THE PENNSYLVANIA STATE UNIVERSITY
SCHREYER HONORS COLLEGE

JOHN AND WILLIE LEONE FAMILY DEPARTMENT OF ENERGY AND MINERAL ENGINEERING

DETERMINANTS OF CREDIT RATINGS IN INVESTOR OWNED UTILITIES

CONNOR DANIK
SPRING 2019

A thesis
submitted in partial fulfillment
of the requirements
for a baccalaureate degree
in Energy Business and Finance
with honors in Energy Business and Finance

Reviewed and approved* by the following:

Seth Blumsack
Professor of Energy Policy and Economics
Thesis Supervisor and Honors Advisor

Farid Tayari
Assistant Teaching Professor
Faculty Reader

*Signatures are on file in the Schreyer Honors College.

ABSTRACT

The utility industry is considered stable. Although utilities work with regulators to recover their costs, there is a wide variation in a utility's creditworthiness. Utilities who consistently recover their costs have higher credit ratings and are stronger financially. A credit rating is not only important to investors, but also relevant to the public. Credit ratings are important because they affect the cost of financing. Utilities who have lower credit ratings face higher costs of debt. As a result, this affects a utility when it has to invest in infrastructure and make other adjustments to the grid. These costs eventually get passed down to ratepayers and it is in the best interest of investors and the public for utilities to have strong credit ratings. This paper analyzes what factors contribute to an investor owned utility's credit rating from 2012 to 2017.

Using the Edison Electric Institute (EEI) as a resource for credit ratings, we selected different financial and operational factors that determine a credit rating. Some of the areas that we focused on were profitability, debt, regulator relationship, fuel, and customer diversity. After reviewing the different credit rating agency (CRA) guidelines, these were the five factors that were shared. Using econometric models and two regressions, this analysis shows that the regulatory environment, interest coverage, and return on equity (ROE) help determine a company's credit rating. It also shows that having a diverse fuel portfolio is beneficial to achieve higher credit ratings. In addition, using fuels such as coal and oil, which have a higher environmental impact, does not guarantee a lower rating. However, companies who suffer the lowest credit ratings have a high concentration of coal. Furthermore, improving the interest coverage ratio and regulator score seems to be the most important factor for companies to achieve higher ratings.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

First, I would like to thank Professor Seth Blumsack for helping me complete my thesis and sparking my interest in this topic. He has done a great job these four years not only as my research advisor but also as an academic advisor. I would like to also thank Professor Chiara Lo Prete who introduced me to electricity markets and gave me the opportunity to conduct a literature review my junior year. I would like to thank Professor Farid Tayari who served as a faculty reader. He has been a great teacher and a fantastic resource these past four years. Finally, I would like to say a general thank you to the College of Earth and Mineral Sciences and specifically to the Department of Energy and Mineral Engineering. I have thoroughly enjoyed all my experiences as an Energy Business and Finance major. The relationships and experiences that I have developed with faculty members and peers have resulted in a highly rewarding and successful four years at Penn State.

Chapter 1

Introduction

1.1: Credit Rating Background

A credit rating is an opinioned metric that is given by a CRA to convey its judgment "about the ability and willingness of an issuer to meet its financial obligations in full and on time" (S&P Global, 2013). This definition applies to entities like corporations and state or city governments. Credit ratings are also used for an individual debt issue like a bond, which expresses the likelihood that the issue will default. Credit ratings are provided mainly by the "Big 3" rating agencies, which are Standard & Poor's, Moody's, and Fitch Group. These agencies account for about 97% of all ratings while Standard and Poor's has the largest market share at 48.9% (Securities and Exchange Commission, 2017).

Credit ratings are separated into three categories known as investment grade, speculative grade, and default. Investment grade reflects a relatively high creditworthiness and credit quality and a confidence to meet financial obligations. Speculative grade expresses the belief that the issuer has the ability to meet financial obligations, but faces challenges such as adverse business or financial conditions. Default describes a scenario where the issuer is in delinquency of their obligation or has broken a commitment. It can also refer to the situation when a bankrupt petition is filed or a similar action (S&P Global, 2014). They are displayed by an alphabetical scale, which expresses the CRA's opinion.

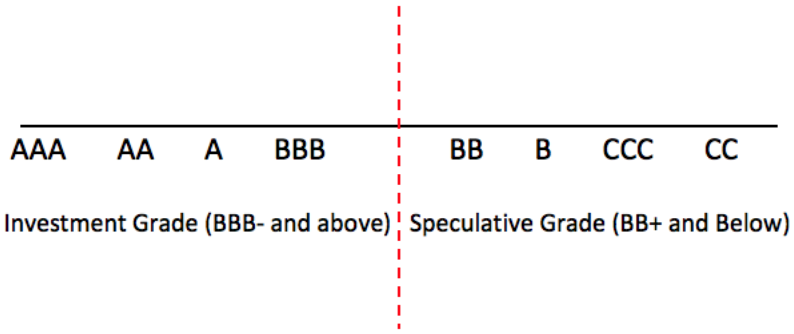

Figure 1. S&P Grade Scale

There are multiple parties that use credit ratings for different purposes. The main four groups are investors, intermediaries, issuers, and businesses. Investors use credit ratings to consider the creditworthiness of different issues and companies before making investment decisions. Institutional investors such as pension and mutual funds also use credit ratings as a reference. Intermediaries are most likely investment bankers, which help raise capital for different businesses and financial institutions. Investment bankers use credit ratings as a benchmark to assess and price different issues. Furthermore, credit ratings are used as a reference to help explain a credit rating agency's opinion about a specific issue. Issuers refer to corporations, national governments, cities, and other entities that use credit ratings to measure their own issues. A credit rating has an influence on the interest rates these parties receive, and they are able to market their creditworthiness to potential investors. Lastly, businesses use credit ratings to assess their counterparty risk. Credit ratings help measure the risk and potential for a counterparty to default on its obligations, which can have serious consequences for a business. It also serves as a benchmark for companies to evaluate potential partners (S&P Global, 2014).

