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Has Electricity Deregulation Eliminated the Nuclear Option?: Rethinking the Coasian IOS for Project-Finance Investments

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Has Electricity Deregulation Eliminated the Nuclear Option?: Rethinking the Coasian IOS for Project-Finance Investments

by

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Abstract

Title: Has Electricity Deregulation Eliminated the Nuclear Option?: Rethinking the Coasian IOS for Project-Finance Investments

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Installed electric generation capacity in the United States is expected to grow significantly over the next two decades. This raises concern about climate change as several common methods of electricity generation emit greenhouse gases. Nuclear power, which doesn't create greenhouse gases while generating electricity, has been heavily promoted by the nuclear industry and a segment of the environmental community ever since it was codified by the United Nation's 26th Climate Change Conference of the Parties as an acceptable energy source to fight climate change. However, this dissertation establishes that the increased revenue risk and uncertainty created by the deregulation of electricity markets negatively affect the ability of nuclear power to attract the requisite debt and equity financing needed for construction, and in turn, affects the availability of nuclear power as an option to reduce greenhouse gases. The argument herein is constructed on the technical, economic, financial, and regulatory issues that systematically build on each other to support the position that electricity deregulation has increased lender risk, increased equity risk, and reduced the requisite underlying credit needed to support the debt and equity financing of a nuclear plant.

This dissertation proposes a theoretical model that links the availability of debt and equity financing to the revenue risk created by electric deregulation and then tests this model by performing both a qualitative phenomenological analysis and a quantitative experimental design analysis that provides support for the model. Also, to demonstrate the effect of deregulation's revenue risk on nuclear vs. non-nuclear generation, this dissertation puts forth a new theoretical investment ranking mechanism compatible with Internalization Theory that is more accurate for ranking project-financed investments than the long-standing Coasian Investment Opportunity Schedule. Support is found for this new investment ranking mechanism. Support is also found regarding electricity deregulation's negative effect on the ability of nuclear power to attract the requisite financing.

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I wish to acknowledge the support and guidance of the members of my dissertation committee, Drs. Dutta, Steelman, and Vamosi, and especially that of my dissertation chair, Dr. Cudmore. Thank you. Your efforts are much appreciated.

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I wish to acknowledge my family members and friends who cheered me on and understood the importance of this endeavor. I also acknowledge the love of learning, the joy of achievement, and the value of perseverance instilled by Philip and Marilyn, of blessed memory.

I also wish to acknowledge, tongue in cheek, the decades of unidirectional competition provided by musician and astrophysicist Sir Dr. Brian May, to whom I say, “Stop it. Enough already.”

Dedication

One summer day, as the world was emerging from the Covid pandemic, my wife Christiane looked up from what she was reading and announced, “I’ve been thinking about going back to school.” I looked up from my reading and responded, “Funny, I’ve been thinking the same thing.” We explained our thoughts to each other, how it’s been something that we’ve each contemplated for quite a long time for reasons deep and meaningful to each other, how the pandemic amplified life’s uncertainties and the urgency of “if not now, then when”, and agreed we should go for it. We were on the same page at the same point in time and this is but one example of why I cherish that she is mine and I am hers.

But nothing in life goes as planned, and the DBA program required much more time each day, every day than I originally contemplated. Fortunately for me, she was there to take on more than her share of the day-to-day management of our lives even though it took time away from her pursuits. I could not have completed this dissertation without her support and extra efforts, and as such, it is with great love and admiration for who she is that I dedicate this dissertation.

“It's not the critic who counts…The credit belongs to the man who is actually in the arena, whose face is marred by dust and sweat and blood; who strives valiantly, who errs, who comes short again and again, because there is no effort without error and shortcoming; but who does actually strive to do the deeds, who knows great enthusiasms, the great devotions; who spends himself in a worthy cause; who at the best knows in the end the triumph of high achievement, and who at the worst, if he fails, at least fails while daring greatly, so that his place shall never be with those cold and timid souls who neither know victory nor defeat.”

-- President Theodore Roosevelt

Chapter 1
Introduction

Three decades ago, the author of this dissertation predicted that the Energy Policy Act of 1992 would likely prevent the financing of new nuclear plants within deregulated electricity markets (Dansky, 1994). The prediction generated little more than a passing interest within the electricity generation finance community. Investors' interest in nuclear power within the United States (US) was already waning as other technologies were attracting increased investment, led by combined cycle units fueled by natural gas -- a fossil fuel (EIA, 2000; Kumar, 2021; World Nuclear Association, 2022). This decline led the four US manufacturers of nuclear plants -- Babcock and Wilcox, Combustion Engineering, General Electric, and Westinghouse -- to either 'close up shop' or sell their declining nuclear businesses to foreign companies. (ABB, 1996; B&W, 2023; GE Hitachi, 2023; Modern Power, 1998).

Today, in 2024, there is renewed interest in nuclear power because global warming has become a hot topic (NASA, 2010; National Geographic, 2022; NOAA, 2023). Carbon dioxide (CO_2) [(1)] has been identified as the largest contributor to global warming and the generation of electricity from nuclear power

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(1) A list of key definitions and abbreviations is presented in Appendix A.

doesn't emit CO_2 (Jaforullah & King, 2015; Penn, 2022; Tollefson, 2021; York & McGee, 2017). On the other hand, some researchers maintain that global warming is caused by something other than CO_2 (Caillon et al., 2003; Climate Change, 2018; Scafetta, 2012). Whether or not greenhouse gases (GHG) such as CO_2 contribute to global warming is immaterial. What is material is that the governments of numerous countries including the US have made international commitments to reduce CO_2 emissions. The United Nation's 26th Climate Change Conference of the Parties (COP26) codified nuclear power as an acceptable energy source for meeting these commitments (Almer & Winkler, 2017; Dimitrov, 2016; Tollefson, 2021). Following suit, the European Union (EU) announced its acceptance of nuclear power as a component of its strategy to meet the EU's climate and energy targets under the European Green Deal (CNN, 2022; Gillet, 2022). Business opportunities often arise whenever there is a change in law or regulation, and these political agreements have fueled a renewed commercial interest in nuclear power (NuScale, 2023; Terra Power, 2023).

Overlooked in these international agreements is the question raised by Dansky (1994) three decades ago whether nuclear power will have the ability to attract the requisite debt and equity financing due to changes in financial risk caused by electricity deregulation. This financing issue also appears to have been overlooked in academic literature, perhaps due to the multi-decade lack of interest in nuclear power. This gap in the literature is now salient because of the potential magnitude of disruption caused by global warming combined with the renewed interest in nuclear power as a CO_2-free technology.

To address the gap, this dissertation establishes that the increased revenue uncertainty created by the deregulation of electric markets negatively affects the ability of nuclear power to attract the requisite debt and equity financing needed for construction, and in turn, affects the availability of nuclear power as an option to reduce CO_2. The argument herein is constructed, sequentially and layer by layer, on the technical, economic, financial, and regulatory issues that systematically build on each other to support the position that deregulation has increased lender risk and increased equity risk, and reduced the requisite underlying credit needed to support the debt and equity financing of a nuclear plant.

This dissertation proposes a theoretical model that links the availability of debt and equity financing to the change in revenue risk created by electric deregulation and then tests this model by performing both a qualitative phenomenological analysis and a quantitative experimental design analysis that provides support for the model. Also, to demonstrate the effect of deregulation's change in revenue risk on nuclear vs. non-nuclear generation, this dissertation puts forth a new theoretical investment ranking mechanism compatible with Internalization Theory (Brigham, 1979; Coase, 1937; Kay, 2015; Williamson, 1975) that appears to be more accurate for the ranking of project-financed investments than the long-standing Coasian Investment Opportunity Schedule which assumes balance-sheet financing. This is important because project financing, not balance sheet financing, is the method of financing used within deregulated electric markets (Buscaino et al., 2012; Jadidi et al., 2020; Kaminker, 2017; Mora et al., 2019).

Power plant financing is critical because the construction of a nuclear power plant is a major cost commitment. Recent data on actual construction costs for a 1,000 MW nuclear power plant exceeds ten billion dollars (King, 2017). Long-term financing is relied upon to pay for most of a power plant's construction costs and twenty-year financing terms are common (IAEA, 2017; Harmon & Reynolds, 2003; Joyner, 2013; Wealer et al., 2021). The quality of a power plant's income stream, as viewed by both lenders and investors, depends on the projections of revenue and the perceptions of revenue risk. Lenders place great weight on the quality of the projected income stream to repay the loans (Harmon & Reynolds, 2003; IAEA, 2014; IAEA, 2017), and equity investors place similar weight on the quality of the projected income stream to provide a return on and return of equity (Brigham & Crum, 1977; Grinyer, 1976).

This emphasis on income stream quality helps to explain why all previous nuclear power plant financings, whether in the US or abroad, have relied on the monopoly status of the electric utility, with its legislatively anointed captive market, to provide an income stream sufficient to ensure debt coverage, provide a return on and of equity, and cover nuclear-related risks to the satisfaction of the lenders and equity investors (Grantham, 2017; Harmon & Reynolds, 2003). But after the passage of legislation enacting electricity deregulation, electric utilities aren't permitted to own regulated power plants in about two-thirds of the US market where electricity is no longer generated by monopolies and state regulators no longer ensure coverage of cost and revenue risks (Ward, 2011; White, 1996). Rather, electricity is generated and sold on a competitive basis by non-utility Independent Power Producers (IPPs), and in many states, end-use customers are now able to choose among competing electricity suppliers (Ward, 2011; White, 1996).

To economists, competitive markets are preferred because they provide greater economic efficiencies than monopoly markets (Isser, 2003; Mankiw, 2015; McConnell et al, 2021; White, 1996). Overlooked by the policymakers at COP26 and other recent environmental forums, where nuclear power has been codified as a solution to global warming, is any consideration and/or analysis of the impact of this electricity deregulation on the ability of new nuclear plants to obtain the debt and equity financing needed for construction and, in turn, on the potential number of new nuclear power plants that could help fight global warming.

On the surface, the impact of deregulation is not evident as the total investment in nuclear power has continued to increase globally over the last two decades (World Nuclear Association, 2022). There are presently 441 nuclear power plants around the world in 32 countries with an additional 55 under development/construction (Kumar, 2021; World Nuclear Association, 2022). However, as explored herein, none of these nuclear plants were financed within a deregulated framework – they all relied on one of several versions of regulatory protection, where the government agreed to assume the cost and revenue risks or these risks were passed on to captive customers who were not legally permitted to purchase their electricity elsewhere (IAEA, 2014; IAEA, 2017).

While there has been a steady flow of investment into the US power plant sector during the past several decades since the onset of deregulation (EIA, 2000, 2021; Statista, 2022), the generation of electricity using nuclear power in the US has not shared the same steady flow of investment (Matthews et al., 2009; Reid, 2000; World Nuclear Association, 2022). Simply stated, the financing of nuclear power plants has increased globally while the financing of nuclear plants in the US has not. Dansky and Cudmore (2022) postulated that the Public Utility Regulatory Policies Act of 1978 (PURPA), the Energy Policy Act of 1992 (EPA of 1992), and other federal actions to encourage competition in the electric generation market appear to have increased power plant revenue risk, which has led to an increased difficulty to attract the debt financing that is needed to construct a nuclear plant. This dissertation extends Dansky and Cudmore (2022) by postulating that these regulatory changes have also led to increased minimum required return on equity hurdle rates which makes it more difficult for projects to attract equity financing.

As noted, this inability to attract debt and equity financing for nuclear plants has become a timely and salient issue because of the increased interest in the problem of global warming by environmentalists, government officials, and the general public. These people recognize that nuclear power is one of several electric-generating technologies that do not produce CO_2 and, as such, could be used to help limit global warming (Dansky & Cudmore, 2022). This issue is also salient because the need for new electric generating capacity in the US is expected to double during the next twenty years, driven largely by the changeover from internal combustion engines to electric vehicles (Dansky, 2021; EIA, 2019; LLNL, 2023). Resources are, by their nature, scarce (Barney, 1991; Mankiw, 2015; McConnell et al., 2021; Peteraf, 2013) and there is value to society (more precisely, the maximization of productive and allocative efficiency (Mankiw, 2015; McConnell et al, 2021)) in knowing whether scarce resources should be directed to the further development of nuclear power, at the above-noted cost exceeding ten billion dollars per plant, or to the development of other CO_2-free technologies. This dissertation is intended to help inform that decision.

Problem Statement and Research Scope

Debt and equity investment in non-nuclear generation has played an important role in the development of new electric generating capacity in the US ever since the passage of PURPA in 1978 and the EPA of 1992 (BEA, 2022; EIA, 2000; Statista, 2022). The research problem addressed by this dissertation is:

> *Can nuclear power, a CO2-free technology, attract debt and equity financing in light of the changes in financial risk that arise from electricity deregulation?*

While there is a multitude of risks that may influence the financing of nuclear plants (see the Chapter 2 section entitled Project Risks That Affect Debt and Equity Financing), the scope of this dissertation is narrowly limited to the changes in revenue risk that are associated with the deregulation of electricity markets and its likely impact on such debt and equity financing.

Research Questions

This dissertation poses the following Research Questions:

RQ1: Does electricity deregulation increase power plant revenue risk relative to cost-of-service regulation and if so, why?

RQ2: Does this increase in revenue risk reduce the ability to attract debt and equity financing for new power plants and if so, why?

RQ3: Is nuclear power affected by an increase in revenue risk more or less than other types of electric generation and if so, why?

The answer to RQ3 appears to lie with the Coasian Investment Opportunity Schedule (IOS) which has its roots in classical economic utility theory, underpins Internalization Theory, and puts forth an investment ranking mechanism to identify which business opportunities should be internalized by a firm (Coase, 1937; Kay, 2015; Rugman, 1986; Williamson, 1975). In lay terms, internalization is the 'make or buy' decision facing all firms. (A detailed discussion of Internalization Theory and the IOS is presented in the Chapter 2 section entitled Internalization Theory.) The conundrum is that the literature on Internalization Theory and the IOS assumes the use of balance sheet financing, whereas project financing is the method of financing used within deregulated electric markets. This leads to the following Research Question:

RQ4: When making use of project financing, as opposed to balance sheet financing, what establishes the extent (or boundary) of the firm, and thus, which business opportunities should be internalized by the firm?

In addressing these research questions, this dissertation fills certain gaps in the literature including:

1) Establishing that there is a relationship between the deregulation of the electric industry and an increase in power plant revenue risk,

2) Performing a qualitative phenomenological analysis that provides support for the relationship between electricity deregulation and an increase in power plant revenue risk,

3) Establishing the existence of two theory-based causality pathways (debt and equity) by building on the financial and economic theories, constructs, and principles of the Capital Asset Pricing Model, Efficient Market Hypothesis, Prospect Theory, Internalization Theory, Price Elasticity, and the Law of Supply and Demand,

4) Unearthing a theoretical assumption in Coase (1937) that limits the applicability of the Coasian IOS to balance-sheet financing, raises a fundamental concern about Internalization Theory, sheds new light on how classical economic utility theory is to be applied to Internalization Theory, and in turn, questions the validity of numerous Internalization Theory papers that were built on a Coasian foundation,

5) Setting forth a new investment ranking mechanism called the Modified Investment Opportunity Schedule (MIOS) which is shown to be the proper ranking mechanism for project-financed investment opportunities, and which fills a long-overlooked gap in Internalization Theory literature,

6) Performing a quantitative experimental design analysis that provides support for the new investment ranking mechanism (the MIOS),

7) Establishing that the variation between the theoretically predicted and the experimentally observed investment choices can be explained by the risk avoidance pattern set forth in Prospect Theory.

8) Finding experimental confirmation of Prospect Theory using a methodology that is different from that used in prior studies,

9) Creating a theory-based model that links debt and equity financing with a change in power plant revenue risk,

10) Establishing that the increase in power plant revenue risk arising from the deregulation of the electric industry affects the ability of all power plants to attract debt and equity financing,

11) Establishing that the deregulation of the electric industry affects revenue risk for certain types of power plants more than others, and consequently, affects the ability to attract debt and equity financing into the US nuclear power sector, and

12) Providing timely and salient policy guidance for the efficient allocation of resources to reduce greenhouse gases based on the new model linking debt and equity financing with a change in power plant revenue risk.

While the focus of this dissertation is on the electric industry, the MIOS ranking mechanism developed herein (#5 above) is universally applicable to all project-financed industries and is not limited to the electric industry. Project financing has grown into a $200+ billion per year global financing market involving various capital-intensive investment opportunities that also include the real estate and the oil and gas industries (Fight, 2006; Yescombe, 2002).

Also, the theory-based model established in this dissertation linking debt and equity financing with the change in power plant revenue risk (item #9 above) is not expected to be limited to only revenue risk. It likely can be applied universally to all types of risk that can affect project financing and as such, likely has wide academic and practical application.

Moreover, while this dissertation's discussion focuses on the US, it might apply to any country that deregulates its electricity markets. Electricity deregulation has been described as "one of the largest single industrial reorganizations in the history of the world" (Kwoka, 2008:165). Various academicians in multiple disciplines in numerous countries are presently studying electricity deregulation (Harrison & Welton, 2021; Hill, 2021; Lee et al., 2021; York & McGee, 2017), as well as developing technologies to reduce climate change (Lopes et al., 2022; Mora et al., 2019; Muther et al., 2022; Wang et al., 2023), and it is hoped that the outcome of this dissertation will inform many of these researchers as to the efficacy of deregulation to attract investment capital and inform others as to the viability of various technological options to reduce greenhouse gases.

As a final introductory note, electricity deregulation was instituted to reduce monopoly markets and increase economic efficiency through competition (Isser, 2003; White, 1996). It has largely succeeded (Csereklyei & Stern, 2018; Fabrizio et al., 2007; GAO, 2002; Lei et al., 2017; Musco, 2017; Switzer & Straub, 2005). This dissertation is narrowly limited to researching a specific economic outcome of this deregulation. It is not normative and does not take a position for or against any electric generation technology. Rather, it is the author's intent to simply point out the effect of the Smithian 'invisible guiding hand' on market efficiency as it applies to the allocation of debt and equity within the electric generation sector.

Chapter 2
Literature Review

Topics of discussion proceed in the following general manner:

1) Climate change has created a renewed interest in nuclear power.

2) Baseload power plants, such as nuclear power, face certain revenue-based financing challenges that are ameliorated by monopoly regulation.

3) The removal of monopoly regulation (deregulation) causes an increase in power plant revenue risk.

4) This increased risk leads to the imposition of higher debt coverage ratios (DCR) which results in lower debt:equity (D:E) ratios.

5) This increased risk leads to higher minimum required return on equity (ROE) hurdle rates.

6) Items 4 and 5, above, individually and/or in combination, work to decrease the availability of debt and equity financing for baseload power plants such as nuclear power.

Climate Change May Open a Window of Opportunity for Nuclear Power

Numerous studies suggest that climate change is a significant threat to the environment and is caused primarily by man-made greenhouse gases (GHG) (Jaforullah & King, 2015; Santana, 2020; Tollefson, 2021). International attention to this problem has been growing during the past several decades. In the three decades between 1992 and 2021, four United Nations (UN) climate agreements were signed, including the Framework Convention, the Kyoto Protocol, the Paris Agreement, and the COP26 Agreement in 2021 (Almer & Winkler, 2017; Dimitrov, 2016; Tollefson, 2021). Over time, the number of countries signing these agreements has grown, and the quantity reductions for greenhouse gases have become more stringent.

These UN agreements identify multiple gases as the cause of climate change, but CO_2 is identified as the largest contributor (Jaforullah & King, 2015; York & McGee, 2017). CO_2 is formed, along with water, when a hydrocarbon molecule combines with oxygen during combustion (Santana, 2020). The largest share of manmade CO_2 (about 87%) comes from the combustion of hydrocarbon fuels (Jaforullah & King, 2015; Santana, 2020; York & McGee, 2017) which are often referred to as fossil fuels due to their prehistoric origins (PSU, 2023). Of this, the majority of fossil fuel combustion occurs within the internal combustion engines used for transportation and within the combustion turbines and steam boilers used for electric power generation. With respect to transportation, oil is the primary fossil fuel that is consumed, and with respect to electric power generation, coal and natural gas are the primary fossil fuels consumed. Therefore, to meet the CO_2 reductions set forth in the UN agreements, new electric generation has to be built, and existing fossil fuel electric generation needs to be replaced, with technologies that are climate-friendly.

Being climate-friendly does not necessarily translate to ‘renewables’ since many renewable fuels produce GHG. For example, the burning of landfill methane, farmed algae, and biomass such as wood waste, all contain carbon and thus are unsuitable for reducing CO_2. The challenge, therefore, is to find electric generation technologies that do not emit GHG.

The above concern for global warming has opened a window of opportunity for the construction of new nuclear power plants in the US because nuclear power does not emit GHG (Penn, 2022). Since 1990, and prior to the heightened global awareness regarding climate change, the window of opportunity for nuclear power in the US had been closing as evidenced by the exit from the market of the four US manufacturers of nuclear plants (ABB, 1996; B&W, 2023; GE Hitachi, 2023; Modern Power, 1998). The installed capacity of nuclear power had declined as the retirement of existing plants exceeded the construction of new plants (Matthews et al., 2009; Reid, 2000; World Nuclear Association, 2022). Many announced new units were canceled and only one nuclear plant (consisting of two units) started construction within the last three decades (King, 2017). Then, in 2021, policymakers at the United Nations COP26 conference declared nuclear power as an acceptable solution to climate change. Subsequently, the European Union announced it has re-classified nuclear power as a 'green' energy source and a component of its strategy to meet climate and energy targets for 2030 under the European Green Deal as well as its COP26 goals (CNN, 2022; Gillet, 2022). Since the announcement of the 2021 COP26 agreement there has been a resurgence of news articles promoting nuclear power as a means to reduce GHG (Freedman, 2022; Halper, 2022; Penn, 2022; WSJ, 2021a; WSJ, 2021b; Yahoo News, 2023).

Economic and Technical Issues Create Financing Implications

Nuclear power is not the only technology that could be used to reduce GHG. There are a number of other carbon-free electric generation technologies such as geothermal, tidal, hydroelectric, wind, and solar. Each of these has certain limitations and, as such, no one technology appears to have the overall advantage.

Geothermal power is limited to locations where the earth's tectonic plates meet, creating fissures in the earth's crust enabling the hot gases to be accessed (Muther et al., 2022). Tidal power is also limited to certain feasible locations, and also suffers due to its distance to load centers (Wu et al., 2016).

Hydroelectric plants are also limited to specific locations and cause high environmental impact such as the effect on existing flora and fauna when a river is transformed into a lake (Burke, 2014; Cudmore, 2011; Moorman et al., 2019). No new large hydroelectric plants have been able to secure the requisite permits from the Federal Energy Regulatory Commission and the US Environmental Protection Agency for several decades and several hydroelectric dams have recently been taken out of service and decommissioned to re-establish fish migration and spawning (USSD, 2015).

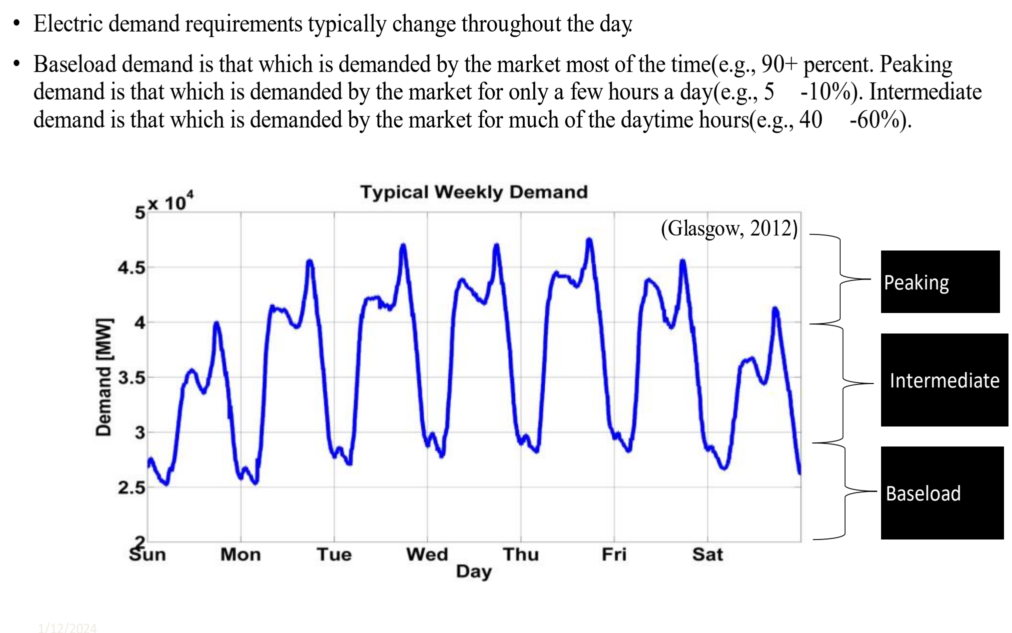
Wind power is limited to locations where the wind is constant (Cudmore, 2011; Moorman et al., 2019; Mora, et al., 2019). Also problematic are the protests of visual pollution and land use issues because wind power turbines are large (typically 300 to 400 ft high) and they are not energy dense (i.e., the amount of electricity generated per acre of land) (Moorman et al., 2019). Furthermore, wind power kills several hundred thousand birds per year and alters migration paths (Eveleth, 2013, Moorman et al., 2019).

Solar power has limitations from inclement weather, cannot generate power at night, and suffers from efficiency losses the further its location from the equator (Boretti & Castelletto, 2021; Cudmore, 2011). Both wind and solar are considered intermittent power and cannot meet ISO reliability standards (PJM, 2021) unless matched with some form of energy storage (Deng & Oren, 2006; Glasgow, 2012). The above-noted drawbacks of geothermal, tidal, hydroelectric, wind, and solar all help to maintain nuclear power's status as an option to combat climate change.

However, nuclear power has many technical and political issues primarily linked to radiation including, but not limited to, the long-term disposal of radioactive spent fuel and irradiated power plant components (Bemš, 2015; Cotton, 2018; Cudmore, 2011; Tuhus-Dubrow, 2022). However, the European Union's recent re-labeling of nuclear as a 'green' energy source and incorporating it into its strategy to meet its climate targets might act as a precedent for other countries such as the US in regard to political acceptance of this energy source.

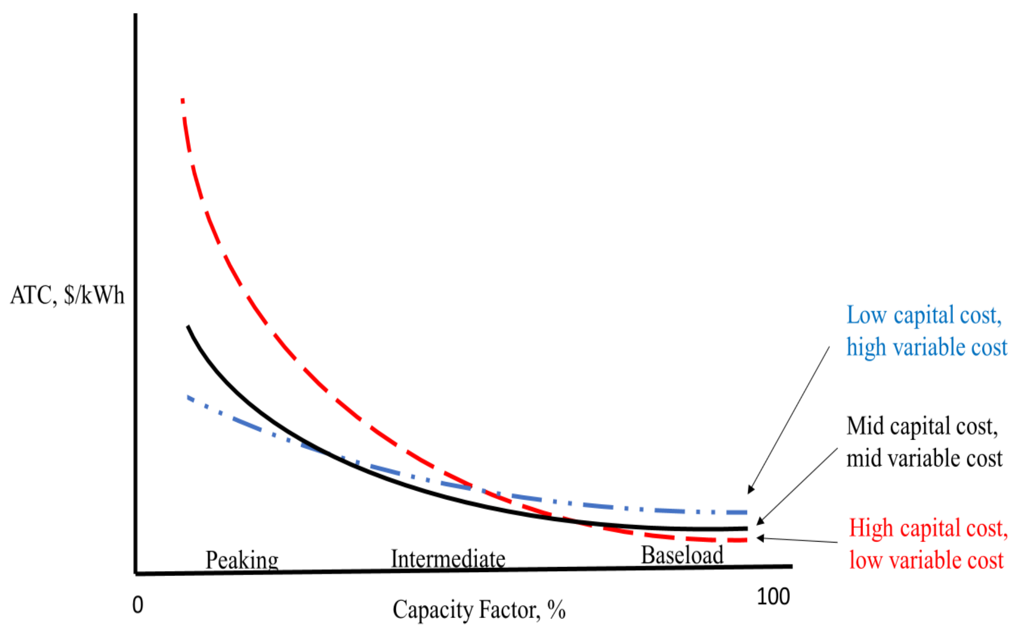
Imposed as a further constraint on the economic and technical viability of nuclear power is that those power plant technologies that have a high fixed capital cost (a high per kW cost) and a low variable cost (a low per kWh cost) are only economic in serving the baseload demand (the level of demand that is present around the clock such as home refrigerators, traffic lights, and cloud-computing servers) as demonstrated in the next several paragraphs. Figure 2-1 depicts a typical weekly load curve and identifies which portions of the load curve are considered baseload, intermediate, and peaking.

Figure 2-1 Depiction of Baseload, Intermediate, and Peaking Load



Building upon the load categories shown in Figure 2-1, Figure 2-2 depicts three hypothetical power plants of indeterminant technology: one with a high fixed cost and a low variable cost, one with a low fixed cost and a high variable cost, and one with a mid-fixed cost and a mid-variable cost. Fixed costs (FC) are those that cannot be changed, such as the annualized fixed capital costs of the power plant, while variable costs (VC) vary with output such as the quantity of fuel consumed. A plant with both a high fixed cost and a high variable cost would always be uneconomic compared to other options, and thus would never be dispatched by the independent system operator (ISO). A plant with both a low fixed cost and a low variable cost does not presently exist but, if it did, would transform the electric market causing existing power plants to lose the ability to service their debt and equity obligations. (See the discussion on unknown risks in the section entitled Project Risks That Affect Debt and Equity Financing.)

Figure 2-2 Average Total Costs (ATC) vs. Capacity Factor

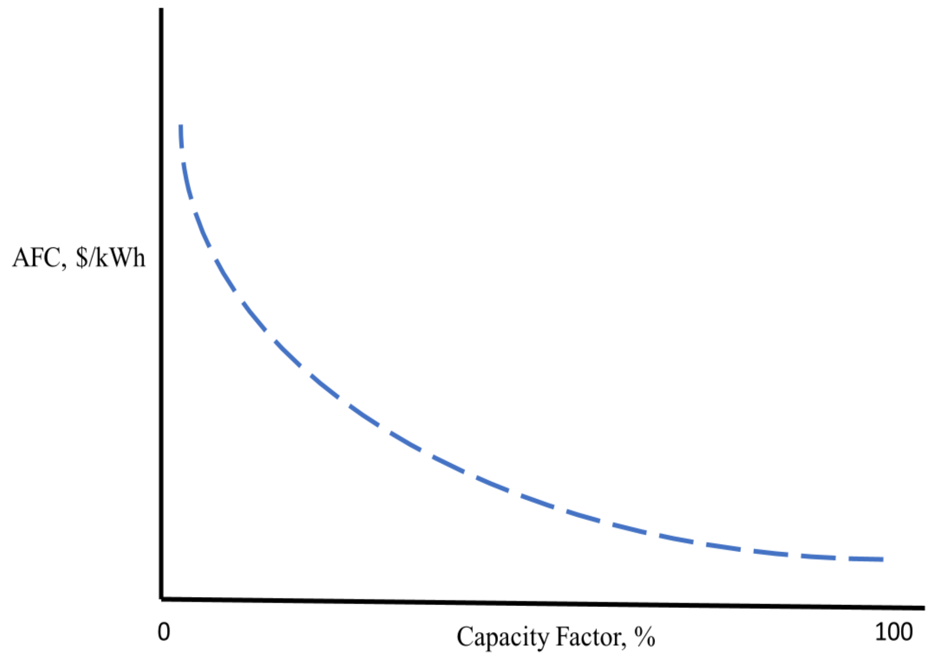


Total cost (TC) is the sum of FC and VC, and when divided by the output quantity (Q), yields average total costs (ATC) (Mankiw, 2015; McConnell et al, 2021). Capacity factor is defined as the actual annual output in kWh divided by the annual potential output in kWh (USNRC, 2023a). As can be seen in the figure, at low capacity factors (i.e., low Q) the low fixed cost/high variable cost plant is more economic, at high capacity factors the high fixed cost/low variable cost plant is more economic, and at intermediate capacity factors the mid fixed cost/mid variable cost plant is more economic.

No one power plant technology existing today is best at economically serving all three segments of the market and this is why different types of power plants are built to serve different segments of the market. Thus, as shown in Figure 2-2, a high fixed cost/low variable cost technology (such as nuclear power) is only economic at high capacity factors, i.e., the baseload segment of the market.

The above characteristic of nuclear power has important financing implications. As noted above, it is necessary that nuclear plants maintain a high capacity factor in order to be cost-competitive. Capacity factors of 90+ percent, as depicted in Figures 2-1 and 2-2, represent the critical range of operation if nuclear power is to be cost-competitive. In other words, using the equation for average fixed costs: AFC = FC/Q, where FC is the annualized fixed capital costs of the power plant, and Q is the annual output of the power plant (Mankiw, 2015; McConnell et al, 2021), it is important to maintain a high Q to keep AFC down because nuclear plant fixed costs are high (EIA, 2017; King, 2017). See Figure 2-3 which shows how, when FC is held constant, the average fixed costs in $/kWh decrease as the capacity factor increases. Thus, by operating as a baseload unit, the high fixed costs of a nuclear plant can be allocated over a greater quantity of kilowatt-hours to minimize AFC, which in turn, minimizes the average total electric costs paid by the consumer.

Figure 2-3 Average Fixed Costs (AFC) vs. Capacity Factor



This restricts nuclear plants from being dispatchable (IAEA, 2009), that is, the ability to increase and decrease output during the course of a day to meet changes in electric demand. This is important as they cannot be used to generate electricity as an intermediate or peaking unit (IAEA, 2009), because this would lower Q and, in turn, increase AFC. Thus, the nuclear plant would have insufficient cash flow to meet its debt and equity obligations as discussed in the section entitled The Impact of Risk on Debt Financing.

This principle that nuclear plants cannot be dispatchable also applies to any of the proposed advanced nuclear plant designs that may provide inherently safer shutdown capability, as well as modular construction techniques to reduce construction schedules and costs (NuScale, 2023; Penn, 2022; Terra Power, 2023; WSJ, 2021a; WSJ, 2021b). These new designs do not alter the high fixed cost/low variable cost relationship that is inherent to nuclear power, and it is this relationship, as noted above, that dictates whether a power plant economically operates as a baseload, intermediate, or peaking unit. As such, the new designs do not alter the key economic and technological issue at the center of our analysis with its important financing implication that nuclear plants are designed for, and require, baseload operation. The key point is that the findings of this dissertation will be generalizable to both existing and advanced nuclear plant designs.

The conundrum, whether analyzing existing nuclear plant technology or a proposed advanced modular design, is that the price (P) of the generated power must remain low enough to ensure that the plant will be called on (dispatch) to sell a high quantity (Q) of the plant's output, and thus be a baseload unit, yet the total revenue (TR = P x Q) must be large enough to cover all costs, including the plant's high capital costs. This is a tight operating window and the nuclear plant must be able to satisfy this constraint over the plant's life, despite changes in competing technologies, regulations, and customer demand in order to attract financing (Fight, 2006; Yescombe, 2002). The debt and equity financiers of the nuclear plant seek to have this operating risk minimized (Fight, 2006; Yescombe, 2002) because the tight operating window leaves little cushion to absorb the effects of the long-term revenue risks discussed in the next section.

Project Risks That Affect Debt and Equity Financing

All aspects of any new power project have risks, including but not limited to, revenue, cost, schedule, cost and availability of insurance, political risk, and end-of-project issues such as decommissioning (Bems et al., 2015; Fishman, 2018; Harmon & Reynolds, 2003; IAEA, 1997, 2014, 2017; Joyner, 2013; Kolomitz, 2016; USNRC, 2023b; Wealer et al., 2021). These risks all have the potential to impact a project's long-term profitability, and thus have a potential impact on the risks perceived by bank lenders and equity investors. As such, "all risk is financial risk" (IAEA, 2017: 11). The key, then, to obtaining financing is to provide the lenders and investors with enough assurance (colloquially described as 'belts and suspenders') that the forecasted revenues will always be sufficient to meet the risk-return requirements of the parties (IAEA, 2017).

Long-Term Price and Output Quantity Risks

The first major long-term risk that gives lenders concern is long-term price certainty. To reduce this risk the power plant must sell its output at a price that is high enough to cover both its fixed and variable costs. A long-term concern is the emergence of competing technologies that are able to sell electricity at a lower price and push a power plant out of the market (Harmon & Reynolds, 2003; IAEA, 2014; IAEA, 2017).

The second major risk is long-term output quantity risk. On one hand, this can come about because the plant is unable to generate power at full output for technical reasons (e.g., the historical need for many nuclear plants to plug leaking steam generator tubes, which reduces output (USNRC, 2023b). However, this risk can also come about because of the emergence of a lower costing competing technology that gets sequenced to run each day ahead of the nuclear plant. If this occurs, the lower costing technology will push the baseload plant ‘up the dispatch curve’ and block it from being a baseload plant (and thus reduce Q). This will result in a shortfall of total revenue (Harmon & Reynolds, 2003; IAEA, 2014; IAEA, 2017), and in turn, affect the ability to make payments to the lenders and/or provide a return to equity participants. A more extensive discussion of the dispatch curve is presented in the next section.

Construction Cost and Construction Schedule Risks

The lenders and equity participants are also concerned about the risks of capital cost uncertainty (IAEA, 2017; Joyner, 2013). Construction cost overruns translate into increased annual fixed costs, affect debt coverage ratios, and impact debt ratings (Wealer et al., 2021; Ziegler & Dansky, 1982), and may require a larger equity contribution to cover the funding shortfall. All nuclear plants constructed in the US to date experienced significant construction cost overruns, sometimes doubling and tripling the initial cost projections (Frye, 2008). The Vogtle Units 1 and 2 experienced more than a quadrupling in costs (Patel, 2018). The Seabrook nuclear plant suffered a similar quadrupling in costs before bankrupting its owner. And, the Shoreham nuclear plant saw a quintupling in cost before being canceled and bankrupting its owner (Ross & Staw, 1993). Thus, the history of nuclear power is that cost overruns are more common than not, and this affects the degree of risk as perceived by the lenders and equity investors.

Construction schedule delays impose risk as they affect cash flow, affect the start of debt repayment, and increase the interest on the debt during construction (Wealer et al., 2021). Referred to as Allowance for Funds Used During Construction, or AFUDC, this is the accrued interest on the loans during construction that is capitalized and converted into a fixed cost to be repaid with interest to the lenders (Wealer et al., 2021; Ziegler & Dansky, 1982). The typical decade-long construction schedule for a nuclear plant yields a compounding interest of AFUDC can double the cost of a nuclear plant (Ziegler & Dansky, 1982). Many nuclear plants built in the US experienced significantly different extensions to their construction schedules (Frye, 2008) which widely varied the amount of AFUDC, and this affects the degree of risk as perceived by the lenders and equity investors.

Post Operation Risks

There are risks associated with the cost of decommissioning and decontaminating a nuclear power plant at the end of its useful life, as well as the cost and availability of spent fuel storage (Bems et al., 2015; Cudmore, 2011; IAEA, 1997). There is limited experience decommissioning a nuclear plant, it is unknown how much it will cost several decades in the future and a permanent solution for spent fuel storage has yet to be approved in the US due to political considerations and is thus difficult to quantify (Bems, 2015; Frye, 2008).

Other Risks

Another major risk of concern to lenders and equity participants is the cost and availability of insurance. Commercial insurance companies have not been willing to insure nuclear risk, and as such, the federal government instituted, under the Price Anderson Act, federal insurance guarantees limiting the risk exposure of nuclear plant owners and their insurers (Fishman, 2018; Kolomitz, 2016). Congress has extended the Price Anderson Act several times (Fishman, 2018; Kolomitz, 2016), but it is unknown if they will continue to extend this protection, or if they will extend it to non-utility, non-regulated IPPs.

Finally, political risk can present significant and unexpected risks to lenders and equity participants. For example, recent political tensions between the United Kingdom and China led to China's removal as an equity participant in a British nuclear plant (Daily Telegraph, 2022) and Germany's government voted to shut down all of its nuclear plants prior to the end of their economic lives to help promote wind power (IBT, 2022). Political risks are difficult for lenders and equity investors to identify in advance and difficult to quantify.

Of the above identified risks, the focus of this dissertation is narrowly limited to the revenue risk created by deregulation. Revenue is the product of price and output quantity, and as such, revenue risk can be further divided into price risk and output quantity risk (Condemi et al., 2021) which are addressed in the subsequent section.

Discussion of Risk and Uncertainty

In those electricity markets that have been deregulated, electricity is sold into a wholesale competitive market, much like a stock exchange, where the price received for electricity changes every few minutes in accordance with the specific rules of each regional independent system operator (ISO) (Ward, 2011; Zhongyang, 2022). An ISO is an independent regional organization that oversees the operation of the electric transmission network, manages the wholesale electric market, and performs bulk electric system planning. The creation of ISOs was mandated by Federal Energy Regulatory Commission (FERC) Order 2000 issued December 15, 1999 for the purpose of furthering competition in electric markets and built on earlier FERC Orders 888 and 889 regarding the treatment of electric transmission lines as open access common carriers (FERC, 1999). To maintain objectivity, ISOs are regulated by FERC with the exception of the Texas ISO (ERCOT) which is regulated by the Public Utilities Commission of Texas. To further maintain objectivity, each ISO is managed by an independent board of directors that is not affiliated with any market participant (FERC, 2023). This promotes competition which increases market efficiency (Csereklyei & Stern, 2018; Fabrizio et al., 2007; GAO, 2002; Lei et al., 2017; Musco, 2017; Switzer & Straub, 2005). Figure 2-4 identifies the territories of the various ISOs within North America.

Subject to electric transmission constraints, each power plant within the ISO competes with each other based on price. Daily prices are submitted to the ISO the

Figure 2-4   Map of Independent System Operators

(Enerdynamics, 2023)

day prior by all the power plants within the ISO region, much like a limit order for the sale of stock on a stock exchange. That is, if the stock market price is equal to or higher than the limit order, the stock is sold. If less, the stock is not sold. The submitted electric prices are combined with the estimated daily market demand by the ISO to create a daily dispatch curve (a supply and demand curve that instructs the power plant owners when to turn the plants on and off each day). The actual interaction of supply and demand, as it changes throughout the day, determines the actual wholesale prices received and the quantity of electricity sold that day by each power plant (Condemi et al., 2021; EIA, 2012; Ward, 2011; Zhongyang, 2022). Because of the continually changing interaction of supply and demand, electricity prices determined by the market can be more volatile than regulated prices (Beecher & Kihm, 2016; Deng & Oren, 2006), especially since the market demand curve for electricity in the US and other developed countries is inelastic (Burke & Abayasekara, 2017; Fan & Hyndman, 2011; Wakashiro, 2019). This change in volatility acts to increase financial risk.

Price elasticity of demand is defined as the percentage change in the quantity demanded by the market divided by the percentage change in price, or E_D = (% change in Quantity Demanded) / (% change in Price). When this ratio is less than 1, then the price elasticity of demand is deemed inelastic (McConnell et al., 2021). An inelastic demand signifies that a small incremental change in demand results in an even greater change in price.

