Econ 753 HW4-5

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Problem Set 4

In PS4, we analyze flow of funds accounting data from the Federal Reserve. The Fed releases aggregate flow of funds accounting data in a myriad of tables. In this exercise, we pulled the following data from the Fed database: total internal funds, fixed investment, and net increase in liabilities. We divide total internal funds and net increase in liabilities by fixed investment and plot the results over the time period 1950-present in Figure 1.

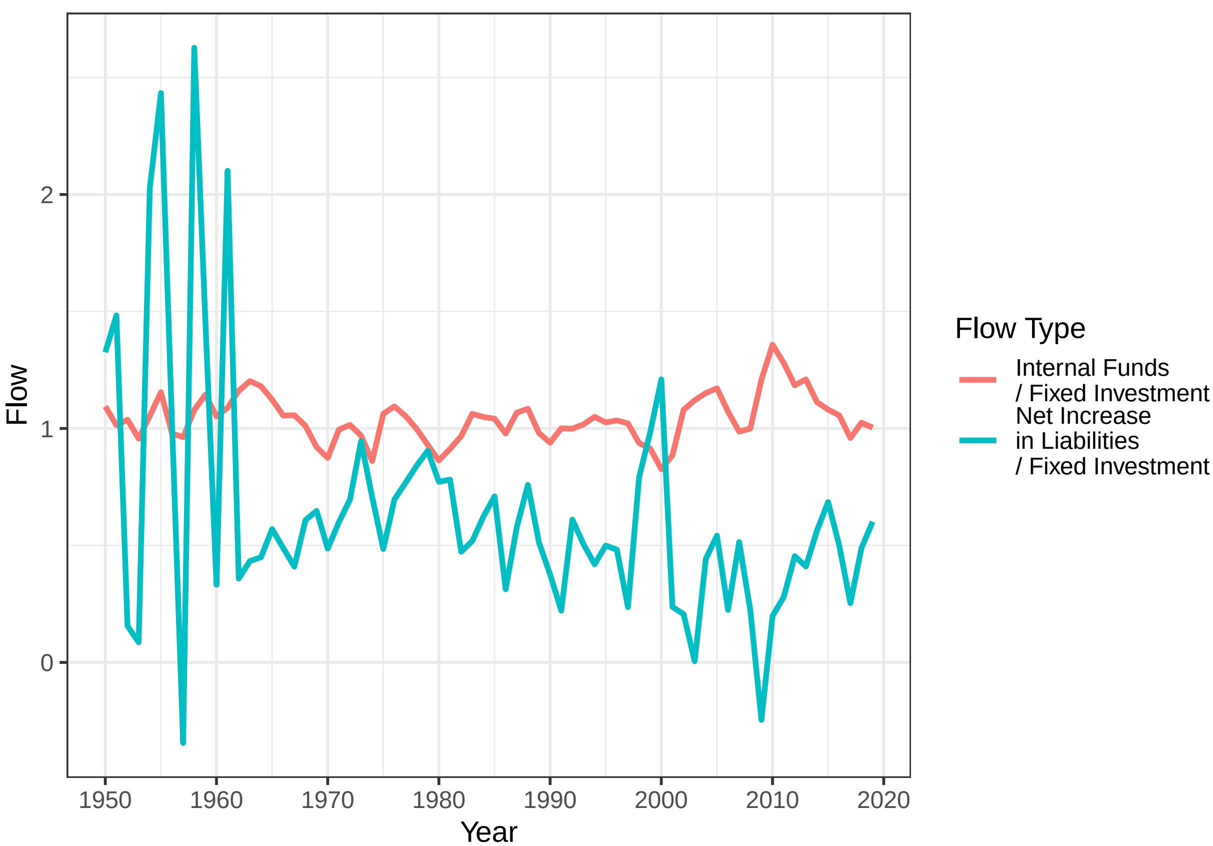

Figure 1: Internal Funds and Net Increase in Labilities per Fixed Investment 1950-Present

While there is not an entirely clear relationship between the two, generally increases in liabilities tend to overlap with decreases in internal funding, and visa versa. This makes sense, as firms which experience a decrease in internal funding would likely need to seek credit from financial markets in order to fulfill their investment needs. Another pattern seems to be that liabilities tend to increase before recessions and decrease at the beginning of recessions. This pattern can be more clearly seen in Figure 2, where we zoom in on the time period 1990-present.