1.2: Why Credit Ratings Matter for Utilities

Credit ratings are important because they affect the cost of financing. It is well-established that utilities with a lower credit rating face higher costs to raise debt (Olsen, 2009). A utility's ability

to recover costs and finance its operations is not only important to shareholders but also the public. If a utility is facing high costs of financing, this eventually gets passed down to customers. A utility's creditworthiness may also play a factor as the country wants to modernize grid infrastructure and create an environment to fight climate change. This ultimately depends if infrastructure upgrades are completed by utilities or other electric sector firms. According to a report by the Edison Foundation, 880 billion dollars of investment in transmission and distribution infrastructure would be necessary to achieve a smarter and cleaner grid (Olsen, 2009). Large investments are required to meet state and national energy policy goals. Therefore, a utility's credit rating is going to become paramount as companies need to raise a large amount of debt, while also focusing on providing the lowest possible cost for rate payers (Olsen, 2009).

Table 1. Cost of Debt

Source: Bloomberg

Table 1 displays the average cost of debt based on credit category for the utilities in our data set. This confirms the theory that companies with a lower credit rating face higher costs of debt.

A-	BBB+	BBB	BBB-	BB+	BB
1.95%	2.24%	2.25%	2.09%	2.27%	2.34%

Levelized Cost of Energy Sample:

The levelized cost of energy (LCOE) is a metric that represents the average revenue per unit of energy output over a project's lifetime in which the plant breaks even (Blumsack, n.d.). The following calculations are for a hypothetical natural gas power plant. The calculation compares the LCOE for a company with an A- credit rating vs. a company with a BBB- rating.

$$LCOE = \left(\frac{TIC \times r}{1-(1+r)^{-T}}\right) \div Q + LVC$$

- TIC=Capital Cost
- r=WACC
- T=Years
- Q=Amount of Energy Produced
- LVC=Levelized Fixed Cost

The values used in this sample LCOE calculation are assumptions. The WACC values are taken from Bloomberg.

Sample Calculation:

- TIC=$600,000
- WACC=4.45% (Southern Company), 6.54% (Otter Tail Corporation)
- T=20 Years
- Q=2628 MWh
- LVC=$50/MWh

Southern Company LCOE=$67.48/MWh
Otter Tail Corporation LCOE=$70.79/MWh

Otter Tail Corporation has a higher LCOE, which means they would need higher market prices to return a profit on their investment. We are assuming that both power plants have the same operational life and will sell electricity in the deregulated generation market. Both power plants would be selling at the same market price. Therefore, Southern Company would have the more profitable power plant.

1.3: Investor Owned Utilities

An investor owned utility (IOU) is a privately-owned utility that is owned by investors or shareholders and is not limited to a geographic service area (California Energy Commission, n.d.). This differs from a publicly owned utility in which ownership is controlled by members or government and is commonly limited to a geographic service area. The goal of an IOU is to

maximize shareholder value and the corporation is financed by the sale of bonds and utilizing capital markets. Although they are private companies, IOU's are subject to regulation by a Public Utilities Commissions (PUC) and the Federal Energy Regulatory Commission. An IOU works with a PUC to set customers rates and to establish a reasonable rate of return to shareholders. This process ensures necessary infrastructure and other projects are completed, which benefit the customer.

1.4: Rate of Return Regulation

Rate of return regulation is the most common way a PUC works with an IOU to set fair and reasonable electricity prices, which get passed down to consumers. This process is considered fair because utilities are able to recover costs, while consumers are ensured an appropriate price to pay. According to a recent report by Lawrence Berkley National Laboratory, a higher frequency of rate cases are associated with higher customer costs (Trabish, 2017). As the business climate becomes more difficult, the amount of rate cases increase and regulatory costs rise (Trabish, 2017). The increase in costs directly leads to an eventual increase for the customer. Rate cases can also have an impact on consumer demands, such as increased renewable policy like rooftop solar and energy efficiency programs (Trabish, 2018). However, if the rate calculation shows that these programs or demands are harming the utility financially, costs will rise for customers (Trabish, 2018).

The first step in the rate case process is determining which costs get passed down to consumers, and what gets included in the "rate base", which describes a utility's profit capabilities. The sum of these two costs creates a "revenue requirement," which serves as a benchmark for establishing prices (Blumsack, n.d.).

$$RR=O + (V-D) * r$$

RR: Revenue Requirement

O: Operating Costs (Fuel, Labor Maintenance, Taxes)
Utility is not allowed to earn profit by passing down operating costs to customers

V: Accounting Value of Utility's Assets

D: Accounting Depreciation of Utility's Assets

r: Allowed Rate of Return

The second step is distributing costs to different customer segments such as residential, commercial, and industrial. It is very difficult to accurately pinpoint utility costs with a specific end-user. This is a result of the power grid being shared by all customers to ensure reliable electric delivery. Therefore, costs are allocated in the rate process by negotiation between the utility and a PUC (Blumsack, n.d.).

The third step is to determine the allowed rate of return. Another term to describe the allowed rate of return is the cost of capital (Blumsack, n.d.). The cost of capital combines the cost of equity and the cost of debt to form what is known as the Weighted Average Cost of Capital (WACC).

WACC=S/(S+B)*Rs + B/(S+B)*Rb * (1- Tax Rate)

S/(S+B): fraction of capital in equity

B/(S+B): fraction of capital in debt

Rs: return on equity

Rb: return on debt

To determine the return on equity, the most popular method is using the Capital Asset Pricing Model (CAPM). The CAPM uses the risk-free rate, beta, and the market risk premium to calculate the return on equity.

Rs=Rf+ B * (Rm-Rf)

Rf: risk rate free of return (most likely a long-term treasury bond)

Rm: market return (most likely S&P 500)

B: Beta (a measure of volatility)

The cost of debt is determined by calculating the yield to maturity on the utility's prior bond issuances (Blumsack, n.d.). The goal of this process is to establish a "fair return" for the utility. The "fair return" allows utilities to pay investors, while making necessary upgrades to infrastructure for their customers.