The market supply curve for electricity is also inelastic. This results from the steep barriers of entry for constructing new power plants, multi-year construction schedules, and because of the limited capability to store electricity (Deng & Oren, 2006). Electricity storage exists in the form of rechargeable batteries and pumped storage hydro (unused electricity is used to pump water up to a storage pond at a higher elevation which is then gravity-fed to a lower elevation to spin a turbine when the electricity is later needed). Inelastic supply signifies that a small incremental change in the availability of supply, such as from an unplanned power plant outage, results in an even greater change in price. Price volatility is magnified due to the combined inelasticities of both the demand curve and the supply curve.

Evidence of severe electric price volatility can be seen in the summer of 1998 when wholesale power prices in the US Midwest reached $7,000 per MWh from typical prices that year of $30–$60 per MWh, and in California in 2000-2001 when utilities improperly balanced long and short-term sales and purchase contracts (Deng & Oren, 2006). Wholesale prices in Texas averaged $22 per MWh in 2020, but in February 2021 reached $9,000 per MWh for several days during a severe storm (EIA, 2021).

To help reduce the impact of electric price volatility, financial markets have developed a series of electricity price hedges which include forwards, swaps, options, and spark spreads (Deng & Oren, 2006; Martinez & Torro, 2018; Mehrdoust et al., 2022; Perchanok, 2012; Pietz, 2009), but longer-term hedges (more than a year) are not available due to market uncertainty (Deng & Oren, 2006; Martinez & Torro, 2018; Mehrdoust et al., 2022; Perchanok, 2012; Pietz, 2009), the inability to incorporate potentially numerous variables into the financial models (Condemi et al., 2021), and the lack of creditworthy counterparties. Clearly, these short-term hedges cannot be used to underpin the long-term debt used in power plant financing because they are not available to reduce the impact of long-term electric price volatility that is perceived by lenders.

This volatility creates risk. “Definitions of risk vary widely and more often than not are incomplete” (Beecher& Kihm, 2016:2). “Risk is a difficult concept to grasp, and a great deal of controversy has surrounded attempts to define and measure it” (Brigham, 1979:101). Some have defined it as “the expected value of a potential loss" (Binz, 2012 in Beecher & Kihm, 2016:2), "the potential for a loss or negative outcome from an uncertain event" (Bean & Hoppock, 2013 in Beecher & Kihm, 2016:2), and "a hazard; a peril; exposure to loss or injury" (Brigham, 1979:96). Risk can also be defined probabilistically in terms of the standard deviation of a distribution, i.e., the greater the standard deviation the greater the risk (Brigham, 1979).

In the previous paragraphs, what has been referred to as risk is, more precisely, risk and uncertainty (Beecher & Kihm, 2016). While related, they are not the same. Risk is based on the quantitative analysis of probabilities while uncertainty stems from a qualitative assessment of possibilities (Beecher & Kihm, 2016). Uncertainty is a function of future outcomes that cannot be envisioned. To borrow from a phrase popularized by former Secretary of Defense Donald Rumsfeld in a Department of Defense news briefing (Rumsfeld, 2011), risk involves the known knowns and the known unknowns, while uncertainty involves the unknown unknowns. Applying this to wholesale electric prices in a deregulated framework, lenders and equity participants can quantitatively analyze a list of risk items that significantly impact the daily dispatch curve including but not limited to short-run demand patterns, supply and demand elasticities, the weather, fuel prices, and the current location, size, and technology of competitors, but they can only qualitatively assess uncertainty, such as that due to the emergence of new technologies or future changes in the law.

The key point here is that while risk and uncertainty are definitionally different, they are not different in the financial theories that are used in our model. As discussed in later sections, the literature on the debt coverage ratio (Boykin & Hoesli, 1990; Klompjan & Wouters, 2002; Schaeffer, 1982), prospect theory (Kahneman & Tversky, 1979; March, 1978; Tversky & Kahneman, 1991), and the capital asset pricing model (Brigham & Crum, 1977; Brigham & Ehrhardt, 2017; Grinyer, 1976; Modigliani & Pogue, 1974; Ross et al., 2016; Sharpe, 1964) each suggest that risk and uncertainty produce the same directional effect and, as such, there is not a need to treat them differently in the proposed model. These financial theories (debt coverage ratio, prospect theory, capital asset pricing model) have been tested extensively and supported in academic literature for several decades, and the literature does not appear to present any contrarian research suggesting that risk and uncertainty produce different directional effects. Furthermore, a determination of whether risk or uncertainty has a greater or lesser effect than the other is outside the scope of this dissertation. Thus, there is no need to treat them separately in the model, and all future discussions of risk in this dissertation include both risk and uncertainty.

Historical Means to Address Project Risks That Affect Financing

Each of the above-enumerated risks that affect debt and equity financing have been historically addressed to the satisfaction of the lenders and equity participants under a regulated monopoly utility cost-of-service framework

(Grantham, 2017; Harmon & Reynolds, 2003). Under this framework, known as the "sovereign method of financing" (IAEA, 2014), the government assumes the revenue and cost risks, or it sets forth regulations that require these risks be assumed by captive customers which increases the inelasticity of demand.

Specifically, in the United States, these long-established cost-of-service regulations go back to the Supreme Court decision in Hope Natural Gas v. Federal Power Commission (FPC) which established the 'used and useful' doctrine for regulated monopoly utilities (Brown, 1944; Cabot, 1929; Pechman, 1993). Under this doctrine, if a power plant (or any utility asset such as a utility's office building) has been determined by the appropriate regulatory body to be used and useful, then the prudently incurred costs, including cost overruns, schedule delays, interest during construction, volatile fuel costs, plus a reasonable rate of return, shall be included in the electric rates charged to customers (Brown, 1944; Cabot, 1929; Pechman, 1993). Moreover, the utility's retail customers situated within the geographic boundaries of the utility's service territory are captive—they cannot switch electric providers no matter how high the regulators set the electric rates or how volatile. From the viewpoint of the lenders and investors, these captive customers provided the ultimate credit support for the utility's construction plans. Under a regulated monopoly utility framework, the revenue and cost risks, such as ensuring baseload operation to maintain a high Q and, in turn, maintaining a low AFC, were reduced to a point sufficient to satisfy the financiers.

This regulatory framework supported the construction of 91.5 GW of nuclear capacity in the US during the 1960-1990 timeframe (Kumar, 2021). In round numbers, this is about 90 nuclear units. Very little was started after 1990 (only Vogtle Units 3 and 4 which are now under construction) (DOE, 2022; Kumar, 2021). Some of this post-1990 drought may be attributable to the 1978 Three Mile Island, 1986 Chernobyl, and 2011 Fukashima nuclear accidents, some of it may be attributable to newer lower-costing generation technologies (EIA, 2017), and some of it may be due to significant regulatory changes within the electric industry, i.e., deregulation, affecting the ability to obtain the needed financing, which is the primary focus of this dissertation.

Despite the post-1990 nuclear construction drought in the US, many other countries continued to construct nuclear plants (Kumar, 2021; World Nuclear Association, 2022). There are presently 441 nuclear power plants around the world in 32 countries with an additional 55 under development/construction (Kumar, 2021; World Nuclear Association, 2022). The sovereign method of financing also holds true for the rest of the world; in some countries, the government agreed to assume the revenue and cost risks, and in other countries, it passed the risks on to captive customers (IAEA, 2014; IAEA, 2017).

The key point is that no nuclear power plant in any country has successfully secured financing anywhere in the world without some form of the sovereign method (IAEA, 2014; IAEA, 2017) including the Vogtle Units 3 and 4 noted in a previous paragraph. Other forms of credit support have been explored (IAEA,

2014) but they have not resulted in the successful financing of a nuclear plant. These other forms of financing, including project financing and balance sheet financing, are used routinely to finance coal, natural gas, wind, and solar projects, all of which have different risk profiles from nuclear plants (Dansky, 1994; IAEA, 2014; IAEA, 2017). These differing risk profiles are reflected in a project's weighted average cost of capital (as later discussed in the section entitled The Impact of Risk on Debt Financing).

Electricity Deregulation Eliminated Cost-of-Service Rate Regulation

The above 'used and useful' regulatory framework served the participants of the US electricity industry well from 1920 to 1970 when there was a long-term general decrease in electricity rates largely due to technological improvements in fossil-fuel steam-generation thermal efficiency (Dansky, 1991a; Isser, 2003). Then in the 1970s inflationary pressures began to drive up electricity prices, the Clean Air Act imposed additional costs on fossil-fired plants, and the OPEC oil embargoes in 1973 and 1978 impacted oil prices (Isser, 2003). Adding to this upward pressure on electricity prices were the cost overruns on the roughly 90 nuclear units that occurred under the monopoly utility cost-of-service regulations. The term "rate shock" was coined at this time, due to the increase in rates caused by high nuclear plant capital costs, and was indicative of the widespread concern of the public over their monthly electric bills (Barber, 1986; EUN, 1984).

Simultaneous with this increase in nuclear plant costs, new technology became available, primarily in the form of natural gas combined-cycle units. This new technology had several advantages: lower capital costs, shorter and predictable construction schedules, efficient heat rates at smaller scales, modularity of design and construction, load-following dispatch capability, competitive long-term fuel supply contracts, and a risk profile that did not depend on cost-of-service regulation to secure financing (Dansky, 1991b; Dansky, 1993; Dansky, 1994; EIA, 2017; Olkhovski et al., 2021).

Consequently, the combination of increasing electricity prices and the availability of smaller-scale new technology captured the attention of economists who had witnessed and/or participated in the deregulation of the airline, package delivery, and trucking industries. To many economists, the risks of regulatory failure, as specifically observed in the lack of economic incentives to curb power plant cost overruns, were greater than the risks of a market failure that might arise from a market that was more oligopolistic than competitive, or from an oligopolistic market that had significant, but different, regulatory impositions (Isser, 2003). This resulted in a concerted push to deregulate the electric power industry, and these efforts were primarily aimed at dissolving the long-standing vertical integration of generation, distribution, and retail sales by a single monopolistic company within a protected service territory.

Congress responded to this push with the Public Utility Regulatory Policies Act of 1978 (PURPA); the first in a series of federal actions to encourage competition and increase economic efficiencies in the electric generation market (Joskow, 1989; White, 1996). PURPA directed state regulators to determine state-by-state rules for electricity pricing based on PURPA's general directive of marginal cost pricing. What emerged was a disparate menu of options specific to each state, some of which were technology and fuel-type specific, rather than a single nationwide pricing formula. Dansky (1987a, 1987b) provided summaries of various marginal cost price formats that emerged from several state hearings.

Other legislation followed to further encourage competition including the Energy Policy Act of 1992 (EPA) which made changes to both the Public Utility Holding Company Act of 1935 (PUHCA) and the Federal Power Act of 1935 (FPA) (Flores-Espino et al., 2016). After the passage of PURPA and the EPA of 1992, most states enacted legislation to deregulate both the generation of electricity and the retail sales of electricity (Dansky, 1994). The Federal Energy Regulatory Commission (FERC) then issued orders 888, 889, 1000, and 2000 to further promote economic efficiencies arising from competition in electric markets by providing open access to electric transmission lines and the creation of the independent system operators (ISO) (FERC, 1999; FERC, 2023; Isser, 2003).

Arising from this string of legal and regulatory changes was a restructured electricity market serving approximately two-thirds of the US market (Dansky, 1994; Flores-Espino et al., 2016; Isser, 2003; Joskow, 1989). Here, electric utilities were required to divest their electric generating assets and electric plants are now developed, owned, and operated by non-utility independent power producers

(IPPs). These IPPs sell their electricity into a competitive wholesale ‘electric grid’ as a commodity using prices provided by each IPP to the ISO the day prior (FERC, 1999; Ward, 2011; White, 1996). Thus, as noted previously, prices change every few minutes and there is no price certainty.

Cost-of-service regulations are not available to these IPPs. They make use of project financing and balance sheet financing the same as other competitive businesses in other markets such as auto manufacturing, oil and gas, pharmaceuticals, defense, and so forth. They survive, or not, on their ability to make a return on investment in a competitive market the same as these other competitive businesses.

In short, the goal of economists several decades ago to deregulate and restructure the electric generation market, and bring economic efficiencies through competition, has largely succeeded. Numerous studies (Csereklyei & Stern, 2018; Fabrizio et al., 2007; GAO, 2002; Lei et al., 2017; Musco, 2017; Switzer & Straub, 2005) have shown that deregulation led to increases in operating performance and plant efficiency, as well as lower electricity prices to customers. Monopolistic inefficiencies were exposed, and there was a 60% decrease in the number of electric utilities (Jirovec, 2022) with assets sold off to the surviving utilities. The deregulated environment has been habitable for new natural gas, solar, and wind power projects as reflected in the quantity of newly installed electric generating plants (EIA, 2000; Statista, 2022). Whether this deregulated environment can be habitable for new nuclear power plants is unknown (Matthews et al., 2009; Reid, 2000; World Nuclear Association, 2022).

Impact of Deregulation on New Power Plants

As of 2023, the regulatory structure affecting the construction of new power plants is divided. In two-thirds of the US, the role of the regulated utility is now limited to distributing the electricity generated by the non-utility IPPs (Ward, 2011; White, 1996). In the other one-third of the country, regulated utilities can continue to own regulated electric power plants because these states never enacted the federal regulations to deregulate (Electric Choice, 2023; Flores-Espino et al., 2016) due to countervailing political pressure (Harrison & Welton, 2021). Consequently, in two-thirds of the US:

1) There are competitive wholesale and retail electricity markets (FERC, 1999; White, 1996),

2) There are no regulated monopolies for the generation of electricity (FERC, 1999; Flores-Espino et al., 2016),

3) The previously captive retail customers are now free to choose their electric suppliers (Flores-Espino et al., 2016),

4) The revenue and cost certainty that the lenders previously relied upon via the ‘used and useful’ doctrine have been eliminated (Dansky, 2002; Ward, 2011), and

5) Deregulation has shifted some of the risk away from electric ratepayers and toward power plant investors (Beecher & Kihm, 2016).

While nuclear power remains potentially financeable in the one-third of the US market that remains regulated, the underlying basis that supported the financing of all power plants (the sovereign method of financing) has been removed in two-thirds of the market (Dansky, 1994). This two-thirds of the market is the focus of this dissertation.

To summarize, the transition from cost-of-service regulation to deregulation resulted in the following changes to revenue risk:

1) An exposure to price volatility amplified by the inelasticities of the electricity supply and demand curves,

2) An exposure to price competition from existing and future power plants located within the same ISO region,

3) An exposure to baseload output quantity uncertainty due to ISO dispatch rules,

4) An exposure to output quantity uncertainty as retail customers, who are no longer captive, can switch electric suppliers, and,

5) An exposure to unknown changes in law and regulation regarding the sale of electricity.

The above changes in exposure, individually or in combination, are believed to increase power plant revenue risk which, in turn, negatively impact the debt and equity financing as discussed in the next several sections.

The Impact of Risk on Debt Financing

Non-utility electric power projects (i.e., non-regulated Independent Power

Producer projects which may include the unregulated affiliate of a regulated utility) use project financing (Buscaino et al., 2012; Jadidi et al., 2020; Kaminker, 2017; Mora et al., 2019). Project financing can be defined as a separable capital investment owned by a special purpose company in which the lenders look to the cash flow of the project to service their loans, as well as to provide the return on, and return of, the participants' equity contributions (Buscaino et al., 2012; Klompjan & Wouters, 2002). Project financing makes use of syndicated loans and, less often, project bonds (Buscaino et al., 2012; Kaminker, 2017). The advantages of project financing are the availability of non-traditional loan sources, off-balance sheet treatment, and the ability to prevent recourse to an affiliate in the event of a project's default (Klompjan & Wouters, 2002).

The disadvantage of project financing is that the lenders only look to the cash flow of the project to service the loan (Fight, 2006; Yescombe, 2002) which limits the pool of projects that can satisfy the loan covenants. This often translates into the need to obtain fuel supply agreements with creditworthy suppliers at least equal in term to that of the debt financing to maintain the 'spark spread' (Dansky, 1991b; Martinez & Torro, 2018), and the need to obtain fixed-price turnkey construction contracts with creditworthy construction companies. This affects cash flow because long-term fuel supply contracts cost more than short-term contracts and fixed-price turnkey construction contracts cost more than traditional construction contracts, both due to the assumption of risks (Fight, 2006; Yescombe, 2002).

A primary task for lenders is to determine whether the project will generate enough cash flow to cover the debt and pay dividends to the equity participants, and this determination gives consideration to all project risks and uncertainties (Buscaino et al., 2012). "Given the high specificity of each transaction, this process is often based on a case-by-case approach" where the lenders, their consultants, and their lawyers review all of the project's contracts and permits (Buscaino et al., 2012:951). There is some, but not much, room for negotiation between lenders and equity owners because "those with the gold make the rules" and the lender "holds all the cards" (Schaeffer, 1982:197). Though competition between lenders helps to provide some counterbalance, there are a limited number of banks that provide project financing for power plants, and many of these banks typically work together in a consortium to dilute lending risk. Based on the risks of a power plant project, the lender(s) will establish a minimum debt coverage ratio (DCR) and then calculate whether the project's cash flow meets this minimum criterion (Boykin & Hoesli, 1990; Klompjan & Wouters, 2002; Schaeffer, 1982). The DCR measures the cash flow available to pay current debt obligations and is calculated by taking net operating income and dividing it by total debt service (Brigham, 1979). If the project's pro forma financial statements indicate that the minimum DCR will not be satisfied, the lender(s) will either impose a new, lower debt:equity ratio that will satisfy the minimum DCR requirement or choose not to participate as a lender to the project. Therefore, revenue risk affects the willingness to lend.

Boykin and Hoesli (1990) provide the merits of using DCR as the basis for arriving at a project's debt:equity ratio. By adjusting a project's pro forma minimum debt coverage ratio, lenders are able to account for a project's risks, such as those associated with price and output quantity (Boykin & Hoesli, 1990; Klompjan & Wouters, 2002; Schaeffer, 1982). This is the primary tool used by lenders for this purpose (Boykin & Hoesli, 1990) and DCR has been used by lenders since the very beginning of lending to account for perceived risk (Schaeffer, 1982). Increasing the interest rate offered to a project is also a method used to account for risk, however, a change in the interest rate is captured in the calculation of the DCR (Brigham, 1979) and, thus, ultimately, as noted by Boykin and Hoesli (1990), the DCR remains the primary tool. As would be expected, in a study of 210 project-financed companies in which there were 37 defaults, Klompjan and Wouters (2002) found a significant negative correlation between the DCR and events of default. The higher the DCR, the greater the ability to withstand revenue volatility and other revenue risks, and thus, reduce the lenders' risk exposure.

When making use of project finance, a firm's debt-to-equity ratio is the firm's long-term debt divided by the equity contribution of the project participants' equity (Brigham, 1979). A lender's insistence on imposing a higher minimum DCR, while holding the project's capital costs, revenue, and all other non-debt expenses constant will, by definition, lower the debt:equity (D:E) ratio and thus require an increase in the quantity of equity (Brigham, 1979). This creates two problems for the equity participants: it reduces their return on equity (ROE) and it increases the weighted average cost of capital for the project.

The weighted average cost of capital (WACC) for a project-financed investment is the percentage of debt used to finance the power plant times the interest rate of this debt plus the percentage of equity used to finance the power plant times the minimum ROE required by the equity participants (Brigham, 1979). This is expressed as:

WACC = (% of debt x the cost of debt) + (% of equity x cost of equity).

The above decrease in the D:E ratio will increase the project's WACC (Beecher & Kihm, 2016) due to 1) the tax advantages of debt, and 2) the cost of equity is typically greater than the cost of debt (Jadidi et al., 2020). By requiring a higher minimum DCR, and thus lowering the quantity of project debt, the lenders have thus transferred some of the project's risk to the equity owners.

The above financial concepts (DCR and WACC) have been tested extensively and supported in academic literature for four decades (Brigham, 1979; Brigham & Ehrhardt, 2017). The financial literature appears to be devoid of any work that would suggest the contrary; that an increase in perceived risk would result in a decrease in the DCR, or that an increase in the DCR would result in an increase in the D:E ratio. Therefore, it is reasonable to assume that the directional relationships incorporated into this dissertation's model will hold.

To exemplify these relationships, a properly structured long-term power purchase agreement (PPA), also known as an off-take agreement, would be expected to provide more revenue certainty and less revenue volatility than selling into a deregulated competitive wholesale market (Klompjan & Wouters, 2002). Off-take agreements were used by almost all non-regulated power producers in the period between the passage of PURPA in 1978 and the EPA of 1992 when electric utilities were required to purchase electricity from specific small power and cogeneration facilities (as defined in PURPA). Various IPP projects continue to use them, when possible, but the opportunities have been greatly reduced since the passage of the EPA of 1992 and its creation of competitive wholesale markets. The lack of a PPA can negatively affect financing. Both Buscaino et al. (2012) and Klompjan and Wouters (2002) note that a higher DCR, and in turn, a lower D:E ratio, is typically required by lenders in the absence of a long-term PPA to address the higher perceived risk.

Examples of the Impact of a Power Purchase Agreement

Consistent with Buscaino et al. (2012) and Klompjan and Wouters (2002), a participant in this dissertation's qualitative analysis pilot study identified a specific instance of lived experience (see the Chapter 3 section entitled Selection of Research Method for Research Area #1 for a detailed discussion of lived experience) involving two power plants for which this person was involved in the financing. One project had a PPA and the other sold its output into the competitive wholesale market. This person noted that the power plant with the PPA was perceived by the lenders as having less risk. The power plant that sold its output into the competitive wholesale market had stricter loan covenants imposed on it by the lenders including a higher DCR. This lived experience is consistent with the proposed model: higher risk results in a higher DCR. (Lived experience is the response of an individual to a phenomenon, as discussed in the Chapter 3 section entitled The Phenomenological Approach.)

This lived experience is also consistent with the lived experience of the author of this dissertation. This author was involved with the financing of two natural gas combined-cycle power plants that were similar to each other in most respects. One project entered into a 20-year PPA and a 20-year natural gas supply agreement with creditworthy counterparties, and contractually negotiated price escalators in these contracts maintained the relationship between the electricity sales price and the fuel cost (i.e., the 'spark spread') to reduce risk. In contrast, the other project sold its electricity into the deregulated competitive wholesale market. The first project was project-financed with an 80:20 D:E ratio while the second project was required to increase the equity portion to 50:50 to account for the additional risk. The direction of the change from 80:20 to 50:50 D:E is consistent with the proposed model: higher risk results in a higher DCR (and thus lower D:E ratio). An explanation for the magnitude of the change (a 30-percentage point shift) may lie in Prospect Theory.

Prospect Theory as Applied to Debt Financing

Loss aversion is a central tenet of Prospect Theory (Farinha & Maia, 2021). The concept that "losses loom larger than equivalent gains" (Tversky & Kahneman, 1991:1039), often referred to as "loss aversion" (Tversky & Kahneman, 1986:258), is one of the core principles in behavioral economics. It has the effect, as used in this dissertation's model, of relating revenue risk to perceived revenue risk.

Prospect Theory describes how people perceive the potential for losses and gains asymmetrically rather than linearly. That is, people perceive a greater impact from an economic loss relative to that of an equal-size economic gain – a concept that has been studied extensively with consistent outcomes. For example, Kalinowski (2020) reviewed numerous papers from the past forty years, including a review of nine analyses that had measured the risk aversion coefficient, lambda, to be greater than unity (and thus, the existence of risk aversion). Kalinowski (2020) also recreated five of the reviewed experiments and found confirmatory support for the original studies, and as such, provide support for this dissertation's model.

Farinha and Maia (2021) report on the universality of loss aversion by noting its observance in children as young as 5 years old as well as in non-human primates. Loss aversion is exacerbated under conditions of increasing risk and uncertainty (Farinha & Maia, 2021; Kahneman & Tversky, 1979; March, 1978; Tversky & Kahneman, 1991) and it has been demonstrated that people will exert more physical effort to avoid a loss than to obtain a gain (Farinha & Maia, 2021). Finally, loss aversion was found to impact the decision-making of electric generating companies in arriving at the daily prices to be submitted to the ISO (Hu et al., 2021). Due to loss aversion, Prospect Theory states that the linear risk/reward relationship assumed in financial models is not linear and that a loss-adverse lender would seek to increase the minimum DCR non-linearly in response to their perceptions of increased revenue risk, leading to the following hypotheses:

H1a: Electricity deregulation increases the price risk perceived by power plant lenders.

H1b: Electricity deregulation increases the output quantity risk perceived by power plant lenders.

The Impact of Risk on Equity

The impact of risk on the valuation of equity has been well-studied in the literature. The seminal work by Akerlof (1970) relates risk and uncertainty to the valuation of a good or service. Seminal works by Sharpe (1964), Modigliani and Pogue (1974), Grinyer (1976), and Brigham and Crum (1977) all address the relationship between risk and return, develop a relationship called the Capital Asset Pricing Model (CAPM), suggest that assets with the same risk should have the same rate of return on equity, and suggest that assets with higher risks should have higher returns (Brigham & Crum, 1977; Grinyer, 1976; Modigliani & Pogue, 1974; Sharpe, 1964). The CAPM has been around for at least five decades (Fama et al., 1969; Sharpe, 1964) and the concepts, principles, and models developed in these earlier works remain relevant today (Brigham & Ehrhardt, 2017; Ross et al., 2016). There have been various refinements to the CAPM model such as incorporating company size as a variable (Brigham & Ehrhardt, 2017), but the literature appears to be devoid of any research that would suggest that there is no relationship between risk and return or that the relationship operates directionally opposite.

Therefore, it is reasonable to assume that the directional relationships incorporated into this dissertation's model will hold.

As discussed by Miller and Modigliani (1966), in a world of perfect information -- an assumption that underlies most economic theory – the cost of capital is simply the market rate of interest. With perfect information, risk disappears, and all securities must then have the same yield in a state of equilibrium. In reality, however, the world is faced with imperfect information, leading to the development of the CAPM with its risk and reward relationship.

In addition to the static analyses addressed above, Fama et al. (1969) demonstrated that stock prices will adjust their valuation due to an adjustment of the imputed cost of equity upon the arrival of new risk information. For example, Pinches and Singleton (1978) showed that a change in a company's bond rating due to a change in perceived risk will result in a change in the company's stock price due to the capital markets processing the new information efficiently. More recently, Nukala and Prasada Rao (2021) performed a case study analysis of two hypothetical companies that re-affirmed the above relationships in Fama et al. (1969) and Pinches and Singleton (1978). The above relationships in Fama et al. (1969) were also re-affirmed by Heinlein and Lepori (2022) in their analysis of stock valuations in the United Kingdom after the introduction of new macroeconomic information, and as such, lend further support for this dissertation's model.

The above reference to market efficiency emanates from the Efficient Market Hypothesis (EMH), often attributed to Samuelson (1965) and to Fama (1965). Asset values change over time to reflect new information, and new information takes many forms, such as a change in management or a new tariff (Fama, 1965). EMH assumes that market participants have processed all available information and have made valuation adjustments based on that information (Colin-Jaeger & Delcey, 2020). The concept has been tested extensively and supported in both academic and popular literature (Malkiel, 2003), and more recent academic literature continues to support the principle that "prices of financial assets fully reflect all available information" (Delcey & Sergi, 2019:2). This includes information regarding the deregulation of electric markets and, as such, changes in revenue risk arising from deregulation will get reflected in the minimum required ROEs of electric projects.

Information cannot be known exactly due to uncertainty and disagreement, but these will show up as "noise" (Fama, 1965:36). The information need not be universally shared among all participants nor is there a need for the information to be centralized within one party (Colin-Jaeger & Delcey, 2020). The "combination of fragments of information existing in different minds" will filter through the market, coalesce around a value, cancel out the noise, and the assets will get valued as if there was "somebody who possessed the combined knowledge of all those individuals" (Hayek, [1937] 1948:50–51 in Colin-Jaeger & Delcey, 2020:100).

In summation, this dissertation proposes that when the electric generation market transformed from regulation to deregulation, the new information was processed into new equity valuations due to a change in the imputed cost of equity. The imputed cost of equity is believed to have been altered due to the five changes specified in the earlier section entitled Impact of Deregulation on New Power Plants. To reiterate here:

1) An exposure to price volatility amplified by the inelasticities of the electricity supply and demand curves,

2) An exposure to price competition from existing and future power plants located within the same ISO region,

3) An exposure to baseload output quantity uncertainty due to ISO dispatch rules,

4) An exposure to output quantity uncertainty as retail customers, who are no longer captive, can switch electric suppliers, and,

5) An exposure to unknown changes in law and regulation regarding the sale of electricity.

These changes in risk would necessarily increase the minimum required ROE required by the owners of an electric power project in accordance with both EMH and CAPM. The increase in the minimum required ROE would, by definition, increase the project's WACC (Brigham, 1979). This is important because the WACC is an input into the calculation of the IOS which provides a systematic ranking of investment opportunities, as discussed in a later section. The minimum required ROE would also be affected by Prospect Theory.

Prospect Theory as Applied to Equity

The principles of Prospect Theory, previously discussed and applied to the valuation of debt, also apply to equity. It has the effect, as used in this dissertation's model, of relating revenue risk to perceived revenue risk. Prospect Theory affects how the new information regarding deregulation is processed into new equity valuations (Kahneman & Tversky, 1979; March, 1978; Tversky & Kahneman, 1991). Due to Prospect Theory's treatment of loss aversion, the risk/reward relationships in the CAPM and EMH models are not linear, and a loss-adverse equity participant would seek to increase the minimum required ROE non-linearly. Thaler et al. (1997) found experimental support for Prospect Theory affecting equity portfolio decision-making, and Barberis et al. (2016) found empirical evidence of the effect of Prospect Theory in the valuation of equities in the US and several international stock markets. Therefore, the perceptions of increased revenue risk by equity investors result in a higher minimum required ROE, and by definition, a higher WACC. This leads to the following hypotheses:

H2a: Electricity deregulation increases the price risk perceived by power plant equity participants.

H2b: Electricity deregulation increases the output quantity risk perceived by power plant equity participants.

Project Investment Ranking Mechanisms

Having explored the relationship between DCR, ROE, WACC and revenue risk, attention is now drawn to investment ranking mechanisms. This dissertation puts forth that the ability to systematically rank order investment opportunities would provide an understanding of how one type of electric generation is affected by deregulation vis-à-vis another, and thus get at the research problem addressed by this dissertation:

Can nuclear power attract debt and equity financing in light of the changes in financial risk that arise from electricity deregulation?

The choice of investment evaluation methods such as Internal Rate of Return (IRR), Net Present Value (NPV), Cost-Benefit Analysis, and Payback Period has been comprehensively studied as different evaluation methods have their advantages and disadvantages (Brigham & Ehrhardt, 2017; Munda & Matarazzo, 2020; Remer & Nieto, 1995a, 1995b; Ross et al., 2016). Another common method that has been used to evaluate power plants is levelized cost (Abdelhady, 2021) however it is recognized that this method is highly sensitive to capacity factor and distorts the timing of costs (Ziegler & Dansky, 1982). The literature also contains other, less used methods including "life cycle costing method, maximum prospective value criterion method, growth rate of return method, premium worth percentage method, profit-to-investment ratio method, savings-to-investment ratio method, cost-effectiveness method, project balance method, and accounting methods" (Remer & Nieto, 1995a:82). Extending this exploration into investment ranking mechanisms further, Remer and Nieto (1995a; 1995b) provide an exhaustive review of 25 different investment evaluation methods. This long-lasting battle over a preferred investment evaluation method has been fought for "more than 100 years" (Osborne, 2010:234) and the literature suggests that this debate will continue. For example, Munda and Matarazzo (2020:1119) review a number of these evaluation methods and attempt to determine which method is best suited for different applications but conclude that it is an "impossible" task and that no obvious selection can be made. While NPV, IRR, and others listed above are often used on a stand-alone basis to evaluate investment opportunities (Brigham, 1979), they do not provide a means to systematically rank order them. For this, we turn to the Investment Opportunity Schedule.

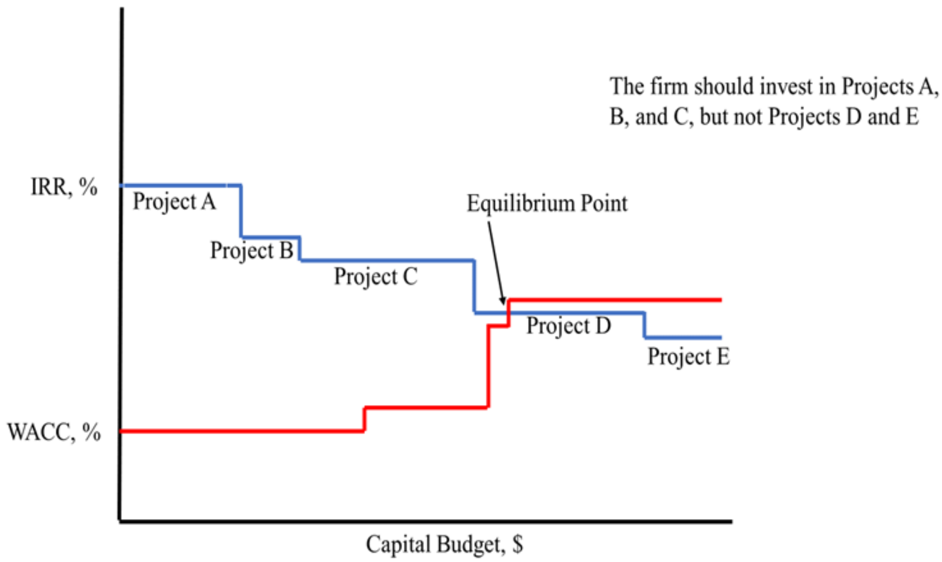
Internalization Theory

The Investment Opportunity Schedule (IOS) was developed by Coase (1937) in his *The Nature of the Firm* and was cited by the Royal Swedish Academy of Sciences in their awarding of the 1991 Nobel Prize in Economics (Nobel, 2023). Coase addressed the question of why firms exist and provided the answer to two key questions: 1) which business opportunities should be internalized by a firm, and 2) arising from this, what should be the extent or boundary of a firm? In this seminal work, Coase presents his marginal cost/marginal benefit logic that a firm should expand (i.e., invest in new assets) up to the point at which it costs the firm the same to 'make or buy'. It is this logic that underpins what later became known as Internalization Theory (Buckley, 1988; Rugman, 1986; Verbeke, 2005). When applied to our discussion, the 'make' choice for the firm is to invest in a new power plant and thus bring the production of electricity inside or internal to the firm (N.B.: internal as in Internalization), the 'buy' choice is to purchase the electricity for resale from another company.

The IOS is a ranking of the various investment opportunities that are available to a firm at a point in time with the Coasian equilibrium point occurring where marginal benefits equal marginal costs (Brigham, 1979; Kay, 2015; Williamson, 1975). Stated another way, the equilibrium point is where the IRR of each of the various investment opportunities, ranked from highest to lowest, equals the above-discussed WACC. Thus, all investment opportunities that have an IRR greater than the firm's WACC should be internalized (i.e., brought in-house or inside) by the firm, and this then defines the boundary or the extent of the firm (Brigham, 1979; Coase, 1937; Kay, 2015; Williamson, 1975). See Figure 2-5 which depicts the equilibrium point. It would be economically perverse for a firm to extend beyond this point to invest in a project where the IRR of the project was less than the firm's WACC (Brigham, 1979; Coase, 1937; Kay, 2015; Williamson, 1975).

Coase's concept rests on the economic principle of marginal utility theory which extends back in time for centuries, and all of Internalization Theory rests on this 1937 paper by Coase (Kay, 2015). Per Kay, if there is one tool that could be said to define economics, it is marginal analysis, and Coase viewed the analysis of organizing transactions in terms of marginal analyses. As shown in Figure 2-5, the

Figure 2-5   The Investment Opportunity Schedule



irm should invest in projects A, B, and C because they provide an increase in utility to the firm, i.e., their marginal benefits exceed their marginal costs or IRR>WACC. The firm should not invest in projects D and E because they do not provide positive marginal utility, i.e., their marginal benefits do not exceed their marginal costs. In a perfect world with no market imperfections, all companies would be single-person firms with contractual relationships between them. This is because all information is known in truly perfect markets and MC=MB. However, markets are usually imperfect, and as Coase pointed out, it is the market imperfections that create the need for the existence of the firm (Kay, 2015; Rugman, 1986). That is, firms exist for the purpose of investing in projects that increase the firm's marginal utility.

Several decades later Williamson (1975) provided the link between Coase and what is now called Internalization Theory. Williamson's arguments can be summarized as follows: In a perfectly competitive market, prices convey all the information that is necessary for the efficient allocation of goods and services. Under some conditions, known as market failures or imperfect markets, prices don't signal accurate information. When this occurs, the acquisition of, or investment by, one entity into another, also known as vertical integration or internalization, may be a more efficient mode of resource allocation depending on the transaction costs (Williamson, 1975).

This choice of whether to keep the costs internal or external (i.e., to invest or not invest in a project) is at the heart of Internalization Theory (Buckley, 1988). Per Rugman (1986), the economic choice of action is to be based on the costs and benefits of the activities being evaluated. Firms grow by internalizing investment opportunities until they are no longer cost-effective (Buckley, 1988). Rugman (1986) and Verbeke (2005) have shown that internalization is a rational response to imperfect markets, and the ability to internalize a market increases market efficiency. More recently, Buckley and Casson (2009) affirmed that Coase (1937) provided the underlying theory on internalization, followed by Williamson (1975). Hennart (1988) extended this thinking from wholly owned subsidiaries to equity joint ventures and states that equity JVs are a subset of internalization and are also a way to internalize an inefficient market. In summation, for the past 40 years, many researchers have labeled Internalization Theory as central to the study of business (Brigham & Ehrhardt, 2017; Buckley, 1988; Buckley & Casson, 2019; Caves, 1996; Hennart, 1988; Narula et al., 2019; Ross et al., 2016; Rugman, 1986; Verbeke, 2005) and the IOS has withstood the test of time when applied to balance sheet financing.

The Change from Balance Sheet to Project Financing

Yet, during the same 40 years, balance sheet financing has been replaced by project financing for the majority of electric power projects around the world and for every electric power project within deregulated markets (Buscaino et al., 2012; Jadidi et al., 2020; Kaminker, 2017; Mora et al., 2019). This changeover was largely driven by the previously noted advantage that project financing prevents recourse to an affiliate (including the parent company) in the event of a project's default and it also makes repossession of an asset by the lender following a default less encumbered (Fight, 2006; Klompjan & Wouters, 2002; Yescombe, 2002). Project financing is also extensively used in other capital-intensive investment opportunities such as the oil and gas industries. Its use is now global and has grown into a $200 billion per year financing market (Fight, 2006; Yescombe, 2002).

Coase made certain assumptions in his derivation of the IOS, one of which is that the firm uses balance sheet financing for its investment decisions. This assumption was reasonable at the time since project financing was a little-known form of financing when his paper was published in 1937. Four decades later, after the passage of PURPA in 1978, the use of project financing spread globally and became commonplace (Yescombe, 2002). A review of the literature indicates that for the past 40 years, this $200 billion per year international project financing market has been overlooked by Internalization Theorists who continue to publish papers referencing the Coasian IOS as the appropriate theoretical yardstick (Buckley, 1988; Buckley & Casson, 2019; Caves, 1996; Hennart, 1988; Narula et al., 2019; Rugman, 1986; Verbeke, 2005). A review also suggests that the literature is devoid of an investment ranking mechanism applicable for project-financed investments. Therefore, this is a significant contribution of this dissertation.

The lack of an investment ranking mechanism applicable to project-financed investments is problematic. As shown herein, the Coasian IOS yields erroneous results when used to determine which project-financed investment opportunities should be internalized as well as when used to determine the extent or boundary of a firm that makes use of project finance. With project finance, it is the WACC of the project, and not the WACC of the firm, that is relevant. As noted in an earlier section, project financing is a separable capital investment owned by a special purpose company in which the lenders look to the cash flow of the project to service their loans (Buscaino et al., 2012; Fight, 2006; Klompjan & Wouters, 2002; Yescombe, 2002). Project financing provides an impenetrable, non-recourse 'wall' between the project and the balance sheet of the investing firm that prevents the lender from accessing the cash of the parent company and from relying on the parent company's balance sheet (Fight, 2006; Klompjan & Wouters, 2002; Yescombe, 2002). The investing firm's WACC is immaterial as both the project's cost of debt and its D:E ratio are different from that of the investing firm. In addition, when the project is a joint venture, the project's cost of equity is a function of all the venture's investing partners. Thus, the WACC of a project-financed project bears little relation to the WACC of the investing company, and this is why the Coasian IOS yields erroneous results.

This can be exemplified as follows: Assume a 50:50 joint venture that will be project-financed on a non-recourse basis with an 80:20 D:E ratio. The equity invested into the JV comes from the two parent companies and the cost of this equity would be the WACC of each of the parent companies. The debt for the JV would be provided by one or more lenders, typically acting together in a consortium so that there is only one debt instrument. This gives us:

$WACC_{JV}$ = (0.8 x the cost of debt) + 0.2(0.5% x $WACC_{P1}$ + 0.5% x $WACC_{P2}$)

where

$WACC_{JV}$ is the weighted average cost of capital of the project-financed joint venture project,

$WACC_{P1}$ is the equity investment into the joint venture project from parent company#1, and

$WACC_{P2}$ is the equity investment into the joint venture project from parent company#2.

Clearly, $WACC_{JV}$ doesn't equal $WACC_{P1}$ or $WACC_{P2,}$ and that is why the Coasian IOS yields erroneous results when applied to project financing. As shown, the Coasian IOS is not universal, but rather, it is contingent on the method of financing. Extending this further, Coase provided the answer to two key questions: 1) which business opportunities should be internalized by a firm, and 2) arising from this, what should be the extent or boundary of a firm? Thus, we can conclude that the key answers provided by Coase are also contingent on the method of financing.

The Modified IOS

To address this problem, i.e., that the Coasian IOS is not universal but is contingent on the method of financing, and to fill the long-standing literature gap, this dissertation introduces a new investment ranking mechanism that is designed for ranking and internalizing project-financed investments: the Modified IOS. Like the Coasian IOS, its roots are in marginal utility theory, and like the Coasian IOS, is a comparison of marginal costs and marginal benefits. The Modified IOS (MIOS) differs from the traditional IOS in that it takes into account each project's specific WACC rather than the WACC of the investing company.

The Modified IOS is a ranking from highest to lowest of the project-financed investment opportunities based upon a ratio of their IRR to WACC. Thus, where the Coasian IOS first ranks the investment opportunities based solely on their respective IRR and then compares this ranking against the firm's WACC (see Figure 2-5), this new MIOS first calculates the IRR to WACC ratio for each project (an indication of the project's marginal utility) and then ranks their ratios. Under the Coasian IOS, the source of funding (debt and equity) for each investment opportunity comes through and from a single source – the parent company. The

MIOS, in contrast, recognizes that the funding (debt and equity) for each project-financed investment opportunity comes through and from multiple sources (equity from the parent company(s) and debt from the project finance lenders). In a sense, each project is its own firm with its own WACC, and the investor is rank ordering the different firms. (N.B. This analogy borrows from, but is different from, the well-studied case of a firm using its WACC to invest in a portfolio of companies.) Thus, while the traditional IOS remains an effective tool to rank investment opportunities that are financed based on the balance sheet of a single company (Brigham & Ehrhardt, 2017; Ross et al., 2016), the MIOS appears to be a proper ranking of project-financed investment opportunities because it takes into account the individual project's own WACC *prior* to rank-ordering so that the ranking is based on the projects' marginal utility, not their IRR as per Coase. Doing so yields a correct ranking for project-financed investments.

