DECISION TREE AND REAL OPTIONS TO VALUE AGTECH STARTUP GROWTH DECISIONS

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ABSTRACT

Agtech startups face multiple uncertainties and have limited flexibility when it comes to growing their business. Companies that are growing ultimately need to take on new capital. This new capital can be from many different sources like strategic partners, investors, angels, VC, grants, and debt. What source is best for the entrepreneur and what will lead to the highest probability of success or the ideal outcome for shareholders can vary depending on the tradeoffs of each funding round. This paper has developed a model to analyze the returns and risks of alternative funding decisions for a prototypical ag-tech startup. By incorporating real options and integrating them within a decision tree, entrepreneurs will be able to see what growth strategy will lead to the most desired outcome. This paper uses one case study of an agtech startup and can be applied to multiple different startups in different sectors.

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CHAPTER 1. INTRODUCTION

1.1. Overview

All startups or early-stage companies face growth decisions that have differing payoffs and risks which are inherent in those decisions. By graphing these decisions using a decision tree analysis, companies can value the inherent information of those decisions by using real-option. All decisions have varying tradeoffs and ripple effects, and many decisions are made using traditional sales-pitch tactics that are derived from ethos, logos, and pathos strategies that appeal to the target audience. When startups run out of cash, they need to raise new funds to pay for the venture. This money can come from various sources and different sizes. These funds are withdrawn without fully understanding the repercussions and benefits related to the decision. Where funds are being sourced from can influence a startup's probability of success. By using statistical approximations to value these decisions, founders can make the best and most informed decisions for their companies. A founder is an individual(s) who established the company.

The objective of this thesis is for startups to value the different growth decisions that all startups ultimately face. These growth decisions are made when companies need to acquire new capital to grow the business. Depending on the industry, it can take startups anywhere from a few years to upwards of 16 years to have an initial public offering (IPO). Also, companies do not always go public; some businesses stay private. During the startup's life, the company will have several funding rounds to keep growing the business. A study by CrunchBase discovered that the average software-as-a-service (SaaS) company had 4 funding rounds and took 9 years to exit (Abdullah, 2021). The duration of years for a startup to exit will vary by industry and business model.

Agtech startups received a record amount of funding in 2021. Growing agtech startups need to take on new capital to grow their business. This money can come from several different sources. The funding source can affect the startup's outcome. The purpose of this thesis is to value these different funding sources and what growth strategy that management should take. The hypothesis is that partnering with the right funding source can increase the probability of a successful outcome and can increase the value of the startup.

The problem with industry today is that funding sources have been understudied when analyzing growth strategies that startups face. Not all capital has the same soft value. One million dollars raised using debt has different tradeoffs compared to partnering with investors, such as venture capitalists. Venture capital (VC) is when investors deploy money to projects that are highly risky in search of asymmetric returns. These investments take the form of investing in startups and early-stage businesses. This thesis has created a model to analyze growth decisions by incorporating real options into a decision tree.

The model allows founders to understand the different probabilities and tradeoffs for each funding source. The primary tradeoff that is analyzed is the dilution of ownership by selling equity to attract investors. Some other risks and tradeoffs for the different funding sources are as follows:

- Soft tradeoffs (All decisions will have varying effects.)
- Network effect
- Opportunity cost
- Dilution of ownership
- Earnings
- Market-share assumptions

- Duration risk
- Skewed valuations (discounted cash flow [DCF], multiples, and Monte Carlo)
- Cashflow liquidity/insolvency issues

This model will allow factors of uncertainty and risk to be statistically approximated, giving management the ability to make better and more informed decisions. Previous methodologies for valuing a startup's business decisions have lacked the flexibility that management often has to pursue an outcome. A typical approach would be the scorecard method utilized by Robert S. Kaplan and David P. Norton (2005) in "The Balanced Scorecard-Measures that Drive Performance." They observed that the scorecard helps managers understand the many interrelationships for business strategies. There are also financial-performance measures that can indicate whether a business is implementing the appropriate strategy. The different financial valuation approaches include methods such as the discounted cash flow (DCF) analysis, multiple analysis, precedent transaction analysis, Monte Carlo simulation, and other business analytics utilized for forecasting. These techniques all use fixed assumptions that underestimate the value of a business given management's flexibility to influence the outcome. If a segment of the business is forecasted out 7 years and is not expected to achieve the set key performance indicators (KPIs), then management can divert funding to the more probable business segment that will lead to higher profitability and a higher probability of success. Fortunately, with VC, these funding rounds can be accurately predicted based on simple arithmetic formulas that utilize management's ability to be selective in the funding process.

The target audience for this thesis is founders, entrepreneurs, investors, and observers who are interested in learning more about venture capital. This model creates new insights to understand how startups make their funding decisions. Although different tools have been used to help management gain novel insight about business strategies, incorporating real options in a decision-tree framework gives a more accurate estimate that management can utilize to make the most informed decisions and to maximize the probability of success. Given the inherent risks and tradeoffs, this success would be the most ideal outcome for a business. The risk is measured in volatility and is incorporated into the real-option value. The data for the model are both simulated and given by expert judgment. Both quantitative and qualitative data estimates are used to determine the model's parameters. The quantitative data include forecast and base-case estimates obtained from historical numbers. The qualitative data come from expert judgment and are subjective in nature.

1.2. Risk Capital and Venture Capital

This section describes the VC industry and why it is considered high-risk capital. High-risk capital is investing in sectors or financial instruments that are considered to be very risky, including endeavors that have high probabilities of failure and should only be executed by using professional investors. These professional investors have expertise in the industry and have years of experience in finance. According to the Small Business Administration (SBA) in 2020, the United States estimated that 90% of startups fail (Bryant, 2021). Hence, this asset class has a high risk.

Early-stage companies need to raise funding to finance their venture. One source that very early-stage startups use is angel investors. These sponsors are generally individuals who provide capital for startups. The funds are can be financed through a convertible note. This convertible note most commonly changes to common shares at the next series funding round. For example, if an angel invests $500,000 in a startup, at the series A round, those funds would convert to common shares at the series A price. If the A round is priced at $10 per share, the angel would receive 50,000 common shares. Wetzel, Jr. (1983) indicated that angels provide very early-stage capital to new business ventures that often don't have revenue and are in the product-development phase. Angels often view their investment as a call option, allowing them to invest with an asymmetric upside while having a limited downside.

Another interesting tool that startups can utilize is incubators/accelerators. An incubator can often provide startups with basic business needs, such as office space, lab space, education tools, mentorship, and access to investors. An accelerator is a program for early-stage companies and offers services in exchange for ownership of a startup. Companies apply to an accelerator to obtain access to an investor network and industry advisers. These tools can provide a unique tool for startups to utilize at an early stage to help the business grow. Figure 1.1 lists some of the most active agtech actechtors.

Figure 1.1

Most Active Accelerator Funds (AgFunder, 2022, p. 48)

RANK	INVESTOR	LOCATION	# INVESTMENTS
1	SOSV	Princeton, NJ	63*
2	Y Combinator	Mountain View, CA	48*
3	TechStars	Global	41*
4	Big Idea Ventures	Singapore, New York, US	30
5	GROW Accelerator	Singapore	20
6	The Yield Lab Plug & Play Ventures	Global	12
7	500 Startups Rockstart Agrifood SVG Partners/THRIVE	San Francisco, CA Amsterdam, The Netherlands Los Gatos, CA	10
8	GLOCAL Alchemist Accelerator	Rosario, Argentina San Francisco, CA	6

Venture capital is a form of private equity (PE) financing where a financial fiduciary raises funds to invest in early-stage companies that have high growth potential. The goal is to invest money across a pool of companies and to help manage these businesses until they are self-sufficient. These VC firms can specialize regarding the type of company, such as agtech, where they place their investments (Figure 1.2). Also, the firm may only do one type of funding, such as only investing in series A rounds, series B rounds, or later. There are also generalist funds that have no specific sector and/or business strategy around their investment structure. There are many uncertainties involved with investing in young companies, which can result in higher perceived failure rates. Ghosh found that 75% of venture-backed companies never return cash to the investors (Hoque, 2014).

Figure 1.2

Most Active Agtech Venture Capital Fund Managers (AgFunder, 2022, p. 49)

RANK	INVESTOR	LOCATION	# INVESTMENTS
1	S2G Ventures	Chicago, IL	39
2	Tiger Global Management	New York, NY	30
4	AgFunder Global Founders Capital	San Francisco, CA Berlin, Germany	22
5	Omnivore	Mumbai, India	18
6	Alexandria Venture Investments Temasek	Durham, NC Singapore	16
7	Gaingels 10X Capital	Burlington, Vermont New York, NY	15
8	CPT Capital GGV Capital Sand Hill Angels FJ Labs DST Global	London, UK Menlo Park, CA Mountain View, CA New York, NY London, UK	14
9	Astanor Ventures SoftBank Vision Fund	London, UK Tokyo, Japan	13
10	Continental Grain Innova Memphis	New York, NY Memphis, TN	12

A primary function of VC is providing risk capital for early-stage companies. VC differs from PE, which provides liquidity for private businesses. A PE firm buys businesses and manages them for a period of years to flip them for a profit at a later date.

One reason that a startup company may like partnering with angels, incubators/accelerators, and VCs is due to the network effect. As discussed in Harvey (1950), the benefit that a consumer derives from the consumption of a product may depend not only on the amount he/she consumes, but also on how many others consume it or the total amount consumed. One example would be the cell phone industry, where the value of each individual phone increases as the number of users grows. This is because adding people increases each user's ability to communicate with others. The cell-phone users form a "network," the size of which is indicated by the number of users, and the consumer benefit from the increased network size is termed a "network effect." Cell phones illustrate "direct network effects" because consumer benefits stem directly from increased network size (Garth, 1995). Similar parallels could be drawn when comes to startups partnering with new VCs. They are now in a "network effect" because, when an investor(s) gives the startup money, they are both incentivized financially/relationally to try and grow that capital. The investor(s) would then try to help give the startup more opportunities and to allow the founders to benefit from their network. The more connections the startup makes between itself and potential investors, the greater the chances that this startup will succeed.

Hedge funds are increasingly participating in later-stage private rounds. In 2021, hedge funds had a record-breaking 770 private deals with an aggregate value of $153 billion. By comparison, in 2020, hedge funds participated in 753 deals with an aggregate value of $96 billion (Shead, 2021). Hedge funds generally have a larger amount of capital to deploy and, hence, make larger investments. This implies that companies are staying private longer (Narasin, 2015) and that investors can't find enough attractive investments in the public market to allocate the funds. As seen from the 1990s to 2016, the number of publicly traded firms decreased by 52% (Kumar, 2021). Lastly, firms are able to raise the needed amount of funding via private markets. This implies that companies are not currently as incentivized to go public as in the past due to a lack of funding opportunities.

Companies go public to raise new capital. However, the average private company is staying private longer today. In year 2020, U.S. companies stayed private for 11 years, on average, compared to roughly 5 years in 2011 (Kruppa, 2020). Historically, when companies needed to raise large amounts of funds, the private market was not a sufficient funding source. Therefore, by going public, companies could partner with larger institutional investors that had more funds to allocate to the business.

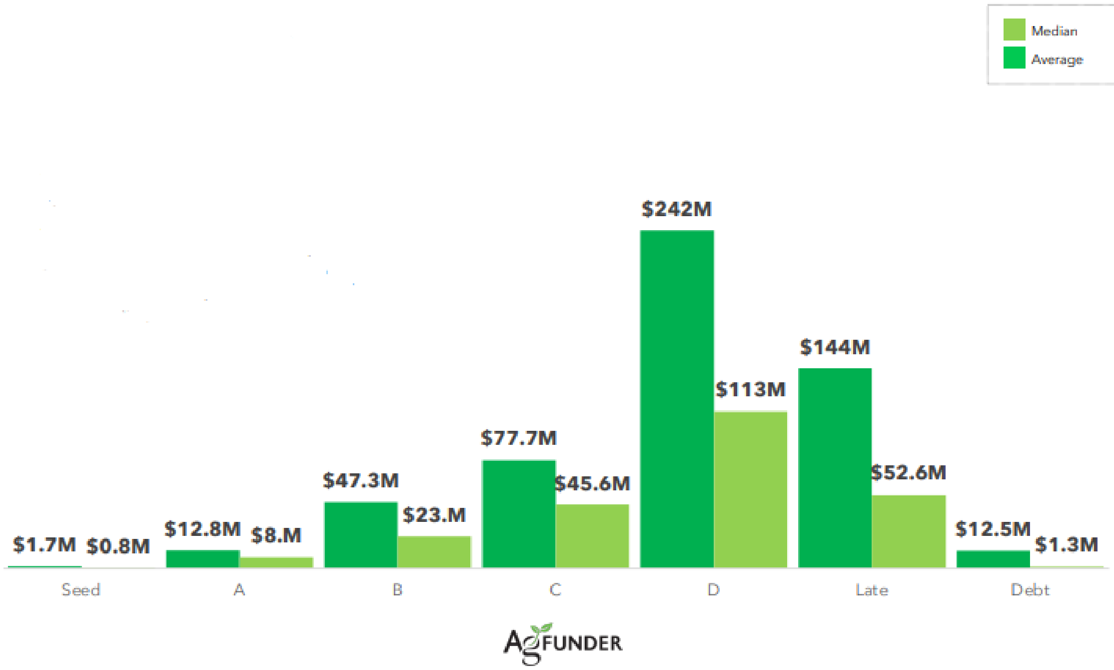
Another reason would be liquidity for shareholders. Going public via an IPO is attractive due to the action providing liquidity for investors and founders whose money has been locked up for several years with no place to liquidate the gains. Transparency is also created when companies go public. They have audited financial statements that provide transparency to potential investors, governments, activists, and customers. Investors like this openness because they can keep better track of management's ability to allocate funds effectively and can hold managers accountable as responsible fiduciaries. Governments and activist groups can more attentively track businesses and can hold the companies responsible for policy and ethical standards. The customers can also see the firm's credibility and can choose to do business with it. If a business is looking for an inventory-management software company with which to partner, the business wants to confirm that this company is going to be around for the long run and won't go bankrupt. It will also create publicity for companies. Hence, they can be more accessibly spotlighted, and this exposure can be good for public relations. Although whether all publicity is good publicity can be debated, this publicity can help give companies different earned-media recognition.

Companies may not go public for several different reasons. The valuation can have higher premiums from private-market valuations. This valuation can be due to lack of transparency and/or the convenience of acquiring a business that is not publicly traded. The majority of the time when companies are private, there aren't as many regulatory barriers to get deals done. The regulations are different, and the ownership pool is essentially fixed with the current ownership until a liquidation event happens. One major reason that a company would go public is due to limited access to capital once a business can't raise the cash needed to grow the business. However, more firms have entered the VC space, and a record amount of funding is available for any stage where a company could be. See (Figure 1.3) for average funding be stage.

Recently, there have been new VC disrupters that could change this space. New forms of funding, such as crowdfunding and initial coin offering (ICO), are slowly becoming more popular. Crowdfunding is when funding is sourced through a large number of people. This task is mainly done through the internet. An ICO is when a digital token, such as cryptocurrency, is issued to fund a project or venture. These disrupters may fundamentally shift how investors participate in venture capital going forward.

Figure 1.3

Average & Median Size by Stage 2021 (AgFunder, 2022, p. 29)



1.3. AgTech Funding

With a growing population, food demand is only going to increase, and with the use of technology, customers can become more aware about knowing where their food originates. With everything from block-chain technology to novel microbial delivery processes, agtech startups have become an area where investors want to spend their time and capital. The Food and Agriculture Organization (FAO) estimates that, by 2050, the world will need to produce 60% more food to feed a population of 9.3 billion (Da Silva, 2022). This production challenge is not only a challenge in and of itself, but will also cause drastic changes on how to grow the current food system. The high demand for natural resources, such as phosphorus, nitrogen, and other fertilizers, could become challenging. Some other tailwinds for the agtech sector are climate change, water scarcity, food safety, and consumer-preference changes. Each problem provides a new opportunity for entrepreneurs to create solutions to resolve the issues. All these solutions need to be multiplied across several categories, including agriculture biotechnology, the agribusiness marketplace, bioenergy, biomaterials, farm-management solutions, Farming-as-a-Service (FaaS), farm robotics, sensors, equipment, indoor farms, innovative foods, retail, and eGrocery.

Americans' food-consumption patterns are changing, with most people wanting to eat more healthy, organic food (Funk and Kennedy, 2016) and locally produced food U.S. Department of Agriculture (USDA). More health-conscious consumers are trying to better understand where their food is being sourced and what type of inputs are being used. It has become increasingly popular to label a product as being made without chemical input or harmful pesticides. Even the Securities and Exchange Commission (SEC) continues to evolve and to incorporate more Environmental, Social, and Governance (ESG) friendly regulations in order to continue mitigating against climate change. Places such as California continue to have water shortages, and even the Colorado River is having severe droughts. These situations will continue to push agtech investment forward into the new era of cross-platform, high-speed data management, which will determine the future agriculture food system.

Another catalyst is that agriculture funding is growing rapidly. In 2021, the biggest agtech IPO was for the food-delivery app Deliveroo, which raised $1.98 billion at the start of the year. Also, an Swedish alternative protein company "Oatly", had an initial public offering (IPO) in 2021, and rose $1.4 billion in May. The agrifood sector is estimated to be a $7.8-trillion industry that is responsible for feeding the planet and employing well over 40% of the global population (AgFunder, 2022).

The innovative foods category, which is cultured meat and plant-based alternative proteins, took off in 2021. The innovative foods sector raised $4.8 billion and was the second-highest invested category behind eGrocery (AgFunder, 2022). In 2020, the innovative food sector had $2.3 billion invested and was the fourth-most invested category in agtech (AgFunder, 2022). Year over year (YoY) increase of 109% for the invested dollars with this category. Some of the big players are Impossible Foods, Memphis Meats, Puris Proteins, and Motif FoodWorks. Overall, innovative food sector had the most deals of any category (AgFunder, 2022). Investors were consistent with their interests in 2021: the top five agtech investment categories simply reshuffled positions from 2020. Innovative food companies topped the ranks, claiming 13.5% of the deals but only 9.6% of the capital (AgFunder, 2022). This shows an underlying culture swing towards non-animal alternatives that investors are pricing in when looking at the agtech space. Both the plant-based and cultured meats have seen tremendous strides forward from both the product-development and commercialization phases. One major problem for the plant-based alternatives is water consumption, which is an issue for growing the underlying proteins. The main protein sources come from peas, lentils, beans, and chickpeas. More acres planted with these crops are expected to meet the demand for the plant-based alternatives. Many of these crops are already being used to make flour and oil as well as being crush for feed.

Figure 1.4

AgriFoodTech Category Definitions (AgFunder, 2022, p. 15)

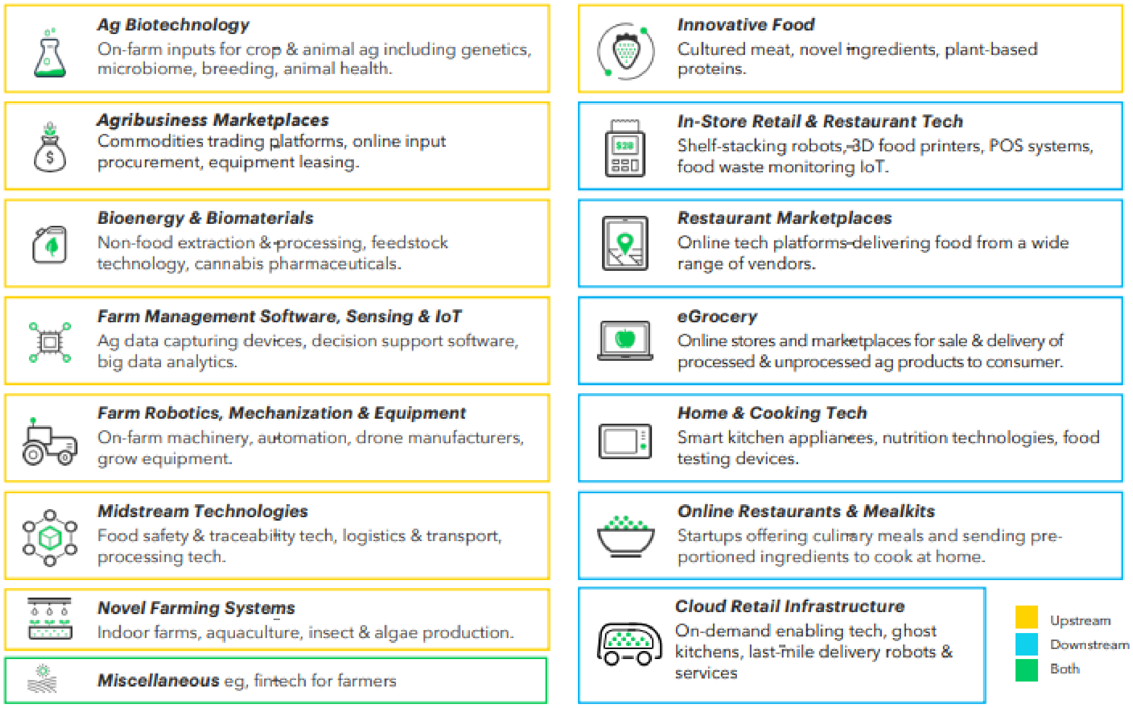
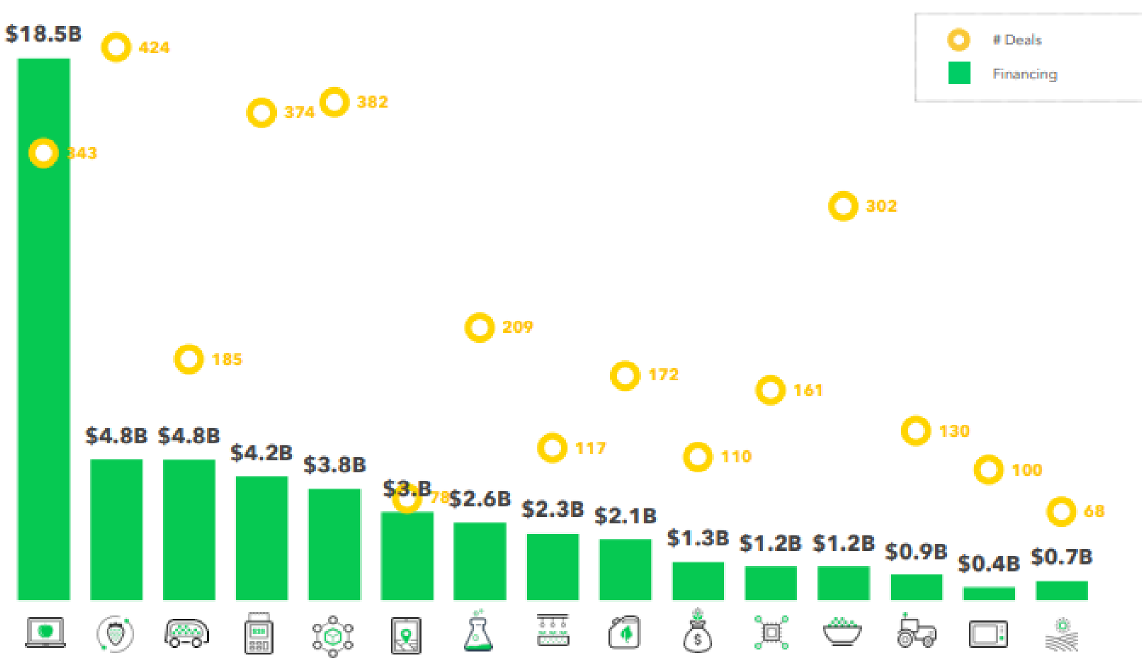


Figure 1.5

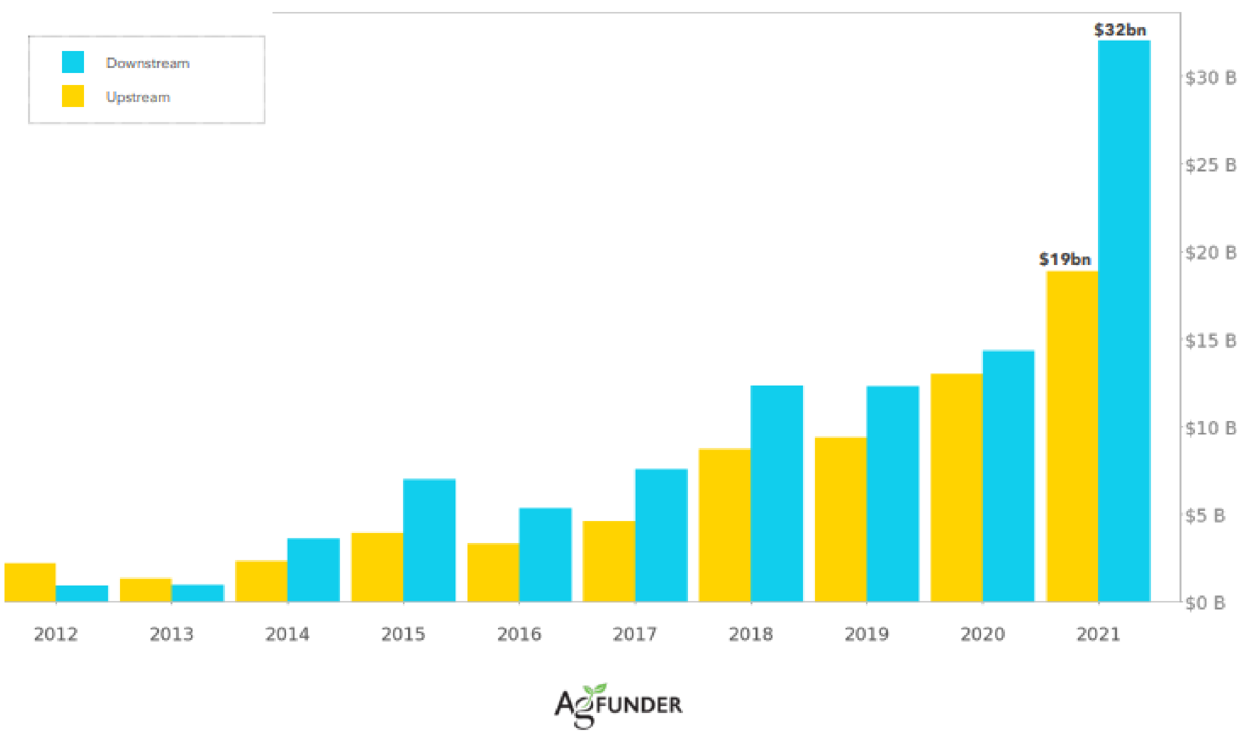
2021 Deal Volume and Activity by Category (AgFunder, 2022, p. 16)



Venture-capital investors pumped $51.7 billion, across 3,155 deals, into agtech in 2021, which was an 85% increase over 2020. These investments were across $18.9 billion for upstream companies and $32.1 billion for downstream companies (AgFunder, 2022). An upstream business would be ag-biotech, farm management SW, robotics, bioenergy, and innovative foods. A downstream company is in-store restaurant and retail, online restaurants, meal kits, eGrocery, marketplaces, and home cooking. In the United States, there was a 50/50 split between the upstream and downstream categories, and a total of $21 billion were raised by U.S.-based companies (AgFunder, 2022).

Figure 1.6

Annual Financings 2012-2021 (AgFunder, 2022, p. 11)



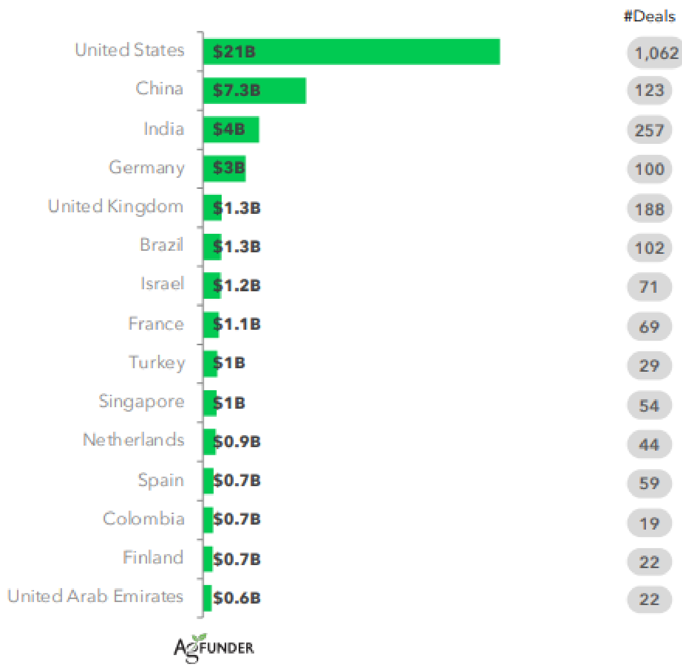
Investment for the eGrocery sector grew an astounding 188% over 2020, controlling more than 35% of all agtech investment. The category was fueled by four companies with funding round sizes greater than $1 billion, all of them in the eGrocery sector. There were 13 additional $500-million+ deals in 2021, compared to 7 in 2020 (AgFunder, 2022).

Figure 1.7

Annual Financings 2012-2021 (AgFunder, 2022, p. 10)

Figure 1.8

Number of Deals by Country (AgFunder, 2022, p. 38)



The main geographic reach for agtech investment is mostly concentrated in the United States and China. The United States still dominates as the world's biggest agtech investment market, with U.S.-based startups raising 41% of all capital and accounting for 34% of the deals in 2021. The United States shows its diversity to the rest of the world with the variety of startups that are raising growth and having late-stage investment rounds during the year. China's agtech funding landscape was synonymous with the eGrocery sector in 2021. Of the $7.3 billion raised by Chinese agtech ventures, 75% went to the eGrocery sector. Of the $30.7 billion that non-U.S. companies raised in 2021, 70% went to downstream ventures, and 44% went to the eGrocery sector companies, whereas only 24% of U.S.-bound capital went to the same category. In 2021, agribusiness marketplaces were the slowest-growing category globally (AgFunder, 2022).

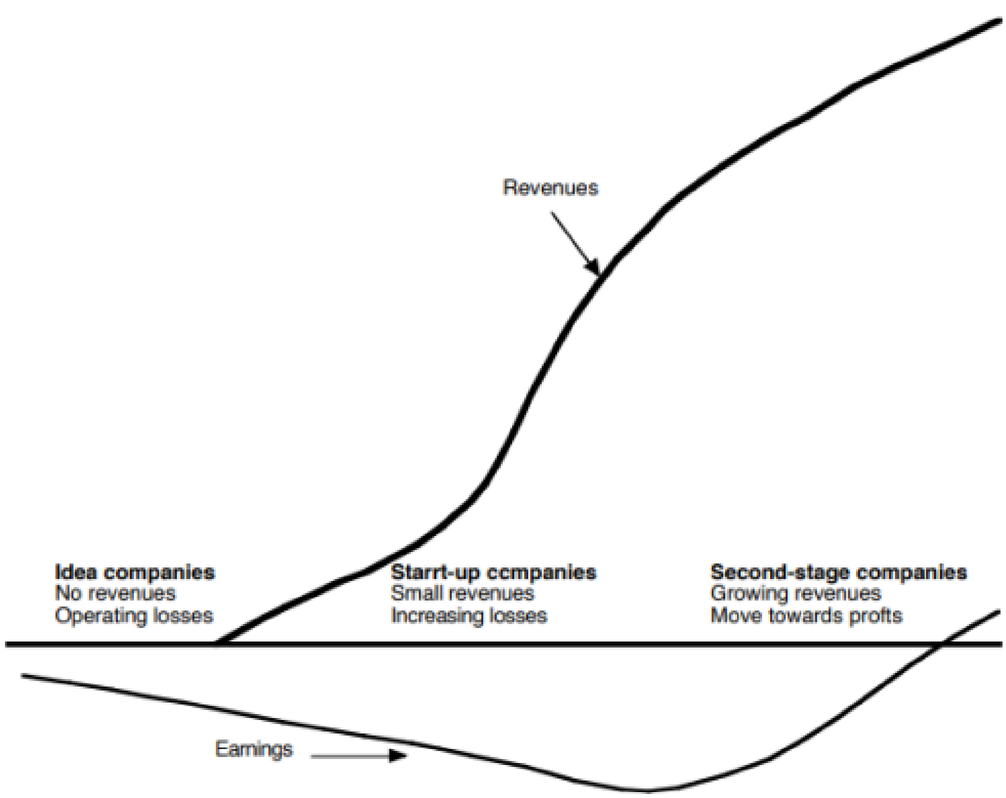
1.4. Problem Statement

Funding strategies for startups have varied over the years. In the early 1800s, capital was scarcely available and more than likely came from the bank or from wealthy individuals who were looking for asymmetric upside on the return of their invested capital. As more money fluctuated into VC, more sophisticated strategies were utilized to value the decisions which startups used to source funding. As seen in PitchBook, the United States had a record-setting $96 billion invested in over 526 funds in 2021 (“These 6 Charts,” n.d.). This analysis includes statistical analysis, scorecards, porter five forces, financial performance valuation, and more. These methodologies are all used to better understand how to allocate investments. However, as mentioned in Yeo and Qiu (2003), the traditional DCF approach is inefficient and implies that management is inflexible when it comes to making an irrevocable commitment to a certain operating strategy and to abiding by it until the end of its pre-specified project life. This assumption is, of course, unrealistic and does not reflect reality. This research has developed a model to analyze the returns and risks of the alternatives for a prototypical agtech startup. All early stage companies will, ultimately, need to take on new capital; this can take the form of public sources, such as partners; investors; angels; venture capital (VC); grants; debt; crowdfunding; joint ventures (JV); mergers and acquisitions (M&A); crypto currency; and, eventually, an IPO. These finance sources generally come through the private market in what is called “series funding rounds.” The first private series round is the seed round, followed with A, B, and C. During each round, a company raises funds to pay for different projects for the venture. As the next series round happens, the size of the round increases. The issue is that the early stage companies have very cheap equity due to the lack of commercial efficacy and/or a proven track record.

Early stage companies usually don't have a viable commercial product, don't have proven revenue, are missing necessary employs, and building out manufacturing. Therefore, the startup has large execution risk. This scenario can be seen in Figure 1.9. To compensate for the added risk, the equity sold to incentivize investors is offered at a discount. As a result, the equity for an investment is the cheapest during the first series round. Generally, as startups have additional funding rounds, the equity's value increases. If the price of the equity doesn't increase, there is a down round. If a startup has a down round, an unfavorable signal is sent to the market. A company would have a down round if it is not accomplishing set milestones for the business. These milestones could be revenue or earning expectations, infrastructure, management, and more.

Figure 1.9

Early Stages of a Company's Life Cycle (Damodaran, 2009, p. 4)



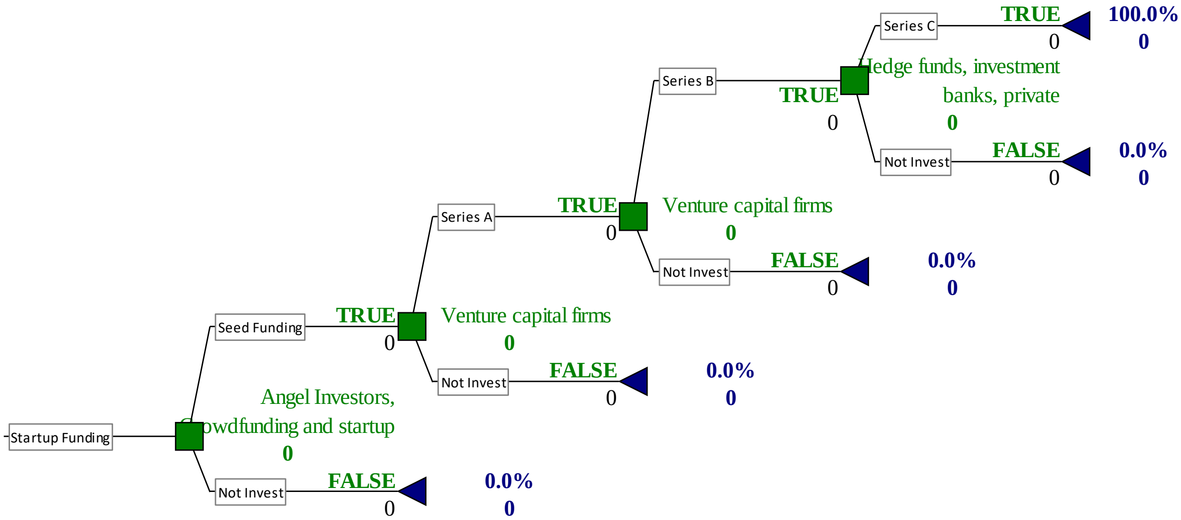
1.5. Objectives and Hypothesis

The purpose of this thesis is to value different sources of funding and to determine what growth strategy that management should take for the capital-raising funding rounds. The hypothesis is that partnering with the right funding source can increase the probability of success, making investment more attractive. However, there are tradeoffs when partnering with different sources. The principal tradeoff is the dilution of ownership. The problem with today's industry is that research about funding sources has been underutilized when considering the growth strategies for an agtech startup. A decision tree is used to structure the analysis, and real-option analysis is incorporated to value the growth decisions that startups face.