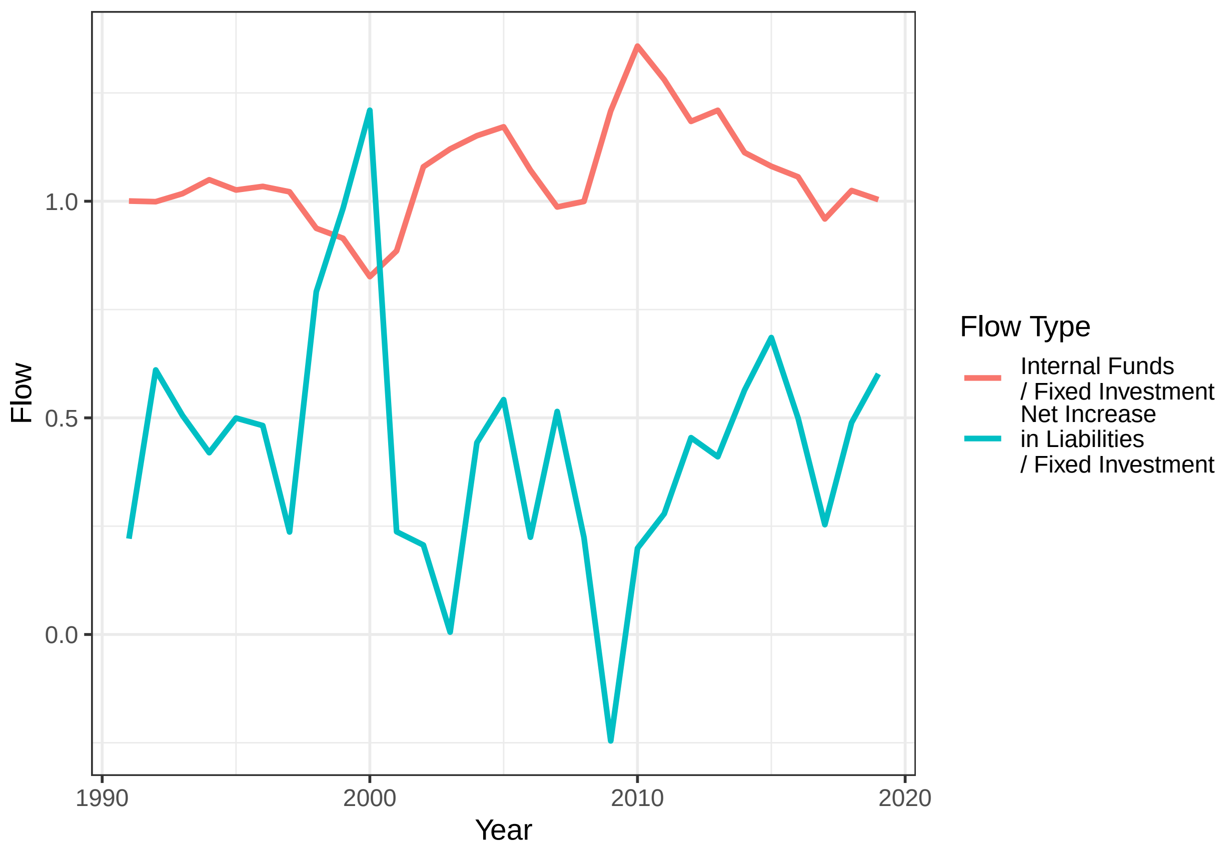

Figure 2: Internal Funds and Net Increase in Labilities per Fixed Investment 1990-Present

We can see from Figure 2 that liabilities increase dramatically throughout the period of the Dot-com bubble (1995-2000) — as firms borrowed excessively in order to conduct large mergers — and fell precipitously following the bursting of the bubble in 2000. Similarly, liabilities increased prior to the 2008 crash and fell precipitously following the bursting of the real estate bubble. This pattern is consistent with Hyman Minsky's theory of financial instability, which posits that booms tend engender a buildup of leverage in financial markets, which weakens the economy's ability to absorb shocks, thus leading to financial crises and recessions which precede a new cycle of a buildup of leverage.