Whenever the IRR:WACC ratio is greater than unity, the marginal benefits of an investment exceed the marginal costs. Whenever this ratio is less than unity, the marginal benefits are less than the marginal costs. Therefore, the extent or boundary of a firm that uses project financing for its investments is defined by where this ratio is equal to unity.

For illustration, assume a parent company that owns electric power projects in a deregulated market. As is typical for this context, all of the company's projects make use of project financing that is non-recourse to the parent company. At this time, the company has four potential power plant investment opportunities. The

IRR and WACC for each of the four opportunities is presented in Table 2-1 along with a calculation of their IRR:WACC ratios.

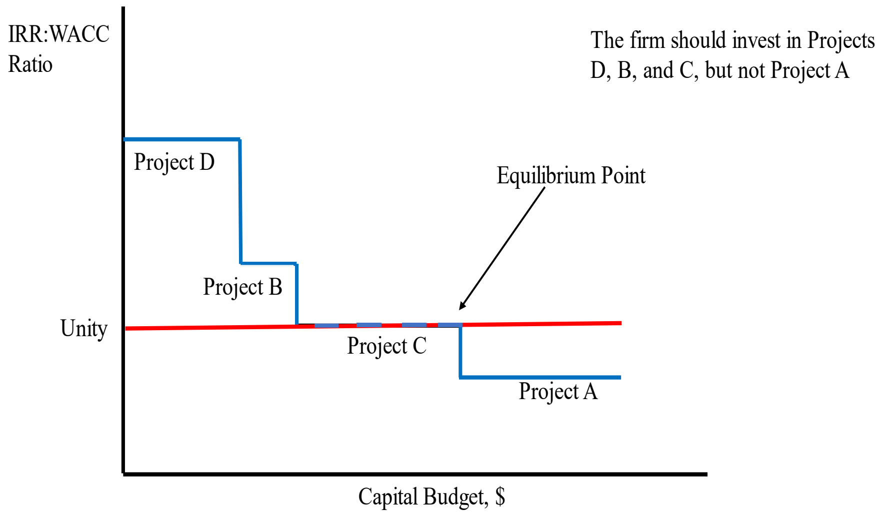
Table 2-1 MIOS Ranking Example

Project	IRR	WACC	IRR:WACC	MIOS Rank
A	20	25	0.8	4
B	15	12	1.25	2
C	15	15	1.0	3
D	15	5	2.0	1

Project A has the highest IRR and would have therefore been ranked first on the Coasian IOS, but project A provides the least marginal utility (actually, negative) and is thus ranked last by the MIOS. Project D with an IRR of 10% would be ranked last on the Coasian IOS but is ranked highest here because it provides the highest marginal utility. Projects A and D thereby illustrate why the Coasian IOS cannot be used for project-financed projects. Both the Coasian IOS and the MIOS arrive at the same conclusion that the investing company should be indifferent about investing in project C which has an IRR:WACC ratio of unity. See Figure 2-6 which depicts the four projects.

Projects D, B, and C (in that order) have an IRR:WACC ratio equal to or higher than 1.0 and thus should be internalized by the company, while project A should be foregone as its IRR:WACC ratio is less than unity. Project C sets the extent or boundary of the firm as its IRR:WACC ratio is unity.

Figure 2-6 The Modified Investment Opportunity Schedule



As discussed above, the IRR:WACC Ratio is an indication of a project's marginal utility. The marginal utility of any investment can be expressed in two ways: as the ratio of its marginal benefits to its marginal costs, or as the difference between its marginal benefits and marginal costs (Hubbard & O'Brien, 2017, Mateer & Coppock, 2021; McConnell et al., 2021). When using the 'ratio' form, the equilibrium point (where marginal benefits equal marginal costs) is predicted to be unity, and when using the 'difference' form, the equilibrium point is predicted to be zero.

Either approach could be used. This dissertation selected the ratio form of marginal utility for the MIOS because financial analyses typically make use of ratios. Finance students are taught ratio analysis throughout their education, and it is common practice within the financial community to use ratios to compare one investment opportunity versus another. Taken together, expressing marginal utility as a ratio may thus increase the pace of the acceptance of the MIOS for use in project financing analyses.

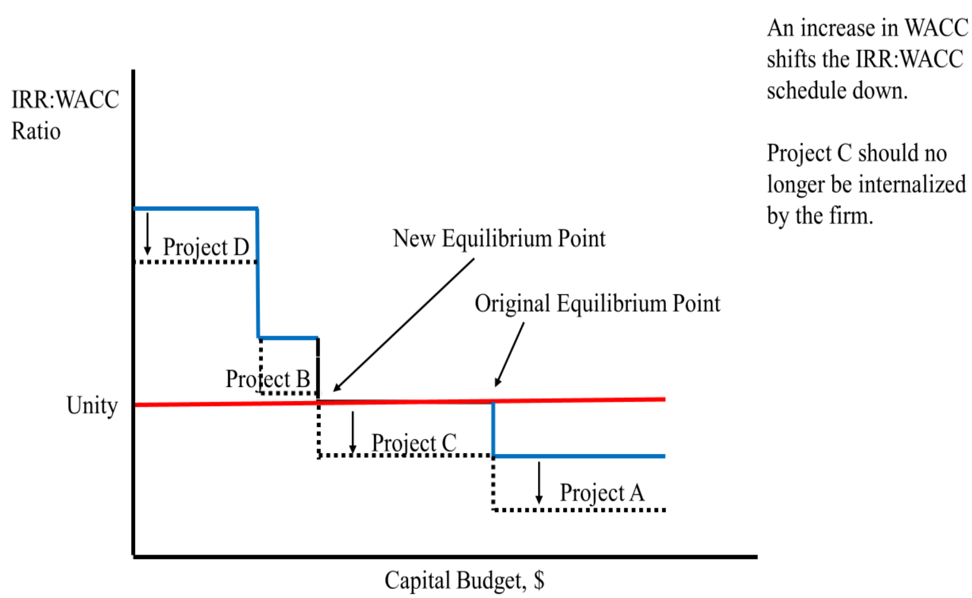
Since the ‘ratio’ form was used in this dissertation, it is recommended (see the Chapter 5 section entitled Limitations and Recommendations for Future Study), that the data collected in this dissertation be analyzed using IRR – WACC as the independent variable in lieu of the IRR:WACC Ratio. This will provide further confirmation that the marginal utility of an investment is the appropriate construct for the ranking of project-financed investments.

Applying the MIOS to the Deregulated Electric Market

The issue is not that investment opportunities whose returns exceed their cost of capital will be attractive to capital. That is a well-explored concept (Coase, 1937; Grinyer, 1976; Modigliani & Pogue, 1974) but outside the narrow scope of this dissertation. The issue here is that as the WACC is increased to reflect the change in revenue risk from deregulation, on the margin, those projects that were marginally above the equilibrium point may now find themselves marginally below the equilibrium point. That is, as WACC increases due to increased revenue risk, the IRR:WACC ratio decreases, the equilibrium point (IRR:WACC = unity) shifts leftward, and ‘weaker’ projects now exhibit IRR:WACC ratios less than unity. Thus, as the WACC increases causing a decrease in the IRR:WACC ratio, it is these projects that no longer get internalized by the firm. See Figure 2-7 which depicts the leftward shift of the equilibrium point.

The increase in the WACC depicted in Figure 2-7 was applied equally to each project simply for illustrative purposes. In reality, the change in WACC due to

Figure 2-7 The Modified Investment Opportunity Schedule, Depicting an Increase in the WACC Following Deregulation



the change in revenue risk from deregulation is believed to be unique to each project as debt lenders and equity participants vary from project to project, and perceptions of risk vary. Moreover, as established earlier, baseload power projects such as nuclear should be affected by the exposure to output quantity risk greater than a technology that is designed for peaking or intermediate dispatch. While every electric generating project should face increased revenue risk from deregulation (see H1a, H1b, H2a, and H2b), baseload projects with their high fixed cost/low variable cost structure that are vitally dependent on maintaining a high Q to ensure a low ATC, such as nuclear, face an even greater revenue risk. This additional exposure to revenue risk should increase the WACC for baseload projects greater than the increase for other types of power projects. In turn, the greater increase in WACC for baseload projects decreases the IRR:WACC ratio for baseload projects more than others. This appears to provide an explanation, on the margin, of the observed difference between the investment in nuclear versus non-nuclear power in deregulated markets during the past several decades.

> *H3: An increase in power plant revenue risk caused by electric deregulation reduces the willingness of debt and equity investors to provide financing for new electric power plants.*
>
> *H4: Because revenue risk affects different types of electric power plants differently, the willingness of debt and equity investors to provide financing differs for different types of electric power plants.*
>
> *H5a: When making use of project financing, as opposed to balance sheet financing, the boundary or extent of the firm is established at a IRR:WACC ratio of unity.*
>
> *H5b: When making use of project financing, as opposed to balance sheet financing, those investment opportunities for which the IRR:WACC ratio is greater than unity should be internalized by the firm.*

The impact of hypotheses 1 through 5 is the following: In order to attract debt and equity financing for nuclear projects: a) within a deregulated market structure, nuclear power needs to increase its IRR:WACC ratio above that of competing technologies so that it can lie to the left of the equilibrium point by either increasing IRR or decreasing WACC, or b) nuclear power requires a cost-of-service regulatory environment to eliminate the revenue risk that is perceived by lenders and investors and thus lower the WACC. Dansky and Cudmore (2022) expound on the policy tradeoffs associated with these two courses of action which reduce to a) maintaining economic efficiency and letting the 'invisible guiding hand' of competitive markets decide what type of GHG-free generation should be built, or b) imposing a hidden tax on electric customers at the expense of economic efficiency to promote the greater number of construction jobs associated with nuclear power. This choice is a matter of determining what is in the public interest -- a concept recognized as rife with complex and diverse multiple definitions (Dadashpoor & Sheydayi, 2021) and beyond the scope of this dissertation.

As stated in Chapter 1, this dissertation is narrowly limited to researching a specific economic outcome of electricity deregulation. While the focus of this dissertation is solely on revenue risk, other risks associated with construction costs, construction schedule, insurance, political risk, decommissioning, and spent fuel storage can also be analyzed using the IRR:WACC construct developed herein, and this is suggested for future analysis. Some of these risks (e.g., spent fuel storage) are unique to nuclear power which should further increase the WACC of nuclear projects relative to non-nuclear projects and thus further decrease nuclear's IRR:WACC ratio relative to non-nuclear projects. This dissertation focuses only on revenue risk and therefore provides a partial explanation of the impact of deregulation. It is theorized that when all the above risks are included in an analysis, the ability to systematically rank nuclear and non-nuclear projects using the IRR:WACC ratio would provide the ability to fully explain the financial challenge facing nuclear power within deregulated markets.

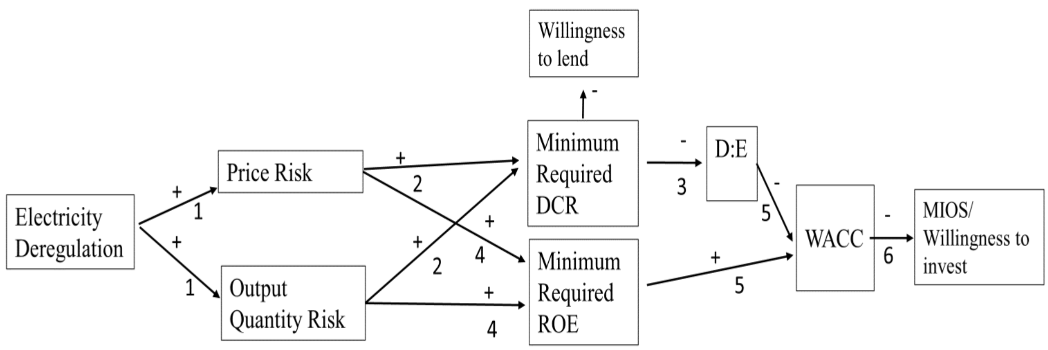
The Proposed Model

The proposed model operates as follows: Revenue is the product of price and output quantity, and as such, revenue risk can be divided into price risk and output quantity risk. Changes in market structure (e.g., deregulation) cause an increase(decrease) in electricity price risk and/or electric output quantity risk. An increase(decrease) in price risk and/or output quantity risk as perceived by the project's lenders results in an increase(decrease) in the minimum debt coverage ratio (DCR) that is imposed on the project by the debt lenders, and in turn, this causes a decrease(increase) in the project's debt to equity (D:E) ratio. As noted in Chapter 1, the model establishes two pathways; this is the model's debt pathway.

Concurrently, an increase(decrease) in price risk and/or output quantity risk as perceived by the project's equity participants results in an increase(decrease) in the minimum ROE hurdle rate that is imposed on the project by its equity participants. This is the model's equity pathway.

A decrease(increase) in the D:E ratio and/or an increase(decrease) in the minimum ROE hurdle rate will increase(decrease) the project's WACC which will decrease(increase) the IRR:WACC ratio. This is depicted in Figure 2-8. The unit of analysis for the model, as employed by Coase (1937) in his discussion of the Investment Opportunity Schedule (IOS), is at the firm level.

Figure 2-8 The Proposed Model



+/- Expected direction of the effect
1- Law of Supply and Demand, and Elasticity of Supply and Demand
2- DCR definition and Prospect Theory
3- Debt:Equity Ratio definition
4- CAPM and Prospect Theory
5- WACC definition
6- Internalization Theory

As depicted in the model, the change in perceived revenue risk is accounted for, from the lender's perspective, by the change in the DCR, and from the equity perspective, by the change in the minimum required ROE. The quantity of revenue is not a variable in the analysis; it is held constant as our concern is limited to the changes in revenue risk.

The model operates in both directions as noted by the use of "increase(decrease)". That is, if the change in the market structure were to go from deregulation back to regulation, the predicted effects would be directionally opposite.

The proposed model is also prescriptive. While this dissertation's discussion focuses on the US, it may apply to any country that deregulates its electricity markets.

Chapter 3
Methodology

There are two distinct areas of research within this dissertation with distinctly different research design considerations, yet it is recommended that the performance of research, including this dissertation, be shaped and guided by a single research paradigm (Creswell, 2007; Creswell and Poth, 2018; Maxwell, 2018). To that end, this chapter begins with a discussion of various research paradigms, epistemologies, and methodologies, and leads to the selection of two distinctly different methodologies (phenomenology and experimental design) coexisting under a single epistemology (post-positivism) under a single research paradigm (pragmatism). It then provides a detailed discussion of how each of the selected research methodologies (phenomenology and experimental design) is to be employed in each of the two distinct areas of research.

Research methodology refers to "the overall approach to the research process, from the theoretical underpinning to the collection and analysis of the data" (Collis & Hussey, 2003:55). A recurring debate in research methodology is the relative value of different research approaches (Venkatesh, 2013). These debates center around different epistemologies (e.g., positivist versus constructionist) and methodologies (e.g., qualitative versus quantitative) (Howe, 2009; Lo et al., 2020; Onweugbuzie, 2002; Venkatesh, 2013). Epistemology is the philosophy of how knowledge is obtained (Greenfield et al., 2007), and a positivist epistemology is typically associated with quantitative methods while a constructivist epistemology is typically associated with qualitative methods (Howe, 1988, 2009). On one hand, positivism is underpinned by the belief that there is an objective reality that can be uncovered/discovered using objectively correct scientific methods (Molina-Azorin & Cameron, 2010). On the other hand, constructivism is based on relativism. Here, "truth and meaning do not exist in some external world but are created by the subject's interactions with the world" (Gray, 2014:20). With constructivism, reality is not objective but is defined within each person (Molina-Azorin & Cameron, 2010) and the focus of research is to understand the particular viewpoint of each research test subject.

The research paradigm selected by the researcher provides a theoretical framework, and this framework consists of a set of beliefs and values that guide how the research is conducted and how the knowledge is conceptualized (Allemang et al., 2021). Pragmatism is such a paradigm. It is based on the premise that the investigator of real-world problems is permitted to choose from among the numerous methods at their disposal (Allemang et al., 2021). The pragmatist's choice of research method(s) should be a function of the research problem, research question, purpose, and context (Molina-Azorin & Cameron, 2010; Venkatesh, 2013). The pragmatist should consider and balance context, substantive theory, practical resource constraints, practical resource opportunities, and political dimensions as decision criteria (Cameron, 2011). With pragmatism, "knowledge is viewed and analyzed through its practical usefulness" (Mumtaz, 2022:1246). The key point is that an ideology can only be pragmatic if it 'works' relative to the various decision criteria and yields practical consequences (Gray, 2014).

Business is a wide, diverse field with numerous sub-divisions having far-ranging practical problems that arise under a very broad umbrella. Pragmatism provides a practical way of reflecting on these diverse business problems and providing practical solutions (Mumtaz, 2022). The desire to focus on solving these diverse, real-world practical problems led to pragmatism's use in business research (Allemang et al., 2021).

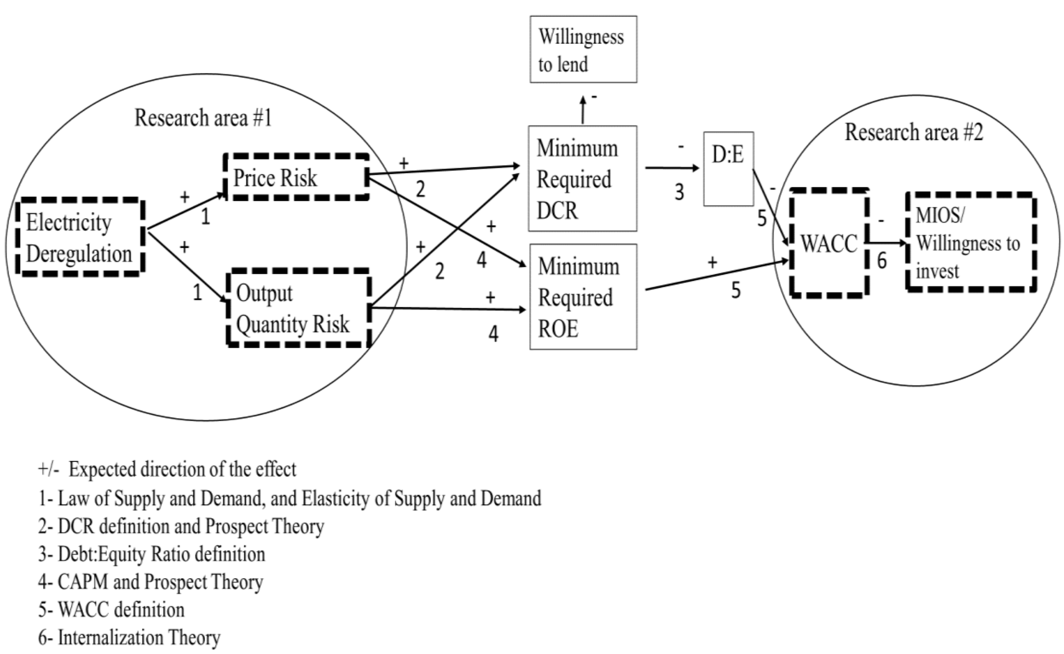
Pragmatism enables researchers to be independent of any epistemological and ontological origins, such as the distinction between positivist versus constructivist described above (Molina-Azorin & Cameron, 2010). Pragmatic research methods can be thought to lie on a hypothetical continuum that connects the various epistemologies rather than at the extremes of any single one (Onweugbuzie, 2002). A post-positivist epistemology, for example, falls under the pragmatism umbrella and lies on this hypothetical continuum connecting the various epistemologies (Creswell, 2007; Creswell & Poth, 2018; Greenfield et al., 2007). It is an outgrowth of positivism, but where positivists emphasize independence and objectivity between the researcher and what is being researched, post-positivists reject the ability of any researcher to be fully independent and objective, and instead accept the belief that the researcher possesses knowledge, values, theories, and hypotheses that will likely have some influence on and, in turn, introduce some bias into the research. Post-positivists maintain that the intentional, visible acknowledgment of these possible biases by the researcher increases research objectivity.

Another characteristic of post-positivism, in contrast to positivism's reliance on quantitative methods, is that researchers are free to consider both quantitative and qualitative methods as valid approaches (Creswell, 2007; Greenfield et al., 2007). This freedom of choice can provide an advantage to post-positivist researchers because different methods have different strengths and weaknesses depending on the problem to be addressed (Lo et al., 2020; Molina-Azorin & Cameron, 2010). Sometimes, the freedom of choice suggests a combination of methods. This combining of methods has come to be called mixed methods research (MMR) and is a subcategory of pragmatism (Cameron, 2011). MMR has been called "the third methodological movement (paradigm), with quantitative and qualitative methods representing the first and second movements (paradigms) respectively" (Venkatesh, 2013:22). Under the MMR school of thought, qualitative and quantitative methods can be compatible, and a researcher is free to employ multiple methods to address a research problem (Molina-Azorin & Cameron, 2010).

Cameron (2011), Miller & Cameron (2011), and Molina-Azorin & Cameron (2010) all quote Creswell and Plano Clark (2007:5) to define MMR as "the use of quantitative and qualitative approaches in combination [which] provides a better understanding of research problems than either approach alone." Cameron (2011:96) further defines mixed methods as "research in which the investigator collects, analyses, mixes, and draws inferences from both quantitative and qualitative data in a single study or a program of inquiry". Supporters of MMR maintain that it can provide an advantage over mono-methods. MMR yields an advantage because different methods of data analysis are appropriate for different research questions and contexts (Lo et al., 2020). Thus, a combination of quantitative and qualitative approaches may give a better understanding of complex research problems than a mono-method used alone (Cameron, 2011).

Such is the case here. As depicted in Figure 3-1, this dissertation has two distinct areas of research within two distinct contexts that suggest the use of two

Figure 3-1 Areas of Research



different research tools. To that end, pragmatism is selected as the research paradigm for this dissertation, and MMR is selected as the overarching research methodology. The two mixed methods selected are a qualitative phenomenology study and a quantitative experimental design study. Both studies follow a post-positivist epistemology because the researcher's objective is to demonstrate that the phenomenon being studied possesses objective reality, yet there is the recognition that there are circumstances where qualitative methods can be useful for extracting embedded tacit experiential knowledge (Greenfield et al., 2007).

Selection of Research Method for Research Area #1

There are two distinct areas of research within this dissertation with distinctly different research design considerations. Pragmatic research is to be informed by the "practicalities of generating data" (Monaro et al., 2022:1042) and the practical reality is that there is a small population of potential respondents that have the requisite abilities to participate in research area #1. There are only about twenty banks in the world that provide project financing for power plants (Yescombe, 2002). Because of the complex and very specific nature of power plant financing, it is necessary that the data be collected from those finance executives having:

- some prior experience with the financing of electric generation projects,
- who are familiar with electricity deregulation, and
- who are familiar with those financing risks that are specific to the electric industry in order to reduce sampling error (Bansal, 2017).

It is unlikely that this study is able to survey a statistically significant number of respondents having the prescribed qualifications. Per Creswell (2007), a qualitative approach may then be more suitable for the problem being studied. While quantitative analyses have been the primary research tool for economics and finance research, there is ample precedent in economics and finance research for the use of qualitative methods. For example, see Starr (2014) for a survey of the growing use of qualitative and mixed methods in economics, see Emerald (2023) for a description of an academic journal dedicated to qualitative financial research, and see Baker et al. (2008), Crawford (2012), and London et al. (2006) for specific applications. Thus, following Creswell's recommendation, pragmatism points to a qualitative study rather than a quantitative study for research area #1.

Creswell (2007:6) states that there are "a baffling number of choices of approaches" for qualitative studies. He points to Tesch's list of 28 approaches, Miller and Crabtree's list of 18 types, as well as ten other lists compiled by other researchers (Creswell, 2007). From this compendium, Creswell reduces the approaches down to the five most common, and based on the pragmatic paradigm, we accept Creswell's reduction.

The five selected by Creswell are Case Study, Grounded Theory, Narrative, Ethnography, and Phenomenology. Of these five, the Case Study approach must be ruled out because there are no directly applicable cases. There are no cases of nuclear plants that obtained financing under the new, deregulated framework.

Thus, no case study comparison between the prior regulatory framework and the new regulatory framework can be made.

The Grounded Theory approach is also ruled out because, in Grounded Theory, the theories are developed or generated during the research process (Corbin & Strauss, 1990; Creswell, 2007). In research area #1, the researcher is starting with a theory that arises from his own lived experience in relation to the phenomenon being studied (see the section entitled Researcher Positionality). In other words, because this dissertation starts with a theory to be tested, rather than developing a theory from the ground up, the process here may be thought as, approximately, the reverse of the Grounded Theory approach. This is referred to as the hypothetico-deductive method (Bougie & Sekaran, 2020).

The Narrative approach is ruled out because this approach is helpful for synthesizing the detailed stories or life of a single person or very small number of persons, and then to “restory” them (Creswell, 2007:56). In this study, the primary focus is centered on a phenomenon (electricity deregulation) and not on individual lives. It is not the intent of this author to develop “a narrative about the stories of an individual’s life” in the finance industry (Creswell, 2007:79).

The Ethnography approach usually involves the study of a group that shares the same culture (Creswell, 2007) and has typically been used to study groups with shared genealogy such as the Siriona people of Bolivia and the Yanomamo people of Brazil whose languages contain a total of five words for numbers (Landon, 1993). Here, that approach may possibly be used to study ‘financiers’ as a culture.

Financiers can be considered as people who have their own language and thought processes which have developed over time from experience, an observable shared culture within the group, and the cultural aspects of their decision-making with respect to the financing of nuclear power plants. It is proposed that this unique avenue of exploration be undertaken, not as part of this dissertation, but as future research because it may provide additional insight into the decision-making of financiers in reaction to electricity deregulation.

The fifth of Creswell's approaches is Phenomenology. This approach seeks to understand the essence of a phenomenon as it is experienced and seeks to describe this 'lived experience' in relation to the phenomenon by interviewing several individuals that have lived through it (Creswell, 2007). This Phenomenological approach is well aligned with research area #1 of this dissertation and should yield reliable results. There is certainly the occurrence of a phenomenon – the Act of 1992 and its related regulations. The lenders and investors within the electric power industry lived through and consciously experienced the impacts of deregulation on electric power generation. Thus, the Phenomenological approach is adopted as the best fit for this study.

The Phenomenological Approach

Phenomenology has its roots and origins in philosophy. It was started by Edmund Husserl (Giorgi, 2010; Moran, 2018) and is centered on intentionality and consciousness (Moran, 2018). Martin Heidegger picked up the baton and further described this philosophy as "the meaning of being" and the "phenomenological exploration of being as understood through lived experience" (Horrigan-Kelly et al., 2016:2), but it was not Heidegger's intention to develop a method for research nor did he set forth a method for research (Horrigan-Kelly et al., 2016). The "philosophy forms the basis for sound…phenomenology" (Monaro et al., 2022:1041) and, as a philosophy, phenomenology lends a certain style to scholarship (Giorgi, 2010). However, there are ongoing debates among practitioners regarding the proper means to employ phenomenology in research (Giorgi, 2010).

These debates yield significant variations in the practice of phenomenology. The method has "some flexible characteristics" when used for scientific analysis (Giorgi, 2006:354), however, "scientific practices and procedures of a science based on phenomenology are not yet systematized or securely established… [and] a tradition of established concrete procedures acceptable to all sympathetic researchers does not yet exist" (Giorgi, 2010:4). For example, Giorgi takes exception to the branch of phenomenology espoused by Smith (Smith & Osborn, 2008) because they suggest "ways that have worked for us"…[but] you may find yourself adapting the method to your own particular way" based on what is being investigated (Giorgi, 2010:6). Unlike Giorgi, and more in the vein of Smith, Moran (2018) states that phenomenology "is a flexible approach and there is not one universally accepted method" (Moran, 2018:73). It is to be thought of as "an outlook or approach rather than as a strict method…despite Husserl's best efforts to stipulate its methodological rigor" (Moran, 2018:74). As discussed below, this flexibility is well adapted to a pragmatic paradigm.

Lived experience is central to all branches of phenomenology and phenomenology involves describing conscious lived experiences. "It depends upon the presence of individuals who are undergoing the experience. If there are no individuals, then there are no phenomena" (Giorgi, 2008:36). To a phenomenologist, a person's "knowledge is explicitly linked with experience", "experience is needed to ascribe meaning to an event", and "knowledge is constructed by interactions between humans and their environment" (Allemang et al., 2021:39). While knowledge exists in the environment, phenomenological research relies on the experience of people in response to a phenomenon to build human knowledge (Allemang et al., 2021).

Thus, the role of the researcher is to listen to what people have to say about their lived experiences. Through the use of interviews, video recordings, and archival writings, the researcher seeks to hear from people who have lived through the phenomenon being investigated because "the researcher is interested in how the phenomenon is lived" (Giorgi, 2008:40). To the researcher, every object or phenomenon is to be understood not just as it is by itself but in relation to "the subjective acts that disclose it" (Moran, 2018:75). Therefore, the phenomenological method states that in order to better understand the deregulation of the electric industry, one must not just look at the words of the written legislation and regulations, but rather, look at its impact on the electric industry as it is experienced by those that lend to and invest equity in the electric industry.

While there are theoretical nuances between Giorgi's Descriptive Phenomenological Method, Benner's Interpretive Phenomenological Method, Smith's Interpretive Phenomenological Method, and others (Giorgi, 2006, 2008, 2010), Creswell (2007) does not differentiate between them, Moran (2018) suggests flexibility, and Giorgi (2006) suggests flexibility in applying phenomenology for research. There is much in the literature regarding phenomenology as a philosophy that can guide research, but "it is difficult to find any literature that actually explains how to do phenomenology" (Fernandez & Crowell, 2021:119) nor is there a template on which to base a phenomenological study (Errasti-Ibarrondo et al., 2018). The researcher should be guided by a "phenomenological attitude" consistent with the phenomenon being studied and not a prescribed step-by-step approach (van Manen & van Manen, 2021:1075). Per Creswell (2007), the researcher is to collect data via interviews with participants who have lived the phenomenon and then develop a composite description of what was obtained in the interviews. Moustakas (1994) takes a similar approach stating that the researcher should first identify a phenomenon to study, collect data from several people who have experienced the phenomenon, and then reduce the information down to common themes. Morgan (2011) borrows different aspects from several different methods to arrive at a general recommended approach, a concept that is pragmatic. From a pragmatism standpoint, there is little substantive difference between the phenomenological methods that would impact this study so long as the common, central tenant of phenomenology is maintained: conscious lived experience that is reduced to common themes. This central tenant is maintained in this study.

Determination of Target Sample Group

Qualitative sampling begins with defining the target population (Bougie & Sekaran, 2020). As noted previously, the practical reality is that there is a small sample of potential respondents that have the requisite knowledge, skills, and abilities to participate in research area #1. There are only about twenty banks in the world that provide financing for power plants and there are only three firms in the US that provide bond ratings: Standard and Poor, Fitch, and Moody's. Because of the complex and very specific nature of power plant financing, it is necessary that the data be collected from those finance executives who have at least some prior experience with the financing of electric generation projects, are familiar with electricity deregulation, and are familiar with those financing risks that are specific to the electric industry so as to reduce sampling error (Bansal, 2017). Moreover, to maintain data independence, respondents are limited to only one interviewee per company, given that co-workers in power plant financings work closely together in a small team (with shared decision-making). To do otherwise would be to potentially reduce data independence (Frost, 2019).

Identification and Determination of Sample Participants

The study will make use of snowball sampling to identify potential participants. Also known as chain sampling or referral sampling, it is commonly used in qualitative research and is “a recognized and viable method of recruiting study participants not easily accessible or known to the researcher” (Leighton et al., 2021:37). Researchers initiate the sampling by connecting with one or more test subjects that closely align with the target population (Leighton et al., 2021). However, this method of sampling can create sampling bias that could impact the application of the study results to larger populations (Leighton et al., 2021). Arguably, this concern is not warranted given the small population of relevant lenders (i.e., there are only about twenty banks in the world that provide power plant financing).

The study will also employ judgment sampling. Judgment sampling requires “special efforts to locate and gain access to the individuals who have the requisite information” as determined by the researcher (Bougie & Sekaran, 2020:233). In this study, the researcher will make use of *a priori* knowledge of the finance and electric power industries to make a determination of the knowledge, skills, and abilities that would comprise the test group. This method of sampling can also introduce sampling bias (Bougie & Sekaran, 2020). As discussed previously, this dissertation is guided by a post-positivist epistemology, and post-positivism rejects the ability of any researcher to be fully independent and objective, and instead accepts the belief that the researcher possesses knowledge, values, theories, and hypotheses that will likely have some influence on and, in turn, introduce some bias into the research. Post-positivists maintain that the intentional, visible acknowledgment of these possible biases by the researcher, as is done here, increases research objectivity.

Determination of Sample Size

Qualitative analysis uses non-probability sampling and allows the use of a smaller sample size because there is no need to draw statistical inferences (Bougie & Sekaran, 2020). The research process involves interviewing a group of people from each targeted sample group and the recommended size of the group varies. For example, Creswell (2007) suggests six to eight interviewees. Giorgi (2008) recommends at least three interviews, but this number is a function of the quality of the data. By analogy, "qualitative data are data in the form of words" (Bougie & Sekaran, 2020:307) and this data can be random or lacking in central tendency thus impacting data quality. Per Bougie and Sekaran (2020), the sample size is dictated by 'saturation' which occurs when interviewing additional participants does not yield new additional information. Morgan (2011) makes the same recommendation regarding saturation. Thus, the sample size cannot be known in advance because the point of saturation cannot be determined in advance. Bougie and Sekaran's (2020) and Morgan's (2011) recommendation that the sample size be based on reaching saturation is adopted for this study in combination with Creswell's suggestion of six to eight interviewees which also satisfies Giorgi's recommendation of a three-person minimum.

Interview Process

In qualitative interviews, the researcher conducts face-to-face interviews with participants, telephone interviews, or engages in focus group interviews (Creswell, 2007). For this study, telephone interviews will be used, and when possible, video calls. The interviews involve unstructured and generally open-ended questions that are few in number and intended to elicit views and opinions from the participants (Creswell, 2007). Per Bougie and Sekaran (2020), in a qualitative study, inquirers state research questions, not objectives or hypotheses, that assume two forms: (a) a central question and (b) associated sub-questions. Along similar lines, Creswell (2007) states that there should only be one or two central research questions and no more than five to seven sub-questions.

This study has one central research question:

Is it your experience that electricity deregulation has caused an increase in perceived price and output quantity risk relative to cost-of-service regulation, and why? This is an open-ended question that intentionally gives the interviewee the freedom to answer without initial bias. It also had seven sub-questions as follows:

1) *How familiar are you with electricity deregulation?* This question intentionally leaves open wholesale versus retail electricity deregulation and gives the interviewee the freedom to express what they know about the topic. It also acts as a discriminator to eliminate potential respondents that do not have the requisite knowledge, skills, and abilities regarding deregulation.

2) *Is it your experience that the change from cost-of-service regulation to deregulation affects the revenue stream of a power plant, and if so, in what ways?* The intent of this question is to begin the focus on the link between deregulation

and revenue risk. This early question is broad, and the questions that follow sequentially become narrower. For example, the next question separates revenue into its two components of price and output quantity, subsequent questions separate out price risk from price and quantity risk from quantity, and subsequent questions separate the perceived risk as seen by the lender from that of the equity participant.

3) *Is it your experience that deregulation affected power plant prices or output quantity or both?* Revenue is a function of price and output quantity. As discussed in the Chapter 2 section entitled Economic and Technical Issues Create Financing Implications, it is important to distinguish what aspect of the phenomenon created the respondents' lived experience. For example, output quantity can be reduced from a physical plant derating such as plugged steam generator tubes, or it can be reduced from being pushed up the ISO's dispatch curve.

4) *Thinking specifically about price risk rather than price, and output quantity risk rather than output quantity, is it your experience that deregulation affected price risk or output quantity risk or both?* With this question, the question gets focused on separating out risk.

5) *Thinking specifically about price risk rather than price, and output quantity risk rather than output quantity, is it your experience that deregulation increases the risk of a project as perceived by a lender?* This question, and the next, put the relationship between deregulation and the lender and the equity investor under the microscope.

6) *Thinking specifically about price risk rather than price, and output quantity risk rather than output quantity, is it your experience that deregulation increases the risk of a project as perceived by an equity participant?*

7) *Is it your experience that projects with and without a power sales agreement have different D:E ratios imposed by the lenders to account for a difference in revenue risk?* In the pilot study, this question surfaced specific data on the relationship between deregulation and the lenders' willingness to lend. Obtaining more data regarding this specific lived experience will lend strong support to the proposed model.

Each of these questions is intentionally open-ended and it is the researcher's intent to allow the interviewees to provide as much insight as they wish. As noted by Maxwell (2013), less structured approaches such as this enable the researcher to focus on the particular phenomenon being studied, rather than on the comparability of data across individuals.

Researcher Positionality

Qualitative researchers need to position themselves reflexively in their writings to self-understand the values, biases, and experiences they bring to the research process. This includes examining the connection of the researcher to the phenomenon (Creswell & Poth, 2018).

The researcher is a former professional within the electric power industry and helped to bring about the phenomenon that is at the center of this dissertation (i.e., electricity deregulation). He has lived experience in response to the phenomenon. It is from this lived experience that the researcher conceived the research problem, the RQs, and the theories to be tested. “The explicit incorporation of [the researcher’s] experience into [the] research has gained wide theoretical and philosophical support” (Maxwell, 2013:45), and is consistent with a post-positivist epistemology.

The researcher holds a B.S. in Astronomy and Physics, an M.S. in nuclear engineering, an M.B.A. in economics, and is presently a D.B.A. doctoral candidate. He teaches micro- and macro-economics as an adjunct professor and developed a microeconomics course in energy economics. The researcher participated in numerous regulatory hearings regarding the deregulation of electric markets as well as the deregulation of natural gas transmission. He submitted testimony in a number of these hearings and was involved in the writing of some of the state and ISO regulations. He has prepared cost studies for the US Department of Energy on various electric technologies including nuclear power. In addition, he has been involved with numerous project financings as a project developer and as a consultant to various lending banks.

Ontological realism pushes the researcher to confirm that their lived experience is not simply internal but exists independently (Maxwell, 2013). The researcher “seek[s] external validation for [their] perceptions and ongoing theories” (Maxwell, 2013:36) by examining whether their lived experience is similar to others. This phenomenological study involves interviewing others regarding their lived experience in relation to the phenomenon to test the researcher’s theory regarding the impact of deregulation on revenue risk. According to Maxwell (2013), it is permissible to use the interview data obtained in a Phenomenological study to provide a confirmatory test of an explicit hypothesis based on an existing theory developed by the researcher, rather than for the development of new questions or new theories as is the process with Grounded Theory.

Validity

Post-positivists accept that the researcher possesses knowledge, values, theories, and hypotheses that will likely have some influence (and inject some bias) on the research, and that objectivity is increased through the intentional, visible recognition of these possible biases. The researcher has reflected on his positionality and its impact on this study (Creswell & Poth, 2018). The phenomenological practice of epoché (i.e., bracketing or the setting aside of the researcher's experiences to allow for a fresh perspective) will be used during the interviews to help to minimize confirmation bias and selective exposure bias (Creswell, 2007; Creswell & Poth, 2018; Giorgi, 2006, 2008, 2010).

As noted previously, interview participants will be selected by snowball sampling and judgment sampling, both of which can introduce bias (Bougie & Sekaran, 2020; Leighton et al., 2021). Sampling error will be reduced by only interviewing those finance executives who understand the complex and very specific nature of power plant financing (Bansal, 2017).

A pilot study (see Appendix C) was performed to pretest questions. Some minor adjustments to the questions were made during the interview process as recommended by Creswell and Poth (2018) and Maxwell (2013), but the pilot study found that the participants were familiar with and understood the questions because they had specific professional experience with the topic. As found in the pilot study, the interview questions get directly to the heart of the phenomenon being studied thus maintaining construct validity.

Phenomenological studies do not typically possess external validity due to a lack of generalizability beyond the respondents being interviewed. Here, however, external validity is anticipated. The sample population represents a relatively large percentage of the total population which arguably affects generalizability. Also, research area #1 has high ecological validity because it investigates actual practices and conditions in the electric generating industry in response to actual changes in regulations. Ecological validity acts to increase external validity (Bornstein, 1999; Studebaker et al., 2002).

Selection of Research Method for Research Area #2

Research area #1, above, focuses on a very narrow phenomenon within the electric power industry, whereas the focus of inquiry for research area #2 pertains to a general research problem with broad applicability in the study of finance. Potential respondents for research area #2 would, therefore, include all experienced financial professionals from all industries with investment evaluation experience. Population size, therefore, does not place a limit on the choice of methodology for research area #2, and in pragmatic terms of what 'works', a quantitative or a qualitative approach is a possible methodological choice in accordance with post-positivism.

A quantitative method would enable the use of probability sampling to draw statistical inferences to increase external validity. The research problem being studied has broad applicability, i.e., the $200 billion per year market for project financing (Fight, 2006; Yescombe, 2002), and thus the use of a methodology that enables wide generalizability would be consistent with the broad nature of the problem being researched. Thus, a quantitative methodology would be better aligned for research area #2.

The pragmatist's choice of a quantitative methodology should be a function of the practical availability of data, resource constraints, and resource opportunities (Cameron, 2011; Molina-Azorin & Cameron, 2010; Venkatesh, 2013). And, as previously discussed, pragmatism requires the researcher to know what 'works' in any specific situation (Cameron, 2011). If the proposed theoretical construct is correct (i.e., that the MIOS appears to be a more appropriate ranking mechanism for project-financed investment opportunities), then it should be possible to observe behavior that aligns with this theoretical construct. Research area #2 seeks to study how companies rank their project-financed investment opportunities, but private data from multiple companies is not expected to be reasonably available. On the other hand, it is possible to design an experiment that replicates the decision-making environment, enables the observation and quantification of this behavior, and generates sufficient data for quantitative analysis. Moreover, the IOS and the

MIOS reflect the rank ordering of preferences and there are various experimental design methods (as discussed below) that yield ranked preferences. Together, these suggest the use of experimental design analysis for research area #2. The next two sections review the application and advantages of different types of quantitative experimental design methods.

Experimental Design Analyses in Economics and Finance

The advantage of experimental design analysis is that the researcher can control for other factors that could affect the results. This is accomplished by manipulating only the variables that are being studied (Bougie & Sekaran, 2020; Levin, 1999). Different levels of the variable are created (i.e., manipulation) and the change in the dependent variable is measured. Manipulation is also referred to as 'the treatment', and the results are called 'treatment effects' (Bougie & Sekaran, 2020).