With venture capital, there are multiple decision points a founder will face. If a company has a series A round and achieves all the milestones, shouldn't the company have a series B round? Should the company pass and fund itself a different way? What about the C round after that? Each decision has a real option attached to it and has a different set of factors that should be considered when raising funds. Every variable that management considers also changes over time, hence management has the flexibility to adjust the strategy going forward in order to increase the probability of achieving the desired outcome. A real option is a project that offers a choice between different cash-flow strategies. In other words, real options allow people to respond to new information. Venture capital has real options because of the staged investments that are inherent when building businesses; future venture investing is dependent on management's success to achieve milestones and to increase the likelihood of reaching the desired outcome. See Figure 1.10 for a hypothetical startup decision tree.

Figure 1.10

Example Tree



A decision tree is a representation of the intrinsic value that an option may take at different time periods. The option's value at any node depends on the probability that the price of the underlying asset will either decrease or increase at any given node. This model is utilized to graph a startup's investment decisions. With each decision comes more information and new probabilities.

When valuing real options, a decision tree is one of four potential tools to value the options. The four choices are closed-form option models, binomial lattices, Monte Carlo simulation, and decision trees. Each technique has a specific situation where it may be preferable with the real option valuation (ROV).

A real option is an economically valuable right to make or to abandon some choice that is available to the company's managers, often concerning business projects or investment opportunities. Startups have the real option to take on funding in three ways, which can be seen in Table 1.1.

Table 1.1

Funding Options

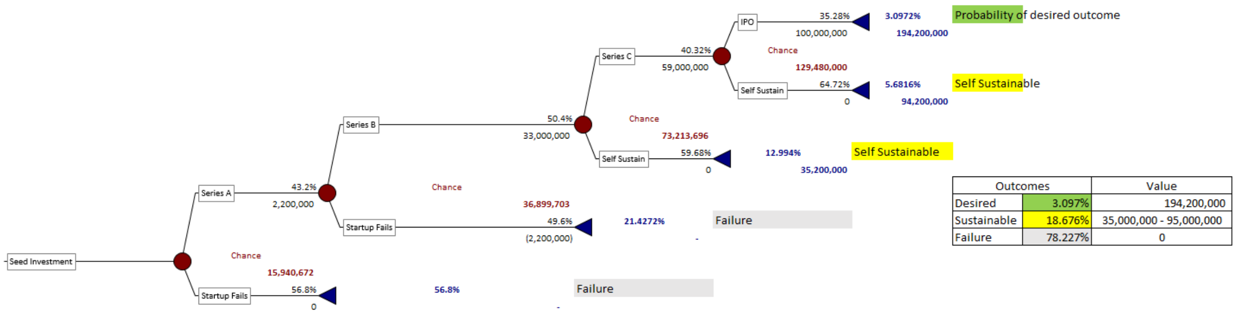
External	Internal	Strategic
Angels	Company Earnings	Joint Venture
Super Angels	Friends, Family, Founders	Merger
Accelerators	Debt	Acquisition
Venture Capital	Grants	Strategic Partnership
Private Equity	Crowd Funding	
Crypto Currency		

As an example, the founders could take an external, external, and external funding strategy. This growth strategy might be the fastest way to grow, but there are inherit tradeoffs with those decisions. Maybe, the founder's ownership is diluted so low that he/she isn't incentivized or loses control of his/her business. This strategy could cause the company to onboard employees too fast and to go insolvent. All these uncertainties can be measured by using statistics and basic assumptions.

Let's take a closer look at the external funding strategy for a better understanding. See Figure 1.11. The results show that there is a 3% chance for the desired outcome, a 20% chance of making money, and an 80% chance of failure. This scenario is a pretty common distribution with private equity because most startups cannot generate positive cashflow. Although this technique might be the fastest way to grow, it may not have the most attractive optionally for the founding investors. Variables such as dilution, controlling rights, and business development could be adversely affected with this funding route. Even though this strategy may give the highest value, this method may not be the optimal choice.

Figure 1.11

External Funding Route



1.6. Thesis Organization

The study is organized in six main chapters. Chapter 2 reviews the literature for this topic. The review is broken into three main sections. The first section discusses agriculture investment. The second section is about VC and how it works. The third section examines the methodologies. First, decision trees are discussed, followed by real options. This section ends with a brief summary of the valuation methods used to analyze businesses. In Chapter 3, the methods and the theoretical model are described. This chapter includes details about how the model incorporates data and what assumptions are being made. Chapter 4 analyzes the base model by using data from the case study. In this section, the base case of how the option to expand is valued depending on funding decisions. Chapter 5 looks at the Results and incorporates different real options into the model to see how they affect the base case from Chapter 4. Chapter 6 is the Conclusion and describes how this study can be expanded.

CHAPTER 2. LITERATURE REVIEW

2.1. Overview

This section discusses the background of the academic literature around agriculture as an investment class, VC, and how startups make decisions. The review of the literature around agricultural investments is to analyze how agriculture performs as an assets class and how to invest in this space. The early forms of VC and how the industry was formed is analyzed next. Then different methodologies on how to value startups will be analyzed. Both business strategy models, and financial valuation techniques. Then review real options in venture capital to better understand what is missing in the current literature. Finally, decisions trees in mapping out startups and adoptions curves to help with market share assumptions will be analyzed.

2.2. Investment in Agriculture

Agriculture is one of the oldest investment classes in history. It underlines every major civilization in history. Everything from early Egyptian irrigation, to US settlers receiving land in to farm for moving to America. Agriculture and food production are needed to have any thriving civilization. The first U.S. Census was in 1790, the nation’s population was about four million people at this time. Almost all of them were living in the countryside or in small towns and villages, and 90% of them listed their occupation as farmers (Allosso, 2022). In the US today direct on-farm employment accounted for about 2.6 million jobs, which is 1.4% of U.S. employment (USDA, 2022). Although the amount of people involved in direct on farm employment has been trending downward, agriculture has seen tremendous growth both technologically and commercially. The benefits of owning agriculture land, hedging using commodity futures, and investing in large publicly traded agricultural companies such as John Deer, Bayer, Syngenta, Bunge, Nutrien, Corteva Agriscience, and others have grown and provided opportunity for outside individuals to participate in investing in U.S. and global agriculture.

2.2.1. Agriculture as an Asset Class

Investing in agriculture has been around for a long time. Studies show the advantages of including agriculture investments to help diversify a balanced portfolio. In a study done by Messner (2019), he showed that including investment of agriculture land in a balanced portfolio can help decrease risk and diversify a portfolio. Bryce uses capital asset pricing model (CAPM) to prove that including agricultural land in a portfolio is beneficial for investors. However, it is noted that the CAPM model may be an over simplification due to it not being able to change the distribution over time. Since the distribution is held constant it may not be that realistic as noted by Shahi and Shaffer (2017). It still can be used as reference to indicate the advantages of including agriculture investment in a portfolio. These investments can take many different forms. This includes, commodities, agriculture derivatives, public equities, farm land, and private equity.

As agriculture continues to see large amount of capital inflow it will continue to generate new data that will prove the efficacy of this asset class. Agriculture as an alternative investment such as commodity hedge funds, to farmland provides a new tool for portfolio managers to diversify their holdings. As shown by Chen and Wilson they use a Copula-VaR model as the optimal portfolio composition and incorporating different agriculture investment including farmland, agriculture equities, and grain futures. The results showed that portfolios with low risk tolerance prefer farmland. As more risk is taken on, returns improve and the composite of the portfolio shifts towards equities (Chen, 2013). This means that farmland can be added to portfolio to serve as a hedge to lower volatility. The paper also showed that when running this regression, the S&P futures never entered the portfolio. This means the agriculture investments have outperformed the broad market index. Although, the short-term volatility can impact this analysis the underlying results support that agriculture is a robust asset class to be invested in. Umbrellaed under this category would be farmland, agriculture technology, seed and traits, logistics, etc.

2.2.2. Ways to Invest in Agriculture

The internet era has created a number of new ways for people to invest in agriculture. Some key ways are using a farm real estate investment trust (REIT). This is publicly traded equity where the managers of the financial product invest in farmland on behalf of the investors. They are responsible for managing the investment and have specific investor guidelines they can a can't invest in. Some examples would be Farmland Partners Inc. (FPI) and Gladstone Land Corporation (LAND). Another option for those interested in investing in agriculture would be buying agriculture stocks. Taking ownership via common stock using the public markets. Some examples would be John Deer, Bayer, Oatly, Mosiac, Bunge, Scotts Miracle Gro. Other ways include electronically traded fund (ETF) or Ag Mutual Funds. Someone can also buy commodities such as livestock, grains, and energy using these methods or using derivatives such as futures and options.

2.3. History of Venture Capital

VC continues to evolve and more capital than ever is being invested. In 2021, there was $612 billion in venture capital globally which is a 108% increase from 2020 (Bryan, 2022). With this evolution of financing new financial engineering is taking place to help give investors and startups an edge on competition. This can be from the alternative funding routes, such as crypto which may give startups more opportunity to find liquidity and funding. To top down government intervention to help stimulate more investments in early stage companies and awarding grants for companies that can fulfill ESG practices.

2.3.1. How Venture Capital Started

When launching a new business founders face many uncertainties when engaging new investors in a potential partnership. These partnerships are difficult to obtain due to startups being considered high risk investment. Funding for early stage companies is regarded as high-risk capital due to their wide distribution of payoffs and the high uncertainty for investors' on losing their investment. Early stage companies are usually unprofitable, have not yet built a sustainable business model, have very little proof of product concept, and have not accrued any market share. This makes it difficult to find funding and is highly risky. Typical funding for these early stage companies comes through the source of VC. VC is deployment of risk capital in the pursuit for outsized returns. Some of the earliest risk capital deployment entities can be seen in sixteenth century with wealthy individuals funding whaling expeditions. Tom Nicholas discuss this concept in his book *VC An American History*, where he shows some of the earliest prototypes for what is now known as VC (Nicholas, 2019). The goal for venture capitalist is to achieve larger return on an investment due to the increased risk of this venture. As mentioned in Nicholas book, Figure 2.1 shows the typical structure of a VC today and how it compares to whaling expeditions in the eighteenth century (Nicholas, 2019).

In the study done by Davis, Gallman, Gleiter, *In Pursuit of Leviathan*, they show that the typical New Bedford whaling venture of the 1850s required an investment of $20,000 - $30,000. Comparatively, US farms were worth $2,258 and the average manufacturing capital stock was valued at $4,335 in 1850. Often the captains of the ship were financially incentivized by receiving partial ownership of the profits the crew would bring back (Davis, 1997). However, the whaling industry was highly volatile where some ships would come back with none to very little cargo or overfilling with oils and whale sperm. This skewed distribution on these whaling ventures and created a asymmetric upside towards successful voyages, which made it extremely attractive for wealthy individuals to dabble in this market for the chance of the optimum upside. Often times when captains came back with empty ships it was meet with a lot of disgrace and embarrassment from the community. If the ship was full of cargo he would become an instant celebrity. Similar reactions can be drawn from entrepreneurs today who's startups fail and you are followed with shame or succeed and become a hero.

Figure 2.1

Whaling Structure (Nicholas, 2019, p. 22)

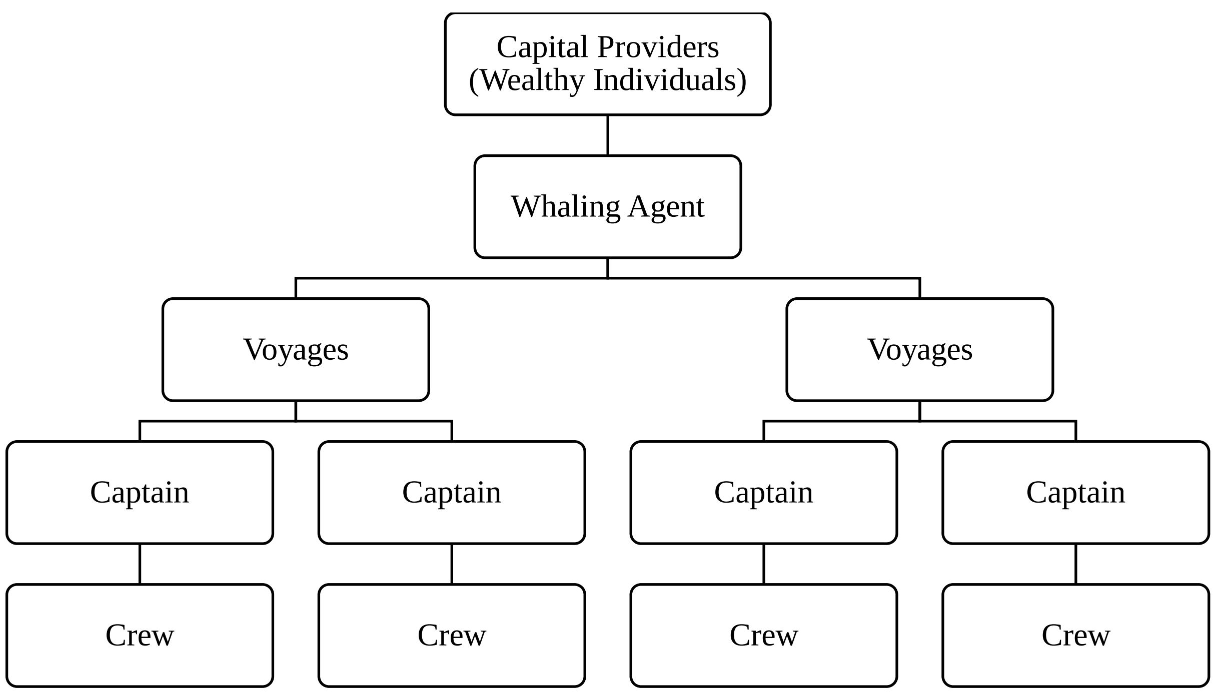
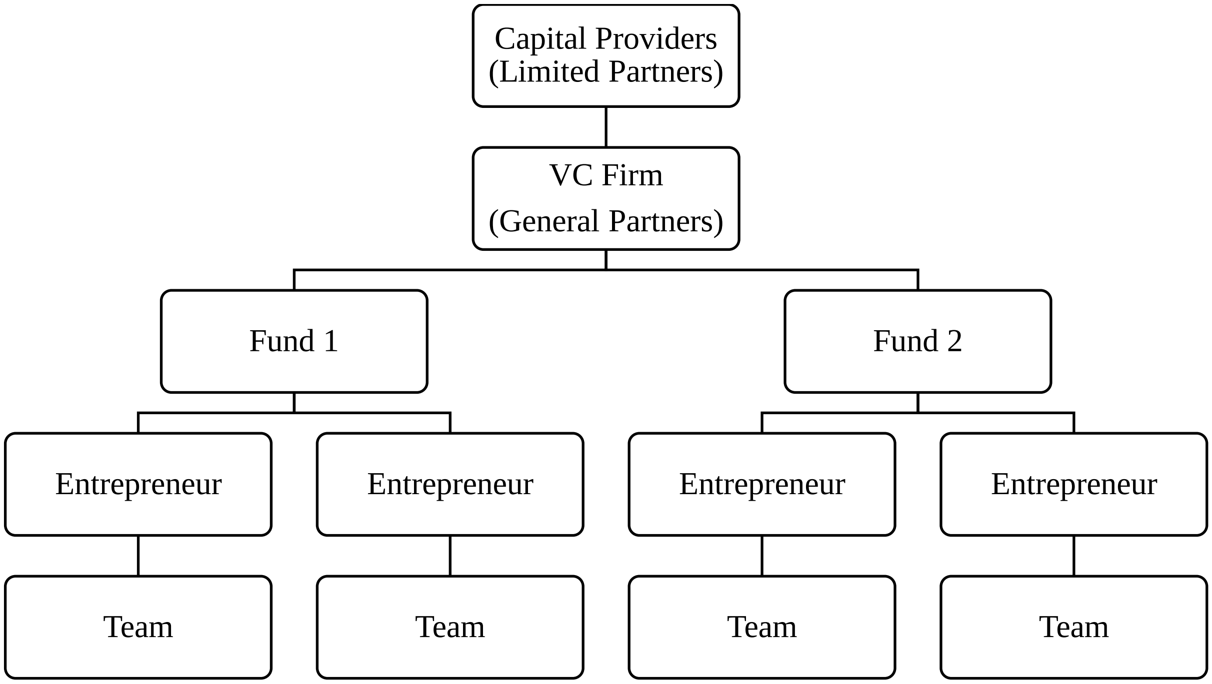


Figure 2.2

Venture Capital Structure (Nicholas, 2019, p. 22)



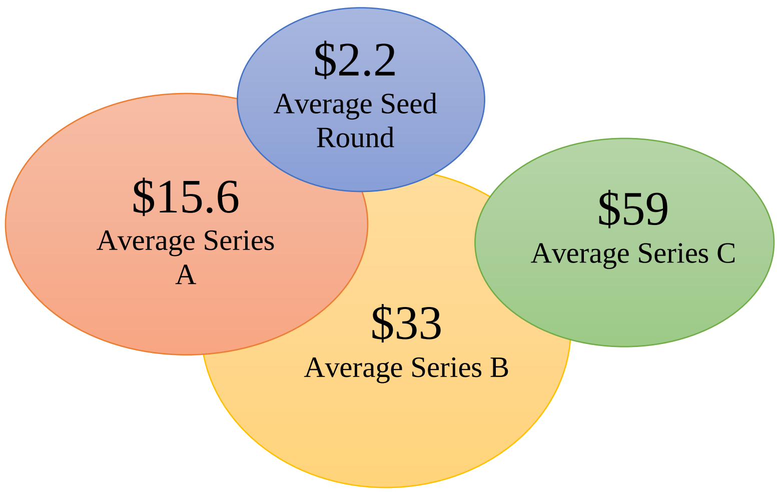
VCs have limited partners (LP) who are investor that invest in a venture capital fund for a fixed period of time. Generally speaking this will be 10 years. The general partner (GP) is the manager of the venture fund(s) and helps make investment decisions and run the portfolio on behalf of the LPs. Together they are both chasing after the long tail distribution of payoffs that investing in startups can reward.

2.3.2. Structure of Venture Capital

VCs partner with entrepreneurs through what's called series funding rounds. There are many types of series funding rounds including seed, A, B, C, and eventually an initial public offering (IPO). Each round will bring in new investors according to financial institutions risk tolerance levels. A seed investment would be considered the riskiest due to that being the earliest funding round. A funding round is when a private company goes to public funding sources (VC, angel investors, accelerators, strategic partners,) and the startup will sell equity which is ownership of their company to the VC in exchange for funding. As the series funding rounds go to A, B, C, the amount of financing provided will generally increase and the riskiness of the company will decrease due to a higher probability of the business being able to become profitable. See image 2 for 2020 average series funding statistics.

Figure 2.3

2020 Mean Series Funding ($mm) (Fundz, n.d.)



There are many different types of funding when it comes to series funding rounds like bridge funding, which is a temporary funding intended to finance a business's short-term expenses until a long-term funding is secured. There can also be several funding rounds at the same series level A, A-1, A-2. For the purpose of this thesis, it is not going to get into all the nuances of series funding, however, it is important that entrepreneurs understand this mechanism and understand the optionality when it comes to different funding opportunities.

At each one of these funding rounds the company is issuing equity to new investor which will be diluting current ownership. This is of course the main trade off entrepreneur's face when trying to scale their business. The more equity they sell the less control they have over the company. This relationship was analyzed by Noam Wasserman in his 2008 paper, *The Founder's Dilemma*. One conclusion was that founder who give up more equity to attract investors will create a more valuable company than one who parts with less, and ultimately will end up with a more valuable investment (Wasserman, 2008). The key observations from this study between the relationship of control and financial gains is summarized in figure 4.

Figure 2.4

Wasserman 2008 Trade-Off Table (Wasserman, 2008)

This relationship shows that the network effect of partnering with investors can help increase a startups probability of being successful. This means that founders need to think more critically on what their goal is with their company. If they want to control business they will not feel successful if they sell their company away. If the founder wants to become rich, selling equity to investors and involving others to help run the business will make them more successful. This is why a decision trees can map out these decisions and a real option can value them. By better understanding what maximizes the founder’s utility they can better make more informed decision about where they get their funding from. However, in 1988, Purdue University strategy scholar Arnold Cooper asked 3,000 entrepreneurs two questions: “What are the odds of your business succeeding?” and “What are the odds of any business like yours succeeding?” The

Founders claimed that there was an 81% chance, on average, that they would succeed but only a 59% probability of success for other ventures like their own. In fact, 80% of the respondents pegged their chances of success at least 70%—and one in three claimed their likelihood of success was 100% (Wasserman, 2008). This shows that often Founders' can show overconfidence in one's abilities, and are naive about what qualities are necessary to run a business. They also might be too confident in their own abilities to raise new ventures and these emotions can cause problems later in the startup's life.

Venture capital is all about the skewed returns. In figure 2.5 is the typical breakdown of $1,000 invested in a VC fund (Zider, 1998). As noted the majority of the investments will lose or receive the initial investment back. The other 40% is where the bulk of the gains from for the investment. The far outliers representing the majority of where the return comes from.

Table 2.1

Venture Capital Return Dist. (Zider, 1998)

	Bad	Alive	Okay	Good	Great	Total
$ Invested	200	400	200	100	100	1,000
Payout Year 5	0	1x	5x	10x	20x	
Gross Return	0	400	1,000	1,000	2,000	4,400
Net Return	(200)	0	800	900	1,900	3,400

2.4. Methods of Valuation

This section of this chapter focuses on the previous studies done related to research around thesis topic. This can be broken down into three main categories, traditional methods for valuing businesses, decision tree use in business development and valuation, and real option use in valuation. A decision tree will allow startups to map out the inherent optionality that come with growing companies and weight the significance of the alternative funding sources. Then a real option approach that uses key characteristics from traditional financial options will offer a new perspective on how to value those growth decisions. Each section can then be broken down into historical literature on the topic, and how this research is differentiated. The scope of this research is done using both academic publication and industry studies.

There are many ways to value a business. For example, one traditional method would be market capitalization, if a stock is trading at $1.00 and there are 100 shares outstanding, the value of this business would be $1.00 * 100 = $100. Other methods include revenue or earnings multiplier, DCF, book value, liquidation value and many other methodologies. Each valuation tactic has a unique insight into the worth of a business and can have different valuation for each method. Depending on what type of company you are trying to estimate, one method may be preferred to another. To value a private company an investor may use a revenue or earnings multiple approach. Firms that largely work with natural resources may be best evaluated using liquidation valuation method. The chosen methodology that will ultimately be used is the valuation that investors are most confident with.

2.4.1. Discounted Cash Flow (DCF)

Typical valuation of companies is based on a DCF analysis which ignores the upside potential for entrepreneurs to be selective of where they receive their funding from. The option to be able to work with different VCs cannot be represented in a DCF approach due to it being a temporary business forecast given today’s current market information with fixed assumptions. Therefore, it implies that entrepreneurs cannot be flexible with their funding sources and hence change the valuation of the business.

Due to management’s flexibility the DCF model’s inability to be fluid cannot capture the dynamic investment decisions that firms face which suggests that the DCF is likely to underestimate the value of the investments (Trigeorgis 1995). This crux fails to accommodate for the value of management flexibility which is the ability to adjust decisions at a later date. This is because DCF assumes that the decision maker has fixed commitments and has no ability to change their initial investment decision at a later date. However, it is known that this is not the case since firms do have the ability to be able to abandon a project if unfavorable outcomes are expected. It may be necessary to abandon a project during the life of the project to cut losses. The flexibility in this decision implies that management has the ability to influence and limit the downside risk of loss, but retain relatively unlimited upside potential for profit. (Yeo, 2003)

2.4.2. Relative Multiples

This method is used to model a company's value using a competitor list or industry peer group to estimate the companies worth. By compiling a good peer group, a model can be created to forecast financial metrics to better understand the company's relative value compared to its peers. For example, if a company has an enterprise value to earnings-before-interest-tax-deprecation-and-ammonization (EV/EBITDA) 5x and the Peer group median multiple is 10x. The company is trading at half the EV/EBITDA multiple of its peers. This can suggest it is currently undervalued relative to its peer. If the company has $10 million in EBITDA the Relative EV would be $100 million. ($10 * 10x = $100M) Hence, if the company is EV is currently less than $100 million it is undervalued. However, some companies may always lag their peer group or demand to trade at a higher multiple. This can be due to a number of different factors including, market leader, competitive advantages, stronger margins, better growth, etc. It is up to the analyst to decide what is the fair relative multiple for this company to trade at.

There are a couple different types of multiples often used in this method and it varies depending on industry, business model, age of company, product development and other factors.

Common multiples used are EV/TV to revenue, EBTIDA, EBIT, FCF, and price to earnings (P/E). In a study done by Liu, Nissim and Thomas, 2002, they found that multiples based on forward earnings explain stock prices best, and historical earnings measures are ranked second, cashflow measures and book value are tied for third, and sales performed the worst. Also, that multiples based on the residual income model, which explicitly forecasts terminal value and adjusts for risk, perform worse than simple multiples based on earnings forecasts (Liu, 2002). The interesting thing here is that the simple arithmetic of the earning forecast was more accurate than the sophisticated income model that carries more assumptions. All be it, that the ultimate multiples used in this analysis that are good measurement of this business but might differ depending what company(s) are being analyzed individually in more micro studies. However, the theoretical structure of the model should be transferable to adjacent studies. Early stage companies often trade at extreme multiples at the beginning due to it's lack of revenue, but becomes more normalized over time as startups become more stabilized.

2.4.3. Precedent Transaction

This is when a group of historic merges or acquisitions are complied with companies that are similar. This could be same industry and/or similar business model. An example could be agriculture biotechnology or SaaS business. All the ag-biotech could be similar companies and have different business models and vice versa for the SaaS example, similar business but could be serving different industries. Like the relative multiples, these companies' transactional numbers can be pulled to estimate the value of a stock. Again, one of the most important things is creating a good peer group and using the multiple that most accurately represents the company's value. This often comes down to personal preference and experience.

2.4.4. Scorecard Valuation

The Scorecard or Bill Payne valuation method is one methodology used by angel investors to analyze startups. It considers 6 criteria with different max (weighted) allocations for each category: management (30%), opportunity (25%), product or service (10%), sales channels (10%), stage of business (10%) and other factors (15%) (Payne, 2011). A value will be assigned according to the angels' confidence in each one of these categories. See figure 2.6. Then by taking the weight times the target value you will get the factor. Sum up the factors to get the multiply and use that multiply times the pre-money valuation to get the value. The pre-money value can be more qualitatively made up then quantitatively created. However, this is a helpful tool in better understanding the value of early stage startups. One nice thing about the scorecard is it can be used for startups that don't have any sales.

Table 2.2

Bill Payne Valuation (Payne, 2011)

Comparison Factor	Range	Target Company	Factor
Strength of Entrepreneur and Team	30% Max	125%	0.3750
Size of the Opportunity	25% Max	150%	0.3750
Product/Technology	15% Max	100%	0.1500
Competitive Environment	10% Max	75%	0.0750
Market/Sales/Partnerships	10% Max	80%	0.0800
Need for Additional Investments	5% Max	100%	0.0500
Other Factors	5% Max	100%	0.0500
Sum			1.0750

2.4.5. Venture Capital Method

This is when investors look at the exit of the investment and price it backwards from there. First the exit price for the investment is estimated. Let's say $200 million. The target ROI is 20x. Hence, The Post-Money Value is $10 million. Then take this minus the cash raise to get the pre-money value and factor in dilution to get the final estimate. This method is used for pre-revenue companies that can be more easily estimated and the potential exit value once certain milestones are reached.

2.4.6. Cost-to-Duplicate

This is when all costs and expenses are compiled in the startup, including the product development and purchase of physical assets are all reconciled in the valuation. In other words, what would it cost to build this exact same company from scratch. The thinking behind this is that investors wouldn't pay for more then what it cost to duplicate. However, this method doesn't consider intangible assets (McClure, 2015). If this was an upstream ag-biotechnology company, it would be the cost of the labor to make the product, raw material cost, and facilities needed to create the product.

2.4.7. Risk-Factor Summation

This is a pre-money valuation method for early stage startups. It uses a base value of a comparable startup and adjust it on 12 standardized risk factors. See figure 2.7. It only goes up and down in constant $250,000 intervals.

Figure 2.5

The Risk Factor Summation Method (Nasser, 2016)

The Risk Factor Summation Method

INITIAL VALUE				**$1,500,000**
1.	MANAGEMENT RISK	*Very low*	*+$500,000*	$2,000,000
2.	STAGE OF THE BUSINESS	*Normal*		
3.	LEGISLATION/POLITICAL RISK	*Normal*		
4.	MANUFACTURING RISK	*Normal*		
5.	SALES AND MANUFACTURING RISK	*Normal*		
6.	FUNDING/CAPITAL RAISING RISK	*Normal*		
7.	COMPETITION RISK	*Very high*	*-$500,000*	$1,500,000
8.	TECHNOLOGY RISK	*Low*	*+$250,000*	$1,750,000
9.	LITIGATION RISK	*Very low*	*+$500,000*	$2,250,000
10.	INTERNATIONAL RISK	*Normal*		
11.	REPUTATION RISK	Very low	+$500,000	$2,750,000
12.	POTENTIAL LUCRATIVE EXIT	Normal		
BOX VALUATION				**$2,750,000**

2.4.8. Dave Berkus Method

Is a method used to figure out pre-money value given the most important element of risk that all early stage companies face. First if the startup has a sound idea, (basic value risk). The second is if the company has a working prototype, (technology risk). Third, is it a quality management team, (execution risk). Fourth, is if the company has good strategic relationships in industry, (go-to-market risk). Lastly, product rollout or sales execution, (production risk). Using these 5 factors, the Berkus model value the company using a max value and gives weight value to each of the five categories depending on the angle's degree of confidence of this category. If the venture was estimated to be max worth $1 million dollars, each section would have a max value of $200,000. Therefore, if the management team didn't seem capable, all you might allocate is $50,000 to that category. Once values have been determined, sum up the project to get the venture value.

2.5. Real Options in Venture Capital

The real option was original created by Stewart Myers (1977: 150), and he argued that this allowed firms to purchase assets at favorable terms. Thus, real options were developed to help managers make better decision when faced with uncertainty (Dixit and Pindyck, 1994). By using real options there is now a methodology that more approximated real-life scenario’s that decision makers face. Unlike the DCF or multiples valuation approach, real option analysis (ROA) created a way to value different decisions that may occur during an options life. As time increases, the uncertainty around that option will increase and vice versa. ROA provided a new way to analyze initial NPV for more complicated outcomes. The ROA value can be added to the initial NPV to get a total value. Therefore, even if a project has a negative initial NPV it can still have a positive overall valuation by adding the real-option value. Hence, this gives the decision maker more information to help aid their final decision.

An option gives the owner the right but not the obligation to buy or sell a specified good at a pre-determined price. This price is called the strike price. A traditional financial option can be a “call” option which grants the holder the right to buy a stock, and a “put” option which give the holder the right to sell a stock. If these options can be exercised before maturity date it is called an American option, and if it can only be exercised at maturity it is a European option. In the early 1970s, Black and Scholes published the first successful model for pricing financial options for call and put options for equities. (Black and Scholes, 1973) Now companies would be able to evaluate the true value of their options and be able to make educated decision according to this model.

Table 2.3

Generic Real-Option Types

Option Type	Description
Expand	Expansion of a new or existing product line; entrance into a new geography, demographic, or other segment.
Abandon	Abandon a project or company via liquidating assets or selling the company. Abandonment is especially helpful in R&D processes.
Delay	Wait to pursue an action by allowing uncertainty to clear. Negotiation or significant investment in new items may require delays to process information.
Contract	Outsource an action to reduce costs or simply the business model. This leads to a monetary savings or re-focused offering.
Choose	Choose between different option types listed above. The option leading to the best return on investment is pursued.
Sequential	Staged options dependent on each other such as an expansion project. For example, regulatory approval may be needed before infrastructure projects.

The Real option frame of thinking is based off the same principles for financial options. A real option means to have the possibility for a certain period time to be able to choose for or against something, without fully committing to that investment. The big difference between a financial option and real option are that a real option can be applied to real assets. (Kumar, 2021) A real asset is usually some sort of tangible item, such as new hardware investment, building a new factory, updating a company's software, etc, compared to a financial asset which normally consist of financial products like bonds and stock. These financial products are traded in markets, while the tangible items are not. This makes it impossible to value these assets using the Black Scholes option pricing model without introducing new assumptions into it. The most common real options are hold or abandon, the option to expand or reduce, an option to contract, choose, and sequential. See table 2.3 for most common real option types and their descriptions. In chapter 5, a sequential option will be used to compare to the base case of the expansion option used in chapter 4.

In a study done by Cruz and Perez, they found that the option value to abandon is greater than or equal to zero and that, as the maturity of the option increases, its value also increases (Cruz, 2016). This shows that the residual value of the option does have tangible worth that historically is underestimated when using traditional valuation approaches. This means projects are already being risk mitigated because management has the ability to abandon it over time and cut losses before they are spent. The major factors impacting this analysis is the uncertainty around how much time is needed to complete a project. With any investment there will be uncertainty around management to allocate these funds effectively to achieve the goals of the investment.

2.6. Decision Tree Use in Venture Capital

In venture capital entrepreneurs and investors face multiple different decisions points. This can be different operational decisions, like whether to allocate more funds into the R&D project. Another could be if a company hits all it’s milestones whether the investors should invest in the next funding round, or pass. These decisions can be represented in a decision tree and valued using statistical approximation. This methodology is helpful in organizing complex decisions to choose the most optimal strategy. A Decision tree is used to map out the product development of R&D projects. Projects that need to prove out different stages of efficacy and cash flows that can be forecasted make using decision tree very optimal.

One of the most common decision tree are the binomial decision tree which measures the intrinsic value an option can take during different points in time. It allows probabilities of success to be easily measured as well as failure. Success represented as P and failure 1 – P. P can be created subjectively or using different methodologies such as the scorecard. This can be represented in a tree with cashflows attached to the different points in time and weighted by the probability. The binomial option pricing model values American options using an iterative approach. There are two possible outcomes at each node. This is a helpful methodology for valuing options that are binomial in nature. This means there are two possible outcomes like failure or success. The key advantages of using this method is it allows American options to be price over consistent intervals overtime using assumptions that are flexible in nature.

2.7. Conclusion

This chapter strives to educate the audience on how venture capital works and provide the fundamental understanding of how industry works. The information to analyze the model and its tradeoffs later should be referenced in the optionality that these companies have in sourcing deal flows. Then creating a foundation of the current state of agriculture investments to give the reader an idea on what the availability of cash flow is today, and the benefits of investing in this market. Investors will ultimately need to value these investments and as discussed, the traditional methods that have been used. This gives the readers a current idea on how industry currently values their investments and the benefits of using these methods. It provides insight on the mechanics of VC financing. Although there is a number of fields that weren’t explored, conversion rates, pro rata, convertible notes, legal, board representation, capital structure, etc. Finally, a review on the current literature on real options and decision tree. By using these two methodologies this study will be able to make a more holistic approach in valuing decisions that startups face.

CHAPTER 3. METHODOLOGY

3.1. Introduction

Business that are growing often need to take on new capital to continue to grow. This new capital can be raised by selling equity. Companies in early stage are often high risk and have unproven technology and business models. This makes the price of equity cheap due to investors low willingness to participate given the high risk of the investment. This means startups need to value how much they are willing to dilute themselves without over selling cheap equity. This creates a challenge to be able to value these early stage businesses. Traditional methods used in valuation modeling including DCF, multiples, scorecard, liquidation valuation, Monte Carlo, cost-to-duplicate, and others that don't represent the true value of a company due to the model's inflexibility for management to adjust their strategy. Management in startups have the ability to reallocate funding towards more profitable business segments which makes them more valuable than traditional methods would suggest.

The data for this project has been simulated using historic information and forecasted forward based off of expert opinion. Different assumptions around distribution and market adoption have been created to allow for flexibility in the model. To do this software's including @Risk 8.2, Precision Tree, and Microsoft Excel have been used.

