Decision Tree Analysis Using Real Options to Give Value to Funding Rounds

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I. Introduction

In the dynamic realm of startups, where uncertainty and innovation intersect, the ability to navigate strategic decisions is important to the success of these emerging ventures. Within this context, the valuation of tech startups appears as a challenge, worsened by the absence of historical financial data, uncertain future performance paths, a lack of comparable benchmarks, a heavy reliance on fluctuating funding rounds, and inherent subjectivity and biases found in conventional valuation methodologies (McClure, 2023). This study hopes to develop a framework designed to empower young startup entrepreneurs with a tool that addresses the limitations of traditional valuation models for tech startups.

Traditional approaches to valuing startups often stutter when confronted with the unique characteristics of these tech startups. The scarcity of historical financial information impedes accurate assessments of performance and profitability, rendering traditional valuation techniques less effective. Due to the inherent lack of cash flow, price-to-earnings ratios, market-based approaches and Discounted Cash Flow (DCF) methods, each have significant shortfalls (Steffens & Douglas, 2007). Furthermore, traditional DCF methods have two major flaws when it comes to evaluating risky enterprises such as tech startups. The first flaw is the assumption of a constant discount rate, failing to recognize the time-varying risk profile of these kinds of enterprises. The second flaw is the failure to capture the value created by future managerial flexibility – whereby the upside of opportunities can be seized and the downside of possible risks can be minimized (Steffens & Douglas, 2007). Additionally, the volatile nature of startup marketplaces makes predicting future growth a formidable task, complicating the valuation process. The innovative technologies and distinct business strategies employed by startups further hinder the identification of comparable benchmarks, a key component in conventional valuation models. Focused on overcoming this challenge, the project introduces a decision tree analysis that intricately weaves together the intricacies of funding rounds, success probabilities, and market dynamics. The ability to account for the probabilistic outcomes is a necessity in order to value startups due to the risk involved for these enterprises. With that said, the capacity to appraise uncertainties would be beneficial in the valuation of startups. By leveraging real options theory, the researchers provide startups with a forward-looking approach that embraces the fluidity of the startup landscape.

Although success is often measured by milestones rather than traditional financial metrics, our project is at the intersection of financial modeling and forecasting. This study aims to serve as a robust tool for startups, enabling them to make informed decisions, set realistic expectations, and navigate the uncertainties inherent in valuing diverse companies. This project sets the stage for a comprehensive exploration of the challenges in valuing start-up ventures and the innovative methodologies employed to address these challenges. Through the lens of the decision tree analysis, this study endeavors to contribute to the evolving discourse on startup valuation, offering a more adaptive and nuanced framework for entrepreneurs and stakeholders in the dynamic technology startup landscape.

II. Significance of the Study

The significance of the study is seen through its innovative and practical approach to addressing the complex challenge of valuing technology startups, particularly in the context of limited historical financial data.

In the absence of comprehensive historical data, this study introduces a novel framework based on decision tree analysis, integrating real options theory to provide a nuanced valuation model for technology startups. A decision tree analysis is a powerful tool that facilitates a systematic and visual representation of decision-making processes under uncertainty. They are able to provide general frameworks for determining solutions to problems, and for managing the realized consequences of major decisions. With that said, decision trees let startups explore the raging elements that could materially impact decisions. These decision trees are composed of the forecast of major decision outcomes, the probability assessment of these outcomes, and the resulting cash flow from these outcomes. All these are noted in order for the startups to better understand the value of their real options. By drawing data on the funding rounds of 20 carefully selected Philippine startups, this approach acknowledges the inherent uncertainties in the startup landscape and positions itself as a valuable tool for entrepreneurs and investors seeking to evaluate the potential of these ventures.

By bridging the gap between theoretical valuation frameworks and the practical realities faced by startups, this study contributes to the evolving landscape of startup valuation methodologies. This study holds particular relevance for emerging tech enterprises in the Philippines and beyond, offering them a customized dashboard to navigate the intricate terrain of funding probabilities and potential success scenarios.

Moreover, the developed dashboard emerging from this study serves as a dynamic tool for young startups, empowering them to gain invaluable insights into the present value of their future options. In a landscape where historical financial data is often hard to find, the dashboard hopes to become a tool for strategy offering actionable intelligence for critical decision-making.

The dashboard acts as a visual representation of the startup's potential trajectories based on funding rounds and associated probabilities. Young entrepreneurs can readily explore diverse scenarios, ranging from highly successful outcomes to more conservative or challenging paths. This visualization not only aids in understanding the range of possibilities but also enables startups to identify key inflection points and make informed strategic decisions. Startups can input real-time data, such as the progress of ongoing funding rounds or shifts in market conditions, to continually refine their projections. This adaptability enhances the dashboard's utility, ensuring that it remains relevant and reflective of the startup's current situation.

