A Beginning Framework for Scholarship Valuation

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Introduction

In Finance, any properly priced financial instrument is priced to risk. This means price and risk are synonymous. If price is not representative of the risk profile, either a lot of money is about to be lost or a lot of money is about to be made because the price-risk balance is out of whack. This writing is an examination of a potential risk-price framework for scholarship money. The framework relies heavily on a "Discount Rate" that acts as a two way indicator of price and risk. Discount Rates are how prices of Fixed Income Securities (like US Gov't bonds, Tesla Corporate Debt, etc…) are quoted. This framework will not evaulate how "good" a player is, how a player's scholarship allocated fits in with the rest of the portfolio (that will come soon), or even if it is wise to invest in a player at x% scholarship (that revolves around risk appetite). What this framework will potentially do is standardize an evaluation of if scholarship money is performing or not.

Risk Case Study

Company A, Company B, and Company C are all looking to borrow money from one investor each. All three companies will pay back the investor in one year with one payment of 1,050,000. The companies do not know how much Investors will pay for 1,050,000 a year from now. So the companies call up all the investors and will choose the investor that is willing to pay the most for $1,050,000 a year from now. Investors need to assess the risk of each company and arrive at a Discount Rate to discount one cash flow of $1,050,000. This Discount Rate should be representative of downside risk and the chance that the chosen investor does not get their money back at the end of the year. A higher Discount Rate would mean higher chance of losing money, at the same time a juiced return in the event the company makes good on its promise because they paid less. The Discount Rate is what determines how much investors pay today for $1,050,000 a year from now. The price investors will pay for $1,050,000 calculation is as follows:

Price paid for \$1,050,000 = $\frac{1{,}050{,}000}{(1+R)}$ $where\ R = Discount\ Rate$

So lets examine some back of the napkin risk assesments of the 3 companies:

Company A: Car Manufacturer. All this company does is make money. Across the Globe in all geographic markets, they have cars that appeal to all walks of life. They are efficient, and make money on every car sold. The executive team told investors the money would be used to allocate more money to self-driving car technology. Investors get excited at the prospect of lending money to this company. Still, crazy things happen in the corporate world…

Company B: Brick and Mortar Apparel Retailer. This company has historically made good on all its promises with regards to borrowing money and has been profitable since the beginning. But the past is unfortunately not an indication of future success in this industry, with the emergence of online shopping. The company has failed to adapt, and the executive team told investors the money would be used to retire the leases of non-performing locations that are losing money. Investors think they will get their money back because the company has plenty of assets to utilize, but the future does not look promising.

Company C: Fast Food Restaurant chain. This company is bleeding to death on the side of the road. The company is in the middle of multiple lawsuits regarding its food preparation methods, the company has not been profitable in 5 years, and the CEO has just resigned. The fill in executive team has told investors that the money would be used to pay off existing debts. If the company does not get the money, the prospect of Chapter 7 Bankruptcy is very real.

The three executive teams assesed the bids that came in. The executive teams will take the money from the investors that assigned the lowest discount rate, because they decided to pay the most for the promised $1,050,000 one year from now. The chosen investors paid Price "X" for 1,050,000 one year from now, using Discount Rate "Y" after assesing the upside and downside risks.