3.2. Problem with Venture Capital Growth Modeling

Investing in startups is high risk with unpredictable revenue and significant execution risk. This execution risk is usually mitigated when companies go public since public companies generally have proven product efficacy and have an experienced management team. Some common problem for startups are that they often have founders who are untested and are inexperienced in running business. Startups usually don't have revenue or any contracts in place for recurring business. This makes it difficult to forecast earnings and market adoption. Also, startups need to hirer key employees to execute on their business strategy. These are just some factors that make it difficult to measure growth of startups and what makes venture capital so high risk. Traditional methods like the DCF can be extremely difficult to forecast because the company has a changing business model with no consistent revenue or contracts put in place. Also, the changing cap-table is way more volatile in startups than in publicly traded companies since, they are not required to raise equity as much to create funding for projects, which dilutes ownership.

Another area that also makes it difficult to value startups decisions is the large execution risk that startups face. This is when a company's business plan is executed poorly and never materialize to any significant gains. Since startups don't have a proven track record of historical successful ventures and generated earnings, this gives investors an even higher degree of uncertainty on why this venture will be successful. They need to execute on several key milestones including steal market share from current competitors, build out the bill of materials (BoM), develop a fully functioning product, employ a capable management team with the capacity to grow their business, and onboard all other underlying business responsibilities not listed here. There is a also market risk stacked on this as well. This meaning if the market this firm is competing in has a downturn it will impact all players in that market. For example, if there is a fertilizer company and there is a recession or natural disaster this will impact all companies in this market. These by nature are unpredictable and will have varying impacts depending on the severity of the disaster.

The multi-stage funding enables VC's to provide capital requirement of the investment in several instalments after the startup has achieved a number of pre-defined milestones. During the time intervals between each funding instalment, VC's can test the performance of the startups ability to execute while not allocating large portions of funds at one point in time. The VC can gather information and if the startup is successful in achieving all their milestones, they can allocate more funds to the startup at a new risk-adjusted price. If the information is less then desirable, they can reject to opportunity to reinvest. Venture capitalists must be careful, because, if early stage investors don't send favorable market signals by reinvesting it can be destructive on the startups ability to raise the next round of funding. Also, VC's can artificially increase the equity of their investment by reinvesting in a higher round. This may look good to the outside observer looking in, but to the limited partners, who understand that this new equity appreciation is only due to the validation of their own funds and not the markets perspective of what it is truly worth. This can make a toxic relationship for general partners and their limited partners by creating a brutal hate cycle of fake validation. This is one of the major problems with VC modeling today there are financial loop holes smart investors can use to disguise their bad investments.

3.3. Decision Tree for Integrating Risk

Analyzing risk can be summarized by looking at the future and estimating the uncertainty around a hypothetical outcome. This is predominantly done by measuring the uncertainty of future cash flows. This is done by using net present value (NPV).

$$NPV = \sum_{i=1}^{n} \frac{R_i}{(1+r)^t} - Initital\ Investment$$

Where:

R_i = net cash flow

r = required rate of return or discount rate

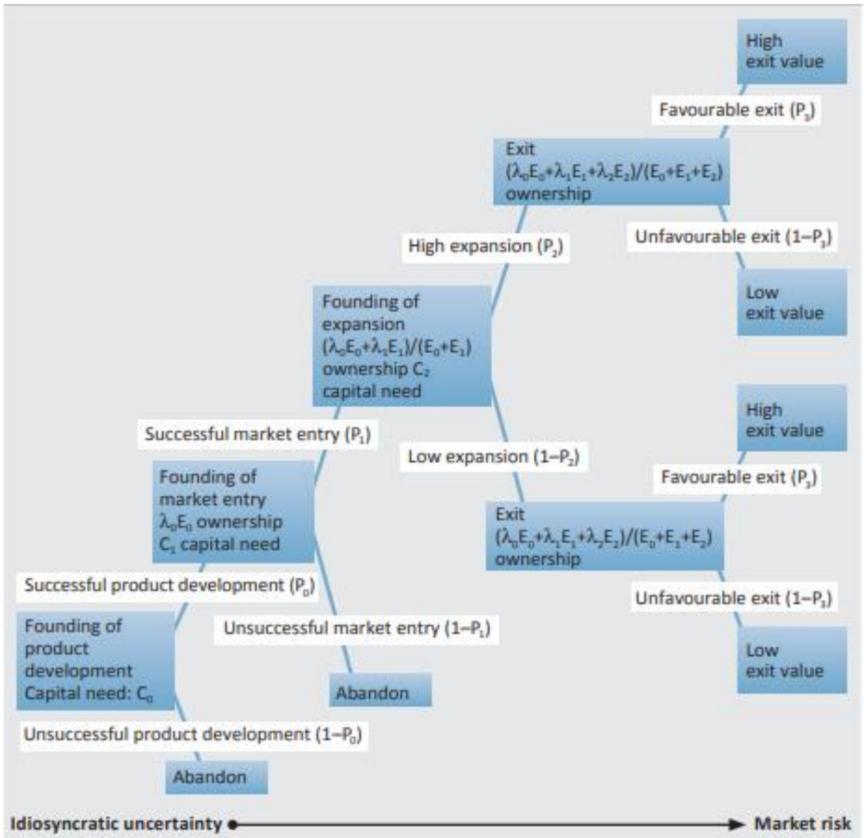
t = time (annual)

The fundamental use of a decision tree is a technique that is used to make decisions today based off of the uncertainty of the future. This technique can be used in infinite amount of ways. However, all these scenarios are based off of the premise that people need to make decisions today about the future, which has some degree of uncertainty. Conversely this makes this methodology more fluid by nature which makes it more attractive for making decisions. The flexibility allows for greater creativity for more precise outcomes based off of the objective of the user.

In 2016 a study was done by Fazekas *Value-creating uncertainty—A real options approach in venture capital.* In this article Fazekas discusses capital investment stages of startups and the risk associated with those raises. In figure 3.1 he shows the basic decision-making possibilities during the life of a venture capital investment. These decisions are all going to be company-company specific, and there is no universal model to describe the real options valuation of venture capital investments based on the integrated approach; however, these individual steps of the valuation can be generalized for evaluating an investment.

Figure 3.1

Option Pricing Valuation Approaches (Fazekas, 2016)



3.4. Real Option Analysis (ROA)

Options derive their value from underlying stock or security. What makes real options difficult to price is that the real asset the option represents does not have readily known present value because they are not subject to open market bidding. One of the benefits of an open market is that it gives information on price discovery of an underlying tradeable product, like a stock, bond, and commodity which provides information on the worth or the option. If the traditional financial option is trading out of the money the owner would not exercise it. There is no profit that can be made by exercising it. However, the real value of these real assets can’t be known without some assumptions. Another issue with real options that it has very little, to no historical data on the value of the real asset (Razgaitis pg #171, 2003). This makes it difficult to know the value of the real asset. However, the value of the real options can be seen in Table 3.1.

Table 3.1

Value of Real Options

		Uncertainty	
		High	Low
Managerial Flexibility	High	High Option Value	Medium Option Value
	Low	Small Option Value	No Option Value

The real option allows for investment decisions to be delayed to account for learning over time. The natural investment time horizon for VC creates the perfect structure for investors and founders to learn more information about a startup before reinvesting. By seeing if management continues to successfully achieve milestones overtime, the delayed investment in the real assets gets a risk adjusted return on capital. The greater the uncertainty and flexibility the more valuable the option will be.

The option to expand gives companies the insight into what decisions are more valuable for a business. This option is more valuable in more volatile business with greater returning ventures, compared to more slow growth business such as manufacturing, automobile, and utilities (Damodaran # 394, 2010). One downside with using this option is that many projects do not have a foreseeable time horizon which makes these open-ended options. Options with longer time horizons have more uncertainty and therefore can be less reliable to depend on. Also, market factors overtime such as market size, adoption, risk free rate can be accurately predicted over longer periods of time. These factors can be problematic in using this approach and should be understood by the user when making their assumptions.

$$Value\ of\ Firm = Discounted\ Cash\ Flow\ Value + Option\ to\ Expand$$

The base case option used in this research is the option to expand. This is when an investment is made in a future project to expand business operations. An example might be if a business wants to build a warehouse or add a new laboratory. This investment has real cost and can be more appropriately evaluated using options rather than just net present value. The variables included in the option to expand are:

Variables:

S = present value of cash flows from the expansion

K = cost of expansion

σ = volatility of returns over life of option

T = number of years

r_f = risk-free rate

A sequential option is used in chapter 5 to compare to the base case results. This option is when a project can be done in sequential steps. The value of the option is dependent on the value of the options preceding it. Unlike an expand (growth) option which measures an investment today that can be delayed over time to prove out the efficacy of a project. Each funding round can be its own option rather than assuming the company must raise three funding rounds in one option. Each round of funding has its own milestones which provides their own validation and risk adjusted price. By valuing each funding round with their own option, additional insights can be gathered with the new information gathered.

Table 3.2

Different Option-Type Descriptions

Option Type	Characterization	Effect	Description
Expand (Growth)	Simple	Call	To expand a product or project with high growth potential.
Defer	Simple	Put	To wait or delay a decision until uncertainty fades or markets become favorable.
Abandon	Simple	Put	To abandon a project and walk away with the salvage value if the project becomes unattractive.
Contract	Simple	Put	To contract or outsource company costs for potential changes in market conditions.
Chooser	Simple	Call & Put	Ability to choose options to expand, contract, abandon, or delay. The option that offers the highest value is the type to choose.
Barrier	Simple	Call & Put	Transforms above option types with a predefined price to avoid any psychological bias in making option decisions.
Sequential	Compound		Options are provided in multi-stage phase where option values are reliant on previous options in an ordering.
Parallel	Compound		Multiple options that are active simultaneously.
Rainbow	Compound		The option or options host numerous sources of uncertainty.
Learner	Compound		Different options can resolve uncertainty and increase effectiveness of other options.

Summarized in table 3.3, are the different approaches of valuations of investments by using option pricing. This table was created by Fazekas (2016) to summarize the different uses of financial and real options. One of the limitations of the mentioned methodology is that real assets are product specific and therefore there is much uncertainty around them. Ultimately these papers have been revised due to the new literature around uncertainty of how to value these real assets.

Figure 3.2

Option Pricing Valuation Approaches (Fazekas, 2016)

Table 1
Real options valuation methods and their applicability

	Assumption	Valuation model	Applicability:
The classic approach (Amram – Kulatilaka 1999)	Replicating portfolios can be constructed from traded products; i.e. the existence of a replication security is assumed that correlates perfectly with the investment and moves closely together with a geometric Brownian motion; consequently the no-arbitrage argument is sound.	A method applied for the valuation of financial options such as the BS or the CRR model based on the market data of the replication security.	Conditions for the classic approach are rarely given. It can be applied if an adequate traded replicating security exists. In the lack of such instrument, however, if project-specific idiosyncratic risks are determinant, the method cannot be applied.
Subjective approach (Luehrman 1998)	It assumes the existence of a replicating portfolio and therefore the applicability of no-arbitrage arguments. It also assumes the portfolio's co-movement with a geometric Brownian motion.	A method applied for the valuation of financial options such as the BS or the CRR model based on the 'price' derived from the DCF-based valuation of the project and estimated volatility.	While the data of the replicating portfolio do not play a key role in the valuation, the reliability of subjective data is questionable. For lack of a replicating portfolio, the application of a valuation method founded on the no-arbitrage argument is inconsistent.
Marketed asset disclaimer (MAD) approach (Copeland – Antikarov 2001)	The replicating security is the project's NPV itself, without flexibility; therefore, the assumptions are the same as those applicable to the use of NPV: the computation of expected returns is based on the existence of (replicating) securities of similar risk. Asset price movements can be described by geometric Brownian motion.	Valuation with a binomial tree method. A CAPM-based discount rate is applied for the calculation of the project's NPV. A subjective estimate of cash flows and volatility.	There is no need for a replicating portfolio. Owing to the subjectivity of the data, assets and options might be mispriced. Estimating subjective data is problematic. A security of similar risk is required for proper NPV calculation.
Revised classic approach (Amram – Kulatilaka 2000)	The model supplements the classic approach, given that the classic approach is based on fairly restricting assumptions. It cancels the assumptions of the former.	Application of decision trees. Allocation of subjective odds to individual outcomes. Subjective estimate of cash flows. NPV calculation by using the appropriate WACC discount rate.	Its application is justified when project-specific risks dominate instead of the risk priced in by the market. Due to the subjectivity of data, mispricing can occur.
The integrated approach (Smith – Nau 1995)	Partially complete market: complete market in terms of market risks, but incomplete market in terms of project-specific (private) risks.	The option pricing model is applied to risks that can be hedged by traded securities and decision trees are applied to project-specific risks.	Due to the integration of the decision tree and the option pricing methods, this approach can be universally applied. Market risks and project-specific risks need to be separated. The perception of project-specific risks is subjective.

Source: Own compilation based on Borison (2005).

3.5. Growth Decision Model

This model has broken down each decision node in the decision tree into three categories: External, Internal, and Strategic. An external is a funding round in which capital is raised by selling shares to private industry such as seed or series funding. The Internal is a choice to expand internally using friends, family, and founders, current investors, debt, and crowdfunding. This is non-dilutive since the raise will be done internally and does not require the sale of equity to new investors. Also, grants or non-diluting capital would be included in this category. Then a Strategic is raising funds through a joint venture (JV), or strategic partnership. An example of a strategic partnership could be a grain elevator software startup who opens a private round of funding to a larger grain elevator like Cargill, ADM, or Gavilon so that their software can be integrated into their elevators. However, management needs to be weary of this decision because it could also limit who is willing to partner with them in the future. These categories roughly umbrella all funding options a management team has to access in order to raise new capital to grow. The real option that is being analyzed in the base case is the real option to expand. Traditionally this option is used by management expanding some sort of tangible assets such as an investment in new factory, or ethanal plant such as (Zou, 2008). However, the same principles are true that they are expanding be taking investors capital to grow the business. This can be in the form of tangible assets such as buildings out infrastructure, hiring new employees, or investing in R&D projects.

The nature of VC funding can be mapped out by understanding the cash burn companies have and knowing what their operating expense is. Traditional models assume fixed decisions that can’t be adjusted due to more favorable outcomes in adjacent markets or varying secular tailwinds. However, by mapping out the decisions for startups using a decision tree management can more accurately estimate their growth strategy going forward with the most desirable outcome. Then by incorporating real options on top of this tree, management will have the ability to analyze their decisions, and have the flexibility to change their decisions for outcomes with a higher probability of success or greater payoff.

In a study done by Zou and Pederson analyzed using the expand option in evaluating an investment in a hypothetical milling ethanol plant. They found that net present value analysis alone does not adequately incorporate the role of uncertainty and the value of management flexibility into the investment decision (Zou, 2008). This shows that a binomial option pricing model can provide additional information to aid in making an investment decision. Their approach offers a more holistic way of viewing investment decisions and give their audience a new perspective on how to analyze investments. Similarly using the real option to expand will give entrepreneurs a new perspective to look at how they source their funding. This additional information will allow founders to make better more informed decisions in the future. With better information and clear value creation this study will analyze the relationship of being selective with investors.

Two methodologies were used to analyze a company's growth decisions: decision tree and Real Options. The decision tree has three main components, the decision nodes represent a choice, the chance nodes denote a probability, and an end node denote the outcomes. This makes up the body of the decision tree. Decision nodes can be binary or nonbinary depending on what is being analyzed. In this analysis the decision nodes are nonbinary due to the categorical formatting of this approach. One could do a binary decision tree to analyze these growth decisions as well. The chance nodes and their probabilities are being pulled from the qualitative and quantitative data sets and can be seen in chapter four A decision tree is mainly used to analyze a complex dataset. A real option is the right to make or else abandon some choice that is available to managers of a company. The most common real options are the decision to expand, defer, or abandon. The variables of a real option valuation are similar to a financial option which includes, duration, discount rate, and volatility or perceived riskiness. The real option current market price will refer to the NPV, which is the cash flows expected from the new investment. These cashflows can be simulated using a Monte Carlo simulation or other projections that will use some mathematical calculation to assign probabilities, given the variables above. The real option gives value of management flexibility to change.

This type of methodology has been used in a number of different studies. Similar assumptions input tables have been created as seen in figure 3.2. This is study from the Harvard business school by Zider, 1998. If just one of these assumptions drops to 50% the probability of success drops to under 10%. This analysis is breaking down probabilities of success into the three different funding rounds based of management's ability to successfully complete set milestones. This design allows for entrepreneurs to see their funding strategies in a more strategic form which will help in making better decisions. These three categories based off of funding rounds is a new way to analyze a company's ability to grow and be successful. Although the allocated probabilities are subjective in nature they do give management their best estimates based off of present information. As new information is learned, updated expectations can be easily integrated into the model for management to update their assumptions. The selected milestones can also be updated and should come from expert advice.

Figure 3.3

Zider (1998) Prob. Success

INDIVIDUAL EVENT	PROBABILITY
Company has sufficient capital	80%
Management is capable and focused	80%
Product development goes as planned	80%
Production and component sourcing goes as planned	80%
Competitors behave as expected	80%
Customers want product	80%
Pricing is forecast correctly	80%
Patents are issued and are enforceable	80%
COMBINED PROBABILITY OF SUCCESS	17%

3.6. Model Assumptions

This model has 27 different scenarios that are run to see the different sensitivities around what funding strategy the startup should select. Each strategy is based off of the three categories organized as above, and each scenario that represent an option assumes three different funding rounds. As an example, companies can raise three external funding rounds to finance their operations. In this process entrepreneurs create a pitch deck convincing why investors should give them their capital. This capital is spent on different projects, such as product development, R&D, and of hiring new employees. In raising the money externally, they are selling equity which is diluting current ownership. However, as mentioned in Wasserman (1996), "startups that sell more equity to investors generally create more valuable businesses." Therefore, it is important for companies to know how much equity to sell to VCs. If the financing can be done via internally it will not dilute current ownership, but may lower probability of success due not being able to access the network effect of partnering with VCs. The reason 27 scenarios were used was because this is the number of combinations of doing three funding rounds (3^3 = 27). Each funding round has its own probability according to expert advice. These probabilities are flexible in nature and are not a universal estimate as each company will differ.

3.6.1. Discounted Cash Flow (DCF)

The DCF is used to value investment decisions based off expected future cashflows. It is one of the most used methods of valuing businesses. Investors like this method because it is easy to obtain an intrinsic value of a business. The intrinsic value tells the investor how much an asset is worth. The formula can be seen below.

$$DCF = \sum_{t=0}^{\infty} \frac{E(CF_t)}{(1+R)^t}$$

E(CF_t) = the expected cashflows

R = risk adjusted cost of capital

T = time (annual)

Some of the advantages of using the DCF is that it is well detailed, includes all future expectations of a business, and has straight forward assumptions. Some of the defects of this analysis is that it does require so many assumptions, which makes it extremely sensitive to outlandish estimates. The amount of details is great but can lead to an overly complex model that doesn't do a good job estimating a business worth.

3.6.2. Terminal Value

Terminal value is the expected value of a project over an explicit investment horizon. It assumes a business will grow at a pre-defined rate forever after the investment forecast. This rate can be determined using several different methodologies, but is most often the expected growth rate of the industry the company is in. The formula can be seen below.

$$Terminal\ Value = \frac{(FCF \times [1+g])}{(R-g)}$$

Where FCF is the free cash flow, g is the expected terminal growth rate, and R is discount rate. This is the model created by Gordon (1962). Startups often don't have positive free cash flowing business; hence the majority of the valuation will come from the terminal value. There are two main methods for calculating the terminal value. That is the terminal growth rate or exit multiple. Whichever method is used comes down to preference. The exit multiple is more of a market approach to calculate the intrinsic worth of a business. Alternatively, the terminal growth rate is used on a more hyper-individualized company focus. It doesn't discriminate based off of where a peer group is trading.

3.6.3. WACC

The weighted average cost of capital (WACC) is used to discount the future cashflows of the startup. The WACC also know as the discount rate is the cost of debt plus the cost of equity. This is the most common method used to calculate the risk adjusted return on capital.

$$WACC = (Cost\ of\ Debt + Cost\ of\ Equity)$$

The cost of equity is the required return a company pays to equity investors. It is the effective return companies requires to compensate for the added risk they undertake by investing in new projects. The cost of debt is the effective rate they pay on debt. See the formula below;

$$WACC = r_E \frac{E}{D+E} + r_D(1-\tau)\frac{D}{D+E}$$

Variables included in this analysis are

r_E = cost of equity

E = market value of equity

D = market value of debt

r_D = cost of debt

t = corporate tax rate

A higher WACC means the projected future cash flows are perceived as less certain and therefore riskier. A higher discount rate, the greater the risk of the investment. Therefore, WACC is the required return on capital to finance an investment. The advantages of using this is that it provides a simple hurdle rate for potential projects which provides management quick decision making. The challenges are that it is changing according to market conditions. This is due to the difficulty to accurately measure market cost of capital.

The CAPM measures the appropriate rate of return on asset based off of the riskiness of the investment. This provides a methodology to quantify the risk into the expected return on equity.

$$E(R_i) = R_f + \beta_i (R_M - R_f)$$

$E(R_i)$ = expected return on asset

R_f = risk free rate

β_i = beta (sensitivity)

$E(R_m)$ = expected return of the market

This assumes that investors make investment decisions based on the riskiness of the investment and the return. Riskiness is measured by variance which is the volatility of a portfolio. Hence, the CAPM measures $E(R_i)$, which measures the cost of equity. This is where the majority of risk comes from for a startup since it is extremely volatile. The cost of equity to investors holds the larger weight on WACC. Most startups, don't have significant debt and hence, debt isn't the variable moving the risk parameters of an investment.

3.7. Data and Software Used

There are two main sources for primary data collection: qualitative and quantitative. The qualitative data doesn't involve any math calculations. The quantitative technique is used to analyze the data based on math and statistics. An NDA was signed to gather historic data and estimates for the business being analyzed. When quoted using expert advice or judgment for forecasts or probabilities is referring to estimates given by management based on their opinion on business growth going forward. This subjective in nature and is reliable due to it being managements best estimate based off of current ownerships understand of the business. Other estimates can be based off of mathematical formulation and industry expert's advice on distributions which will be specified in the research.

The qualitative data used was mainly from conversation with management, and industry professionals. This data represents more of the soft attributes that can't necessarily be represented in numbers but are significant in running a business. Some examples would be management expertise, company culture, ability to execute on milestones, and other soft metrics. The quantitative data used was historical financial statements, macro forecast, industry models, revenue estimates, multiples, cashflows, operating expense, bill of materials (BoM), and other relevant data points for business forecast. This data was received from the agtech startup directly with simulation distribution and generated data from expert judgement.

To make this decision tree Palisade tools suite was utilized, and @RISK to run the model. The simulations for the real option analysis (ROA) overlaying in decision tree's are integrated using these two software's. Both platforms are add-ins working through the excel interface. Monte Carlo is used to simulate data based off of distribution given by expert advice. Generated data for statistical breakdown is used to summarize the results and is created using excel functions to perform the analysis.

3.8. Summary

In this chapter, analysis was done on what are the current issues with VC modeling. Startups are not all created equal and each have their own risk portfolio. Startups have significant market, financial, and execution risk. Traditional valuation methods including DCF, multiples, scorecard, liquidation valuation, Monte Carlo, cost-to-duplicate, and others don't represent the true value of a startups due to the model's inflexibility for management to adjust their strategy. Management in startups have the ability to reallocate funding towards more profitable business segments which makes them more valuable than traditional methods would suggest. Than management can make the most informed decision based off of the most probable and profitable strategies.

Then by integrating risk using decision tree and integrating ROA, management can make the most informed decisions. Due to the nature of the venture capital a startups business plan can be easily mapped out due to the flexibility of uses with the decision tree. Inserting ROA into the tree is a natural way to value these growth decisions, and most accurately simulates real world similarities.

Finally understanding the underlying assumptions backed into these methodologies gives the model more validity in this study. There is a unique insight that have not yet been researched due to the low availability of data and lack of activity in VC. The record amount of activity in this space makes this an optimal time to do research on how startups make funding decisions. Each startup is unique and has its own assumptions, and this study provides a framework for founders, entrepreneurs, VCs, and other invested parties to make more informed decisions.

CHAPTER 4. AGTECH-STARTUP CASE STUDY

4.1. Introduction

This study has created a new framework for startups to analyze growth decision for VC series funding rounds. This is done by using decision tree's and integrating real options to analyze these funding decisions. The hypothesis is that founders can be more strategic in their funding decisions and the fastest growing strategy may not lead to the most optimal outcome. The expected value and CARA utility function are used to analyze the different funding decisions. The different maximization on certain variables like ownership, expected return, and expected weighted return were all analyzed to configure the best response management would choose depending on what variable they are trying to maximize. The idea is that traditional agtech VC series funding rounds that use the external-external-external (EEE) strategy may not be the best option for the startups, rather a strategic or internal funding decision may lead to a more optimal outcome. By having a better understanding of how funding is obtained, startups can make more informed decisions on what the best funding option is today with the information that is given. The key assumption is that a growing startup ultimately needs to take on new capital in order to grow the business.

The data has been both simulated using triangular distribution based off of expert advice and forecasted based on historic data and management input. The simulated data was used for the size of the series round raises, and the probability to receive funding. These both used a @RISK triangular distribution function to simulate the round sizes and probabilities given by expert advice. The forecasted data was based on management expectations on growth going forward and the probability are based on their expectations of achieving those milestones based on the information management knows today.

4.2. Model Overview

This model uses an agtech startups case study that operates in the digital technology and diagnostics sector. 27 scenario analyses are analyzed. This model assumes three options are offered per funding round with three funding rounds included (3^3 = 27), and are categorized in the following order: External (E), Internal (I), and Strategic (S). For example, if a startup chooses an external-external-external funding route, that would be (EEE), or external-internal-strategic (EIS). These categories represent funding opportunities from different financiers. An external and strategic route, the startup will need to sell equity. Equity is ownership of a business. Therefore, when startups sell equity to raise capital they are selling ownership. The external is selling equity to VCs, private equity, angles, and other investors. With a strategic a startup is selling equity to another business to gain value with partnering with another businesses network. For example, this could be a JV where an agtech digital software company partners with a market leader who will utilize their software. An internal round is non-dilutive capital. No equity is issued using these sources. Some examples are grants, debt, crowd funding, friends, family, and founders.

To analyze the real option value of this venture, the NPV was calculated for the projected cashflows and the expected investments. The initial investment is the PV of the series funding round investments. This assumes in the expansion option that the investors do not have the flexibility to reinvest over time, and that all three rounds of funding need to happen for a successful investment. Rather the sequential option values each funding round individually and sums them together. This means that investors don’t have to invest all their money today and can wait to invest until the startup provides better efficacy around set milestones. These are all measured using NPV.

$$NPV = \sum_{i=1}^{n} \frac{R_i}{(1+r)^t} - Initital\ Investment$$

Where the R_i is the net cash flow from this venture. The r is the discount rate of 15%, and t is 7-year duration of this venture. The initial investment is the PV cost of the series funding round investments. These cost for the series funding rounds can be seen in figure 4.1. A triangle distribution is used to project these cash raises. The reason this distribution is chosen is based off of management's expectations on the company's future cash needs for this venture. Each raise is based off the cost of achieving the set milestones in table 4.1. These milestones are subjective in nature and are more accurately represented using a distribution rather than a fixed assumption.

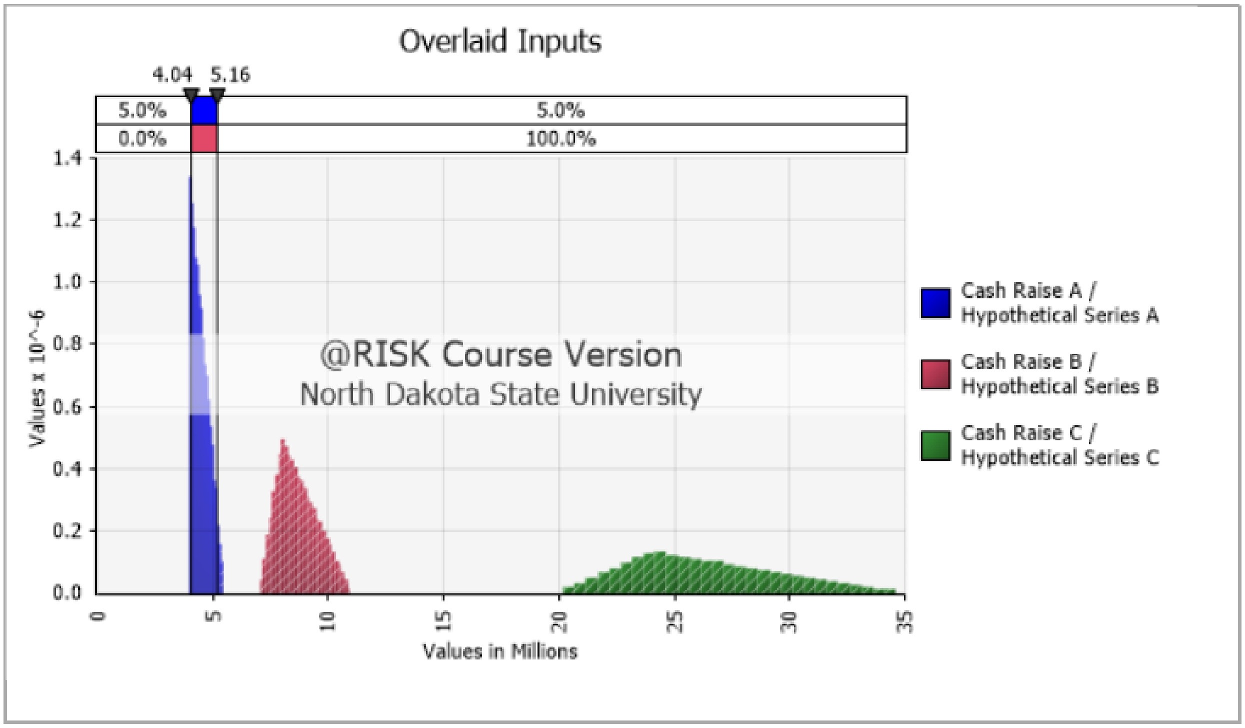
If these milestones are met the company will need to raise new capital to fund the next venture. This will come through the series funding rounds. To raise the series A round, the startup will have to operate in a large market, have a product idea, begin analyzing customer adoption strategy, have an experienced founding team, and is able to find an investor. This series A raise will happen in 2023, and the mean cash raise is $4,000,000.

To raise the series B, the startup will need to begin penetrating the market, have product market fit, have new protypes of the product, expand management, and be able to find an investor. The series B will happen in 2025, at a mean cash raise of $8,000,000.

To raise the series C, management will need to have rapid revenue expansion, grow internal operations, steal market share from current competitors, have strong balance sheet, and is able to find investors. This raise will happen in 2028 at a mean cash raise at $24,000,000.

Figure 4.1

Series Cash Raises Distribution



The distribution has a right skewedness because the startup would rather raise less cash than more so that they do not dilute themselves more than needed. If a venture takes longer to hit the milestones or the cost is greater than expected, the cash raise needed to fund the venture is greater. This could be due to raw material cost, labor, R&D, natural disaster, and black swan events such COVID-19. The more cash raised the greater the dilution. This makes representing this data on a spectrum more accurate because it simulates the real startups lifespan more appropriately. This model uses simulated data that is summarized using random and non-random inputs. These are all the flexible inputs that are fundamental in raising series funding rounds. The triangular distribution is chosen based on expert advice.

4.3. Data Types, Sources, and Distributions

The data was both simulated using Monte Carlo and forecasted using expert advice. Historic data was also collected for reference. This framework can be recreated to analyze other startups. However, different startups will have varying growth expectations and should be reassessed on a per company bases. Depending on the funding stage of a company, the growth expectations, and probabilities of accomplishing set milestones for the company going forward will all vary for each startup. The industry the company operates in and the ability of management to execute on business strategy will also bring a large amount of uncertainty that can only be measured using a case by case bases.

4.3.1. Sources

Historical financial audited statements were collected to analyze the startups financial positioning. Other variables such as terminal growth, WACC, revenue, and operating expenses were calculated using expert advice and management's expectations. These sources include speaking with management, and reading industry reports on the expected growth of the agtech digital/diagnostic sector.

Excel was used to run as the interface for running the underlying model. Two excel add-in were used to generate the simulated data, @RISK 8.2, and PrecisionTree 8.2. @RISK is used to run the Monte Carlo simulation. PrecisionTree is used to generate the decision tree. These two software packages can easily be integrated together to perform statistical analysis and analyze a data set. These two add-ins allow for risk and uncertainty to be better estimated. The PrecisionTree can accurately map out the funding rounds and @Risk can be used to incorporate simulated data to better analyze the subjective estimates management has given.

Conversation were held with management and founders of case study company to better understand business strategy and growth expectations going forward. Audited financial statements were received to estimate the growth expectations going forward and the strength of the company's financial positioning. Other data such as the risk-free rate is based off of the current US 10-year treasurer bond.

4.3.2. Base Case Description

The base case for this analysis is the EEE expansion option. This is the base case due to this being the primary way industry operates. Startups currently find outside investors using external sources. This can be seen in the whaling operations talked about in chapter two. To the industry reports analyzed in chapter one. The overlying pattern is that companies that onboard new capital often use external sources to fund these ventures. Although this is common in the past it does not fully appreciate the strategic proposition of the source of funding. The different sources bring inherit network effects that impact outcome and have varying tradeoffs. This is why it is important for agtech startups to better understand where their capital source comes from, and the benefits with partnering with these sources.

Each round of funding will give different probabilities of success and will differ depending on managements capacity to be able to execute on key business milestones. As seen in table 4.1, shows that selling equity to investors is the fastest way for a startup to grow. This is due to the network effect of partnering with other investors. However, by doing this, current shareholders are simultaneously losing control of the business. Comparatively, if you raise funds internally you do not dilute the current ownership but do not profit from the network effect of selling equity to a new investor(s) or strategic partner(s). This would inheritably lower the probability of accomplishing the set milestones. Also, depending on who the strategic is, it may also vary the probability of set milestones. See table 4.1 for the summarization of these milestones and the probabilities associated with them.

Table 4.1

Milestone Assumptions

Milestones	Probability External	Probability Internal	Probability Strategic	Definition
Market Size	1	1	1	Large addressable market size.
Product	0.9	0.9	0.9	Satisfy a need in society.
Customer Adoption	0.7	0.7	0.6	Product offers clear and tangible value proposition to customer.
Founding Team	0.8	0.8	0.8	Founder has industry experience and resources around him to be successful.
Finding Investor	0.90	0.90	0.05	What certainty of raising Funds in this category during this stage.
Probability of Raising Series A	0.45	0.45	0.02	
Market Penetration	0.7	0.6	0.7	Can enter a market and steal market share from current competitors.
Product Market Fit	0.8	0.9	0.9	Quantifiable value added.
Update Product	0.8	0.7	0.7	Make product more approachable for consumers.
Management Team	1	1	1	A management team that has strong competency and industry experience.
Finding Investor	0.97	0.96	0.06	What certainty of raising Funds in this category during this stage.
Probability of Raising Series B	0.44	0.36	0.03	
Rapid Initial Expansion	0.9	0.7	0.9	Growing geographically and financially.
Growing Internally	0.7	0.7	0.75	Onboarding new talent to improve product offering.
Market Share	0.8	0.6	0.8	Continue to increase market share and power.
Financial standing	0.8	0.7	0.7	Have strong liquidity pipelines for economic uncertainties.
Finding Investor	0.87	0.94	0.96	What certainty of raising Funds in this category during this stage.
Probability of Raising Series C	0.35	0.19	0.36	

This model has incorporated milestones that are based off of management's expectations on what items they need to accomplish to raise the next funding round. The probabilities associated with these milestones are based off management's expectations of being able to accomplish them. For milestone "finding investor" this shows management's expectations of the probability to be able to find financing within that category. For example, currently management does not see any opportunity to secure funding via a strategic investor. Hence, 0.05 is inputted in the milestone in that category due to the low probability. One problem with early stage companies is that it is often harder for them to find funding due to the company's unproven track record and low if any revenue. This means it will be more difficult to find financing from banks or other traditional debt issuers because the risk with funding startup is far greater then what the bank is willing to take. On the flip side, investors want to have optimal upside to hedge the risk they are taking on. Hence, they will want to argue for cheaper equity which can dilute founders more quickly. This is the cornerstone of this research project. By better knowing these probabilities entrepreneurs will be able to make more informed and better funding decisions based off their confidence of finding funding from these different investors/funding partners.