Experimental design analysis provides improved internal validity, replicability, and causality because only the manipulated variables are changed and, to the extent there may be confounding variables, they are spread evenly across all groups (Bougie & Sekaran, 2020; Levin, 1999). The tradeoff for this high internal validity is lower external validity. This arises because respondents in an experiment are not making real decisions and their answers may not reflect real-life decision-making (Portney, 1994). However, this can be partially offset by employing manipulated scenarios that exhibit high ecological validity (Bornstein, 1999; Bougie & Sekaran, 2020; Studebaker et al., 2002). See the later section entitled Validity for a more specific discussion as it relates to the selected experimental manipulations.

This laboratory versus real-life debate created resistance in the economics profession because experiments were seen as artificial and not transferrable to real economic environments. Historically, most economics research has been nonexperimental, yet there has been an experimental strand in economics that is traceable back to Bernoulli's work in 1738 and Hume's work in 1739. Along the way, there have other notable economics studies using experimental design such as Jevons in 1871 and Edgeworth in 1881 (Bardsley et al., 2010), and later von Neumann and Morgenstern in 1944 with their landmark *Theory of Games and Economic Behavior* (Levin, 1999). Since the 1980s, the use of experimental methods in economics research has grown significantly and is now carried out by economists globally. Daniel Kahneman and Vernon Smith were awarded the 2002 Nobel prize for their pioneering work in experimental economics (Bardsley et al., 2010) and Richard Thaler was awarded the 2017 Nobel prize for his work using experimental economics (Nobel, 2023). Experimental economics is now part of mainstream economics (Levin, 1999; Nermend & Latuszynska, 2016). It is adept at describing the decision-making of individuals under controlled experimental conditions and it broadens traditional economics research by allowing the study of individual human choices that are difficult to observe in natural environments (Levin, 1999; Nermend & Latuszynska, 2016). Such is the case here.

There is also ample precedent in the financial literature for the use of experimental design analyses. For example, Sudhir (2014) used an experimental design analysis to test an individual's investment risk perceptions consistent with Prospect Theory, Sengupta et al. (2021) performed a between-subject 2x2 experimental design analysis to test investors' portfolio diversification choice decisions, and Gärling et al. (2017) performed a pair of experimental design analyses regarding the timing of stock purchases.

Recently, several economics papers used experimental design analyses in their investigation of electricity-related topics. Botta (2019) looked at the ranked preferences of investors in regard to hypothetical electric capacity auctions for the European electric markets, Gamel et al. (2016) looked at the imputed return on investment for homeowner wind power projects using a ranked preference experimental design study, and Yiakoumi et al. (2022) performed an experimental design analysis regarding electricity generation where the authors manipulated the three variables of electric capacity auctions, electric price feedback, and changes in electric market demand. Thus, we find support for the use of experimental design analyses in both economics and finance, and closer to 'home', in studies involving electric markets.

Ranked Preferences Methods

Experimental economics is adept at describing the decision-making of individuals and broadens economics research by enabling the study of individual human choices that are difficult to observe in natural environments (Levin, 1999; Nermend & Latuszynska, 2016). The IOS and the MIOS reflect the rank-ordering preferences of decision-making individuals within a firm. To that end, an experimental design method that yields rank-ordering is sought.

There are numerous experimental design methods that yield ranked preferences (Bardsley et al., 2010; Hawkins et al., 2014; Lehmann, 2011; Marley & Louviere, 2005; Nermend & Latuszynska, 2016). Many of these are capable of analyzing experiments with numerous independent variables. Some, like conjoint ranking methods, work well when a study seeks to have respondents consider simultaneous tradeoffs such as an increase in variable X_1 while reducing variable X_2 (Gamel et al., 2016). Conjoint analyses enable the manipulation of more than two variables at the same time and the price of a good or service is often one of the manipulated variables (Mahajan et al., 1982). For example, participants may choose between multiple proposed versions of a manufactured product with and without various features while simultaneously choosing the price they are willing to pay for the various combinations of features. The method is adaptable to many applications and, recently, conjoint analysis was used to understand people's willingness to receive the Covid-19 vaccine alone, with family members, or with friends (Hanako, 2022).

In another ranked preference method, MaxDiff, respondents are presented with multiple choices in each comparison set and are asked to pick the two with the maximum differential between them; thus, the moniker MaxDiff (Cohen & Orme, 2004; Rausch et al., 2021; Tanaka et al., 2022). The method was first put forth by Louviere and Woodworth in 1990, and its formal statistical and measurement properties were later proven by Marley and Louviere in 2005 (Massey et al., 2015). The two items that are selected in each set become the ‘best’ and “worst’, and inferences based on transitivity can be made regarding the unselected middle choices relative to the best and the worst (Rausch et al., 2021; Tanaka et al., 2022). Transitivity is the concept that if A is tested as preferred to B, and B is tested as preferred to C, then it is inferred that A is also preferred to C without direct testing. These inferences help reduce the number of analysis iterations that are required, but these inferences affect the quality of the output because not all inferences are correct (Kingsley & Brown, 2010). To reduce respondents’ cognitive confusion, the number of choices in a decision set is often limited to six items (Cohen & Orme, 2004).

Numerous papers refer to MaxDiff as Best-Worst Scaling (BWS), however, MaxDiff is but one form of BWS and attempts have been made to provide clarification (Marley & Louviere, 2005). For example, another form of BWS is Paired Comparison Best-Worst Scaling (PCBWS). PCBWS dates to Fechner in 1860 and has been further developed over time (Kingsley & Brown, 2013). Koczkodaj et al. (2015) date the use of PCBWS to at least the 13th century. Sometimes referred to as the Paired Comparison Method, it is “a straightforward way of presenting items for comparative judgment” (USDA, 2023:1) and can provide an interval-scale ordering of items (USDA, 2023). PCBWS is often used to compare a benefit, as one dimension, and price, as the other dimension, thus yielding estimates of monetary value or the willingness-to-pay (Kingsley & Brown, 2013; USDA, 2023).

In contrast to Conjoint and MaxDiff analyses where respondents are presented with multiple choices in each comparison set, PCBWS respondents are given a series of direct comparisons between only two items and are asked to select their preference in each set (Kingsley & Brown, 2013; USDA, 2023). In each direct comparison, the respondent's selected preference is the 'best' in that set and the unselected item is the 'worst' in that set (Cohen & Orme, 2004; Massey et al., 2015). It is a binary choice. There is no indifference option, however, indifference gets accounted for, when applied across many comparisons, as it shows up in the summed data as equal scale values (Brown & Peterson, 2009).

There are $T(T - 1)/2$ direct comparisons that can be made in a PCBWS experiment having T manipulated scenarios (Brown & Peterson, 2009). For example, a 2x2 matrix of two independent variables has six direct comparisons. A 2x3 matrix of two variables has 15 direct comparisons. If the series of direct comparisons include all possible permutations, then it is said to be balanced. A balanced PCBWS introduces less error than an unbalanced PCBWS, less error than MaxDiff, and less error than conjoint analyses because all comparisons are direct and there are no inferred comparisons (Kingsley & Brown, 2010). PCBWS can be used with more than two independent variables (e.g., a 2x2x2 matrix), and for this, the use of computer software is suggested because of the escalation in the number of direct comparisons. Smaller two-dimensional matrices can be analyzed 'by hand' (Brown & Peterson, 2009; Furlan & Turner, 2014) which can present an advantage over other methods.

In comparison to more commonly used scaling methods such as Likert and Semantic scales, PCBWS has been shown to provide greater discrimination between the items being compared because it eliminates both extreme response bias and middle response bias (Lee et al., 2007; Massey et al., 2015; Rausch et al., 2022). This comes about because there are no middle points or interpretations of scalar gradations; PCBWS forces respondents to choose between only two items at a time. Research has also found that rating scales such as Likert and Semantic lead to greater data skewness than PCBWS (Lee et al., 2007).

PCBWS is relatively easy for the researcher to administer (Brown & Peterson, 2009; Furlan & Turner, 2014) and instructions given to respondents are easy to understand (Brown & Peterson, 2009; Marley & Louviere, 2005). Because only two items are presented at a time, PCBWS is cognitively simpler for respondents than ranking multiple items or making a selection along a continuum such as a Likert rating scale (Marley & Louviere, 2005; Massey et al., 2015).

PCBWS, like many other techniques, allows researchers to use large samples (Massey et al., 2015) which can help reduce sampling error and increase the validity of the results. At the same time, PCBWS has been found to enable the use of smaller sample sizes compared to other common survey techniques such as Likert scales due to the multiple replications of each item in a balanced set of

PCBWS comparisons (Bougie & Sekaran, 2020; Brown & Peterson, 2009). Another advantage is that PCBWS acts to minimize potential cross-cultural issues that can afflict more common rating scales. PCBWS only presents a choice between two items which is more likely to reduce biases due to differences in cultural response styles (Auger et al., 2007; Furlan & Turner, 2014; Lee et al., 2007). Thus, PCBWS presents multiple advantages for use in this dissertation over Conjoint and MaxDiff analyses.

PCBWS has been applied in a wide range of contexts and problems. It has been used in studies on food safety, retailing, wine marketing, quality of life healthcare studies, and willingness-to-pay studies (Massey et al., 2015). Willingness-to-pay, in economics, is the maximum price at which consumers will purchase a product (Kuperstein-Blasco & Mäkinen, 2022), is one method used to calculate consumer demand curves, and is rooted in marginal utility theory (Mankiw, 2015; McConnell et al., 2021). There is a long list of precedents in economics and finance literature for the use of PCBWS in willingness-to-pay analyses including Louvierre and Islam (2008), Rausch et al. (2022), Samarzija (2019), and Tanaka et al. (2022). This relates directly to this dissertation because the willingness to pay (or purchase or invest in) a financial investment that yields a future payment stream (such as an equity investment in a power plant) is a specific subset of the more general willingness of a purchaser to pay for any good or service that provides, or is expected to provide, marginal utility.

It is this logic that underpins the valuation of debt and equity securities (Brigham & Ehrhardt, 2017; Ross et al., 2016) and further points to PCBWS as a methodology that is aligned with this dissertation's research. Specifically, the willingness-to-pay point is the same as the equilibrium point in the IOS and the MIOS. The equilibrium point represents the maximum price that investors should be willing to pay for an investment. As such, investors should be willing to invest when IRR is greater than the cost of capital (i.e., IRR>WACC) and not willing to invest when IRR is less than the cost of capital (i.e., IRR<WACC). As noted above, PCBWS has been successfully used in various willingness-to-pay studies and this is why PCBWS appears well-aligned for this dissertation.

Conjoint analyses and MaxDiff analyses work well for decision sets that contain multiple choices within each set. Research area #2 has only two dimensions, IRR and WACC, and its ability to employ full direct comparisons to minimize transitivity error also suggests the use of PCBWS rather than MaxDiff and Conjoint analyses. Along with PCBWS' ease of use for both the researcher and respondent, its reduction of biases, and its prior use in willingness-to-pay analyses, a post-positivism pragmatist would conclude that PCBWS 'works' for this dissertation.

Manipulations

Each respondent is presented six scenarios that manipulate the IRR and WACC of a long-term investment across conditions to measure the willingness of test subjects to provide equity financing. The six scenarios form a 2x3 experimental design. The 2x3 design was selected over a 2x2 design (four scenarios) or a 3x3 design (nine scenarios) on grounds similar to the use of a 7-point Likert scale over a five- and nine-point Likert scale. It has been shown that a five-point Likert scale does not always provide enough discrimination and a nine-point Likert scale can overwhelm the participant with too many choices (Pearse, 2011). That 'goldilocks' logic was assumed here in arriving at the number of manipulations.

As a case in point, going from a 2x3 design to a 3x3 design more than doubles the number of direct comparison questions (from 21 to 45) that are required to be answered by each respondent to maintain a balanced PCBWS analysis. This may create survey fatigue within a respondent which has been shown to increase response error (Ambler et al., 2021; Jeong et al., 2023). Also of possible concern is that the incentive for a respondent to complete a survey quickly may not be aligned with completing a survey accurately. However, it is possible to test additional manipulations while avoiding survey fatigue by repeating the experiment with multiple groups of respondents using different variations of the 2x3 manipulation matrix. While this requires a significant increase in the number of respondents, it enables the analysis of more manipulation treatments, minimizes the potential for survey fatigue, and can increase validity through triangulation. For these reasons, the use of three different manipulation matrices presented to three different survey groups is proposed. See Table 3-1.

Table 3-1 The Manipulated Experimental Conditions

Matrix A		IRR,%	
		Low	High
	Low	10/7	15/7
WACC,%	Medium	10/10	15/10
	High	10/17	15/17

Matrix B			IRR,%	
		Low	Medium	High
WACC,%	Low	8/5	10/5	12/5
	High	8/20	10/20	12/20

Matrix C			IRR,%	
		Low	Medium	High
WACC,%	Low	8/7	10/7	12/7
	High	8/11	10/11	12/11

The manipulations contain either a) two choices of IRR (high, low) and three choices of WACC (high, medium, low) or b) three choices of IRR (high, medium, low) and two choices of WACC (high, low). This allows for combinations where the IRR:WACC ratio is less than, greater than, and equal to unity which is important because the MIOS equilibrium point is equal to unity. Also, each matrix contains a minimum of two direct comparisons where a potential investment has a higher IRR than another yet has the lower IRR:WACC ratio.

The comparisons within each matrix form a balanced PCBWS analysis because each possible combination faces off in a direct comparison, transitivity is not used to reduce the number of direct comparisons, and there are no omitted combinations. This increases internal validity and reduces error. In addition, each of the six manipulations within each matrix is given a direct comparison against the scenario of ‘no investment’. This direct comparison is included in the design because the MIOS equilibrium point represents the point of indifference between investment and no investment. By including the ‘no investment’ option within the direct comparisons, the calculation of the ranked choices will determine the location of the MIOS equilibrium point within the rankings. Thus, to address Hypotheses 5a and 5b, this PCBWS analysis is designed to yield both the extent or boundary of the firm and identify which investments should be internalized by the firm. Moreover, repeating the experiment using three different combinations of treatments is anticipated to provide even greater support for the MIOS construct.

Consistent with the T(T-1)/2 formula provided in the previous section for the number of direct comparisons for a balanced PCBWS, the six manipulations of each 2x3 matrix, plus the direct comparisons of the manipulations against the ‘no investment’ scenario (shown as “0”), yields 21 direct best-worst comparisons for each of the three matrices as follows:

1-2	2-3	3-4	4-5	5-6	6-0
1-3	2-4	3-5	4-6	5-0	
1-4	2-5	3-6	4-0		
1-5	2-6	3-0			
1-6	2-0				
1-0					

Participants are presented with the IRR and WACC values for each of the manipulated treatments and are asked to make the 21 direct comparisons. See

Appendix B which provides the survey instrument. Moreover, while the respondents are presented with the IRR and WACC values, they are held blind to the MIOS construct and are not instructed whether to use the MIOS construct, the traditional Coasian IOS approach, or any specific method. The maximum score of the direct comparisons in a 2x3 matrix is six, and the minimum score is zero. A score of six means that one combination of IRR and WACC is preferred over the other five treatments within the matrix as well as preferred over the 'no investment' scenario. A score of zero means that one combination of IRR and WACC is never the preferred combination. A score of three means that the combination is preferred three times but not preferred three times.

The data from each survey participant creates a matrix of preferences (see Table 3-2), and the summed preferences for each manipulation are used to create a

Table 3-2 Typical Survey Respondent Output Matrix of Ranked Preferences

Investment		Investment						
		1	2	3	4	5	6	0
Investment	1	-	0	0	1	1	0	0
	2	1	-	0	1	1	0	0
	3	1	1	-	1	1	1	1
	4	0	0	0	-	0	0	0
	5	0	0	0	1	-	0	0
	6	1	1	0	1	1	-	1
	0	1	1	0	1	1	0	-
	sum	4	3	0	6	5	1	2

scatter plot of ranked preference (on the y-axis) vs. the IRR:WACC ratio of the potential investments (on the x-axis). The slope (β) of the line that fits this data is statistically compared to the slope of the line that is predicted by the MIOS to test the following hypotheses (separately for each of the three matrices):

H_0: β equals the slope of the line as predicted by the MIOS.

H_{alt}: β does not equal the slope of the line as predicted by the MIOS.

As developed in the Chapter 2 section entitled Internalization Theory, respondents should be indifferent towards an investment when it has an IRR:WACC ratio of unity. This is the MIOS equilibrium point developed from marginal utility theory. If the survey data comports to theory, the analysis will show that the MIOS equilibrium point passes through the line x = 1 (i.e., an IRR:WACC ratio of unity).

People, however, perceive the potential for losses and gains asymmetrically rather than linearly, as developed in the Chapter 2 sections regarding Prospect Theory. For example, when presented with a coin flip where the odds are 50:50, people do not exhibit indifference and shy away when money is involved because there's a chance they might lose (Tversky & Kahneman, 1986). Such may be the case here and is tested in Matrix A where a potential investment with an IRR:WACC ratio equal to unity is one of the treatments. In accordance with Prospect Theory, the survey data can be expected to show the MIOS equilibrium point positioned more conservatively (IRR:WACC >1) than what would be predicted by marginal utility theory alone (IRR:WACC =1).

This effect is depicted in Figures 3-2 and 3-3. Figure 3-2 depicts the results of a PCBWS survey for matrix A wherein the respondent selected IRR:WACC = 1 as preferred to the choice of 'no investment'. Figure 3-3 depicts the results wherein the respondent prefers the more conservative choice of making 'no investment' compared to the investment where IRR:WACC =1. This change has the effect of switching the ranking of these two options and moving the equilibrium point to the right, a more conservative investment position.

Figures 3-2 and 3-3 represent the ranked preferences of two respondents that reflect the boundary conditions (i.e., with and without the effect of Prospect Theory). It is anticipated that the ranked preferences of the full sample population

Figure 3-2 Ranked Preference vs. IRR:WACC

IRR:WACC Ratio	Ranked Preference
0.59	0
0.88	1
Don't Invest	2
1.00	3
1.42	4
1.50	5
2.14	6

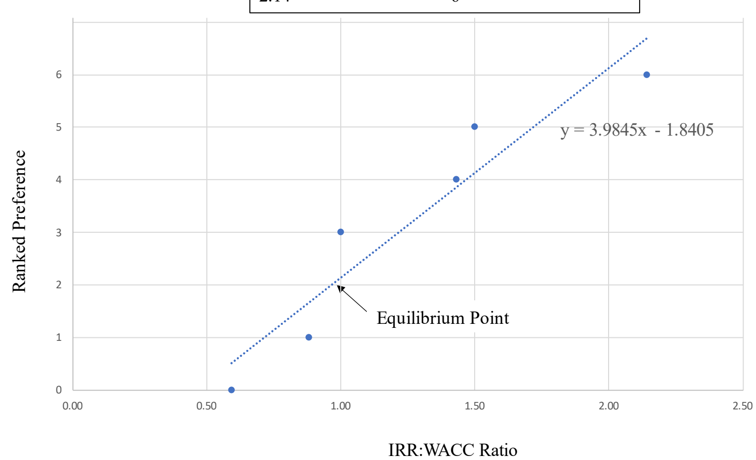
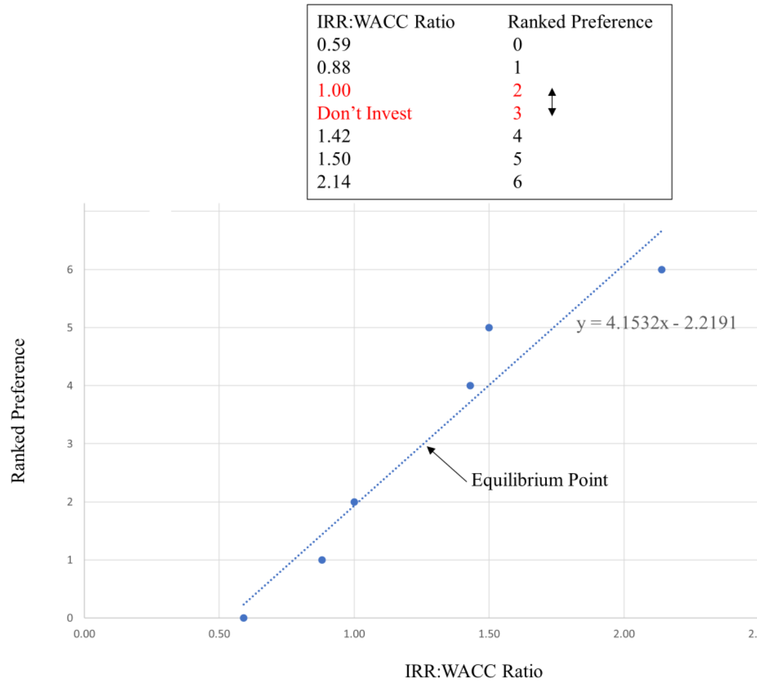


Figure 3-3 Ranked Preference vs. IRR:WACC
Depicting Prospect Theory Effect



for the group presented with Matrix A will lie between these two boundary conditions, however, its exact position is experiment-specific, cannot be known in advance, and is revealed through experiment (Tversky & Kahneman, 1986). Therefore, for Matrix A, a comparison will also be made against the slope of the MIOS-predicted line incorporating Prospect Theory to test the following hypotheses:

H_0: β equals the slope of the line as predicted by the MIOS when incorporating Prospect Theory.

H_{alt}: β does not equal the slope of the line as predicted by the MIOS when incorporating Prospect Theory.

The slope of the line predicted by MIOS is specific to each matrix because the IRR:WACC manipulations plotted on the x-axis are unique to each matrix. For matrix A, β is predicted by MIOS to be 3.98 and 4.14 for the two boundary conditions (i.e., with and without the effect of Prospect Theory). For matrix B, β is predicted by MIOS to be 2.69. For matrix C, β is predicted by MIOS to be 6.27.

Determination of Target Sample Group

The focus of inquiry for research area #2 pertains to a general research problem with broad applicability in the study of finance, i.e., the $200 billion per year market for project financing (Fight, 2006; Yescombe, 2002). To help establish wide generalizability of the results, potential respondents should, therefore, be drawn from the pool of all financial professionals from all industries who have experience evaluating financial investments. Setting a minimum level of financial investment experience will reduce sampling error (Bansal, 2017). To that end, the minimum requirements to participate in the survey are an academic degree in Economics or Finance (bachelor's degree and above) and a minimum of five years of business investment work experience. Screener questions are used in the survey to ensure each respondent's understanding of financial concepts.

Determination of Sample Size

Smaller sample sizes can be used with PCBWS compared to other common survey techniques such as Likert and Semantic scales due to the multiple replications of each item in a balanced set of PCBWS comparisons. A general rule of thumb is 30 respondents for each manipulation when using Likert and Semantic scales, however, this number can be reduced to 10-20 for paired comparison analyses (Bougie & Sekaran, 2020). Brown and Peterson (2009) demonstrated that using 10 respondents in a paired comparison analysis can yield high reliability and there is only a small increase in reliability with increasing the number of respondents. This analysis will use 10 respondents per manipulation as it satisfies both Brown and Peterson and Bougie and Sekaran. There are six manipulations, thus 60 respondents for each variation of the experiment, however, the experiment is being performed three times (using three sets of manipulations) for a total of 180 respondents, and this replication adds experimental validity.

Identification and Determination of Sample Participants

A market research company was retained to identify and determine the participants as well as manage the survey process. As discussed in Chapter 4, telephone interviews were held, and proposals were collected from four market research companies which led to the selection of IPSOS-Insight, LLC, a subsidiary of IPSOS S.A., a publicly traded market research firm headquartered in France with over a hundred international offices including offices in the US.

Survey Process

Respondents are asked to complete an online survey (see Appendix B). The survey is divided into three parts. Part 1 contains several demographic questions primarily aimed at ensuring that the respondent has the requisite knowledge, skills, and abilities to accurately perform the survey. Part 2 provides the respondent with

21 direct comparisons and asks the respondent to select their preferred choice within each comparison. Part 3 provides the respondent with several questions that may lead to future studies. One-third of the respondents see the Matrix A manipulations, one-third see the Matrix B manipulations, and one-third see the Matrix C manipulations.

Validity

As noted in a previous section, experimental design analysis provides high internal validity, replicability, and causality because only the manipulated variables are changed and, to the extent there may be confounding variables, they are spread evenly across all groups (Bougie & Sekaran, 2020; Levin, 1999). In the proposed analysis, all external influences are held constant and only the IRR and WACC are varied.

The tradeoff for this high internal validity is lower external validity. This is because experimental design scenarios by their nature require respondents to imagine how they would react to stimuli that have been presented in a controlled format. Reactions of people to real-life stimuli may exhibit more variability because they are being made while subject to more variability. Thus, answers provided by respondents in a controlled environment may not reflect real-life decision-making (Portney, 1994). However, this can be partially offset by employing manipulated scenarios that exhibit high ecological validity (Bougie & Sekaran, 2020). Lancsar and Swait (2014) confirmed that when PCBWS experiments possess ecological validity they can also provide external validity.

This conclusion was based on real-life follow-up studies performed in various industries including transportation, environmental economics, and marketing. While there is some degree of external validity in the proposed analysis because investors often make real-world financial decisions using IRR and WACC, the selected manipulations may not reflect ecological validity. This is because the manipulations were chosen at specific intervals to ensure that specific conditions were tested to help find support for the model. The objective of this dissertation is to test specific hypotheses that may or may not be supported by the data. If the model is supported, a follow-up study using real-life project finance data is recommended along the lines of Lancsar and Swait (2014) to establish ecological validity.

Internal validity is increased as the use of PCBWS provides greater discrimination by eliminating both extreme response bias and middle response bias (Lee et al., 2007; Massey et al., 2015; Rausch et al., 2022). A balanced PCBWS is being proposed which increases internal validity because all comparisons are direct and there are no inferred comparisons (Kingsley & Brown, 2010). Reliable results can be obtained with small sample sizes (Bougie & Sekaran, 2020; Brown & Peterson, 2009) which can increase validity. Cognitive error by the respondents is reduced with PCBWS due to binary choice (Marley & Louviere, 2005; Massey et al., 2015), however Brown and Peterson (2009) and Kingsley and Brown (2010) found increased error when the presented binary choice is perceived as being close to indifference.

Brown and Peterson (2009) and Kingsley and Brown (2010) have found that there is an increase in error early in the survey process that drops off quickly. This error can be evenly distributed by randomizing question order. Other advantages of question order randomization include eliminating order bias, anchoring bias, and pattern recognition, as well as minimizing researcher-induced influence.

Research for Areas Outside of Research Areas #1 and #2

No research is proposed for the causal relationships within the model that lie outside of research areas #1 and #2. These relationships, as discussed in Chapter 2, have been well-researched and well-established over the past four decades and it is not envisioned that this dissertation would contribute anything new to that body of knowledge. It is the findings from research areas #1 and #2 that are expected to make new, unique, and substantive contributions. In addition, it is the application of the findings from research areas #1 and #2 to the existing, well-established relationships that are expected to make new, unique, and substantive contributions.

Pilot Study That Informed the Selected Methodology

A qualitative pilot study was performed using a phenomenological methodology following the same methodological approach as set forth in this dissertation. This pilot study evaluated research area #1 as well as the area outside of research areas #1 and #2, but did not include research area #2. The section from the pilot study entitled Data Analysis and Results is provided in Appendix C.

The results of the pilot study were as follows:

1) Four of the four people interviewed provided confirmation for the relationships shown in research area #1, and

2) Eight of the eight people interviewed provided confirmation for the relationships shown in the area outside of research areas #1 and #2.

The pilot study suggested that:

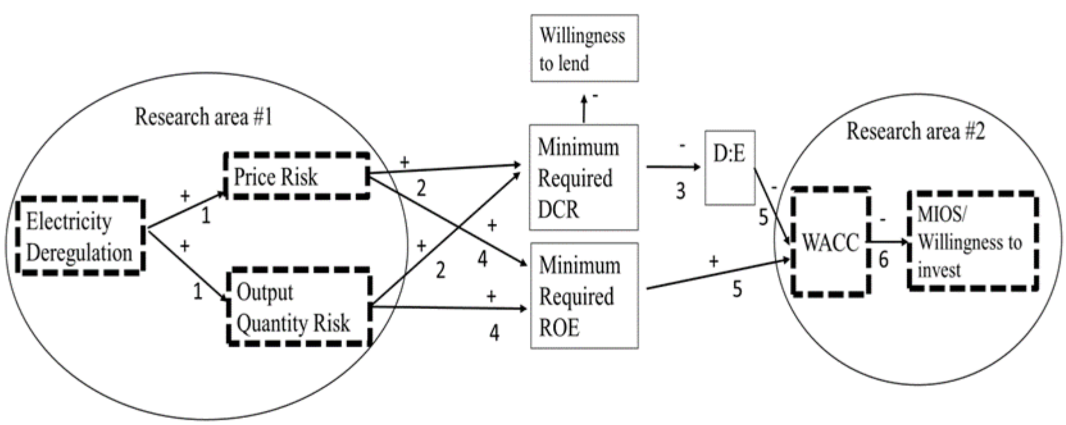
1) Despite reaching saturation, research area #1 warrants further study because of the small sample size (four interviewees).

2) No further study is warranted for the area outside of research areas #1 and #2. As noted above, these relationships are already well-researched and well-established, and no new contribution to the literature is anticipated.

Chapter 4
Findings and Data Analysis Results

This dissertation has two distinct areas of research that make use of two different research methods, as depicted in Figure 3-1 (and re-presented below for convenience as Figure 4-1). The two methods selected are a qualitative phenomenology study for Research Area #1 and a quantitative experimental design study for Research Area #2, and the specific reasons for their selection are provided in Chapter 3.

Figure 4-1 Areas of Research



+/- Expected direction of the effect
1- Law of Supply and Demand, and Elasticity of Supply and Demand
2- DCR definition and Prospect Theory
3- Debt:Equity Ratio definition
4- CAPM and Prospect Theory
5- WACC definition
6- Internalization Theory

Research Area #1

The objective of Research Area #1 was to find support for the proposition that the change from regulation to deregulation in the electricity industry increased a power plant's price risk and output quantity risk. See the leftward area encircled within Figure 4-1. To accomplish this, Research Area #1 consisted of a qualitative phenomenological analysis as described in Chapter 3. Because of the complex and extremely specific nature of power plant financing, it was necessary that the data for this phenomenological study be collected from interviewees having:

- Prior experience with the financing of electric generation projects,
- Familiarity with electricity deregulation, and
- Familiarity with the financing risks that are specific to the electric industry.

Ten interviews were conducted in accordance with the methods and procedures set forth in Chapter 3, and the ten interviews satisfied the sample size criteria. Four of the interviewees were previously known to the researcher from his involvement in various regulatory proceedings and power plant financings that took place in the 1980s and 1990s. The remainder were obtained by referral (defined in Chapter 3 as snowball sampling) either from the four interviewees noted above or from other financial contacts known to the researcher. On the other hand, all attempts to solicit participation via "cold calling" (telephone calls and emails to people identified on the corporate websites of investment banks that finance power plants) proved fruitless.

The ten people interviewed demonstrated extensive experience with the financing of electric generating projects and comfortably satisfied the three bulleted conditions listed above. The experience of these interviewees ranged from 15 to 40+ years with the average being greater than 30 years. Six of the interviewees worked in the electricity industry both before and after the passage of the Energy Policy Act of 1992 (see Chapter 2 for a discussion of the importance of this legislation to the deregulation of the electricity industry) and thus experienced the transition from regulation to deregulation and the differences between regulated and deregulated frameworks. The remaining four interviewees had extensive experience working post-deregulation on both regulated utility and non-regulated independent power producer (IPP) financings which afforded exposure to, and experience with, the differences between regulated and deregulated frameworks. Seven of the interviewees worked as investment bankers serving the electricity industry and three worked as consultants to the investment banks that serve the electricity industry. The three consultants also had prior experience working at one or more state and/or federal regulatory agencies that were charged with enacting the deregulation statutes which also led to a lived experience (as defined in Chapter 3) of the phenomenon. Five of the ten interviewees had experience with both lending and equity investing. As discussed in Chapter 3, data independence was maintained by ensuring that none of the ten interviewees were presently employed at the same company. (A due diligence review of resumes found that two of the interviewees were employed at the same regulatory agency but in different departments in the 1990s but have not worked for the same company or regulatory agency since, and this was confirmed during the interviews.) Thus, all ten of the interviewees, individually and together, met the requirements of the analysis set forth in Chapter 3 as well as having significant subject matter experience, which all led to increased analysis validity.

The interviews took place between June 13, 2022, and August 1, 2023, and eight of the interviews were conducted via telephone, and two made use of video conferencing. The video conferencing was at the suggestion of the two interviewees who were interviewed while at their place of employment and used the video conferencing technology regularly for work. Both telephone and video conferencing worked well in maintaining the flow of information during the interviews.

The interviews lasted between 30 minutes and two hours; an hour was typical. Four of the interviewees sent material *sua sponte* to the researcher after the interviews including copies of their own regulatory testimony, industry conference presentations, academic research, and a book, all of which related to the interviews. It was perceived by the researcher that eight of the interviewees seemed to enjoy talking at length about their lived experiences, if not excited at the opportunity. The other two were more reticent, and these were the shorter interviews. The two might have participated in the interviews out of obligation to the person who recommended them, and the researcher perceived that the obligatory participation may have affected interview rapport. It is believed that interview rapport can increase the motivation of interviewees during an interview and result in higher-quality interview responses, however, the literature is mixed. Some studies have found that rapport improves response quality while others found the opposite (Belli et al., 2001). Other studies have shown that rapport only affects the disclosure of highly sensitive information (Sun et al., 2021) and the information disclosed in this study was neither sensitive nor confidential. In summary, a review of the information disclosed by the two more reticent interviewees vis-à-vis the others indicated that the degree of rapport did not appear to affect the quality of their responses because the content of their statements was found to be consistent with the statements made by the others.

The interviewees were presented with the seven questions listed in Chapter 3 and were allowed to spend as much time as they wished discussing each question. The sequence of the questions varied in some of the interviews to maintain interview flow based on something said by the interviewee in their response to a question, but all interviewees were asked the same seven questions. The questions were not shared with the interviewees in advance, and to eliminate response bias, none of the interviewees knew the objective of the research prior to the interview other than that it was being done for academic research regarding electricity deregulation.

In accordance with the recommendations of Bougie and Sekaran (2020), Creswell (2007), and Creswell and Poth (2018), each interviewee voluntarily agreed to participate in the interview, and each was informed of the measures being taken to ensure confidentiality in accordance with the Florida Institute of Technology Institutional Review Board (IRB) submission and approval for this analysis. For example, interviewee names and places of employment are not reported; each is only identified by a single letter. See Table 4-1 for a list of the interviewees by their designated letter, type of experience, and years of experience.

To help ensure that interviewees would speak freely, candidly, and at length, the interviewees were informed, as per the IRB submission and approval for this study, that the interviews were not being recorded but that the researcher would be taking handwritten notes. Research has shown the recording of interviews can both decrease certain biases and increase others, handwritten notes can be as effective as recorded interviews, and a researcher's decision to record or not record should be contingent on the circumstances (Rutakumwa et al., 2020). In making this decision, researchers must consider that no technology, "not even ubiquitous technologies such as telephones, recording devices, or e-mail" is neutral in an interview (Paulus, et al., 2017:753).

Handwritten notes for each interview were recorded on a specific form created by the researcher which provided specific places to record the name, interview date, interviewee work experience, the seven interview questions, responses to the seven interview questions, and a space for additional notes. (See Appendix D for the interview form). The interview form followed the general guidance of Creswell (2007) and Creswell and Poth (2018), and the researcher found the form effective for its purpose.

Table 4-1 Interviewees for the Qualitative Analysis

Abbreviation	Years of Experience	Type of Electric Industry Experience	Interview Date
B	40+	Investment banking for power plants Power plant equity investor Regulatory lawyer	7/26/23
C	15	Investment banking for power plants Power plant analysis and lending Credit ratings of utilities and IPPs	6/13/22
F	40+	Federal regulator Investment bank consultant Power plant equity investor	7/24/23
G	18	Investment banking for power plants Power plant analysis and lending Credit ratings of utilities and IPPs	6/24/22
H	40+	Investment banking for power plants ISO Board of Directors CFO of IPP Company	8/1/23
K	25	Investment banking for power plants Utility Board of Directors Power plant equity divestments	7/1/22
M	19	Investment banking for power plants Investment analyses of IPPs and power projects	7/1/22
P	40+	State and Federal regulator Investment bank consultant	7/20/23
R	40+	Investment banking for power plants ISO Board of Directors Partner, IPP Company	7/26/23
S	40+	State regulator Investment bank consultant	7/21/23

“Qualitative data are data in the form of words” that can consist of interview notes, answers to questions, and accounts of experiences (Bougie & Sekaran, 2020:307). The data collected in this study clearly fit this definition, and the analysis of such qualitative data requires that accepted procedures be followed during its collection, analysis, and interpretation to provide validity, authenticity, credibility, and research strength (Creswell, 2007; Corbin & Strauss, 1990).

To that end, the analysis performed herein followed the six data analysis steps put forth by Creswell (2007) and Corbin and Strauss (1990) for qualitative studies, which are generally similar to those provided by Bougie and Sekaran (2020):

1. Organize and prepare the data for analysis by reviewing the interview notes after each interview to correct hastily written notes for legibility, reflect on what was said during the interview, and ensure that the notes properly reflect what was said in the interview.

2. Become familiar with the interview notes by reading them and reflecting on their overall meaning. Creswell (2007) further recommends that this be done multiple times for each interview over multiple days, each time approaching it with an open mind.

3. Code the data for consistency and similarity, and then label the data with distinguishable codes. Even though coding software was acquired by the researcher, the decision was made to hand-code the data due to the sample size and the narrowly defined topic. Hand coding may take longer when the sample size is

large (Charmaz, 2014), however, the researcher found hand-coding effective for this study.

4. Create general descriptions and categories (themes) that emerge from the data.

5. Analyze and discuss emergent themes and develop a narrative that will represent the data.

6. Bring meaning to the data and provide an interpretation of the data. Describe how the phenomenon was experienced because “the researcher is interested in how the phenomenon is lived” (Giorgi, 2008:40).

Recurring Themes

Several themes emerged during the coding process that appeared in every interview. It is noteworthy that nothing was said in an interview that countered the lived experiences of other interviewees or that affected reaching saturation, as that term is defined in the Chapter 3 section entitled Determination of Sample Size. In that regard, the phenomenological data analysis proceeded straightforwardly, and saturation was reached early in the interview process. Despite saturation being reached, and additional interviews providing repetition of the themes, the interview process continued until all ten interviews were conducted.

The following themes emerged and were universally supported by all the interviewees:

1) The change from cost-of-service regulation to deregulation affected the revenue stream of power plants,

2) This change increased revenue (price and output quantity) uncertainty,

3) This uncertainty increased price and output quantity risk, and

4) Lenders and equity investors made changes in response to the increase in uncertainty and risk.

Each interviewee pointed to one or more phenomenological lived experiences to support the increase in revenue risk arising from the deregulation of the electricity market, and these risks were all consistent with those identified by the researcher in Chapter 2 of this dissertation. The researcher practiced epoché (Creswell, 2007; Creswell & Poth, 2018; Giorgi, 2006, 2008, 2010) during the interviews, let each interviewee discuss what came to their mind, and did not lead an interviewee in the direction of any additional electricity revenue risk items not raised by the interviewee so as to minimize bias. There was a substantial overlap in their responses as is evident in the following summaries. As a group, they addressed the revenue risk categories identified by the researcher in Chapter 2 (and re-presented below for convenience as Table 4-2). It is an observation of the researcher from performing the coding that the interviewees did not discuss the issues evenly in depth. Revenue risk categories 1, 2, and 3 were discussed by the interviewees in greater depth than categories 4 and 5, however, this did not impact the overall results.

The researcher is unable to explain why the interviewees mentioned revenue risk categories 4 and 5 in less depth, but surmises the following:

Table 4-2 Postulated Changes to Revenue Risk Post-Deregulation

1) An exposure to price volatility amplified by the inelasticities of the electricity supply and demand curves 2) An exposure to price competition from existing and future power plants located within the same ISO region. 3) An exposure to baseload output quantity uncertainty due to ISO dispatch rules. 4) An exposure to output quantity uncertainty as retail customers, who are no longer captive, can switch electric suppliers. 5) An exposure to unknown changes in law and regulation regarding the sale of electricity.

1) It is possible that revenue risk category 4 was minimally mentioned because there has not been a rapid flight of retail customers from one company to another in recent years as much as there was when "retail choice" programs were first initiated. Thus, while the risk may exist and may be significant in the future, the present rates of customer retention are not creating an immediate financing problem.

2) It is possible that risk category 5 was minimally mentioned because a recent change in law has not negatively affected the financing of power plants in a material manner. Thus, while the risk may exist and may be significant in the future, it isn't creating an immediate financing problem.

As noted above, the researcher surmises these two explanations. Future research (see Chapter 5) could investigate these issues further and seek adequate support.

Theme #1: Deregulation Affected the Revenue Stream

Emerging from the coding process is that each of the interviewees opined that the change from cost-of-service regulation to deregulation affected the revenue stream of a power plant. Interviewees F, G, K, P, and S (interviewees are not identified by name but by a single letter) each made specific statements regarding deregulation's removal of the revenue guarantees associated with a power plant's capital cost that were an integral part of cost-of-service regulation, and R mentioned the lack of these guarantees on both capital and variable costs. As an illustration, fuel costs are variable costs that were treated as a cost pass-through to the ratepayers under cost-of-service regulation (i.e., added to the price of the electricity as revenue), but under deregulation, the power plant owners assume all fuel cost risk.

Interviewees M and R both noted the change in price volatility that stems from the switch from regulated average cost pricing to deregulated marginal cost pricing which can be evidenced in the ISO bidding systems because the clearing prices (the price of the highest bid power plant being dispatched at that moment) are designed to reflect marginal costs. This change to marginal cost pricing affects both capacity (kW) and energy (kWh) prices, and F, G, H, P, and S all noted how market signals in the deregulated ISO bidding systems are now all short-term (such as every 15 minutes for the kWh energy component) and reflect short term supply and demand inelasticities whereas under cost-of-service regulation the kWh energy prices were typically established annually during rate case hearings. F noted how the bidding system set up by one ISO does not allow capacity (kW) prices to be bid separately and distinct from energy (kWh) prices but must be incorporated into a single daily energy price. R noted how deregulation led to more competition which fueled "the juices of capitalism" and led to lower prices for electricity. Lower electricity prices from competition were also discussed by B, C, F, G, H, and S. In summary, all of the interviewees stated at least one way in which deregulation changed the revenue stream for power plants and none of the interviewees stated anything to the contrary.

Theme #2: Increase in Uncertainty

The coding process showed that each of the interviewees made at least one statement that the change from regulation to deregulation increased revenue (price and output quantity) uncertainty. Some of this uncertainty comes from the removal of cost-of-service regulatory set prices which was noted by P, F, G, and R. Also, F, G, H, P, and S all mentioned that market signals in the IOS bidding systems are now short-term (as discussed in the preceding section), thus adding uncertainty to any projection of long-term electricity prices used to secure debt and equity financing. M noted that the process of bidding, in and of itself, adds uncertainty to the revenue stream because a power plant never knows from day to day which bids, theirs and those of its competitors, will be accepted, nor do they ever know the relationship of their bid to others. H and P both noted that output quantity is a function of bid prices, and, similar to the preceding statement by M, power plant operators are blind to the prices bid by individual competitors which creates uncertainty. P notes that the power plant operator can regain some control over the output quantity by bidding a very low price to the ISO to ensure baseload operation "but loses all price certainty in doing so." This is due to the tradeoff between price and quantity, as discussed in the Chapter 2 section entitled Discussion of Risk and Uncertainty, in the daily electricity bids made by the power plant operators to the ISO. At the other end of the spectrum, a power plant operator can seek price certainty (submit a bid that covers its costs), but in doing so loses all quantity certainty because that price may be too high in a competitive market to provide the needed quantity of hours of generation.

