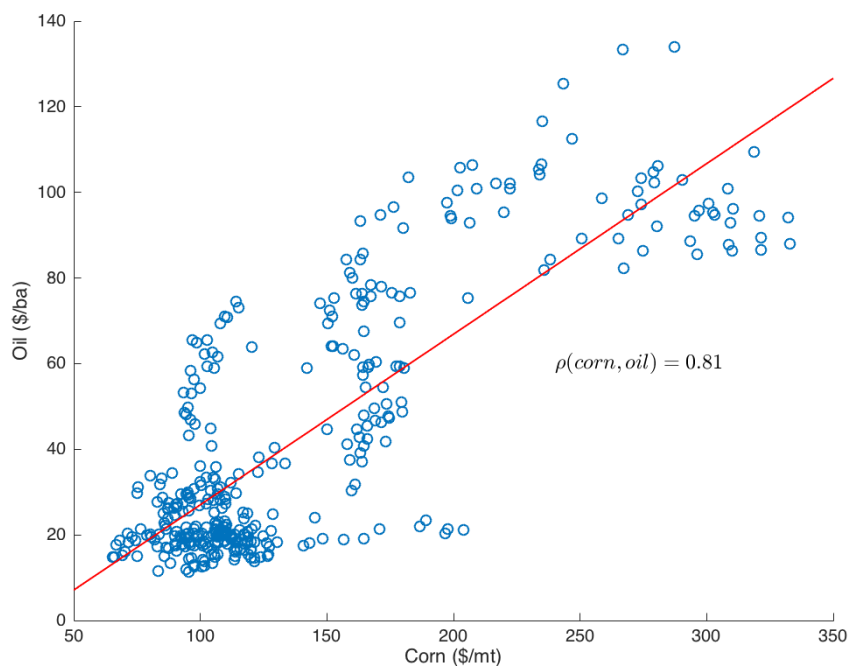
2. Describe the movement of corn price and crude oil price during this time period. (2 Points)

¹The FRED data on global corn prices are obtained from the **IMF database** on primary commodity prices.

²West Texas Intermediate (WTI), also known as Texas light sweet, is a grade of crude oil used as a benchmark in oil pricing.

³The FRED data on WTI crude oil **spot prices** are obtained from the **U.S. Energy Information Administration (EIA)**.

3. Draw a scatter plot of corn price vs. crude oil price. Add a linear best-fit line to the scatter plot. (4 Points)



4. What is the correlation between the price of corn and crude oil over this time period?
(2 Points)
0.81
5. Based on the observed pattern in the data, do you think corn and crude oil are *more likely* to be substitutes, complements, or neither? (2 Points)

Corn and crude oil are *more likely* to be substitutes because their prices are positively correlated (i.e. their prices tend to rise and fall together).

6. Other than corn and crude oil being substitutes or complements, are there any other explanations for the observed pattern in the data?⁴ (2 Points)

There are other possibilities that may cause the prices of corn and crude oil to move together. One such possibility is change in people's income. When people's income rises, they demand both more ethanol/corn and more gas/crude oil⁵, and when their income falls⁶, they demand less of both. This has nothing to do whether corn and crude oil are substitutes or not, but can lead their prices to rise and fall together.

Another possibility is that the price of oil can affect the cost of supplying corn and vice versa, since both are used to produce fuel for transportation. Yet another (theoretical) possibility is if the costs of supplying corn and crude oil are positively correlated themselves. In that case their prices will be positively correlated too, other things being equal.

7. What are the conditions that need to be satisfied for you to definitely conclude whether corn and crude oil are substitutes, complements, or neither? (2 Points)

We need to know that when the price of crude oil rises⁷, nothing changes for the corn market other than this increase in oil price and that gas price does not significantly affect the cost of supplying corn. In this case, if we observe an increase in corn price, we can conclude that it is because corn and crude oil are substitutes (in fuel production). Similarly, when the price of corn rises, if the only thing that has changed for the market of crude oil is the corn price, and we observe an increase in oil price, then we can conclude that they are substitutes.

⁴If your answer to question 5 is that corn and crude oil are substitutes because you think that explains the observed data, then this question asks you to imagine if there are any other possibilities in which these two goods are *not* substitutes that may also explain the observed data. Similarly, if you answer that corn and crude oil are complements, then this question asks you to imagine other possibilities.

⁵For example, China's economic growth has led to a significant increase in global demand for both commodities.

⁶such as after the financial crisis of 2008.

⁷due to supply and/or demand shifts as a result of changes in factors such as income and cost.

8. Read the following articles and use supply and demand analysis to explain the oil price movements from 2002 to 2017. In particular, what explains the rise in oil price from 2002 to July of 2008? What explains its collapse from July of 2008 to February of 2009 and its subsequent rebound? What explains the fall in oil price from July 2014 to February 2016? (10 Points)

- Hamilton, J., “[What’s up with oil prices?](#)” Econbrowser, 2005/06/04.
- Hamilton, J., “[The China Syndrome](#),” Econbrowser, 2010/06/29.
- The Economist, “[Cheaper oil: Both symptom and balm](#),” 2014/10/21.
- Hamilton, J., “[Trends in oil supply and demand](#),” Econbrowser, 2016/05/29.
- Russell, K., “[How Oil Prices Are Falling Again](#),” New York Times, 2016/07/29

The rise in oil price from 2002 to 2008 was mainly due to increased demand from emerging economies, especially China. The collapse from July 2008 to February 2009 was due to decreased demand as a result of the global financial crisis. Oil prices rebounded after 2009 as world economies started to recover. The fall in oil price from 2014 to 2016 was mainly due to increased supply from the U.S. (shale oil) and the middle east.