The milestones were selected by management as the most important variables to prove company efficacy with investors. These milestones will change depending on the startup and industry the startup is participating in. Founders should adequately analyze this table to make the most informed decisions based off of what they need to do today to get funding tomorrow. It is important to note that the probabilities associated with the milestones are subjective in nature and should be analyzed under a spectrum of possibilities and not fixed probability. This is why a triangular distribution was used to better understand the relationship with funding routes and the probabilities assigned to this route. The ultimate marker of a successful business will be raising three funding rounds. The probability of the startup being successful is multiplying the probabilities of raising these three funding rounds together

4.3.3. Monte Carlo and Distribution

A triangular distribution is used to estimate the round sizes and probabilities of raising the next funding round. When a startup raises a funding round the cash raise is based off the cash needs of the startup to fund its future venture. These venture costs can vary depending on size of the venture, duration, cost associated to labor and materials. Therefore, there is uncertainty on how much cash is needed to fund this project depending on these variables. The mean raise is based on management's expectations on the cost of the next venture. The low is based off of the lowest expected cost to fund that venture, and the max is the highest potential cost of the venture. This will vary each round and should increase as companies grow a raise later stage rounds like B and C series. The higher the round the more equity needs to be sold. This is why management does not want to raise more than the amount of funds needed and dilute themselves more than necessary. The finding investors milestone uses triangular distribution because there is not an exact degree of certainty on whether there will be funding opportunities in each category. This can be seen in table 4.1. The mean probability is management's expectations on finding funding using this category. The low and max are the minimum and maximum probabilities of finding an funding option using these categories for each round. This will differ for each series funding round depending on what category is used to fund the venture. The distribution of the probability of finding investors can be seen in table 4.2.

Table 4.2

Input Distribution Summary

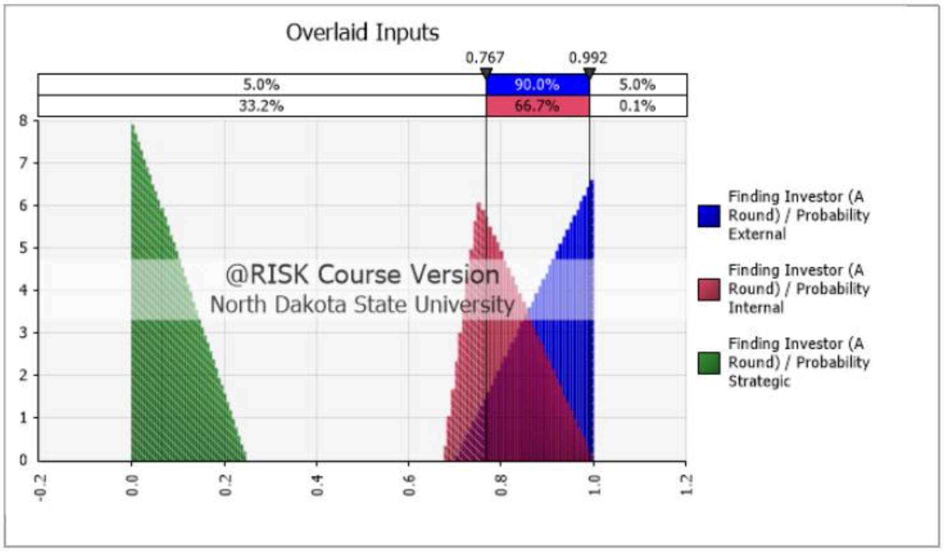
Model Input	Mean	Min	Max	Source
Finding Investor Series A External	1.000	0.700	1.000	Management
Finding Investor Series A Internal	1.000	0.675	0.750	Management
Finding Investor Series A Strategic	0.250	0.000	0.000	Management
Finding Investor Series B External	1.000	0.800	1.000	Management
Finding Investor Series B Internal	1.000	0.800	1.000	Management
Finding Investor Series B Strategic	0.500	0.000	0.000	Management
Finding Investor Series C External	1.000	0.800	1.000	Management
Finding Investor Series C Internal	1.000	0.900	1.000	Management
Finding Investor Series C Strategic	1.000	0.900	1.000	Management

These distributions were run using Monte Carlo for 10,000 iterations. The variables show the probability of finding funding using these categories in each series round. Even if all milestones are met, a funding option may not be available for the startup to utilize. These are forward looking estimates that are better utilized using a spectrum of possibilities due to the uncertainty of these variables. The parameters are based on management best estimate today on the information they have.

The series A finding an investor can be seen in figure 4.2 for each category. The management currently has very low expectations on their being a strategic funding option at this point in the startup’s life. However, the external has the highest probability of finding an investor.

Figure 4.2

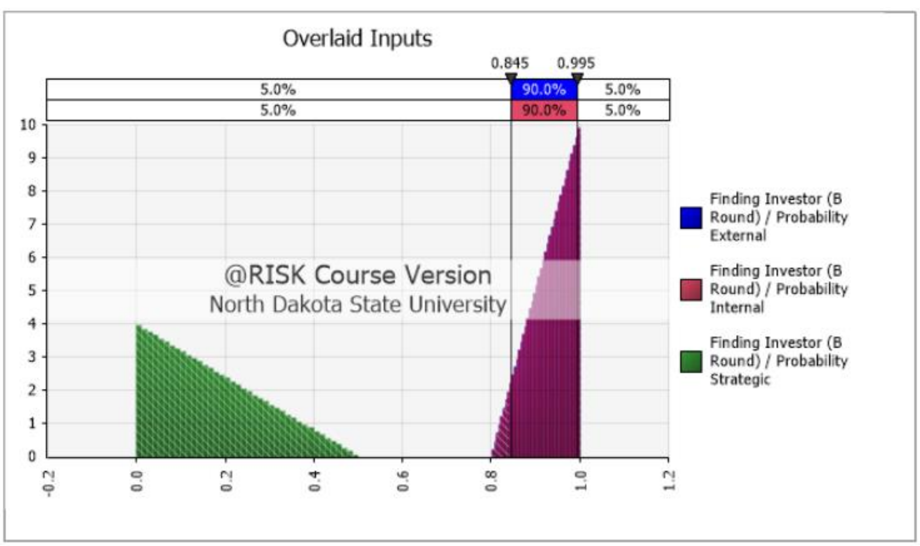
Series A Finding Investors Milestone Distribution



The series B finding an investor can be seen in figure 4.3 for each category. The management currently has very low expectations on their being a strategic funding option. The external and internal have the same probabilities.

Figure 4.3

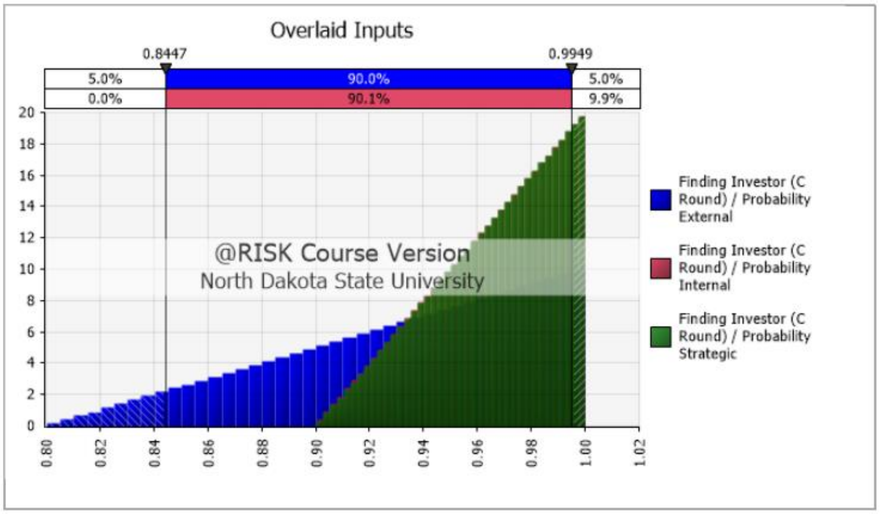
Series B Finding Investors Milestone Distribution



The series C finding an investor can be seen in figure 4.4 for each category. The management currently has very high expectations on their being a funding option in this stage of the startup. The strategic and internal have the same probabilities.

Figure 4.4

Series C Finding Investors Milestone Distribution



4.3.4. Random Inputs

The data for the random inputs generated for this model are used for the variables that are exogenous to the company. These variables are generated randomly in this model using Monte Carlo. These variables have their own parameters dependent on outside factors. This means managements expertise has little impact on the outcome of these variables. These variables are fundamental in a company ability to raise funding rounds. Every startup will have different variables that should be included on a case by case basis. The framework can be recreated and adjusted to help improve the efficacy of the outcome for each startup. The random variables are summarized in table 4.3.

Table 4.3

Random Variable Input Table

Model Input	Mean	Min	Max	Source
Cash Raise Size A	$4,000,000	$4,000,000	$5,000,000	Management
Cash Raise Size B	$8,000,000	$8,000,000	$11,000,000	Management
Cash Raise Size C	$24,000,000	$24,000,000	$35,000,000	Management
Probability of Raising Series A External	0.45360	0.35365	0.50399	Expert Judgement
Probability of Raising Series A Internal	0.40740	0.34071	0.50355	Expert Judgement
Probability of Raising Series A Strategic	0.03600	0.00002	0.10765	Expert Judgement
Probability of Raising Series B External	0.41813	0.35898	0.447999	Expert Judgement
Probability of Raising Series B Internal	0.35280	0.30273	0.377999	Expert Judgement
Probability of Raising Series B Strategic	0.07350	0.00000	0.21958	Expert Judgement
Probability of Raising Series C External	0.37632	0.32326	0.403199	Expert Judgement
Probability of Raising Series C Internal	0.19894	0.18534	0.205800	Expert Judgement
Probability of Raising Series C Strategic	0.36540	0.34051	0.377999	Expert Judgement

These random variables are generated using Monte Carlo with 10,000 iterations to estimate the data. The parameters are based off of management and expert advice. Management are the current founders who are running this startup. They would be the ones most informed on the cost of the venture going forward. The expert advice is management and industry advisors who have years of experience with raising series funding rounds. These assumptions are most similar to real life when simulated using this framework.

4.3.5. Non-Random Inputs

The non-random inputs are the endogenous variables in the model. These are inputs that are non-random values for the base case. These variables are determined by management based on the information they know today. This would be the expected earnings the company is planning to generate. Also, the years that funding is raised in and the pre-money valuation. These non-random inputs can be seen in table 4.4.

Table 4.4

Non-Random Input Table

Model Input	Value	Unit	Source
Series A Pre-Money Valuation	$15,000,000	USD ($)	Management
Series B Pre-Money Valuation	$60,000,000	USD ($)	Management
Series C Pre-Money Valuation	$150,000,000	USD ($)	Management
Series A New Shares Issued	2,133	Number	Formula
Series B New Shares Issued	1,408	Number	Formula
Series C New Shares Issued	1,851	Number	Formula
Series A Funding Year	2023	Date	Management
Series B Funding Year	2025	Date	Management
Series C Funding Year	2028	Date	Management
Revenue 2022	$12.500	$(M)	Forecast
Revenue 2028	$52.500	$(M)	Forecast
Free Cash Flow 2022	$1.979	$(M)	Forecast
Free Cash Flow 2028	$9.633	$(M)	Forecast

The pre-money valuation is management expectations the business is worth. These numbers based in what management believes the company is worth at that point in time. The higher the pre-money valuation, the less number of shares need to be sold to raise the series funding round. This will lead to less dilution. Traditionally these pre-money valuation rounds are estimated using the venture capital approach. Shares issued are based on the average cash raise and pre-money valuation. The share number will change depending on the size of the cash raise in the round. As the cash raise increases the number of newly issued shares will increase. Formula can be seen below.

$$\#\ of\ Issued\ Shares = \frac{Cash\ Raise\ in\ Series\ Round}{PreMoney\ Price\ per\ Share}$$

Ultimately the startup will be more valuable the greater the earnings are and the expectations for the company. The earning can be both the current and projected earnings that startup generates. Different companies will have higher expectations depending on the industry it operates in. A tech company trades at higher value according to the P/E ratio compared to industrial companies. The higher the multiple the greater the valuation the company can trade at.

4.3.6. Assumptions

The model is forecasted 7 years in the future. A WACC of 15% is used with a terminal growth rate of 3%. The WACC is based off the calculated weighted cost of equity and cost of debt. The terminal growth rate is based off current industry trends, and assumes that the digital agtech sector will grow at 3% indefinitely. See table 4.2 for more details. The key assumption for this model is that for the subjective data such as forecasted financial data, and milestone probabilities, are given with management's best guesses today based on the information they know about the future.

Table 4.5

Fixed Input Parameters

Parameter	Value	Source	Comments
Risk Free Rate	2.78%	FRED	Based on the 10-year treasury yield Nov 8th 2022.
Discount Rate	15.0%	Calculated, Bloomberg, and Macrotrends	Cost of equity based of public agtech volatility and expert advice.
Terminal Growth	3.0%	Macrotrends	Industry reports for agtech sector and expert advice.

4.4. Real Option Analysis

The expansion option is used as the base case. The expansion option is the option for a firm to purchase a real asset to expand it's operation. For example, the expansion option can be used for a new product line, or a firm entering into a new market. The next option is the sequential option. This is when staged options are dependent on the options preceding it. In this analysis, the option preceding it is the successful series raise of the A, B, and C rounds. For example, the sequential option assumes a series A raise is needed before a series B and C round. Hence, a sequential option provides a risk adjusted return on the assumption that a successful previous funding round was raised. If a round is raised the company has proven out product efficacy and set milestones which makes it a new adjusted valuation. The value of this option is derived from value of waiting to invest based on the information you will know in the future. Rather than the expansion option that assumes a successful investment is raising 3 funding rounds. The sequential option gives the owner the right not to invest if the company doesn't achieve all their milestones. This will provide additional insights on how management should strategically think about series funding rounds. All startups need to raise funding to grow the business and no methodology exist on which funding route you should take. This model can be applied to all types of startups and will vary on a case by case basis.

This section is broken down into two categories: expansion option and sequential option. These sections will discuss the calculation of the real options and the positives and negatives of using these methodologies. Each provide their own insights and novel information into funding rounds. This empirical model provides new novel insights of real options use in value startup funding decisions in the literature. By better understanding the mechanics of how a startup raises a series funding round, the real option analysis can simulate the most realistic model to map out these decisions.

4.4.1. Expansion Option

This expansion option is valued using the net-present-value of the venture. The expected probability success is the cumulative probability of raising three series funding rounds. Each round is multiplied by the probability of raising the previous funding round.

$$Expand\ Option = NPV\ Venture\ Cash\ Flow\ *\ \text{Expected Probability of Success}$$

This model uses the free cash flow the venture has forecasted to generate the duration of the venture. In the 7-year forecast this option assumes three funding rounds are raised. These rounds are calculated back to PV and subtracted from the generated cash flows. The higher the option value the more valuable the funding strategy is. Hence, the highest grossing strategy may not be the best strategy for management. If one funding route generates higher venture cash flow but has a lower expected probability of success, it would be in the favor of shareholders for the company to pick the strategy with the highest expected value out of all the options. See table 4.6 for option input details.

Table 4.6

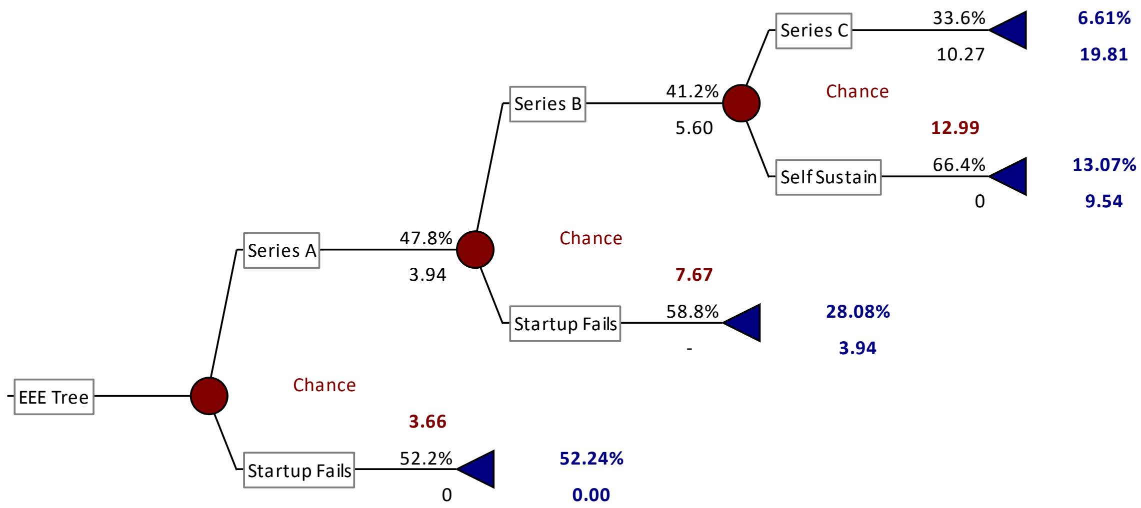
Expansion Option Variables

Variables	Notation	Explanation	Model Input
Cash Flow of Venture	S	Cash generated from the venture.	Mean Cashflow
Investment (Cost)	K	The sum of series cash raises.	Mean Cash Raises
Volatility	σ	The variance of NPV of venture.	Mean Volatility
Time	T	Duration of venture is 7 years.	7
Risk Free Rate	r_f	10-year U.S. treasury yield.	2.78

The EEE strategy will be analyzed to illustrate the function of the branches of the master tree. The is used to demonstrate how the branches of the tree work. Each one of the 27 scenario have their own branch and are summarized in the results in chapter 5. See figure 4.5 for the EEE tree branch.

Figure 4.5

Tree Branch EEE Option

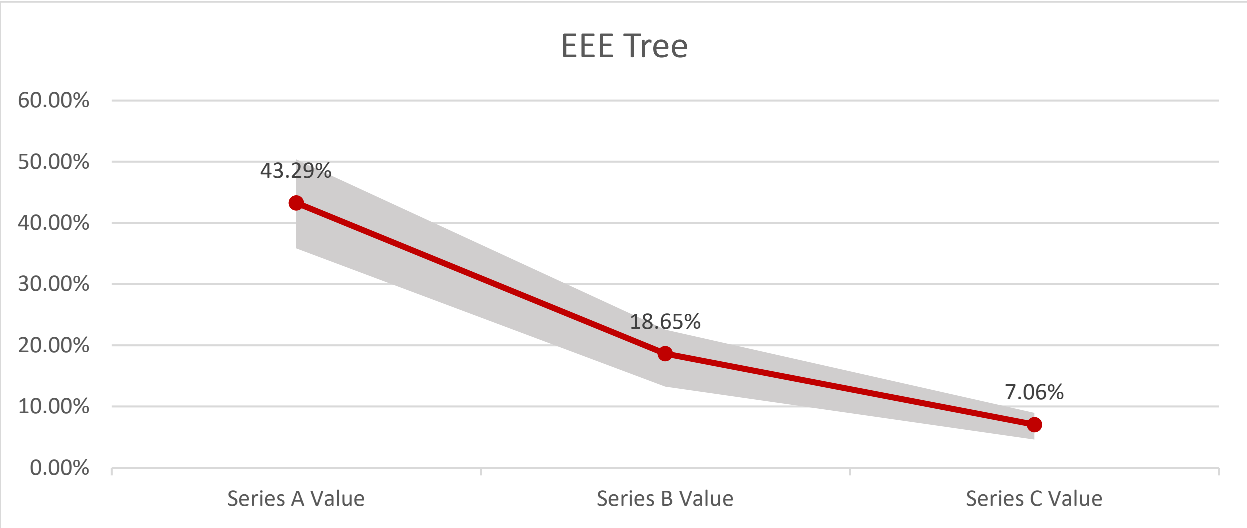


In this iteration of the EEE strategy it assumes that the probability of success is 6.61%. The 19.81 is the cumulative NPV of the cashflow from the venture. This mean the startup has an 80.32% of failure. Even if the business does not raise all three series funding rounds, it still can have residual value. Hence if the startup raises the first 2 rounds and doesn't raise a series C, there is a 13.07% chance of the business being self-sustained. This means it can operate without the need of raising another cash raise. Each branch has its own probabilities and cash flows attached to it. The CARA coefficient is used with an exponential utility function based on the expected value of the venture. This is imbedded in Precession-tree and @RISK. The CARA utility value of this branch is 3.66.

The probability of success is summarized in figure 4.7. Each branch has its own probability based on table 4.1. The strategy with the highest probability of success may not lead to the ideal outcome if the NPV of the venture has lower returning cash flows.

Figure 4.6

Tree Branch EEE Probability of Success Curve



4.4.2. Sequential Option

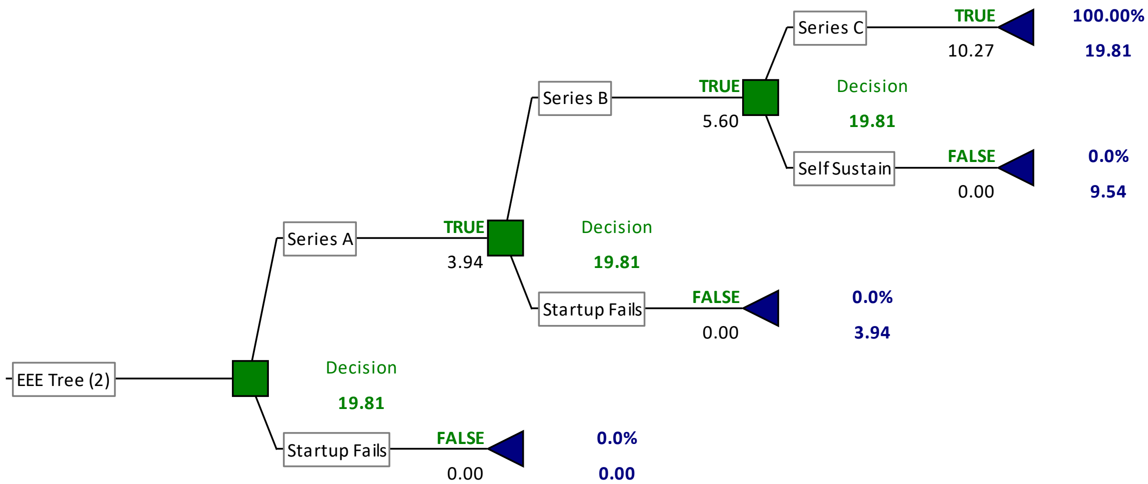
The sequential option is cumulative values of the real option embedded in it. Unlike the expand option, the sequential option assumes each funding round is its own option. These options are the NPV of the venture for each round. Rather the expansion option assumes 3 rounds in each option, this takes each round individually. The weighted probability of success is the probability of raising each funding round. This can be seen in table 4.1. That means you are taking the NPV of the venture multiplied by the probability of raising that series round. See formula below.

$$Sequential\ Option = NPV\ Venture\ Cash\ Flow\ * Weighted\ Probability\ of\ success$$

Each tree branch for this option will have its own probabilities and cash flow. Hence, the assumption of a successful business is still raising three series funding rounds, but using a sequential option assumes that the cost of the investment is not fixed. Rather founders, VCs and other investors can better analyze a startup by understanding the mechanics of how industry works. Traditional growth methods have not given the real option call nature inherit in traditional startups life cycle. The sequential option can be seen in figure 4.8.

Figure 4.7

Tree Branch EEE



The key value that comes from the sequential option is that is assumes that money does not have to be invested if the startup does not hit their milestones. Rather if the forecast for the startup is bearish the investment is not fixed. The expansion option assumes investments are fixed. This real option replicates real life more appropriately due to time value of a startup's life. Due to the high changing nature of startup and inconsistent earnings it makes investing in these businesses highly uncertain. Overtime, a startup will have a risk adjusted return on capital as new series rounds are raised and new information is learned.

Table 4.7

Sequential Option Variables

Variables	Notation	Explanation	Model Input
Cash Flow of Venture	S_x	Cash generated from the series round.	Mean Cashflow
Investment (Cost)	K_x	The sum of series cash raises.	Mean Cash Raises
Volatility	σ	The variance of NPV of venture.	Mean Volatility
Time	T	Duration of venture is 7 years.	7
Risk Free Rate	r_f	10-year U.S. treasury yield.	2.78

The S_x is the cash generated by each series round. This is broken into the three funding rounds. The cash generated by the series A, B, and C rounds. K_x is the mean cash raises in 2023, 2025 and 2028 for the series A, B, and C rounds respectively. The series A is the cash generated in 2022 to 2023. The series B is the cash generated in 2024 to 2025. The series is the cash generated in 2026 to 2028.

4.5. Decision Analysis with CARA Utility Function

The CARA coefficient is used with an exponential utility function based on the expected value of the venture. This is imbedded in Precession-tree and @RISK. The CARA utility value used to analyze the risks present in an investment in which the selected outcome is the expected utility is maximized. This is valuable because it allows management to select the best capital raising strategy given their risk preference.

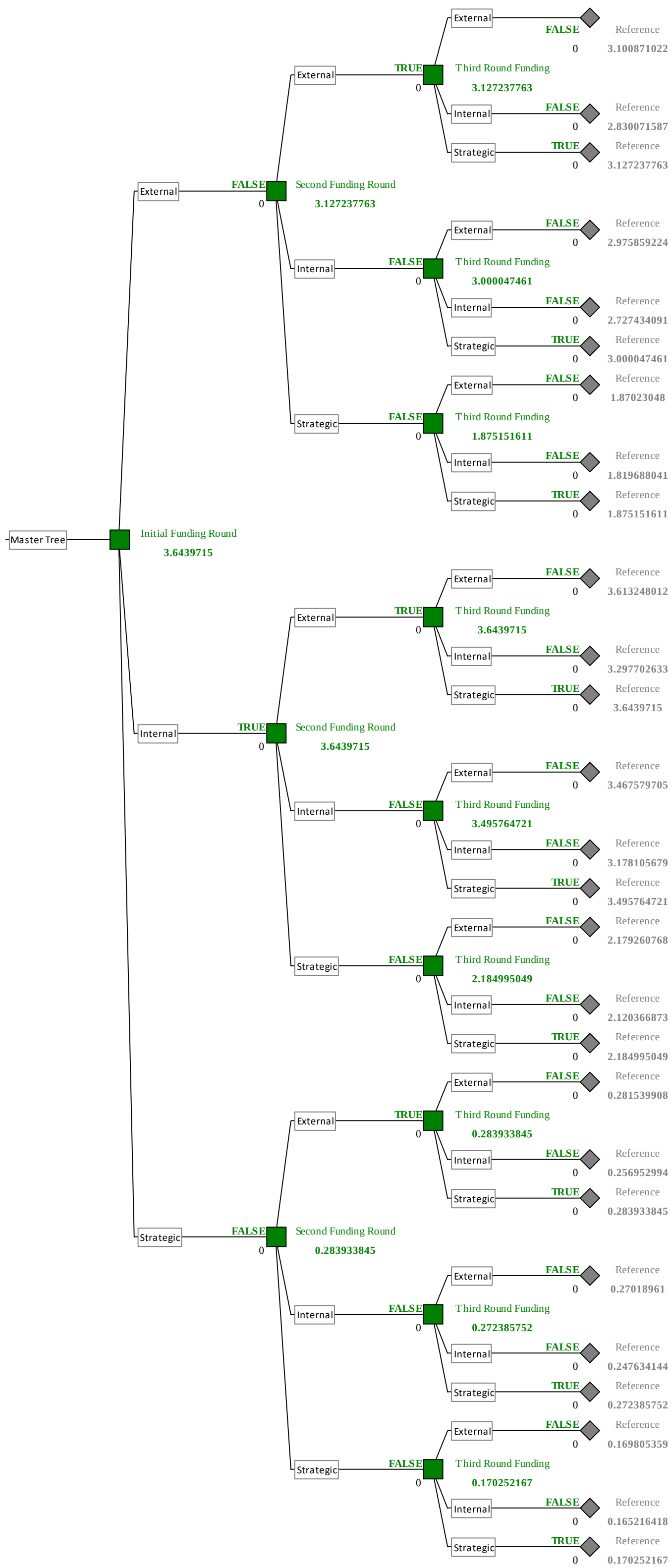
When structuring this analysis, a decision tree is incorporated to map out the 7-year venture of an agtech startup. A decision tree is used as a support tool that creates a tree model to map out decisions for chance-based outcomes. The outcome is the probability of the startup to be successful. Success is defined as raising all 3 funding rounds. If a company can raise a series A and B round but doesn’t raise a C round they are referenced to as self-sustained. Self-sustained business may have some monetary value or salvage value at this point of the startup life. This could be the value of the intellectual property (IP) the company has created, or the book value of the raw materials and assets the company owns. After a successful series B it is possible for the company to be self-sustaining and not need to raise another round of funding. However, the opposite is also possible. This model analyzes the successful business strategy and does not do any further research on the company post series B round with no additional raise(s). This is important because some startups don’t need to raise a series C unless it is optimal for their outcome. This can be further researched and analyzed to better understand the dynamic of company funding and business strategy.

On this tree there are 27 different branches each representing a different funding scenario. This analysis will look at the payoffs of each branch. The best payoff of the tree is determined by the highest expected value of the option. The expected value is the expected future cashflow of the venture multiplied by the expected probability of success. The highest cash flowing strategy may not be the most optimal outcome if the probability of success is too low. Rather the expected value considers both the NPV of the venture and the weighted probability of receiving those cashflows. This is essentially a mean variance framework. If an outcome leads to a similar return but one venture has less risk than the other, the venture with less risk will be preferred. Similarly, the less uncertainty around the venture the more preferred an outcome is compared to similar returning venture.

Each branch is projected independently in different tabs in the excel. A master tree is created to consolidate the data and results. This tree can be seen in figure 4.5. This figure shows the 27 different funding strategies and which decision the ownership should make. This decision is based on the highest returning expected value strategy for the startup. However, the founder will be most persuaded by the strategy that grosses them the highest returning route. This is calculated by taking the expected value multiplied by the founder’s ownership. Of course, ownership will vary depending on how funding was raised. If raising all external and strategic rounds the founder will be most diluted. This might make the founder financially disincentivized to execute on this business due to the non-optimal financial upside. On the other hand, internal rounds may bring a high enough expected value to be worth the decision.

Figure 4.8

Master Tree



4.6. Summary

The highest expected value may not be the most optimal outcome based on what the management is trying to maximize. If the goal is to minimize dilution then internal rounds are going to be more favorable then external or strategic. The expand and sequential options offer new insights into what founding routes management should take. Ultimately these strategies are based on the expected value of the CARA utility function. The flexible nature of VC financing is better represented using a call option methodology. The natural staging of VC agtech funding provides the perfect replication of a real asset call option.

CHAPTER 5. RESULTS

5.1. Overview

This chapter describes the results from the empirical model discussed in the previous chapter. The optimal strategy will be analyzed using the Monte Carlo and sensitivity analysis to provide novel insights into funding options that startups face. The base case is analyzed first to discuss initial results and provide a foundation for comparison. Both a description and key takeaways of the most significant variables will be discussed. Next the statistical analysis was run to analyze the 27 different scenarios for each expansion and sequential option. Then sensitivities are analyzed for the random and non-random variables to understand the impact on the optimal growth strategy. All results are displayed using tabular and/or graphical structure and are discussed to provide full insight from the analysis.

5.2. Detailed Base Case Model Results

The base case is the expansion option. An in-depth analysis is done using this scenario to provide the fundamental back drop necessary for analyzing the empirical model. The key assumptions and results are explored using graphs and figures. The overview of all scenarios will be analyzed in the expansion and sequential option section in 5.3 and 5.4.

5.2.1. Base Case Definition and Assumptions

The expansion option is used as the primary vehicle to analyze these funding rounds. The key assumption is that three funding rounds are needed to have a successful startup. The round sizes are estimated using a triangular distribution based on management's expectations. Each expansion option has its own probability of success and its own inherit tradeoffs. The primary tradeoff that is analyzed is the dilution of ownership with every external and strategic funding round. The highest returning strategy may not be the optimal outcome if the tradeoffs are greater than the return of the network effect of partnering with investors. If the equity issued dilutes current ownership more than necessary, management may not be financial incentivized. This can ultimately lead to underperformance of the startup and actually decrease the probability of success.

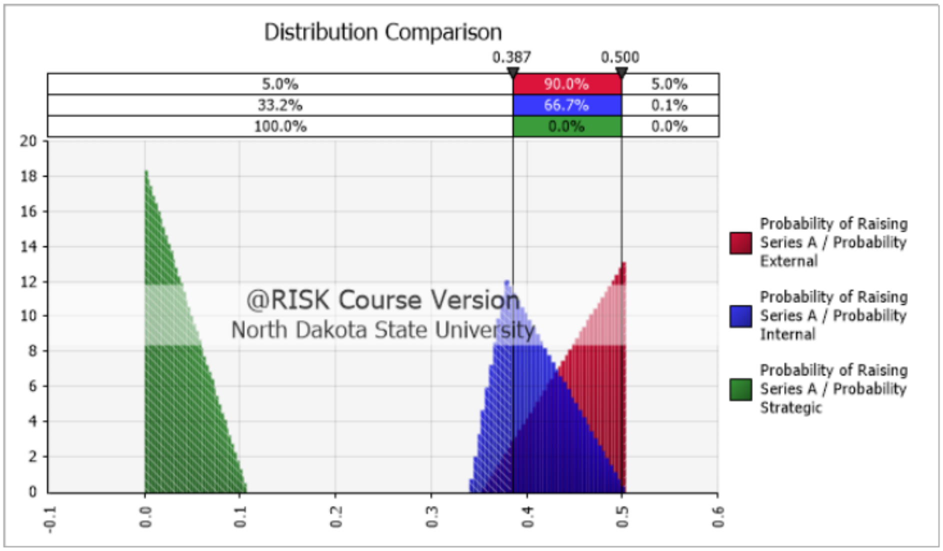
There are random and non-random data points that are generated using Monte Carlo. These random variables are the size of the series funding rounds and the probabilities of raising the series for each category. The non-random variables are the pre-money valuation, shares issued, funding year, and earning generated. The base case assumes that the cost of the venture is the present value of the cash raises. The value of the venture is the present value of the forecasted cashflows. The NPV takes the value of the venture minus the cost. The expected value is the NPV of the venture multiplied by the probability of the success.

5.2.2. Base Case Results

Each funding category has its own probability of raising funds. These probabilities are based on management's expectations of completing set milestones. These are the milestones discussed in chapter four and displayed in table 4.1. The results of raising these funds are the probabilities of multiply each milestone by its respective probability. Each distribution can be seen in the figures below. Figure 5.1 shows the probability of raising a series A. This figure shows that the external and internal funding round have a higher probability then a strategic funding route. This is due to managements low expectations to be able to find a strategic investor at this stage of the startup. This is logical due to strategic partners not wanting to partner with the startups at this stage due to unproven track record and product efficacy. The external probability is the favored outcome over the internal the majority of the time. However, the internal if funding is available may be favored over the external so that non-dilution happens. If management selects internal funding strategy they will not benefit from the network effect of partnering with investors. The mean size of the series A round is $4,000,000. The distribution for the probability of raising the series A round can be seen in table 5.3.

Figure 5.1

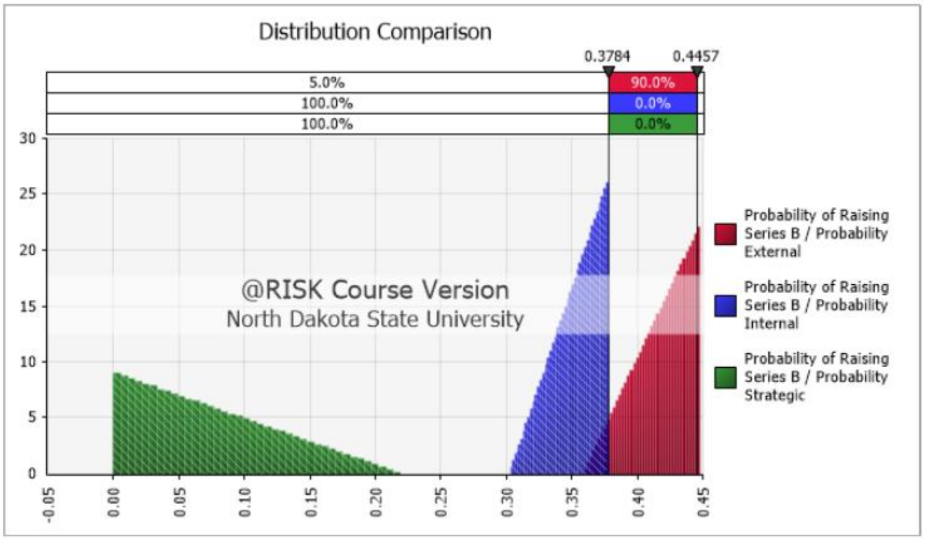
Probability of Raising Series A



The series B funding round has a similar outcome as the series A. The strategic funding option has the lowest probability. However, management expects a higher potential for partnering with strategic investors compared to the first round. The external round has the highest probability and will be preferred on the majority of the time due to it having the greatest chance of being able to receive funding. The mean size of the series B round is $8,000,000. The distribution can be seen in figure 5.2.