Interviewee B noted that under deregulation the introduction of new, competing technology adds uncertainty compared to cost-of-service regulation where inefficient plants were able to operate so long as the plant was deemed "used and useful." K noted that there is greater uncertainty under deregulation for those power plants, such as coal and natural gas, that now have to maintain a long-term "spark spread" between revenue and fuel costs in order to pay for the plant's fixed capital costs. C noted that electricity price hedges to protect this spark spread, specifically, and to insure against price volatility, in general, are not available for longer than a year and, thus, the increase in long-term uncertainty cannot be eliminated and now resides with the power plant equity investors and not the retail consumers.

Providing more support for this increase in uncertainty, a majority of the interviewees (B, C, G, H, K, and S) point to the efforts of some IPPs to sell all or a portion of their electric output via long-term contracts directly to large, credit-worthy industrial companies or sell directly via long-term contracts to regulated utilities that are looking to add renewable energy (specifically wind and solar) into their generation mix pursuant to regulatory directives. This approach bypasses the uncertainty of the ISO bidding systems but the opportunities for this approach are limited. Also, when these long-term contracts are entered into pursuant to a regulatory directive, S noted that the regulatory "stamp of approval" can add additional long-term certainty compared to the ISO bidding systems.

In summary, all the interviewees stated at least one way in which the change from regulation to deregulation increased revenue (price and output quantity) uncertainty. In addition, none of the interviewees stated anything to the contrary.

Theme #3: Increase in Risk

The coding process showed that it was universally supported by the interviewees that the change from cost-of-service regulation to deregulation increased revenue (price and output quantity) risk. As noted by F, "without used-and-useful, risk goes up". B noted that the "risk profile changed for the entire industry", and H, K, P, and S all noted that without cost-of-service regulation significant risks shifted from the utility's ratepayers to the investors. B and C noted that the increase in risk was evidenced by the across-the-board downgrading of utility bond ratings by the rating agencies after deregulation. B noted that some lenders changed their practices, in response to the increase in risk after deregulation, to only provide financing for projects that have established a multi-year operating history and by doing so, "reduce the risk profile". In addition, B noted that the lenders now needed to consider "more variables in their loan analyses" than before, and this increase in complication added to the lenders' risks.

Additional support for the increase in revenue risk was that numerous utilities sold off their generation assets, as discussed by B, K, R, and S. According to R, "numerous utilities exited the [electric generation] business because they didn't have the risk appetite" that came with deregulation. A first-hand account of this selling-off of generating assets was provided by K who, in addition to being an investment banker, also sits on the Board of Directors of an electric utility that sold off its generating assets in response to deregulation.

Another first-hand account comes from S who provided expert testimony before the New York Public Service Commission (NYPSC) in regard to multiple utilities in New York State auctioning off their nuclear power plant assets because of the change in revenue risk being shifted from the utility's ratepayers to the utilities' stockholders. S believes that the testimonies of multiple parties in NYPSC Case 98-E-0405 and Case 0l-E-0011 strongly suggest that deregulation increased revenue risk, and points to the difference in the two auction bid prices received from Constellation Energy (the winning bidder for two of the nuclear plants). One bid reflected future electricity sales into the deregulated ISO bidding system and the other bid reflected future electricity sales pursuant to a long-term power purchase agreement (PPA) to be made with the multiple utilities that sold the nuclear units. The PPA provided that the two nuclear plants would run as baseload units for ten years, thus eliminating output quantity risk during that period. In addition, the PPA also provided that the output would be sold at a fixed price during those ten years, thus reducing price risk. It is important to note that the fixed price for electricity over the ten-year period was neither higher nor lower than the price projection made by the NYPSC and, as such, only served to reduce price risk. Therefore, the reduction of revenue risk by incorporating a PPA into their bid (while all else was held constant in the two bids) resulted in a higher bid price. This is fully consistent with the discussion in Chapter 2 and fully supportive of the proposed model. That is, the reduction in risk resulted in a lower required ROE, and in turn, a lower WACC, which increased the value of the power plants.

In summary, the lived experiences of the ten interviewees clearly support the proposition that the change from regulation to deregulation increased revenue risk. Moreover, none of the interviewees stated anything that suggested otherwise.

Theme #4: Lenders and Equity Investors Made Changes in Response to the Increase in Uncertainty and Risk

Emerging from the coding process was that there was unanimous support by the interviewees that the power plant lenders and equity investors were impacted by the increase in revenue risk. Some of the interviewees initially responded with very short, emphatic answers to this question (F said “Oh, sure, yeah”, C and P both responded with the same word "Absolutely", and H responded with a resounding "Yes"), and the tone, quickness, expressiveness, and certainty of these responses were noted by the researcher. The researcher perceived that the interview question (regarding revenue risk impacting power plant lenders and equity investors) triggered an emotional response.

Interviewees C, F, G, and M all expressed that both lenders and equity investors experience more risk under deregulation. As noted by F, both lenders and equity investors were affected by the removal of regulated cost-of-service guarantees. K and M said that lenders responded to this risk by increasing interest rates and K noted that this negatively affected debt coverage ratios (DCR). K recounted his involvement with the financing of two power plants that were similar except that one project had a PPA and the other sold its output into the competitive wholesale market. K noted that the power plant with the PPA was perceived by his lending team as having less risk. The power plant that sold its output into the competitive wholesale market had stricter loan covenants imposed on it including a higher DCR. This is as predicted by the proposed model in Chapter 3, i.e., higher perceived risk results in a higher DCR.

In addition, seven of the interviewees (B, C, G, H, K, R, and S) recalled situations when lenders mandated lower D:E ratios to compensate for the increased risk, again as predicted by the proposed model in Chapter 3. Another two interviewees (M and P) stated that they believed this practice did occur but couldn't recall specific instances where they witnessed this behavior by the banks. R also said that the lenders reacted to the increase in risk by cutting back on the number of loans, and these loans often were of a shorter term. While the shorter term reduced risk to the lenders, it negatively impacted the debt coverage ability of the projects which led to a lower D:E ratio, again consistent with the proposed model.

On the equity side, C, K, and R each noted that the equity investors sought higher minimum ROEs to compensate for the increased risk. Similarly, G stated that the higher minimum ROEs are being driven by the increase in uncertainty. This is exactly what is predicted by the proposed model.

Also on the equity side, S pointed to testimony that was given by a utility executive in NYPSC Case 0l-E-0011 that nuclear plants were designed for an earlier regulatory structure (i.e., where baseload operation was at the discretion of the utility) and not designed for the new deregulated structure where the nuclear plants are dispatched by the ISO. As a result, this testimony stated that nuclear power plants now require a higher ROE to account for this output quantity risk. Similar thoughts were echoed by C; that a nuclear plant in a deregulated environment would need a higher ROE than other types of power plants to account for output quantity risk, and opined (based on his current job establishing credit ratings) that any company that chooses to pursue the development of a nuclear plant would have its debt downgraded due to the risk of being able to achieve this higher ROE. Once again, this is consistent with the proposed model.

In addition to many utilities selling off their generating assets due to the increased risk, which was discussed in the previous section, R stated that numerous deregulated IPP companies also exited the power plant development business because they did not have the appetite for the increase in revenue risk. To put this in context, under the first wave of deregulation after the passage of the Public Utility Regulatory Policies Act of 1978 (PURPA) discussed in Chapter 2, the deregulated IPP companies were legally entitled to a long-term power sales agreement with the local electric utility; typically 15 years. However, under the second wave of deregulation after the passage of the Energy Policy Act of 1992 (EPA of 1992) also discussed in Chapter 2, IPP companies were no longer legally entitled to these long-term contracts. The legislation replaced them with the creation of the ISO bidding systems. The change from the long-term contracts to the ISO bidding systems increased revenue risk, and as discussed by R, a number of firms exited the business because they could no longer earn a return on equity commensurate with the increased risk. C noted that the introduction of competition into the deregulated markets lowered electric prices which lowered IRRs, and this exacerbated the inability of some IPPs to earn a return on equity commensurate with the increased risk.

Finally, M believes that the response of equity investors to this increased risk has been the “drive to wind and solar”. Per M, wind and solar do not have fuel risk, are less complicated to construct and operate, and have fewer moving parts, thus reducing some amount of risk to the equity investors. In a similar vein, G noted that from a lender’s perspective, the risk profiles of wind and solar are the “closest thing there is in the energy business to an annuity”.

It is noted that the above comments regarding the impact of revenue risk on the Minimum Required DCR and Minimum Required ROE provide support for that section of the proposed model situated between Research Areas #1 and #2. See Figure 4-1. As discussed at the end of Chapter 3, no research was proposed for this section of the model because these relationships have been well-researched and well-established over the past four decades and it is not envisioned that this dissertation would contribute anything new to that body of knowledge. While this study did not intend to investigate this specific section of the model, the comments made by the interviewees did emerge as a consistent theme during the interviews, and the researcher has chosen to report them because they confirm the well-researched, well-established financial relationships, and because they help illuminate the causal flow through the model.

To summarize this section, whether it is the "drive to wind and solar", the exiting of some firms from the market, the selling off of generating assets, or the reduction in D:E ratios to name a few, there are sufficient observable "fingerprints left behind at the scene" to find support for the proposition that electricity deregulation did increase price risk and output quantity risk.

The coded remarks sorted by interviewee are presented in Appendix E.

Discussion and Synthesis of Research Area #1

As discussed above, the relationship between electricity deregulation and revenue (price and quantity) risk is supported, and this support was found via a qualitative phenomenology study that interviewed ten people who had significant experience with the financing of electric generation projects, familiarity with electricity deregulation, and familiarity with the financing risks that are specific to the electric industry. Specifically, electricity deregulation increased revenue risk due to several factors including an increase in price volatility arising from the ISO bidding systems, the creation of shorter-term price signals, an increase in long-term uncertainty, a decrease in quantity certainty, an increase in the exposure to technology change, the removal of regulated revenue guarantees, and the shifting of risks from the utility's ratepayers to the investors.

As discussed in Chapter 2 and earlier in this chapter, the design of the competitive ISO bidding systems creates a tradeoff between the two components of revenue: price and quantity. On one hand, a power plant operator can gain some certainty over the quantity of output generated by the power plant by bidding a very low price each day to the ISO to ensure baseload operation but loses all price certainty in doing so because the actual prices it receives from the ISO are based on the ISO's moment-by-moment systemwide marginal cost. At the other end of the spectrum, a power plant operator can seek price certainty by submitting a bid that covers its costs, but in doing so loses all quantity certainty because that price may be too high in a competitive market to provide the needed quantity of hours of generation to earn a return on the investment. Thus, inherent to this increase in revenue risk is the increase in price risk and quantity risk.

Evidence of the existence of this increase in price and quantity risk was provided by the study participants through several phenomenological lived experiences including a downgrading of utility bond ratings by the rating agencies right after the passage of the EPA of 1992, a change in lending practices regarding an asset's operating experience, loan term length, interest rates, higher DCR and lower D:E ratios, the selling off of generating assets by utilities, a difference in power plant valuation with and without a long-term PPA, the exiting of multiple IPP companies from the industry due to an increase in higher minimum ROEs, and the drive to less complicated technologies such as wind and solar. Some of these lived experiences directly relate to lenders and some of these lived experiences directly relate to equity owners, but most of the lived experiences listed above relate to both lenders and equity owners.

Therefore, the qualitative phenomenological study performed for Research Area #1 provided the answer to RQ#1 put forth in Chapter 1: *Does electricity deregulation increase power plant revenue risk relative to cost-of-service regulation, and if so, why?* Clearly, the answer is yes, and for the reasons provided above.

Ontological realism pushes the researcher to confirm that their own lived experience is not simply internal but exists independently (Maxwell, 2013). The researcher "seek[s] external validation for [their] perceptions and ongoing theories" (Maxwell, 2013:36) by examining whether their lived experience is similar to others. According to Maxwell (2013), interview data obtained in a phenomenological study can be used to provide a confirmatory test of an explicit hypothesis based on an existing theory developed by the researcher, rather than for the development of new questions or new theories as is the process with Grounded Theory. Such is the case here. The researcher had lived experiences that were in response to the phenomenon of deregulation (see the Chapter 3 section entitled Researcher Positionality), which led to hypotheses 1a, 1b, 2a, and 2b provided in Chapter 2 of this dissertation. The phenomenological study performed for Research Area #1 provided a confirmatory test of the researcher's lived experiences and found sufficient support for the following hypotheses from Chapter 2:

H1a: Electricity deregulation increases the price risk perceived by power plant lenders.

H1b: Electricity deregulation increases the output quantity risk perceived by power plant lenders.

H2a: Electricity deregulation increases the price risk perceived by power plant equity participants.

H2b: Electricity deregulation increases the output quantity risk perceived by power plant equity participants.

Research Area #2

As noted at the beginning of this chapter, this dissertation has two distinct areas of research. The objective of Research Area #2 was to find support for the proposed Modified Investment Opportunity Schedule (MIOS) concept. More specifically, it was to investigate the willingness of investors to provide equity into a project-financed investment as a function of the IRR and the WACC of the individual project, and not the IRR of the individual project and the WACC of the investing company as first put forth by Coase (1937) for balance-sheet financing. See the rightward area encircled within Figure 4-1. To accomplish this, Research Area #2 consisted of a quantitative Paired Comparison Best-Worst Scaling (PCBWS) analysis as described in Chapter 3.

PCBWS is well suited for this analysis because it calculates both a rank ordering of the investment opportunities that are available to a company and the placement of the equilibrium point within that ranking. Thus, to address Hypotheses 5a, the PCBWS analysis yields the boundary or extent of the firm, and to address Hypotheses 5b, the analysis identifies which investments should be internalized by the firm.

The equilibrium point represents the maximum price that investors should be willing to pay for an investment. As such, classical economics utility theory states that investors should be willing to invest when IRR is greater than the cost of capital (i.e., IRR>WACC) and not be willing to invest when IRR is less than the cost of capital (i.e., IRR<WACC). However, this willingness to invest is affected by risk aversion in accordance with Prospect Theory, and the PCBWS method can also be structured to yield information about the respondents' risk aversion.

PCBWS respondents are given a series of direct comparisons between only two items and are asked to select their preference in each set (Kingsley & Brown, 2013; USDA, 2023). In each direct comparison, the respondent's selected preference is the 'best' in that set while the unselected item is the 'worst' in that set (Cohen & Orme, 2004; Massey et al., 2015). It is a binary choice.

Repeating the experiment multiple times using different combinations of treatments provides even greater support for the MIOS construct. As detailed in Chapter 3, this study made use of three sets of 2x3 manipulations, plus the 'no investment' option, thus presenting each respondent with 21 direct comparisons for each of the three sets of manipulations. A minimum of 60 respondents was established as the sample size for each of the three sets of manipulations (Bougie & Sekaran, 2020; Brown & Peterson, 2009), thus yielding a total of a minimum of 180 respondents.

Description of the Survey Instrument

An online survey instrument was created by the researcher using the Qualtrics platform. Access to this platform is provided by the Florida Institute of Technology for use by its students and faculty, and screenshots of the online survey instrument used in this study can be found in Appendix B. The use of online surveys for academic research is commonplace and well-accepted (Berinsky et al., 2014; Sharpe-Wessling et al., 2017; Strickland & Stoops, 2020), however, certain protections such as screening questions and attention checks, as discussed below, are encouraged to ensure data validity (Berinsky et al., 2014; Danilova et al., 2022; Desimone et al., 2015; Toich et al., 2021; Verbree et al., 2020).

The survey instrument created for this study requested each respondent's consent to their voluntary agreement to participate in the interview in accordance with the recommendations of Bougie and Sekaran (2020), Creswell (2007), and Creswell and Poth (2018), and each respondent was then informed of the measures being taken to ensure confidentiality in accordance with the Florida Institute of Technology Institutional Review Board (IRB) submission and approval for this analysis. The survey instrument was designed so that the failure of the respondent to provide consent to their voluntary participation resulted in the immediate disqualification of the respondent.

The survey instrument then requested specific information about the respondents' educational background and work experience. A selection of twelve academic majors was presented as possible choices to help ensure that the respondents could not guess the educational requirements of the study. The survey instrument was designed so that a respondent without an academic degree in finance or economics and at least five years of business investment work experience was immediately disqualified. Setting a minimum level of financial knowledge and investment experience reduces sampling error (Bansal, 2017) as discussed in the Chapter 3 section entitled Determination of Target Sample Group.

This was followed in the survey by five screener questions to determine each respondent's understanding of financial concepts. The use of screener questions is recommended to ensure that the respondents to a survey hold specific expertise (Danilova et al., 2022; Sharpe-Wessling et al., 2017; Strickland & Stoops, 2020). All five questions needed to be answered correctly, and if not, the survey instrument was designed to immediately 'screen out' (disqualify) that respondent. The five screener questions are presented in Table 4-3.

Table 4-3 Screener Questions to Test Financial Knowledge

1. If an investment has an IRR of 10% and its WACC is 12%, then:
   - The D:E Ratio is greater than zero.
   - The D:E Ratio is less than zero.
   - The NPV is greater than zero.
   - The NPV is less than zero.

2. In the CAPM equation, beta represents…
   - The volatility of a company's stock relative to the overall market.
   - The daily movement of the market's composite average.
   - The allocation percentage of each capital asset in a portfolio.
   - The slope of the line that is equal to the current price of a capital asset divided by its initial price.

3. Consider a capital investment with a known capital cost that is to be funded by both debt and equity. Which of the following statements is true?
   - If the D:E ratio is increased, then the projected IRR will increase.
   - If the D:E ratio is increased, then the projected IRR will decrease.
   - If the D:E ratio is increased, then the projected ROE will increase.
   - If the D:E ratio is increased, then the projected ROE will decrease.

4. Why is depreciation added back in a cash flow analysis?
   - Because depreciation is added back in the Income Statement.
   - Because assets get depreciated and are treated as a sunk cost.
   - Because assets get depreciated and have negative cash flows.
   - Because depreciation is a non-cash charge on an income statement.

5. EBIT is an abbreviation for which of the following?
   - Equity Before Income and Taxes
   - Earnings Before Interest and Taxes
   - Expenses Based on Interest and Taxes
   - Expenditures Based on Income and Taxes

These five screener questions were pre-tested on two different groups; one group consisted of six people who met the minimum sampling requirements (an academic degree in finance or economics and at least five years of business investment work experience) and the other group consisted of six people without an academic background in finance or economics and without business investment work experience. All of the people in the two groups were well known to the researcher and, as such, their academic and work experience was verified. The first group was able to correctly answer all five screener questions and the second group averaged two correct questions with a range of zero to three correct. The screener questions were also tested by an industrial organization management professor with no finance experience but making use of the ChatGPT software. The professor was unable to pass all five of the screener questions using ChatGPT,
thereby adding confidence to the viability of the screener questions to distinguish between respondents who held the requisite expertise from those who did not.

Respondents who provided the requested consent of voluntary participation, who met the academic and work experience requirements, and who correctly answered all five screener questions were then presented with the survey instructions/scenario description, followed by the 21 PCBWS direct comparisons. There are no guarantees that a respondent, even after successfully hurdling the screener competency questions, will complete a survey thoughtfully and effortfully, and so to minimize this problem, the use of attention checks within the survey instrument has emerged as best practice (Berinsky et al.,2014; Desimone et al., 2015; Toich et al., 2021; Verbree et al., 2020).

One attention check was inserted at the end of the instructions/scenario description to help ensure that they were carefully read. Two more attention checks were embedded within the 21 PCBWS direct comparisons. The design of the attention checks followed the guidance of Berinsky et al. (2014), Desimone et al. (2015), Toich et al. (2021), and Verbree et al. (2020). The failure of a respondent to correctly answer any one of the three attention checks resulted in disqualification.

Three versions of the survey instrument were created; one for each 2x3 manipulation set. See Table 3-1 for the manipulated experimental conditions identified as Matrix A, Matrix B, and Matrix C. Everything about the three versions of the survey instrument was identical (instructions, question sequence, font size, font style, screener questions, method of delivery, and method of data collection)¸ except for the IRR and WACC values that were unique to each manipulation set.

Finally, placed at the end of the survey instrument were a series of seven questions that did not directly relate to this study but might be used for future study. These questions, in general, related to the ease and confidence of the respondents in completing the survey and to their experience with electric utility investments.

All questions in the survey instrument were presented to the respondent one at a time and the survey instrument was constructed so that respondents could not go back to revise earlier answers. The survey was also set up so that respondents could visually track their percentage of completion as they progressed through the survey. The Qualtrics platform also provides respondents with the ability to take the survey on their computer or on their cell phone, and the researcher ensured that the survey instrument was properly formatted for font style and size, and general readability using either device. Adjustments to font size and the spacing between numerical values were made by the researcher to ensure that all questions were formatted and presented similarly on either technology to eliminate bias.

Prior to distribution, the researcher pretested the survey instrument to confirm readability, interpretation of the instructions/scenario description, and logic flow including the logic programming of the disqualification questions. The pretesting, which included the participation of the researcher's committee chair and several graduate business students known to the researcher, resulted in minor adjustments to the instructions and to the qualification logic flow. The survey was also pretested to determine the approximate expected length of time to complete (15 to 20 minutes) which is consistent with recommendations to minimize survey fatigue (Ambler et al., 2021; Jeong et al., 2023).

Distribution of the Survey and Collection of the Data

A market research firm was retained to distribute the survey as proposed in Chapter 3. Telephone interviews were held, and proposals were collected from four market research companies which led to the selection of IPSOS-Insight, LLC, a subsidiary of IPSOS S.A., a publicly traded market research firm headquartered in France with over a hundred international offices including offices in the U.S. The company's policy on data privacy and data protection is presented on its website (https://www.ipsos.com/en-us).

An anonymous online link to each of the three versions of the survey (Matrix A, Matrix B, and Matrix C) was generated by Qualtrics, and these links were distributed online by IPSOS to the potential respondents within the company's survey panels. The researcher was not privy to the specific mechanics of how IPSOS distributed the survey links, such as the company's distribution algorithms. Per IPSOS, these algorithms enabled the targeting of potential respondents based on academic and work experience previously reported to IPSOS. IPSOS confirmed that the surveys were distributed only to respondents within the U.S. This intermediary use of a market research firm also enabled the study to be performed 'double-blind' (Marshall et al., 2023) as the researcher and the respondents were not provided any information that could be used to determine the other's identity, and any bias arising from the physical presence of the researcher or respondent was avoided.

IPSOS was retained solely to perform the survey distribution and did not provide data analysis. All data from the respondents solicited by IPSOS were collected on the Qualtrics platform, and the researcher confirmed that there were not any duplicate IP addresses among the respondents. The researcher then reviewed the collected data for incompletes, disqualifications, and low-quality data responses. A total of 378 responses were collected between August 28 and

September 11, 2023, which included 124 responses for Matrix A, 126 for Matrix B, and 128 for Matrix C.

Of these, 193 were rejected by the researcher (64 rejections for Matrix A, 66 rejections for Matrix B, and 63 rejections for Matrix C) for the disqualification reasons described previously (i.e., failure to consent to voluntary participation, failure to meet the academic and work experience requirements, failure to correctly answer all five screener competency questions, and the failure of the attention checks) as well as for low-quality responses such as incomplete surveys, 'long-stringing' and 'Christmas tree' responses (DeSimone et al., 2015; DeSimone & Harms, 2017). One hundred and eighty-five responses were retained as qualified completed surveys (60 for Matrix A, 60 for Matrix B, and 65 for Matrix C). The responses arrived over a two-week period which afforded the researcher the opportunity to accept or reject responses as qualified or disqualified on a daily basis. The researcher aimed to cease data collection as soon as 60 qualified completed surveys were obtained for each matrix. While this was achieved with Matrices A and B, a total of 65 qualified completed surveys were collected for Matric C before the researcher was able to shut down data collection. The additional five responses met the survey requirements and, as such, were retained as there was no valid reason for disqualification from the sample.

Demographics

The minimum requirements to participate in the survey were an academic degree in Economics or Finance (bachelor's degree and above), and a minimum of five years of business investment work experience. Of the 185 qualified responses, 41% self-reported a degree in Economics and 59% self-reported a degree in Finance. For both Economics and Finance, the mode for the level of academic attainment was a Master's (MA, MS, MBA) degree. See Table 4-4.

Table 4-4 Demographics

Education Demographics

	Matrix A		Matrix B		Matrix C		Total		Total (percent)	
	Economics	Finance	Economics	Finance	Economics	Finance	Economics	Finance	Economics	Finance
Bachelors	6	8	2	10	0	20	8	38	4.3%	20.5%
Masters	32	12	12	26	14	18	58	56	31.4%	30.3%
Doctorate	1	1	3	7	6	7	10	15	5.4%	8.1%

Investment Experience Demographics

	Matrix A	Matrix B	Matrix C	Total	Total, %
General Business Investment Experience, years					
5-10	10	25	25	60	32.4%
11-15	43	33	34	110	59.5%
16+	7	2	6	15	8.1%
Project Investment Experience, years					
0-1	0	0	0	0	0%
2-5	13	15	17	45	24.3%
6-10	38	34	37	109	58.9%
11+	9	11	11	31	16.8%

With respect to general business investment work experience, the mode was 11-15 years (60% of the responses) followed by 5-10 years (32%), and then by 16+ years (8%). The mode of 11-15 years of experience was consistent across all three of the data manipulation sets. Separate from general business investment work experience, all respondents indicated some work experience with project financing with a mode of 6-10 years of experience. This mode of 6-10 years of project finance experience was also consistent across all three of the data manipulation sets.

The respondents also self-reported a high level of responsibility regarding investment decision-making. As shown in Table 4-5, a significant majority (80.0%) responded that they are decision-makers regarding potential investments, while 10.8% selected that they make recommendations for submittal to the decision-makers and 9.2% reported that they perform investment analyses for submittal to the decision-makers.

Table 4-5 Investment Experience

Which of the following most closely describes your work responsibilities regarding business or financial investments?

	Matrix A	Matrix B	Matrix C	Total	Total, %
I make or made decisions regarding potential investments	53	46	49	148	80.0%
I make or made recommendations of potential investments for submittal to decision-makers	5	9	6	20	10.8%
I perform or performed analyses of potential investments for submittal to decision-makers	2	5	10	17	9.2%

Data Reduction

The data for each of the three matrices was downloaded from Qualtrics in Excel format for analysis by the researcher. From this, another Excel spreadsheet was created for each matrix containing only the qualified responses. The data for each respondent's 21 direct comparisons (see Appendix F) was then used to create an output matrix of ranked preferences for each respondent similar to that presented in Table 3-2 (and re-presented below for convenience as Table 4-6). These ranked preferences were added together for all the respondents within each matrix and then divided by the number of respondents to obtain the average ranked preferences for each matrix as per Brown and Peterson (2009) and Kingsley and Brown (2010). This data was then plotted as Ranking vs. IRR:WACC Ratio for each matrix for both predicted and experimental values, and regressed lines were fitted to both the predicted and experimental values. See Tables 4-7, 4-8, and 4-9. These regressed lines were then used to calculate the experimentally determined equilibrium point, as discussed in a later section.

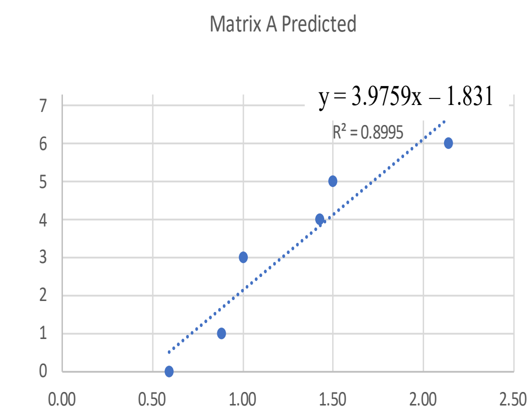
Table 4-6 Typical Survey Respondent Output Matrix of Ranked Preferences

		Investment						
		1	2	3	4	5	6	0
Investment	1	-	0	0	1	1	0	0
	2	1	-	0	1	1	0	0
	3	1	1	-	1	1	1	1
	4	0	0	0	-	0	0	0
	5	0	0	0	1	-	0	0
	6	1	1	0	1	1	-	1
	0	1	1	0	1	1	0	-
	sum	4	3	0	6	5	1	2

Next, the output matrix of ranked preferences for each respondent was used to plot Ranking vs. IRR:WACC Ratio for each individual respondent. A regressed line was fit to each, and the slope of each individual regressed line was calculated (see Appendix F). The numerical values of these individually calculated slopes were populated into Excel CSV files (60 data points each for Matrices A and B, and 65 data points for Matrix C).

Table 4-7 The Experimental vs. Predicted Rankings Matrix A (N=60)

Investment-->	**1**	**2**	**3**	**4**	**5**	**6**	**0**
Sum	241	168	0	360	291	60	140
Avg	4.017	2.800	0.000	6.000	4.850	1.000	2.333
Predicted	4	3	0	6	5	1	2



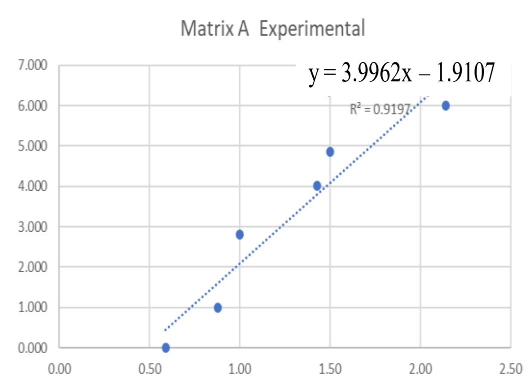
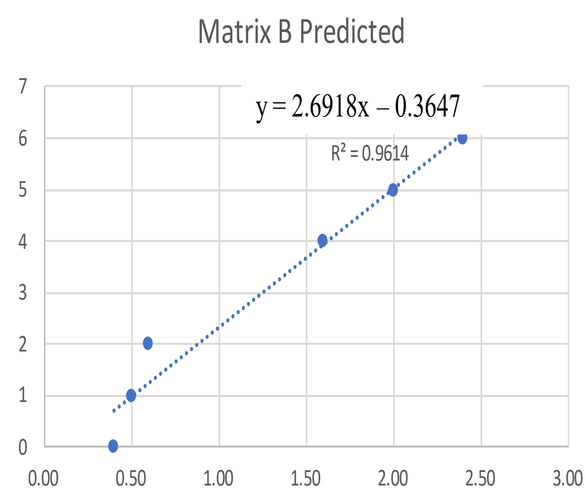


Table 4-8 The Experimental vs. Predicted Rankings
Matrix B (N=60)

Investment-->	**1**	**2**	**3**	**4**	**5**	**6**	**0**
Sum	239	300	360	0	60	120	181
Avg	3.983	5.000	6.000	0.000	1.000	2.000	3.017
Predicted	4	5	6	0	1	2	3



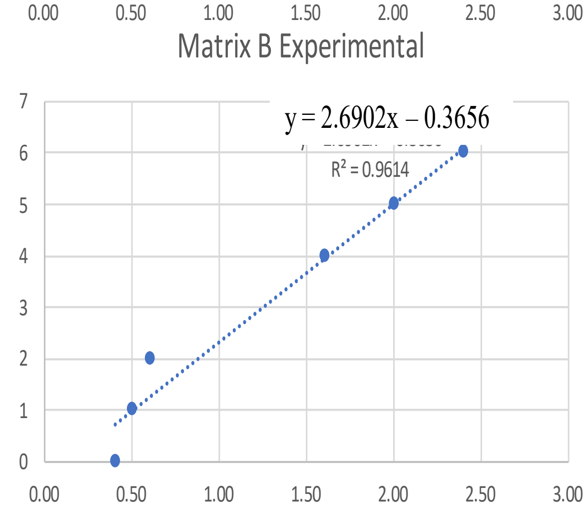
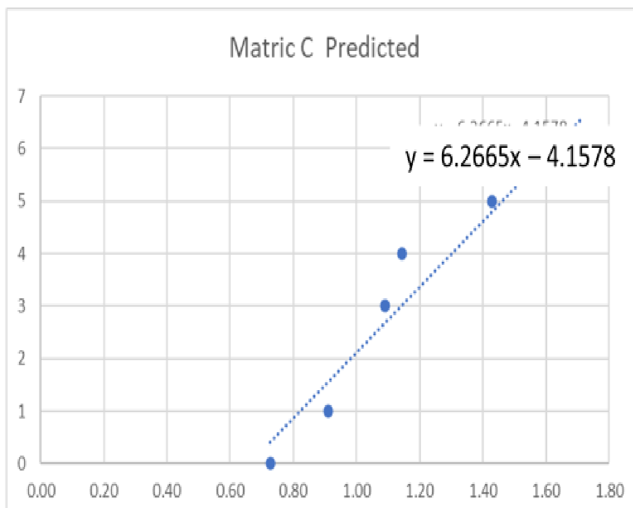
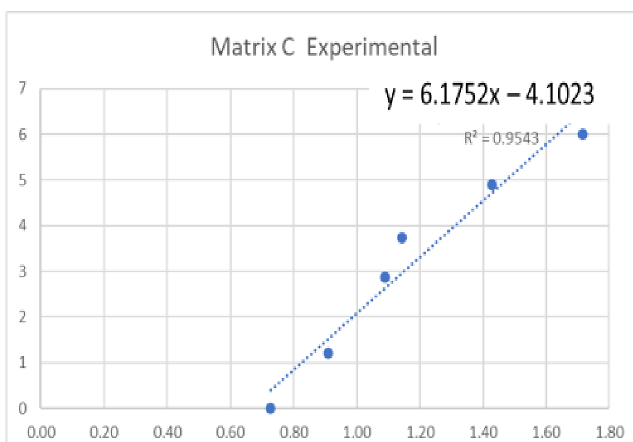


**Table 4-9 The Experimental vs. Predicted Rankings
Matrix C (N=65)**

Investment-->	1	2	3	4	5	6	0
Sum	242	319	390	0	78	186	150
Avg	3.723	4.908	6.000	0.000	1.200	2.862	2.308
Predicted	4	5	6	0	1	3	2





Statistical Analyses

The Excel CSV files for each matrix were read by a statistical software package (JASP 18.1) to compare the slope of the line obtained experimentally to the slope of the line predicted by MIOS to test the following hypotheses (separately for each of the three matrices):

H_0: β equals the slope of the line as predicted by the MIOS.

H_{alt}: β does not equal the slope of the line as predicted by the MIOS.

In addition, for Matrix A which included a specific direct comparison for the purpose of evaluating the impact of Prospect Theory (investment #2 with an IRR:WACC Ratio = 1 against the 'no investment' option) as discussed in Chapter 3 section entitled Manipulations:

H_0: β equals the slope of the line as predicted by the MIOS when incorporating Prospect Theory.

H_{alt}: β does not equal the slope of the line as predicted by the MIOS when incorporating Prospect Theory.

As a first step in analyzing the data, the Shapiro-Wilks test was employed which indicated that all three data sets were not normally distributed, and this was visually confirmed by looking at the Distribution plots and the Q-Q plots (Frost, 2020). Normality may not be an issue when the test sample is sufficiently large and, given a sufficiently large sample, the sampling distribution will approximate a normal distribution (Frost, 2020; Harris & Hardin, 2013; Neuhäuser, 2015). However, there is no agreement on how large a test sample needs to be to approximate normality, and computer simulation suggests it is case-specific (Neuhäuser, 2015). Therefore, in this study, the test sample of 60 may or may not be sufficiently large enough for using a parametric t-test.

A nonparametric test, such as the Wilcoxon signed rank test, is recommended in lieu of the t-test when data is not normally distributed, when there are outliers, or when ordinal data is used. Parametric tests such as the t-test require a normal distribution of continuous data whereas nonparametric tests can also analyze ordinal and ranked data (Frost, 2020; Harris & Hardin, 2013; Kitani & Murakami, 2022; Neuhäuser, 2015; Rosenblatt & Benjamini, 2018). Also, because nonparametric tests evaluate the median and not the mean, they can reduce the impact of outliers in comparison to parametric tests such as the t-test (Frost, 2020; Kitani & Murakami, 2022; Neuhäuser, 2015). Under instances of non-normality, the Wilcoxon signed rank test is more powerful than the t-test" (Neuhäuser, 2015; Rosenblatt & Benjamini, 2018). Similarly, Kitani and Murakami (2022) provide an overview of various studies that indicate the Wilcoxon signed rank test shows increased performance over the t-test when normality cannot be assumed.

The calculated slopes of Ranking vs. IRR:WACC Ratio may look like continuous values, but they are calculated from ordinal preference rankings. This results in a discrete set of possible values for the slopes, and this also points to the use of the nonparametric Wilcoxon signed rank test.

Therefore, because of potential non-normality concerns and because the paired comparison rankings are ordinal, both the parametric one-sample t-test and the non-parametric Wilcoxon signed rank test were used to compare the experimentally derived slopes to the MIOS predicted slopes.

For Matrix A, the results of both the t-test and the Wilcoxon test suggest rejecting the null hypothesis for both boundary conditions, and thus conclude that 1) there is a significant difference ($\alpha = 0.05$) between the slope of the experimentally calculated line and the slope of the predicted MIOS line, 2) there is a significant difference ($\alpha = 0.05$) between the slope of the experimentally calculated line and the slope of the predicted MIOS line when incorporating Prospect Theory, and 3) these results provide statistical support that the slope of the experimentally calculated line lies between the boundary conditions of a) the slope of the predicted MIOS line and b) the slope of the predicted MIOS line when incorporating Prospect Theory. See Figures 4-2, 4-3, and 4-4 which contain the statistical results including the p values. This is the expected outcome based on Prospect Theory, i.e., that the experimental results would lie between the two boundary conditions. See Table 4-10 which shows the experimental slope situated between the two predicted slopes. Therefore, this supports the prediction in Chapter 3 that the slope of the experimental line should fall somewhere between the two, and thus the MIOS accurately predicted the ranking of the project-financed investments.

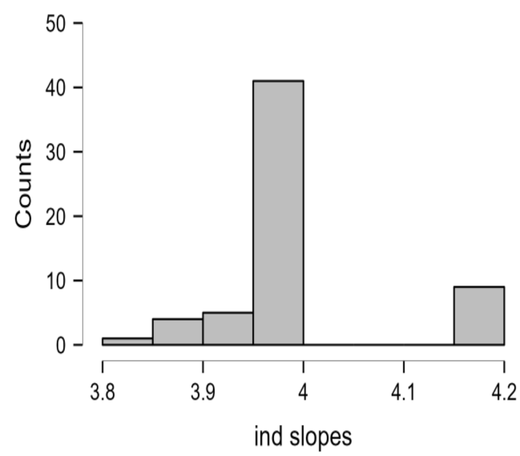
Table 4-10 Matrix A Results

Slope of the line predicted by MIOS with Prospect Theory	4.144
Experimental Mean (relevant to t-test)	3.996
Experimental Median (relevant to Wilcoxon test)	3.985
Slope of the line predicted by MIOS	3.976

Figure 4-2 Matrix A

Descriptive Statistics

	ind slopes	
Valid	60	
Missing	0	
Median	3.985	
Mean	3.996	
Std. Deviation	0.075	
Shapiro-Wilk	0.711	
P-value of Shapiro-Wilk	< .001	1.442×10^{-9}
Minimum	3.825	
Maximum	4.153	



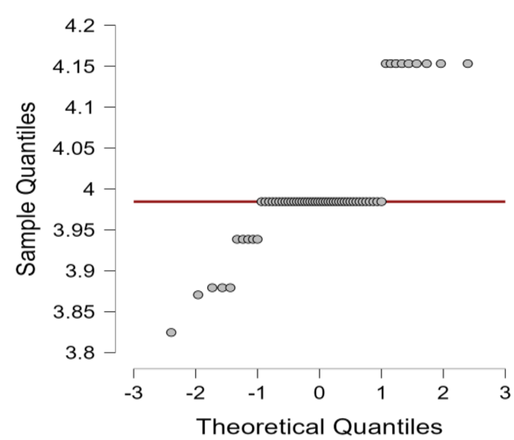
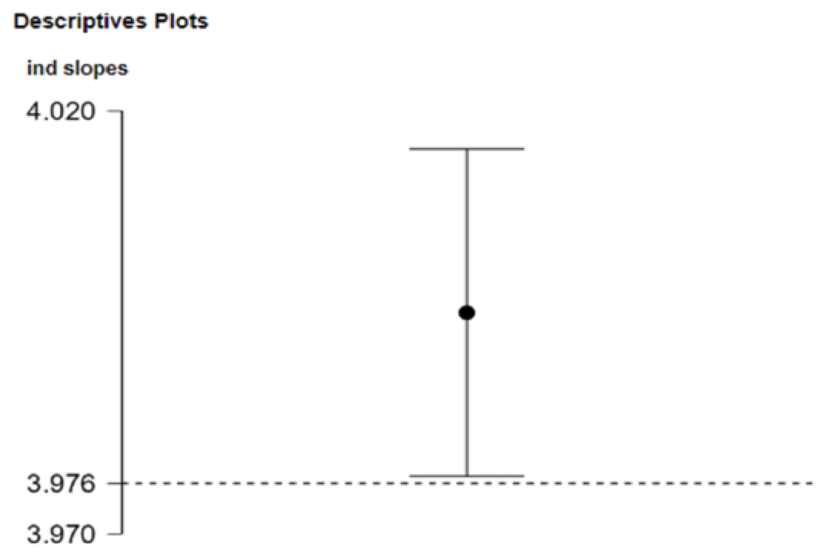


Figure 4-3 Matrix A

One Sample T-Test

	Test	Statistic	df	p
ind slopes	Student	2.086	59	0.041
	Wilcoxon	1365.000		5.657×10^{-4}

Note. For the Student t-test, the alternative hypothesis specifies that the mean is different from 3.976. For the Wilcoxon test, the alternative hypothesis specifies that the median is different from 3.976.



Confidence Interval (95%)

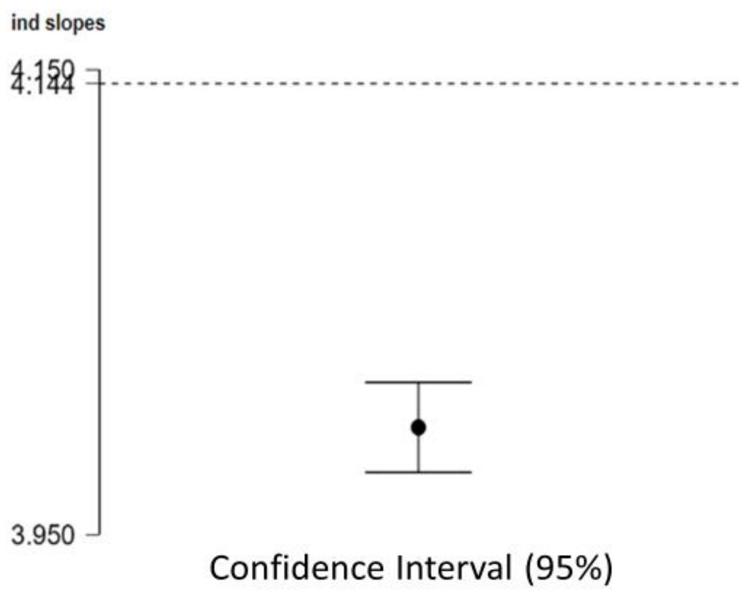
Figure 4-4 Matrix A -- Incorporating Prospect Theory

One Sample T-Test

	Test	Statistic	df	p
ind slopes	Student	−15.306	59	3.291×10^{-22}
	Wilcoxon	45.000		2.578×10^{-11}

Note. For the Student t-test, the alternative hypothesis specifies that the mean is different from 4.144. For the Wilcoxon test, the alternative hypothesis specifies that the median is different from 4.144.

