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Stock Returns and Industrial Production: A Sectoral Analysis

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Abstract

This paper analyzes the relationship between stock returns and future industrial production growth rates from 1926-1940. It replicates the work of Fama (1990) and Schwert (1990) with the intent to see if the relationship continues to hold using sector data. Furthermore, this paper focuses on the 1926-1940 sample period to explore how the relationship is affected by the stock market crash of 1929. It is expected that the relation will be weak for the industry sectors experiencing strong growth prior to the crash. The results indicate that the relationship between stock returns and future industrial production growth rates persists on the sectoral level, however, the inclusion of the stock market crash of 1929 undoubtedly weakens the relation, especially for sectors growing rapidly prior to the crash.

I. Introduction

The stock market has traditionally been viewed as a leading indicator of future economic activity. However, the question of whether the stock market can predict future economic activity has been widely debated. Some argue that the stock market is forward looking and thus can predict future economic activity, while others point to a number of reasons not to trust the stock market as a leading indicator (Comincioli, 1996). Moreover, skeptics can point to the stock market crash of 1929, where according to Reynolds (2016) the market lost over 85% of its value from its peak in mid-September 1929 through the second quarter of 1932, as a reason to doubt the markets predictive ability.

While there have been studies that examine the relationship between current stock returns and future industrial production, there has been no analysis of this relationship on the sectoral level. Most studies (see Fama 1990 and Schwert 1990), have conducted research on this topic focusing on aggregate stock return and industrial production data. Therefore, this paper will attempt to see whether this relationship continues to hold on a sectoral level. While there is ample research examining this relationship, I focus on the sample period from 1926-1940 to test whether this relationship holds with the inclusion of a major market event like the stock market crash of 1929. In my paper, I argue that the relationship between stock returns and future industrial production will hold using sectoral data. In addition to my analysis, I use sub-periods to see how market sentiment for the high-flying industry sectors prior to the crash affect the relation between stock returns and future industrial production growth rates. I argue that these sectors, as suggested by Bierman (1998) and Richardson (2013) to be the Utilities, Cars, Oil, and Steel sectors, will show a weak relation between sector returns and future industrial production growth rates in the 1926-1932 sub-period, and show a stronger relation in the 1933-1940 sub-period. For the remaining sectors in my tests, I expect the sectors' returns will present a strong relation with future industrial production growth rates in both sub-periods.

I use data, compiled by French (2016), on monthly stock returns for each sector for the sample period from July 1926 to December 1939. For the regression involving quarterly observations, I construct the quarterly returns by compounding the monthly returns from French's (2016) industry portfolios. I use industrial production data from the industrial production index collected by the *Survey of Current Business*. I use leads of three months for monthly observations and leads of one year for quarterly observations in my regressions. I run these tests on 8 sectors from Kenneth French's 17 Industry Portfolio (Utilities, Clothes, Mines, Cars, Construction, Oil, Steel, Durables), and compared the results to my arguments above.

My study shows that the relation between stock returns and future industrial production growth rates persists using sectoral data. However, the inclusion of a stock market crash in my sample period weakens the relation, especially the sectors that were experiencing strong growth prior to the crash. Moreover, the analysis using sub-periods are generally in line with my argument above. The exceptions to my argument are the Steel and Construction sectors. The results for the Steel sector, which I argued to have a weak relation in the 1926-1932 sub-period, had a strong relation in both sub-periods. However, it is still meaningful that the results for the 1933-1940 sub-period has a much stronger relation than the 1926-1932 sub-period. On the other hand, the Construction sector did not present significant results in either sub-period. The results for the Construction sector are much stronger on the quarterly horizons than the monthly horizon, which explains why the results in the sub-period analysis, which uses monthly observations, were insignificant.

II. Literature Review

White (1990) revisits the United States Stock Market Crash of 1929 by examining a variety of hypothesis that attempt to explain the causes of the crash. White (1990) suggests that while the technological and structural changes in industry in the 1920s created a stock market boom, the developments also made fundamentals more difficult to evaluate, setting the stage for a bubble. He explains that speculation was a contributor to the crash due to investment trusts and credit expansion, which provided fuel for an economic boom and led to higher trading activity and valuations. White (1990) also notes that utilities were the favorites of speculators, citing that the sector was a central feature of the bull market, although their fundamentals were difficult to assess.

Bierman (1998) also examines the causes of the 1929 stock market crash. He argues that one of the primary causes of the crash was due to the actions of important people and the media to stop market speculators. Bierman (1998) also attributes the expansion of investment trusts, as well as public utility holding companies, for fueling the purchase of utility stocks and driving up their prices. In addition, he also mentions the incredible amount of leverage these institutions had which made them increasingly vulnerable to a crash. Given the incredible amount of leverage, Bierman (1998) believed that the crash started in the Utilities sector, noting that the sector was vulnerable to the arrival of bad news regarding utility regulation. Additionally, he notes that stock prices did not rise across all industries. The stocks that went up the most, such as airplanes, agricultural implements, chemicals, department stores, steel, utilities, telephone and telegraph, electrical equipment, oil, paper, and radio, were in industries where economic fundamentals indicated good reasons for optimism. Moreover, Richardson (2013) also mentions that automobiles were one of the sectors that was growing rapidly prior to the crash.

Reynolds (2017) examined the sectoral effects of the U.S stock market decline from 1929 through 1933. Using Kenneth French's 17 Industry Portfolio data, Reynolds (2017) analyzes the effects of the Wall Street Crash on October 28, 29, and 30, 1929, on 17 industry sectors across the entire market. Reynolds (2017) finds that finance, utilities, and consumer durables sectors took major hits to their value. Conversely, sectors that encompassed necessities performed well through the crash, such as consumer goods and transportation. The Construction sector also, surprisingly, outperformed the market. However, this abnormality may have been due to the sector's decline in the earlier months of 1929, thus making the crash less severe on the sector's value. Reynolds (2017) also explores three sub-sectors of the Finance industry sector, finding that Banking and Trading took abnormally large hits during the crash. While examining sectoral returns during the Great Depression, Reynolds (2017) does not examine the relationship between stock returns and industrial production.

Despite the dividend yield being the most intuitive variable used in predicting stock returns, multiple studies have tested the use of variables which proxy for economic activity. Studies such as Fama (1981), Geske and Roll (1983), Kaul (1987), and Barro (1990) find that forecasts of variables such as real GNP, industrial production, and investment explains a large portion of annual stock-return variances, given that these factors are important determinants of the cash flows to firms.