Figure 5.2

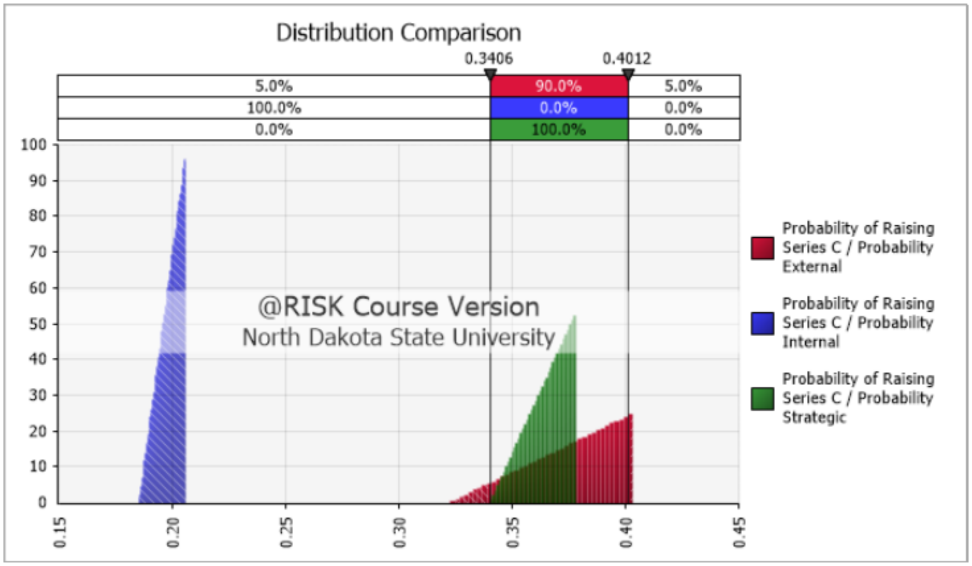
Probability of Raising Series B



The series C funding round favors external and strategic funding options rather than internal. At this stage of the company management expects for them to be at an optimal growth stage to partner with investors and strategic partners. At this stage the equity will not be as cheap compared to the series A and B rounds. This is due to the risk adjusted return of the startup at this stage. The company will have proven revenue record, high product efficacy, market share, and track record on managements ability to execute on business strategy. This will increase the probability of external or strategic partners willingness to partner with the startup. The internal round has a low probability due to unlikely being able to obtain the amount of funding they are looking for through the non-dilutive sources. If the series C funding round has a lower cash raise then anticipated it would have a higher probability to be able to raise all the funding internally. The Series C round has a mean value of $24,000,000. Currently management doesn't foresee a high probability to find a bank or grants large enough to fund this amount of money required for this round. The distribution for the probability of raising a series C can be seen in figure 5.3.

Figure 5.3

Probability of Raising Series C

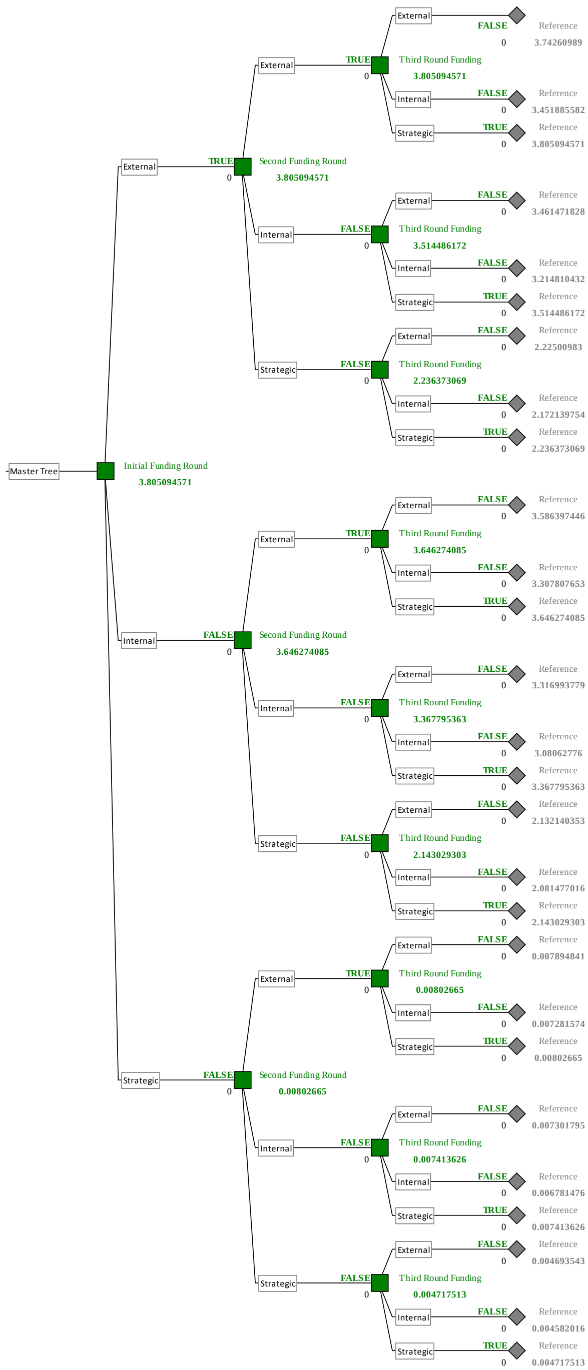


The CARA coefficient is used to analyze the most optimal strategy. The CARA uses the expected value of the real expansion option to value these decisions. This was overlaid in a decision tree using PrecisionTree 8.2. These results can be seen in the master tree in figure 5.4. The CARA coefficient considers the decision makers risk tolerance level. The empirical model assumes a highly risk tolerant decision maker. This uses an exponential formula for the utility function. The master tree displays the expected value.

The optimal strategy according to the CARA coefficient of the base case is EES. This is the optimal strategy for the expansion and sequential option. This means the startup should raise a series A and B with external funding sources. Then in the series C round a strategic partner. This creates the optimal payoff for the risk tolerant investor. Most investors, founders, entrepreneurs and management in the agtech startup space are risk tolerant due to the nature of VC in this space.

Figure 5.4

Master Tree Overview



	Founder 1 Ownership (%)	Expected Value: Expand Option ($M)	Expected Value: Sequential Option ($M)
EEE	16.24%	$0.20	$1.14
EEI	18.87%	$0.12	$0.98
EES	16.24%	$0.21	$1.17
EIE	18.10%	$0.17	$1.07
EII	21.43%	$0.10	$0.92
EIS	18.10%	$0.18	$1.11
ESE	16.24%	$0.04	$0.81
ESI	18.87%	$0.02	$0.65
ESS	16.24%	$0.04	$0.84
IEE	19.50%	$0.19	$1.12
IEI	23.42%	$0.11	$0.97
IES	19.50%	$0.20	$1.15
IIE	22.24%	$0.16	$1.06
III	27.50%	$0.09	$0.90
IIS	22.24%	$0.17	$1.09
ISE	19.50%	$0.03	$0.79
ISI	23.42%	$0.02	$0.64
ISS	19.50%	$0.04	$0.83
SEE	16.24%	$0.00	$0.79
SEI	18.87%	$0.00	$0.63
SES	16.24%	$0.00	$0.82
SIE	18.10%	$0.00	$0.72
SII	21.43%	$0.00	$0.57
SIS	18.10%	$0.00	$0.76
SSE	16.24%	$0.00	$0.46
SSI	18.87%	$0.00	$0.30
SSS	16.24%	$0.00	$0.49
Max	27.50%	$0.21	$1.17
Min	16.24%	$0.00	$0.30

5.3. Expansion Option

The expansion option results are summarized in table 5.1. This table shows that the highest expected value of the expansion option is the EEE strategy. The expected value is $110,866. This is calculated by taking the expected NPV of the venture multiplied by the probability of success. Hence the NPV of this venture using the EEE strategy is $1,553,180 and the probability of success is 7.138%. The mean probability of success can be interpreted as the startups likelihood of raising three series funding rounds. This follows the assumption listed in chapter 4 that a successful startup will have raised three rounds of funding. That means according to the probabilities listed in table 5.1, this startup has a 7.138% chance of being successful. This is one reason why VC is considered highly risky. This space is for experienced investors who are willing to take on the added risk in promise for asymmetric upside potential.

Table 5.1

Average Value of Expansion Option

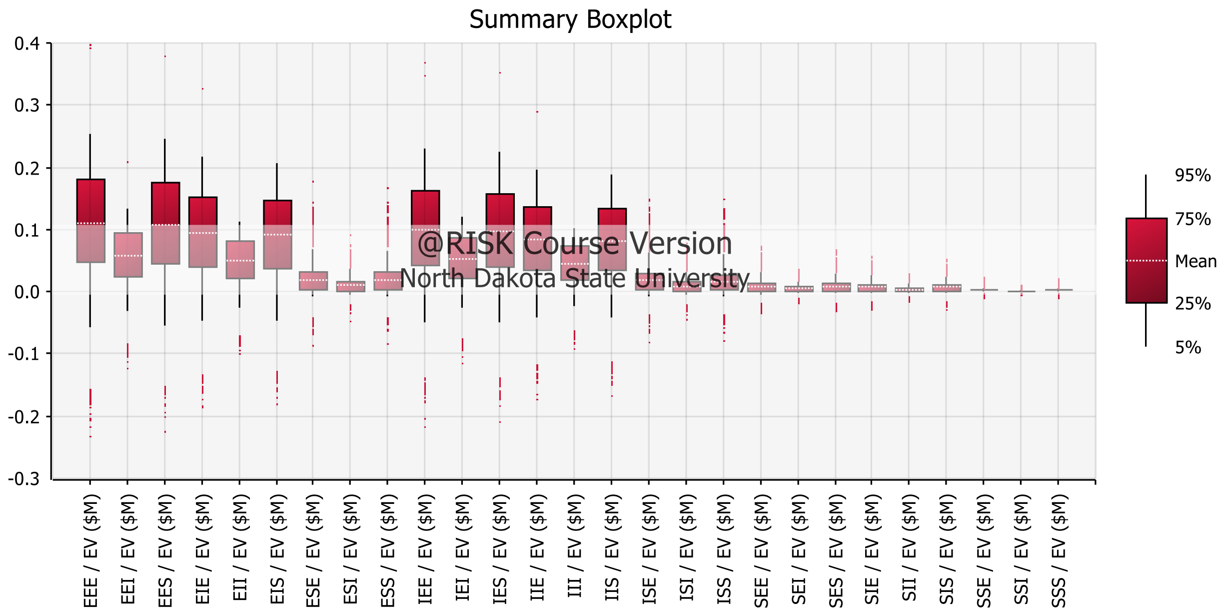
Funding Rounds	Probability of Success	NPV ($M)	EV ($M)	Ownership
EEE	7.138%	1.552	0.111	15.2%
EEI	3.773%	1.552	0.059	17.9%
EES	6.931%	1.552	0.108	15.2%
EIE	6.022%	1.552	0.094	17.1%
EII	3.184%	1.552	0.049	20.6%
EIS	5.848%	1.552	0.091	17.1%
ESE	1.253%	1.552	0.020	15.2%
ESI	6.225%	1.552	0.010	17.9%
ESS	1.218%	1.552	0.019	15.2%
IEE	6.411%	1.552	0.100	18.5%
IEI	3.389%	1.552	0.053	22.9%
IES	4.925%	1.552	0.097	18.6%
IIE	5.409%	1.552	0.084	21.5%
III	2.859%	1.552	0.044	27.5%
IIS	5.252%	1.552	0.082	21.5%
ISE	1.127%	1.552	0.018	18.6%
ISI	0.596%	1.552	0.009	22.9%
ISS	1.095%	1.552	0.017	18.6%
SEE	0.567%	1.552	0.009	15.2%
SEI	0.299%	1.552	0.005	17.9%
SES	0.550%	1.552	0.009	15.2%
SIE	0.478%	1.552	0.007	17.1%
SII	0.253%	1.552	0.004	20.6%
SIS	0.464%	1.552	0.007	17.1%
SSE	0.099%	1.552	0.002	15.2%
SSI	0.053%	1.552	0.001	17.9%
SSS	0.097%	1.552	0.001	15.2%
Max	7.14%	1.552	0.111	27.50%
75th Percentile	5.41%	1.552	0.084	20.60%
Mean	**2.80%**	**1.552**	**0.041**	**18.27%**
Median	**1.25%**	**1.552**	**0.019**	**17.90%**
25th Percentile	5.41%	1.552	0.084	20.60%
Min	0.05%	1.552	0.001	15.20%

In this data some trends can be observed to better analyze what funding strategy the startup should take. First, the strategy’s that has a higher probability of success will have a greater option value. Why this is important is because it stresses the importance of the network effect that raising series funding rounds can have on a startup. Although the startup is being more diluted this way, the management team is compensated with a greater probability of success. In this scenario the founders are maximum diluted to roughly 15.2% using the EEE strategy. Rather the minimum dilution strategy would come from the III route which keeps the founder's ownership at 27.5%, with a probability of success of 2.859% on average. This gives an expansion option value of $44,000. This means the network effect of the EEE strategy is generating an alpha of 4.3% higher chance of being successful, and adds $67,000 to the expected value of the option. This is a way for management to quantify the effect of partnering with the most optimal sources. Of course, the probabilities for success for most startups are still very low. According to the Small Business Administration (SBA), the United States Small Business Profile, 2020 report estimated that 90% of startups fail (Bryant, 2020). This is not specific trend in agtech startups but can be used as a proxy for how the VC investment space operates.

The assumption of the expansion option assumes that three funding rounds have accrued there are fixed cost, it has a symmetric return on the NPV of the venture. This is due to startups not being able to take the risk adjusted valuation of the venture and reinvest at favorable opportunities as it is presented. An investor would reinvest if the company has shown strong growth, and validated its listed set milestones. This is what the sequential option allows for. See figure 5.5 for the expansion option results.

Figure 5.5

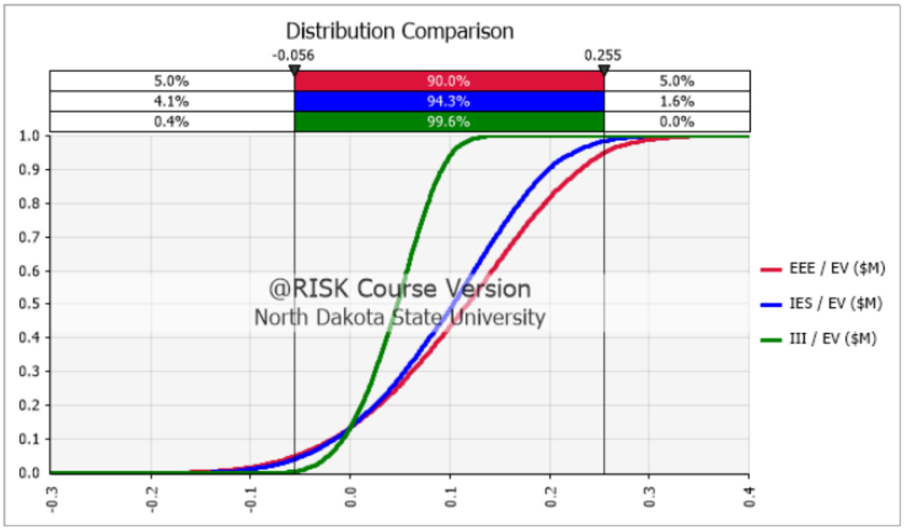
Expand Option Boxplot



Let's breakdown this analysis further to better understand the insights of the different growth decisions. Three distributions will be analyzed. The red strategy is EEE, the blue strategy is IES, and the green strategy is III. These will each provide management unique insights into the funding sources they partner with. All options are tracking the same venture with fixed cost and risk assumption and therefore do not differentiate themselves very well. If a startup does not execute on their set milestones and needs to raise a series funding round it can lower the size of the round or lower the pre-money valuation to incentivize investors. This is not considered in the model since rounds that are being raised at different valuation and sizes lose the comparative capabilities. This symmetry of the distribution can be seen in figure 5.6 where the cumulative-distribution-function (CDF) is shown. None of these strategies first or second order stochastically dominate one another.

Figure 5.6

Expand Option CDF

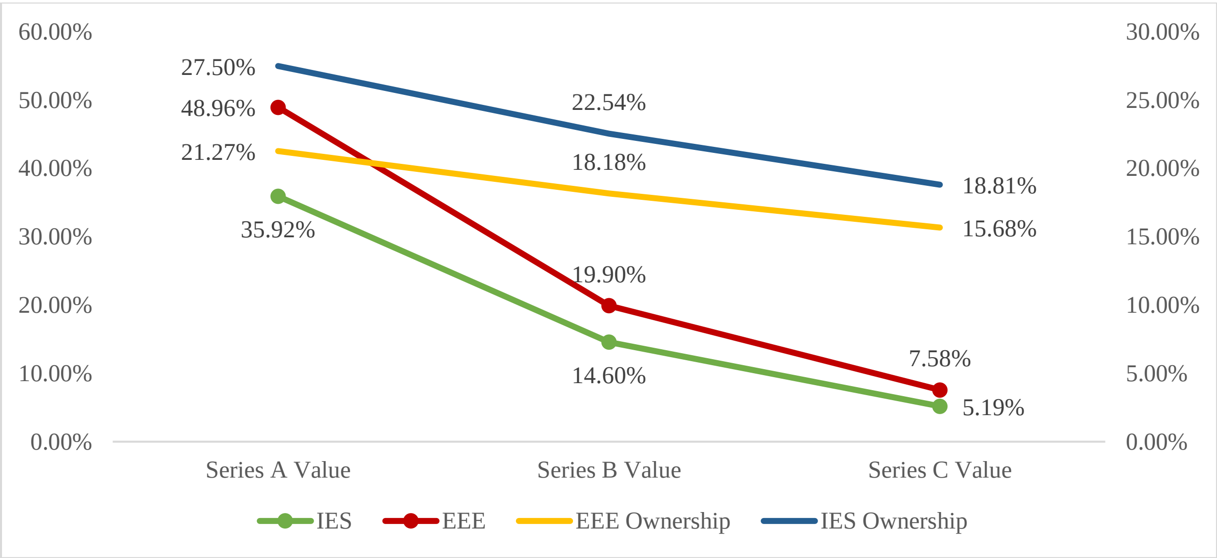


The CDF shows that not one strategy really dominates one another and that the leading strategy cannot be distinguished using stochastic dominance. Since, using the expansion option does not generate a stochastically dominated strategy the CARA coefficient is used to select the preferred strategy for the startup. This was analyzed in the base case and can be seen using the master tree in figure 5.4. The EEE strategy is the most preferred strategy for the highly risk tolerant startup.

Figure 5.7 displays the expected payoffs and dilution of the EEE and IES strategies. As it is shown the EEE strategy gives a probability of success of 7.58% and dilutes ownership to 15.68%. The IES strategy has a probability of success of 5.19% and only dilutes ownership to 18.81%. This extra 2.29% probability of success for doing the EEE strategy and dilutes ownership an additional 3.13%. This is the tradeoff management faces when raising capital and the network effect increases the likelihood of this being a successful business. The risk adverse manager will choose the strategy with the highest expected value. In the expansion option, this would be the strategy with the highest expected probability of success. Which in this scenario is the EEE strategy.

Figure 5.7

EEE and ESI Option Value and Ownership



5.4. Sequential Options

The sequential option assumes that the value of the venture is the sum of the option values for each funding round preceding it. The venture is still only considered successful if it raises all three funding rounds. However, the cost of the venture is not sunk, since funding sources have the ability to choose whether to invest or not according to favorable outcome of the investment. This option better simulates real life and adds new insights into the growth decisions management should make. Unlike the expansion option which assumes the cost of the three series funding rounds are fixed, the sequential assumes that those cost are flexible. An investor does not have to invest in a B or C round if the company does not execute on key milestones that were set to raise the later rounds. Hence each round must be calculated individually to know whether the whole venture offers a more attractive upside.

The sequential option results are summarized in table 5.2. This table shows that the highest expected value of the sequential option is EEE strategy. This is the same for both the sequential and expansion option. This expected value is $676,000. Like the expansion option, this is calculated by taking the expected NPV of the venture multiplied by the probability of success for each funding round. This creates a weighted NPV for each sequential option. The mean probability of success can be interpreted as the startups likelihood of raising three series funding rounds. This option still follows the assumption listed in chapter 4, which are that a successful startup will have raised three funding rounds and follows the same size of the cash raises. That means according to the probabilities listed in table 4.1, the start has a weighted probability of raising each series cash raise to be successful. Therefore, the sum of each cash raise and the cashflows generated directly in the raise is the NPV of the venture. The expected value is the weighted NPV of the cash raises multiplied by its respective probability. For example, for the EEE strategy, the expected NPV of the series A is $177,000, and the probability is 39.06%, this gives the expected value for the series A of $69,136. Then the sum of the series A, B, and C round are added to get a final expected value of $676,000. This illustrates that the majority of the value for the EEE route is derived from the B and C rounds.

Table 5.2

Average Value of Sequential Option

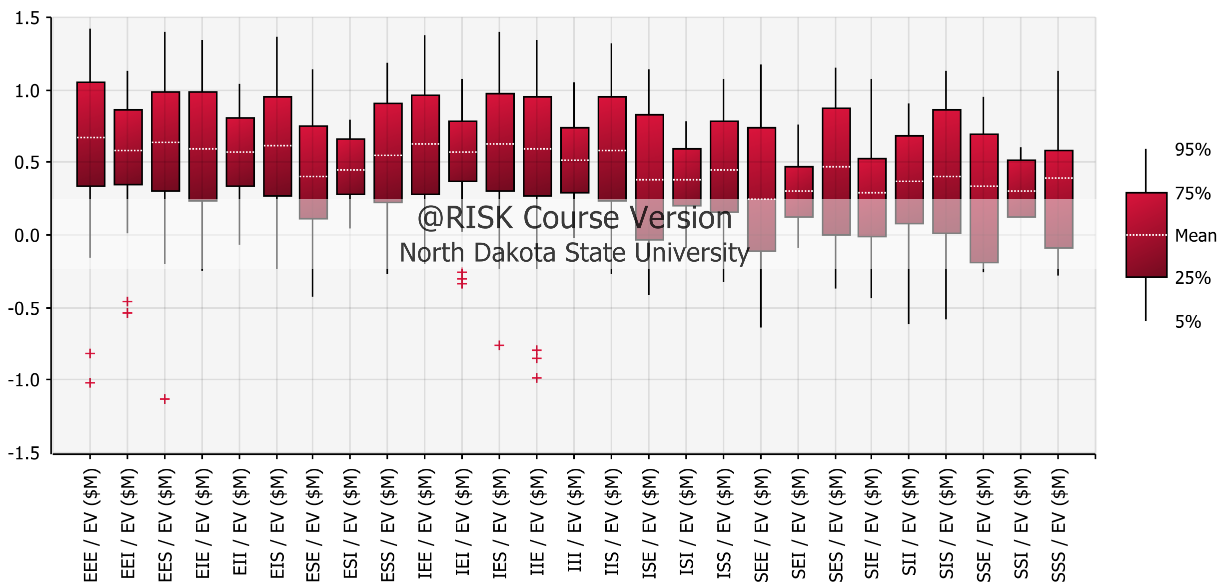
Funding Rounds	NPV Series A ($M)	NPV Series B ($M)	NPV Series C ($M)	Probability of Series A	Probability of Series B	Probability of Series C	EV ($M)
EEE	0.540	0.642	0.371	45.36%	41.81%	37.63%	0.676
EEI	0.540	0.642	0.371	45.36%	41.81%	19.89%	0.591
EES	0.540	0.642	0.371	45.36%	41.81%	36.54%	0.642
EIE	0.540	0.642	0.371	45.36%	35.28%	37.63%	0.613
EII	0.540	0.642	0.371	45.36%	35.28%	19.89%	0.545
EIS	0.540	0.642	0.371	45.36%	35.28%	36.54%	0.586
ESE	0.540	0.642	0.371	45.36%	7.35%	37.63%	0.432
ESI	0.540	0.642	0.371	45.36%	7.35%	19.89%	0.395
ESS	0.540	0.642	0.371	45.36%	7.35%	36.54%	0.456
IEE	0.540	0.642	0.371	40.74%	41.81%	37.63%	0.606
IEI	0.540	0.642	0.371	40.74%	41.81%	19.89%	0.566
IES	0.540	0.642	0.371	40.74%	41.81%	36.54%	0.625
IIE	0.540	0.642	0.371	40.74%	35.28%	37.63%	0.569
III	0.540	0.642	0.371	40.74%	35.28%	19.89%	0.521
IIS	0.540	0.642	0.371	40.74%	35.28%	36.54%	0.583
ISE	0.540	0.642	0.371	40.74%	7.35%	37.63%	0.421
ISI	0.540	0.642	0.371	40.74%	7.35%	19.89%	0.357
ISS	0.540	0.642	0.371	40.74%	7.35%	36.54%	0.470
SEE	0.540	0.642	0.371	3.60%	41.81%	37.63%	0.407
SEI	0.540	0.642	0.371	3.60%	41.81%	19.89%	0.364
SES	0.540	0.642	0.371	3.60%	41.81%	36.54%	0.484
SIE	0.540	0.642	0.371	3.60%	35.28%	37.63%	0.452
SII	0.540	0.642	0.371	3.60%	35.28%	19.89%	0.385
SIS	0.540	0.642	0.371	3.60%	35.28%	36.54%	0.470
SSE	0.540	0.642	0.371	3.60%	7.35%	37.63%	0.204
SSI	0.540	0.642	0.371	3.60%	7.35%	19.89%	0.214
SSS	0.540	0.642	0.371	3.60%	7.35%	36.54%	0.354
Max	0.540	0.642	0.371	45.36%	41.81%	37.63%	0.676
75th Percentile	0.540	0.642	0.371	45.36%	41.81%	37.63%	0.587
Mean	**0.540**	**0.642**	**0.371**	**29.90%**	**28.15%**	**31.35%**	**0.481**
Median	**0.540**	**0.642**	**0.371**	**40.74%**	**35.28%**	**36.54%**	**0.470**
25th Percentile	0.540	0.642	0.371	3.60%	7.35%	19.89%	0.587
Min	0.540	0.642	0.371	3.60%	7.35%	19.89%	0.204

The sequential option has a higher valuation then the expansion option. This is due to cost of the investment being flexible unlike the expansion option. These sequential options assume if the venture is not favorable, an investment does not have to be accrued. Hence, the expected value will be greater than the expansion options. As shown the III strategy will gives an expected value of $520,900 which minimally dilutes ownership to 27.5%. Comparatively the EEE strategy gives has an expected value of $676,000 and dilutes ownership to 15.2% on average. This shows that the network effect is generating an alpha of $155,100 of expected value and dilutes ownership a total of 12%.

The ability to not make an investment brings more flexibility to these growth decisions. A venture may not warrant an investment for many reasons and will have different thresholds for each source of funding. Banking, VC, private equity, and strategic partner each will have its own unique parameters for how sources allocate funds. The option value is shown in figure 5.8.

Figure 5.8

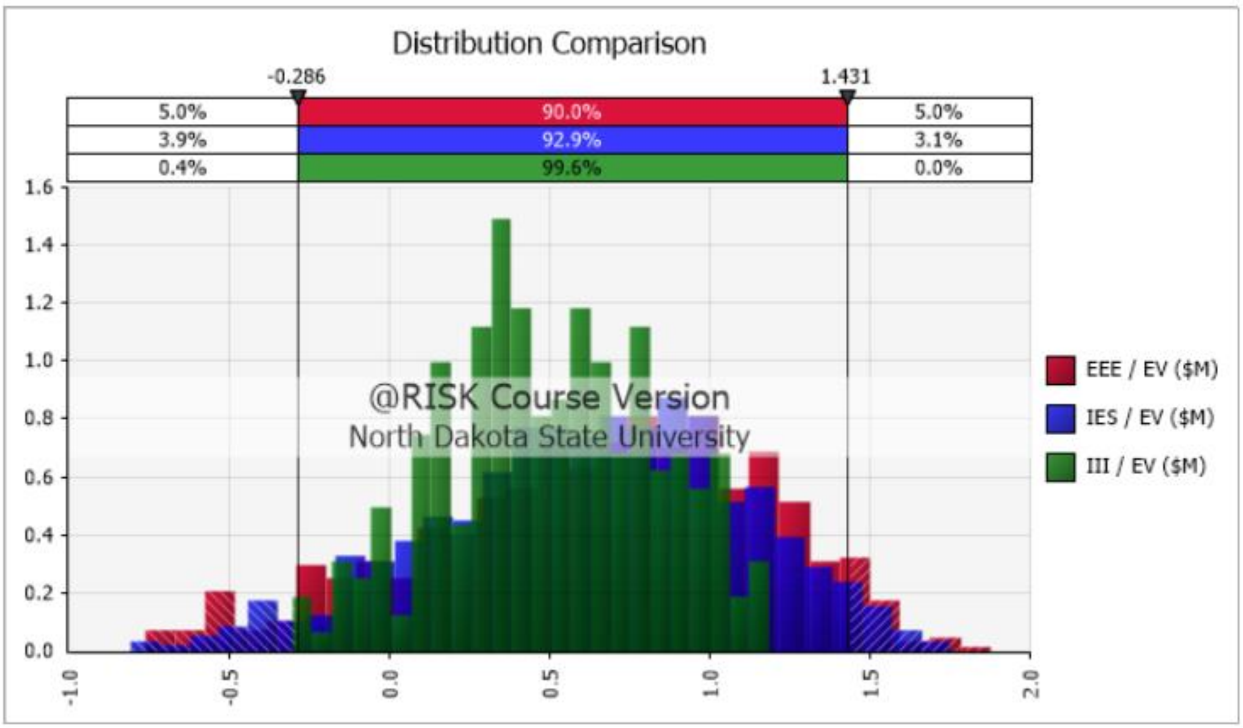
Sequential Option Boxplot



Note for both the expansion and the sequential option the box and whisker plot display that the real option can be negative. Unlike traditional options where the premium is the maximum losses a buyer can lose, a real option does allow for negative return. Negative real options would be interpreted as a bad investment, and the startup should not use that option to fund its business. This is negative due to the sunken cost of the real assets the underlying option represents. This is shown in figure 5.9, which shows the distribution of the sequential option for EEE, IES, and III growth strategies. In this figure, the EEE and IES strategies have the widest distribution. This shows there is greater uncertainty around using these funding strategies. The network effect can be seen in the tail-ends of the distribution. Hence, selling equity for the startup can lead to higher expected values, it simultaneously has more uncertainty.

Figure 5.9

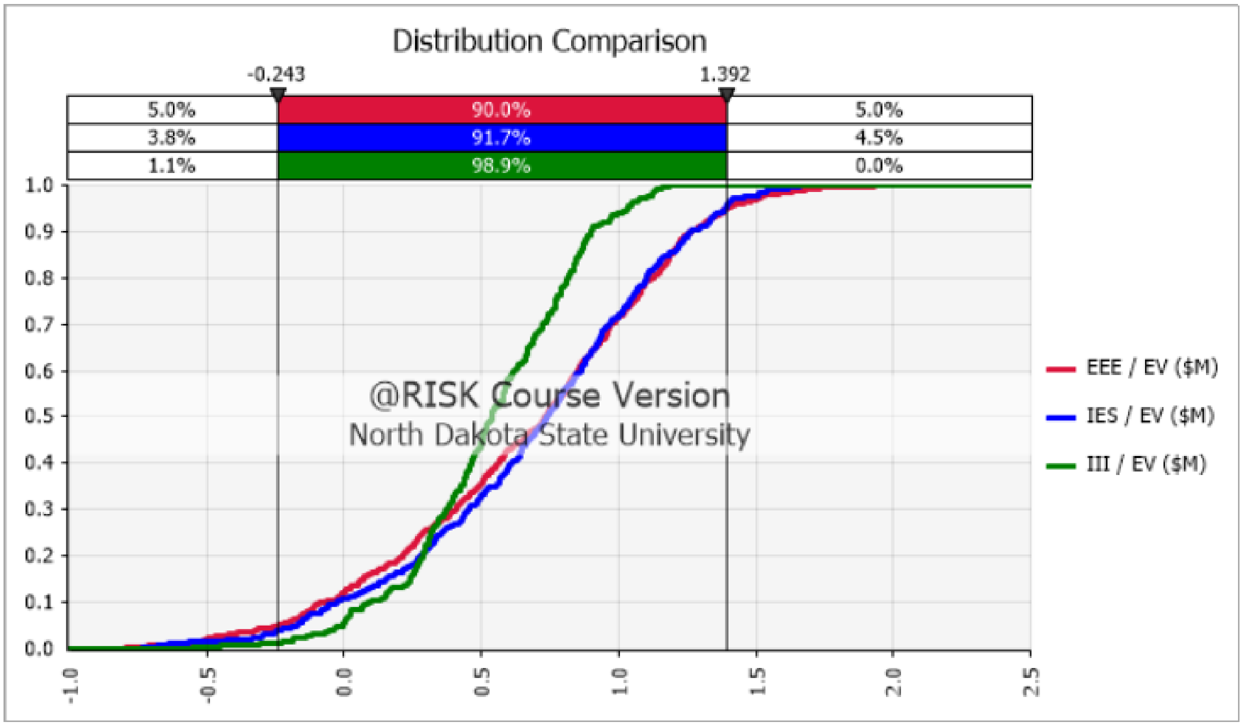
Sequential Option EV ($M)



The CDF is used to illustrate what decision strategy is favorable in this analysis. It can be seen in figure 5.10, that the EEE and IES strategy are very similar and actually and is preferred to the III strategy if management is seeking the greater values of the option. This means it would be in managements best interest to partner with an external or strategic to fund their venture. However, no one strategy first or second order stochastically dominates. Hence, if management would like to maximize value for shareholders the strategy with the most optimal outcome given expected value of the option and the dilution should be considered.

Figure 5.10

Sequential Option CDF



5.5. Sensitivities and Scenarios

This section analyzes what variables that have the most significant impact on the decision management should take on what growth strategy leads to most optimal outcome. This section is broken down into two categories, random and non-random data. Random data is the data points used that are generated randomly. Non-random are variables that are decided by management based on the information they know today. These data points all have varying impacts on the optimal outcome and create unique insights on what strategy is preferred in certain situations.

To understand what variables have the most significant impact sensitivity analysis is run using tornado, distribution overlay, and strategy parameters are all used to analyze the variables.

Monte Carlo was used to see the impact of these variables as well. This was done using @RISK and PrecisionTree. The results are further expanded on in appendix A. In the appendix, more details are provided around the option assumptions for each scenario. This is broken down by expansion and sequential option sections.

5.5.1. Random Data

The variables analyzed in this section are the size of the cash raises and the probability of finding an investor. The size of the cash raise is the most significant variable on the expected value of the option. This is for both expansion and sequential option. A large amount of the value of the expansion and sequential option is derived from the series C round. This can be seen in figures 5.11 and 5.12. This is due to the majority of the outsized return coming from the cash generated at the series C stage of the startup. At the series C the startup will be generating far more cash than at any other point in the startups life if it has been successful in raising its previous funding rounds.

These results show that the greatest opportunity for this venture comes from the series C cash raise which has the most uncertainty. The results are interpreted as following, by having a lower series C round, the upside for the expected value of the option increases ceteris paribus. Meaning if the cost of the venture decreases and all other assumption including earnings growth, and probabilities of raising funding rounds remain fixed, the expected value will increase. This is true for both expansion and sequential options across all scenarios.

The finding an investor variable does not impact the EV of the option as much as the size of the series cash raises. This is true across all scenarios for the expansion and sequential option. These results can be interpreted as the probability of finding the series round investor increases, so does the expected value of the option. Hence, as the probability goes down, the attractiveness of the venture will also decrease. This is why management needs to have a good understanding of what sources of funding are available to utilize, and what one is most likely to impact the final outcome.