The main dashboard hopes to become a strategic tool for young startups, guiding them through the intricacies of funding uncertainties. It transforms abstract probabilities into tangible insights, allowing entrepreneurs to make more informed decisions, allocate resources judiciously, and ultimately navigate the challenging journey of building a successful technology startup.

III. Review of Related Literature

A Real Options Model for Tech Startups' Valuation

This journal aligns with this project as it addresses the process of startup valuation, particularly within the negotiation context where founders and investors engage in determining valuation ratios and the dynamics between founders and investors. Central to both studies is the recognition of the pivotal role played by managerial flexibility and real options in the valuation process of tech startups. The utilization of decision trees to capture and quantify this managerial flexibility would be able to acknowledge the uncertainties inherent in the early-stage venture landscape.

The method outlined in the article provides a structured and systematic approach to probability assessment in the context of startup valuation, particularly focusing on three distinct scenarios: "Extremely Successful," "Successful," and "Failure." The assumption created by the article is that each business, after 7 years, will be "Extremely Successful", businesses with more than $40M in valuation, "Successful", businesses with a valuation between $40M and $10, and lastly, "Failure" business with $0 in valuation.

The probabilities are tied to the acceptance rates derived from YCombinator's experience with startup incubation. YCombinator had incubated 511 start-ups. Since it has an acceptance rate of 3–5% (companies that are chosen are given 120k USD in exchange for 7% of equity) we can say that the range of probabilities (0.03, 0.05) is also the success rate of the first fundraising campaign (Dotta, 2022). The upper and lower bounds are meticulously calculated based on these acceptance rates, offering a range within which the probabilities for each scenario lie.

The reasoning behind the assumptions acknowledges the correlation between funding and scalability. Notably, the assumption that a startup, without receiving funding, is destined to fail introduces a conditional probability framework. The method effectively considers the interdependence of probabilities associated with securing funding and achieving scalability and profitability.

In the subsequent practical application section, the article introduces a derivatives-based approach to high-tech startup valuation. The example demonstrates the differentiation in pricing options when the outcome is directed toward founders versus investors. The concept of Short Call and Long Call Options is employed, aligning with the perspective of stakeholders influencing the valuation strategy.

For this new study, the researchers aim to adapt and extend this method to develop probabilities for 20 startups based on their funding rounds. With that said, the project drew inspiration from the scenarios from this paper. Similar to the YCombinator, the first and second scenarios are "Extremely Successful", businesses with more than $40M in valuation, and "Successful", businesses with a value between $40M and 10$. The scenario outside these two i.e businesses with $0 valuations would be labeled as "Mediocre." The probability calculations for these scenarios were directly adapted from this paper. The researchers acknowledge the robustness of this approach in capturing the intricacies of startup valuation, offering a nuanced understanding of the potential outcomes and derivative implications for founders and investors. This method provides a solid foundation for our research, allowing us to tailor the approach to the unique characteristics of our dataset and contributing to the refinement of startup valuation methodologies within the real options framework.

By drawing upon the insights from the referenced journal, this study aims to contribute nuanced perspectives and refinements to the existing literature on tech startup valuation within the framework of real options. Through this journal, our project hopes to use insights to enhance the understanding of the intricate interplay between negotiation dynamics, managerial flexibility, and real options in the valuation processes of tech startups.

Valuing Technology Investments: Use Real Options Thinking but Forget Real Options Valuation

This journal provides a detailed exploration of alternative valuation methodologies for new technological ventures that challenges conventional Real Options Valuation (ROV) approaches. The journal **places a strong emphasis on incorporating the option to abandon projects post-Research and Development (R&D) expenditures**, aligning with the practical considerations found in initial funding rounds, as evidenced on platforms such as Crunchbase.

Within the proposed Decision Tree Analysis (DTA) framework, the paper introduces a set of scenarios that aims to explore the decision points that arise during the technology investment lifecycle. Instead of just focusing on what to do in successful R&D efforts, the scenarios encompass the success or failure of said R&D efforts. Giving the estimates of how much loss will happen after a failed R&D attempt and branching out what to do with a successful R&D venture. The success would then branch out to the probabilities of a good market and a poor market, though these probabilities are assumptions based on current market trends and conditions. The next decisions seen would then be to commercialize or to abandon the R&D expenditures; these probabilities are still assumptions based on market trends and conditions. Subsequent scenarios within commercialization endeavors distinguish between best, median, and poor outcomes, providing a detailed understanding of potential trajectories in positive market conditions. However, it is important to note that it is assumed that there is no chance to get the best outcome in a poor market. See figure 1 below, to better understand the paper's Decision Tree Analysis Framework. Using the NPV of the initial investment and the expected values from the probabilities, the investors are able to better understand the value of their options. This comprehensive approach acknowledges the multifaceted nature of decision-making in the technology industry.