1.5: Objective of Thesis

The utility industry is considered low risk and rates are regulated to assure cost recovery. However, there is a wide variation in perceived creditworthiness in utilities. The spectrum of credit ratings is large when comparing companies. There are many utilities with a strong profile who have investment grade ratings. On the other hand, there is a significant amount of companies who have weak investment grade ratings and companies whose rating is considered speculative. Not only do companies with low ratings face higher costs of financing, but they also face limited capital markets.

This paper tries to identify key variables that determine a utility's credit rating. By focusing on financial, regulatory, and operational factors, this analysis looks to discover the most important factors that make up a credit rating. After completing the analysis, we can also determine what factors utilities should improve on to boost their credit rating.

Chapter 2

Credit Rating Agency Guidelines

The three main CRA publish rating factors and methodology that explain their process in rating the regulated utility industry. This paper is uniquely focused on identifying key variables for utilities that factor into its credit rating.

It is generally acknowledged that the utility industry is low risk and has low cyclical risk. One of the reasons is that electricity is an inelastic commodity and the utility sector is an accepted natural monopoly. Some of the factors that contribute to this classification is low competitiveness, high barriers to entry, and high capital costs. Despite the relatively "safe" business environment that IOU operate in, there is a wide variety of factors CRA identify to assess credit ratings (S&P Global, 2013).

All three CRA mention that regulation has a profound effect on a utility's credit rating. One of the factors that is deemed important is the transparency and consistency of the regulatory process. In the utility sector, predictability is desired between the relationship between the company and the regulator (Moody's Investor Service, 2017). This includes the regulator allowing the utility to recover costs, as well as maximizing consumer interest. It is desired to minimize political interference within the relationship, and politically motivated decisions are seen as a negative. (S&P Global, 2013). It is preferred for a utility to operate in an environment, in which its regulator can support its long-term future, and can protect it from politically motivated decisions (S&P Global, 2013).

Another important factor is cost recovery. Earning a sufficient return is not enough, and the time period to recover costs is vital (S&P Global, 2013). Avoiding a long lag concerning rate cases and other regulatory situations is critical. In addition, regulatory frameworks that include

mechanisms to recover costs, rather than filling rate cases is looked favorably upon. The results of the rate cases and tariff reviews are also considered and compared to peers with similar profiles. Another characteristic that is positive is the presence of fuel adjustment mechanisms that limit commodity exposure and allow cost recovery during extreme weather events (Moody's Investor Service, 2017).

Diversification of business operations is important as utilities will ultimately face hardships such as regulatory changes and commodity price volatility. It is preferred that utilities operate in multiple geographic locations with a diverse customer base. This helps insulate the utility from suffering from one unfavorable regulatory decision or problems with one customer base. For example, having a healthy balance between residential customers, which represent stable demand vs. industrial customers who are more susceptible to economic cycles (S&P Global, 2013). A CRA will look at the utility's sale volumes and trends to see if there is an appropriate balance. Having exposure to multiple regulatory regimes who are considered supportive to the utility is also considered a positive.

Fuel diversification is considered as utilities want to avoid relying on two or less resources. A lack of fuel diversity can become a problem especially when a resource is threatened during weather disasters or regulation (Moody's Investor Service, 2017). Moody's guidelines regarding fuel diversity state that utilities with a high concentration of one or two sources of generation could receive lower scores. Furthermore, this problem elevates if the source is "threatened" or "challenged." Challenged sources are generation plants that face higher economic costs due to penalties or taxes on their operation, as well as mandatory or future mandatory environmental upgrades. Some examples include power plants that face carbon taxes, plants that are forced to buy emission credits, or plants that have to install environmental equipment. Threatened sources

are generation plants that are not able to operate or have a high probability to close due to regulation or economic conditions. The most recent example are coal fired power plants that have had to close because they could not economically adhere to environmental regulation (Moody's Investor Service, 2017).

The financial health of a utility is critical to its credit rating. All three CRA use ratios to try to assess the finances of the company but they especially value leverage ratios. Leverage ratios are useful because it displays how much debt a company possesses. As a result, leverage ratios can be an indicator of how a company finances its operations and if it will be able to pay off debt and other obligations.

Chapter 3

Literature Review

This paper focuses on the determinants of credit ratings for an IOU and investigates how a utility's relationship with its regulator affects its rating. There has not been a significant amount of research or papers that focus on the determinants of credit ratings in the utility space. Much of the literature has been focused on determinants in other segments such as sovereign debt ratings and credit spreads in bonds. In addition, there has been some investigation into the determinants of changes in credit ratings of bonds for utilities.

A utility's credit rating is determined by four main categories. The categories are regulatory framework, cost recovery/return on investment, financial health, and diversity of operations/assets (Holt, 2016). Two desirable traits within the regulatory framework are predictability and consistency. A stable regulatory environment is essential because utilities have to recover costs. This can become a problem if the regulatory environment begins to affect a company's cash flow in a negative way (Holt, 2016). The two main ratios that regulators tend to focus on are interest coverage and debt-to-total-capital. These ratios are directly tied into rate cases. During rate cases, a PUC negotiates with a utility to set an allowed ROE. As a result, rate cases affect a utility's income and cash flow, which eventually have an effect on coverage and debt ratios. It has also been observed that utilities with credit ratings on the lower spectrum of investment grade may receive favorable decisions. This can be explained by a PUC not wanting to place additional negative pressure on a company's finances, which could harm its fragile credit rating. On the other hand, utilities with high credit ratings are not receiving the same consideration during rate cases (Olson, 2009).

Utilities investing in new technology can be risky if there is no guarantee that the regulator will allow it to recover costs. Another costly activity that is popular in the utility industry is mergers and acquisitions (M&A). Many utilities pursue M&A to create synergies and to maximize shareholder value. This strategy is also becoming more popular as companies want to diversify their customer base to improve regulatory exposure. M&A is not inherently bad, but it is usually financed by a large amount of debt, which can negatively affect a credit rating (Holt, 2016). Furthermore, investment in renewables can be a positive to diversify a fuel mix, but it can become problematic if costs run too high. Maintaining good cost control is essential as cost overruns and schedule delays can downgrade ratings. As the electrical and energy market evolves, new problems have the possibility of disrupting a utility's financial health. Some possible problems include energy efficiency programs, which could help utilities but pose as a risk from a loss of revenue. Distributed energy is also a possible threat as more people could leave the grid resulting in a loss of revenue (Holt, 2016). In the future, traditional power plant-based generation could be replaced by smaller and more localized distributed energy resources. Some possibilities include solar photovoltaic panels, small wind turbines, and combined heat and power systems.