Company A: $\frac{1{,}050{,}000}{(1+.0355)}$ = 1,014,002

Company B: $\frac{1{,}050{,}000}{(1+.0470)}$ = 1,002,865

Company C: $\frac{1{,}050{,}000}{(1+.1342)}$ = 925,762

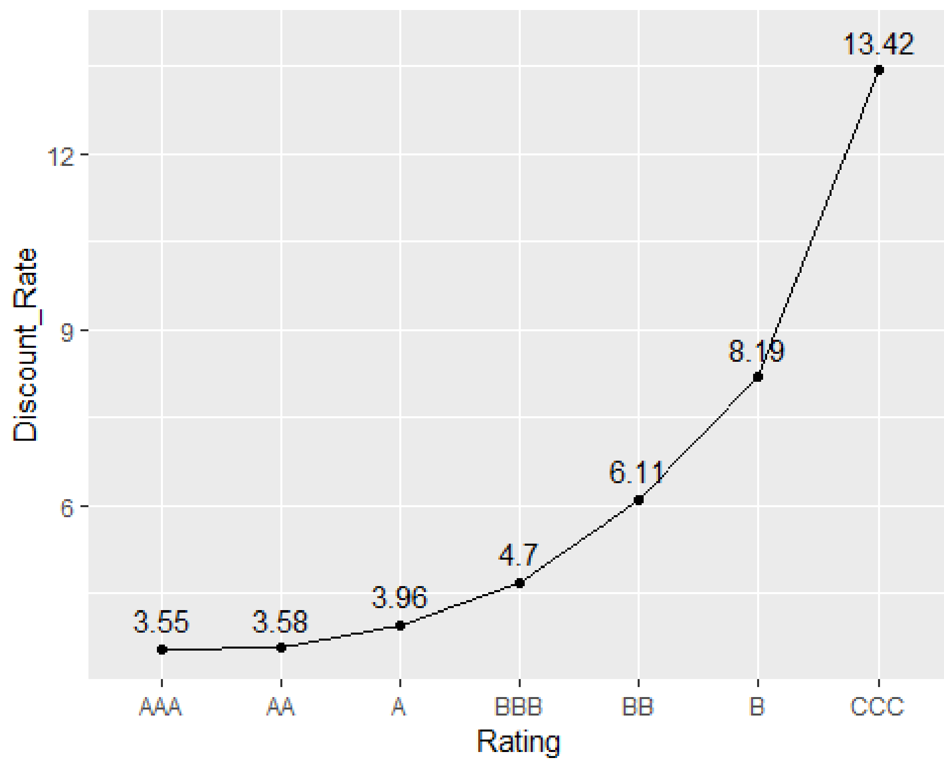
This is not an exploration of if investing at these Discount Rates is a good decision. This is a discussion of how risk is what drives price, price and risk are synonymous. The Discount Rate Company C received is because investors believe the probability of a downside risk event (not paying back investor) is greater than for Company B or A. **But people think of risk as an exclusively downside idea, but it is not. If all 3 companies make good on the $1,050,000, the investor in Company C made the most money. The higher Discount Rate means paying less for the same $1.5m in cash flow. More risk always (hope to God) means more potential reward. Investors MUST be compensated for taking on more risk if their bets work out.**

Just a little more Finance

Company C could not borrow at the rate Company A could. The probability of experiencing a downside risk event is hgher for Comapny C than Company A. The investor market settled on the 13.42% Discount Rate for Company C. Once again, this is not an analysis of if that was a good investment. But if you are wondering if there is a systematic set of ratings that investors give borrowers, there are. Multiple rating agencies publish their rating systems/methodologies and apply them to companies. Bank of America/Merrill Lynch goes a step further and publishes Discount Rates observed in markets for different ratings of borrowing entities (Companies, Governments, Banks, etc…). I pulled the Discount Rates for end of day 12/20/2018 , they are as follows:

```
##   Rating Discount_Rate
## 1    AAA          3.55
## 2     AA          3.58
## 3      A          3.96
## 4    BBB          4.70
## 5     BB          6.11
## 6      B          8.19
## 7    CCC         13.42
```

In the spectrum, AAA is the safest credit rating, and CCC is most dangerous. Company A is AAA and Company C is CCC. Visually, the relationship between the Bank of America/Merrill Lynch published Ratings and Discount Rates is as follows:



This visual shows that there is a relationship between risk and discount rate. A higher level of risk means a higher Discount Rate. investors in markets are applying about a 3.5% discount on cash flow lent to AAA companies and a much higher 13.42% on the risky companies. For the same amount of cash flow, an investor investing in CCC companies will make 10% more. But there is a greater potential of downside risk event for CCC companies. Moving forward with the understanding that the greater risk would require a higher discount rate, lets start examining what a potential framework like this would apply to scholarship valuation.

Baseball, Finally

Lets imagine for a bit, imagine the scale of Baseball players the USF Baseball program could offer scholarship dollars to in exchange for a roster spot and production. Imagine that USF Baseball is the investor, and the players are the companies that need money. Players are looking for a place to play and an education. USF Baseball is looking for players that hopefully will at least perform to the level of their level of borrowing. So:

Player A: Shortstop. 6’2 215 pounds. Player A moves like a tank and a shark at the same time. Is already a 5 tool player. Player A is a Baseball rat through and through. Mental makeup is great. Professional scouts are all over him, but he wants to continue his Jesuit education.