Fama (1990) explores the relationship between stock returns and future production growth rates for the period from 1953-1987, arguing that future production growth rates reflect information about cash flows that is impounded in stock prices. Fama (1990) analyzes the combined explanatory power of three major sources of return variation: shocks to expected cash flows, time-varying expected returns, and shocks to expected returns. He includes dividend yield on stocks, default spreads on corporate bonds, and term spreads on bonds to control for additional variation in expected returns. Additionally, Fama concentrates on annual returns due to measurement-error problems that arise from using short-horizon returns, as it includes growth rates for future periods, that is when using current industrial production growth rates it has already incorporated the effects of previous periods. He finds that 59% of the variance of annual returns on the value-weighted portfolio of NYSE stocks can be explained primarily by time-varying expected returns and forecasts of real activity. Although his regressions find that the combined explanatory power of the variables is very high (about 0.85), he notes that the variables used to explain returns are chosen primarily on the basis of goodness-of-fit rather than chosen on the basis of well-developed theory.

Schwert (1990) replicates Fama's (1990) results for the 1953-1987 period but uses an additional 65 years of data, including data from 1889-1952. Schwert (1990) aims to investigate the stability of the relations estimated by Fama (1990) using different data with different sample periods. Schwert (1990) confirms previous studies that find there to be a relationship between stock prices and future production growth rates 1889-1952, but not as strong as Fama's (1990) findings for the 1953-1987 period. This is noted by Schwert (1990) as likely be due to measurement error in pre-1953 data. Schwert (1990) offers three explanations for such relations:

> First, information about future real activity may be reflected in stock prices well before it occurs – this is essentially the notion that stock prices are a leading indicator for the well-being of the economy. Second, changes in discount rates may affect stock prices and real investment similarly, but the output from real investment doesn't appear for some time after it is made. Third, changes in stock prices are changes in wealth, and this can affect the demand for consumption and investment goods (Schwert, 1242).

Schwert (1990) also notes that it is unlikely that "data-mining" could explain Fama's (1990) results. He further compares the new Miron-Romer (1989) index of industrial production for 1884-1940 with the Babson index for 1889-1918. Schwert (1990) finds that the Miron-Romer production growth rates are more variable and have smaller autocorrelations than Babson and Federal Reserve data. He also notes that the Miron-Romer data is less strongly related to stock returns on a monthly and quarterly horizon than the Babson and Federal Reserve data, and equally related on an annual basis. These results suggest that the new Miron-Romer index does not exhibit more explanatory power than the older Babson and Federal Reserve data.

Balvers, Cosimano and McDonald (1990) examined the theory that stock returns can be predicted by forecasts of industrial output, utilizing data from 1947 - 1987. Balvers, Cosimano and McDonald (1990) used lagged industrial output in predicting stock returns based on the behavior of rational consumers and how they would react to economic events. They verified their tests by applying their model to not only the US, but Canada, Japan, and the United Kingdom (UK). Their results show that their model appears to be able to predict stock returns, and the prediction strengthens the longer the measurement period. Their results showed that the industrial output variables predict 20% of the variation in stock returns. Moreover, they find that the relationship between stock returns and industrial production is stronger than that of dividend yields and stock returns. These results also hold up for the tests from Japan, Canada, and the UK, which shows that current industrial output can predict stock returns in the following periods.

Young (2006) extends Schwert's (1990) work with the intent to see if the relationship between stock returns and industrial production persists with the addition of the years 1989 to 2004. Young (2006) hypothesized that the relationship between stock returns and industrial production will cease in the 1989-2004 period due to the U.S. economy transitioning from a manufacturing to a service oriented economy in the concluding years of the 20th century. Young (2006) finds there to be a statistically significant relationship using the seasonally adjusted index after a lag, with the explanation that increased industrial production leads to increased economic activity, thus resulting in higher earnings for companies. However, the results for the non-seasonally adjusted data did not indicate a relationship between stock returns and industrial production. Additionally, the results for the sub-period from 1988-2000 indicate that industrial production can no longer predict stock returns, which confirms the U.S. economy's transition from a manufacturing to a service oriented economy.

While there has been a significant amount of research on the relation between stock returns and industrial production, no other papers have examined the relationship on the sectoral level. Furthermore, I focus my tests on the sample period from 1926-1940 to determine how the inclusion of a stock market crash will affect my results. Thus, the goal of this paper is to determine whether the relationship between sector returns and future industrial production growth rates holds using sectoral data, as well as assessing whether the relationship holds with the inclusion of a stock market crash in the sample period.

III. Data

a. Stock Return Variables

I use the data from Kenneth French's 17 Industry Portfolios sample, which tracks monthly returns across 17 sectors from 1926 through 2015. Reynolds (2016) argues that the 17 industry sectors that he used for the analysis accurately divides and captures the entire U.S. financial market. I use returns for each sector using end-of-month values for the sample period 1926-1940. The industry sector variables include Consumer, Transportation, Mines, Construction, Utilities, Oil, Steel, Retail, Clothes, Fabric products, Finance, Durables, Machines, Chemicals, Cars, and Other. However, I only use the sectors that provide industrial production data dating back to 1926. Thus, my tests primarily focus on the Mines, Clothes, Construction, Utilities, Oil, Steel, Cars, and Durables sectors. Table 1 illustrates the varying returns across the eight industry sectors I examine.

Table 1.

Sample Statistics: Monthly Industry Sector Returns

	Utilities	*Clothes*	*Mines*	*Cars*	*Constr*	*Oil*	*Steel*	*Durables*
Mean	0.759	0.340	0.696	1.667	0.740	0.544	1.195	0.723
Standard Error	0.837	0.670	0.790	1.102	0.904	0.751	1.147	1.172
Median	0.935	0.225	0.755	1.145	0.955	-0.435	1.960	0.315
Standard Deviation	10.648	8.522	10.051	14.027	11.508	9.562	14.594	14.920
Sample Variance	113.377	72.619	101.032	196.752	132.437	91.437	212.978	222.603
Range	76.510	65.330	78.860	115.290	74.350	68.710	111.110	108.060
Minimum	-33.050	-20.830	-31.390	-34.860	-31.540	-29.710	-30.270	-36.740
Maximum	43.460	44.500	47.470	80.430	42.810	39.000	80.840	71.320
Count	162	162	162	162	162	162	162	162

Source: *Kenneth French 17 Industry Portfolio* (French, 2016) *b. Industrial Production*

Industrial production data are obtained from the *Survey of Current Business,* compiled by the *Department of Commerce and Bureau of Economic Analysis*. I obtained industrial production data for each sector that I examine.