Chapter 4

Data

This paper examines possible determinants of credit ratings for an IOU. The 44 IOU were selected from the EEI. The EEI is an association that represents all the investor owned electric companies in the United States (Edison Electric Institute, n.d.). The association lobbies on behalf of members to federal and state governments as well as regulatory agencies. It advocates for policies and legislation in which members and customers will benefit. Each financial quarter the EEI publishes data which includes credit ratings. I have used the EEI database to form an average weighted credit rating and score for each IOU based on S&P ratings.

To obtain the ROE, interest coverage ratio, and cost of debt data, I used a Bloomberg terminal and FactSet Research Systems. A Bloomberg terminal is a product offered by Bloomberg L.P which provides real time financial data, news feeds, messages, and facilitates placement of financial transactions. FactSet Research Systems is a product that is offered by FactSet that provides financial data.

To calculate an average weighted regulator score, I have used a rating from Regulatory Research Associates (RRA), which is a subsidiary of S&P. RRA provides independent research and analysis of regulatory issues affecting energy utilities.

To get a utility's annual electric customer base, I used the Energy Information Administration (EIA) independent statistics and analysis page. I used form EIA-861 for the data. I have also used SNL Energy to obtain financial information about the utility as well as customer and power plant data. SNL Energy is a subsidiary of S&P, which contains market news, data, research and analytics for the energy industry.

4.1: Sources of Data

Table 2. Data Sources

Data	Source
Credit Ratings	Edison Electric Institute
Interest Coverage Ratio	FactSet
Return on Equity	Bloomberg
Cost of Debt	Bloomberg
Annual Electric Customer Base	EIA Form 861
Power Plant Data	SNL Energy
Customer Segment Data	SNL Energy
Regulator Score	Regulatory Research Associates

Overview of Regression Variables:

There is a wide variety of factors that can affect an IOU credit rating. The dependent variable is a weighted credit score. The independent variables that I have chosen to research are Fuel Mix Diversity, Average Return on Equity, Average Interest Coverage Ratio, Average Weighted Regulator Score, and Service Diversity. I would expect that Average Return on Equity, Average Interest Coverage Ratio, and Average Weighted Regulator score would have a positive coefficient. Regarding Fuel Mix Diversity and Service Diversity, I would suspect that the lower

the HHI score, the better the credit rating. I would expect these two variables to have a negative coefficient. I have chosen 44 IOU to research and the time period is from 2012 Q1 to 2017 Q4

List of Companies:

Table 3. Company List

Southern Company	MDU Resources Group, Inc.	Avista Corporation
Eversource Energy	Sempra Energy	El Paso Electric Company
Consolidated Edison Inc.	PPL Corporation	Exelon Corporation
NextEra Energy. Inc	SCANA Corporation	IDACORP, Inc.
Vectren Corporation	Public Service Enterprise Group Incorporated	NorthWestern Corporation
Wisconsin Energy Corporation	Great Plains Energy Inc.	Portland General Electric Company
Xcel Energy Inc.	Westar Energy, Inc.	NiSource Inc.
Alliant Energy Corporation	Ameren Corporation	Otter Tail Corporation
CenterPoint Energy. Inc	American Electric Power Company, Inc	Black Hills Corporation
OGE Energy Corp.	CMS Energy Corporation	First Energy Corp.
Dominion Energy. Inc	PG&E Corporation	Hawaiian Electric Industries, Inc.
Pinnacle West Capital Corporation	Edison International	Puget Energy, Inc
Duke Energy	Entergy Corporation	ILPALCO Enterprises, Inc.
ALLETE, Inc.	Cleco Corporation	DPL Inc.
DTE Energy Company	PNM Resources, Inc.	

4.2: Weighted Credit Score

The weighted credit score is an average credit rating based on each quarter over the six-year time period. The EEI assigns a numeric score to each credit rating using the S&P system.

Score	Rating
1	R
2	SD
3	D
4	D+
5	C
6	C+
7	CC
8	CCC-
9	CCC
10	CCC+
11	B-
12	B
13	B+
14	BB-
15	BB
16	BB+
17	BBB-
18	BBB
19	BBB+
20	A-
21	A
22	A+
23	AA-
24	AA
25	AA+
26	AAA

Figure 2. S&P Rating Scale

Source: EEI

4.3: Fuel Mix Diversity

Fuel mix diversity is a variable that measures the diversity of a utility's generating portfolio. I have used the theory behind the Herfindahl-Hirschman Index (HHI) to create this variable. Normally the HHI is a metric used by the U.S. Department of Justice in perspective mergers. The index is used to determine the concentration of a market. The HHI is normally calculated by squaring each market share a company has, then summing the result. The larger the sum, the less competitive the market becomes. The formula I used is similar, but I squared the percentage of operating capacity of a utility's portfolio sorted by fuel type. I then took the summation of this result and divided it by 1000 to obtain a variable between zero and ten. The categories for different fuel type were coal, natural gas, oil, and other petroleum products, hydro and renewable. In this scenario, a value of 0 represented a utility with no generation assets, while a score of 10 would represent a utility with only one fuel type for all assets.

$$\text{Fuel Mix Diversity}=\sum_{i=1}^{n}(S_i^{\wedge 2})/1000$$

- n=number of fuel types

4.4: Average Weighted Regulator Score

The average weighted regulator score is a metric that describes the regulatory climate that the utilities are present in. The RRA assigns a commission ranking for each state, in which "Above Average 1" being the best and "Below Average 3" being the worst. I have translated the ranking into a numerical score below. The ranking is assessed from an investor perspective and describes the regulatory risk associated with owning securities of the utility in the state's jurisdiction. It also reflects the RRA's evaluation of the "probable level and quality of earnings…as a result of regulatory, legislative and court actions" (SNL Energy, n.d.) Since the utilities I selected operate

and have subsidiaries in multiple states, I created a weighted score to reflect their large regulatory footprint. I did this by recording the number of electric customers each company has in each state they operate in. Therefore, I was able to create a weighted regulatory score based on where the company has the most regulatory exposure.