Player B: Outfielder 5’10 175 pounds. Player B has an exceptional speed tool and can play all three outfield positions adequately. His hit tool is average and power tool is non-existent. But the coaching staff figures that with 2 years of practice repetition, summer ball, and spot starts that this player will be an above average all around player and potentially all-WCC type player.

Player C: Pitcher. 6’4 185 pounds. Player C is not ready to pitch at the Division 1 level. Player C long tosses 400 feet and puts on fun to watch pull down phases. But for some reason when he gets on the mound, the train comes off the rails. No control and/or command of offspeed of any kind. His fastball is inconsistent at best, but for about 10 pitches in a game, his fastball and mechanics show flashes of elite potential. He is a project, and at this point should not be relied on to contribute meaningful innings for a while.

The 3 companies in the example earlier carried different levels risk, and the 3 players in the example above carry different levels of risk. Lets experiment a bit and replicate the pricing process of the discounted future cash flow for the investment opportunity for application to Baseball players.

Simplified Framework and Model for computing moving Discount Rates

We need ratings: For consistency, lets use the ratings from Finance: AAA, AA, A, BBB, BB, CCC. This is not a final proposal, but just an example. So we have to seperate players into AAA, AA, A, BBB, BB, CCC catagories. The rating assigned is two pronged: How much is the player receiving in scholarship? And to what rating is the player performing? The intuition can be stated like, “**Player X is performing at a “AA” level, but we are only allocating “A” level money to him**”. Lets explore further.

We can start by taking down the ratings. For this example, lets divide up the entire WCC player population into the 7 buckets from best performing to worst performing:

AAA 1.00 - .833

AA .833 - .666

A .666 - .500

BBB .500 - .333

BB .333 - .166

CCC .166 - 0

The numbers above refer to a systematic and equal distribution of discount rates (1-Discount Rate). This can be adjusted and probabily will, but for the analysis and to get the model framework running, these will do. These are rankings of risk and performance. The AAA's being the best performing and/or least risky. CCC's being the players that have not performed and/or deemed riskiest.

We need Discount Rates: There is risk in lending a 90% scholarship to a player. There is also risk in lending a 25% scholarship to a player. But lets think about Discount Rates for a second. In order to value an investment, in our case offering a scholarship to a player, we need to price synonymously to the risk profile of the player. Setting aside the occasions where overpaying out of NEED is necessary, the goal should be to price to risk. **Pricing to risk involves utilizing Discount Rates to factor in the downside risks of future performance of an investment. The higher the Discount Rate the higher the chance of experiencing downside risk event**.

For example, and I know this does not entirely mimic reality, but lets think that allocating 100% scholarship was "risk free". The 100% scholarship level player is expected to perform in the top tier of "AAA" level throughout his career at USF. If this player is "risk free", he should receive absolutely no discount. How about a player receiving 90%? We would expect the player to also perform at a AAA level, but why did we not allocate 100%? Because we believed the 90% player carried just a bit more risk than the "risk free" player. Specifically, we believed that there was a 10 percentage point difference. So far, we can calculate the Discount Rate as:

Signing Discount Rate = 1-(% schoarship allocated)

In our case, the Discount Rate is a spread. It is the spread distance from the Risk-Free Rate (100% scholarship). Our relationship still holds that higher risk players (lower scholarship allocated) receive higher discount rates, and lower risk players (higher scholarship allocated) receive a smaller discount.

Something we need to address is the issue of playing time. If an AA level 75% scholarship signed player only played in the 25th percentile of innings pitched/plate appearances/etc… for his position, we need to adjust for that. I propose a simple and linear method that I think should work. If we were taking pitchers, lets examine the percentiles of innings pitched in the WCC:

```r
as.data.frame(quantile(wcc_pitchers$IP, probs = seq(.1,1,by=.1)))
```

```
##      quantile(wcc_pitchers$IP, probs = seq(0.1, 1, by = 0.1))
## 10%                                                       3.1
## 20%                                                      10.1
## 30%                                                      16.2
## 40%                                                      24.0
```

```
## 50%                                                        31.1
## 60%                                                        38.2
## 70%                                                        48.0
## 80%                                                        62.2
## 90%                                                        83.0
## 100%                                                      118.1
```

In the table, a pitcher in the 50th percentile of Innings pitched, threw 31.1 innings. A pitcher that pitched in the 90th percentile threw 83 innings. We can create an adjustment for this playing time aspect of discounting. Our revised calculation for Discount Rate is here:

Playing Time Adjusted Discount Rate = (1-(Scholarship Allocated %)) + (Playing Time Actual - Playing Time Expected given Scholarship Allocated)

The second portion is more so an adjustment. It will come together soon.