I use the business indices of industrial production that measures output of manufactured goods, both durable and nondurable, and minerals, provided by the *Board of Governors of the Federal Reserve System*. These indices provide a measure for the changes in the physical volume of manufactured goods and minerals. The manufactured goods and minerals indices can be further broken down into specific goods and minerals, which allows me to match the industry sector with the proper industrial output.

While both adjusted and non-adjusted indices are provided, I primarily focus on the adjusted indices. The adjusted index is constructed by taking the weighted daily average for each component of the manufactured goods index and minerals index, and then adjusting for seasonal variations, which is derived from the “ratio-to-moving-average” method. The aggregate of the seasonally adjusted weighted daily averages is then compared to the aggregate of base years 1923-1925. Table 2 illustrates the varying growth rates of industrial production across the eight industry sectors I examine.

Table 2.

Sample Statistics: Monthly Industrial Production Growth Rates

	Utilities	*Clothes*	*Mines*	*Cars*	*Constr*	*Oil*	*Steel*	*Durables*
Mean	0.554	0.420	0.229	2.328	0.242	0.530	1.136	0.319
Standard Error	0.375	0.624	0.443	1.839	0.757	0.419	1.063	0.507
Median	0.980	0.000	0.930	0.000	0.000	0.578	0.000	0.000
Standard Deviation	4.767	7.948	5.639	23.405	9.629	5.336	13.531	6.454
Sample Variance	22.724	63.174	31.794	547.773	92.724	28.473	183.089	41.660
Range	23.009	62.520	41.525	162.478	58.316	64.019	103.277	47.588
Minimum	-11.959	-21.250	-16.250	-42.478	-26.316	-27.011	-44.186	-18.421
Maximum	11.050	41.270	25.275	120.000	32.000	37.008	59.091	29.167
Count	162	162	162	162	162	162	162	162

Source: U.S. Department of Commerce, Bureau of Foreign and Domestic Commerce, *Survey of Current Business*

I compiled the Industrial Production data from the annual supplements of the *Survey of Current Business*. For the Mines sector, I use the industrial production index for minerals which includes output for Anthracite, Bituminous Coal, Iron Ore Shipments, Lead, Crude Petroleum, Silver, and Zinc. For the Clothes, Oil, Cars, and Steel sectors, I use the textiles, crude petroleum, automobile, and iron and steel indices, respectively, as measurements of industrial production for each sector. For the Construction sector, I use the Federal Reserve Index of contracts awarded, which is compiled by the P. W. Dodge Corporation. The data is provided by reports covering contracts awarded in 37 states east of the Rocky Mountains. The output data I used for the Utilities sector measures electric power output, compiled by the *U.S. Department of Interior, Geological Survey*, from the reports of 1,632 establishments of 4,088 operating plants. The output of the plants, measured in millions of kilowatt hours, includes production from privately and municipally owned electric utilities, electricity produced by mining and manufacturing facilities, railways and railroads, Bureau of Reclamation plants and other Federal Projects, cooperatives, power districts, state projects, and publicly owned non-central stations. For the Durables sector, I use the composite index of durables manufacturers, which is compiled by the *Board of Governors of the Federal Reserve System*. The series was revised in 1941 due to the exceptional volume of output under the United States defense program.

I find there to be some limitations in my data set, especially for industrial production. Most importantly, the data I use for industrial production is not representative of the entire industry sectors production. I use industrial production data that I believe represents a majority of the sectors output. For example, the industrial output data used for the Clothes sector does not include footwear products. Therefore, there may be variances in the industrial production data I used in my analysis and the actual sectors' output, which may have a material impact on my tests. Another limitation in my data is the potential presence of measurement error in industrial production data due to the data set being old. However, I don't believe this will have a significant material impact on my tests.

IV. Empirical Strategy

The goal of this paper is to determine whether the relation between stock returns and future industrial production growth rates holds in the 1926-1940 sample period using sectoral data. To formally test the relationship between sectoral stock returns and future industrial production, I replicate Schwert's (1990) regression using sectoral data. I run regressions of each industry sector returns on the related industrial production output. I conduct two regressions, one using monthly observations and the other using quarterly observations. Given that French (2016) 17 Industry Portfolios are only in daily, monthly, and annual observations, I compounded the monthly returns to create quarterly observations. The regressions use non-overlapping monthly and quarterly observations. Due to using non-overlapping observations, I omit a regression using annual observations due to a limited amount of data in the sample period. The two regressions contain the following form:

Regression of Monthly Industry Sector Returns on Three Months of Leads of Monthly Production Growth Rates, 1926-1940

$$R(t,t+1) = a + \sum_{k=1}^{3} b_k P(t+k, t+k+1) + e(t,t+1) \quad (1)$$

where R(t,t + 1) is the monthly return for the specific industry sector and P(t + k, t + k + 1) is the monthly industrial production growth rate with three months of leads.

Regression of Industry Sector Returns on One Year of Leads of Quarterly Production Growth Rates, 1926-1940

(2) $$R(t, t+3) = a + \sum_{k=1}^{4} b_k P(t+3k, t+3k+3) + e(t, t+3)$$

where R(t,t+3) is the quarterly return for the specific industry sector and P(t + 3k, t + 3k + 3) is the quarterly industrial production growth rate with one year of leads.

V. Results

Table 3 and table 4 contain estimates of the regression of industry sector stock returns on industrial production growth rates. Table 3 describes the estimates using monthly observations while table 4 contains the estimates using quarterly data. I conduct both regressions on the eight sectors that I examine. The results show the industry sectors' returns ability to forecast economic activity in the 1926-1940 sample period. Table 3 contains leads of three months while table 4 contains leads up to one year.