These data series can help shed light on the relative importance of factors such as cash flow and the Q ratio in determining investment activity in the U.S. A general scan of the data suggests that, as noted above, decreases in cash flows tend to precede recessions, where investment levels fall. This can be seen more clearly in Figure 3, where total internal funds, net increases in liabilities, and fixed investment levels are plotted from 1990-present. In Figure 3, we can directly see investment levels fall after slow downs in cash flows and increases in liabilities in the years prior to the 2000 and 2008 crashes. Furthermore, Tobin's Q ratio — which expresses the relation between market value and intrinsic value — is likely to rise during periods when decreasing cash flows overlap with increased borrowing, which, as noted above, precede periods of recession and falls in investment.

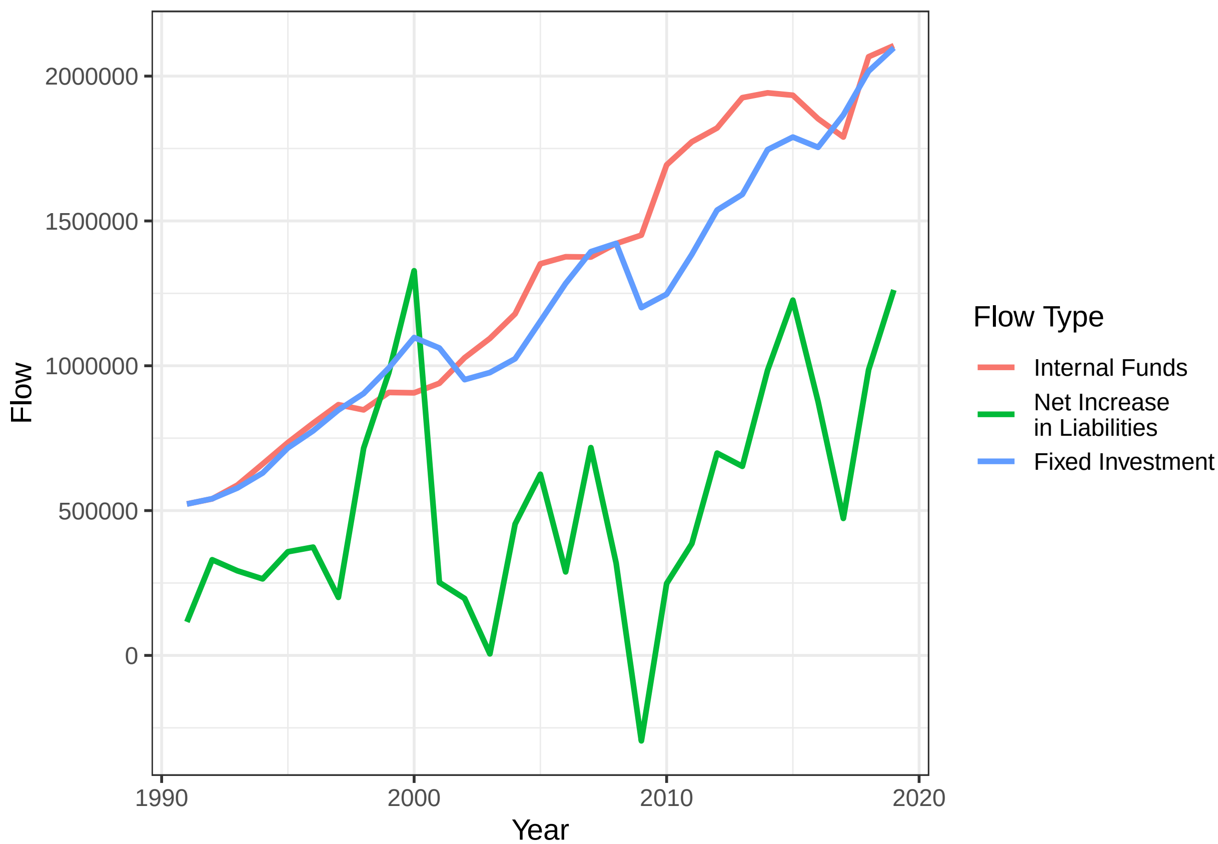

Figure 3: Internal Funds, Increase in Labilities, and Fixed Investment 1990-Present