Rating	Score
Below Average 3	*1*
Below Average 2	*2*
Below Average 1	*3*
Average 3	*4*
Average 2	*5*
Average 1	*6*
Above Average 3	*7*
Above Average 2	*8*
Above Average 1	*9*

Figure 3. Regulator Score

4.5: Average Interest Coverage Ratio

The interest coverage ratio is a measure of credit quality. It is also used in rate cases to check the result of a proposed outcome. It quantifies how easily a company can pay interest on debt. It is also used by investors to see the possible risk of loaning capital to a company (Kenton, 2019).

Interest Coverage Ratio=EBIT/Interest Expense

- *EBIT: Earnings Before Interest and Taxes*

4.6: Average ROE

ROE is a good ratio to assess how effective the company is generating profit and it is one of the main ratios S&P uses to measure profitability. It is a straightforward ratio to evaluate returns and measure efficiency (Hargrave, 2019).

ROE=Net Income/ Shareholder Equity

4.7: Service Diversity

Service Diversity is an interaction variable that was created by multiplying two variables together which were Geographic Diversity and End Use diversity. Geographic Diversity represented a weighted HHI metric to see how many regulatory regimes the utility was exposed to. End Use Diversity represented an HHI metric to see how diverse a utility's customer portfolio is. Geographic Diversity was calculated by squaring the percentage of electric customers a utility had in each state, which represents a weighted regulatory exposure value. End Use Diversity was calculated by squaring the percentage of "uses of energy", which were Residential, Commercial, Industrial, Public Street and Highway Lighting, Other Sales to Public Authorities, Sales to Railroad and Railways, and Interdepartmental Sales. I then took the summation of both and divided by 1000 to get a variable between 0 and 100. I then multiplied them together to create the interaction variable. A Score of 0 would represent a utility who has a perfectly diverse customer base and regulatory exposure. A score of 100 would represent a utility with one customer base and exposure to only one regulatory regime.

Diversity=Geographic Diversity * End Use Diversity

Geographic Diversity=$\sum_{i=1}^{n} (S_i^{\wedge 2})/1000$

- n=number of states

End Use Diversity=$\sum_{i=1}^{n} (S_i^{\wedge 2})/1000$

- n=number of customer segments

Chapter 5

Methodology and Results

Methodology:

Two regressions were run using the variables mentioned before. The first regression was a cross sectional ordinary least squared regression, while the second was an ordered probit regression. The first regression was used to determine the relationship and significance between the variables and the credit rating. The second regression was used to determine how changes in the variables would affect a company's likelihood to be rated in a certain category.

Regression 1 Equation:

$$\text{Credit Score}_i=\beta_0+\beta_{1*}\text{Fuel Mix Diversity}_i+\beta_{2*}\text{Weighted Regulator Score}_i+\beta_{3*}\text{Interest Coverage Ratio}_i+\beta_{4*}\text{ROE}_i+\beta_{5*}\text{ Service Diversity}_i+\varepsilon_I\text{, Robust}$$

- Where $\varepsilon_I \sim N(0, \delta^{\wedge 2})$
- Robust is used to account for heteroscedasticity

Regression 2 Equation:

$$\Pr(y_i \; I \; x_i)$$

$$L=\prod_{i=1}^{n} \Pr(y_i=j \; I \; x_i)$$

$$\ln(L)=\sum_{i} \Pr(y_i=j \; I \; x_i)$$

$$\Pr(y_i=j)=a_o+ a_1\text{Fuel Mix Diversity}_i + a_2\text{Regulator Score}_i + a_3\text{Interest Coverage}_i + a_4\text{ROE}_i + a_5\text{Service Diversity}_i + \varepsilon_i$$

Table 4. Exploratory Data Analysis

Sample Size of 44

Variable Name	Mean	Median	Min	Max	Standard Deviation
Fuel Mix Diversity	4.25	4.00	0.00	8.66	1.37
Regulator Score	5.28	5.32	2.83	8.13	1.36
Interest Coverage Ratio	3.33	3.19	1.88	6.19	0.84
ROE	8.07	9.07	-14.04	13.93	5.2
Service Diversity	28.51	32.31	5.59	53.81	13.14

Results:

For both regressions, STATA software was used to generate these results. A t test and z test are conducted and significance is reported at the 10% (*), 5% (**) and 1% (***) level.

Table 5. Regression 1 Results

Predictor	Coefficient	T Test
Fuel Mix Diversity	-0.39***	-4.04
Regulator Score	0.19**	2.38
Interest Coverage	0.33**	2.19
ROE	9.27***	3.08
Service Diversity	-0.02*	-1.78

Number of Observations	44
F Statistic	14.60
R Squared Value	0.56

Table 6. Regression 2 Results

Predictor	Coefficient	Z Test
Fuel Mix Diversity	-0.45***	-3.08
Regulator Score	0.23*	1.72
Interest Coverage	0.41*	1.83
ROE	9.27**	2.54
Service Diversity	-0.02	-1.18

Number of Observations	44
Log Likelihood	-52.68

Marginal Effects

Table 7. Marginal Effects

Rating	A-	BBB+	BBB	BBB-	BB+	BB
Fuel Mix Diversity	-0.075	-0.088	0.079	0.0653	0.017	0.003
Regulator Score	0.039	0.046	-0.041	-0.034	-0.009	-0.001
Interest Coverage Ratio	0.068	0.079	-0.071	-0.059	-0.015	-0.003
ROE	0.015	0.018	-0.016	-0.013	-0.003	-0.000
Service Diversity	0.003	-0.003	0.003	0.002	0.001	0.000
No of Observations	7	10	19	5	2	1