Just as Schwert (1990) and Fama (1990) found, the results show there to be a relation between current stock returns and future industrial production growth rates. Moreover, the relation appears to strengthen with longer horizons. Some sectors were better at forecasting future industrial production growth than others, but this may be due to some sectors having more representative data for industrial production than others. For both the monthly and quarterly regressions, the Durables, Steel, Construction, Clothes, and Mines sectors presented the strongest relations between sector returns and future industrial production. The *t* statistics for the leads of production are often greater than 2 for these sectors. In particular, the Durables sector appears to have forecasted future industrial production much better than the other sectors, both on a monthly basis and quarterly basis. The R^2 for the monthly and quarterly regressions of the Durables sector are 0.34 and 0.61, respectively. The results for the Steel sector also showed a strong relationship with the sector's returns and future industrial production growth rates, with an R^2 for the monthly and quarterly regressions of 0.26 and 0.35, respectively. The Construction sector posted significant results only in the quarterly regression. The *t* statistics for the coefficients of the current and 6 month leads of industrial production for the Construction sector were greater than 3, with an R^2 of 0.34. The results for the Steel sector is interesting due to the sector experiencing massive growth before the Stock Market Crash of 1929. The Clothes and Mines sector also forecasted future economic activity exceptionally well, especially on the monthly horizons, with *t* statistics well over 2.

Surprisingly, the results for the Utilities sector show a positive relation between sector returns and future industrial output on the monthly horizon. The results for the Utilities sector is surprising because it was widely believed that this sector was in a bubble prior to the crash, as White (1980) suggested. Therefore, due to the noise in the earlier part of the sample period in the Utilities sector, I expected a weaker relation. On the other hand, the Cars and Oil sector's returns showed a weak relationship with future industrial production growth rates. The R^2 for these sectors were considerably lower than the other sectors, which I expect to be due to the noise from the stock market crash in the earlier part of the sample period. I conduct a sub-period analysis in the following section to examine the impact of the stock market crash of 1929 on the relationship between stock returns and future industrial production growth rates.

Table 3.

Linear Regression Output: Monthly Data

	Utilities		Clothes		Mines		Cars	
	b	t(b)	b	t(b)	b	t(b)	b	t(b)
				1926-1940				
Constant	-0.35	-0.41	0.55	0.78	0.43	0.56	1.25	1.09
P(t,t+1)	0.37	1.72	0.23	2.59	0.33	2.45	0.05	1.09
P(t+1,t+2)	0.81	3.41	0.51	5.66	0.38	2.81	0.08	1.67
P(t+2,t+3)	0.79	3.32	0.16	1.73	0.59	4.31	0.01	0.17
P(t+3,t+4)	0.12	0.56	-0.49	-5.49	0.03	0.25	0.07	1.34
R^2	0.10		0.34		0.15		0.03	
S(e)	10.34		8.84		9.49		14.09	
Sample Size	159		159		159		159	

	Construction		Oil		Steel		Durables	
	b	t(b)	b	t(b)	b	t(b)	b	t(b)
				1926-1940				
Constant	0.68	0.76	0.24	0.31	0.47	0.46	0.34	0.34
P(t,t+1)	0.21	1.90	0.30	2.03	0.16	1.98	-0.13	-0.66
P(t+1,t+2)	0.09	0.78	0.29	1.96	0.38	4.51	1.14	4.82
P(t+2,t+3)	0.09	0.75	0.24	1.59	0.11	1.36	0.48	2.03
P(t+3,t+4)	0.05	0.46	-0.06	-0.40	0.12	1.49	-0.15	-0.77
R^2	0.08		0.05		0.26		0.34	
S(e)	11.31		9.49		12.84		12.36	
Sample Size	159		159		159		159	

Table 4.

Linear Regression Output: Quarterly Data

	Utilities		Clothes		Mines		Cars	
	b	t(b)	b	t(b)	b	t(b)	b	t(b)
				1926-1940				
Constant	5.20	3.24	0.42	0.19	6.91	1.90	4.57	0.92
P(t,t+3)	1.35	0.82	0.94	5.22	0.69	1.41	0.36	2.09
P(t+3,t+6)	2.20	0.68	0.07	0.40	1.00	2.05	0.37	1.95
P(t+6,t+9)	-0.04	0.71	-0.06	-0.33	0.16	0.33	0.12	0.61
P(t+9,t+12)	1.40	0.69	-0.06	-0.33	1.03	2.17	0.47	2.50
P(t+12,t+15)	-1.10	0.81	-0.06	-0.32	-0.29	-0.61	-0.02	-0.11
R^2	0.24		0.43		0.20		0.22	
S(e)	21.89		15.40		23.33		34.15	
Sample Size	50		50		50		50	

	Construction		Oil		Steel		Durables	
	b	t(b)	b	t(b)	b	t(b)	b	t(b)
				1926-1940				
Constant	3.15	0.88	-0.09	-0.03	-1.40	-0.30	2.49	0.64
P(t,t+3)	0.86	3.57	0.57	1.17	0.59	3.52	1.32	4.03
P(t+3,t+6)	0.00	0.01	0.17	0.33	0.34	2.05	1.38	4.18
P(t+6,t+9)	0.90	3.64	0.27	0.54	-0.06	-0.33	-0.94	-2.88
P(t+9,t+12)	-0.25	-1.07	0.45	1.05	0.45	2.68	1.45	4.42
P(t+12,t+15)	0.07	0.32	0.20	0.48	0.05	0.31	0.03	0.10
R^2	0.34		0.04		0.35		0.61	
S(e)	25.16		18.91		29.01		27.50	
Sample Size	50		50		50		50	

In this section, I expand my analysis by incorporating sub-periods to see how the results would change when splitting the sample period into two sub-periods, the first being from 1926-1932, and the second from 1933-1940. I conduct this analysis to determine the impact of the Great Depression on my results. I am particularly interesting in the Utilities, Cars, Oil, and Steel sectors due to the massive growth of these sectors prior to the crash. I expect that the results for these sectors will show a stronger relationship in the 1933-1940 sub-period than the 1926-1932 sub-period. I run the same regression from the previous section using monthly data, with sub-periods 1926-1932 and 1933-1940. I exclude the quarterly regression in this analysis due to the limited number of data in the quarterly sample. Table 5 illustrates the results using sub-periods. The sub-period 1933-1940 consistently showed a stronger relationship across all the sectors with an exception for the Mines and Construction sector. Moreover, the results for the Utilities, Cars, Oil, and Steel sectors demonstrated a considerable shift in significance from the 1926-1932 sub-period to the 1933-1940 sub-period. The R^2 and t statistics of the coefficients for industrial production for these sectors increased substantially. In particular, the R^2 for the Utility sector increased from 0.07 to 0.16 from the 1926-1932 sub-period to the 1933-1940 sub-period. Additionally, the t statistics for the leads of production became considerably greater than 2 in the latter sub-period. The shift in the R^2 for the Oil sector is even more dramatic than the Utilities sector, with an increase from 0.01 to 0.15 from the 1926-1932 sub-period to the 1933-1940 sub-period. In general, the results using sub-periods illustrate the considerable amount of noise in the data generated by the Great Depression, especially for the sectors growing rapidly prior to the stock market crash of 1929. Sectors that were not growing rapidly prior to the crash did not have as much of a weakened relation in the regression. The exceptions to my argument are the Steel and Construction sectors. The results for the Steel sector had a strong relation in both sub-periods, which I expected to have a weak relation in the first sub-period. Nevertheless, the strong shift in significance from the 1926-1932 sub-period to the 1933-1940 sub-period is still telling. On the other hand, the Construction sector did not present significant results in either sub-period. The results for the Construction sector only indicated a strong relation on the quarterly horizon, which explains why the Construction sector had weak results in the sub-period analysis, which uses monthly observations.