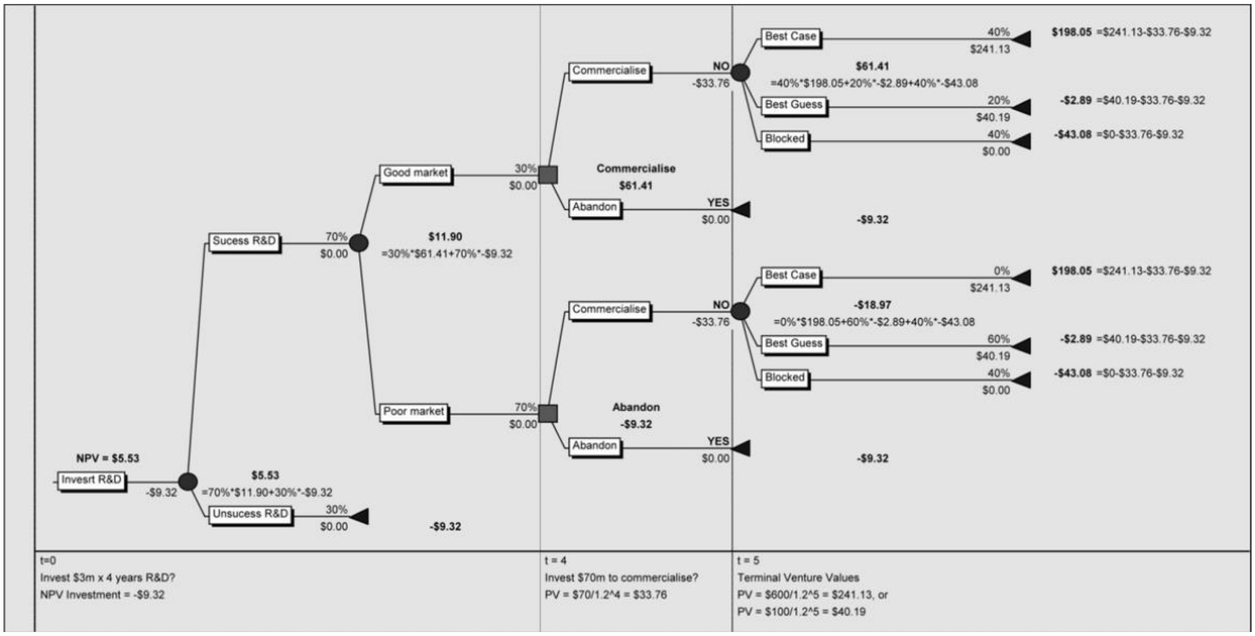

Figure 1. Decision Tree Analysis from Valuing Technology Investments: Use Real Options Thinking but Forget Real Options Valuation by P. R. Steffens & J. E. Douglas, 2007, Int. J. Techno entrepreneurship, Vol. 1, p.66 , 2007

The researchers drew multiple inspiration from this journal to be added into their study's dashboard. Beginning with the use of "commercialization" as an expansion option for the dashboard after the funding rounds. Furthermore, the researchers agree with the paper on some of the assumptions made such as the fact that the best case scenario is impossible to be achieved in poor market conditions giving it a probability of zero in the decision tree. As such, some of the assumptions in the dashboard are based on intuitive thinking on market trends and conditions. The assumption of a 10% risk-free rate provides a standardized benchmark, ensuring consistency in discounting future cash flows. Furthermore, a 10% risk-free rate is a generous assumption for the volatility found in tech startups as such the dashboard uses this as its risk-free rate.

While the paper makes assumptions about the dominance of firm-specific risk and the challenges of fully hedging such risks, it emphasizes the necessity for rigorous studies to validate these assumptions.

Technology-Based Startup Valuation Using Real Options with Edgeworth Expansion

The valuation of technology startups poses a unique challenge due to the absence of historical data, the intangibility of assets, and the innovative nature of their ventures. Traditional valuation methods, including balance sheet-based, relative valuation, cash flow discounting, and goodwill-based approaches, often fall short in capturing the strategic flexibility inherent in these startups. This literature review explores the application of real options theory, specifically utilizing the Edgeworth expansion, to address the limitations of conventional valuation methods in the context of technology-based startups.

The literature suggests that traditional cash flow discount methods may undervalue tech startups because of its simplistic assumptions. Though these methods act a significant role in mature industries, their limitations are highlighted when dealing with and assessing younger companies such as tech start ups. Unlike the business in mature industries, these tech startups are hard to evaluate due to their multitude of intangible assets, the absence of comparable companies, historical data gaps, and the difficulty in estimating volatility due to high uncertainty associated with technology-based startups. The comparative analysis in this article shows the potential undervaluation of the project when they do not account for strategic flexibility. Moreover, it suggests that the application of real options theory emerges as a promising approach to capture and incorporate the strategic flexibility inherent in entrepreneurial ventures, including possibilities like expansion or transferring licenses, rights, and patents. The proposed model overcomes the limitations of traditional methods by incorporating subjective probabilities. The researchers see that there is an importance to further create more valuation methods for tech startups. The constructed dashboard is predicated upon a comprehensive exploration of the utility and efficacy of real options within the context of technology startup valuation

IV. Methodology

Creation of Decision Tree

The decision tree of this study takes inspiration from "A Real Options Model for Tech Startups' Valuation" and "Valuing Technology Investments: Use Real Options Thinking but Forget Real Options Valuation". The decision trees both studies presented were used as starting points in the periods needed and the necessary decisions that each period entailed. Assumptions made were based on the methodology that both papers presented, but contextualized in this study through the data gathered from Crunchbase on Philippine-based Startups. It must be noted that it is not the valuation that is measured, but the amount raised through funding as a measure of success.