Figure 5.11

EEE Tornado Graph (Expand Option)

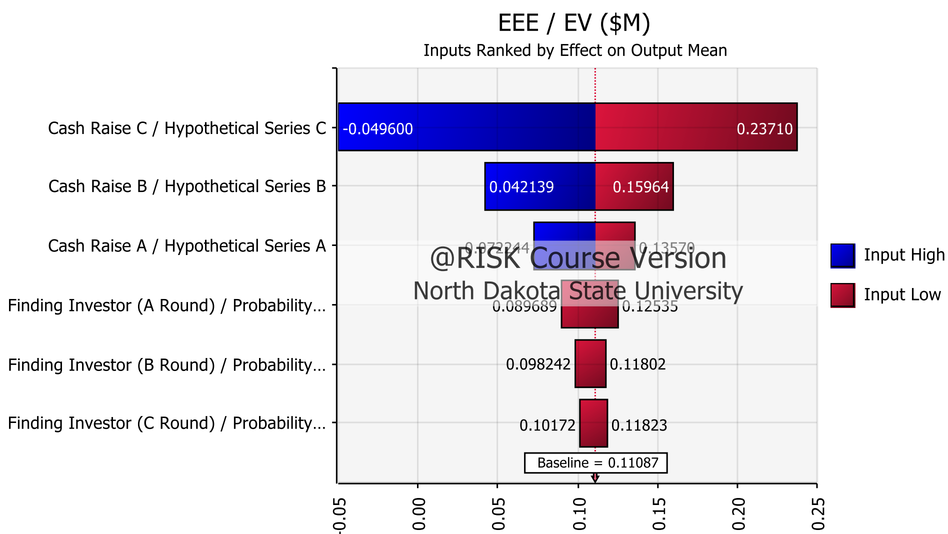
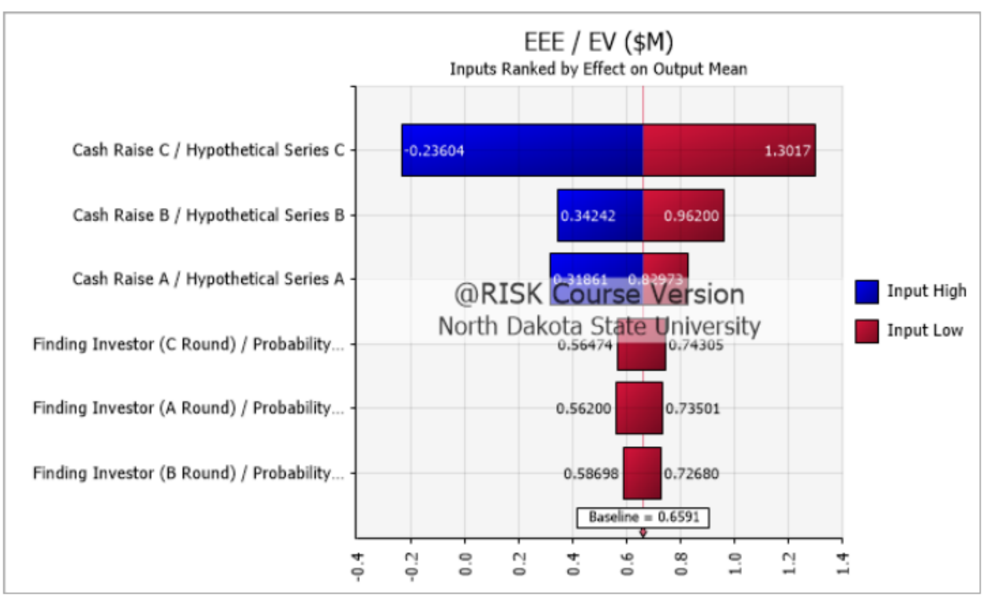


Figure 5.12

EEE Tornado Graph (Sequential Option)



Note that the sequential option has a larger range of expected value for the EEE strategy compared the expansion option. This is due to the fixed cost inherit in the expansion option. As the size of the cash raise increases, and the later the raise is expected to happen, the greater the uncertainty of being able to fund these rounds. This can be seen using table 5.3. The standard deviation of the series C round is roughly ten times greater than the series A round. That is why the C round has much more significance. There is more uncertainty around the cash need and generated earnings at the C stage of the business. The C round is forecasted to happen in year 2028. The further out the estimate and the larger the funding round the greater the uncertainty for the startup.

Table 5.3

Series Cash Raise Statistics

Statistic	Cash Raise Series A	Cash Raise Series B	Cash Raise Series C
Minimum	$4,000,038	$7,008,441	$20,061,791
Maximum	$5,497,084	$10,971,601	$34,950,417
Standard Deviation	$353,571	$849,879	$3,171,236
Range	$1,497,046	$3,963,160	$14,888,626

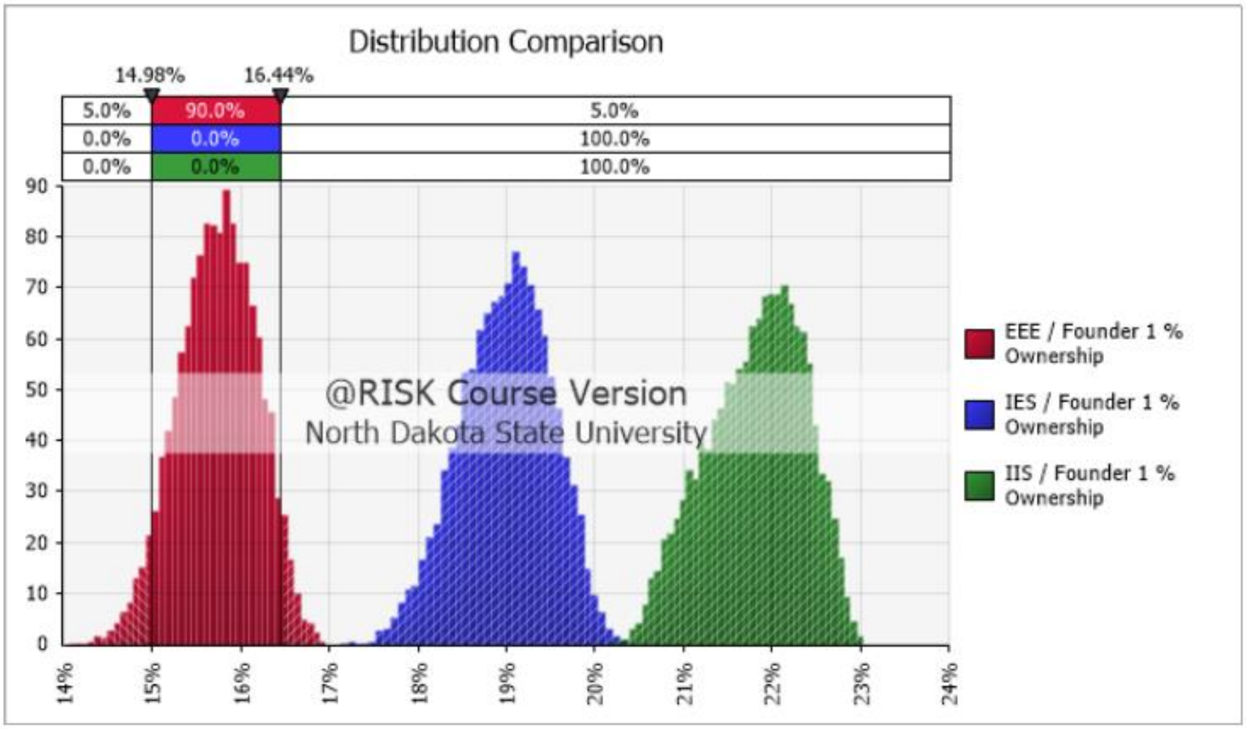
5.5.2. Non-Random Data

The non-random data points analyzed were predominantly the fixed assumptions around business metrics such as ownership, valuation, and earnings. These variables are fixed by management in order to analyze the base case. These sensitivities were run to understand the inflection points of these variables and the impact they have on the optimal growth strategy.

In figure 5.13 shows the distribution of ownership for three options. Those options are the EEE, IES, and IIS growth strategies. It shows that the EEE strategy has the greatest dilution to ownership. This is due to equity have to be sold for every funding round. Equity is ownership of a business and is the main tradeoffs startups face when raising a series funding round. They can minimize this dilution by doing internal rounds such as the IIS strategy which shows a higher retention of ownership for the business. The III strategy is not used since there is no dilution using this funding strategy.

Figure 5.13

Founder Ownership



For the III strategy management will not be diluted at all. This can be seen in table 5.4. This table shows the ownership statistics for each funding route. As noted the standard deviation for III route is zero since no equity is needed to raise those funds. However, every other strategy requires some equity to be sold to incentivize investors to fund the startup. One trend is that the ownership that has the greatest volatility is the strategies in which management doesn't sell equity in the first round. If management raises an internal round first, they will not be selling equity at the cheapest value. Hence, it leads to a lower dilution but greater spectrum of possibilities. The price per share for the series A round is $1,875, the B and C are $5,920 and

$13,044 respectively. The price of the series A equity is roughly 1/3 the cost of the series B and 2/13 the cost of the Series C respectively. This assumes there will be no stock splits. This shows how important it can be for a company to not dilute its self too early in the life of a startup. Often times at this stage of the company it can be dramatically undervalued and lead to over dilution if not done correctly.

Table 5.4

Ownership Statistics

	Mean	Std Dev	5%	95%
EEE / Founder % Ownership	15.21%	2.34%	11.98%	17.48%
EEI / Founder % Ownership	17.94%	2.69%	14.32%	20.34%
EES / Founder % Ownership	15.21%	2.34%	11.98%	17.48%
EIE / Founder % Ownership	17.08%	2.62%	13.50%	19.53%
EII / Founder % Ownership	20.60%	3.05%	16.48%	23.11%
EIS / Founder % Ownership	17.08%	2.62%	13.50%	19.53%
ESE / Founder % Ownership	15.21%	2.34%	11.98%	17.48%
ESI / Founder % Ownership	17.94%	2.69%	14.32%	20.34%
ESS / Founder % Ownership	15.21%	2.34%	11.98%	17.48%
IEE / Founder % Ownership	18.57%	6.99%	16.48%	20.34%
IEI / Founder % Ownership	22.94%	2.16%	21.27%	24.16%
IES / Founder % Ownership	18.57%	6.99%	16.48%	20.34%
IIE / Founder % Ownership	21.52%	2.05%	19.43%	23.15%
III / Founder % Ownership	27.50%	0.00%	27.50%	27.50%
IIS / Founder % Ownership	21.52%	2.05%	19.43%	23.15%
ISE / Founder % Ownership	18.57%	6.99%	16.48%	20.34%
ISI / Founder % Ownership	22.94%	2.16%	21.27%	24.16%
ISS / Founder % Ownership	18.57%	6.99%	16.48%	20.34%
SEE / Founder % Ownership	15.21%	2.34%	11.98%	17.48%
SEI / Founder % Ownership	17.94%	2.69%	14.32%	20.34%
SES / Founder % Ownership	15.21%	2.34%	11.98%	17.48%
SIE / Founder % Ownership	17.08%	2.62%	13.50%	19.53%
SII / Founder % Ownership	20.60%	3.05%	16.48%	23.11%
SIS / Founder % Ownership	17.08%	2.62%	13.50%	19.53%
SSE / Founder % Ownership	15.21%	2.34%	11.98%	17.48%
SSI / Founder % Ownership	17.94%	2.69%	14.32%	20.34%
SSS / Founder % Ownership	15.21%	2.34%	11.98%	17.48%

5.5.3. CARA Sensitivities

The CARA utility function is used to show additional insights on what growth strategy should be selected. It assumes that the R value is 1,000. As R increases the decision maker becomes more tolerant to risk. Hence, the decision maker is assumed to be risk tolerant. The exponential utility function based on the expected value of the venture for each strategy. See table 5.5 for the CARA utility values.

Table 5.5

Expected Value of CARA Utility function

Funding Rounds	Probability of Success	CARA Value (Bear)	CARA Value (Base)	CARA Value (Bull)	Average Ownership
EEE	7.138%	1.777	3.601	5.394	15.2%
EEI	3.773%	1.580	3.177	4.758	17.9%
EES	6.931%	1.803	3.478	5.218	15.2%
EIE	6.022%	1.640	3.334	4.981	17.1%
EII	3.184%	1.475	3.015	4.514	20.6%
EIS	5.848%	1.634	3.196	4.866	17.1%
ESE	1.253%	1.050	2.122	3.199	15.2%
ESI	6.225%	1.024	2.065	3.005	17.9%
ESS	1.218%	1.035	2.116	3.161	15.2%
IEE	6.411%	1.610	3.206	4.850	18.5%
IEI	3.389%	1.521	2.924	4.428	22.9%
IES	4.925%	1.599	3.187	4.853	18.6%
IIE	5.409%	1.463	2.971	4.444	21.5%
III	2.859%	1.348	2.675	4.074	27.5%
IIS	5.252%	1.482	2.949	4.419	21.5%
ISE	1.127%	0.947	1.808	2.842	18.6%
ISI	0.596%	0.928	1.820	2.777	22.9%
ISS	1.095%	0.960	1.888	2.837	18.6%
SEE	0.567%	0.149	0.288	0.449	15.2%
SEI	0.299%	0.132	0.242	0.405	17.9%
SES	0.550%	0.152	0.289	0.384	15.2%
SIE	0.478%	0.124	0.247	0.411	17.1%
SII	0.253%	0.121	0.247	0.334	20.6%
SIS	0.464%	0.132	0.258	0.386	17.1%
SSE	0.099%	0.086	0.175	0.240	15.2%
SSI	0.053%	0.085	0.151	0.249	17.9%
SSS	0.097%	0.079	0.164	0.253	15.2%

Table 5.5 CARA utility values were generated using 10,000 iterations. The scenarios were run to analyze what strategy would be used if the startup had a faster more bullish growth or more sluggish and bearish. The categories were bear, base, and bull. The bear and bull case increased and decrease the forecasted base case revenue by 50% respectively. The bear case showed that the preferred strategy according to the CARA utility function is the EES for the bear case. While the other two strategies still supported the EEE strategy. This is different when compared to the expansion and sequential options which also both recommended the EEE strategy. Hence, the EEE strategy on average has the highest expected value, but the risk tolerant investor would take the EES strategy if earnings are being missed. This is important because it shows that startups do not only need to think of funding rounds as a blanketed slate of cash financiers, rather there is real strategy with partnering with the right investors.

5.6. Summary

In this chapter the results were summarized for the expansion and sequential options. Then sensitivities were run to better understand the inflection point of the growth decision management faces. This was analyzed for both the random and non-random variables. Overall the results show the impact of the network effect and the tradeoff it has on management. This showed that the highest grossing strategy according to expected value may not be the optimal choice if the tradeoff of ownership is greater than the added return of the network effect.

The results showed that the CARA coefficient in the base case gave the optimal outcome of EES for the risk tolerant manager. This differs from the expansion and sequential options which gave on average the highest expected value was the EEE strategy for both. The sensitivity analysis shows that the series C round has the most significant impact on what growth strategy management will ultimately take. It also showed that the size of the cash raise increases, and the later the raise is expected to happen, the greater the uncertainty of being able to fund these rounds. These uncertainties can have a dramatic impact on the expected value of the option.

CHAPTER 6. CONCLUSION

This chapter provides a synopsis of this thesis. The purpose of the model is to provide a new framework for entrepreneurs, investors, managers, private equity, VC, hedge funds, banks, and founders to look at the optimal growth decision that startups face when taking on new capital. Depending on what strategy is deployed can have significant impact on what growth strategy is selected. The principle tradeoff analyzed is the issuance of equity to attract investors and the impact on dilution on ownership. By better understand the tradeoffs with raising capital startups can make the best and most informed decision when it comes to growing their business through onboarding new capital. This model framework of using real options and decision tree's to value growth decisions startups make has provided new novel insights into VC agtech funding rounds. Although this analysis assumes an agtech industry caveat, other startups can use this framework and tailor it towards the industry the startup operates in.

The chapter is organized in six sections. The objective and results section will discuss the key takeaways of this analysis and why it is important for startups to use. The model overview will briefly discuss the techniques and methodologies used. Then the contribution that this research to literature will be discussed. Then an explanation of limitations in the final analysis is given. Then a summarization of the thesis, and how it can be improved.

6.1. Objective and Results

All startups or early stage companies face growth decision that have differing payoffs and risk inherent in those decisions. These decisions have a spectrum of uncertainty and graphing out these decisions using a decision tree companies can value the inherent information attached to those decisions using real options. These decisions are manifested through the sources of financing through series funding rounds. Unlike traditional valuation and decision-making methodologies, real options allow for the flexibility of management to be able to allocate time and financing appropriately to ventures that show optimal opportunity. All these decisions have varying tradeoffs and ripple effects. The most obvious tradeoff is the dilution of ownership. As startups sell equity they dilute their current shareholders ownership. If a company sells to much equity it may not give management enough financial incentive for them to execute well. The primary way founders are compensated for their work is through appreciation of stock value. The typical founder usually takes a lower salary and/or bonus if it means they have more opportunity for the asymmetric upside of the potential return. This is intuitive, since the usual startup doesn't have a historic revenue, earnings or other performance metric to be incentivized on. Hence, this is the crux of what the series funding rounds do. It provides validation for the startup's equity value, and simultaneously dilutes ownership if equity is issued to incentivize investors.

The objective is for startups to look at the potential growth decisions and pick the most strategic option. This would be the option that has the highest expected value. Both the expansion and sequential real option are analyzed to help validate what funding strategy management should take. The CARA utility function is also used to provide additional insights on what strategy management should take given their risk tolerance levels. The base case showed that the EES strategy was preferred for the risk tolerant manager.

The results show that the expansion option favored working with industry partners by issuing equity for the highest expected value. By doing this the startup benefited by using the network effect of these partners. However, since the model assumed cost of the series rounds were sunk, and management/investors didn't have the opportunity to reinvest at risk adjusted valuation, the results were very symmetric. Hence, the key takeaways with the expansion option are that partnering with investors lead to a higher expected value. The alpha generated by this network effect could be seen in the increased probability of successful outcome when partnering with an external or strategic funding source. Results ranged from an increased probability of being successful by as much as five additional percentage points. Even though this may not seem significant, remember that 90% of startups fail. If the startup fails it's doesn't matter for management or the founders how much they own. Failure means no return for anyone.

The sequential option allowed for management to be more flexible on what funding strategy the startup should take. It assumed that if the startup does not execute on set milestones, the cost of that series round is not sunk. Meaning if the venture does not look favorable the cost is not accrued unlike the expansion option. The value of the sequential option is the sum of each of the expected values of the series funding rounds. This option showed that the EEE, EES and IES rounds were all favored. The EEE and EES round has similar distribution and diluted ownership the same amount. The interesting inflection is that the IES strategy gave a similar expected value but didn't dilute ownership as much. Hence, this would be one of the strategic funding routes management could take to fund their venture.

One other interesting result from this analysis was that the real option allows for options value to be negative. This would be interpreted as an option that is a bad investment. Hence, if the growth strategy has an expected negative value management should not use that strategy. It is effectively the same as if the company had failed in raising three series rounds, and should be treated with the same respect. If the strategy is negative you don't want to own it, or be an investor in it.

One final takeaway was that the series C round had the greatest impact on what growth strategy management would ultimately take. The other sensitivities showed that as the size of the cash raise increases, and the later the raise is expected to happen, the greater the uncertainty of being able to fund these rounds. This greater uncertainty can have a dramatic impact on the expected value of the option. More analysis can be done on these variables to maximize the value of these funding strategies. For example, if there is a better way in estimating the size of the series raises rather then a triangular distribution. This could have a more precise impact on the startups funding strategy and may lower its significance on the expected value of the option.

6.2. Model Review

The required data to run this empirical model was financial statements, earning estimates, capitalization table, pre-money valuation for each funding round, milestones, probabilities associated to the set milestone and other date points. This was organized into two sections, random and non-random data. The random data was the data generated from a triangular distribution using Monte Carlo. The non-random was the earnings estimates, ownership assumptions, milestones, year of series raise for the A, B, and C rounds. These were all based on expert opinion. It is important to note that the predefined variables for the non-random data are a framework and items such as the set milestones can differ depending on the startup. For example, the assumption around market size can be different depending on the startups business model and industry it operates in. However, the framework can be recreated and adjusted to meet the criteria of the analysis.

The key assumptions were that the three funding rounds were needed to be raised to have a successful startup. If the business could not do this it was assumed that the startup was a failure. This assumption may not be all accurate to real life, since a startup may have some sort of salvage value. This could be the assets they accrued on the balance sheet or the IP they own. Even though the startup couldn’t generate a product and have commercial success, there can still be value created. Another assumption was that the expected earnings and forecast given by management would be utilized in the base case. Even though sensitives were run around this input, the forecast given by management may not be the best way to incorporate revenue projections going forward. Lastly, the model has many assumptions around the categorization of how funding sources are organized. One VC firm may be better than another, or one strategic partner compared to another may have differed probabilities. Hence, the different funding strategies could have a different probability of success in each individual category. To simplify the model the framework was created of the three funding categories, and it is assumed that the given probabilities represents managements best estimate on the probability of accomplishing set milestones based on what funding source you partner with.

To create the bases of the model the funding sources were broken down into three categories, external, internal, strategic. External and strategic sources diluted ownership while the internal non-dilutive. These categories could be broken down further to give a better analysis on what funding source is preferred. However, this can be easily recreated in a new framework and gives actionable items for management regarding their funding strategy. Every startup should be analyzed on a case by case basis.

Two real options were used. The expansion option was the base case. The expansion option seemed to be the best fit initially. The expansion option is often used by firms to analyze and expansion of operation. Essentially the series funding rounds were being invested in ventures to expand startups operations. However, the objective of the analysis is to know what funding strategy is optimal for three series funding rounds. This then has the cost of the venture, which was the series funding rounds become fixed. Hence, a secondary analysis was done using sequential options to gain key insights from these growth decisions. The key difference being that the cost of the series raise is not sunk if funding cannot be obtained or is unfavorable. This allowed for further diligence to be done on each funding strategy. With both the expansion and sequential option management know could make the most informed decision on what funding strategy optimizes their business. The sequential option seemed to emulate agtech VC better than the expansion option. It would be recommended that further research could be done around this option to gather additional insights on funding strategies management can take. The sequential option replicates the VC funding process better than the expansion option.

6.3. Contribution to Literature

The target audience for this paper is founders, entrepreneurs, investors, and observers interested in learning more about venture capital. In the literature was research done around the value of partnering with investors. In the study from the Harvard business school by Zider, 1998, he shows the first probability of success table for a startup. Not going in-depth in the network effect of different funding sources has on probability of success for a startup. Later a paper by Noam Wasserman in 2008, called *The Founder's Dilemma*, concluded that founder(s) who give up more equity to attract investors will often times create a more valuable business than the one who parts with less. This will ultimately lead to a more valuable investment for the founder. However, no further analysis is done on the value of each funding source. This paper displays the impact of the network effect startups get with partnering with new investors while simultaneously analyzing the tradeoff of ownership. These funding categorizations create new novel insights in how funding strategies should impact startups.

This model framework incorporates real options and decision tree's to value growth decisions. The real option is underutilized in industry to calculate the value of a venture. By using the real option startups can better replicate the similarity of the value of a startup in real life. Additionally, the decision tree creates a clean template that is easily interpretable with clear actionable items.

6.4. Limitations

This section analyzed the limitation of this thesis. Some of the items would be good starting points for continuing the further research around agtech growth decisions. Not all variables are able to be represented in the model completely and hence, this provides the perfect opportunity for continued collaboration in additional research for this space.

The assumption that in the expansion option for three funding rounds represent a successful business does not best accurately replicate VC funding. In reality the VC can gather information and if the startup is successful in achieving all their milestones from the first round of funding they can allocate new funds to the startup at a new risk-adjusted price. If the information is less then desirable, they can reject to opportunity to reinvest. VC firms need to send early stage investors favorable market signals to encourage a new round of funding. If a VC doesn't reinvest it can be destructive on the startups ability to raise the next round of funding.

Even though sensitives were run around these inputs, the forecast given by management may not be the best way to incorporate revenue projections going forward. Adoption curves and time series correlation could be added to create new novel insights into the analysis. Also, the earnings could be projected individually for each scenario.

One other limitation is that the external and strategic sources dilute ownership while the internal is non-dilutive. In reality the startup doesn't have to wait for a series funding round to raise capital. If there are non-dilutive forms of funding that require no new issuance of equity and aren't debt, the startup could accept these funds at any time in the startup's life. An example would be if a grant is issued the startup, it would be startups best interest to accept the funding.

6.5. Conclusion

To conclude this model has created a new way for startups to value growth decisions. Traditional methods do not value where the sourcing of capital is coming from and does not give management any insights on the tradeoffs with these partnerships. This means investment decision are missing one of the biggest criteria when it comes to selecting funding sources. By better understanding these categories, the startup can most informed decision and choose the strategy that will lead to the most optimal outcome.

The sequential option provided additional insights into what strategy the startup should take. The expansion and sequential options showed that the network effect of partnering with investors leads to a higher probability of a startup being successful. Much of the data and inputs received in this analysis is subjective in nature and will vary by each startup. Depending on business model and the industry it operates in. However, this framework can easily be reconstructed and customized based on the startup being analyzed.

6.6. Suggestions for Further Research

This analysis can be expanded in a number of different ways. The earnings can be analyzed and forecasted using adoption curves and time series correlation methods. This could add new novel insights such as, what the inflection point is for when a startup should partner with external or strategic sources. In other words, there is a curtain growth threshold with partnering with investors that gives the startup an alpha generated due to the network effect. Hence the dilution of ownership has to be worth the return you are getting from the generated alpha of the investors. Another way this could be expanded is further specific categorization of funding sources. Not all VCs or angel investors are the same value. However, additional branches would need to be created to analyze these strategies, which could lead to messy data.

Finally, more sensitivities can be run and omitted variables not considered in this analysis could be added. More milestones, funding rounds, and simulations could be run. This would create additional insights but may not be significant.

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APPENDIX A. BASE CASE GRAPH AND OUTPUTS

Table A1

Statistical Summary of Expansion Options

	Minimum	Maximum	Mean	Std. Deviation	Variance
EEE / EV ($M)	-0.232	0.396	0.111	0.095	0.009
EEI / EV ($M)	-0.124	0.209	0.059	0.050	0.003
EES / EV ($M)	-0.224	0.380	0.108	0.092	0.008
EIE / EV ($M)	-0.186	0.326	0.094	0.080	0.006
EII / EV ($M)	-0.099	0.168	0.049	0.042	0.002
EIS / EV ($M)	-0.179	0.303	0.091	0.078	0.006
ESE / EV ($M)	-0.087	0.178	0.020	0.025	0.001
ESI / EV ($M)	-0.046	0.092	0.010	0.013	0.000
ESS / EV ($M)	-0.084	0.169	0.019	0.024	0.001
IEE / EV ($M)	-0.216	0.368	0.100	0.086	0.007
IEI / EV ($M)	-0.115	0.179	0.053	0.045	0.002
IES / EV ($M)	-0.208	0.353	0.097	0.083	0.007
IIE / EV ($M)	-0.173	0.291	0.084	0.072	0.005
III / EV ($M)	-0.092	0.152	0.044	0.038	0.001
IIS / EV ($M)	-0.167	0.273	0.082	0.070	0.005
ISE / EV ($M)	-0.081	0.149	0.018	0.022	0.000
ISI / EV ($M)	-0.043	0.079	0.009	0.012	0.000
ISS / EV ($M)	-0.078	0.148	0.017	0.021	0.000
SEE / EV ($M)	-0.034	0.074	0.009	0.011	0.000
SEI / EV ($M)	-0.018	0.036	0.005	0.006	0.000
SES / EV ($M)	-0.032	0.068	0.009	0.011	0.000
SIE / EV ($M)	-0.029	0.058	0.007	0.009	0.000
SII / EV ($M)	-0.015	0.028	0.004	0.005	0.000
SIS / EV ($M)	-0.027	0.054	0.007	0.009	0.000
SSE / EV ($M)	-0.011	0.023	0.002	0.003	0.000
SSI / EV ($M)	-0.006	0.012	0.001	0.001	0.000
SSS / EV ($M)	-0.010	0.022	0.001	0.003	0.000

Figure A1

Expansion Option Tornado Charts

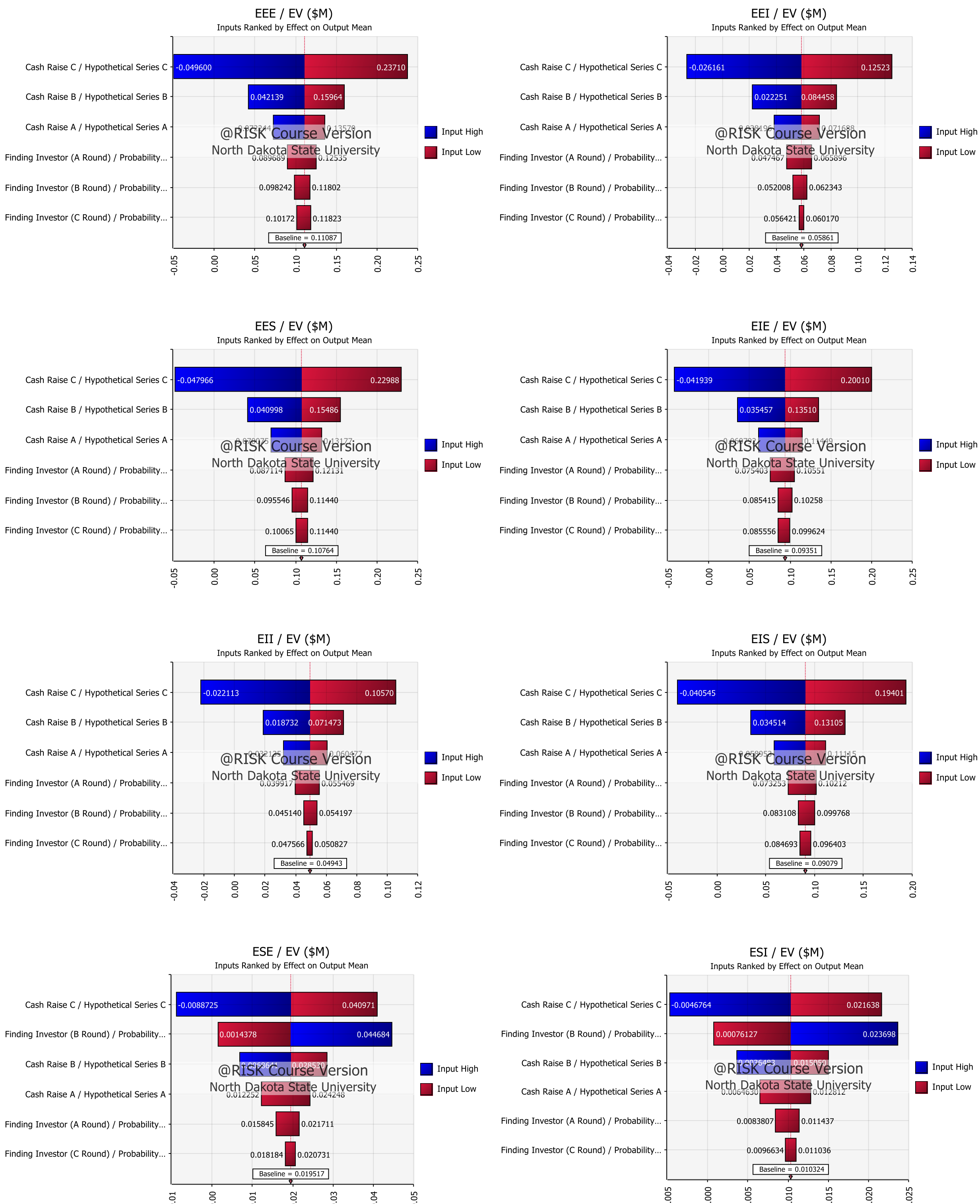


Figure A1. *Expansion Option Tornado Charts* (continued)

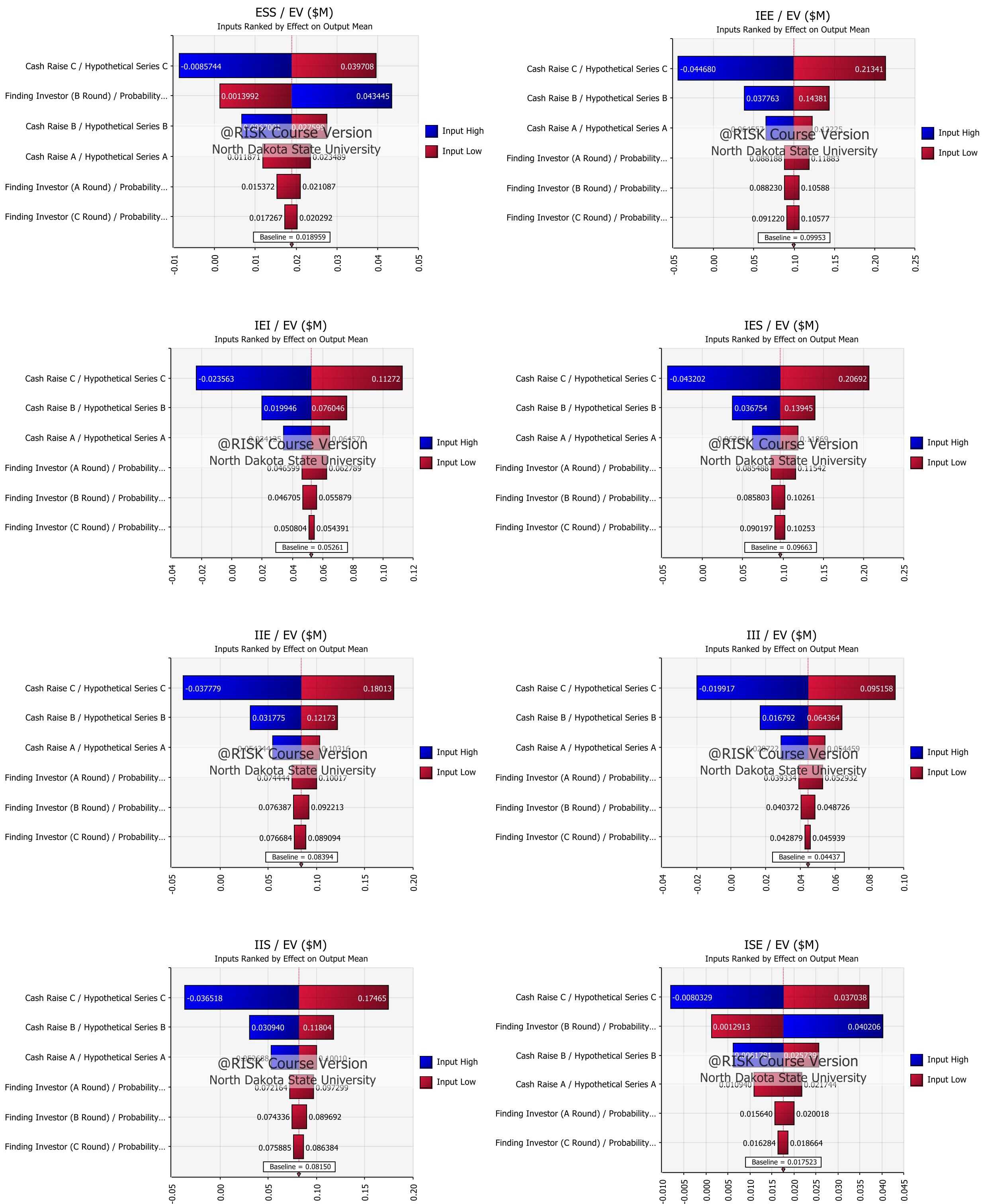
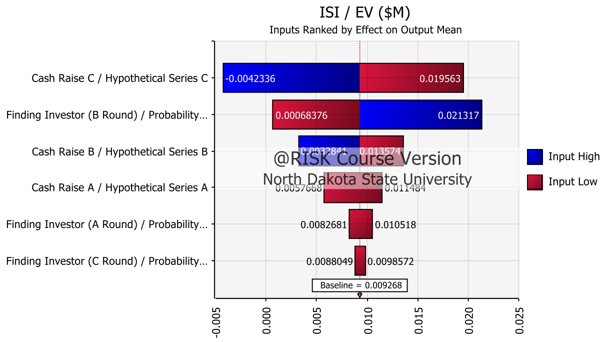
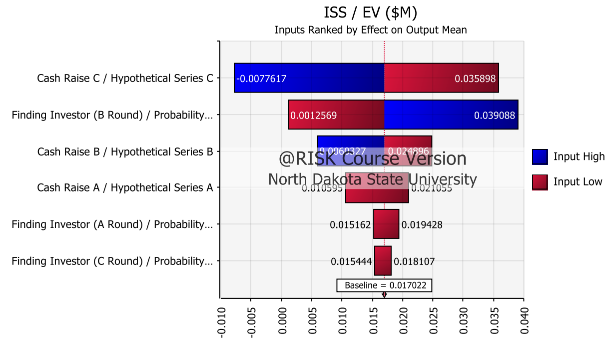
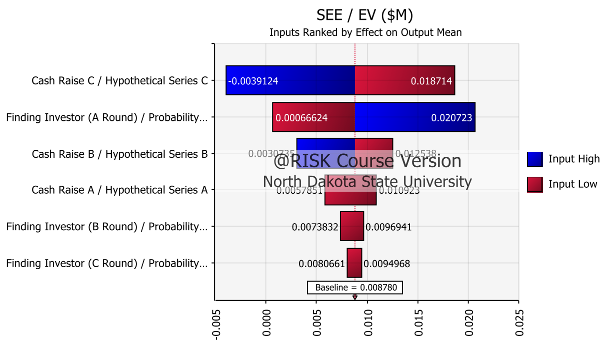
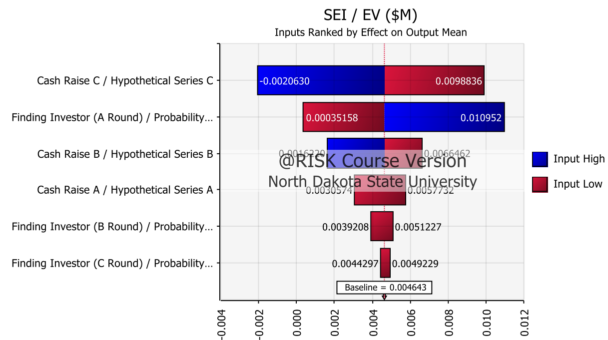