Table 5.

Linear Regression Output: Sub-Periods (Monthly)

	Utilities				Clothes			
	b	t(b)	b	t(b)	b	t(b)	b	t(b)
	1926-1932		1933-1940		1926-1932		1933-1940	
Constant	0.52	0.39	-1.39	-1.21	-0.85	-1.14	1.03	1.26
P(t,t+1)	0.15	0.41	0.55	2.21	0.42	3.11	0.25	2.90
P(t+1,t+2)	0.75	1.83	0.88	3.12	0.14	0.99	0.53	6.21
P(t+2,t+3)	0.77	1.95	0.89	3.03	-0.07	-0.52	0.23	2.73
P(t+3,t+4)	0.20	0.57	0.13	0.50	-0.22	-1.67	-0.25	-2.92
R^2	0.07		0.16		0.24		0.47	
S(e)	11.45		9.21		6.43		7.23	
Sample Size	78		84		75		81	

	Mines				Cars			
	b	t(b)	b	t(b)	b	t(b)	b	t(b)
	1926-1932		1933-1940		1926-1932		1933-1940	
Constant	0.65	0.53	1.04	1.03	0.61	0.39	1.73	1.10
P(t,t+1)	0.47	1.73	0.29	1.91	-0.14	-1.59	0.15	2.18
P(t+1,t+2)	0.59	2.17	0.28	1.83	0.04	0.44	0.18	2.54
P(t+2,t+3)	0.91	3.38	0.45	2.93	-0.02	-0.25	0.05	0.74
P(t+3,t+4)	0.08	0.30	-0.01	-0.04	-0.01	-0.10	0.09	1.25
R^2	0.18		0.14		0.04		0.17	
S(e)	10.39		8.70		13.54		13.74	
Sample Size	75		81		75		81	

Table 5. (Continued)

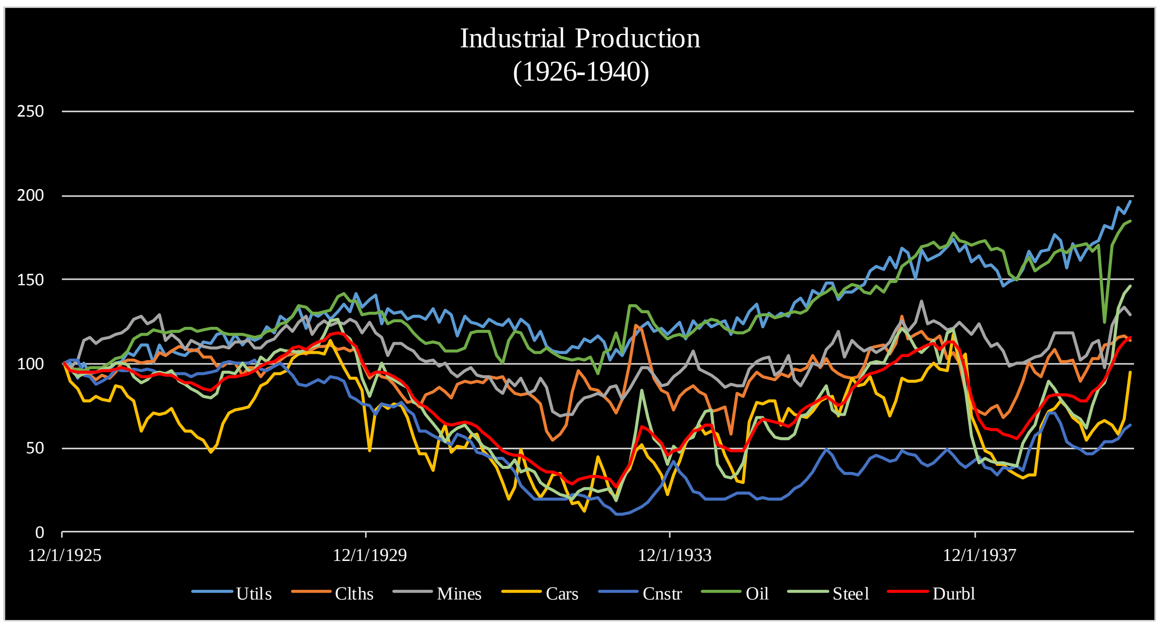
Linear Regression Output: Sub-Periods (Monthly)

	Construction				Oil			
	b	t(b)	b	t(b)	b	t(b)	b	t(b)
	1926-1932		1933-1940		1926-1932		1933-1940	
Constant	0.80	0.61	1.46	1.02	-0.33	-0.28	0.67	0.62
P(t,t+1)	0.42	1.73	0.14	1.06	0.11	0.29	0.41	2.52
P(t+1,t+2)	0.37	1.44	0.05	0.35	-0.17	-0.44	0.47	2.69
P(t+2,t+3)	0.13	0.53	0.10	0.66	0.19	0.50	0.29	1.64
P(t+3,t+4)	-0.17	-0.70	0.04	0.27	0.09	0.25	-0.12	-0.74
R^2	0.14		0.05		0.01		0.15	
S(e)	10.17		12.35		10.10		9.04	
Sample Size	75		81		75		81	

	Steel				Durables			
	b	t(b)	b	t(b)	b	t(b)	b	t(b)
	1926-1932		1933-1940		1926-1932		1933-1940	
Constant	2.47	1.58	0.46	0.31	1.26	0.79	0.38	0.28
P(t,t+1)	0.15	0.74	0.18	2.01	-1.85	-3.58	0.16	0.80
P(t+1,t+2)	0.53	2.55	0.36	3.91	2.34	3.76	0.96	4.15
P(t+2,t+3)	0.39	1.89	0.08	0.82	1.08	1.75	0.35	1.49
P(t+3,t+4)	0.42	2.07	0.09	0.96	0.08	0.15	-0.13	-0.63
R^2	0.22		0.33		0.38		0.47	
S(e)	12.72		12.65		12.05		11.23	
Sample Size	75		81		75		81	

I constructed a chart that graphs the industrial production data for each sector. I create an index, where December 1925 = 100, and the growth of each sector is derived from the base year. Figure 1 graphs the industrial production data by sector from 1926-1940. The graph illustrates each sector's growth throughout the sample period. The Utilities sector presented the strongest industrial production growth throughout almost the entire sample period, along with the Oil sector. The graph also shows which sectors' industrial output were hit hardest by the crash, which includes the Durables, Steel, Construction, and Cars sectors.