Descriptives Plots



For Matrix B, the results of both the t-test and the Wilcoxon test suggest that the null hypothesis cannot be rejected ($\alpha = 0.05$), and thus conclude that there isn't a significant difference between the slope of the experimentally calculated line and the slope of the MIOS predicted line. See Table 4-11 and Figures 4-5 and 4-6, which contain the statistical results including the p values. This supports the prediction of Chapter 3 that the slope of the experimental line should equal that of the predicted line, and thus, as with Matrix A, the MIOS accurately predicted the ranking of the project-financed investments in Matrix B.

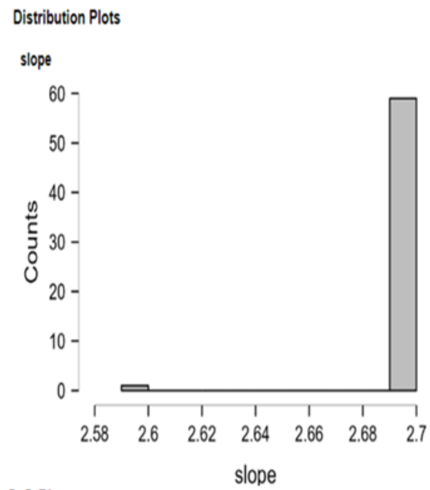
Table 4-11 Matrix B Results

Slope of the line predicted by MIOS	2.692
Experimental Mean (relevant to t-test)	2.690
Experimental Median (relevant to Wilcoxon test)	2.692

Figure 4-5 Matrix B

Descriptive Statistics

	slope	
Valid	60	
Missing	0	
Median	2.692	
Mean	2.690	
Std. Deviation	0.012	
Shapiro-Wilk	0.110	
P-value of Shapiro-Wilk	< .001	3.100×10^{-17}
Minimum	2.598	
Maximum	2.692	



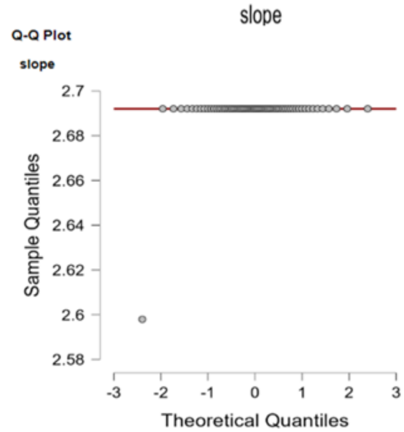


Figure 4-6 Matrix B

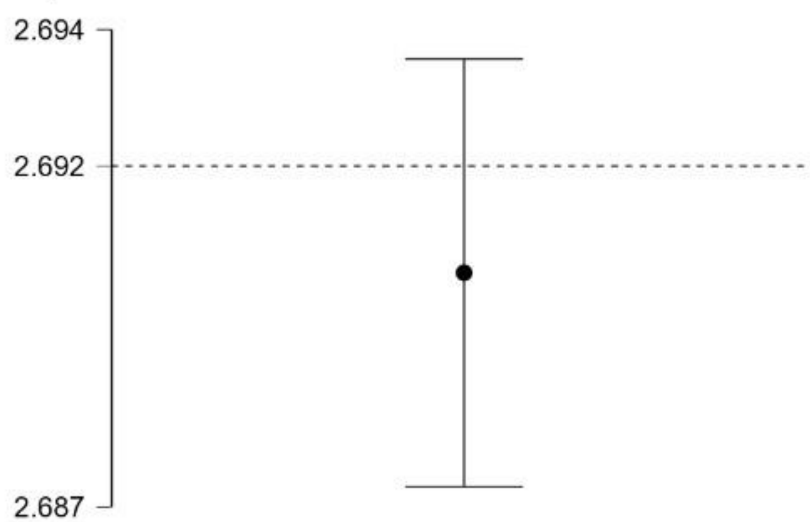
One Sample T-Test

	Test	Statistic	df	p
slope	Student	−1.000	59	0.321
	Wilcoxon	0.000		1.000

Note. For the Student t-test, the alternative hypothesis specifies that the mean is different from 2.692. For the Wilcoxon test, the alternative hypothesis specifies that the median is different from 2.692.

Descriptives Plots

slope



Confidence Interval (95%)

For Matrix C, the results of the t-test and the Wilcoxon test do not align. The t-test suggests that the null hypothesis can be rejected ($\alpha = 0.05$) and conclude that there is a significant difference between the slope of the experimentally calculated line and the slope of the MIOS line. On the other hand, the Wilcoxon test suggests that the null hypothesis cannot be rejected ($\alpha = 0.05$) and conclude that there is not a significant difference between the slope of the experimentally calculated line and the slope of the MIOS line. See Table 4-12 and Figures 4-7 and 4-8, which contain the statistical results including the p values. Given the non-normality of the data and given that the data was calculated from ordinal preference rankings that create a discrete set of possible data values, the literature (Frost, 2020; Harris & Hardin, 2013; Kitani & Murakami, 2022; Neuhäuser, 2015; Rosenblatt & Benjamini, 2018) states a preference here for the Wilcoxon test. This test supports the prediction in Chapter 3 that the slope of the experimental line should equal that of the predicted line, and thus, as with Matrix A and Matrix B, the MIOS accurately predicted the ranking of the project-financed investments in Matrix C.

To summarize, the analysis was repeated using three different sets of 2x3 manipulations. Each time, statistical support was found for the MIOS as an appropriate method for ranking project-financed investments.

Table 4-12 Matrix C Results

Slope of the line predicted by MIOS	6.267
Experimental Mean (relevant to t-test)	6.205
Experimental Median (relevant to Wilcoxon test)	6.296

Figure 4-7 Matrix C

Descriptive Statistics

	slope	
Valid	65	
Missing	0	
Median	6.296	
Mean	6.205	
Std. Deviation	0.207	
Shapiro-Wilk	0.812	
P-value of Shapiro-Wilk	< .001	1.125×10^{-7}
Minimum	5.754	
Maximum	6.420	

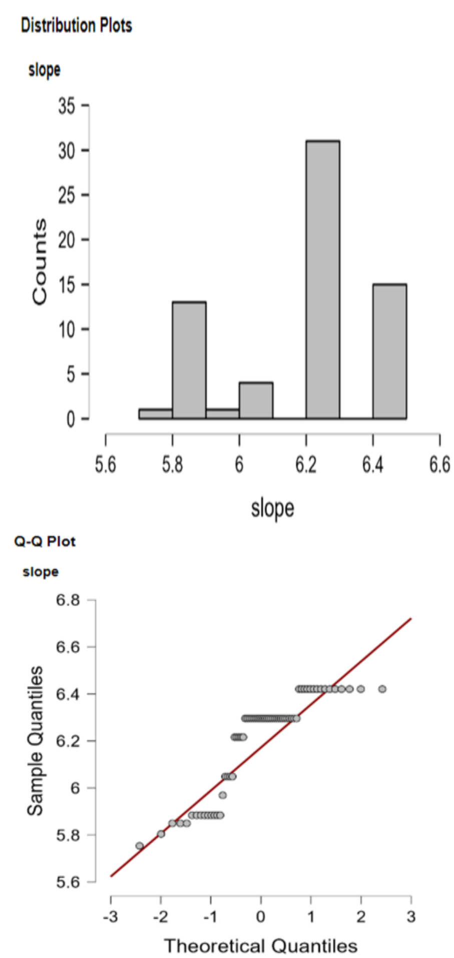


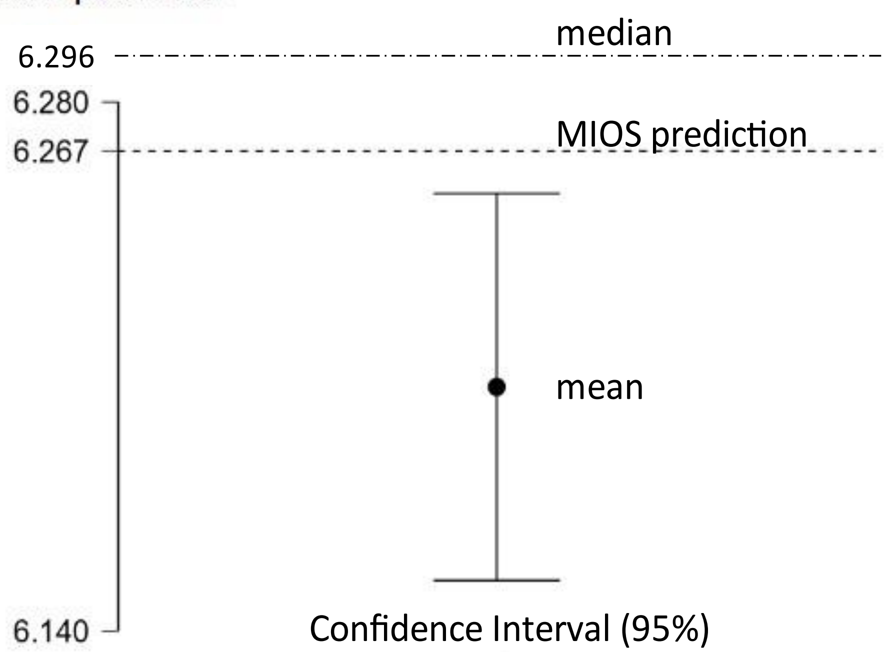
Figure 4-8 Matrix C

One Sample T-Test

	Test	Statistic	df	p
slope	Student	−2.434	64	0.018
	Wilcoxon	936.000		0.369

Note. For the Student t-test, the alternative hypothesis specifies that the mean is different from 6.267. For the Wilcoxon test, the alternative hypothesis specifies that the median is different from 6.267.

Descriptives Plots ▼



Observations Regarding the Data

Certain specific tests were designed into the manipulations. In Matrix A, one of the direct comparisons was between an investment having an IRR:WACC Ratio equal to unity (Investment #2; IRR=10%; WACC=10%) and the 'no investment' choice. When the IRR equals the WACC, this is the MIOS-predicted equilibrium point in the absence of Prospect Theory. Prospect Theory states that some percentage of the respondents will select Investment #2 over the 'no investment' option and some percentage, being those that are more risk-adverse, will prefer the 'no investment' option, thus pushing the experimental equilibrium point higher than IRR:WACC = 1.

The MIOS predicted that the experimental equilibrium point for the specific manipulations contained in Matrix A would lie somewhere between 1.0 and 1.257. The exact percentage of respondents that will choose one way versus the other, and thus the exact location of the experimental equilibrium point, cannot be known in advance and is revealed through experiment (Tversky & Kahneman, 1986). The data for Matrix A shows that 80% (48 out of 60) of the respondents selected Investment #2 as their preference while 20% (12 out of 60) selected the more risk-adverse choice of 'no investment'. This resulted in an experimental equilibrium point of 1.062 (see Table 4-7) which lies between the values of 1.0 and 1.257 as predicted by the MIOS.

In Matrix B, consistent with the MIOS predictions, the respondents presented clear preferences for investing in those projects with the higher

IRR:WACC Ratios, clear preferences for those investments with IRR:WACC Ratios greater than unity, and a 'no investment' preference for those projects with IRR:WACC Ratios less than unity.

Unlike Matrix B where the IRR:WACC choices were spread numerically further apart and perhaps easier for the respondents to mentally calculate while taking the survey, Matrix C contained a direct comparison where some of the IRR:WACC Ratios were close together. Specifically, the MIOS predicted that Investment #1 (IRR=8; WACC=7) with an IRR:WACC Ratio of 1.14 would be preferred over Investment #6 (IRR=12; WACC=11) with an IRR:WACC Ratio of 1.09. However, 13.8% (9 of 65) of the respondents selected Investment #6 over Investment #1 even though it had a slightly lower IRR:WACC Ratio.

This type of inconsistency tends to occur in paired comparison analyses when choices are close in value (Brown & Peterson, 2009; Choi et al., 2013; Johanson & Gips, 1993; Kingsley & Brown, 2010). This effect has been recorded as far back as Fechner in 1860 (Kingsley & Brown, 2010) and has been studied extensively since then (Johanson & Gips, 1993). Such is the case here where the choice was between two investments that have the same IRR – WACC differential (Investment #1 having IRR=8 and WACC=7 and Investment #6 having IRR=12 and WACC=11). This may have affected the results of Matrix C.

The survey instructions stated that "the use of a calculator is permitted", however, the financial incentive for a respondent to complete the survey quickly is not aligned with completing the survey accurately. It is unknown if any respondents took the time to use a calculator when the choices were close in value or whether the use of a calculator would have changed the results of Matrix C.

Finally, each of the matrices included specific comparisons to determine if the respondents were making selections based on the IRR and not the IRR:WACC Ratio. Matrix A included two such tests and Matrices B and C each included three such tests. For example, in Matrix A, a respondent could select Investment #6 with an IRR of 15% over Investment #1 having an IRR of 10%, yet Investment #1 has a higher IRR:WACC Ratio than Investment #6 (1.43 vs. 0.88). See Table 4-13.

Table 4-13 List of Direct Comparisons to Test the Choice of IRR vs. IRR:WACC Ratio

Matrix A:

- Investment #1; IRR=10%; WACC=7% vs.Investment #6; IRR=15%; WACC=17%
- Investment #2; IRR=10%; WACC=10% vs. Investment #6; IRR=15%; WACC=17%

Matrix B:

- Investment #1; IRR=8%; WACC=5% vs. Investment #5; IRR=10%; WACC=20%
- Investment #1; IRR=8%; WACC=5% vs. Investment #6; IRR=12%; WACC=20%
- Investment #2; IRR=10%; WACC=5% vs. Investment #6; IRR=12%; WACC=20%

Matrix C:

- Investment #1; IRR=8%; WACC=7% vs. Investment #5; IRR=10%; WACC=11%
- Investment #2; IRR=10%; WACC=7% vs. Investment #6; IRR=12%; WACC=11%
- Investment #1; IRR=8%; WACC=7% vs. Investment #6; IRR=12%; WACC=11%

Without exception, all of the respondents in Matrix A and Matrix B made all their selections based on the IRR:WACC Ratio in support of the MIOS and not based on the IRR. However, in Matrix C, the responses were mixed. When the choice was between an IRR:WACC Ratio >1 against an IRR:WACC Ratio <1, all of the respondents in Matrix C made their selection based on the IRR:WACC Ratio and not on the IRR. When both investments had an IRR:WACC Ratio >1, and one ratio was significantly greater than the other, all but one person out of 65 chose the investment with the higher IRR:WACC Ratio. However, as discussed previously, when the IRR:WACC Ratios were close together (1.09 vs. 1.14) making it more difficult to ascertain which investment had the higher IRR:WACC Ratio without using a calculator, 13.8% (9 of 65) selected the investment with the higher IRR and not the higher IRR:WACC Ratio.

In summary, of the 495 responses involving the eight comparisons noted above, there were only 10 instances where a respondent selected the investment with the higher IRR rather than the higher IRR:WACC Ratio, and nine of these occurred when the IRR:WACC Ratios were close together. This represents a very high "coefficient of consistency" (Peterson & Brown, 1998). Thus, in general, it appears that the respondents made their selections based on the IRR:WACC Ratio in support of the MIOS and not based on the IRR.

Discussion of the Effects of Prospect Theory on the Data

As developed in the Chapter 2 sections regarding Prospect Theory, people perceive the potential for losses and gains asymmetrically rather than linearly. It was postulated in Chapter 3 that this might affect the outcome of the PCBWS analysis. Indeed, it did. The survey data positioned the MIOS equilibrium point more conservatively (IRR:WACC >1) than what would be predicted by marginal utility theory alone (IRR:WACC =1).

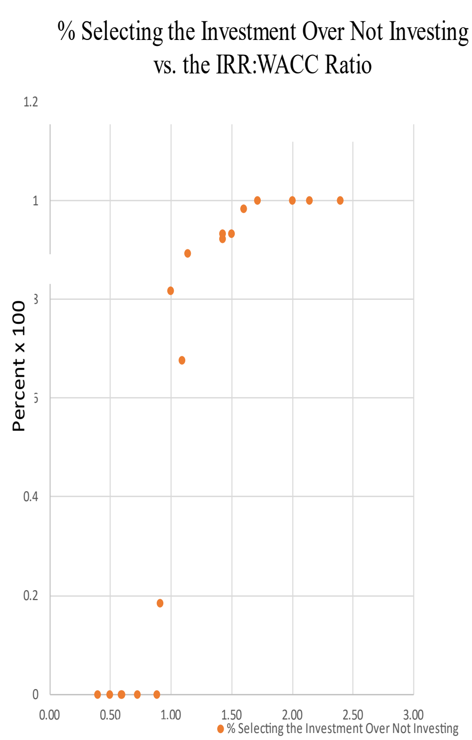
In Matrix A, as predicted, a percentage of the respondents selected the ‘no investment’ option over the investment option having a IRR:WACC Ratio = 1. In Matrix C, a percentage of the respondents selected the ‘no investment’ option over the two investments that had IRR:WACC Ratios that were close to 1.0 (i.e., 1.09 and 1.14).

This leads to an interesting finding not originally contemplated by this study. See Figure 4-9 which presents the percentage of respondents preferring to invest in a specific investment rather than the ‘no investment’ option as a function of the IRR:WACC Ratio. When the data is plotted as such, it suggests, consistent with Prospect Theory, that the respondents displayed maximum risk aversion when the IRR:WACC Ratio was at or near unity and the risk aversion decreased as the IRR:WACC Ratio increased, even though the survey instructions stated that the respondent is to “assume that the IRR and WACC values provided and the information you gathered from your due diligence are known with certainty for the duration of the investments.” As shown, once the IRR:WACC Ratio increased to approximately 1.5, the expectation of profitable returns appears sufficient to overcome any risk aversion. This outcome is consistent with experiments carried out by Kahneman and Tversky (1979) and Tversky and Kahneman (1986, 1991).

The pattern of the data in Figure 4-9 follows that which would be anticipated per Prospect Theory except for one data outlier (Matrix C, investment #5). That is, the anticipated data pattern was a zero preference for investing when IRR:WACC < 1, a 100% preference for investing when IRR:WACC reached some risk-less point above IRR:WACC > 1, and the effect of Prospect Theory appearing in between. It is noted that the one data outlier is the result of 12 of 65 respondents selecting investment #5 (with an IRR:WACC of 0.91) over the 'no investment' choice.

Figure 4-9 Percent Selecting the Investment Over Not Investing vs. IRR:WACC Ratio

	Investment #	IRR:WACC Ratio	% Selecting the Investment Over Not Investing
Matrix A	1	1.43	93.3%
	2	1.00	81.7%
	3	0.59	0.0%
	4	2.14	100.0%
	5	1.50	93.3%
	6	0.88	0.0%
Matrix B	1	1.60	98.3%
	2	2.00	100.0%
	3	2.40	100.0%
	4	0.40	0.0%
	5	0.50	0.0%
	6	0.60	0.0%
Matrix C	1	1.14	89.2%
	2	1.43	92.3%
	3	1.71	100.0%
	4	0.73	0.0%
	5	0.91	18.5%
	6	1.09	67.7%



The existence of a positive slope between the data range of IRR:WACC =1 and IRR:WACC =1.5, rather than a singular step function at IRR:WACC =1, demonstrates the specific pattern of risk aversion put forth in Prospect Theory. That is, as the reward (i.e., IRR) increased relative to the cost of capital (WACC), the percentage of respondents willing to make the investment increased. The same outcome was found whether the marginal utility of the investment was expressed as the ratio of IRR:WACC as shown in Figure 4-9 or expressed as the difference of IRR-WACC. This is an important finding of this study because a) it accounts for the variation between the theoretically predicted and the experimentally observed investment choices, and b) it supports the findings of Kahneman and Tversky (1979) and Tversky and Kahneman (1986, 1991) through the use of a different experimental method than that found in prior literature.

Calculation of the Experimental Equilibrium Point

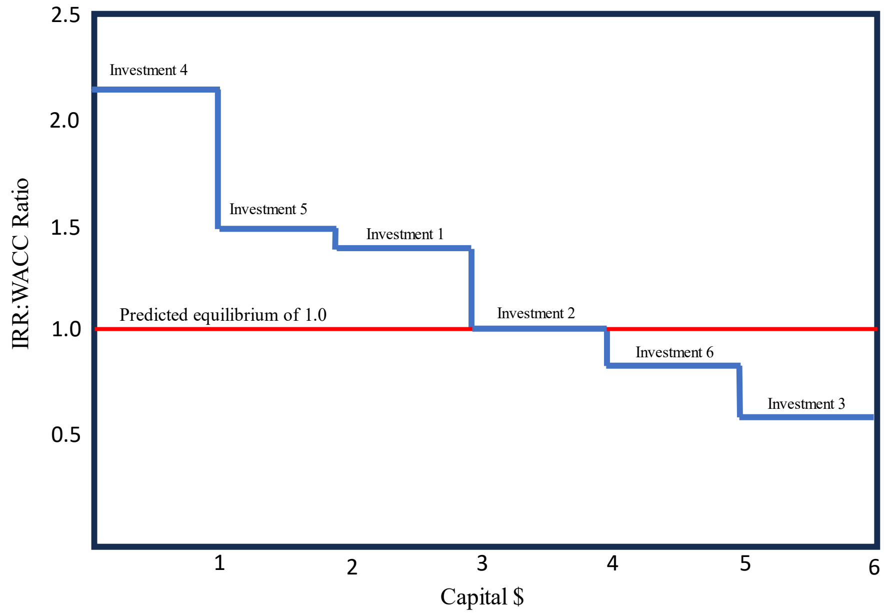
To calculate the experimental equilibrium point, the experimentally derived average ranking for the 'no investment' option (2.333 for Matrix A, 3.017 for Matrix B, and 2.308 for Matrix C) was inputted as "y" into the equation of the regressed line fitting the experimental data for each matrix. The equation of the regressed line for each matrix is provided in Tables 4-7 through 4-9. This equation was solved for "x" which is the IRR:WACC Ratio that represents the experimental equilibrium point for each matrix.

The results for each matrix are shown in Figures 4-10 through 4-15. These graphs are similar to the graphs used by Coase (1937) to demonstrate his investment opportunity schedule (IOS) for balance sheet financing, except that the vertical axis is IRR:WACC in lieu of IRR. It is a key finding of this study that the specific rank ordering of the experimentally derived investment choices shown in Figures 4-10 through 4-15 are identical to the predicted rank ordering, thus providing support for the MIOS ranking mechanism.

In Matrix A, as predicted, the experimentally derived equilibrium of 1.065 appears to show the impact of risk avoidance (Prospect Theory) as 20% (12 of 60) respondents selected the 'no investment' option over Investment 2 (having an IRR:WACC Ratio = 1). In Matrix C, the experimentally derived equilibrium of 1.038 also appears to show the impact of risk avoidance as 32% (21 of 65) respondents selected the 'no investment' option over Investment 6 (an IRR:WACC Ratio of 1.09) as well as 11% (7 of 65) selected the 'no investment' option over Investment 1 (an IRR:WACC Ratio of 1.14). Evidence of risk avoidance did not appear in Matrix B likely because the numerical distance between Investment 1 (having an IRR:WACC Ratio of 1.6) and the 'no investment' option was too large. As previously shown in Figure 4-9, once the IRR:WACC Ratio exceeded approximately 1.5, the expectation of profitable returns appeared sufficient to overcome any risk aversion.

Figure 4-10 Matrix A: Predicted Ranking vs. Capital Budget

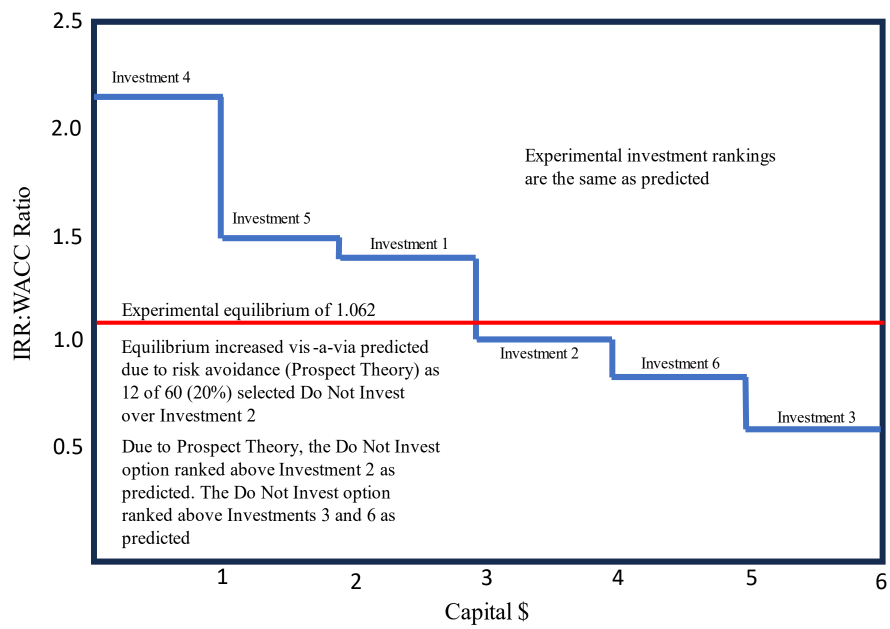
Investment#	IRR:WACC
1	1.43
2	1.00
3	0.59
4	2.14
5	1.50
6	0.88



Note: Each investment has an identical capital cost per the experimental design

Figure 4-11 Matrix A: Experimental Ranking vs. Capital Budget

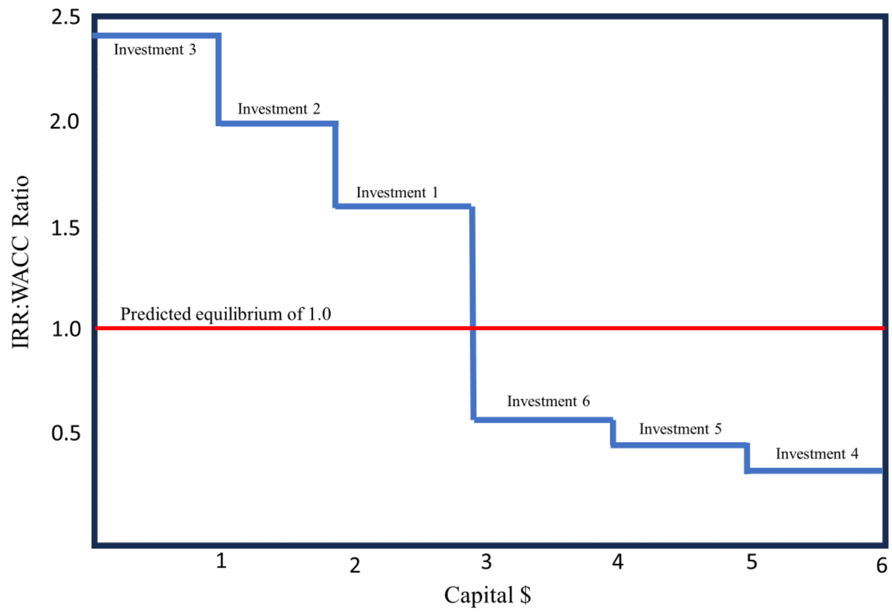
Investment#	IRR:WACC
1	1.43
2	1.00
3	0.59
4	2.14
5	1.50
6	0.88



Note: Each investment has an identical capital cost per the experimental design

Figure 4-12 Matrix B: Predicted Ranking vs. Capital Budget

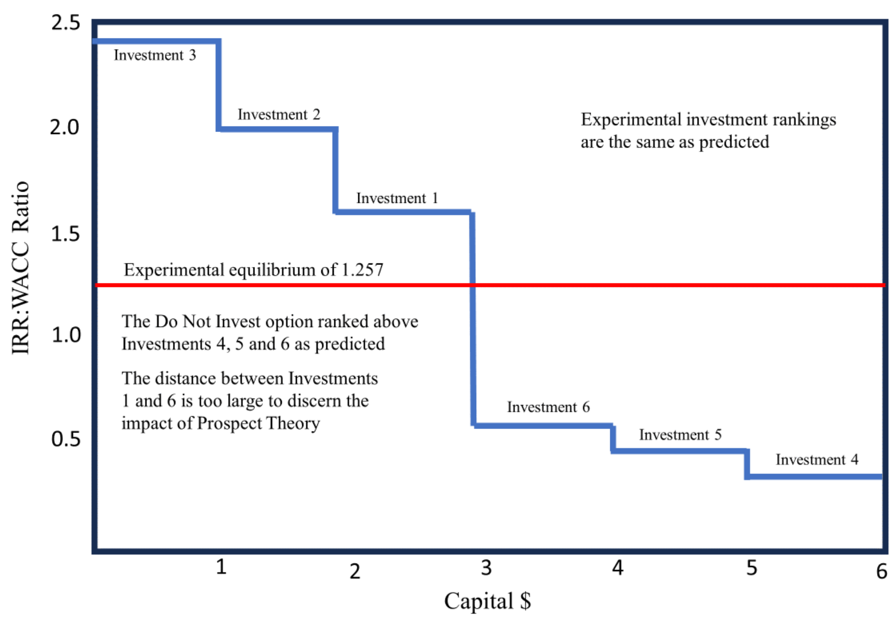
Investment#	IRR:WACC
1	1.60
2	2.00
3	2.40
4	0.40
5	0.50
6	0.60



Note: Each investment has an identical capital cost per the experimental design

Figure 4-13 Matrix B: Experimental Ranking vs. Capital Budget

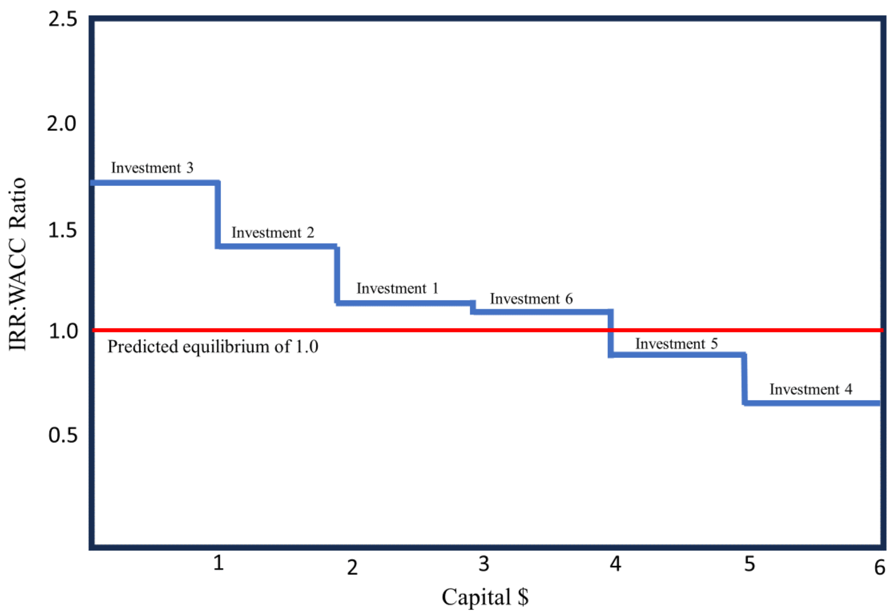
Investment#	IRR:WACC
1	1.60
2	2.00
3	2.40
4	0.40
5	0.50
6	0.60



Note: Each investment has an identical capital cost per the experimental design

Figure 4-14 Matrix C: Predicted Ranking vs. Capital Budget

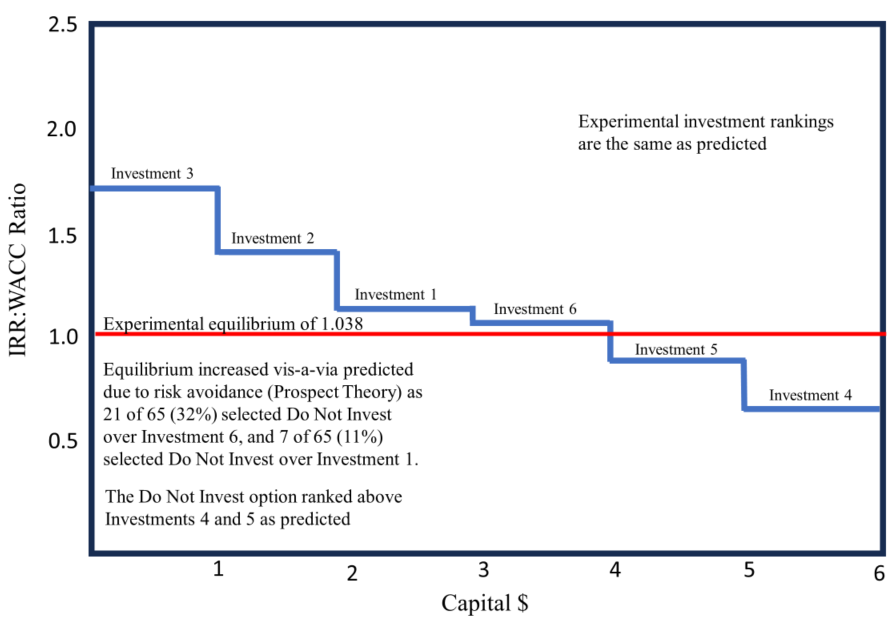
Investment#	IRR:WACC
1	1.14
2	1.43
3	1.71
4	0.73
5	0.91
6	1.09



Note: Each investment has an identical capital cost per the experimental design

Figure 4-15 Matrix C: Experimental Ranking vs. Capital Budget

Investment#	IRR:WACC
1	1.14
2	1.43
3	1.71
4	0.73
5	0.91
6	1.09



Note: Each investment has an identical capital cost per the experimental design

Discussion and Synthesis of Research Area #2

As discussed above, the PCBWS analysis found support for the proposed MIOS ranking mechanism. The MIOS is shown to be a more appropriate ranking mechanism for project-financed investment opportunities and fills a long-overlooked gap in Internalization Theory literature. This is because the Coasian IOS assumes the use of balance sheet financing and thus uses the wrong WACC for project financing. As discussed in the Chapter 2 section entitled The Change from Balance Sheet to Project Financing, this comes about because the Coasian IOS first ranks the investment opportunities based solely on their respective IRR and then compares this ranking against the firm's WACC. In contrast, the MIOS first calculates the IRR to WACC ratio for each project (an indication of the project's marginal utility) and then ranks their ratios.

This procedural difference between the IOS and the MIOS is important because the source of funding (debt and equity) for each investment opportunity under the Coasian IOS comes through and from a single source – the parent company. The MIOS, on the other hand, recognizes that the funding (debt and equity) for each project-financed investment opportunity comes through and from multiple sources (equity from the parent company(s) and debt from the project finance lenders).

Thus, while the traditional Coasian IOS remains an effective tool to rank investment opportunities that are financed based on the balance sheet of a single company (Brigham & Ehrhardt, 2017; Ross et al., 2016), the MIOS appears to be the proper ranking of project-financed investment opportunities because it takes into account the individual project's own WACC prior to rank-ordering so that the ranking is based on the projects' marginal utility, not their IRR. Doing so has been shown in this dissertation to yield a correct ranking for project-financed investments. This is important because project financing, not balance sheet financing, is the method of financing used within deregulated electric markets (Buscaino et al., 2012; Jadidi et al., 2020; Kaminker, 2017; Mora et al., 2019).

As put forth in the Chapter 2 section entitled Project Investment Ranking Mechanisms, without the MIOS ranking mechanism there hasn't been a means to systematically rank order project-financed investment opportunities nor has there been the means to understand how one type of project-financed electric generation is affected by a change in risk vis-à-vis another. Developing and establishing the validity of the MIOS was therefore necessary to establish the link between electricity deregulation and the willingness to invest.

Nor has there been a means to determine the extent or boundary of a firm that uses project financing for its investments without the MIOS ranking mechanism. Now, as established in this dissertation, the extent or boundary of a firm using project financing is where the IRR:WACC Ratio is equal to unity. This is because when the ratio is greater than unity, the marginal benefits of an investment exceed the marginal costs and thus increase the value of the firm, and whenever this ratio is less than unity, the marginal benefits of the investment are less than the marginal costs and thus decrease the value of the firm. Thus, all project-financed investments situated to the left of the MIOS equilibrium point should be internalized by the firm. Those situated to the right should remain external to the firm. (N.B. As developed in Chapter 2, the MIOS project-financing equilibrium point is different from the IOS balance sheet financing equilibrium point derived by Coase.)

The predicted and experimentally obtained equilibrium points are depicted in Figures 4-10 through 4-15. In turn, these graphs identify which investments should be internalized (those to the left of the MIOS equilibrium point) and which should remain external to the firm (those to the right of the MIOS equilibrium point). As shown in these figures, the PCBWS quantitative analysis found that for all three matrices analyzed:

1) The experimentally derived investment rankings were the same as the rankings predicted by the MIOS, and

2) The placement of the equilibrium point within the rankings was the same as predicted by the MIOS.

Thus, this analysis provided the answer to RQ4: *When making use of project financing, as opposed to balance sheet financing, what establishes the extent (or boundary) of the firm, and thus, which business opportunities should be internalized by the firm?* The answer is that point where IRR:WACC equals unity sets the boundary, and those investments with a higher IRR:WACC Ratio should be internalized. As such, the analysis also provided support for the following hypotheses:

H5a: When making use of project financing, as opposed to balance sheet financing, the boundary or extent of the firm is established at a IRR:WACC ratio of unity.

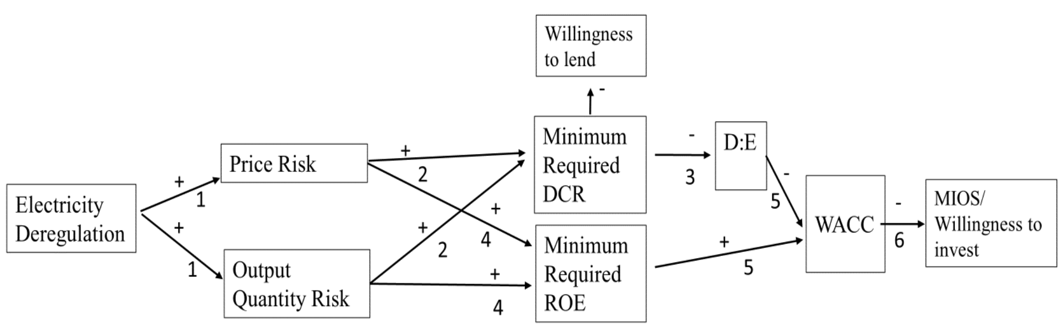
H5b: When making use of project financing, as opposed to balance sheet financing, those investment opportunities for which the IRR:WACC ratio is greater than unity should be internalized by the firm.

Discussion and Synthesis of the Two Research Areas with the Proposed Model

This dissertation's qualitative analysis in Research Area #1 demonstrated that the deregulation of the electric industry increased power plant revenue risk. Existing, well-established financial relationships reviewed in Chapter 2 link this increase in risk to an increase in the minimum required DCR which reduces the willingness of lenders to lend. At the same time, existing, well-established relationships link this increase in revenue risk to an increase in the minimum ROE that will be sought by equity investors. Both of these (the increase in the minimum required DCR and the increase in the minimum required ROE), acting alone or in tandem, result in an increase in the WACC based on existing, well-established relationships. This increase in the WACC, as established by this dissertation's quantitative analysis in Research Area #2, reduces the IRR:WACC Ratio for project-financed investments. This reduces the willingness of equity investors to provide equity investment as established by the MIOS ranking mechanism. Therefore, *a continuous linkage from one end of the proposed model to the other* *has now been established*. See Figure 2-8 which provides the proposed, and now supported, model which is re-presented below for convenience as Figure 4-16.

The above model can be applied as follows. An increase in price risk and/or quantity risk, such as from electricity deregulation for which support has now been found, will result in a corresponding increase in the minimum required DCR, a decrease in the D:E Ratio, and an increase in the minimum required ROE. In turn, an increase in the minimum required DCR reduces the number of power plants that will qualify for a loan, and thus on the margin shrinks the pool of potential borrowing candidates. The increase in the minimum required DCR causes

Figure 4-16 The Proposed Model



+/- Expected direction of the effect
1- Law of Supply and Demand, and Elasticity of Supply and Demand
2- DCR definition and Prospect Theory
3- Debt:Equity Ratio definition
4- CAPM and Prospect Theory
5- WACC definition
6- Internalization Theory

a decrease in the D:E Ratio, and the increase in the minimum required ROE, acting alone or in tandem, increases the WACC which reduces the IRR:WACC Ratio. In turn, this reduces the number of power plants that will remain to the left of the equilibrium point, and thus on the margin shrinks the pool of potential investment candidates.

The above summary of the now supported model provides an answer to RQ2: *Does this increase in revenue risk reduce the ability to attract debt and equity financing for new power plants and if so, why?* Clearly, the answer is yes, and the reason is explained above by the model. It also provides support for the following hypothesis from Chapter 2:

> *H3: An increase in power plant revenue risk caused by electric deregulation reduces the willingness of debt and equity investors to provide financing for new electric power plants.*

Also arising out of the qualitative study was the phenomenon that different types of power plants are affected by revenue risk differently. For example, it was supported that deregulation exposed all types of power plants to price volatility amplified by the inelasticities of the electricity supply and demand curves. However, it was also supported that baseload power plants, with their high fixed cost/low variable cost structure, are vitally dependent on maintaining a high Q to ensure a low ATC, and thus have a higher exposure to output quantity uncertainty than other types of power plants due to ISO dispatch rules. Thus, some types of plants are exposed to additional forms of revenue risk. By applying the above model's relationship between deregulation and risk, this additional risk further increases the minimum required DCR and the minimum required ROE for those types of power plants. As such, support is found for the following hypothesis:

> *H4: Because revenue risk affects different types of electric power plants differently, the willingness of debt and equity investors to provide financing differs for different types of electric power plants.*

Furthermore, the above synthesis provides an answer to RQ3: *Is nuclear power affected by an increase in revenue risk more or less than other types of electric generation, and if so, why?* The answer is yes, and it is because nuclear power is a baseload technology that has a higher exposure to output quantity uncertainty due to the ISO dispatch rules.

In summary, as set forth above, answers were found for all four research questions (RQ1, RQ2, RQ3, and RQ4) put forth in Chapter 1 of this dissertation, and support was found for all of the hypotheses (H1a, H1b, H2a, H2b, H3, H4, H5a, and H5b) put forth in Chapter 2.