A Quick Trip Back to Finance

Company A was our AAA rated company to lend to. But what if we lent the money, and two months after, we learned the feds were investigating potential accounting fraud for the company? And two weeks before that, the entire executive team had used company funds for employing the services of strippers after an investor conference in Las Vegas. Our opinion of the company has changed. The company may still be AAA rated, but our assesment of the risk has changed. Therefore, Discount Rate and Price of the future cash flow have changed. In Finance, **Discount Rates change every day, and we need to be flexible in monitoring investment performance. When Discount Rates change, we make or lose money in the form of opportunity cost. When Discount Rates on our investment move down, we have made money, and when they move up we have lost money in the form of opportunity cost. I will bring this all together in an example next.**

For our Baseball scholarship evaluation, we do not have a “market” to move Discount Rates. We need to come up with our own methodology that produces a Discount Rate, that moves with performance. To start, in this analysis lets just use a sample statistic. In the coming examples, I will use WHIP (Walks and Hits per Inning Pitched) for pitchers. This is an arbitrary statistic, and is mainly being used for the example. As a pitcher’s WHIP changes, so will his Discount Rate. If we sign a player to 50% scholarship, we are using the 50th percentile of WHIP as the benchmark of performance. When we observe the pitcher’s actual WHIP, we can adjust the discount rate and assess if the pitcher is performing to his scholarship.

Performance Adjusted Discount Rate = (1-(Scholarship Allocated %)) + (Expected Playing Time Percentile Given Scholarship Allocated - Actual Playing Time Percentile) + (Expected Performance Percentile Given Scholarship Allocated - Actual Performance Percentile)

I am not entirely confident in this calculation, yet. I think the intuition is sound, but things get out of control real fast when dealing with multiple additions and subtractions of decimals. And for this analysis, we are basing a player's entire performance from innings pitched and WHIP, which is not representative of reality. I will work to develop a better, more robust calculation for a player's discount rate. Therefore, we are able to reconcile prices we are paying in scholarship with the risk and performance profile. But lets see what some intuition would sound like:

2018 Joey Steele

```
wcc_pitchers %>%
  filter(Name == "Steele, Joey") %>%
  filter(Year == "201718")

##           Name Class   Year School     Pos App GS CG W L SV ShO IP  H  R
## 1 Steele, Joey   Jr. 201718    USF Pitcher  16  1  0 0 2  0   0 20 19 11
##   ER BB SO  ERA WHIP header
## 1  7  8 22 3.15 1.35   TRUE
```

Per the scholarship allocation spreadsheet, Joey Steele is being allocated xx% scholarship. For the scholarship allocated, **Joey Steele is rated BB by risk. A player allocated xx% scholarship should be riskier than a player allocated yy%, all else held equal**. For the price we signed Joey after his recruiting cycle, Joey Steele should be a relatively risky player if xx% was the best price he received on the open market. Or perhaps there are external factors such as family income, commitment to Jesuit education, desire to live in SF, etc… and we have signed him for a great price! Before the season begins, lets see what Benchmarks Joey has to hit to outperform his scholarship allocated.

```
as.data.frame(quantile(wcc_pitchers$IP, probs = .xx))

##     quantile(wcc_pitchers$IP, probs = 0.xx)
## xx%                                    13.2

as.data.frame(quantile(wcc_pitchers$WHIP, probs = .xx))

##     quantile(wcc_pitchers$WHIP, probs = 0.xx)
## xx%                                 1.864812
```

You may be wondering, why I set the WHIP percentile to .xx. WHIP is a statistic where a lower number is desirable. For pitching statistics where lower numbers are more desirable, we have to work backward. Until I can develop some code, I will have to utilize the base function for cranking out percentiles.