Figure 1.



Source: U.S. Department of Commerce, Bureau of Foreign and Domestic Commerce, *Survey of Current Business*

I then graph the sector's stock return with the sector specific industrial production output. The graphs include the sample period from 1926-1940. The graphs illustrate the relationship between industry sector returns and industrial production. The graphs show the deviation in the relation in the first sub-period, especially for the Utilities, Cars and Steel sectors.

Figure 2.

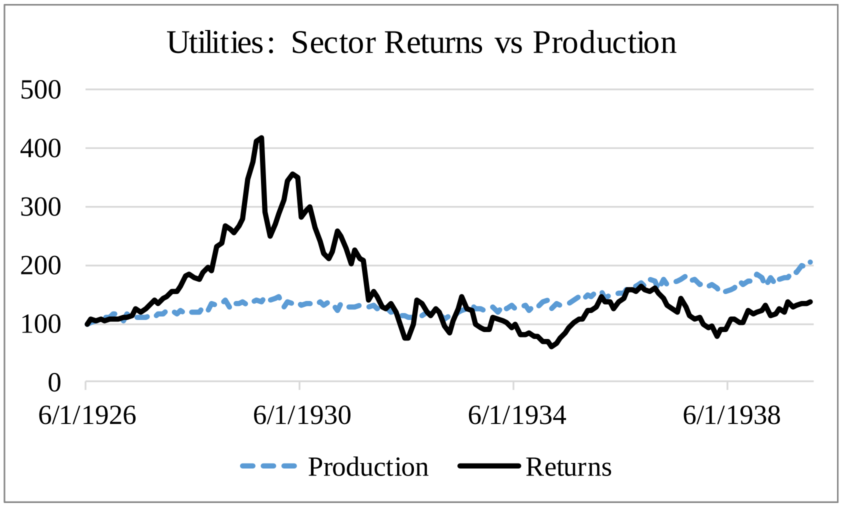
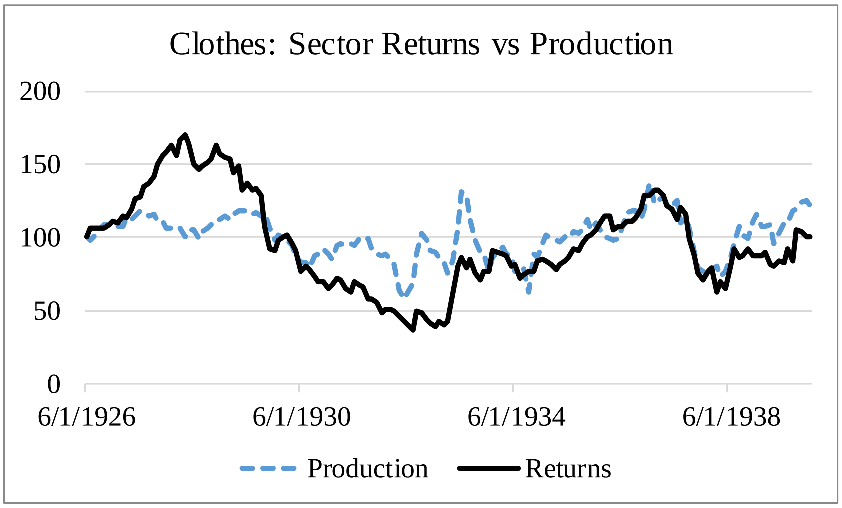


Figure 3.



Source:

(1) U.S. Department of Commerce, Bureau of Foreign and Domestic Commerce, *Survey of Current Business*

(2) *Kenneth French 17 Industry Portfolio* (French, 2016)

Figure 4.

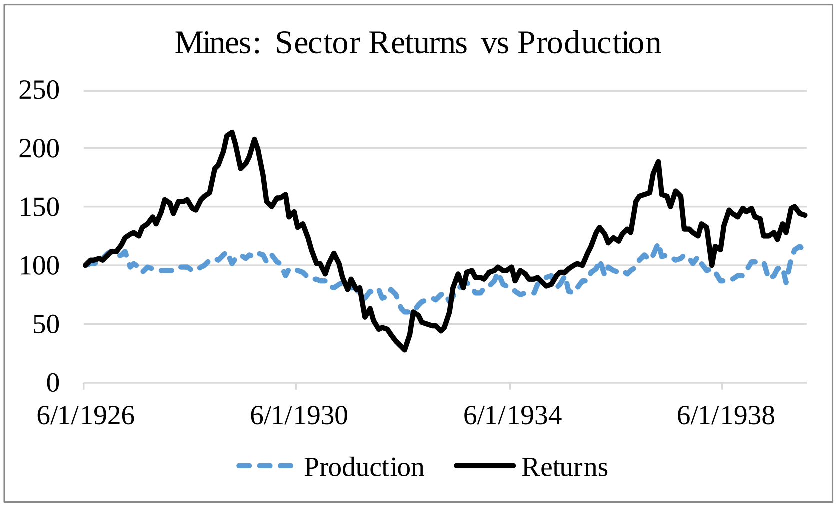
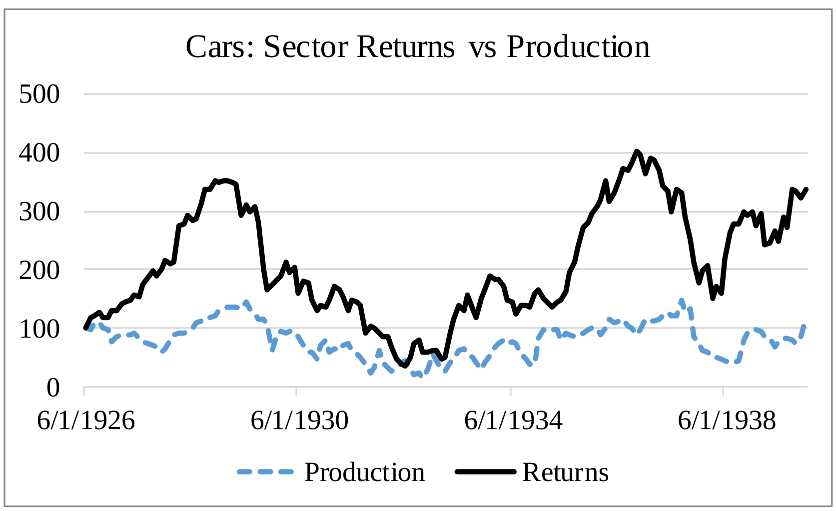


Figure 5.