Table 1: Augmented Dicky-Fuller Test on Federal Funds Rate and BAA Rate

	BAA Rate						Federal Funds Rate					
	No Drift & No Trend		Drift & No Trend		Drift & Trend		No Drift & No Trend		Drift & No Trend		Drift & Trend	
Lag	ADF	p Value	ADF	p Value	ADF	p Value	ADF	p Value	ADF	p Value	ADF	p Value
0	-0.45	0.51	-0.65	0.83	-1.83	0.65	-1.14	0.27	-1.63	0.48	-2.66	0.30
1	-0.58	0.47	-1.30	0.60	-2.17	0.51	-1.69	0.09	-2.69	0.08	-3.77	0.02
2	-0.52	0.49	-1.06	0.68	-2.03	0.56	-1.43	0.17	-2.20	0.25	-3.25	0.08
3	-0.54	0.49	-1.15	0.65	-2.09	0.54	-1.38	0.19	-2.11	0.28	-3.17	0.09
4	-0.56	0.48	-1.21	0.63	-2.14	0.52	-1.29	0.22	-1.94	0.35	-3.01	0.15
5	-0.58	0.47	-1.30	0.59	-2.21	0.49	-1.30	0.21	-1.93	0.36	-2.95	0.17
6	-0.59	0.47	-1.33	0.58	-2.24	0.48	-1.23	0.24	-1.81	0.40	-2.88	0.21

Problem Set 5 - Granger Causality Test

The Granger Causality Test is a regression of Y on lagged values of X, controlling for lagged values of Y. The null hypothesis is that X does not "Granger-cause" Y, i.e. lagged values of X are not correlated with present values of Y, controlling for past values of Y. The test can also be run in reverse, i.e. whether Y "Granger-causes" X. While it is generally impossible to test true "causality", the Granger Causality Test can test whether X precedes Y in time or visa versa.

In PS5, we use the Granger Causality Test to answer the question: does the Federal Reserve control interest rates? In order to target interest rates, the Federal Reserve maintains direct control over the Discount Rate and performs "open market operations" to determine its one true target interest rate, the Federal Funds Rate. Theoretically, raising or lowering the Federal Funds Rate should sprinkle through the economy to raise and lower other interest rates. Interest rate "exogeniety" (i.e. the ability for the Central Bank to directly control "the" interest rate) is an important assumption in much of neoclassical macroeconomic theory. In order to test for Granger-causality, we test whether the Federal Funds Rate Granger-causes the BAA corporate bond yield rate — which has a 10 year maturity and thus is not a short-term interest rate — from March of 1963 to the present. This time period contains business cycle troughs over seven full cycles.

Stationarity

Since regressions often reveal false correlations with non-stationary variables, the first step to answer our question is to determine whether the Federal Funds Rate and BAA rates are stationary. First, we plot these rates over time in Figure 4. It seems that there is no persistent trend and that neither variable seems stationary, as the distribution over time for both series does not seem constant. However, the Augmented Dicky-Fuller (ADF) test provides a formal method for testing for unit roots.

We conduct an ADF test on both the Federal Funds Rate and the BAA rate and give the results in Table 1. ADF tests can be run with three specifications: whether the model contains no drift and no trend, a drift and no trend, or a drift and trend. The ADF test also needs a "lag" input, which is the number of time observations prior to the present which might affect the present observation (or, in the case of the ADF test, change in the present observation). In each rate, we should expect no drift and no trend in the rates. Nonetheless, all of the formulations for several lag values are given in table 1. We can see that, no matter the specification and number of lags, the p-values are very high for the BAA rate and fairly high enough above 0.05 for us to fail to reject the null hypothesis — that there is no unit root for each variable. Thus, both of our variables are not stationary.

We therefore have to first-difference both variables and re-run the test for stationarity. The differenced rates are plotted in Figure 5. By visual inspection, each variable seems stationary, as each hovers around 0 without drifting. We re-run the ADF test, with the results given in Table 2. Now, after differencing, the p-values for each variable for all specifications are less than 0.02, which means we can safely reject the null hypothesis that there is a unit root for each variable. Thus, each variable is now stationary.