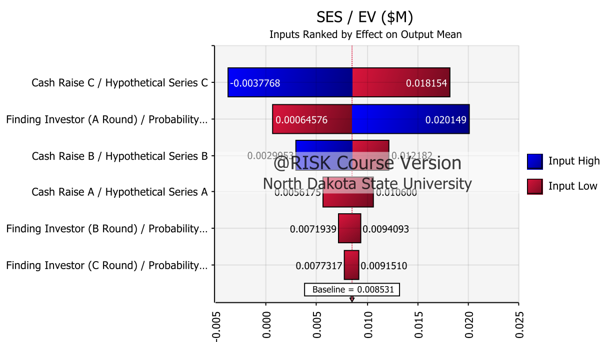
Figure A1. *Expansion Option Tornado Charts* (continued)

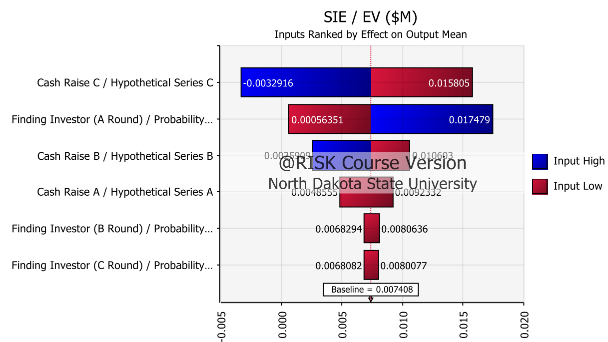


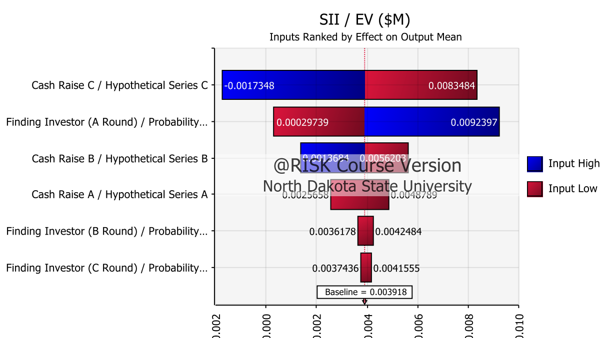












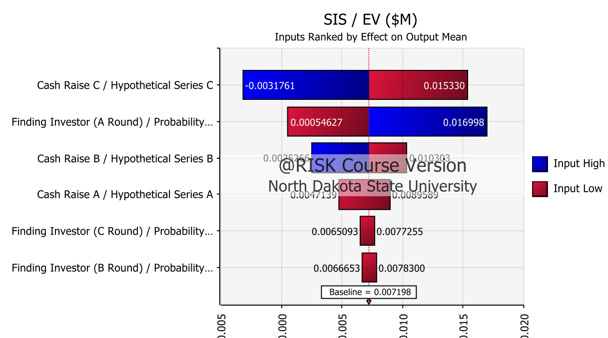
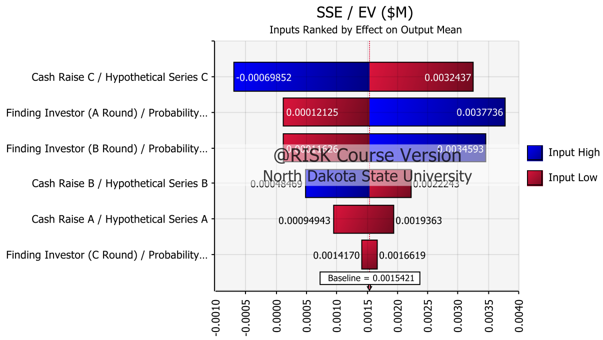
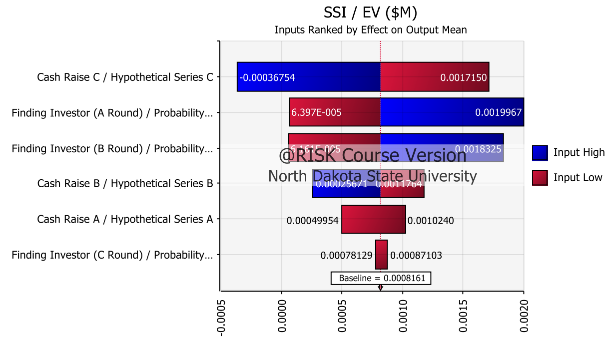
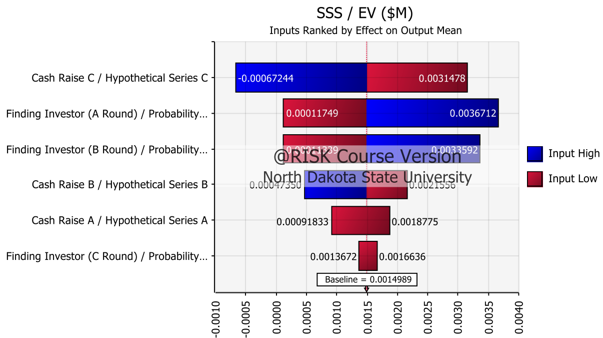


Figure A1. *Expansion Option Tornado Charts* (continued)







APPENDIX B. SEQUENTIAL OPTION GRAPHS AND OUTPUTS

Table B1

Statistical Summary of Sequential Options

	Minimum	Maximum	Mean	Std. Deviation	Variance
EEE / EV ($M)	-0.6488	1.9054	0.676	0.4871	0.2327
EEI / EV ($M)	-0.3608	1.4066	0.5911	0.3443	0.1186
EES / EV ($M)	-0.6380	1.7728	0.6422	0.5011	0.2511
EIE / EV ($M)	-0.8834	1.8301	0.6133	0.5058	0.2559
EII / EV ($M)	-0.3792	1.3486	0.5453	0.3053	0.09323
EIS / EV ($M)	-0.6207	1.6758	0.5866	0.4839	0.2342
ESE / EV ($M)	-0.5029	1.4622	0.4316	0.4639	0.2152
ESI / EV ($M)	-0.2475	0.8789	0.3951	0.2644	0.06988
ESS / EV ($M)	-0.6893	1.2902	0.4557	0.4678	0.2188
IEE / EV ($M)	-0.8232	1.8313	0.6056	0.5024	0.2524
IEI / EV ($M)	-0.5612	1.2537	0.5661	0.3323	0.1105
IES / EV ($M)	-0.7439	1.7832	0.6254	0.4891	0.2393
IIE / EV ($M)	-0.8390	1.7413	0.5687	0.5098	0.2599
III / EV ($M)	-0.3067	1.3099	0.5209	0.3050	0.09304
IIS / EV ($M)	-1.0176	1.6846	0.5826	0.4926	0.2427
ISE / EV ($M)	-0.6022	1.5279	0.4211	0.4991	0.2491
ISI / EV ($M)	-0.1149	0.9712	0.3572	0.2720	0.07396
ISS / EV ($M)	-0.7222	1.2330	0.4704	0.4788	0.2292
SEE / EV ($M)	-0.6550	1.2191	0.4069	0.4905	0.2406
SEI / EV ($M)	-0.2223	0.8989	0.3639	0.3194	0.1020
SES / EV ($M)	-0.7859	1.2587	0.4838	0.4204	0.1767
SIE / EV ($M)	-0.3465	1.4929	0.4522	0.4856	0.2358
SII / EV ($M)	-0.2306	0.8869	0.3851	0.2977	0.08862
SIS / EV ($M)	-0.4777	1.1687	0.4699	0.4530	0.2052
SSE / EV ($M)	-0.7076	0.9716	0.2036	0.6087	0.3706
SSI / EV ($M)	-0.26682	0.64251	0.21438	0.39249	0.1541
SSS / EV ($M)	-0.4858	1.0324	0.3536	0.4412	0.1946

Figure B1

Sequential Option Tornado Charts

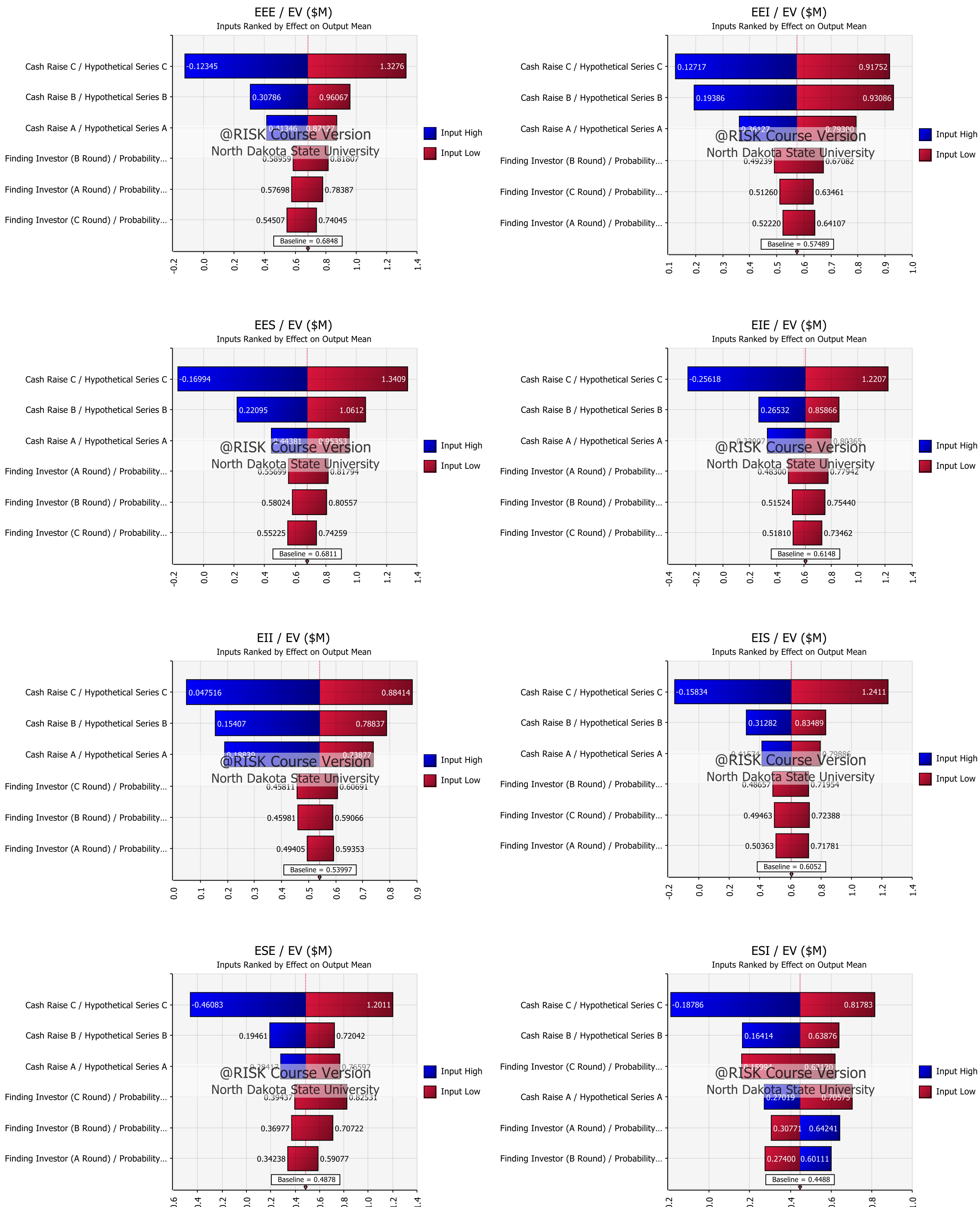


Figure B2. *Sequential Option Tornado Charts* (continued)

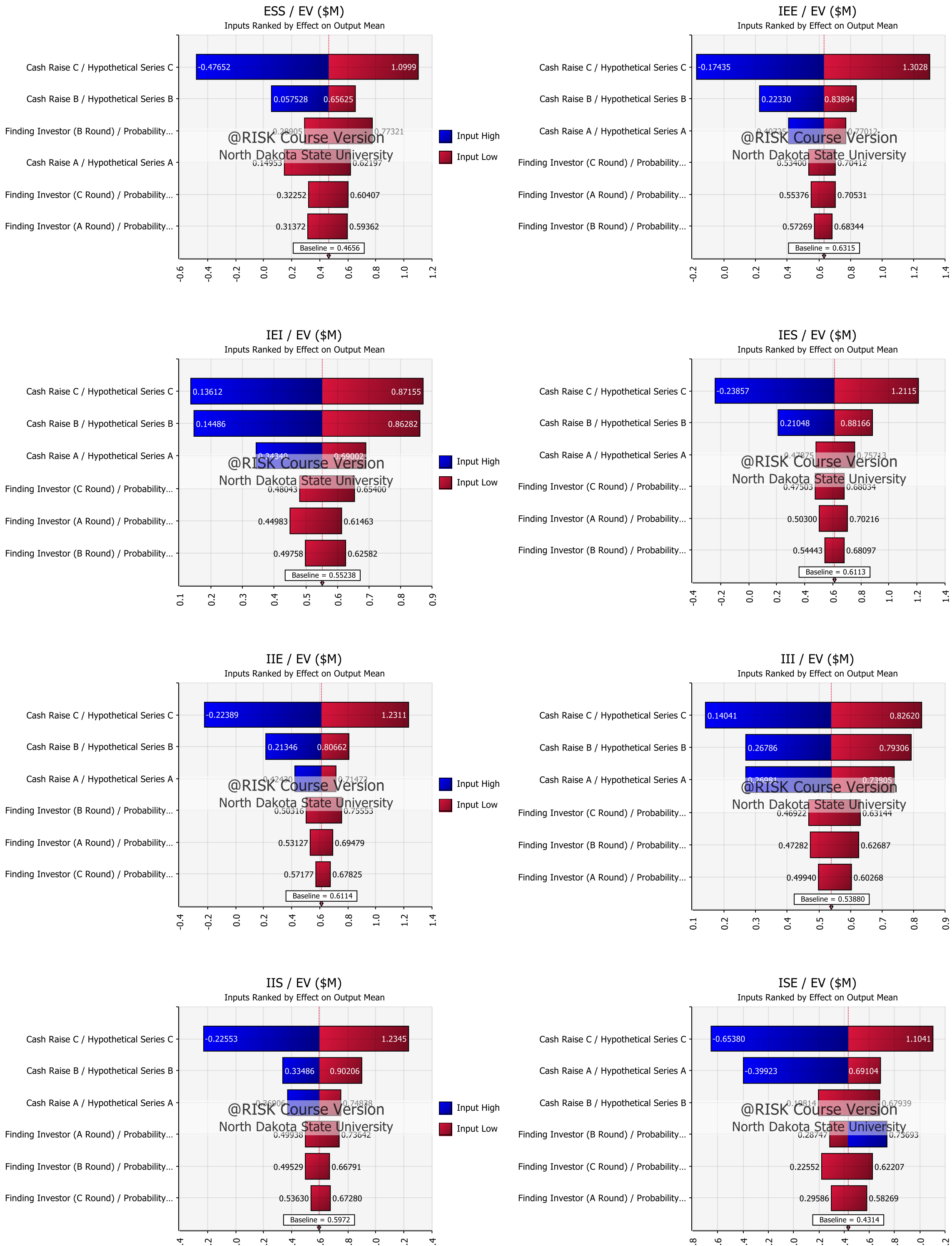


Figure B2. *Sequential Option Tornado Charts* (continued)

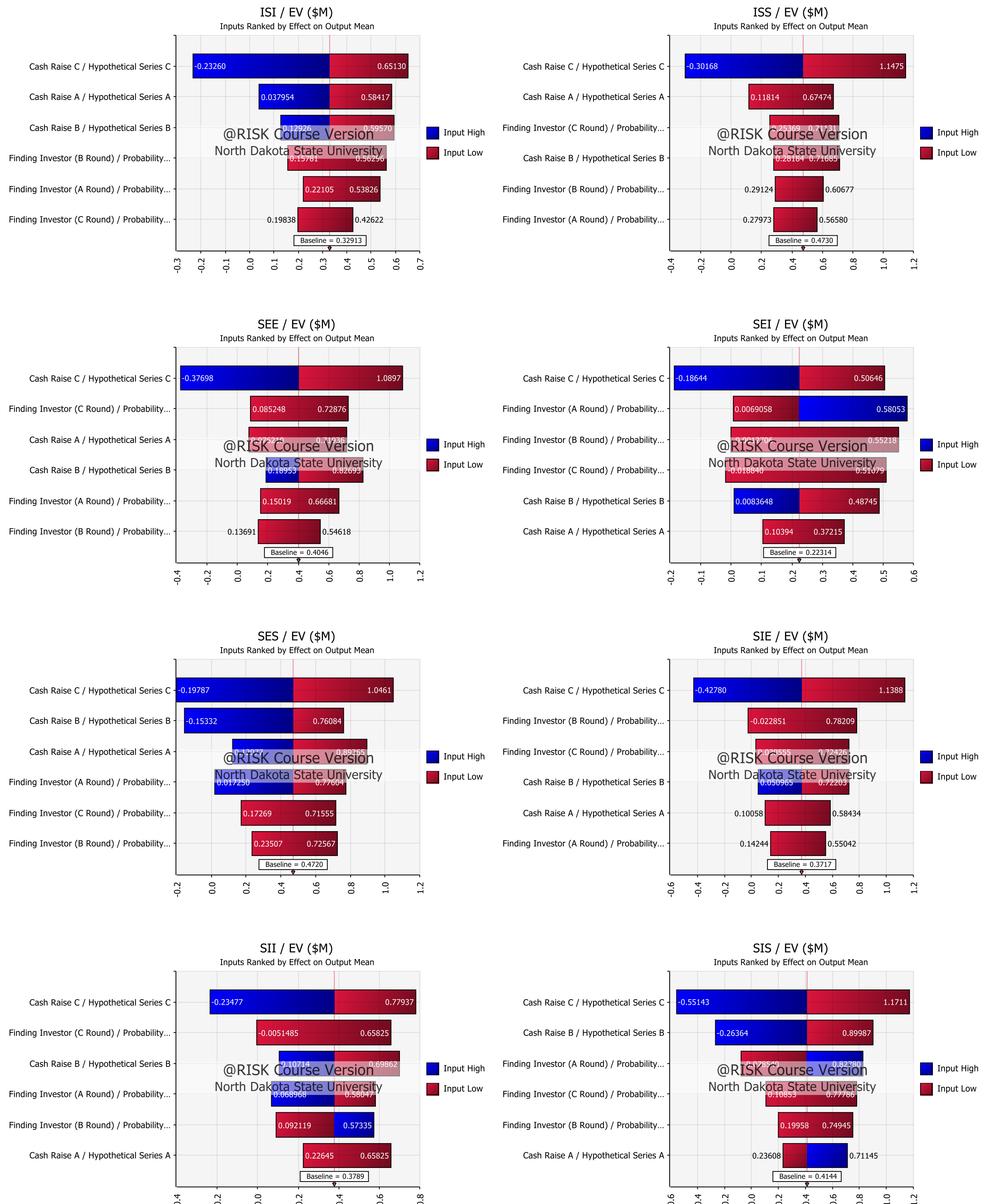
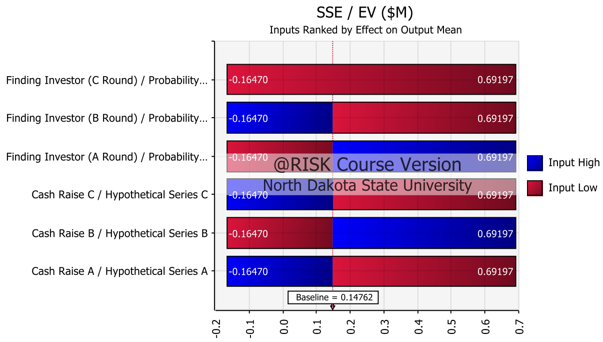
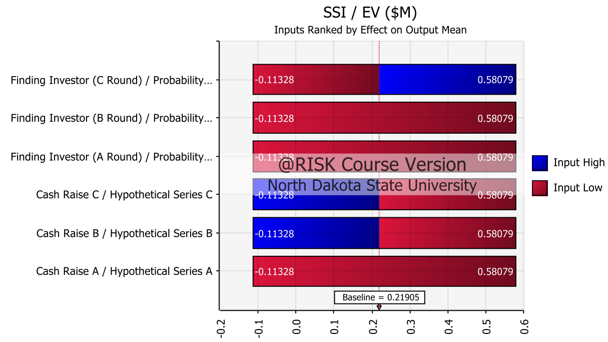
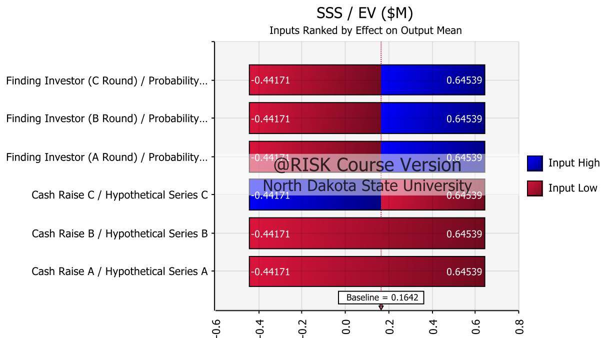


Figure B2. *Sequential Option Tornado Charts* (continued)







APPENDIX C. BASE CASE RESULTS AND ASSUMPTIONS

Table C1

Hypothetical Series A

Pre-Fully Diluted Shares	8,000
Series A Pre-Money Valuation	15,000,000
Pre Money-Price Per Shares	1,875
Cash Raise A	4,000,000
Series A Post-Money Valuation	19,000,000
New Issued Common Shares	2,133
Fully Diluted Shares	10,133
Post-Money PPS	1,875

Table C2

Hypothetical Series B

Pre-Fully Diluted Shares	10,518
Series A Pre-Money Valuation	60,000,000
Pre Money-Price Per Shares	5,705
Cash Raise B	8,000,000
Series A Post-Money Valuation	68,000,000
New Issued Common Shares	1,402
Fully Diluted Shares	11,920
Post-Money PPS	5,705

Table C3

Hypothetical Series C

Pre-Fully Diluted Shares	11,767
Series A Pre-Money Valuation	150,000,000
Pre Money-Price Per Shares	12,748
Cash Raise C	24,000,000
Series A Post-Money Valuation	174,000,000
New Issued Common Shares	1,883
Fully Diluted Shares	13,649
Post-Money PPS	12,748

Table C4

Base Case Capitalization Table Post Series C

Shareholder	Number of Common Shares Owned	Percentage Ownership of Authorized and Issued Shares
CEO (Founder 1)	2,200	16.51%
CTO (Founder 2)	2,200	16.51%
Series Seed Investor	3,600	27.02%
Series A Investors	2,133	16.01%
Series B Investors	1,351	10.14%
Series C Investors	1,838	13.79%
Total	13,322	100.00%