5.1: Regression 1 Analysis

After running the first regression, the results confirmed my prediction about the variables. First, ROE is positively associated with credit ratings and it is significant at the 1% level. A 1% increase in ROE increases a company's credit score by 0.0927. ROE is a good proxy for measuring profitability and indicates that management is effective in generating shareholder value. It is clear that CRA assign higher ratings to companies who generate high returns and who have effective management practices. It is also evident that CRA value the importance of a strong regulatory environment. The regulator score variable is significant at the 5% level and positively associated with credit ratings. A one unit increase in the regulator score increases a company's credit score by 0.19. The regulatory environmental is critical because a PUC has a lot of influence and power over rate cases and business activity. The results show that utilities in a supportive environment achieve sufficient rate of returns and are able to recover costs. Furthermore, companies with a higher increase coverage ratio are associated with higher ratings. The variable is significant at the 5% level and has the largest magnitude in terms of its effect on the credit rating. A one unit increase in the ratio causes a 0.33 increase in the credit score. The variable is important because CRA value the ability to pay off existing debt. This ratio could be used as a snapshot into a company's finances and to see if they will encounter any difficulties in the future.

According to the results, utilities with a lack of fuel portfolio diversity suffer from lower ratings. The coefficient is negative indicating that the greater the portfolio diversity a utility has, the less negative effect it has on its credit rating. The variable is significant at the 1% level, and a one-unit increase results in the credit rating decreasing by 0.39. This means that companies want a more diverse portfolio to minimize the negative effect of this coefficient. It is observed that

companies who heavily rely on one fuel suffer lower credit ratings. DPL's portfolio consists mainly of coal, while Hawaiian Electric Industries is almost all oil and their average weighted credit rating is BB and BBB- respectively. However, the opposite of this theory is present with companies who have some of the highest ratings observed in the data set of A- such as Consolidated Edison and Vectren Corporation. Consolidated Edison does not have a lot of assets. Instead they most likely rely on purchased power to deliver electricity to their customers. Therefore, having a less than average fuel diversity would not harm their credit rating. A possible reason for Vectren not being affected is electric delivery is not the biggest revenue asset. The company's profitability is strongly linked to its natural gas delivery business. The diversity variable is most likely the least important determinant and is only significant at the 10% level. A one unit increase in service diversity only results in a decrease of 0.02. This can be explained by the lack of variance in the end use diversity variable. The majority of companies have similar customer profiles and this may indicate that the diversity of customers from different segments such as commercial or industrial is not critical. Focusing on geographic diversity, larger utilities have the greatest geographical customer footprint. However, this does not correlate to higher credit ratings.

5.2: Regression 2 Analysis

The ordered probit regression produced the same coefficients as the first regression. The regulator score, interest coverage, and ROE are positively associated with credit ratings. Furthermore, the fuel mix diversity and service diversity had negative coefficients. This indicates that a utility will benefit from a diverse fuel and customer portfolio.

The more interesting feature of the ordered probit model is running the marginal effects analysis. Marginal effects show the change in probability when an independent variable changes by one unit (Reyna, n.d.). Focusing on the higher category of credit ratings, which included A- and BBB+ there was a trend between three variables. The regulator score, interest coverage, and ROE all had positive coefficients. This shows that utilities who improve these three metrics have a higher probability of landing in a high credit rating category. A one unit increase in ROE would have increased the likelihood of landing in the A- and BBB+ category by around 2%. In addition, improving the interest coverage and regulator score had a positive effect. Improving these metrics increased the likelihood of 4% and 5% for the regulator score and 7% and 8% for the interest coverage. Therefore, this regression indicates that increases in interest coverage and regulator score has the best potential to achieve high credit ratings. Regarding the fuel mix diversity variable, it had a negative coefficient for both A- and BBB+ categories. This follows the trend from the first regression because a one unit increase in the variable means a decrease in portfolio diversity. As a result, utilities benefit from a diverse fuel mix. The service diversity variable seems the least important as the coefficient is very close to zero. The next two categories of BBB and BBB- displayed a similar trend. The regulator score, interest coverage and ROE all had negative coefficients. By having negative coefficients, improving these three metrics decreases the probability that the utility will have a credit score of BBB or BBB-. This could mean that utilities could be boosted into higher ratings by improving these three variables. In addition, the fuel diversity variable had a positive coefficient. This indicates that reducing fuel portfolio diversity increases your chance of having lower ratings by around 8% for BBB and 7% for BBB-. The service diversity variable for these categories was very close to zero. Regarding

the BB+ and BB categories, there is only three companies, and it would be unwise to try to speculate on the possible meaning on the marginal effects.

5.3: Overview and Analysis of Variables by Rating

Table 8 is the aggregated average value for each independent variable, separated into their respective rating category.

Table 8. Overview of Variables

Grade	Investment	Investment	Investment	Investment (Weak)	Speculative	Speculative
Rating	**A-**	**BBB+**	**BBB**	**BBB-**	**BB+**	**BB**
Fuel Mix Diversity	4.23	3.37	3.93	5.83	5.53	7.18
Regulator Score	6.22	5.55	4.70	5.38	5.67	5.17
Interest Coverage Ratio	3.73	3.37	3.21	2.97	2.7	6.19
ROE	10.70	9.36	8.37	3.47	10.38	-10.24
Diversity	29.20	28.09	26.59	22.99	42.06	53.81
No of Observations	7	10	19	5	2	1

The most prominent observation is the trend observed for the regulator score, interest coverage and ROE. First, companies with an A- rating hold the highest metrics for these three variables. There is only one deviation from this trend, in which the BBB- category has a higher regulator score than the BBB category. This trend occurs from A- to BBB- and it displays that the higher the rating, the better the metric. Focusing on fuel mix diversity, the HHI variable is fairly consistent from A- to BBB. These three categories fall under investment grade ratings, in which the utility has a strong creditworthiness and the CRA has confidence that the company will pay

its financial obligations. The categories of BB+ and BB are designated as speculative and these are some of the lowest possible ratings. In this situation, companies face significant challenges and conditions that could harm their ability to pay.

One of the interesting observations is that the companies with the lowest credit rating have a lack of diversity. Specifically, these companies have a large percentage of "dirty" fuels in their portfolio. "Dirty" fuels consist of oil and coal because of the increased regulatory and political pressure in recent years. These fuels are more likely to be scrutinized and could pose as a liability to companies who have a large percentage in their portfolio.