Back to Joey, if all we were looking at was Innings Pitched and WHIP, Joey would AT LEAST need to pitch 13.2 innings and have a WHIP of 1.864 to perform to his xx% scholarship. Prior to the 2018 season, Joey's signing Discount Rate is equal to .xx. Joey is supposed to be very risky. This is reflected in the price we paid. Lets compute Joey's performance adjusted Discounted Rate and see how significantly it moves Joey's rating.

Joey pitched 20 innings in 2018 and had a 1.35 WHIP. He outperformed both numbers! Lets dig deeper.

Performance Adjusted Discount Rate = (1-(Scholarship Allocated %)) + (Expected Playing Time Percentile Given Scholarship Allocated - Actual Playing Time Percentile) + (Expected Performance Percentile Given Scholarship Allocated - Actual Performance Percentile)

Joey Steele's Performance Adjusted Discount Rate = (1 -.25) + (.25 - .35) + (.25 - .75) = .15

In our framework for evaluating Joey Steele, we paid Joey Steele at a xx% Discount Rate (xx% scholarship). Adjusting his 2018 Innings Pitched and WHIP, he came in at yy% (yy% scholarship performance). From our simplified model of reconciling cost to performance, if Joey Steele were to hit the recruiting trail upon with his new discount rate, our model says he would command xx% scholarship. He started at BB level and ended up at AAA. level Is Joey Steele really a AAA level pitcher? Tough to say, perhaps he is. But since this is an oversimplified model, I would be skeptical. The equation gives unequal weight to the great WHIP number versus his innings pitched. Is he outperforming his xx% scholarship? That I would say yes to. But I want to know by how much.

2018 Daniel Slominski

```
wcc_pitchers %>%
  filter(Name == "Slominski, Daniel") %>%
  filter(Year == "201718")

##                 Name Class   Year School     Pos App GS CG W L SV ShO   IP
## 1 Slominski, Daniel   Jr. 201718    USF Pitcher  18  4  0 3 2  0   0 32.1
##    H  R ER BB SO  ERA     WHIP header
## 1 32 17 16  9 28 4.45 1.277259   TRUE
```

Per the scholarship allocation spreadsheet, Daniel Slominski is being allocated xx% scholarship. Per the scholarship allocated, **Daniel Slominski is rated AA** prior to any performance. For the price we signed Daniel after his recruiting cycle, he should be a relatively risk free player with the expensive xx% price paid. Before the season begins, lets see what Benchmarks Daniel has to hit to outperform his scholarship allocated.

```
as.data.frame(quantile(wcc_pitchers$IP, probs = .xx))

##     quantile(wcc_pitchers$IP, probs = 0.xx)
## xx%                                   49.68

as.data.frame(quantile(wcc_pitchers$WHIP, probs = .xx))

##     quantile(wcc_pitchers$WHIP, probs = 0.xx)
## xx%                                    1.3572
```

Per our simple model, Daniel needs to hit 49 innings pitched and bring in a 1.35 WHIP. He hit on bringing in a 1.28 WHIP (in the 80th percentile), but unfortunately for 72% scholarship, Daniel was expected to produce 49 innings and only produced 32 (in the 51st percentile). Lets see how he ended up:

Daniel Slominski's Performance Adjusted Discount Rate = (1 -.72) + (.72 - .51) + (.72 - .80) = .41

Daniel Slominski was downgraded from AA to A, given his performance adjusted discount rate. In a made up world where he could hit the recruiting trail with this information, our model would say he has not performed to the level of a xx% scholarship. We paid a xx% scholarship but really got xx% scholarship in production.

In Conclusion

So perhaps we "overpaid" for Daniel Slominski's production in 2018 (and by xx% per our model). Why is it so important to know? If we can measure by how much we overpaid, we can examine the opportunity cost. If we can develop a robust calculation of discount rate, that acts as a two-way indicator of risk and price, we can continually monitor scholarship performance. We can perform calculated analysis of how efficient our decisions have been, in what instances we misunderstood risk and perhaps overpaid, and in what instances we were able to successfully mitigate losses by seeing other players perform above their allocation %. The intuition takeaway should not be, "We should only allocate maximum of 50% to players so we do not observe any losses". This framework is simply a way to measure, not provide yes/no answers to something like the allocation% of a player. With a calculated process and framework for analysis of players performing above or under their scholarship allocated, we can evaluate present and past mistakes and successes in pricing (scholarship allocation decisions) with the end goal of measuring how cost efficient our decisions are.