Chapter 5
Contributions of the Dissertation, Implications, Limitations, and Recommendations

There is a renewed interest in nuclear power because of global warming (NASA, 2010; National Geographic, 2022; NOAA, 2023). Carbon dioxide (CO_2) is identified as the largest contributor to global warming and electricity generated by nuclear power doesn't emit CO_2 (Jaforullah & King, 2015; Penn, 2022; Tollefson, 2021; York & McGee, 2017). Numerous countries including the US have made international commitments to reduce CO_2 emissions and some of these agreements include nuclear power as an acceptable energy source for reducing CO_2 (Almer & Winkler, 2017; Dimitrov, 2016; Tollefson, 2021). Overlooked in these agreements is whether nuclear power will have the ability to attract the requisite debt and equity financing due to the changes in financial risk caused by electricity deregulation.

As discussed in Chapter 4, this dissertation has established that the deregulation of electric markets has indeed increased power plant revenue risk which negatively affects the ability of nuclear power to attract the requisite debt and equity financing needed for construction. This was established through the use of the qualitative phenomenological analysis and the quantitative Paired Comparison Best Worse Scaling (PCBWS) experimental design analysis described in Chapter 3. In turn, the inability to attract financing within deregulated electricity markets affects the availability of nuclear power as an option to reduce CO_2. This conclusion and its implications are further discussed in the section entitled Implications Regarding Nuclear Power and Climate Change, below.

As discussed in the previous chapter, each of the four research questions put forth in Chapter 1 and all of the hypotheses put forth in Chapter 2 (see Tables 5-1 and 5-2) have been addressed and supported. Furthermore, to demonstrate the effect of deregulation's change in revenue risk on nuclear vs. non-nuclear generation, this dissertation developed a new investment ranking mechanism (the MIOS) compatible with Internalization Theory (Brigham, 1979; Coase, 1937; Kay, 2015; Williamson, 1975) that is more accurate for the ranking of project-financed

Table 5-1 Research Questions

RQ1: Does electricity deregulation increase power plant revenue risk relative to cost-of-service regulation and if so, why?
RQ2: Does this increase in revenue risk reduce the ability to attract debt and equity financing for new power plants and if so, why?
RQ3: Is nuclear power affected by an increase in revenue risk more or less than other types of electric generation and if so, why?
RQ4: When making use of project financing, as opposed to balance sheet financing, what establishes the extent (or boundary) of the firm, and thus, which business opportunities should be internalized by the firm?

Table 5-2 Hypotheses

H1a: Electricity deregulation increases the price risk perceived by power plant lenders. H1b: Electricity deregulation increases the output quantity risk perceived by power plant lenders. H2a: Electricity deregulation increases the price risk perceived by power plant equity participants. H2b: Electricity deregulation increases the output quantity risk perceived by power plant equity participants. H3: An increase in power plant revenue risk caused by electric deregulation reduces the willingness of debt and equity investors to provide financing for new electric power plants. H4: Because revenue risk affects different types of electric power plants differently, the willingness of debt and equity investors to provide financing differs for different types of electric power plants. H5a: When making use of project financing, as opposed to balance sheet financing, the boundary or extent of the firm is established at a IRR:WACC ratio of unity. H5b: When making use of project financing, as opposed to balance sheet financing, those investment opportunities for which the IRR:WACC ratio is greater than unity should be internalized by the firm.

investments than the long-standing Coasian IOS. This is important because project financing, not balance sheet financing, is the method of financing used within deregulated electric markets (Buscaino et al., 2012; Jadidi et al., 2020; Kaminker, 2017; Mora et al., 2019). The implications of this new project-finance investment ranking mechanism are discussed further in the section entitled Implications Regarding the New MIOS Ranking Mechanism, below.

The remainder of this chapter discusses, in order, the contributions of this dissertation for both academic purposes and practical application, the implications of the dissertation findings, and finally, the study's limitations and future study recommendations.

Contributions of the Dissertation for Academic Purposes and Practical Application

This dissertation fills a gap in the literature by establishing that the deregulation of the electric industry increases power plant revenue risk which negatively affects the ability of all power plants to attract debt and equity financing. It also fills a gap in the literature by performing a qualitative phenomenological analysis that provides support for this relationship.

The dissertation found that certain types of power plants such as baseload units are affected more than others, and as a result, it is highly unlikely that nuclear power will be able to attract the requisite financing within deregulated electricity markets. This suggests that any reliance on nuclear power to reduce greenhouse gases will be limited to those jurisdictions that remain regulated. This dissertation, therefore, fills a gap in the literature by providing timely and salient policy guidance for the efficient allocation of resources to reduce greenhouse gases based on a new model linking debt and equity financing with a change in power plant revenue risk.

This dissertation fills a gap in the literature by establishing the existence of two causality pathways (debt and equity) by building on the financial and economic theories, constructs, and principles of the Capital Asset Pricing Model, Efficient Market Hypothesis, Prospect Theory, Internalization Theory, Price Elasticity, and the Law of Supply and Demand. Building on this, it fills another gap in the literature by creating a theory-based model that links the change in power plant revenue risk with the ability to secure debt and equity financing. The model can be modified to address other forms of risk beyond revenue risk. As such, it provides a framework that can be used by both academicians and business practitioners to relate risk and project-financed investment decisions.

The dissertation unearths a theoretical assumption in Coase (1937) that limits the applicability of the Coasian IOS to balance-sheet financing. By shedding light on this limitation, this dissertation fills a gap in the literature by showing that the process by which classical economic utility theory gets applied to Internalization Theory is contingent on the method of financing. In doing so, it raises a fundamental concern about how Internalization Theory has been used in numerous academic papers during the past 40 years. This dissertation, therefore, questions the validity of numerous Internalization Theory papers that were built on a Coasian foundation.

To address the above limitation of the Coasian IOS to balance sheet financing, this dissertation fills a 40-year gap in Internalization Theory literature by putting forth a new investment ranking mechanism called the Modified Investment Opportunity Schedule (MIOS) that is shown to be the proper ranking mechanism for project-financed investment opportunities. The MIOS contributes a useful tool, sitting alongside the IOS, for corporate strategic planning; one tool for balance sheet investments and the other for project financed investments. This dissertation also fills a gap in the literature by performing a PCBWS quantitative experimental design analysis that provides support for the new MIOS investment ranking mechanism.

Finally, the dissertation fills a gap in the literature by establishing that the observed variation between the MIOS theoretical and experimental investment choices can be explained by the asymmetrical risk avoidance pattern of Prospect Theory. This dissertation also fills a gap in the literature by finding experimental confirmation of Prospect Theory using a methodology, PCBWS, that is different from that used in prior studies.

Implications of the Dissertation's Findings

Implications Regarding Nuclear Power and Climate Change

The research problem stated at the beginning of this dissertation was: *Can nuclear power, a CO_2-free technology, attract debt and equity financing in light of* *the changes in financial risk that arise from electricity deregulation?* This dissertation established in the previous chapter that the deregulation of the electric industry increased power plant revenue risk and that this increase in revenue risk affects the ability of all power plants to attract financing. However, it also established that the deregulation of the electric industry affects revenue risk for baseload power plants more than others.

This is because baseload power projects face greater revenue risk because of their high fixed cost/low variable cost structure which is vitally dependent on maintaining a high Q to ensure a low ATC. As discussed in Chapter 4, this additional exposure to revenue risk increases the WACC for baseload projects greater than that for other types of power projects which further decreases their IRR:WACC Ratio. As established as a significant finding in this dissertation, the ability to attract financing is linked to the IRR:WACC Ratio. Nuclear power is a baseload technology, and this reduction in its IRR:WACC Ratio relative to other types of electricity generation, provides an explanation, on the margin, of the observed difference between the investment in nuclear versus non-nuclear power in deregulated markets during the past several decades.

Thus, the answer to the above research problem is: Within deregulated markets, nuclear power should *not* expect to attract debt and equity investment. Its IRR:WACC Ratio vis-à-vis other electric generating technologies is expected to result in a lower MIOS ranking, all other things being held equal. Therefore, a key implication of this dissertation is that nuclear power is unlikely to be a viable option to reduce greenhouse gases within deregulated electricity markets no matter how many global warming treaties, accords, and protocols the US government enters into.

A further implication is that the market for the sale of nuclear plants within the US will likely be small, i.e., limited to the one-third of the US market that remains regulated. This implication applies to both the traditionally larger 1,000 MW projects and the proposed smaller modular projects in the 100 to 300 MW range; this because they both have a high fixed cost/low variable cost structure which is vitally dependent on maintaining a high Q to ensure a low ATC. Nor can extra nuclear plants be built within the regulated one-third of the US with the intent of making interstate sales of nuclear-generated electricity into the deregulated two-thirds of the country as this would be a violation of the 'used and useful' regulations within the regulated jurisdictions (Brown, 1944; Cabot, 1929; Pechman, 1993).

Electricity deregulation was instituted to reduce monopoly markets and increase economic efficiency through competition (Isser, 2003; White, 1996), and it has largely succeeded (Csereklyei & Stern, 2018; Fabrizio et al., 2007; GAO, 2002; Lei et al., 2017; Musco, 2017; Switzer & Straub, 2005). If electricity markets are to remain deregulated and continue to provide the benefits of competition, then the key policy implication of this dissertation is that scarce resources should be redirected toward other GHG-free options that have a higher IRR:WACC Ratio and, commensurate with their higher MIOS ranking, more likely to attract debt and equity investment.

Another implication is that nuclear power needs to increase its IRR:WACC Ratio to be on par with other GHG-free options. Since all deregulated power plants within an ISO receive the same price for their electricity at any given point in time (see Chapter 2), the implication is that the engineering design of nuclear plants must be revamped so that the total capital costs of a nuclear power plant, including capitalized interest during construction, be reduced below that of competing GHG-free alternatives if it is to be a viable option within competitive markets. Presently, there are no projections of nuclear plant costs, including those of small modular reactors, that come close to achieving this (NuScale, 2023; Terra Power, 2023).

Implications Regarding the New MIOS Ranking Mechanism

The new MIOS ranking mechanism fills a long-overlooked gap in Internalization Theory literature and is the proper ranking mechanism for project-financed investment opportunities. The impetus behind the development of the MIOS was the recognition that the Coasian IOS does not apply to project financing, and this is the method of financing used within deregulated electricity markets. However, project financing is used in various other global markets such as real estate and the oil and gas industries, and the global project financing market exceeds $200 billion per year. Thus, the long-overlooked gap in Internalization Theory literature is large which raises broad implications for the MIOS:

1) Introductory finance textbooks, many of which present the Coasian IOS to explain how rational investment decisions are based on classical marginal utility theory, require an update because the Coasian IOS is no longer universal but limited to balance sheet financing. The global project-financing market is too large to ignore and is a leading form of financing within certain industries. These textbooks should note that the Coasian IOS yields erroneous results when applied to project financing and that rational investment decisions must take into consideration the method of financing.
2) Economics textbooks that address Internalization Theory require an update because the seminal concepts that emerged from Coase (1937) are no longer universal, but rather, contingent on the method of financing. All of Internalization Theory rests upon Coase's two foundational questions: Which business opportunities should be internalized by a firm, and what establishes the extent or boundary of a firm? The answers to these questions are now known to be contingent on whether the firm makes use of balance sheet financing or project financing. This is important because the Coasian IOS may indicate that a potential investment should be internalized while the MIOS may indicate that it remains external to the firm, and vice versa. To make use of an old adage, you have to use the right tool for the right job.

3) There is a 40-year history of the Coasian IOS being relied on in hundreds of academic papers to explain why and where businesses expand internationally. The validity of these papers may be in question because they were built upon a balance sheet financing assumption made by Coase, and the authors of these papers either overlooked this assumption or did not understand the critical difference between balance sheet and project financing. The Coasian IOS can no longer be used as a foundation in Internalization Theory research studies that include project-financed investments. The global project-financing market is so large that there is a reasonable probability that the data in many of these academic papers contain numerous project-financed investments for which the Coasian IOS does not apply. This is analogous to when the medical field recognized that men and women have different physiologies, and the prior co-mingling of experimental data led to the publishing of inaccurate research outcomes (Ahnstedt et al., 2013; Boese et al., 2017; Hoang-Kim et al., 2020).

Limitations and Recommendations for Future Study

The scope of this dissertation was narrowly limited to the changes in revenue risk caused by the deregulation of the electricity industry that affects the availability of debt and equity financing. There are a multitude of other risks that may affect the financing of a power plant as discussed in the Chapter 2 section entitled Project Risks That Affect Debt and Equity Financing including construction costs, construction schedule, insurance, political risk, decommissioning, and spent fuel storage. These risks can also be analyzed using the IRR:WACC construct developed herein, and this is recommended for future analysis.

Some of these risks (e.g., spent fuel storage) are unique to nuclear power which should further increase the WACC of nuclear projects relative to non-nuclear projects and thus further decrease nuclear power's IRR:WACC Ratio relative to non-nuclear investments. The focus of this dissertation was only on revenue risk and therefore provides a partial explanation of the impact of deregulation. It is theorized that when all the above risks are included in an analysis, the ability to systematically rank nuclear and non-nuclear projects using the IRR:WACC Ratio will provide the ability to fully explain the financial challenge facing nuclear power within deregulated markets.

Electricity deregulation has taken place in numerous countries around the globe, however, the regulations are country-specific. This dissertation was constrained to one country, the US, to ensure data validity and not introduce data variability due to differing regulations. Further research could be carried out by looking at the effect of deregulation on revenue risk in other countries, such as Canada and the United Kingdom which also have deregulated electric markets.

As for recommending changes in the analysis, the PCBWS quantitative analysis followed the recommended 'best practice' procedures for online data sampling as discussed in Chapter 4. However, there is always the possibility that the answers to the screener questions were inappropriately shared on the internet (Wessling et al., 2017). This can be remedied by carrying out the survey in a proctored setting, or by enlisting respondents within a financial company whose work experience can be verified by the company.

The instructions contained within the PCBWS survey instrument stated that respondents may use calculators when making their best/worst direct comparisons, however, the financial incentive for a respondent to complete the survey quickly is not aligned with completing the survey accurately. As noted in Chapter 4, it is unknown if any respondents took the time to use a calculator when the experimental investment choices were close in value. Ensuring the use of a calculator may increase data validity. Should an online analysis be repeated, a survey question regarding calculator use should be included and the time to perform each calculation should be collected. Should the analysis be repeated in a proctored setting, the researchers may be able to better ensure calculator use and respondent involvement might be higher.

The PCBWS analysis made use of 2x3 matrices because larger matrices would require more direct comparisons which, as discussed in Chapter 3, could lead to survey fatigue. Survey fatigue leads to respondent error, and in turn, this could decrease data validity (Ambler et al., 2021; Jeong et al., 2023). However, a larger matrix should provide a more accurate placement of the invest/do not invest equilibrium point within the results. A PCBWS analysis could be performed without increasing survey fatigue that removes the investment ranking portion of the analysis and increases the number of invest/do not invest comparisons, thus enabling greater precision for the placement of the equilibrium point.

This dissertation found support for Prospect Theory using the PCBWS methodology which has not been used in previous Prospect Theory studies. It is suggested that this methodology be used as a springboard for further Prospect Theory research. As a case in point, the data presented in Figure 4-9 suggested that the survey participants displayed maximum risk aversion when the IRR:WACC Ratio was at or near unity and the amount of risk aversion decreased as the IRR:WACC Ratio increased, a result consistent with prior Prospect Theory experiments (Kahneman & Tversky, 1979; Tversky & Kahneman, 1986, 1991). This specific line of inquiry was not originally contemplated by this dissertation but emerged organically out of the collected data. The PCBWS analysis that was performed in this dissertation was not designed to collect the data that was plotted in Figure 4-9. As a result, the data available for this specific line of inquiry was limited to only 18 data points. Repeating the PCBWS analysis with more versions of the 2x3 matrices would yield more data points to add to the 18 data points, and thereby increase statistical power.

Research Area #2 made use of an experimental design analysis, however, answers provided by respondents in a controlled environment may not reflect real-life decision-making (Portney, 1994). As noted in Chapter 3, this can be partially offset by employing manipulated scenarios that exhibit high ecological validity (Bougie & Sekaran, 2020). In the analysis performed herein, the manipulations were varied at specific intervals to ensure that specific conditions were tested to help find support for the model. The manipulations were not selected to reflect ecological validity. Now that support for the model has been found, a follow-up study using real-life project finance data is recommended along the lines of Lancsar and Swait (2014).

In the Chapter 4 section entitled Recurring Themes, the researcher observed while performing the coding that the interviewees did not discuss the revenue risk issues evenly in depth. Specifically, revenue risk categories 1, 2, and 3 from Table 4-2 were discussed in greater depth by the interviewees than categories 4 and 5. The researcher could only surmise the reasons for this pattern and recommends that this be investigated in future research.

In Chapter 2 it is noted that the marginal utility of an investment can be expressed as either IRR:WACC or as IRR-WACC. This dissertation made use of IRR:WACC. It is recommended that the data collected in this dissertation for Research Area #2 be analyzed using IRR – WACC as the independent variable in lieu of the IRR:WACC Ratio. This is expected to provide additional confirmation that the marginal utility of an investment is appropriate for the ranking of project-financed investments.

Finally, there are numerous academic papers published during the past 40 years that relied on the Coasian IOS to explain why and where businesses expanded internationally. It is recommended that the conclusions reached in these papers, and the data used to support these conclusions, be re-examined. The global project-financing market is so large that there is a reasonable probability that the data in many of these academic papers contain numerous project-financed investments for which the Coasian IOS does not apply.

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Appendix A

Key Definitions

AFC	Average fixed costs, equal to FC/Q, in dollars per kWh.
AFUDC	Allowance For Funds Used During Construction, the accrued interest on the loans during construction that is capitalized and converted into a fixed cost to be repaid with interest to the lenders.
Baseload	A power plant that is intended to operate at a high capacity factor (e.g., above 90%).
Capacity Factor	The actual annual output of a power plant in kWh divided by the potential annual potential output in kWh, expressed as a percent.
CO_2	Carbon dioxide, a byproduct of hydrocarbon combustion and believed to be the major contributor to global warming.
COP26	The 26th United Nations Climate Change Conference of the Parties held in Glasgow on October 31 through November 13, 2021.
DCR	Debt coverage ratio
D:E	The capitalization of a company expressed as a ratio of the debt to equity.
Deregulation	The removal of some or all of the monopoly regulatory protections provided to electric utilities for the purpose of increasing competition in wholesale and/or retail electricity markets.
Dispatch	Instructions from the ISO to turn a power plant on and at which level of output.
Dispatchable	A power plant that is subject to inter-day instructions from the ISO regarding dispatch.
EPA of 1992	Energy Policy Act of 1992

FC	The annualized fixed capital costs of a power plant in dollars.
FERC	Federal Energy Regulatory Commission
FPA	Federal Power Act of 1935
GHG	Greenhouse gases, such as carbon dioxide and methane.
GW	GigaWatt, or 1,000 MW.
Intermediate plant	A dispatchable power plant that is intended to operate with a capacity factor of about 40-60%, between that of a peaking and baseload unit.
IPP	Independent Power Producer; a non-utility electric generating company pursuant to the Energy Policy Act of 1992.
IOS	The Investment Opportunity Schedule, first put forth by Coase (1937).
IRR	Internal rate of return
ISO	Independent System Operator; the entity that coordinates the dispatch of electric power generation within a region, aka the grid operator.
kW	kiloWatt, equal to 1,000 watts.
kWh	kiloWatt-hour, a measure of electric current typically used in the sale and purchase of electricity.
Load	The demand for electricity measured by the ISO at a point in time in watts.
MW	MegaWatt, equal to 1,000 kilowatts or 1,000,000 watts.
Must-run	A power plant that is not subject to inter-day instructions from the ISO regarding dispatch – generally a baseload unit.
NPV	Net present value

Open Access	The treatment of electric transmission lines as common carriers.
P	The price of electricity in kWh.
Peaking plant	A dispatchable power plant that is intended to only operate during peak load periods with a low capacity factor (e.g., 5-10%).
Project financing	A separable capital investment owned by a special purpose company in which the lenders look to the cash flow of the project to service their loans as well as to provide the return on, and return of, the participants' equity contributions. It is typically non-recourse to the parent company.
PUHCA	Public Utility Holding Company Act of 1935
PURPA	Public Utility Regulatory Policies Act of 1978
Q	The annual output of a power plant in kWh.
ROE	Return on equity
Spark spread	The numeric value between the price of the electricity sold by a power plant and the cost of the power plant's fuel, expressed in MMBtu
TR	Total revenue, equal to P x Q.
WACC	Weighted average cost of capital

Appendix B
Survey Instrument

Thank you for taking this survey. The following contains 40 multiple-choice questions and has been measured to take about 15 minutes to complete.

Informed Consent. The data collected from the interview will be used to help support certain conclusions that will be discussed in an academic research paper. Your name, title, position, place of employment, and contact information will not be known to the researcher, and as such, will not appear in the research paper or in any drafts of the research paper. Your participation is voluntary. Informed consent is an ethical requirement for performing research, and as such, please acknowledge your consent as indicated below before proceeding with the questions.

- ○ I consent to this voluntary questionaire
- ○ I do NOT consent to this voluntary questionaire

Q2

Representations. It is vital to our study that you respond honestly and thoughtfully to all survey questions. Otherwise, the result of the survey would be invalid. Your careful and complete attention is greatly appreciated! To help ensure the validity of the survey, a combination of multiple logistical mechanisms is used to eliminate careless and/or random responses to the survey questions. If your responses are determined to be careless and/or random, or if you do NOT answer all of the questions, your responses will not be included in the study.

- ○ I agree to answer all of the questions honestly and thoughtfully
- ○ I do NOT agree to answer all of the questions honestly and thoughtfully

Education Level

Q3

Your highest (most recently completed) academic degree is:

- ○ High School
- ○ Four year Undergraduate (e.g., BS, BA)
- ○ Masters (e.g., MA, MS, MBA, MPP)
- ○ Doctorate (e.g., PhD, DBA, JD, MD)

Q4

Your most recently completed academic degree major, or area of concentration, is in:

- ○ Biology
- ○ Economics
- ○ Education
- ○ Engineering
- ○ Finance
- ○ Health Sciences
- ○ Humanities
- ○ Literature
- ○ Marketing
- ○ Music
- ○ Psychology
- ○ None of the above

Q5

Your second most recently completed academic degree major, or area of concentration, is in:

- ○ Biology
- ○ Economics
- ○ Education
- ○ Engineering
- ○ Finance
- ○ Health Sciences
- ○ Humanities
- ○ Literature
- ○ Marketing
- ○ Music
- ○ Psychology
- ○ None of the above

Q6

The following five questions are designed to test your general knowledge of finance.

1. If an investment has an IRR of 10% and its WACC is 12%, then:

- ◯ The D:E ratio is greater than zero.
- ◯ The D:E ratio is less than zero.
- ◯ The NPV is greater than zero.
- ◯ The NPV is less than zero.

+ Add page break

Q7

2. In the CAPM equation, beta represents...

- ◯ The volatility of a company's stock relative to the overall market.
- ◯ The daily movement of the market's composite average.
- ◯ The slope of the line that is equal to the current price of a capital asset divided by its initial price.
- ◯ The allocation percentage of each capital asset in a portfolio.

Q8

3. Consider a capital investment with a known capital cost that is to be funded by both debt and equity. Which of the following statements is true?

- ◯ If the D:E Ratio is increased, then the projected IRR will increase.
- ◯ If the D:E Ratio is increased, then the projected IRR will decrease.
- ◯ If the D:E Ratio is increased, then the projected ROE will increase.
- ◯ If the D:E Ratio is increased, then the projected ROE will decrease.

+ Add page break

Q9

4. Why is depreciation added back in a cash flow analysis?

- ◯ Because depreciation is added back in the Income Statement.
- ◯ Because assets get depreciated and are treated as a sunk cost.
- ◯ Because assets get depreciated and have negative cash flows.
- ◯ Because depreciation is a non-cash charge on an income statement.

Q10

5. EBIT is an abbreviation for which of the following?

- ◯ Equity Before Income and Taxes
- ◯ Earnings Before Interest and Taxes
- ◯ Expenses Based on Interest and Taxes
- ◯ Expenditures Based on Interest and Taxes

Q11

How many years of professional experience do you have analyzing or making decisions regarding business or financial investments?

- ○ 0-4 years
- ○ 5-10 years
- ○ 11-15 years
- ○ More than 15 years

+ Add page break

Q12

Which of the following most closely describes your work responsibilities regarding business or financial investments?

- ○ I perform or performed analyses of potential investments for submittal to decision-makers.
- ○ I make or made recommendations of potential investments for submittal to decision-makers.
- ○ I make or made decisions regarding potential investments.

Q13

How many years of professional experience do you have analyzing non-recourse project-financing investments?

- ○ 0-1 year
- ○ 2-5 years
- ○ 6-10 years
- ○ More than 10 years

<u>Background and Instructions.</u> Please read the following instructions slowly, carefully, and intently because you will not be able to return to them.

You have been asked to advise a company on the attractiveness of six potential long-term investments. Each investment will make use of non-recourse project financing. The equity portion of the financing will be provided by the company and the debt portion will be provided by an investment bank under a fixed-rate long-term bond.

The investments are independent of each other and assume that the company has more than sufficient funds readily available to invest equity in one, some, or all of the investments. Assume that **you have performed your due diligence** and **have all the information** you believe is necessary and relevant to your investment decisions. You have determined that the investments are **identical** in every regard except that they **differ** in their internal rate of return (IRR) and their weighted average cost of capital (WACC). Assume that the IRR and WACC values provided and the information you gathered from your due diligence are **known with certainty for the duration** of the investments.

To simplify the task of comparing the six investments, you will be asked to make a series of one-on-one direct comparisons. With six potential investments, as well as the option not to invest, there are twenty-three possible one-on-one direct comparisons. The twenty-three comparisons are presented below.

For each comparison, please select your preference, even if you determine that a comparison appears equal. The use of a calculator is permitted. You **must** answer each of the comparisons. Finally, your reference code is: blueberry. Please remember this code as you will be asked for it shortly.

○ I have read and understand the instructions.

○ I have NOT read nor do I understand the instructions.

Q15

You were given a reference code in the instructions. Your reference code is:

○ Football

○ Stapler

○ Blueberry

○ Insurance

Comparison 1

Investment	IRR, %	WACC, %
1	10	7
2	10	10

Which investment do you prefer? (You must select one of them.)

- ○ Investment 1
- ○ Investment 2

Comparison 2

Investment	IRR,%	WACC,%
1	10	7
3	10	17

Which investment do you prefer? (You must select one of them.)

- ○ Investment 1
- ○ Investment 3

Comparison 3

Investment	IRR, %	WACC, %
1	10	7
4	15	7

Which investment do you prefer? (You must select one of them.)

- ○ Investment 1
- ○ Investment 4

Comparison 4

Investment	IRR, %	WACC, %
2	10	10
3	10	17

Which investment do you prefer? (You must select one of them.)

- ○ Investment 2
- ○ Investment 3

Comparison 5

Investment	IRR, %	WACC, %
2	10	10
5	15	10

Which investment do you prefer? (You must select one of them.)

- ○ Investment 2
- ○ Investment 5

Comparison 6

Investment	IRR, %	WACC, %
3	10	17
6	15	17

Which investment do you prefer? (You must select one of them.)

- ○ Investment 3
- ○ Investment 6

Comparison 7

Investment	IRR, %	WACC, %
4	15	7
5	15	10

Which investment do you prefer? (You must select one of them.)

○ Investment 4

○ Investment 5

Comparison 8

Investment	IRR, %	WACC, %
4	15	7
6	15	17

Which investment do you prefer? (You must select one of them.)

○ Investment 4

○ Investment 6

Comparison 9

Investment	IRR, %	WACC, %
5	15	10
6	15	17

Which investment do you prefer? (You must select one of them.)

- ◯ Investment 5
- ◯ Investment 6

Comparison 10

Investment	IRR, %	WACC, %
1	10	7
6	15	17

Which investment do you prefer? (You must select one of them.)

- ◯ Investment 1
- ◯ Investment 6

Comparison 11

Investment	IRR, %	WACC, %
2	10	10
4	15	7

Which investment do you prefer? (You must select one of them.)

- ◯ Investment 2
- ◯ Investment 4

Comparison 12

Investment	IRR, %	WACC, %
3	10	17
5	15	10

Which investment do you prefer? (You must select one of them.)

- ◯ Investment 3
- ◯ Investment 5

Comparison 13

Investment	IRR, %	WACC, %
A	5	7
B	9	10

Do you agree that you are a real, live person and not a computer bot?

- ◯ Yes, I am a real, live person
- ◯ No, I am a computer bot

Comparison 14

Investment	IRR, %	WACC, %
3	10	17
4	15	7

Which investment do you prefer? (You must select one of them.)

- ○ Investment 3
- ○ Investment 4

Comparison 15

Investment	IRR, %	WACC, %
2	10	10
6	15	17

Which investment do you prefer? (You must select one of them.)

- ○ Investment 2
- ○ Investment 6

Comparison 16

Investment	IRR, %	WACC, %
1	10	7
5	15	10

Which investment do you prefer? (You must select one of them.)

- ○ Investment 1
- ○ Investment 5

Comparison 17

Investment	**IRR, %**	**WACC, %**
1	10	7
none	no investment, do nothing	

Which choice do you prefer? (You must select one of them.)

- ○ Investment 1
- ○ None-not investing is preferred

Comparison 18

Investment	**IRR, %**	**WACC, %**
2	10	10
none	no investment, do nothing	

Which choice do you prefer? (You must select one of them.)

- ○ Investment 2
- ○ None--not investing is preferred

Comparison 19

Investment	**IRR, %**	**WACC, %**
3	10	17
none	no investment, do nothing	

Which choice do you prefer? (You must select one of them.)

- ○ Investment 3
- ○ None--not investing is preferred

Comparison 20

Investment	IRR, %	WACC, %
4	15	7
none	no investment, do nothing	

Which choice do you prefer? (You must select one of them.)

- ○ Investment 4
- ○ None--not investing is preferred

Comparison 21

Investment	IRR, %	WACC, %
A	5	7
B	9	10

Do you agree that you are a computer bot and not a real, live person?

- ○ Yes, I am a computer bot
- ○ No, I am a real, live person

Comparison 22

Investment	IRR, %	WACC, %
5	15	10
none	no investment, do nothing	

Which choice do you prefer? (You must select one of them.)

- ◯ Investment 5
- ◯ None--not investing is preferred

Comparison 23

Investment	IRR, %	WACC, %
6	15	17
none	no investment, do nothing	

Which choice do you prefer? (You must select one of them.)

- ◯ Investment 6
- ◯ None--not investing is preferred

Q39

In performing the above one-on-one comparisons, how confident did you feel about your selections?

- ◯ Very confident
- ◯ Moderately confident
- ◯ Not confident

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Q40

In performing the above one-on-one comparisons, how difficult was it for you to arrive at your selections?

- ◯ Difficult
- ◯ Slightly difficult
- ◯ Not difficult

In performing the above on-one-on comparisons, was your level of financial expertise sufficient to arrive at your selections?

- ◯ More than sufficient
- ◯ Sufficient
- ◯ Not sufficient

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Q42

Reflecting on the past five years, have you, in a professional capacity, been involved with a debt or equity transaction regarding the electric power industry?

- ◯ Yes
- ◯ No
- ◯ Don't know

Q43

How do you feel about the following statement?: Electric utility stocks and bonds are for "widows and orphans".

- Strongly agree
- Moderately agree
- Somewhat agree
- Moderately disagree
- Strongly disagree

+ Add page break

Q44

How do you feel about the following statement?: The degree of risk in electric industry stocks and bonds has changed due to deregulation.

- Strongly agree
- Moderately agree
- Somewhat agree
- Moderately disagree
- Strongly disagree

Q45

How do you feel about the following statement?: The degree of risk in electric industry stocks and bonds is similar to risk in other capital intensive industries.

- Strongly agree
- Moderately agree
- Somewhat agree
- Moderately disagree
- Strongly disagree

Appendix C
The Data Analysis and Results Section from the Pilot Study

The pilot study was entitled:

Can We Rely on Nuclear Power to Help Solve Climate Change?: A Phenomenological Study of the Impact of Revenue Risk Created by Electricity Deregulation on Inward FDI into the U.S. Nuclear Power Sector

Stephen Dansky
BUS 6036/6993
Florida Institute of Technology
August 1, 2022

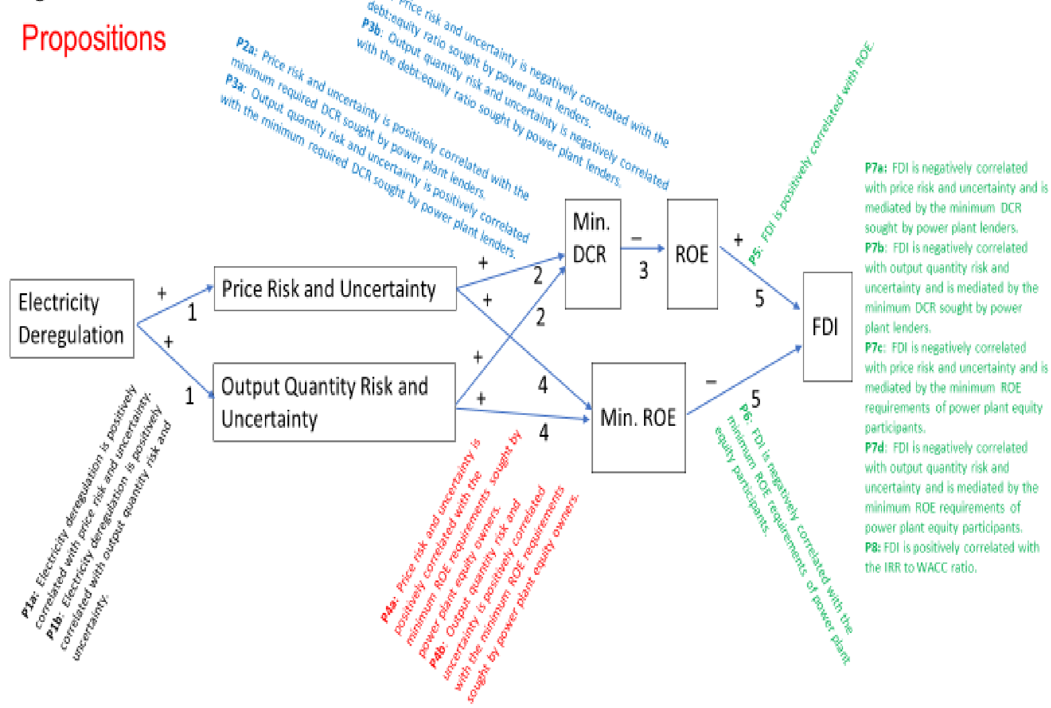
Data Analysis and Results

A total of eight interviews were conducted consisting of four participants from two groups. The response rates differed between the two groups: Group-1 had a 50% response rate (4 out of 8) while Group-2 had a 100% response rate (4 out of 4). Group-1 consisted of finance executives having at least some prior experience with the financing of electric generation projects, were familiar with electricity deregulation, and were familiar with those financing risks that are specific to the electric industry. Group-2 included financial portfolio managers who, from time to time, recommend various electric power stocks and bonds to their clients, who were generally aware of electricity deregulation but not specifically aware, and had experience with the analysis of financial risk and reward. Group-2 was not expected to possess "lived experience" regarding the increased risk and uncertainty from deregulation as they are "one step removed" from working on a regular basis with the change from deregulation, but they were expected to provide insight regarding other portions of the proposed model and the theories underlying the model.

All interview participants were asked the same questions. Saturation was reached early, and some interviews were conducted post-saturation for greater congruence certainty. Data from the two groups were analyzed separately.

The primary finding was that the phenomenological qualitative analysis provided support for the model. This held true for each segment of the model as there was 100% support from the interviews for each segment regarding the direction of the effect (positive vs. negative vs. neutral). None of the interviewees provided information that was contrary to the stated propositions. None of the responses resulted in a modification of the proposed model. Thus, the propositions all appear to be supported. See Figure-2, below.

Figure-2



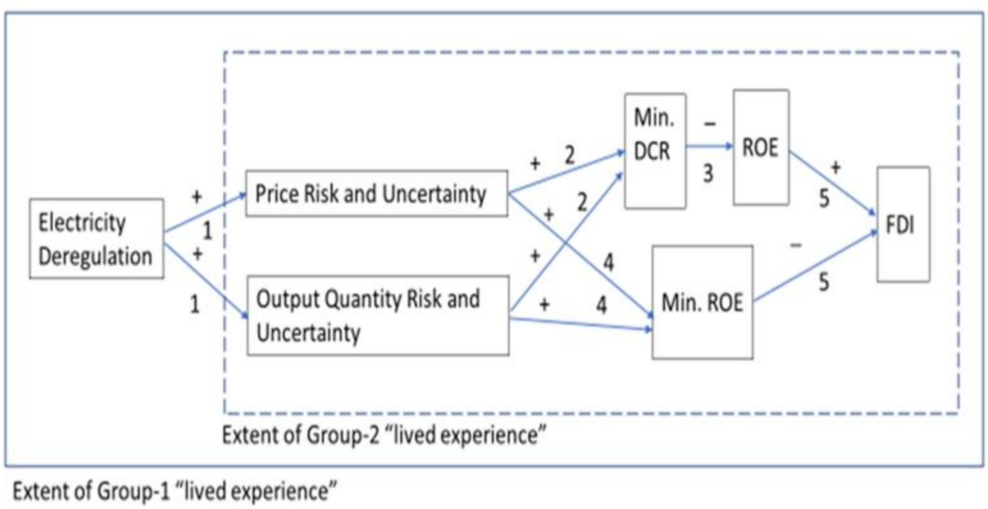
Another key finding, in support of future study, was that the interview questions were understood and interpreted by the participants without the need for clarification. The interview questions contained words and terms that have very specific financial meanings, nonetheless, the participants' professional experience within the finance industry provided sufficient ability to understand the questions, as demonstrated by the respondent's answers to the questions.

There was a clear difference between the information cultivated from the two groups with respect to deregulation's impact on price and output quantity risk and uncertainty. Participants in Group-1 were fully conscious of the increased risk and uncertainty in price and output quantity caused by deregulation; this is likely because they are required in their professional lives to evaluate these impacts on electricity projects regularly. Participants in Group-2 were all aware of deregulation, knew that both wholesale and retail competition existed, but did not know enough about its details to comment with confidence on its impact on risk and uncertainty. It was the difference in the confidence of their responses on this issue, and the much greater length of their responses, that stood out between Group-1 and Group-2.

All participants in both groups fully commented with confidence on the financial portions of the model and confirmed the underlying financial theories that support the model. Common responses used the words "sure", "of course", "absolutely", "no question about it", and "that's how it works". The participants in both groups concurred that an increase in price risk and uncertainty and/or output quantity risk and uncertainty would a) result in lenders increasing the DCR, which would lower the D:E ratio, which would lower the ROE, and b) result in equity participants increasing the minimum ROE requirements. It was regarding these financial concepts that all participants provided lengthy, confident responses indicative of their “lived experience”. This researcher’s interpretive comments regarding the confidence and length of responses form a part of phenomenology (Creswell, 2007).

In summary, both groups had the “conscious lived experience” to verify that a change in risk and uncertainty leads to a change in foreign direct investment along both pathways shown in the model. However, Group-1 also had the “conscious lived experience” to verify that electricity deregulation leads to a change in risk and uncertainty. See Figure-3, below, which compares the extent of the observed “lived experiences” between Group-1 and Group-2.

Figure-3



Appendix D
Interview Sheet

Interviewee: Date:

Interviewee Bio/Experience:

This study has one central research question:

Is it your experience that electricity deregulation has caused an increase in perceived price and output quantity risk relative to cost-of-service regulation, and why?

1) How familiar are you with electricity deregulation?

2) Is it your experience that the change from cost-of-service regulation to deregulation affects the revenue stream of a power plant, and if so, in what ways?

3) Is it your experience that deregulation affected power plant prices or output quantity or both?

4) Thinking specifically about price risk rather than price, and output quantity risk rather than output quantity, is it your experience that deregulation affected price risk or output quantity risk or both?

5) Thinking specifically about price risk rather than price, and output quantity risk rather than output quantity, is it your experience that deregulation increases the risk of a project as perceived by a lender?

6) Thinking specifically about price risk rather than price, and output quantity risk rather than output quantity, is it your experience that deregulation increases the risk of a project as perceived by an equity participant?

7) Is it your experience that projects with and without a power sales agreement have different D:E ratios imposed by the lenders to account for a difference in revenue risk?

Appendix E
Key Remarks Sorted by Interviewee

Interviewee: B

Electricity Industry Experience: 40+ years of experience, investment banking for power plants, power plant equity investor, regulatory lawyer

1) The “risk profile changed for the entire industry” as a result of deregulation.

2) Deregulation enabled competition which resulted in lower electricity prices.

3) The increase in risk was evidenced by the across-the-board downgrading of utility bond ratings by the rating agencies.

4) The increase in revenue risk was evidenced by numerous utilities selling off their generation assets.

5) Deregulation allowed for the introduction of new, competing technology which added uncertainty compared to cost-of-service regulation because inefficient plants were able to operate so long as the plant was deemed “used and useful”.

6) To reduce revenue risk, some IPPs try to sell all or a portion of their electric output via long-term contracts directly to large, credit-worthy industrial companies or sell directly via long-term contracts to regulated utilities that are looking to add renewable energy.

7) Some lenders changed their practices to only provide financing for projects that have established a multi-year operating history and by doing so, “reduce the risk profile”.

8) Lenders now need to take into account “more variables in their loan analyses” than before and this increase in complication added to the lenders’ risks.

9) Lenders mandated lower D:E ratios to compensate for the increased risk.

Interviewee: C

Electricity Industry Experience: 15 years of experience, investment banking for power plants and power plant analysis and lending

1) The introduction of competition into the deregulated markets lowered electric prices which lowered IRRs, and this exacerbated the inability to earn a return on equity commensurate with the increased risk.

2) The increase in risk was evidenced by the across-the-board downgrading of utility bond ratings by the rating agencies.

3) A nuclear plant in a deregulated environment would need a higher ROE than other types of power plants to account for output quantity risk, and opined that any company that chooses to pursue the development of a nuclear plant would have its debt downgraded.

4) To reduce risk, some IPPs try to sell all or a portion of their electric output via long-term contracts directly to large, credit-worthy industrial companies or sell directly via long-term contracts to regulated utilities that are looking to add renewable energy.

5) Both lenders and equity investors experience more risk under deregulation.

6) Lenders mandated lower D:E ratios to compensate for the increased risk.

7) Equity investors sought higher minimum ROEs to compensate for the increased risk.

8) Electricity price hedges to protect against spark spread and insure against price volatility are not available for longer than a year and, thus, the increase in long-term uncertainty can not be eliminated and now resides with the power plant equity investors.

Interviewee: F

Electricity Industry Experience: 40+ years of experience, power plant equity investor, federal regulator, investment bank consultant

1) The removal of revenue guarantees under deregulation that were associated with a power plant's capital cost that was an integral part of cost-of-service regulation. Uncertainty comes from the removal of cost-of-service regulatory set prices.

2) "Without used-and-useful, risk goes up".

3) Both lenders and equity investors were affected by the removal of regulated cost-of-service guarantees.