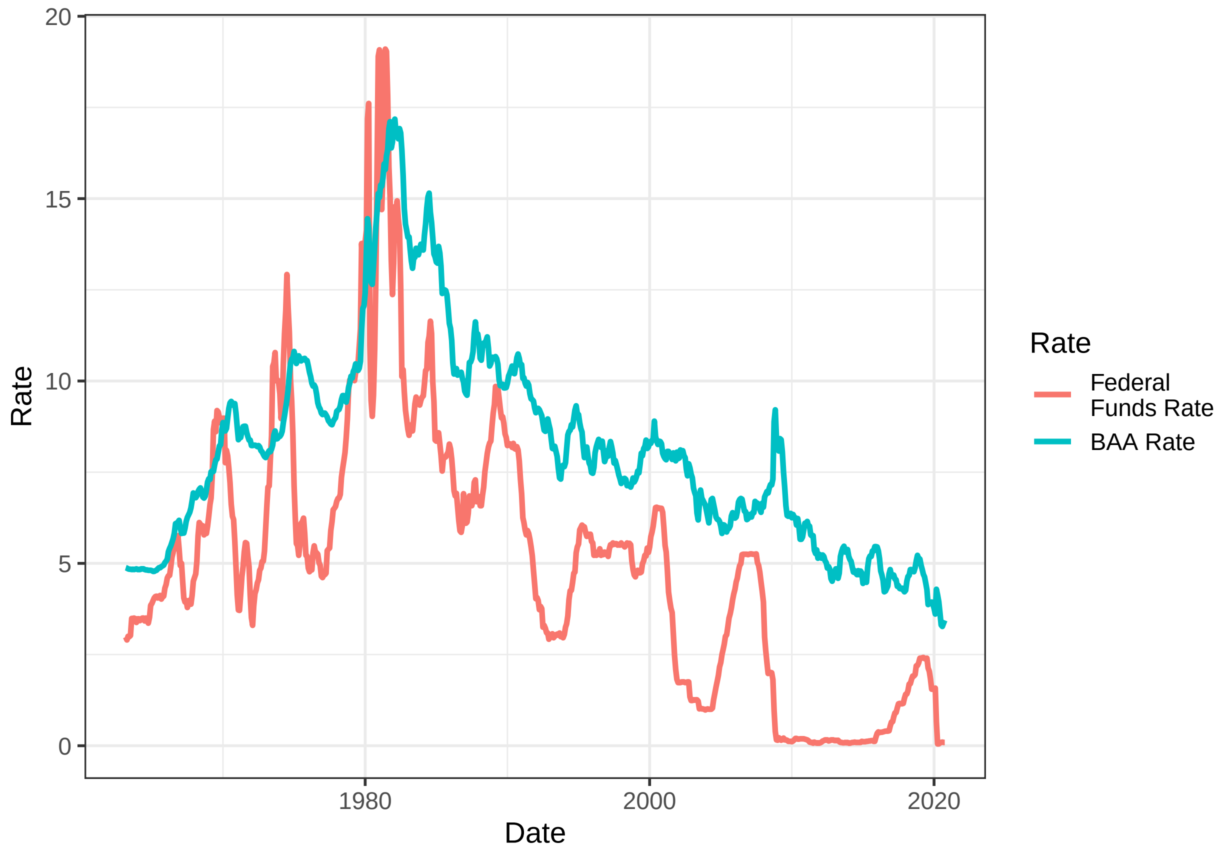

Figure 4: Federal Funds Rate and BAA Rate Over Time

Table 2: Augmented Dicky-Fuller Test on Differenced Federal Funds Rate and BAA Rate

	BAA Rate						Federal Funds Rate					
	No Drift & No Trend		Drift & No Trend		Drift & Trend		No Drift & No Trend		Drift & No Trend		Drift & Trend	
Lag	ADF	p Value	ADF	p Value	ADF	p Value	ADF	p Value	ADF	p Value	ADF	p Value
0	-17.24	0.01	-17.23	0.01	-17.32	0.01	-17.11	0.01	-17.10	0.01	-17.11	0.01
1	-16.61	0.01	-16.60	0.01	-16.73	0.01	-17.15	0.01	-17.14	0.01	-17.15	0.01
2	-13.28	0.01	-13.27	0.01	-13.40	0.01	-14.92	0.01	-14.91	0.01	-14.92	0.01
3	-11.35	0.01	-11.34	0.01	-11.48	0.01	-13.93	0.01	-13.92	0.01	-13.94	0.01
4	-9.84	0.01	-9.84	0.01	-9.98	0.01	-12.27	0.01	-12.27	0.01	-12.28	0.01
5	-9.03	0.01	-9.03	0.01	-9.18	0.01	-11.74	0.01	-11.73	0.01	-11.75	0.01
6	-8.65	0.01	-8.64	0.01	-8.80	0.01	-11.59	0.01	-11.59	0.01	-11.62	0.01