APPENDIX D. RANDOM DATA FOR THE BASE CASE

Figure D1

Probability of Success for EEE Strategy

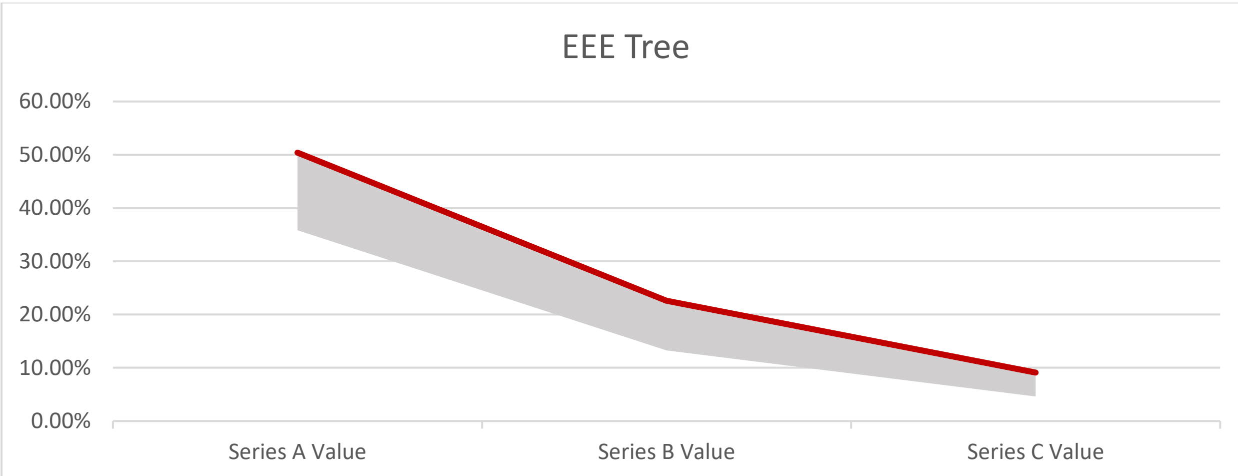


Figure D2

Probability of Success for EEI Strategy

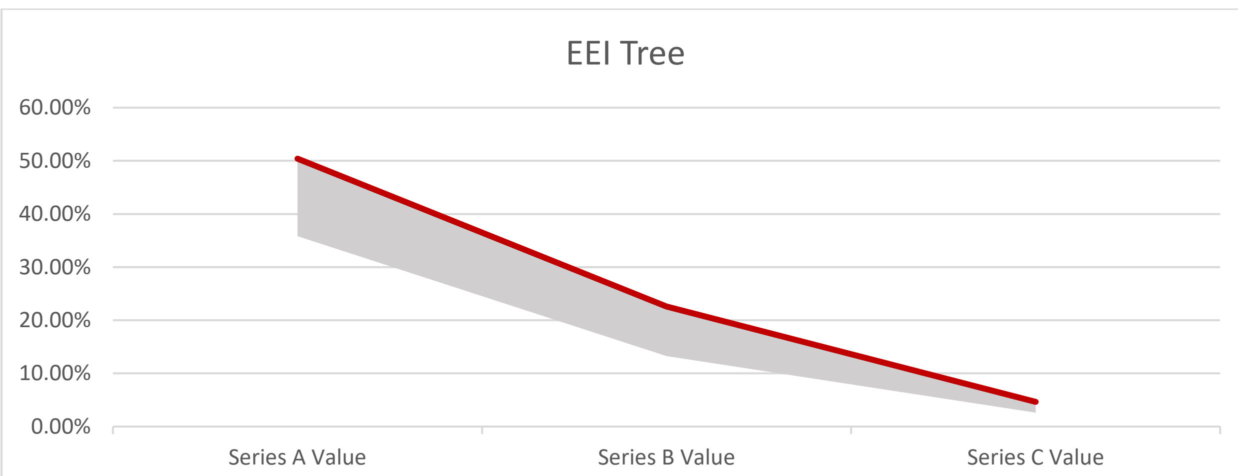


Figure D3

Probability of Success for EES Strategy

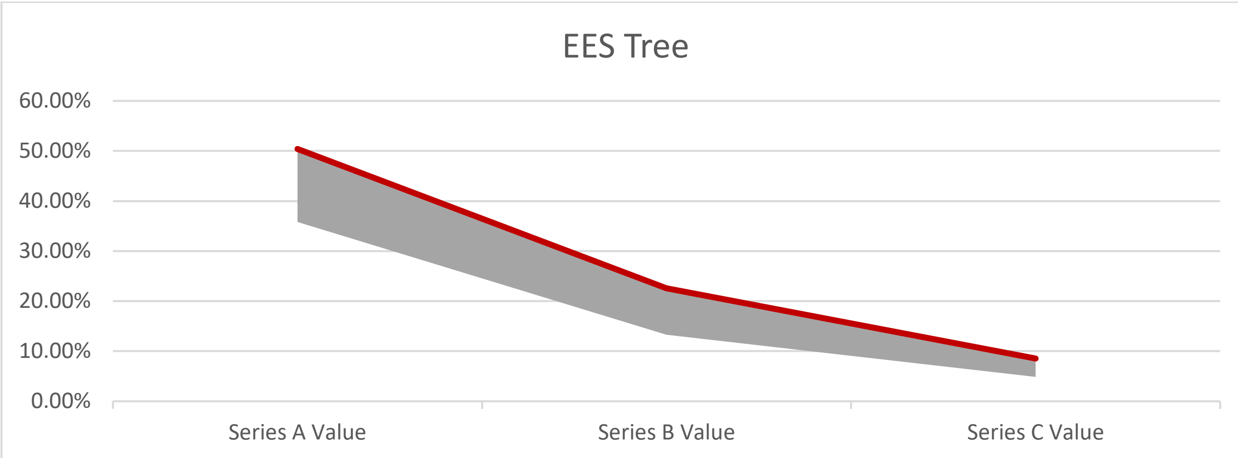


Figure D4

Probability of Success for EIE Strategy

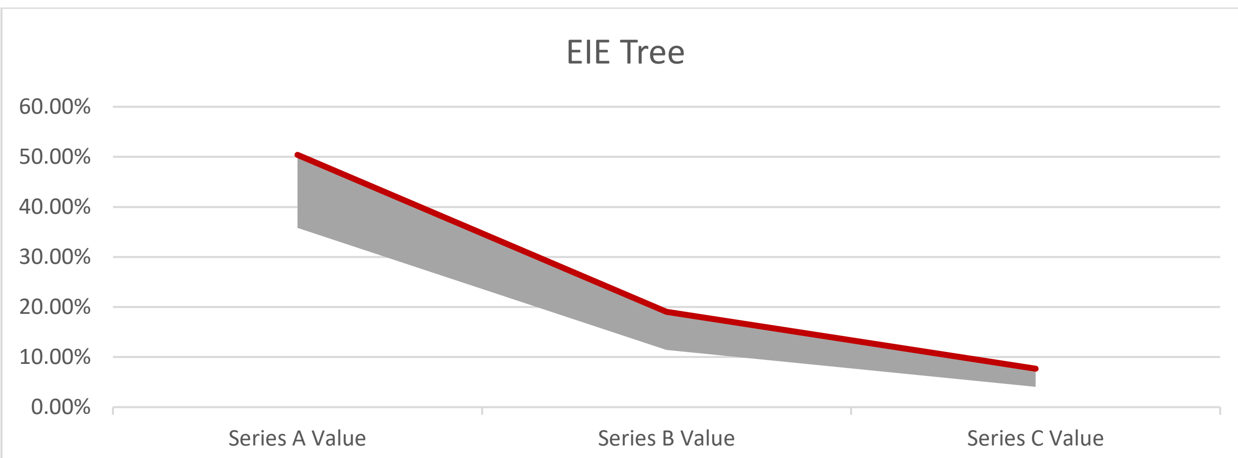


Figure D5

Probability of Success for ESE Strategy

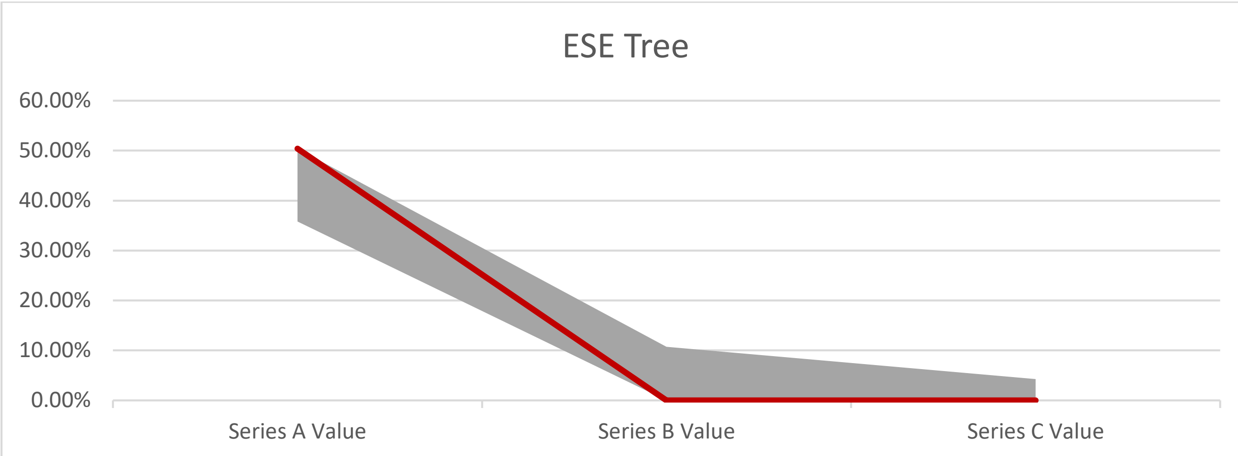


Figure D6

Probability of Success for IEE Strategy

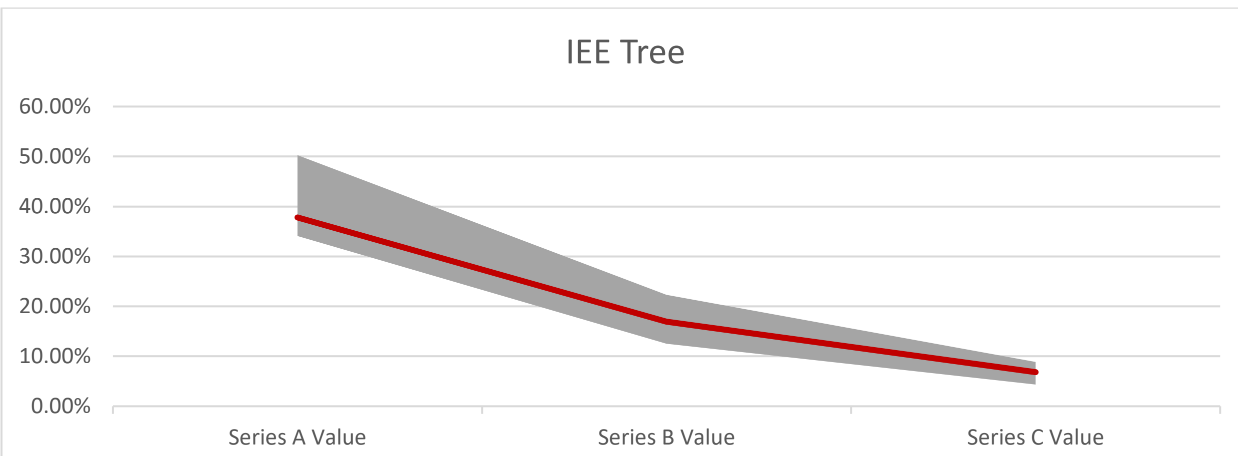


Figure D7

Probability of Success for SEE Strategy

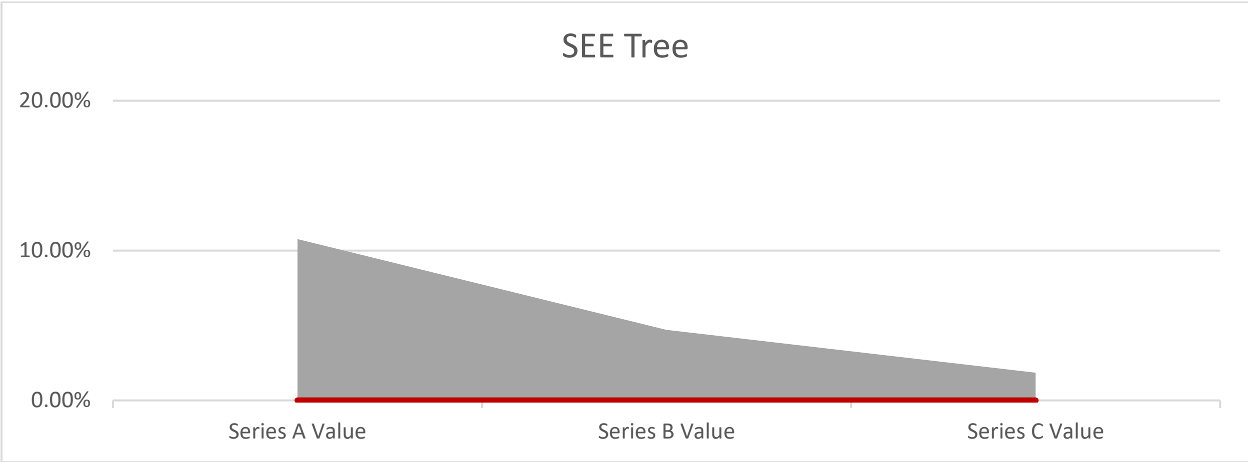


Figure D8

Probability of Success for III Strategy

Figure D9

Probability of Success for IIE Strategy

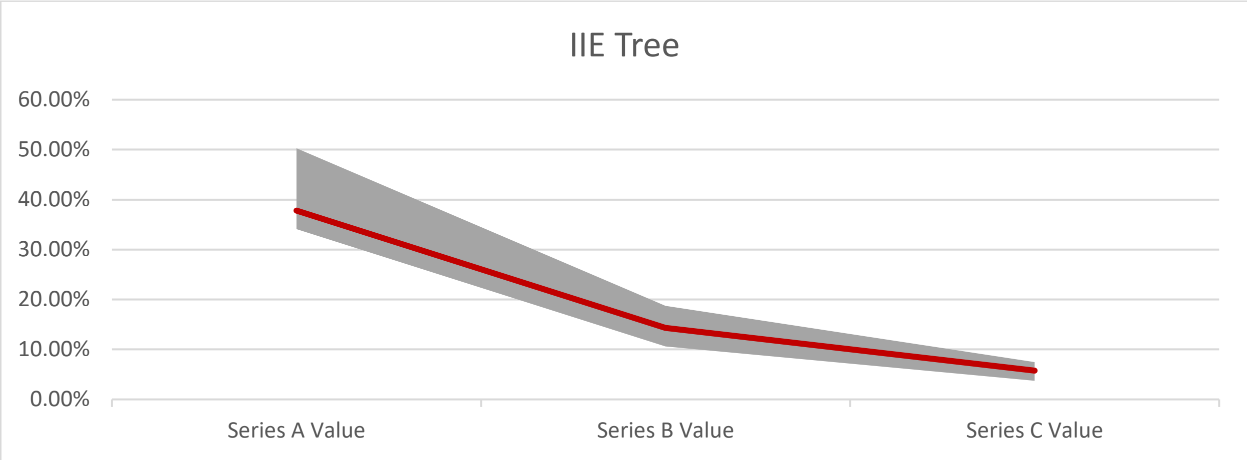


Figure D10

Probability of Success for IIS Strategy

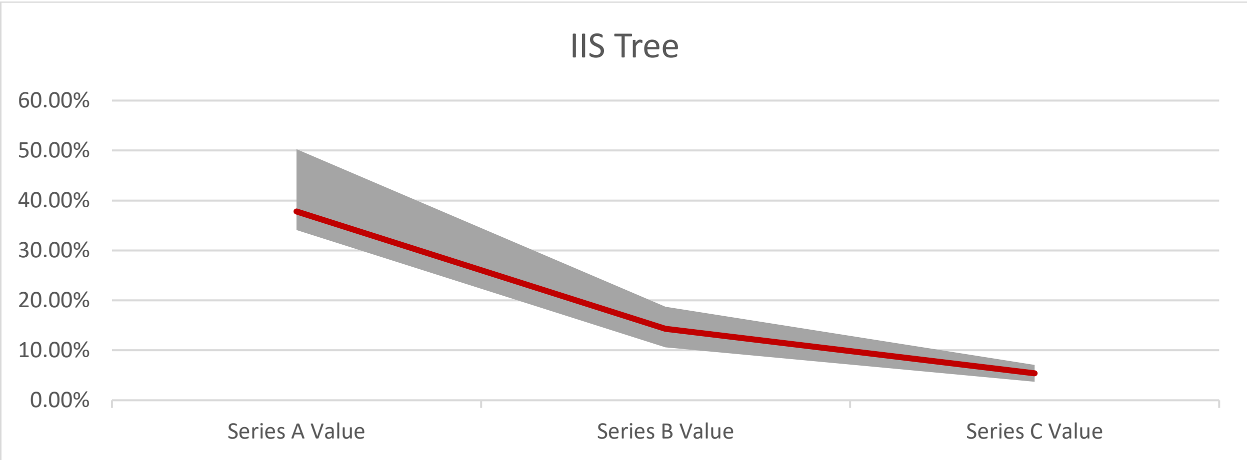


Figure D11

Probability of Success for IEI Strategy

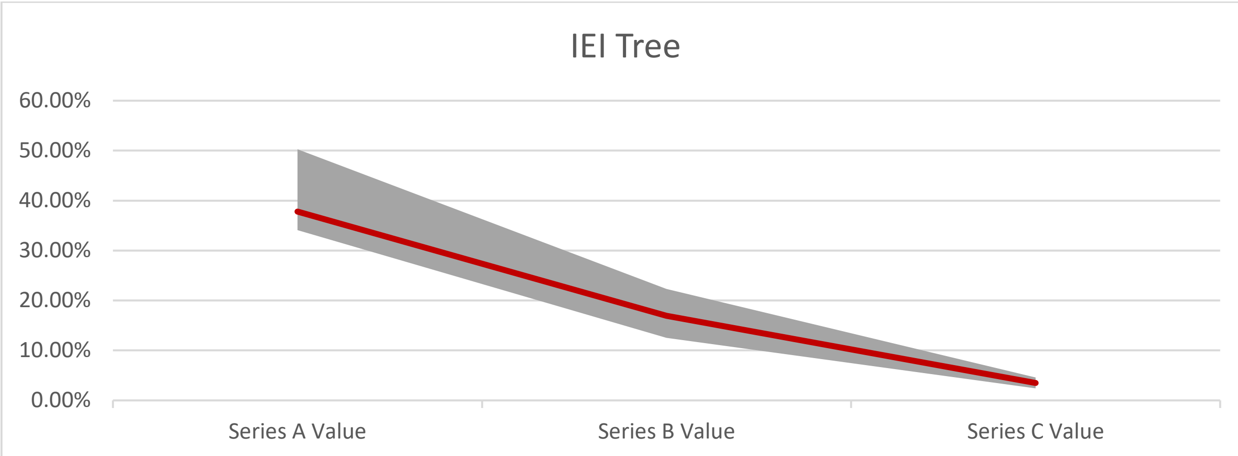


Figure D12

Probability of Success for ISI Strategy

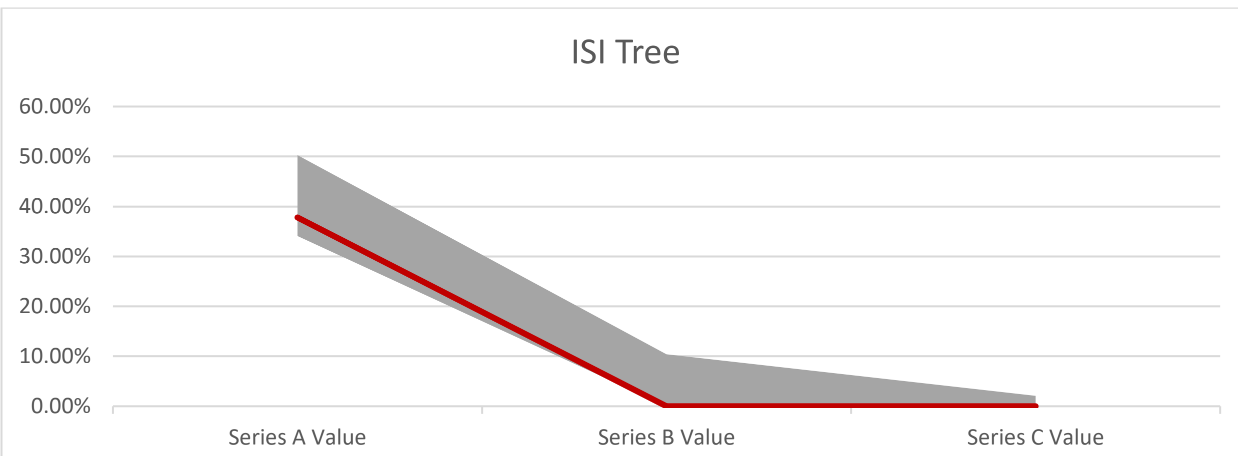


Figure D13

Probability of Success for EII Strategy

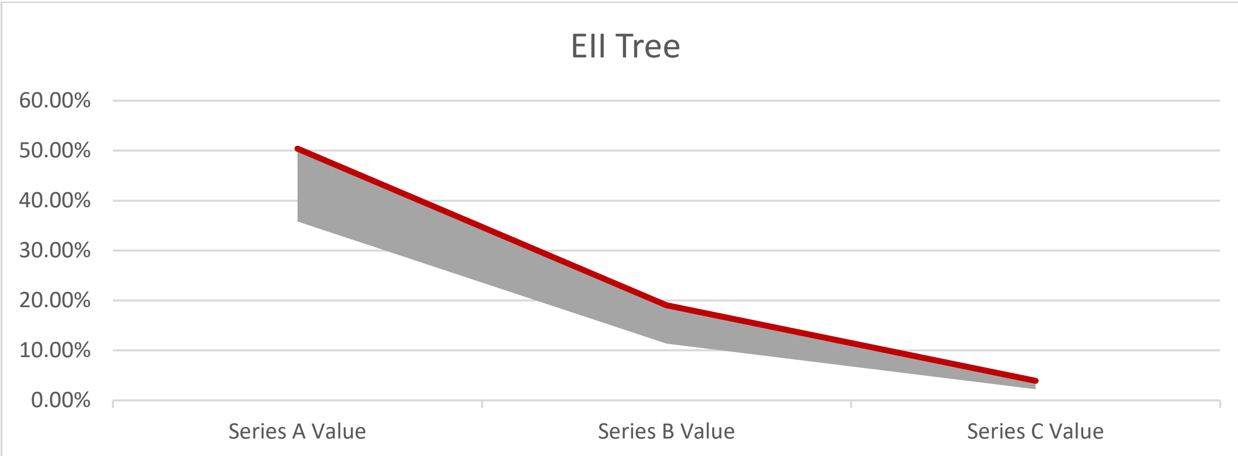


Figure D14

Probability of Success for SII Strategy

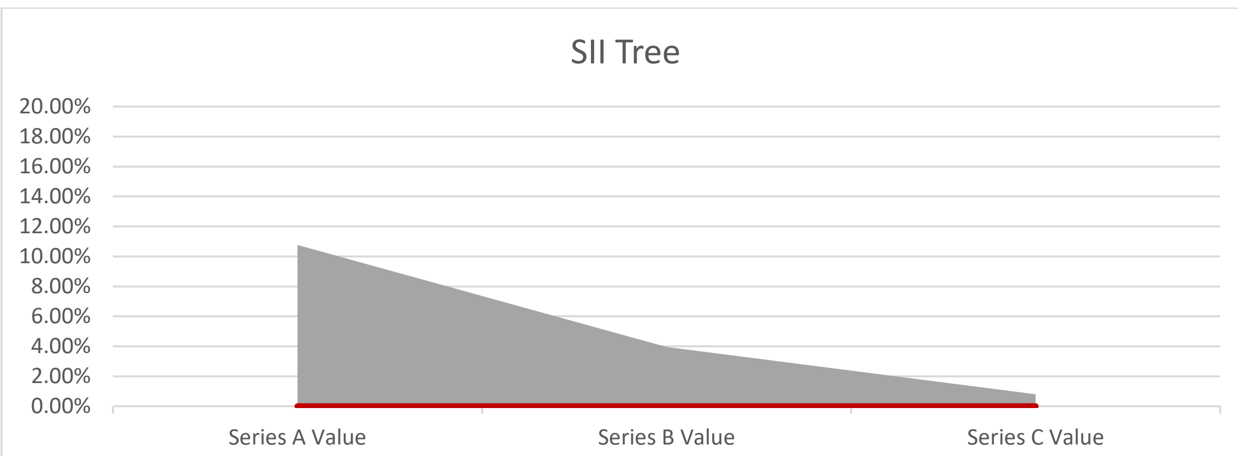


Figure D15

Probability of Success for SSS Strategy

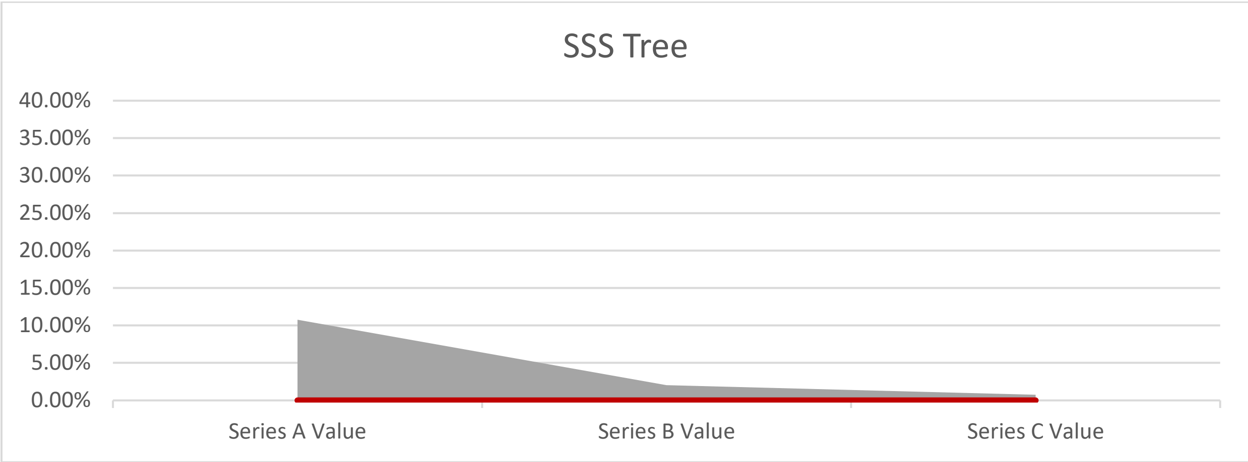


Figure D16

Probability of Success for SSE Strategy

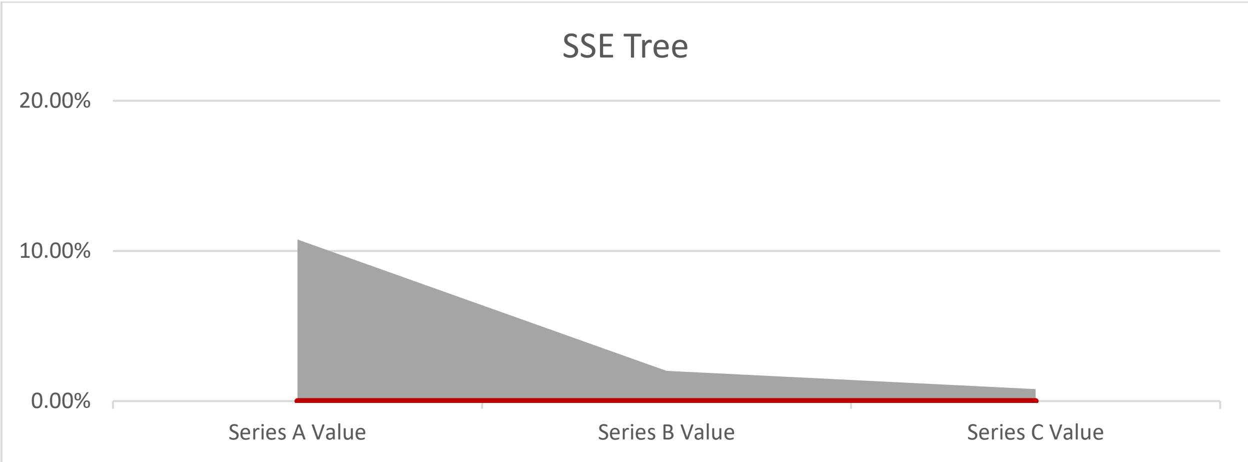


Figure D17

Probability of Success for SSI Strategy

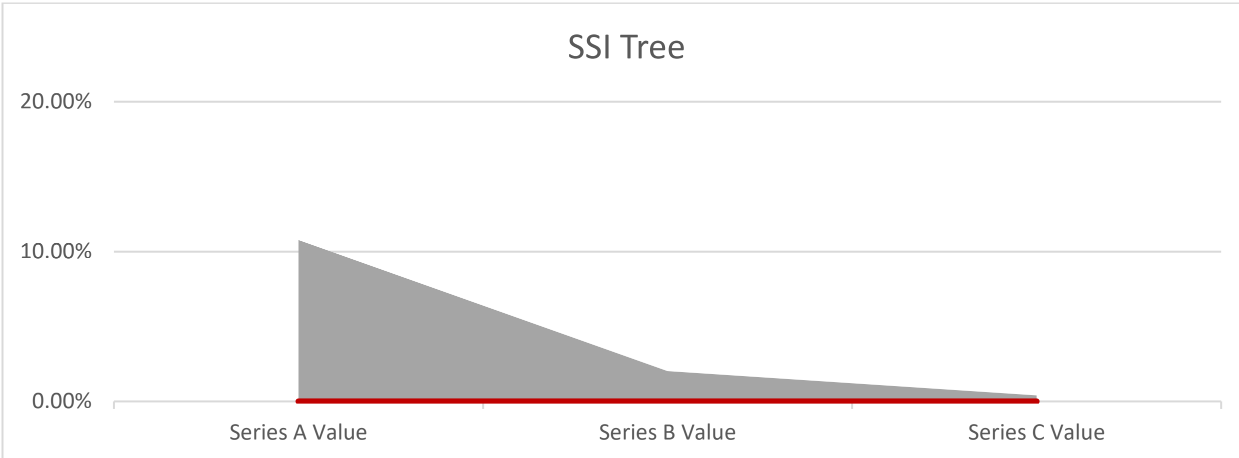


Figure D18

Probability of Success for SES Strategy

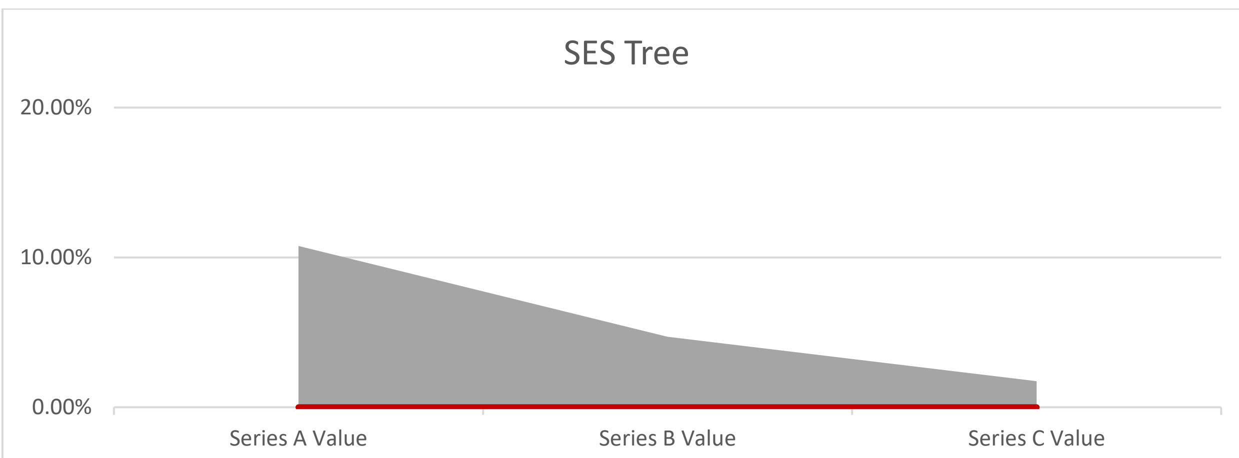


Figure D19

Probability of Success for SIS Strategy

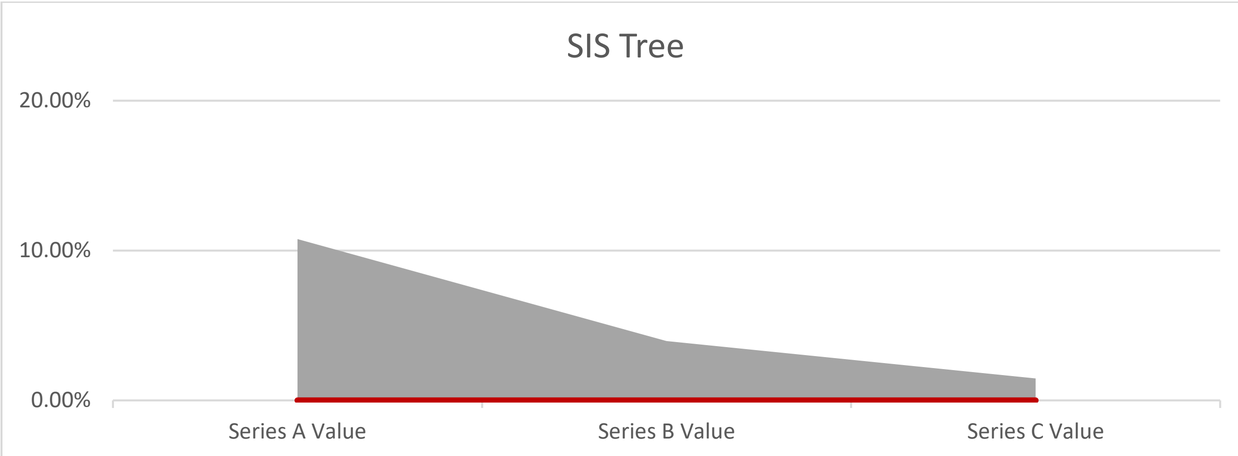


Figure D20

Probability of Success for ESS Strategy

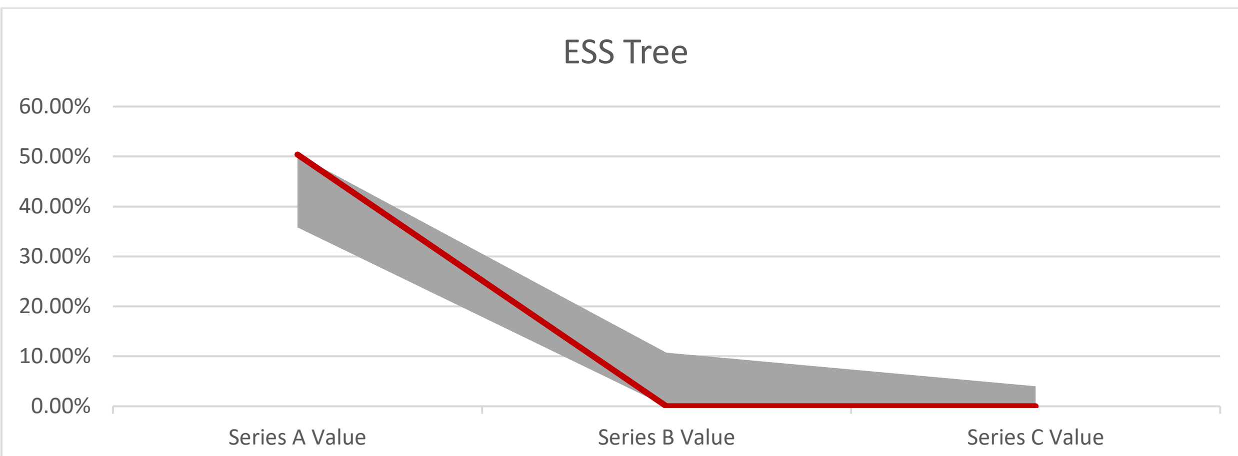


Figure D21

Probability of Success for ISS Strategy

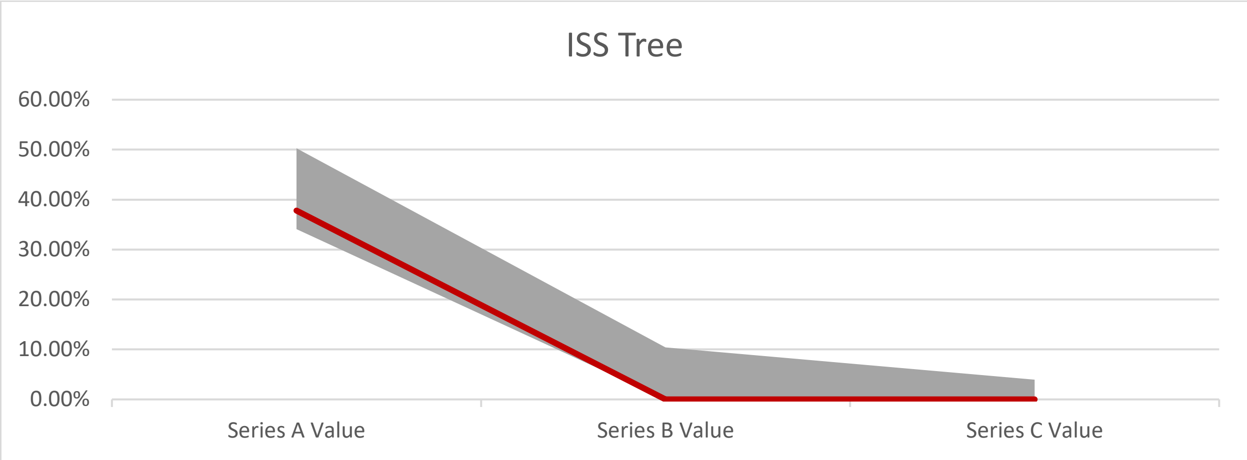


Figure D22

Probability of Success for ESI Strategy

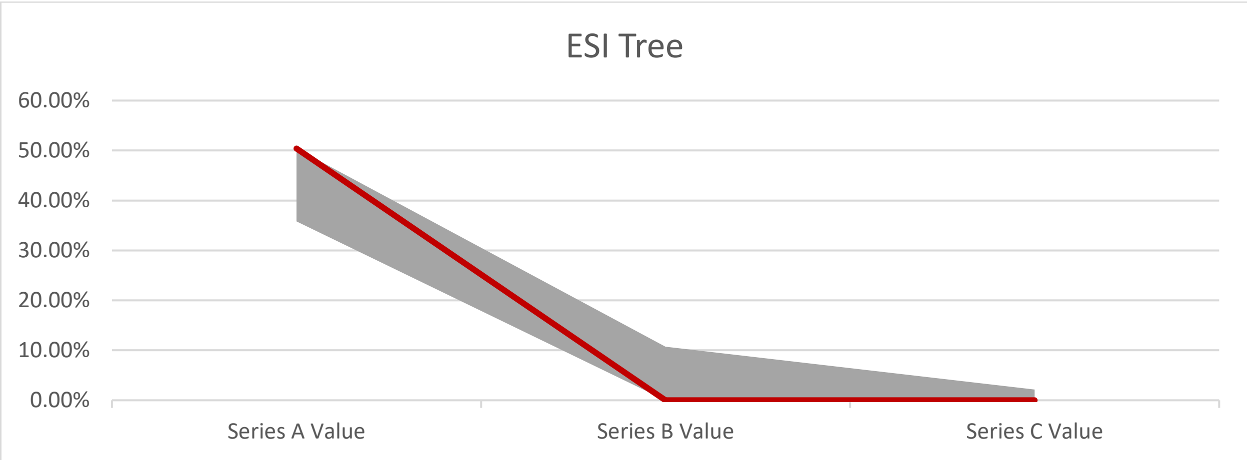


Figure D23

Probability of Success for EIS Strategy

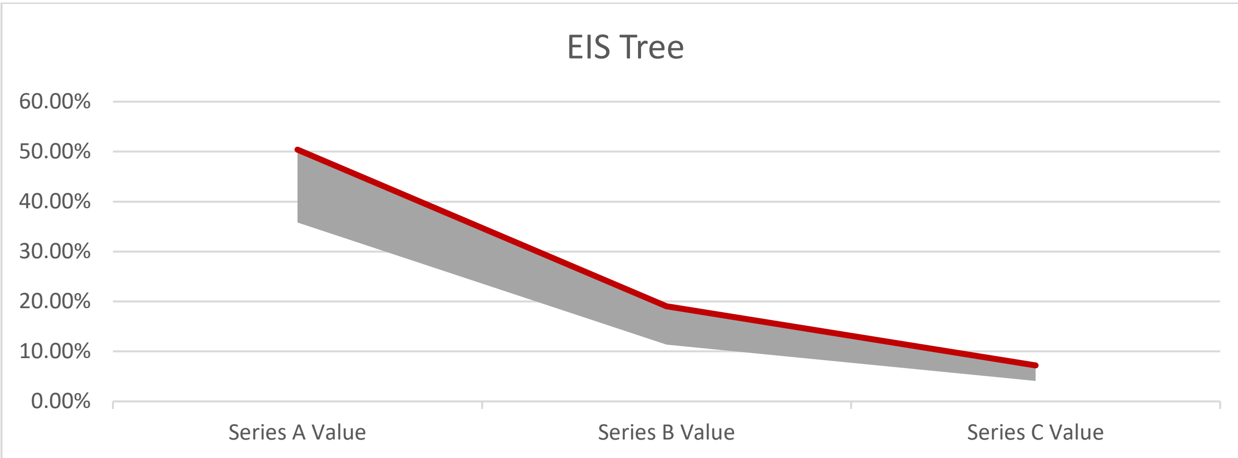


Figure D24

Probability of Success for SIE Strategy

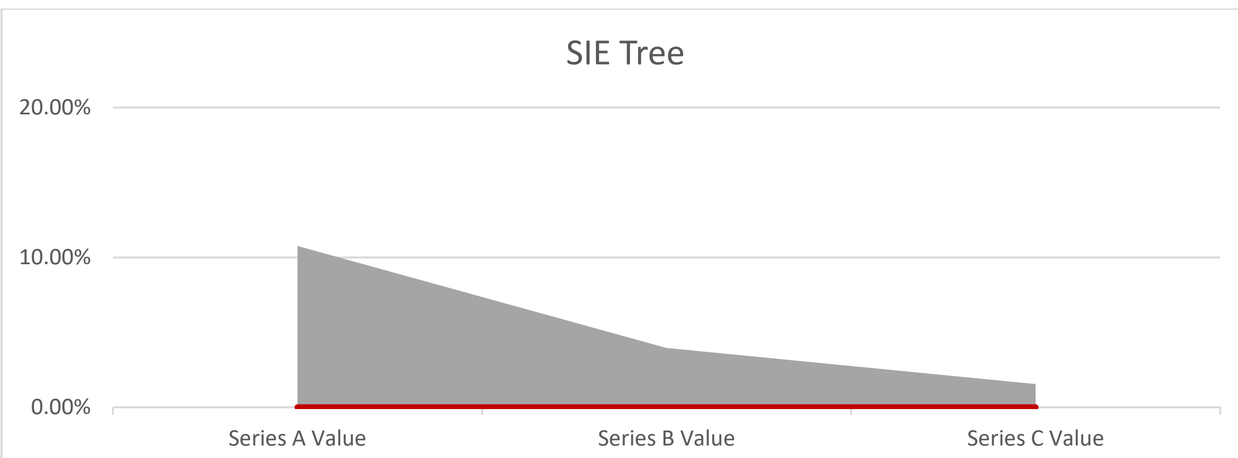


Figure D25

Probability of Success for SEI Strategy

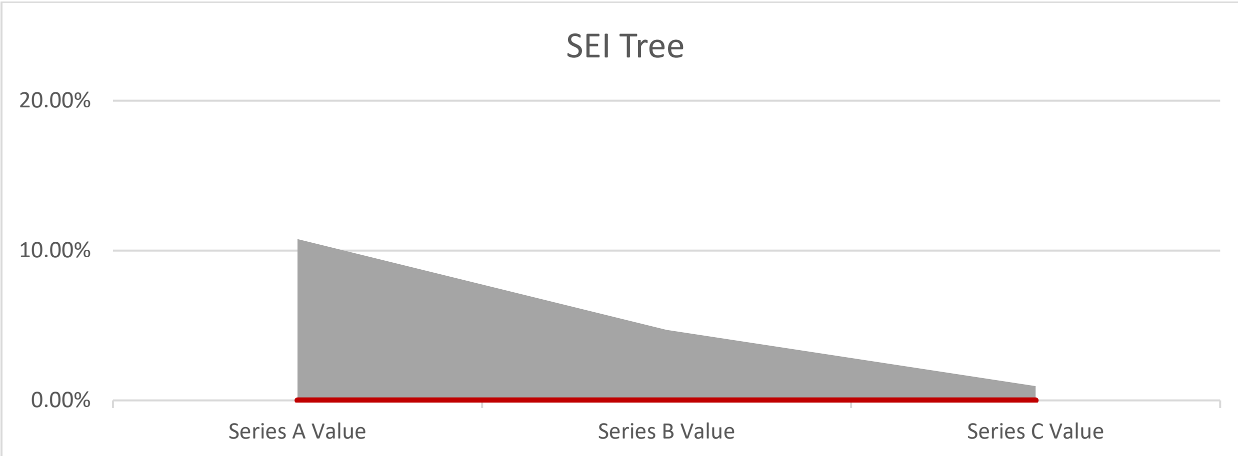


Figure D26

Probability of Success for ISE Strategy

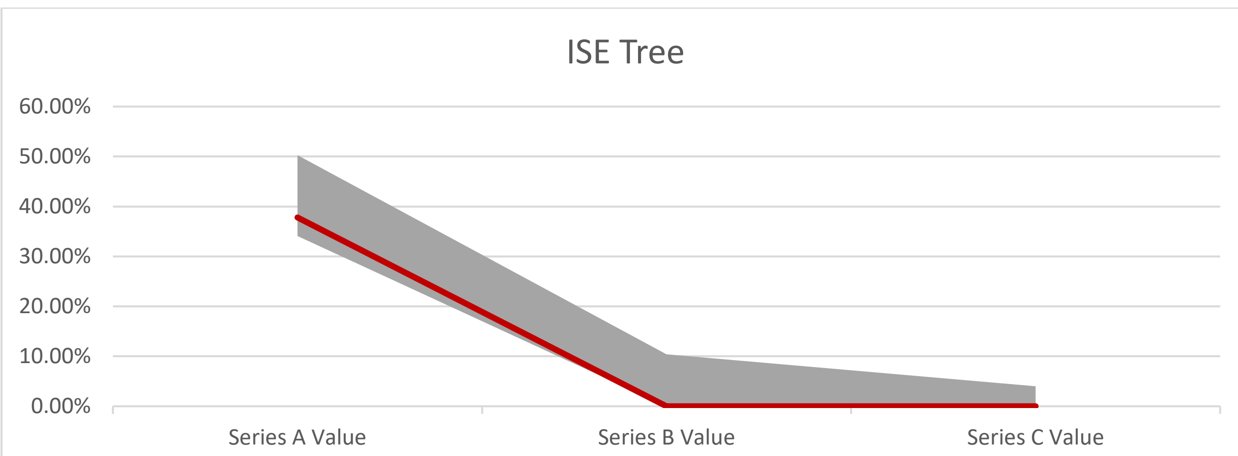
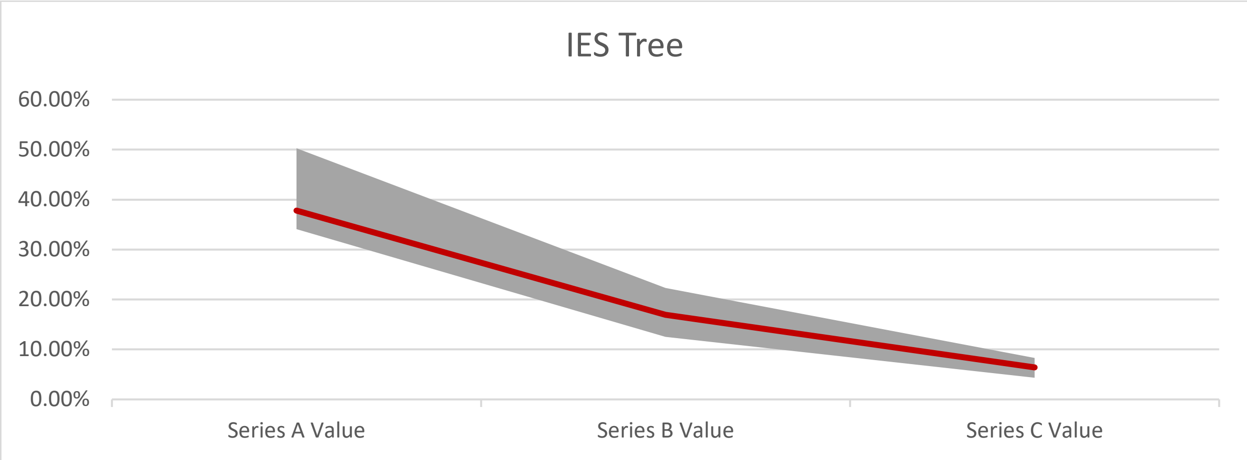


Figure D27

Probability of Success for IES Strategy



APPENDIX E. NON-RANDOM DATA FOR THE BASE CASE

Figure E1

Average Ownership Graph