4) Both lenders and equity investors experience more risk under deregulation.

5) Market signals in the deregulated ISO bidding systems are now all short-term.

6) One ISO (ERCOT) does not allow capacity (kW) prices to be bid separately and distinct from energy (kWh) prices but have to be incorporated into a single daily energy price.

7) Deregulation increased competition which lowered electricity prices.

Interviewee: G

Electricity Industry Experience: 18 years of experience, investment banking for power plants, power plant analysis and lending, credit ratings of utilities and IPPs

1) The removal of the revenue guarantees under deregulation that were associated with a power plant's capital cost that were an integral part of cost-of-service regulation.

2) Uncertainty comes from the removal of cost-of-service regulatory set prices.

3) Market signals in the deregulated ISO bidding systems are now all short-term .

4) Lower electricity prices from competition

5) To reduce risk, some IPPs try to sell all or a portion of their electric output via long-term contracts directly to large, credit-worthy industrial companies or sell directly via long-term contracts to regulated utilities that are looking to add renewable energy (specifically wind and solar) into their generation mix pursuant to regulatory directives.

6) From a lender's perspective, the risk profiles of wind and solar are the "closest thing there is in the energy business to an annuity".

7) Both lenders and equity investors experience more risk under deregulation.

8) Lenders mandated lower D:E ratios to compensate for the increased risk.

9) Higher minimum ROEs are being driven by the increase in uncertainty.

Interviewee: H

Electricity Industry Experience: 40+ years of experience, investment banking for power plants, ISO Board of Directors, CFO of IPP Company

1) Market signals in the deregulated ISO bidding systems are now all short-term .

2) Competition resulted in lower electricity prices.

3) With deregulation, a plant's output quantity is a function of bid prices.

4) IPPs are selling all or a portion of their electric output via long-term contracts directly to large, credit-worthy industrial companies or sell directly via long-term contracts to regulated utilities that are looking to add renewable energy.

5) Without cost-of-service regulation significant risks shifted from the utility's ratepayers to the investors.

6) Lenders mandated lower D:E ratios to compensate for the increased risk

Interviewee: K

Electricity Industry Experience: 25 years of experience, investment banking for power plants, electric utility Board of Directors, power plant equity divestments

1) The removal of the revenue guarantees associated with a power plant's capital cost that were an integral part of cost-of-service regulation.

2) Greater uncertainty under deregulation for those power plants, such as coal and natural gas, that now have to maintain a long-term "spark spread" between revenue and fuel costs in order to pay for the plant's fixed capital costs.

3) Without cost-of-service regulation significant risks shifted from the utility's ratepayers to the investors.

4) Equity investors sought higher minimum ROEs to compensate for the increased risk.

5) The increase in revenue risk was also evidenced by numerous utilities selling off their generation assets.

6) Lenders responded to this risk by increasing interest rates.

7) The increasing interest rates negatively affected debt coverage ratios (DCR).

8) Lenders mandated lower D:E ratios to compensate for the increased risk.

9) The effort of some IPPs to sell all or a portion of their electric output via long-term contracts directly to large, credit-worthy industrial companies or sell directly via long-term contracts to regulated utilities that are looking to add renewable energy.

10) Pointed to two similar power plants, one with and one without a long-term PSA, having different D:E Ratios to account for the risk.

Interviewee: M

Electricity Industry Experience: 19 years of experience, investment banking for power plants, and investment analyses of IPPs and power projects

1) The change in price volatility that stems from the switch from regulated average cost pricing to deregulated marginal cost pricing

2) The process of bidding adds uncertainty to the revenue stream because a power plant never knows from day to day which bids, theirs and/or their competitors, will be accepted.

3) The response of equity investors to this increased risk has been the “drive to wind and solar” thus reducing some amount of risk to the equity investors.

4) Both lenders and equity investors experience more risk under deregulation.

5) Lenders responded to this risk by increasing interest rates.

6) Lenders likely mandated lower D:E ratios but couldn’t think of specific instances where they witnessed this behavior.

Interviewee: P

Electricity Industry Experience: 40+ years of experience, state and federal regulator, and investment bank consultant

1) Deregulation’s removal of the revenue guarantees associated with a power plant’s capital cost that were an integral part of cost-of-service regulation.

2) Market signals in the deregulated ISO bidding systems are now all short-term.

3) Uncertainty comes from the removal of cost-of-service regulatory set prices.

4) Under deregulation, output quantity is a function of bid prices.

5) A power plant operator can regain some control over the output quantity by bidding a very low price to the ISO to ensure baseload operation “but loses all price certainty in doing so”.

6) Without cost-of-service regulation significant risks shifted from the utility’s ratepayers to the investors.

7) Lenders likely mandated lower D:E Ratios but couldn’t think of specific instances during the interview where this behavior was seen.

Interviewee: R

Elecetricity Industry Experience: 40+ years of experience, investment banking for power plants, ISO Board of Directors, and Partner, IPP Company

1) The removal of regulation removed the guarantees on both capital and variable costs.

2) The change in price volatility that stems from the switch from regulated average cost pricing to deregulated marginal cost pricing.

3) Deregulation led to more competition which fueled “the juices of capitalism” and led to lower prices for electricity.

4) Uncertainty comes from the removal of cost-of-service regulatory set prices.

5) The increase in revenue risk was evidenced by numerous utilities selling off their generation assets.

6) “Numerous utilities exited the [electric generation] business because they didn’t have the risk appetite” that came with deregulation.

7) Numerous IPP companies exited the power plant development business because they didn’t have the appetite for the increase in revenue risk after the Energy Policy Act of 1992.

8) Equity investors sought higher minimum ROEs to compensate for the increased risk.

9) Lenders reacted to the increase in risk by cutting back on the number of loans, and these loans often were of a shorter term.

10) Lenders mandated lower D:E ratios to compensate for the increased risk

Interviewee: S

Electricity Industry Experience: 40+ years of experience, state regulator and investment bank consultant

1) Market signals in the deregulated ISO bidding systems are now all short-term.

2) Lower electricity prices from competition.

3) Some IPPs try to sell all or a portion of their electric output via long-term contracts directly to large, credit-worthy industrial companies or sell directly via long-term contracts to regulated utilities that are looking to add renewable energy.

4) Selling output to a utility might get a regulatory "stamp of approval" that can add additional long-term certainty compared to the ISO bidding systems.

5) Without cost-of-service regulation significant risks shifted from the utility's ratepayers to the investors.

6) Lenders mandated lower D:E ratios to compensate for the increased risk.

7) The increase in revenue risk was also evidenced by numerous utilities selling off their generation assets.

8) Testimony by a utility executive in NYPSC Case 0l-E-0011 that nuclear plants were designed for an earlier regulatory structure (i.e., where baseload operation was at the discretion of the utility) and not designed for the new deregulated structure where the nuclear plants are dispatched by the ISO. As a result, this testimony stated that nuclear power plants now require a higher ROE to account for this output quantity risk.

9) The testimonies of multiple parties in NYPSC Case 98-E-0405 and Case 0l-E-0011 strongly suggest that deregulation increased revenue risk, and points to the

difference in the two auction bid prices received from Constellation Energy (the winning bidder for two of the nuclear plants).

Appendix F
Respondents' Direct Comparisons Data
And
Slope of Ranking vs. IRR:WACC Ratio Data

Matrix A

																				Investment-->		1	2	3	4	5	6	0
Investment 1	Investment 1	Investment 4	Investment 2	Investment 5	Investment 6	Investment 4	Investment 4	Investment 5	Investment 1	Investment 4	Investment 5	Investment 4	Investment 2	Investment 5	Investment 1	None--not investing is preferr	None--not investing is preferr	Investment 4	Investment 5	None--not investing is preferr		4	2	0	6	5	1	3
Investment 1	Investment 1	Investment 4	Investment 2	Investment 5	Investment 6	Investment 4	Investment 4	Investment 5	Investment 1	Investment 4	Investment 5	Investment 4	Investment 2	Investment 5	None-not investing is preferr	None--not investing is preferr	None--not investing is preferr	Investment 4	None--not investing is preferr	None--not investing is preferr		3	2	0	6	4	1	5
Investment 1	Investment 1	Investment 4	Investment 2	Investment 5	Investment 6	Investment 4	Investment 4	Investment 5	Investment 1	Investment 4	Investment 5	Investment 4	Investment 2	Investment 1	Investment 1	Investment 2	None--not investing is preferr	Investment 4	Investment 5	None--not investing is preferr		5	3	0	6	4	1	2
Investment 1	Investment 1	Investment 4	Investment 2	Investment 5	Investment 6	Investment 4	Investment 4	Investment 5	Investment 1	Investment 4	Investment 5	Investment 4	Investment 2	Investment 5	None-not investing is preferr	None--not investing is preferr	None--not investing is preferr	Investment 4	None--not investing is preferr	None--not investing is preferr		3	2	0	6	4	1	5
Investment 1	Investment 1	Investment 4	Investment 2	Investment 5	Investment 6	Investment 4	Investment 4	Investment 5	Investment 1	Investment 4	Investment 5	Investment 4	Investment 2	Investment 1	Investment 1	Investment 2	None--not investing is preferr	Investment 4	Investment 5	None--not investing is preferr		5	3	0	6	4	1	2
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Investment 1	Investment 1	Investment4	Investment2	Investment5	Investment6	Investment 4	Investment 4	Investment 5	Investment 1	Investment4	Investment5	Investment4	Investment2	Investment5	Investment 1	None--not investing is preferr	None--not investing is preferr	Investment4	Investment5	None--not investing is preferr		4	2	0	6	5	1	3
Investment 1	Investment 1	Investment4	Investment2	Investment5	Investment6	Investment 4	Investment 4	Investment 5	Investment 1	Investment4	Investment5	Investment4	Investment2	Investment1	Investment 1	Investment 2	None--not investing is preferr	Investment4	Investment5	None--not investing is preferr		4	3	0	6	5	1	2
Investment 1	Investment 1	Investment4	Investment2	Investment5	Investment6	Investment 4	Investment 4	Investment 5	Investment 1	Investment4	Investment5	Investment4	Investment2	Investment5	Investment 1	Investment 2	None--not investing is preferr	Investment4	Investment5	None--not investing is preferr		4	3	0	6	5	1	2
Investment 1	Investment 1	Investment4	Investment2	Investment5	Investment6	Investment 4	Investment 4	Investment 5	Investment 1	Investment4	Investment5	Investment4	Investment2	Investment5	Investment 1	Investment 2	None--not investing is preferr	Investment4	Investment5	None--not investing is preferr		4	3	0	6	5	1	2
Investment 1	Investment 1	Investment4	Investment2	Investment5	Investment6	Investment 4	Investment 4	Investment 5	Investment 1	Investment4	Investment5	Investment4	Investment2	Investment5	Investment 1	Investment 2	None--not investing is preferr	Investment4	Investment5	None--not investing is preferr		4	3	0	6	5	1	2
Investment 1	Investment 1	Investment4	Investment2	Investment5	Investment6	Investment 4	Investment 4	Investment 5	Investment 1	Investment4	Investment5	Investment4	Investment2	Investment5	Investment 1	None--not investing is preferr	None--not investing is preferr	Investment4	Investment5	None--not investing is preferr		4	2	0	6	5	1	3
Investment 1	Investment 1	Investment4	Investment2	Investment5	Investment6	Investment 4	Investment 4	Investment 5	Investment 1	Investment4	Investment5	Investment4	Investment2	Investment5	Investment 1	None--not investing is preferr	None--not investing is preferr	Investment4	Investment5	None--not investing is preferr		4	2	0	6	5	1	3
Investment 1	Investment 1	Investment4	Investment2	Investment5	Investment6	Investment 4	Investment 4	Investment 5	Investment 1	Investment4	Investment5	Investment4	Investment2	Investment5	Investment 1	None--not investing is preferr	None--not investing is preferr	Investment4	Investment5	None--not investing is preferr		4	2	0	6	5	1	3
Investment 1	Investment 1	Investment4	Investment2	Investment5	Investment6	Investment 4	Investment 4	Investment 5	Investment 1	Investment4	Investment5	Investment4	Investment2	Investment5	Investment 1	None--not investing is preferr	None--not investing is preferr	Investment4	Investment5	None--not investing is preferr		4	2	0	6	5	1	3
Investment 1	Investment 1	Investment4	Investment2	Investment5	Investment6	Investment 4	Investment 4	Investment 5	Investment 1	Investment4	Investment5	Investment4	Investment2	Investment5	Investment 1	None--not investing is preferr	None--not investing is preferr	Investment4	Investment5	None--not investing is preferr		4	2	0	6	5	1	3
Investment 1	Investment 1	Investment4	Investment2	Investment5	Investment6	Investment 4	Investment 4	Investment 5	Investment 1	Investment4	Investment5	Investment4	Investment2	Investment5	Investment 1	None--not investing is preferr	None--not investing is preferr	Investment4	Investment5	None--not investing is preferr		4	2	0	6	5	1	3
Investment 1	Investment 1	Investment4	Investment2	Investment5	Investment6	Investment 4	Investment 4	Investment 5	Investment 1	Investment4	Investment5	Investment4	Investment2	Investment5	Investment 1	None--not investing is preferr	None--not investing is preferr	Investment4	Investment5	None--not investing is preferr		4	2	0	6	5	1	3

Matrix B

																				Investment-->		1	2	3	4	5	6	0
Invest ment 2	Invest ment 3	Invest ment 1	Invest ment 3	Invest ment 2	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 3	Invest ment 6	Invest ment 5	Invest ment 6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investi ng is preferr	None--not investi ng is preferr	None--not investi ng is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment 1	Invest ment 3	Invest ment 2	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 3	Invest ment 6	Invest ment 5	Invest ment 6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investi ng is preferr	None--not investi ng is preferr	None--not investi ng is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment 1	Invest ment 3	Invest ment 2	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 3	Invest ment 6	Invest ment 5	Invest ment 6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investi ng is preferr	None--not investi ng is preferr	None--not investi ng is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment 1	Invest ment 3	Invest ment 2	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 3	Invest ment 6	Invest ment 5	Invest ment 6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investi ng is preferr	None--not investi ng is preferr	None--not investi ng is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment 1	Invest ment 3	Invest ment 2	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 3	Invest ment 6	Invest ment 5	Invest ment 6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investi ng is preferr	None--not investi ng is preferr	None--not investi ng is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment 1	Invest ment 3	Invest ment 2	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 3	Invest ment 6	Invest ment 5	Invest ment 6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investi ng is preferr	None--not investi ng is preferr	None--not investi ng is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment 1	Invest ment 3	Invest ment 2	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 3	Invest ment 6	Invest ment 5	Invest ment 6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investi ng is preferr	None--not investi ng is preferr	None--not investi ng is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment 1	Invest ment 3	Invest ment 2	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 3	Invest ment 6	Invest ment 5	Invest ment 6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investi ng is preferr	None--not investi ng is preferr	None--not investi ng is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment 1	Invest ment 3	Invest ment 2	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 3	Invest ment 6	Invest ment 5	Invest ment 6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investi ng is preferr	None--not investi ng is preferr	None--not investi ng is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment 1	Invest ment 3	Invest ment 2	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 3	Invest ment 6	Invest ment 5	Invest ment 6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investi ng is preferr	None--not investi ng is preferr	None--not investi ng is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment 1	Invest ment 3	Invest ment 2	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 3	Invest ment 6	Invest ment 5	Invest ment 6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investi ng is preferr	None--not investi ng is preferr	None--not investi ng is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment 1	Invest ment 3	Invest ment 2	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 3	Invest ment 6	Invest ment 5	Invest ment 6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investi ng is preferr	None--not investi ng is preferr	None--not investi ng is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment 1	Invest ment 3	Invest ment 2	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 3	Invest ment 6	Invest ment 5	Invest ment 6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investi ng is preferr	None--not investi ng is preferr	None--not investi ng is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment 1	Invest ment 3	Invest ment 2	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 3	Invest ment 6	Invest ment 5	Invest ment 6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investi ng is preferr	None--not investi ng is preferr	None--not investi ng is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment 1	Invest ment 3	Invest ment 2	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 3	Invest ment 6	Invest ment 5	Invest ment 6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investi ng is preferr	None--not investi ng is preferr	None--not investi ng is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment 1	Invest ment 3	Invest ment 2	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 3	Invest ment 6	Invest ment 5	Invest ment 6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investi ng is preferr	None--not investi ng is preferr	None--not investi ng is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment 1	Invest ment 3	Invest ment 2	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 3	Invest ment 6	Invest ment 5	Invest ment 6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investi ng is preferr	None--not investi ng is preferr	None--not investi ng is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment 1	Invest ment 3	Invest ment 2	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 3	Invest ment 6	Invest ment 5	Invest ment 6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investi ng is preferr	None--not investi ng is preferr	None--not investi ng is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment 1	Invest ment 3	Invest ment 2	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 3	Invest ment 6	Invest ment 5	Invest ment 6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investi ng is preferr	None--not investi ng is preferr	None--not investi ng is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment 1	Invest ment 3	Invest ment 2	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 3	Invest ment 6	Invest ment 5	Invest ment 6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investi ng is preferr	None--not investi ng is preferr	None--not investi ng is preferr		4	5	6	0	1	2	3

Investment 2	Investment 3	Investment 1	Investment 3	Investment 2	Investment 1	Investment 1	Investment 2	Investment 2	Investment 3	Investment 3	Investment 3	Investment 6	Investment 5	Investment 6	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Investment 2	Investment 3	Investment 1	Investment 3	Investment 2	Investment 1	Investment 1	Investment 2	Investment 2	Investment 3	Investment 3	Investment 3	Investment 6	Investment 5	Investment 6	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Investment 2	Investment 3	Investment 1	Investment 3	Investment 2	Investment 1	Investment 1	Investment 2	Investment 2	Investment 3	Investment 3	Investment 3	Investment 6	Investment 5	Investment 6	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Investment 2	Investment 3	Investment 1	Investment 3	Investment 2	Investment 1	Investment 1	Investment 2	Investment 2	Investment 3	Investment 3	Investment 3	Investment 6	Investment 5	Investment 6	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Investment 2	Investment 3	Investment 1	Investment 3	Investment 2	Investment 1	Investment 1	Investment 2	Investment 2	Investment 3	Investment 3	Investment 3	Investment 6	Investment 5	Investment 6	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Investment 2	Investment 3	Investment 1	Investment 3	Investment 2	Investment 1	Investment 1	Investment 2	Investment 2	Investment 3	Investment 3	Investment 3	Investment 6	Investment 5	Investment 6	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Investment 2	Investment 3	Investment 1	Investment 3	Investment 2	Investment 1	Investment 1	Investment 2	Investment 2	Investment 3	Investment 3	Investment 3	Investment 5	Investment 5	Investment 6	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Investment 2	Investment 3	Investment 1	Investment 3	Investment 2	Investment 1	Investment 1	Investment 2	Investment 2	Investment 3	Investment 3	Investment 3	Investment 6	Investment 5	Investment 6	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Investment 2	Investment 3	Investment 1	Investment 3	Investment 2	Investment 1	Investment 1	Investment 2	Investment 2	Investment 3	Investment 3	Investment 3	Investment 6	Investment 5	Investment 6	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Investment 2	Investment 3	Investment 1	Investment 3	Investment 2	Investment 1	Investment 1	Investment 2	Investment 2	Investment 3	Investment 3	Investment 3	Investment 6	Investment 5	Investment 6	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Investment 2	Investment 3	Investment 1	Investment 3	Investment 2	Investment 1	Investment 1	Investment 2	Investment 2	Investment 3	Investment 3	Investment 3	Investment 6	Investment 5	Investment 6	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Investment 2	Investment 3	Investment 1	Investment 3	Investment 2	Investment 1	Investment 1	Investment 2	Investment 2	Investment 3	Investment 3	Investment 3	Investment 6	Investment 5	Investment 6	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Investment 2	Investment 3	Investment 1	Investment 3	Investment 2	Investment 1	Investment 1	Investment 2	Investment 2	Investment 3	Investment 3	Investment 3	Investment 6	Investment 5	Investment 6	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Investment 2	Investment 3	Investment 1	Investment 3	Investment 2	Investment 1	Investment 1	Investment 2	Investment 2	Investment 3	Investment 3	Investment 3	Investment 6	Investment 5	Investment 6	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Investment 2	Investment 3	Investment 1	Investment 3	Investment 2	Investment 1	Investment 1	Investment 2	Investment 2	Investment 3	Investment 3	Investment 3	Investment 6	Investment 5	Investment 6	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Investment 2	Investment 3	Investment 1	Investment 3	Investment 2	Investment 1	Investment 1	Investment 2	Investment 2	Investment 3	Investment 3	Investment 3	Investment 6	Investment 5	Investment 6	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Investment 2	Investment 3	Investment 1	Investment 3	Investment 2	Investment 1	Investment 1	Investment 2	Investment 2	Investment 3	Investment 3	Investment 3	Investment 6	Investment 5	Investment 6	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Investment 2	Investment 3	Investment 1	Investment 3	Investment 2	Investment 1	Investment 1	Investment 2	Investment 2	Investment 3	Investment 3	Investment 3	Investment 6	Investment 5	Investment 6	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Investment 2	Investment 3	Investment 1	Investment 3	Investment 2	Investment 1	Investment 1	Investment 2	Investment 2	Investment 3	Investment 3	Investment 3	Investment 6	Investment 5	Investment 6	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Investment 2	Investment 3	Investment 1	Investment 3	Investment 2	Investment 1	Investment 1	Investment 2	Investment 2	Investment 3	Investment 3	Investment 3	Investment 6	Investment 5	Investment 6	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3

Invest ment 2	Invest ment 3	Invest ment1	Invest ment3	Invest ment2	Invest ment1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment3	Invest ment3	Invest ment6	Invest ment5	Invest ment6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment1	Invest ment3	Invest ment2	Invest ment1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment3	Invest ment3	Invest ment6	Invest ment5	Invest ment6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment1	Invest ment3	Invest ment2	Invest ment1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment3	Invest ment3	Invest ment6	Invest ment5	Invest ment6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment1	Invest ment3	Invest ment2	Invest ment1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment3	Invest ment3	Invest ment6	Invest ment5	Invest ment6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment1	Invest ment3	Invest ment2	Invest ment1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment3	Invest ment3	Invest ment6	Invest ment5	Invest ment6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment1	Invest ment3	Invest ment2	Invest ment1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment3	Invest ment3	Invest ment6	Invest ment5	Invest ment6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment1	Invest ment3	Invest ment2	Invest ment1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment3	Invest ment3	Invest ment6	Invest ment5	Invest ment6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment1	Invest ment3	Invest ment2	Invest ment1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment3	Invest ment3	Invest ment6	Invest ment5	Invest ment6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment1	Invest ment3	Invest ment2	Invest ment1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment3	Invest ment3	Invest ment6	Invest ment5	Invest ment6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment1	Invest ment3	Invest ment2	Invest ment1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment3	Invest ment3	Invest ment6	Invest ment5	Invest ment6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment1	Invest ment3	Invest ment2	Invest ment1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment3	Invest ment3	Invest ment6	Invest ment5	Invest ment6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment1	Invest ment3	Invest ment2	Invest ment1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment3	Invest ment3	Invest ment6	Invest ment5	Invest ment6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment1	Invest ment3	Invest ment2	Invest ment1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment3	Invest ment3	Invest ment6	Invest ment5	Invest ment6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment1	Invest ment3	Invest ment2	Invest ment1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment3	Invest ment3	Invest ment6	Invest ment5	Invest ment6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment1	Invest ment3	Invest ment2	Invest ment1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment3	Invest ment3	Invest ment6	Invest ment5	Invest ment6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment1	Invest ment3	Invest ment2	Invest ment1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment3	Invest ment3	Invest ment6	Invest ment5	Invest ment6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment1	Invest ment3	Invest ment2	Invest ment1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment3	Invest ment3	Invest ment6	Invest ment5	Invest ment6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment1	Invest ment3	Invest ment2	Invest ment1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment3	Invest ment3	Invest ment6	Invest ment5	Invest ment6	None--not investing is preferr	Invest ment 2	Invest ment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		3	5	6	0	1	2	4
Invest ment 2	Invest ment 3	Invest ment1	Invest ment3	Invest ment2	Invest ment1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment3	Invest ment3	Invest ment6	Invest ment5	Invest ment6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Invest ment 2	Invest ment 3	Invest ment1	Invest ment3	Invest ment2	Invest ment1	Invest ment 1	Invest ment 2	Invest ment 2	Invest ment 3	Invest ment3	Invest ment3	Invest ment6	Invest ment5	Invest ment6	Invest ment 1	Invest ment 2	Invest ment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3

Matrix C

																					Investment-->	1	2	3	4	5	6	0
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	None--not investing is preferr	None--not investing is preferr	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		3	4	6	0	1	2	5
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	None--not investing is preferr	None--not investing is preferr	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		3	4	6	0	1	2	5
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 6	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	Investment 6		4	4	6	0	1	4	2
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	Investment 6		4	5	6	0	1	3	2
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	Investment 6		4	5	6	0	1	3	2
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	Investment 6		4	5	6	0	1	3	2
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	Investment 6		4	5	6	0	1	3	2
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	Investment 6		4	5	6	0	1	3	2
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	Investment 6		4	5	6	0	1	3	2
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	Investment 6		4	5	6	0	1	3	2
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	Investment 6		4	5	6	0	1	3	2
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	Investment 6		4	5	6	0	1	3	2
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	Investment 6		4	5	6	0	1	3	2
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 6	None--not investing is preferr	None--not investing is preferr	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		2	4	6	0	1	3	5
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None--not investing is preferr	None--not investing is preferr	None--not investing is preferr		4	5	6	0	1	2	3

Invest ment 3	Invest ment 2	Invest ment 6	Invest ment 6	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 5	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 3	None– not investi ng is preferr	None– not investi ng is preferr	None-- not investi ng is preferr		4	5	6	0	1	2	3
Invest ment 3	Invest ment 2	Invest ment 6	Invest ment 6	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 5	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 3	None– not investi ng is preferr	None– not investi ng is preferr	Invest ment 6		4	5	6	0	1	3	2
Invest ment 3	Invest ment 2	Invest ment 6	Invest ment 6	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 5	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 3	None– not investi ng is preferr	None– not investi ng is preferr	Invest ment 6		4	5	6	0	1	3	2
Invest ment 3	Invest ment 2	Invest ment 6	Invest ment 6	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 5	Invest ment 6	Invest ment 1	Invest ment 2	Invest ment 3	None– not investi ng is preferr	None– not investi ng is preferr	Invest ment 6		3	5	6	0	1	4	2
Invest ment 3	Invest ment 2	Invest ment 6	Invest ment 6	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 5	Invest ment 6	Invest ment 1	Invest ment 2	Invest ment 3	None– not investi ng is preferr	None– not investi ng is preferr	Invest ment 6		3	5	6	0	1	4	2
Invest ment 3	Invest ment 2	Invest ment 6	Invest ment 6	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 5	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 3	None– not investi ng is preferr	None– not investi ng is preferr	Invest ment 6		4	5	6	0	1	3	2
Invest ment 3	Invest ment 2	Invest ment 6	Invest ment 6	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 5	Invest ment 6	Invest ment 1	Invest ment 2	Invest ment 3	None– not investi ng is preferr	None– not investi ng is preferr	Invest ment 6		3	5	6	0	1	4	2
Invest ment 3	Invest ment 2	Invest ment 6	Invest ment 6	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 5	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 3	None– not investi ng is preferr	None– not investi ng is preferr	Invest ment 6		4	5	6	0	1	3	2
Invest ment 3	Invest ment 2	Invest ment 6	Invest ment 6	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 5	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 3	None– not investi ng is preferr	None– not investi ng is preferr	Invest ment 6		4	5	6	0	1	3	2
Invest ment 3	Invest ment 2	Invest ment 6	Invest ment 6	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 5	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 3	None– not investi ng is preferr	None– not investi ng is preferr	Invest ment 6		4	5	6	0	1	3	2
Invest ment 3	Invest ment 2	Invest ment 6	Invest ment 6	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 5	Invest ment 6	Invest ment 1	Invest ment 2	Invest ment 3	None– not investi ng is preferr	None– not investi ng is preferr	Invest ment 6		3	5	6	0	1	4	2
Invest ment 3	Invest ment 2	Invest ment 6	Invest ment 6	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 5	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 3	None– not investi ng is preferr	None– not investi ng is preferr	Invest ment 6		4	5	6	0	1	3	2
Invest ment 3	Invest ment 2	Invest ment 6	Invest ment 6	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 5	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 3	None– not investi ng is preferr	None– not investi ng is preferr	Invest ment 6		4	5	6	0	1	3	2
Invest ment 3	Invest ment 2	Invest ment 6	Invest ment 6	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 5	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 3	None– not investi ng is preferr	None– not investi ng is preferr	Invest ment 6		4	5	6	0	1	3	2
Invest ment 3	Invest ment 2	Invest ment 6	Invest ment 6	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 5	Invest ment 6	Invest ment 1	Invest ment 2	Invest ment 3	None– not investi ng is preferr	None– not investi ng is preferr	Invest ment 6		3	5	6	0	1	4	2
Invest ment 3	Invest ment 2	Invest ment 6	Invest ment 6	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 5	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 3	None– not investi ng is preferr	None– not investi ng is preferr	Invest ment 6		4	5	6	0	1	3	2
Invest ment 3	Invest ment 2	Invest ment 6	Invest ment 6	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 5	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 3	None– not investi ng is preferr	None– not investi ng is preferr	Invest ment 6		4	5	6	0	1	3	2
Invest ment 3	Invest ment 2	Invest ment 6	Invest ment 6	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 5	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 3	None– not investi ng is preferr	Invest ment 5	Invest ment 6		4	5	6	0	2	3	1
Invest ment 3	Invest ment 2	Invest ment 6	Invest ment 6	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 5	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 3	None– not investi ng is preferr	Invest ment 5	Invest ment 6		4	5	6	0	2	3	1
Invest ment 3	Invest ment 2	Invest ment 6	Invest ment 6	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 5	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 3	None– not investi ng is preferr	Invest ment 5	Invest ment 6		4	5	6	0	2	3	1
Invest ment 3	Invest ment 2	Invest ment 6	Invest ment 6	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 5	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 3	None– not investi ng is preferr	Invest ment 5	Invest ment 6		4	5	6	0	2	3	1
Invest ment 3	Invest ment 2	Invest ment 6	Invest ment 6	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 3	Invest ment 3	Invest ment 1	Invest ment 2	Invest ment 5	Invest ment 1	Invest ment 1	Invest ment 2	Invest ment 3	None– not investi ng is preferr	Invest ment 5	Invest ment 6		4	5	6	0	2	3	1

Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None – not investing is preferr	None – not investing is preferr	Investment 6		4	5	6	0	1	3	2
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None – not investing is preferr	None – not investing is preferr	Investment 6		4	5	6	0	1	3	2
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None – not investing is preferr	None – not investing is preferr	Investment 6		4	5	6	0	1	3	2
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None – not investing is preferr	None – not investing is preferr	Investment 6		4	5	6	0	1	3	2
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None – not investing is preferr	Investment 5	Investment 6		4	5	6	0	2	3	1
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None – not investing is preferr	None – not investing is preferr	None-- not investing is preferr		4	5	6	0	1	2	3
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None – not investing is preferr	None – not investing is preferr	None-- not investing is preferr		4	5	6	0	1	2	3
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None – not investing is preferr	Investment 5	Investment 6		4	5	6	0	2	3	1
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 6	Investment 1	Investment 2	Investment 3	None – not investing is preferr	Investment 5	Investment 6		3	5	6	0	2	4	1
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None – not investing is preferr	Investment 5	Investment 6		4	5	6	0	2	3	1
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None – not investing is preferr	None – not investing is preferr	None-- not investing is preferr		4	5	6	0	1	2	3
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None – not investing is preferr	None – not investing is preferr	None-- not investing is preferr		4	5	6	0	1	2	3
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None – not investing is preferr	None – not investing is preferr	None-- not investing is preferr		4	5	6	0	1	2	3
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None – not investing is preferr	None – not investing is preferr	None-- not investing is preferr		2	5	6	0	2	4	2
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None – not investing is preferr	None – not investing is preferr	Investment 6		4	5	6	0	1	3	2
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 6	None-- not investing is preferr	Investment 2	Investment 3	None – not investing is preferr	Investment 5	Investment 6		2	5	6	0	2	4	2
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 6	None-- not investing is preferr	Investment 2	Investment 3	None – not investing is preferr	Investment 5	Investment 6		2	5	6	0	2	4	2
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None – not investing is preferr	None – not investing is preferr	None-- not investing is preferr		4	5	6	0	1	2	3
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	Investment 1	Investment 2	Investment 3	None – not investing is preferr	Investment 5	Investment 6		4	5	6	0	2	3	1
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	None-- not investing is preferr	None-- not investing is preferr	Investment 3	None – not investing is preferr	None – not investing is preferr	None-- not investing is preferr		3	4	6	0	1	2	5
Investment 3	Investment 2	Investment 6	Investment 6	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 3	Investment 3	Investment 1	Investment 2	Investment 5	Investment 1	None-- not investing is preferr	None-- not investing is preferr	Investment 3	None – not investing is preferr	None – not investing is preferr	None-- not investing is preferr		3	4	6	0	1	2	5

Matrix A								Do Not	Slope of
								Invest	Ranking vs.
Respondent	Investment-->	**1**	**2**	**3**	**4**	**5**	**6**	**0**	IRR:WACC Ratio
1		4	2	0	6	5	1	3	4.1532
2		3	2	0	6	4	1	5	3.8793
3		5	3	0	6	4	1	2	3.9385
4		3	2	0	6	4	1	5	3.8793
5		5	3	0	6	4	1	2	3.9385
6		3	2	0	6	4	1	5	3.8793
7		5	3	0	6	4	1	2	3.9385
8		5	3	0	6	4	1	2	3.9385
9		5	3	0	6	4	1	2	3.9385
10		3	3	0	6	5	1	3	3.8706
11		4	3	0	6	5	1	2	3.9845
12		4	3	0	6	5	1	2	3.9845
13		4	3	0	6	5	1	2	3.9845
14		4	3	0	6	5	1	2	3.9845
15		4	3	0	6	5	1	2	3.9845
16		4	3	0	6	5	1	2	3.9845
17		4	3	0	6	5	1	2	3.9845
18		4	3	0	6	5	1	2	3.9845
19		4	3	0	6	5	1	2	3.9845
20		4	3	0	6	5	1	2	3.9845
21		4	3	0	6	5	1	2	3.9845
22		4	3	0	6	5	1	2	3.9845
23		4	3	0	6	5	1	2	3.9845
24		4	3	0	6	5	1	2	3.9845
25		4	3	0	6	5	1	2	3.9845
26		4	3	0	6	5	1	2	3.9845
27		4	3	0	6	5	1	2	3.9845
28		4	3	0	6	5	1	2	3.9845
29		4	3	0	6	5	1	2	3.9845
30		4	3	0	6	5	1	2	3.9845
31		4	3	0	6	5	1	2	3.9845
32		4	3	0	6	5	1	2	3.9845
33		4	3	0	6	5	1	2	3.9845
34		4	3	0	6	5	1	2	3.9845
35		4	3	0	6	5	1	2	3.9845
36		4	3	0	6	5	1	2	3.9845
37		4	3	0	6	5	1	2	3.9845
38		4	3	0	6	5	1	2	3.9845
39		4	3	0	6	4	1	3	3.8246
40		4	3	0	6	5	1	2	3.9845
41		4	3	0	6	5	1	2	3.9845
42		4	3	0	6	5	1	2	3.9845
43		4	3	0	6	5	1	2	3.9845
44		4	3	0	6	5	1	2	3.9845
45		4	3	0	6	5	1	2	3.9845
46		4	3	0	6	5	1	2	3.9845
47		4	3	0	6	5	1	2	3.9845
48		4	3	0	6	5	1	2	3.9845
49		4	2	0	6	5	1	3	4.1532
50		4	3	0	6	5	1	2	3.9845
51		4	3	0	6	5	1	2	3.9845
52		4	3	0	6	5	1	2	3.9845
53		4	3	0	6	5	1	2	3.9845
54		4	2	0	6	5	1	3	4.1532
55		4	2	0	6	5	1	3	4.1532
56		4	2	0	6	5	1	3	4.1532
57		4	2	0	6	5	1	3	4.1532
58		4	2	0	6	5	1	3	4.1532
59		4	2	0	6	5	1	3	4.1532
60		4	2	0	6	5	1	3	4.1532

Matrix B								Do Not	Slope of
								Invest	Ranking vs.
Respondent	Investment-->	**1**	**2**	**3**	**4**	**5**	**6**	**0**	IRR:WACC Ratio
1		4	5	6	0	1	2	3	2.6918
2		4	5	6	0	1	2	3	2.6918
3		4	5	6	0	1	2	3	2.6918
4		4	5	6	0	1	2	3	2.6918
5		4	5	6	0	1	2	3	2.6918
6		4	5	6	0	1	2	3	2.6918
7		4	5	6	0	1	2	3	2.6918
8		4	5	6	0	1	2	3	2.6918
9		4	5	6	0	1	2	3	2.6918
10		4	5	6	0	1	2	3	2.6918
11		4	5	6	0	1	2	3	2.6918
12		4	5	6	0	1	2	3	2.6918
13		4	5	6	0	1	2	3	2.6918
14		4	5	6	0	1	2	3	2.6918
15		4	5	6	0	1	2	3	2.6918
16		4	5	6	0	1	2	3	2.6918
17		4	5	6	0	1	2	3	2.6918
18		4	5	6	0	1	2	3	2.6918
19		4	5	6	0	1	2	3	2.6918
20		4	5	6	0	1	2	3	2.6918
21		4	5	6	0	1	2	3	2.6918
22		4	5	6	0	1	2	3	2.6918
23		4	5	6	0	1	2	3	2.6918
24		4	5	6	0	1	2	3	2.6918
25		4	5	6	0	1	2	3	2.6918
26		4	5	6	0	1	2	3	2.6918
27		4	5	6	0	1	2	3	2.6918
28		4	5	6	0	1	2	3	2.6918
29		4	5	6	0	1	2	3	2.6918
30		4	5	6	0	1	2	3	2.6918
31		4	5	6	0	1	2	3	2.6918
32		4	5	6	0	1	2	3	2.6918
33		4	5	6	0	1	2	3	2.6918
34		4	5	6	0	1	2	3	2.6918
35		4	5	6	0	1	2	3	2.6918
36		4	5	6	0	1	2	3	2.6918
37		4	5	6	0	1	2	3	2.6918
38		4	5	6	0	1	2	3	2.6918
39		4	5	6	0	1	2	3	2.6918
40		4	5	6	0	1	2	3	2.6918
41		4	5	6	0	1	2	3	2.6918
42		4	5	6	0	1	2	3	2.6918
43		4	5	6	0	1	2	3	2.6918
44		4	5	6	0	1	2	3	2.6918
45		4	5	6	0	1	2	3	2.6918
46		4	5	6	0	1	2	3	2.6918
47		4	5	6	0	1	2	3	2.6918
48		4	5	6	0	1	2	3	2.6918
49		4	5	6	0	1	2	3	2.6918
50		4	5	6	0	1	2	3	2.6918
51		4	5	6	0	1	2	3	2.6918
52		4	5	6	0	1	2	3	2.6918
53		4	5	6	0	1	2	3	2.6918
54		4	5	6	0	1	2	3	2.6918
55		4	5	6	0	1	2	3	2.6918
56		4	5	6	0	1	2	3	2.6918
57		4	5	6	0	1	2	3	2.6918
58		3	5	6	0	1	2	4	2.5976
59		4	5	6	0	1	2	3	2.6918
60		4	5	6	0	1	2	3	2.6918

Matrix C								Do Not	Slope of
								Invest	Ranking vs.
Respondent	Investment-->	**1**	**2**	**3**	**4**	**5**	**6**	**0**	IRR:WACC Ratio
1		4	5	6	0	1	2	3	6.4204
2		4	5	6	0	1	2	3	6.4204
3		4	5	6	0	1	2	3	6.4204
4		3	4	6	0	1	2	5	6.0487
5		3	4	6	0	1	2	5	6.0487
6		4	4	6	0	1	4	2	5.754
7		4	5	6	0	1	3	2	6.2956
8		4	5	6	0	1	3	2	6.2956
9		4	5	6	0	1	3	2	6.2956
10		4	5	6	0	1	3	2	6.2956
11		4	5	6	0	1	3	2	6.2956
12		4	5	6	0	1	2	3	6.4204
13		4	5	6	0	1	3	2	6.2956
14		4	5	6	0	1	3	2	6.2956
15		4	5	6	0	1	3	2	6.2956
16		4	5	6	0	1	3	2	6.2956
17		4	5	6	0	1	3	2	6.2956
18		4	5	6	0	1	2	3	6.4204
19		2	4	6	0	1	3	5	5.969
20		4	5	6	0	1	2	3	6.4204
21		4	5	6	0	1	2	3	6.4204
22		4	5	6	0	1	2	3	6.4204
23		4	5	6	0	1	2	3	6.4204
24		4	5	6	0	1	3	2	6.2956
25		4	5	6	0	1	3	2	6.2956
26		3	5	6	0	1	4	2	6.216
27		3	5	6	0	1	4	2	6.216
28		4	5	6	0	1	3	2	6.2956
29		3	5	6	0	1	4	2	6.216
30		4	5	6	0	1	3	2	6.2956
31		4	5	6	0	1	3	2	6.2956
32		4	5	6	0	1	3	2	6.2956
33		3	5	6	0	1	4	2	6.216
34		4	5	6	0	1	3	2	6.2956
35		4	5	6	0	1	3	2	6.2956
36		4	5	6	0	1	3	2	6.2956
37		3	5	6	0	1	4	2	6.216
38		4	5	6	0	1	3	2	6.2956
39		4	5	6	0	1	3	2	6.2956
40		4	5	6	0	2	3	1	5.8841
41		4	5	6	0	2	3	1	5.8841
42		4	5	6	0	2	3	1	5.8841
43		4	5	6	0	2	3	1	5.8841
44		4	5	6	0	2	3	1	5.8841
45		4	5	6	0	1	3	2	6.2956
46		4	5	6	0	1	3	2	6.2956
47		4	5	6	0	1	3	2	6.2956
48		4	5	6	0	1	3	2	6.2956
49		4	5	6	0	2	3	1	5.8841
50		4	5	6	0	1	2	3	6.4204
51		4	5	6	0	1	2	3	6.4204
52		4	5	6	0	2	3	1	5.8841
53		3	5	6	0	2	4	1	5.8044
54		4	5	6	0	2	3	1	5.8841
55		4	5	6	0	1	2	3	6.4204
56		4	5	6	0	1	2	3	6.4204
57		4	5	6	0	1	2	3	6.4204
58		2	5	6	0	2	4	2	5.8496
59		4	5	6	0	1	3	2	6.2956
60		2	5	6	0	2	4	2	5.8496
61		2	5	6	0	2	4	2	5.8496
62		4	5	6	0	1	2	3	6.4204
63		4	5	6	0	2	3	1	5.8841
64		3	4	6	0	1	2	5	6.0487
65		3	4	6	0	1	2	5	6.0487