Source:

(1) U.S. Department of Commerce, Bureau of Foreign and Domestic Commerce, *Survey of Current Business*

(2) *Kenneth French 17 Industry Portfolio* (French, 2016)

Figure 6.

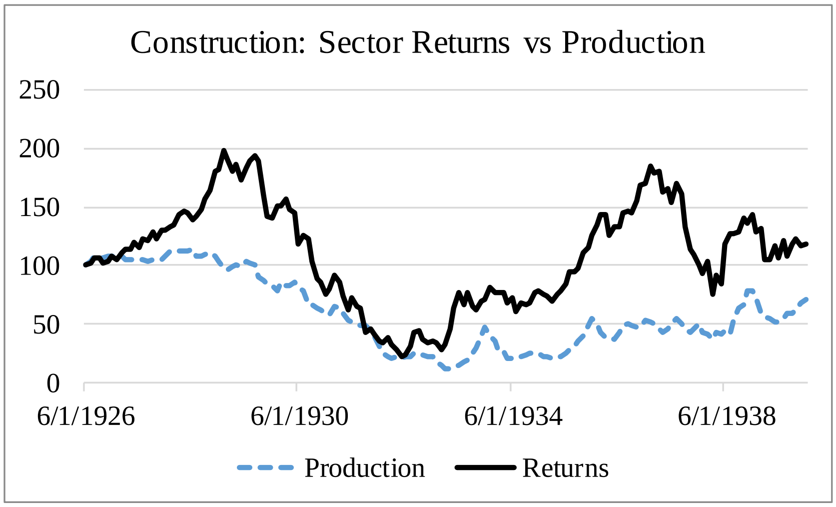
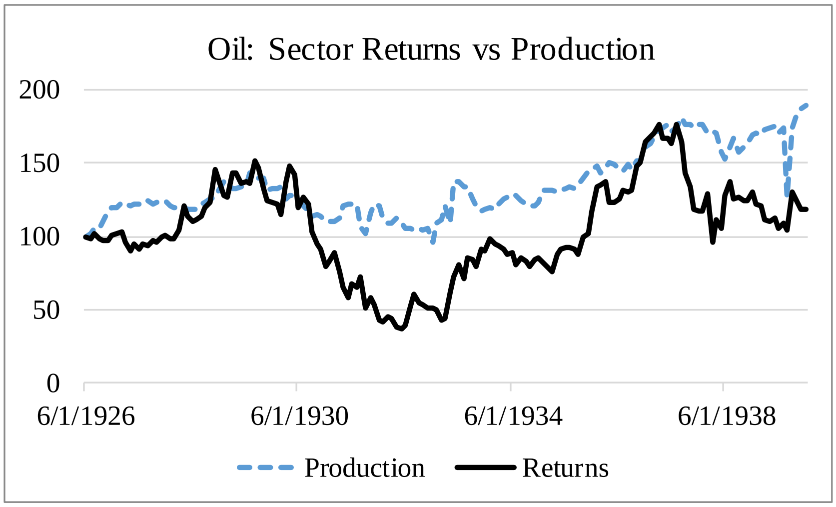


Figure 7.



Source:

(1) U.S. Department of Commerce, Bureau of Foreign and Domestic Commerce, *Survey of Current Business*

(2) *Kenneth French 17 Industry Portfolio* (French, 2016)

Figure 8.

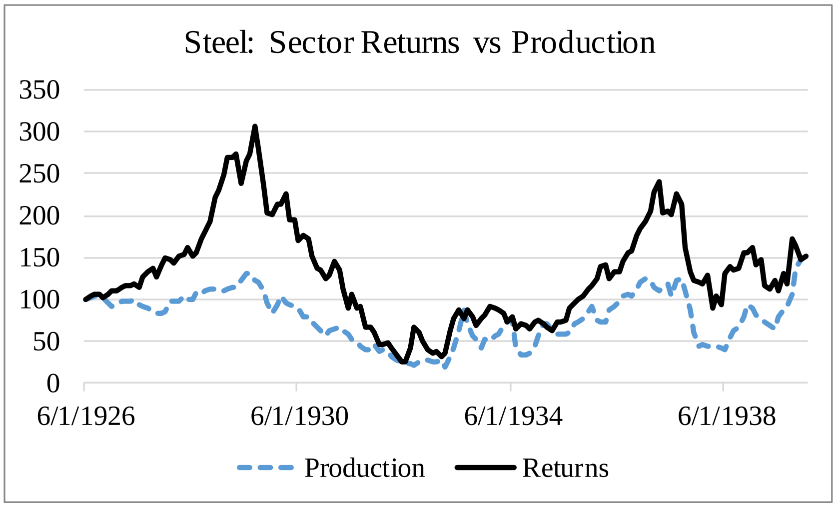
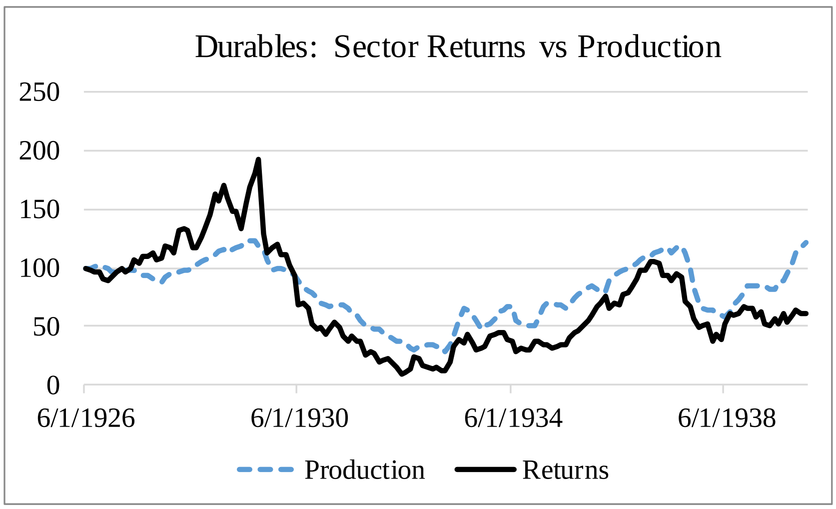


Figure 9.