This study's decision tree's start is a pre-seed funding round. It asks for user input of the funds that have been gathered in this phase before it goes into two subsequent funding rounds and then a decision of expanding or abandoning the project entirely. With varying probabilities, Funding Round: Stage 1 will come to an outcome of "extremely successful," "successful," or "mediocre". This takes inspiration from "A Real Options Model for Tech Startups' Valuation" as a classification of the amount of money raised in the round. In this round, it is assumed that the company will always want to gain funding, and it is too early for them to choose to abandon the project. From this, Funding Round: Stage 2 follows the same criteria, albeit with changes. Funding Round: Stage 2 will open the option to abandon the project entirely, in the case that the funding round does not go well and the company does not have enough to continue their operations. Probabilities of the outcome of the stage are also varying, subject to a Markov Chain. After Funding Round: Stage 2, it goes into Options Round: Stage 3. In this stage, the company will choose to either expand or abandon the project. Expanding would entail a projection of an investment and the expected percentage return.

Calculating Probabilities (Stage 1)

Crunchbase was utilized to gather financial information on 20 startups in the Philippines, and information on their funding rounds was gathered, including the amount gained per funding round, total amount raised from funding rounds, and the number of funding rounds.

Company Name	Amount Earned in Funding Rounds (millions)					Total Funding	Number of Funding Rounds	Average Funding Per Round
Great Deals E-commerce	12	1400				1412	2	706
Mynt	175	300				475	2	237.5
Voyager Innovations	175	40	120	167	210	712	5	142.4
PDAX	1.1	630	50			681.1	5	136.22
Mosaic Solutions	1.5	0.6	1	1	282	286.1	5	57.22
Biocare Medical	85					85	2	42.5
Pickup Coffee	40					40	2	20
Grow Sari	14	77.5				91.5	5	18.3
Salmon	16	20				36	2	18
BillEase	11	20	20			51	3	17
Kumu Holdings	0.35	5	15	73.6		93.95	6	15.65833333
PayMongo	2.7	12	31			45.7	3	15.23333333
Inteluck	1	1	5	15	34	56	5	11.2
SariSuki	7.1	12.7				19.8	2	9.9
Edamama	5	20	10			35	4	8.75
Coins.ph	5	5	30			40	5	8
First Circle	1.2	1.3	26			28.5	5	5.7
Kalibrr	2	5.5				7.5	7	1.071428571
Qwikwire	0.125	0.5	0.4	0.1845	0.4	1.6095	7	0.2299285714
CirroLytix	0.1	0.014				0.114	2	0.057
					Avg:	**209.893675**	**Avg:**	**73.54700119**

Figure 2. Data Gathered from Crunchbase on 20 Philippine Startups

This data was then manipulated to draw out the probabilities of achieving a "extremely successful," "successful," or "mediocre" funding round. Specifically, the same metrics from "A Real Options Model for Tech Startups' Valuation" of raising more than USD 40 Million, USD 10 Million, and less than USD 10 Million were used as the baseline lower bound for achieving "extremely successful," "successful," or "mediocre" funding round respectively. Based on the gathered data of 20 notable startups in the Philippines, 6 were able to raise more than USD 40 Million, 7 were able to raise more than USD 10 Million, and 7 were able to raise less than USD 10 Million. Tumber of companies that reached each metric was then divided over the total number of companies. Computing these values for probability of achieving any of the three outcomes, there was a 30% probability that a startup would be extremely successful, 35% probability that it would be successful, and 35% probability that it would be mediocre in a funding round.

Criteria	Lower Bound of Funding per Round	Number within the range	Probability
Extremely Successful	40	6	30.00%
Successful	10	7	35.00%
Mediocre	0	7	35.00%
		20	**1**

Figure 3. Probabilities Calculated for each Criteria

Implementing Markov Chain and Sequential Probabilities (Stage 2)

Inspiration from the "Valuing Technology Investments: Use Real Options Thinking but Forget Real Options Valuation" was manifested through Funding Round: Stage 2. In this stage, the aforementioned computation of probabilities no longer hold, as the company will now have the option to abandon the project. As such, there are 4 outcomes in this stage with varying probabilities of occurrence. To account for this, user input will be needed. The model's dashboard will ask the user for a percentage value that will be a uniform increase or decrease that will alter the probabilities, based on the performance in the previous stage. These new probabilities will be used in a Markov Chain as a transition matrix that is based on the previous outcome and the intended new outcome. This assumes that progress is dependent on the previous outcome, where if you do well, you have a higher probability of doing well again, and if you do not do well in the previous stage, you have a lower probability of doing well in the next stage. For example, if you only achieve a mediocre level in stage 1, you have a lower probability of achieving high success in the next stage, as opposed to another company who achieved high success in the previous stage who has a higher probability of achieving high success in the next stage.