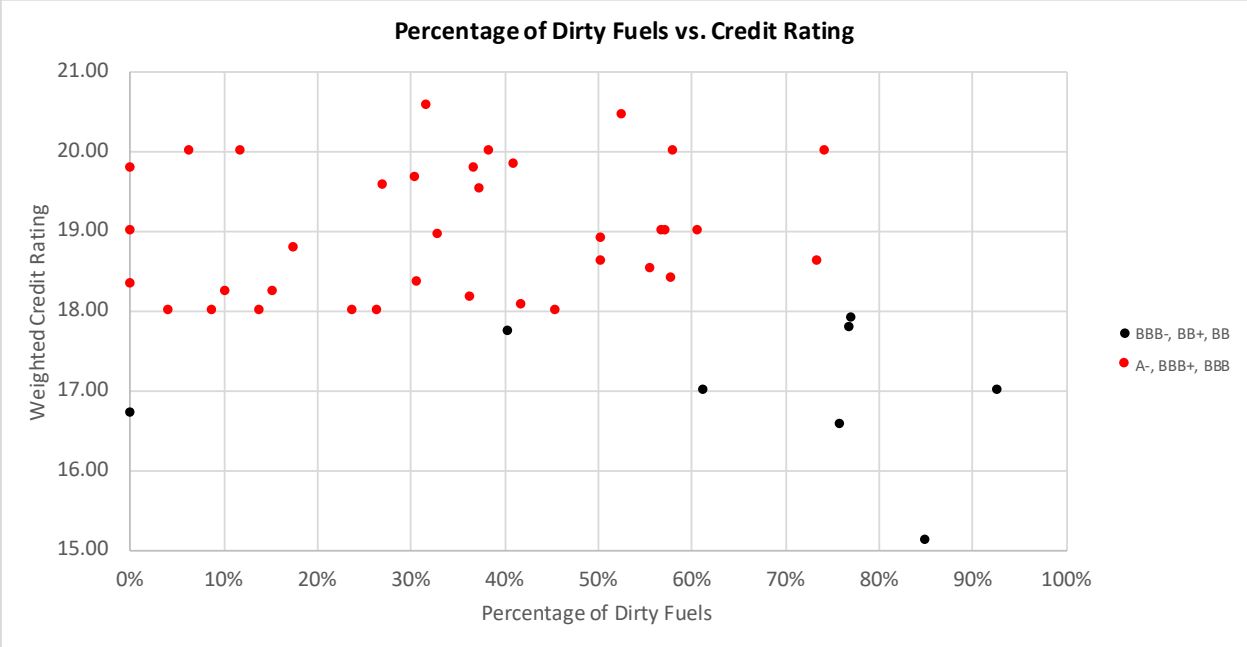

Figure 4. Dirty Fuels Graph

Table 9. Dirty Fuels Table

Utility	Credit Rating	Deviation from Mean
NiSource Inc.	BBB-	1.49
Black Hills Corporation	BBB-	0.05
Otter Tail Corporation	BBB-	1.47
First Energy Corp	BBB-	0.87
Hawaiian Electric Industries, Inc.	BBB-	2.10
ILPALCO Enterprises, Inc.	BB+	1.44
DPL Inc.	BB	1.80

One of the observations that is interesting is five out of the seven companies have a high percentage of dirty fuels in their portfolio. Focusing on First Energy and DPL, the companies have 60% and 80% of coal as part of their portfolio. One of the themes that the two companies share is the closure of multiple coal power plants. These closures were a result of a lack of competitiveness, environmental pressure, and financial unsustainability. Because coal makes up a large percentage of these companies' portfolio, closures represent a significant operational and revenue loss. This loss is reflected in the companies' ability to generate meaningful returns. Both DPL and First Energy have the lowest two average ROE in the dataset over this time period. Black Hills is closer to the average coal percentage at around 40%. However, the company is below average in three important metrics such as ROE, interest coverage, and regulator score. Despite our findings, we cannot say companies with a large percentage of dirty fuels in their portfolio cause lower ratings. It is interesting to point out that 7 out of the eight lowest rated companies have a dirty percentage of 40% and much higher. Another interesting observation is the three lowest rated companies have a lack of customer diversity and geographic diversity.

Chapter 6

Conclusion

This paper confirms that there are core metrics that help explain a company's credit rating. After reviewing the guidance of the CRA, the most important categories to focus on were profitability, debt, regulatory environment, and diversity.

The first regression, which was ordinary least squares displayed that four out of five variables were significant at the 5% level, and our service diversity variable was significant at the 10% level. A good ROE, interest coverage, and regulatory score are all associated with higher ratings. The fuel mix diversity variable had a negative coefficient and this indicates that a more diverse fuel portfolio is a positive for a company's credit rating. Furthermore, it seems customer segment and geographic diversity play a minimal role in determining a credit rating.

The second regression produced the same coefficient signs, but marginal effects revealed the more important trends. Increases in the interest coverage ratio and regulator score seem to be the most important factor in achieving ratings in the higher spectrum such as A- and BBB+. In regards to fuel mix diversity, it is a benefit to all companies as it reduces exposure to price volatility and other events that can harm a credit rating. It was also interesting that increases in regulator score, interest coverage, and ROE reduce the probability to fall into the lower categories. This could mean that improving these three metrics are key if companies want to boost their rating.

After analyzing both regressions and reviewing the data for the independent variables separated by rating category, IOU should focus on four key metrics for achieving a high credit rating. The four variables that seem to have the most weight and positive effect are regulator score, interest coverage and ROE, and fuel mix diversity.