Source:

(1) U.S. Department of Commerce, Bureau of Foreign and Domestic Commerce, *Survey of Current Business*

(2) *Kenneth French 17 Industry Portfolio* (French, 2016)

VI. Conclusion

In Fama (1990) and Schwert's (1990) studies, they find a strong positive relation between stock returns and future industrial production growth rates using aggregate data from 1889-1988. In my paper, I conduct the same analysis but on a sectoral level, exploring whether the relation holds using sectoral data. I conduct my analysis on 8 sectors from Kenneth French's 17 Industry Portfolio dataset, focusing on the sample period from 1926-1940. I am particularly interested in this sample period because I want to see how the relationship will be affected with the inclusion of the stock market crash of 1929. I also conduct a sub-period analysis to examine how the market sentiment for the high-flying industries prior to the crash will affect the relationship between sector returns and future industrial production growth rates, and also to see if the relationship reappears after the crash. I argue that sectors experiencing the strongest growth prior to the crash, as noted by Bierman (1998) and Richardson (2013) to be the Utilities, Cars, Oil, and Steel sectors, will show a weak relation in the 1926-1932 sub-period and a strong relation in the 1933-1940 sub-period. On the other hand, I argue that the results for the remaining sectors, such as the Clothes, Mines, Construction, and Durables sectors, will show a strong relation in both sub-periods.

In conclusion, I find that the results reported by Fama (1990) and Schwert (1990) hold up using sectoral data. There is a strong relation between current sector returns and future industrial production growth rates on the sectoral level. The inclusion of a stock market crash in my sample period undoubtedly weakens this relation. When using sub-periods in my analysis, the results are generally in line with my arguments above. The results show that the Utilities, Cars, and Oil sectors presented weak relations in the 1926-1932 sub-period and stronger relations in the 1933-1940 sub-period. On the other hand, the results for the Clothes, Mines, and Durables sectors showed strong relations in both sub-periods.

The exceptions for my argument are the Steel and Construction sectors. The Steel sector showed a strong relationship in both sub-periods, while the Construction sector showed a weak relationship across both sub-periods. I conclude that this may be due to using monthly data rather than quarterly data in the sub-period analysis, which, as I noted, the Construction sector has better results on the quarterly horizon.

Future research can explore the relation between stock returns and future industrial production growth rates in current periods. Young (2006) finds that stock returns are no longer able to predict industrial production from 1988-2000 due to the U.S. transition from a manufacturing to a service oriented economy. Conducting a sectoral analysis during that sub-period can provide more granular detail into Young's (2006) findings.

VII. Works Cited

Balvers, Ronald J., Thomas F. Cosimano, and Bill McDonald. "Predicting Stock Returns in an Efficient Market." *The Journal of Finance* 45.4 (1990): 1109-128. JSTOR. Web. 14 Feb. 2017.

Barro, Robert J. "The Stock Market and Investment." *The Review of Financial Studies* 3.1, National Bureau of Economic Research Conference: Stock Market Volatility and the Crash, Dorado Beach, March 16-18, 1989 (1990): 115-31. *JSTOR*. Web. 19 Feb. 2017.

Bierman, Harold. “The 1929 Stock Market Crash”. EH.Net Encyclopedia, edited by Robert Whaples. March 26, 2008.

Comincioli, Brad "The Stock Market As A Leading Indicator: An Application Of Granger Causality," *University Avenue Undergraduate Journal of Economics*: 1.1 (1996): n. pag. Web. 21 Apr. 2017

Fama, Eugene F. "Stock Returns, Real Activity, Inflation, and Money." *The American Economic Review* 71.4 (1981): 545-65. *JSTOR*. Web. 19 Feb. 2017.

Fama, Eugene F. "Stock Returns, Expected Returns, and Real Activity." *The Journal of Finance* 45.4 (1990): 1089-108. JSTOR. Web. 14 Feb. 2017.

French, Kenneth R. "17 Industry Portfolios." Data Library Industry Portfolios. Kenneth French, 2016. Web.

Geske, Robert, and Richard Roll. "The Fiscal and Monetary Linkage Between Stock Returns and Inflation." *The Journal of Finance* 38.1 (1983): 1. Web.

Kaul, Gautam (1987/06)."Stock Returns and Inflation: The Role of the Monetary Sector." *Journal of Financial Economics* 18(2): 253-276.

Reynolds, Paul Edward III, "A Sectoral Analysis of the 1929 Stock Market Crash" (2017). *CMC Senior Theses*. 1487.

Richardson, Gary, Alejandro Komei, Michael Gau, and Daniel Park. "Stock Market Crash of 1929 - A Detailed Essay on an Important Event in the History of the Federal Reserve." *Federal Reserve History*. N.p., 22 Nov. 2013. Web. 07 Apr. 2017.

Schwert, G. William. "Stock Returns and Real Activity: A Century of Evidence." *The Journal of Finance* 45.4 (1990): 1237-257. JSTOR. Web. 14 Feb. 2017.

White, Eugene N. "The Stock Market Boom and Crash of 1929 Revisited." *The Journal of Economic Perspectives* 4.2 (1990): 67-83. *JSTOR*. Web. 21 Mar. 2017

U.S. Department of Commerce, Bureau of Foreign and Domestic Commerce, "1932 Annual Supplement," *Survey of Current Business* 12 (1932): 6-11, 30, 142.

U.S. Department of Commerce, Bureau of Foreign and Domestic Commerce, "1936 Annual Supplement," *Survey of Current Business* 16 (1936): 6-8, 16, 85.

U.S. Department of Commerce, Bureau of Foreign and Domestic Commerce, "1940 Annual Supplement," *Survey of Current Business* 20 (1940): 7-9, 16, 97.

Young, Peter. *Industrial Production and Stock Returns*. Diss. Simon Fraser U, 2006. Print.