ROUND 2 ASSUMPTIONS		
High Success % Fund Acquired	150.00%	*input*
Success % Fund Acquired	140.00%	*input*
Mediocre % Fund Acquired	130.00%	*input*
Uniform % increase or decrease (for Markov Chain)	15.00%	*input*

Figure 4. Stage 2 Assumptions Input

STAGE 2 TRANSITION MATRIX					
		0	1	2	3
		High Success	Success	Mediocre	Abandonment
0	High Success	0.3	0.35	0.35	0%
1	Success	0.15	0.35	0.35	15%
2	Mediocre	0	0.2	0.35	45%

Figure 5. Markov Chain Transition Matrix for Stage 2

For example, Figure 5 shows a user input of 15% for the "uniform % increase or decrease" for the Markov Chain. For the row of high success, the same probabilities from stage 1 still hold. It must be noted that the probability of abandonment is assumed to be 0% if the previous stage achievement is high success as there is no reason to abandon the project if it is going well. If high success was achieved in the first stage, the probabilities for the same criteria still hold. However, things change for outcomes that are successful and mediocre, and these probabilities use the uniform increase and decrease as conditional probabilities. This is based on the concept of conditional probabilities where since an event has occurred, a shift in the probabilities of other events will occur. As such, if a company only achieved a level of success in stage 1, the 15% uniform increase or decrease will be deducted from the probability of achieving high success in stage 2 as it now becomes a conditional probability. The probability of achieving high success from a previous stage of success becomes 15%, and the deducted 15% goes to the probability of abandonment. In a similar way, if the company reaches only a mediocre level in stage 1, its probability of achieving high success and success is reduced. The probability of achieving high success from a previous stage of mediocre is further reduced by the uniform percentage decrease, which is 15% in this case, which results in a 0% probability of achieving high success. The probability of achieving success from a previous stage of mediocre is now reduced by 15% as well, which results in a probability of 20%. The total deducted probability of 15% from these two outcomes is then added to the probability of abandonment, which results in a total of 45%.

All throughout the Markov Chain, it is assumed that any deductions from the user input of decrease or increase will only go to the probability of abandonment and not the other states. The benchmark of the state is the earlier calculated probabilities based on the data from Philippine startups, so it should not go above the benchmark.

Probabilities for Expand or Abandon (Stage 3)

Stage 3 presents two options: expand or abandon. The probabilities of choosing either are purely arbitrary and ask for the user input, depending on how they think their company will choose a decision. This decision is no longer an external based decision but a choice made by the company and is therefore an arbitrary probability that is dependent on them. The choice of expansion entails an investment cost, and a projected gain, measured in the model as a percentage of their cash flow from the previous funding round. This is also a user input as expansion costs and projected gain vary per industry and cannot be set to a certain standard.

Creation of a Usable Dashboard

All of the aforementioned probabilities and the decision tree come together as a dashboard that requires user input for the model to function. As established, startups present a volatile nature with their funding metrics as there is not much financial data available at their early stages, apart from the funding they have raised. The inputs needed from the user include the pre-seed funding, their own metric for “high success” funding acquired, “success” funding acquired, “mediocre” funding acquired, uniform percent increase or decrease for the Markov Chain, the costs and profit associated with expansion, and the probability of expansion depending on the achieved level in the previous funding round. All of these data inputs are non negotiable and all must be filled for the model to work.

Amount Earned in Pre-Seed Round	100	*input, may refer to industry options*
ROUND 1 ASSUMPTIONS		
High Success % Fund Acquired	100.00%	*input*
Success % Fund Acquired	60.00%	*input*
Mediocre % Fund Acquired	50.00%	*input*
Probability of High Success	30.00%	*calculated based on PH startups*
Probability of Success	35.00%	*calculated based on PH startups*
Probability of Medicority	35.00%	*calculated based on PH startups*
ROUND 2 ASSUMPTIONS		
High Success % Fund Acquired	150.00%	*input*
Success % Fund Acquired	140.00%	*input*
Mediocre % Fund Acquired	130.00%	*input*
Uniform % increase or decrease (for Markov Chain)	15.00%	*input*
DECISION ASSUMPTIONS		
Value Percentage Increase from Expansion	60.00%	*input*
Cost Percentage Increase from Expansion	20.00%	*input*
If Highly Successful, what is the probability of Expansion	80.00%	*input*
If Successful, what is the probability of Expansion	50.00%	*input*
If Mediocre, what is the probability of Expansion	20.00%	*input*