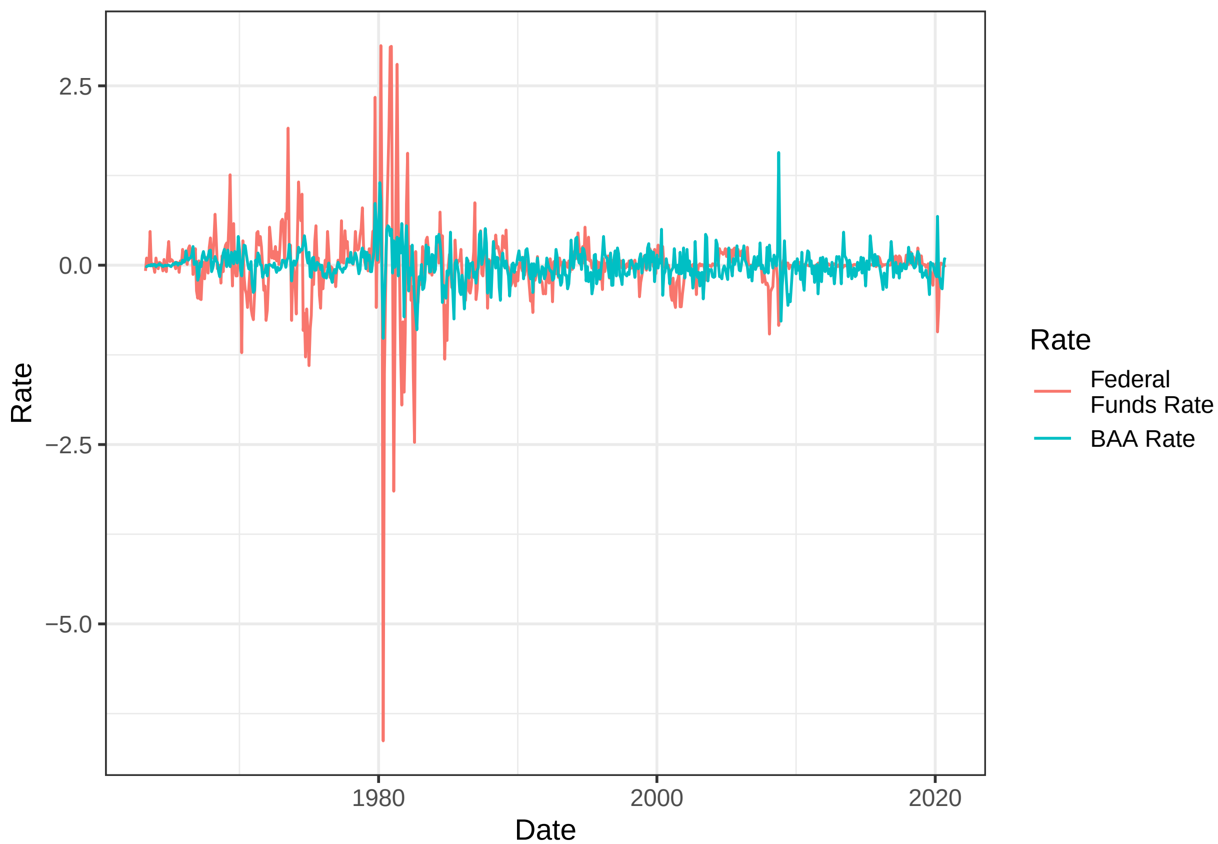

Figure 5: Differenced Federal Funds Rate and BAA Rate Over Time

Table 3: Granger Causality Test of the Federal Funds Rate and BAA Rate

	Seven Full Cycles		Particular Full Cycles				Recent Years	
	1963.03-Present		1973.11-1981.06		2001.03-2008.02		2008.03-Present	
Lag	F-Stat	p-Value	F-Stat	p-Value	F-Stat	p-Value	F-Stat	p-Value
Null Hypothesis: BAA Rate Does Not Cause Federal Funds Rate								
1	8.76	0.00	6.52	0.01	0.16	0.69	0.46	0.50
4	4.59	0.00	4.21	0.00	0.49	0.74	0.22	0.93
8	5.91	0.00	8.63	0.00	1.00	0.45	1.79	0.08
12	3.88	0.00	6.54	0.00	1.00	0.46	1.53	0.12
Null Hypothesis: Federal Funds Rate Does Not Cause BAA Rate								
1	1.55	0.21	1.22	0.27	0.06	0.81	3.33	0.07
4	2.17	0.07	0.49	0.74	0.37	0.83	2.05	0.09
8	2.68	0.01	1.68	0.12	0.38	0.93	4.59	0.00
12	2.15	0.01	4.58	0.00	0.50	0.90	2.80	0.00

Granger-Causality Test

After first-differencing the data to ensure stationarity, we then run the Granger-Causality test. The results are given in Table 3. We run the test in both directions, i.e. whether the Federal Funds Rate Granger-causes the BAA rate and whether the BAA rate Granger-causes the Federal Funds Rate. The tests were run for various lag indices, with Table 3 showing the results for lags of one month, four months, eight months, and one year. The tests were also run on different time periods: the full range of dates (1963-present), one full cycle from 1973-1981, another full cycle from 2001-2008, and from the 2008 recession to the present. The two full business cycles were chosen to match with the two full business cycles tested in Pollin 2008, "Considerations on Interest Rate Exogeneity".

When first looking at the results for the full range of dates, we fail to reject the null hypothesis that BAA rates do not Granger-cause the Federal Funds Rate for all lag indices. This runs directly counter to the idea of interest rate exogeneity, which instead posits that the Federal Funds Rate should precede BAA rates. However, we also fail to reject the null hypothesis in the reverse direction for lag indices of eight months and one year. Thus, when analyzing the full range of dates, the Granger-Causality Test indicates simultaneous causality for the Federal Funds Rate and BAA rates, although there is a stronger case for BAA rates Granger-causling the Federal Funds Rate.