BIBLIOGRAPHY

Bloomberg. (2019) *Bloomberg Professional*. [Online]. Available at: Subscription Service

Blumsack, S. (n.d.). Project Decision Metrics: Levelized Cost of Energy (LCOE). Retrieved from https://www.e-education.psu.edu/eme801/node/560

Blumsack, S. (n.d.). The Mechanics of Rate of Return Regulation. Retrieved from https://www.e-education.psu.edu/eme801/node/531

Blumsack, S. (n.d.). Weighted Average Cost of Capital. Retrieved March 20, 2019

California Energy Commission. (n.d.). Differences Between Publicly and Investor-Owned Utilities. Retrieved from https://www.energy.ca.gov/pou_reporting/background/difference_pou_iou.html

Distributed Generation of Electricity and its Environmental Impacts. (n.d.). Retrieved from https://www.epa.gov/energy/distributed-generation-electricity-and-its-environmental-impacts

FactSet. (2019) *FactSet Research Systems*. [Online]. Available at: Subscription Service

Edison Electric Institute. (n.d.). About EEI. Retrieved from http://www.eei.org/about/Pages/default.aspx

EEI. (n.d.). Electric Utility Industry Financial Data and Trend Analysis. Retrieved from http://www.eei.org/resourcesandmedia/industrydataanalysis/industryfinancialanalysis/QtrlyFinancialUpdates/Pages/default.aspx

FitchRatings. (2014, March 11). Rating U.S. Utilities, Power and Gas Companies. Retrieved from https://www.fitchratings.com/site/re/735155

Hargrave, M. (2019, February 24). How Return on Equity Works. Retrieved from https://www.investopedia.com/terms/r/returnonequity.asp

Holt, L. (2016). The importance of the regulatory framework for U.S. electric utility creditworthiness. *The Electricity Journal*,*29*(3), 13-18. doi:10.1016/j.tej.2016.03.002

Katchova, A. (2013). Ordered Probit and Logit Models.pdf. Retrieved from https://docs.google.com/file/d/0BwogTI8d6EEiSEdfdVpsLVBYcGM/edit

Kenton, W. (2019, February 20). Interest Coverage Ratio. Retrieved from https://www.investopedia.com/terms/i/interestcoverageratio.asp

Moody's Investor Service. (2017, June 23). Regulated Electric and Gas Utilities. Retrieved from https://www.moodys.com/researchdocumentcontentpage.aspx?docid=PBC_1072530

Olson, W. P. (2009). At a Crossroads: Modernizing Utility Infrastructure in a Tough Credit Environment. *The Electricity Journal*,*22*(7), 6-26. doi:10.1016/j.tej.2009.06.014

Rating U.S. Utilities, Power and Gas Companies (Sector Credit Factors). (n.d.). Retrieved from https://www.fitchratings.com/site/re/735155

Reyna, O. T. (n.d.). Predicted probabilities and marginal effects after (ordered) logit/probit using margins in Stata. Retrieved from http://www.princeton.edu/~otorres/Margins.pdf

Securities and Exchange Commission. (2017, December). Annual Report on Nationally Recognized Statistical Rating Organizations. Retrieved from https://www.sec.gov/ocr/reportspubs/annual-reports/2017-annual-report-on-nrsros.pdf

S&P Global. (2013, November 19). Corporate Methodology. Retrieved November 19, 2013, from https://www.spratings.com/scenario-builder-portlet/pdfs/CorporateMethodology.pdf

S&P Global. (2014). Guide to Credit Rating Essentials. Retrieved from https://www.spratings.com/documents/20184/760102/SPRS_Understanding-Ratings_GRE.pdf/298e606f-ce5b-4ece-9076-66810cd9b6aa

S&P Global. (2013, November 19). Key Credit Factors For the Regulated Utilities Industry. Retrieved from https://www.maalot.co.il/Publications/MT20180809101648.PDF

SNL Energy. (n.d.). Retrieved from https://www.snl.com/web/client?auth=inherit#news/home

Trabish, H. K. (2018, July 02). As the power sector transforms, can utilities and customers find common ground on ratemaking? Retrieved from https://www.utilitydive.com/news/as-the-power-sector-transforms-can-utilities-and-customers-find-common-gro/526399/

Trabish, H. K. (2017, August 15). Fewer rate cases mean better utility performance and growth, LBNL finds. Retrieved from https://www.utilitydive.com/news/fewer-rate-cases-mean-better-utility-performance-and-growth-lbnl-finds/448700/

U.S. Energy Information Administration - EIA - Independent Statistics and Analysis. (2018, October 12). Retrieved from https://www.eia.gov/electricity/data/eia861/

Academic Vita

Connor Danik
danikconnor@gmail.com

Education

The Pennsylvania State University
Schreyer Honors College
Bachelor of Science in Energy Business and Finance
Minor in Economics

Full Time Employment

PwC: Power and Utilities Division September 2019
Deals Associate

Internship

Citi: Commodities Division June 2018-August 2018
Summer Analyst on Natural Gas Trading Desk

- Improved and revitalized regional market models to effectively display and store data
- Conducted analysis to determine if there was a relationship between ETFs and futures prices
- Researched the status and background of pipeline expansion projects to see how they affect basis markets
- Revised and distributed morning reports covering natural gas markets

Work Experience and Leadership

Penn State Learning February 2017-December 2017
Guided Study Group Leader: Micro and Macro Economics

- Built student confidence and understanding of economics through practice problems and presentations
- Facilitated and organized group learning sessions in groups ranging from 10-50 students
- Created exam and quiz review sessions for over 100 students
- Encouraged group learning and participation by leading discussions and study activities

Penn State Department of Economics August 2016-May 2017
Undergraduate Teaching Assistant: Macroeconomics

- Assisted undergraduates during lectures by explaining concepts and topics of macroeconomics
- Completed weekly reports on how students respond to material and how to improve lectures
- Attended weekly meetings with professor to discuss and modify upcoming lectures
- Proctored exams and quizzes to uphold academic integrity standards

Penn State Department of Energy and Mineral Engineering September 2017-May 2019
Undergraduate Grader: Global Finance for the Earth, Energy and Materials Industries

- Evaluated assignments for global energy finance class
- Assessed student responses for simulated commodity futures trading

Honors

- EMS Student Merit Award Winner 2018
- Energy Business and Finance Scholarship 2018
- R. Wayne Atwell Scholarship 2018
- David Demshur Global Business Strategies Scholarship 2017
- Matthew J. Wilson Honors Scholarship 2016