Figure 6. Data Input Needed from the Dashboard User

Amount Earned in Pre-Seed Round	This pertains to the amount that was raised by the startup company before they started funding rounds. This could be through their own investments or from other sources.
High Success % Fund Acquired	This is an arbitrary number that must be user input. This is based on their own personal metric or their industry standards of what high success funding is. This is measured in terms of a percentage of what they were able to raise in the previous stage.
Success % Fund Acquired	Similar to high success fund acquired, this is a user input that should be lower than the input for high success fund acquired. This is also a percentage of what they were able to raise in the previous stage.
Mediocre % Fund Acquired	This is a user input as well, and is expressed as a percentage of what they were able to raise in the previous stage. It is lower than the percentage of high success and success.
Uniform % increase or decrease (for Markov Chain)	This asks for the user's input to decide the decrease in achieving a state in stage 2, given a certain outcome in stage 1. The probability

	input is deducted from the original probabilities of achieving high success, and success, based on the state achieved in stage 1. The deducted amount is then transferred as an increase to the probability of abandonment.
Value Percentage Increase from Expansion	This is a user input that will be used to compute how much the company will make from the decision of expansion. The percentage input will be multiplied to the total sum of money raised from the funding rounds and the pre-seed round.
Cost Percentage Increase from Expansion	This is a user input that will be used to compute how much the company will spend for the decision of expansion. The percentage input will be multiplied to the total sum of money raised from the funding rounds and the pre-seed round.
If Highly Successful, what is the probability of Expansion	This is a user input of their own probability of expanding given a high success outcome in stage 2.
If Successful, what is the probability of Expansion	This is a user input of their own probability of expanding given a success outcome in stage 2.
If Mediocre, what is the probability of Expansion	This is a user input of their own probability of expanding given a mediocre outcome in stage 2.