However, these conclusions change when we zoom into specific time periods. When we look into the 1973-1981 cycle, the tests again indicate that BAA rates Granger-cause the Federal Funds Rate, but we fail to reject the null hypothesis that the Federal Funds Rate does not Granger-cause BAA rates for all lag periods except for one year. These results are reversed when we look at the period of 2008-present, as the Federal Funds Rate Granger-causes BAA rates while we fail to reject the null hypothesis that BAA rates do not Granger-cause the Federal Funds Rate. Furthermore, we fail to reject the null hypothesis of both directions of causality when examining the 2001-2008 period. These results all align with those in Pollin 2008.

The interpretation I take from these results is that, overall, there is no evidence for interest rate exogeneity, i.e. that the Federal Reserve controls interest rates. Besides the apt question of what "the" interest rate means in neoclassical theory — there are variegated interest rates over multiple maturities, and we simply choose the 10-year BAA rate to examine in this exercise — the evidence suggests that the level of interest rate exogeneity changes over time and in fact often exhibits reverse and/or simultaneous causality. The fact that the most recent period examined exhibits Federal Reserve control over the BAA rate may have to do with historically low interest rates continuously targetted by the Federal Reserve, coupled with unprecedented monetary policy in quantitative easing operations. However, past periods show that it might in fact have been the Federal Reserve which responded to interest rates set in financial markets, and that during other periods the Federal Reserve simply could not keep pace with nor push interest rates in the direction it wanted. Overall, hese results are consistent with the "structuralist" Post-Keynesian school, which questions orthodox theory on both interest rate exogeneity and exogeneity of the money supply.