Preliminary Simulation

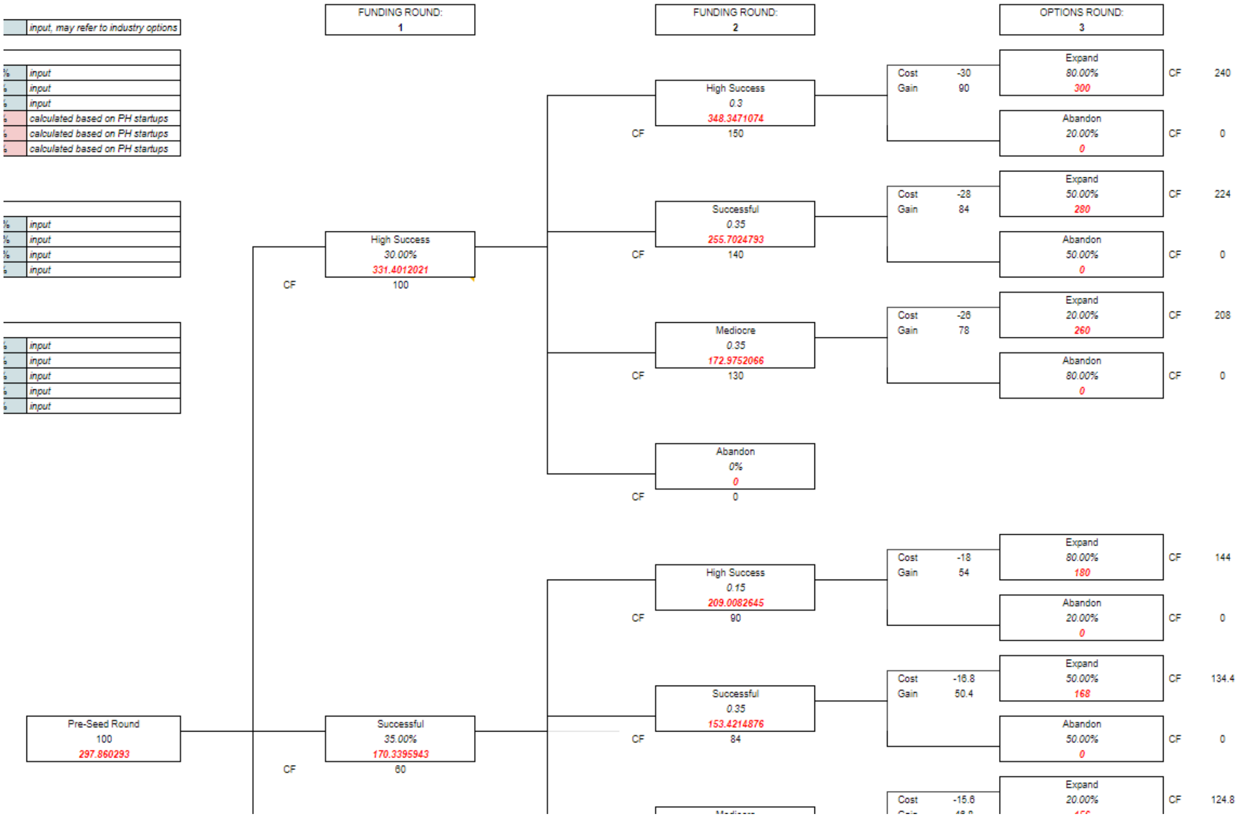

Figure 7. Preliminary Simulation

A preliminary simulation was done to ensure that the model works and all the inputs are coded in such a way that it is automated and referenced. Users will have the liberty to input any data, and the results will yield the present value of the funds. For this model, it was considered that the Seed Round Funding would be round 1, and the Series A funding round would be round 2 so on and so forth. The cash flow for each classification of funding was calculated through multiplying the respective multiplier for each classification, which was denoted by the input of % Fund Acquired. The present value was then calculated through getting the expected return for each cash flow with their respective probabilities and adding the current cash flow for the current round. Then, the value obtained was divided by the risk free rate which was assumed to be 10%. It is important to note that for each round, the risk free rate was raised to the exponent of the current round. At the end of the simulation, the cost and gain from the expansion was deducted from the present value of round 3. After all calculations, the net present value can be obtained through the value on the pre-seed round.

V. Analysis and Discussion

Given that the dashboard is now usable, an initial simulation was done apart from the preliminary simulation. This was done in order to use inputted values based on actual data on start-ups and studies. The present value of the funding was calculated through the inputs which will be discussed.

The first input would be the amount of funding in the pre-seed round. From the initial simulation, the rationale for this value would be the average of the first column of funding from the Crunchbase data of start-ups. The assumption here is that the first column of funding would be the pre-seed round. With that, the value used for this input was 27.75875 (in millions).

Moving forward, the next input would be the percentages of a high success, success, and mediocre success of acquiring funds for round 1. This serves as the multiplier for the next round of funding based on the previous round. For the rationale of the values in the initial round, the averages of change from the pre-seeding to the first round (1st column to 2nd column) in the Crunchbase data of start-ups was obtained. These were then classified accordingly based on the three classifications (high success, success, and mediocre). This yielded in a multiplier of 0.4x, 2x, and 120x. In addition, a study also stated that successful ventures tend to have a multiplier to their funding of around 3x - 5x (Hirai 2007). Given that a multiplier of 120x might seem aggressive, the study was instead used as the basis. As such, the assumption for the multipliers were 0.5x, 2x, and 5x respectively for each classification of funding. The same assumption applies for round 2.

The next input would be the uniform percentage of increase or decrease in the probabilities of each classification of funding. This was made arbitrary and based on the Markov Chain, in which the assumption was that the value would be 15%. Additionally, the multiplier for the cost and gain from expansion were made arbitrary as well. The last input would be the value and cost percentage increase from expansion. This growth varies widely based on numerous factors such as the type of industry, market conditions, quality of product/service, and the goals in the business plan. The assumption was that this would range from around an increase of 20% to 100%. As such, the inputted values were 60% and 20% for the value and cost percentages respectively which was loosely based off of that assumption.

With that being said, the start-up company using this dashboard can now determine their possible present value for funding through this simulation of a decision tree analysis. In this simulation, the funding had a present value of 357.24 (in millions). The results of this analysis would largely be influenced by the input of the start-up company. It is also important to note that funding is a debt, in which it would be pertinent for a start-up company to be aware of their potential debts. This dashboard can serve as a scale on whether a start-up company is already too aggressive on acquiring funds, or needs to be more aggressive. In addition, it would be a good visualization as to what possibilities are there for the start-up when it comes to funding.

VI. Recommendations

The developed dashboard serves as a valuable tool for evaluating tech startups, offering a structured and systematic approach to decision-making in the complex landscape of early-stage ventures. By drawing inspiration from established models such as YCombinator, Real Options Thinking and incorporating specific data from Philippine startups, the dashboard provides a tailored solution for the local investors.

However, as with any analytical tool, there exist opportunities for refinement and enhancement. The current version of the dashboard primarily focuses on fundraising success and its financial implications, specifically measuring the amount raised as a metric for success. While this is a significant aspect, there is room for improvement in capturing a more comprehensive set of success metrics and incorporating a broader range of scenarios. Due to the volatility of tech startups, it is important to consider more scenarios to ensure more flexibility and a clearer overall picture of the market. This could include additional funding rounds after expansion and abandonment options and an additional option to delay, where cash flow is maintained, instead of just expanding or abandoning.

Just like the proposed model, as outlined in the article "Technology-Based Startup Valuation Using Real Options with Edgeworth Expansion," the challenges outlined in the article are similar to the issues faced by the researchers in attempting to value tech startups knowing that there is an absence of traditional financial metrics. The proposed model addresses this challenge by implementing subjective probabilities and the Marketed Asset Disclaimer (MAD) approach. As such, implementing the MAD approach inside the dashboard may see benefits in being an overall versatile and robust tool for startup valuations.

One of the dashboard's advantages is its versatility especially working towards the probability as it is user-input based. However, this could be further improved by finding numbers on growth and different assumptions backed up by research articles rather than it being arbitrary or market intuition based. This information can then be incorporated to the dashboard making it more robust.

The project used the financial information of 20 Philippine startups, this could further be enhanced by segmenting companies by industry. Furthermore, providing average seed rounds per industry segment will assist investors in valuing seed rounds based on the unique characteristics of each industry, offering tailored insights. With that said, an expansion of sample size will also give the dashboard more accuracy as it provides a better probability estimation.

One of the unique aspects of this dashboard is the presence of a Markov Chain of Probability. With that said, the implementation of the Markov Chain can be further enhanced. With further research, it can be enhanced by finding research material that proves how the uniform distribution of the % increase/decrease affects all options rather than just allocating it to the abandonment. Additionally, with further research and understanding of market conditions, a Markov Chain of Probability may be implemented in the % expansion and abandonment found at the end of the dashboard.

VII. Conclusion

The valuation of tech startups has posed a unique challenge due to the absence of historical financial data, uncertain future performance paths, and the inherent volatility of the startup ecosystem. This paper explored the difficulties of using traditional valuation methods like the DCF methods when it comes to the task of valuing tech startups. The paper aimed to address these challenges by developing a decision tree analysis dashboard infused with real options thinking, creating a user-friendly dashboard tailored for the Philippine tech startup landscape.

The methodology employed in this study was a blend of insights drawn from YCombinator, existing research papers, and real-world data from Crunchbase on Philippine startups. It embraced a forward-looking approach, incorporating real options theory to capture the strategic flexibility inherent in startup ventures. The working dashboard, inspired by proven models and customized for the local context, allowed for a systematic evaluation of funding probabilities and potential success scenarios.

The analysis and discussion section delved into the practical application of the decision tree through a simulated scenario, offering a glimpse into the potential present value of funding for a startup. It revealed the dashboard's utility in visualizing diverse funding trajectories, aiding startups in understanding the range of possibilities and making informed strategic decisions.

The strengths of the dashboard, such as its adaptability and user-friendliness, were highlighted. It was shown to be a valuable tool for startups to navigate uncertainties, explore funding scenarios, and gain insights into the present value of their future options. The simulation emphasized the influence of user inputs on the results, reinforcing the importance of informed decision-making by startup stakeholders.

While the developed dashboard provides a solid foundation for startup valuation, there are areas for future refinement and enhancement. The emphasis was placed on incorporating a broader range of success metrics, considering more scenarios, and conducting additional research on growth and assumptions to strengthen the model's robustness and versatility. Segmenting startups by industry and providing industry-specific average seed rounds was identified as a crucial recommendation. This tailored approach ensures that the dashboard considers the unique characteristics of each sector, offering more accurate insights for both entrepreneurs and investors.

In conclusion, this study contributes to the evolving discourse on startup valuation by providing an innovative and practical tool for tech startups in the Philippines. The significance of this study lies not only in its theoretical underpinnings but also in its practical application, offering startups a dynamic framework for decision-making in an uncertain environment.As the startup ecosystem continues to evolve, this research aims to offer valuable insights and methodologies. The adaptive and nuanced approach to startup valuation, coupled with user-friendly features, positions the developed dashboard as a valuable resource for startups navigating the complexities of early-stage funding. This project, therefore, stands as a testament to the synergy of theoretical concepts, practical considerations, and the ever-changing dynamics of the technology startup landscape.

VIII. Bibliography

Chi, T., & Huang, Y. (2023). The application of real option approach in International Business Research. *Oxford Research Encyclopedia of Business and Management*. doi:10.1093/acrefore/9780190224851.013.337

Dotta, P. (2022). A real options model for a tech startup valuation. Retrieved from https://altar.io/real-options-model-tech-startups-valuation/?fbclid=IwAR2PezuIXZgK_g72IFWxW2hvzTqRI7jS9cPa8gk6ZhDAjMS7ioi0Qz03eJg

Hirai, A. (2007). Valuing pre-revenue companies - Angel Capital Association. https://angelcapitalassociation.org/data/Documents/Resources/AngelCapitalEducation/ACEF_-_Valuing_Pre-revenue_Companies.pdf

McClure, B. (2023). Retrieved from https://www.investopedia.com/articles/financial-theory/11/valuing-startup-ventures.asp#:~:text=Lack%20of%20Historical%20Financial%20Information,result%20of%20this%20data%20shortage.

Milanesi, Gastón & Pesce, Gabriela. (2013). TECHNOLOGY-BASED STARTUP VALUATION USING REAL OPTIONS WITH EDGEWORTH EXPANSION. Journal of International Financial & Accounting. 1. 54-61.

Pinkasovitch, A. (2021). Retrieved from https://www.investopedia.com/articles/financial-theory/11/decisions-trees-finance.asp

Steffens, P. R., & Douglas, E. J. (2007). Valuing technology investments: Use real options thinking but forget real options valuation. *International Journal of Technoentrepreneurship*, *1*(1), 58. doi:10.1504/ijte.2007.013270