Replication Paper

I will replicate the paper titled "National Patterns in Environmental Injustice and Inequality: Outdoor NO_2 Air Pollution in the United States (2014)" by Clark et al. The paper describes spatial patterns in environmental injustice and inequality based on nitrogen dioxide (NO_2) concentrations in the United States. The paper uses data from "National Satellite-Based Land-Use Regression: NO2 in the United States (2011)" (from similar authors), which estimates year-2006 satellite data NO_2 concentrations using LUR regression and matches these concentrations to year-2000 census block groups (BG). As census block groups are the smallest Census geography with publicly available demographic data, the authors are able to compare NO_2 concentrations for different demographic groups.

The paper calculates population-weighted mean NO_2 concentrations by race-ethnicity, poverty status, household income, education status, and age, using annual mean BG concentrations (from year-2006 LUR data) and population estimates (from year-2000 Census data). NO_2 concentrations are measured in parts per billion (ppb).

One major problem I have run into thus far is that I believe I do not have the correct dataset with the LUR regression estimations of NO_2 BG concentrations. In brief sum, the 2011 paper with the LUR NO_2 estimations provides a broken url which is supposed to contain the data, and the only dataset I could locate comes from a more recent LUR regression estimate of NO_2 concentrations, which (I believe) gives slightly different estimates. For example, in their paper, they mention that the mean BG NO_2 concentration (not weighted by population) is 11.4, while the mean BG NO_2 concentration I calculate is 11.59. This furthermore causes all of my population-weighted NO_2 concentrations to be slightly off of their values. However, so far, the values I have calculated are similar to theirs and provide the same conclusions. I will continue with the replication even though my numbers will be slightly off due to the difference in data.

The results I have replicated so far are given in Tables 4 and 5. In Table 4, population-weighted mean NO_2 concentrations are given by race, poverty level, household income, and education level, with each of those broken down by urban/rural/mixed BG status. The most immediate statistic that stands out is that population-weighted mean NO_2 concentrations are 3.98 ppb (32%) higher for nonwhites than for whites. This is consistent with the results reached in the original paper, as they calculate a 4.6 ppb (38%) difference. This difference has significant consequences, as the authors estimate (based on the 4.6 ppb difference) that reducing nonwhites' NO_2 concentrations to levels experienced by whites would reduce Ischemic Heart Disease (IHD) mortality by ~7,000 deaths per year.

Furthermore, the population-weighted mean NO_2 concentrations are higher for households below the poverty level than for those above, and (correspondingly) lower the further up the income ladder. Surprisingly, the population-weighted mean NO_2 concentrations are higher for people with high school degrees or more than for people without high school degrees, but this might be because people with more education are more likely to live in cities. In general — as would be expected — urban areas face significantly higher NO_2 concentrations than rural areas. Table 5 directly compares population-weighted mean NO_2 concentrations for specific groups. Tables 4 and 5 correspond to the original paper's Tables 1 and 2, respectively.

I have a great deal of calculations left to perform. My remaining tasks are to compute the population-weighted mean NO_2 concentrations for more demographic groups, run regressions on NO_2 concentrations by income for different demographic groups, and construct environmental injustice and environmental inequality indices from the data. However, the bulk of the heavy lifting has been done, as I am now familiar with the data and how the calculations are made.

Table 4: Population-weighted mean NO_2 concentration in ppb

	Total	Urban	Mixed	Rural
Total	11.52	13.88	7.44	5.53
Race				
White	10.30	12.69	7.46	5.60
Nonwhite	14.28	15.83	7.34	5.09
Poverty Level				
Below Poverty Level	12.44	14.86	6.91	5.32
Above Poverty Level	11.42	13.76	7.51	5.56
Income				
<$20,000	12.07	14.93	7.10	5.45
$20,000-$35,000	11.32	13.58	7.52	5.56
$35,000-$50,000	11.54	13.94	7.01	5.36
$50,000-$75,000	11.19	13.55	7.16	5.44
>$75,000	11.17	13.54	7.28	5.50
Education				
Less Than High School Degree	11.27	13.56	7.47	5.61
Greater Than High School Degree	11.97	13.90	7.98	5.84

Table 5: Comparisons between population-weighted mean NO_2 concentrations for specific populations

Group1_Name	Group1_Val	Group2_Name	Group2_Val	Difference_ppb	Difference_Percent
Nonwhite	14.28	White	10.3	3.98	0.32
Below Poverty	12.44	Above Poverty	11.42	1.02	0.09
<High School Degree	11.27	>=High School Degree	11.97	-0.70	-0.06