**An analysis of debt beta and equity beta for publicly and non-publicly traded food and agriculture companies**

by

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## ABSTRACT

Is there a difference in risk between public and private companies that borrow funds using bonds? The purpose of this thesis is to determine differences in the market risk of companies that are both public and private. Food and agricultural firms are selected for analysis and are viewed using a four-year observation for five-year time intervals on a weekly and monthly basis. The relative risk of these companies is determined in three different ways. The first two ways are by analyzing company bond price changes with the S&P 500 or thirty-year treasury bond prices to determine the debt beta and beta, respectively. The third way is by using the equity beta that is determined with this same set of companies by using the publicly traded, adjusted close prices from Yahoo Finance for each company and the S&P 500.

It was found that the debt beta and beta were relatively low, at or close to zero, showing little systematic risk. This means when looking at companies from a bond borrowing standpoint, much of the risk will be unsystematic risk from the company itself. When analyzing the equity beta, the three publicly traded companies track close to one another. There is more systematic risk with the equity beta with it being relatively close to one for each company, meaning these companies are more likely to move with the market.

This study shows that there is a stronger relationship with the equity yield to the market than the debt yield. Both the slope (beta) and R-squared are higher when comparing the monthly bond rate to the 30-year treasury than to the S&P 500. Over time, the volatility of the debt and equity betas remain relatively unchanged, with the exception of early COVID-19 influence.

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## ACKNOWLEDGMENTS

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# CHAPTER I: INTRODUCTION

Firms of all sizes use bonds and banks to raise debt capital for expanding their businesses, with needs ranging from purchasing equipment/ property to working capital for operating activities. Debt capital brings different levels of risk to entities that are both publicly traded and non-publicly traded. With rising levels of interest rates, it is helpful to see where the levels of risk and uncertainty lie when comparing these two different borrowing options for different kinds of agricultural entities that are both publicly and non-publicly traded.

There are banks that have a close relationship with the debt they hold and then there is bond financing that relies on publicly available information (De Fiore and Uhlig 2011). Information used for bond financing typically is public, but some companies in agriculture are non-publicly traded companies. It is known that high yield corporate bonds behave differently from government and investment grade bonds (Aslanidis, Christiansen and Cipollini 2019). Because of this, it is interesting to see how the different debt betas compare between publicly and non-publicly traded companies that use bond financing in this analysis.

Beta indicates the level of systematic/ market risk for a firm. Depending on the beta value, it will determine how the firm will move/ react with the market. Beta is determined by using the historical slope for the change in price over a set period of time. Beta can be used to predict the different costs of funds available based on the levels of systematic risk. Debt beta and equity beta are both estimated in this thesis. The debt beta measures the systematic risk when the companies are levered with bonds and shows debt fluctuations within the company. The equity beta is calculated based on the firm's market movements on the public exchange and shows the systematic risk relative to the overall market.

Further, beta is only an estimate of a historical time period. In this thesis, the specific time periods used for each beta calculation are five recursive years long meaning that there are sixty months for the monthly beta calculations and 260 weeks for the weekly beta calculations. Because a beta calculation uses historical figures, it is a future estimate of market movement. The R-squared then determines the proportion of the total variance that can be attributed to the market movements versus the unsystematic risk factors that include firm specific risk and risk that is diversifiable. R-squared measures how the independent variables will affect the dependent variables.

Four companies were selected to analyze debt beta and three of the four will be used to analyze equity beta. These four companies are Archer-Daniels-Midland, commonly known as ADM, Cargill, ConAgra and John Deere. The data used for each individual company was downloaded from Bloomberg and Yahoo Finance. The thirty-year treasury and S&P 500 data were downloaded from the St. Louis Federal Reserve Bank and Yahoo Finance, respectively.

The four agricultural companies analyzed cover a wide range of industries within the agricultural sector. Cargill deals in the agricultural sector in many facets ranging from animal nutrition, marketing, and meat processing, etc. Cargill is one of the largest privately held companies in the United States and is the only privately held company used for this analysis. ADM is a multinational food processing and commodity trading company. ConAgra is a packaged consumer goods company that sells products under multiple brand names. John Deere is an equipment manufacturing company for the agricultural, construction, and forestry sectors. ADM and Cargill are the most similar companies of the four analyzed since they both process foods and trade commodities.

# CHAPTER II: LITERATURE REVIEW

## 2.1 Methods

It is often typical to assume a zero-debt beta when considering companies financed by bonds. However, it should not be assumed that there is zero debt beta when looking at companies financed by bonds and instead the beta on debt can be derived from the bond yields (Bodmer n.d.). The debt beta can be found using the credit spreads when both the Equity Market Risk Premium (EMRP) and the Risk-Free Rate (Rf) are obtained (Bodmer n.d.). Another method that works well in predicting bond betas is regression (Aslanidis, Christiansen and Cipollini 2019). Beta is the covariance between the bond return and the overall stock market return normalized by the stock market variance (Aslanidis, Christiansen and Cipollini 2019).

Looking at the market risk for a company is another way to analyze the risk of the company because it determines the return on equity. There are modeling options that relate accounting variables to market betas, allowing non-traded firms' market beta to be estimated (Berkowitz 1998). Berkowitz found the market beta from non-traded companies are best explained by variables such as dividend payouts, asset growth, and earnings variability that together show 44.7% of the variance of market betas (Berkowitz 1998).

## 2.2. Conceptual Model (Theory)

Using beta as a tool to measure risk provides decision support for investors (Hachicha, Hachicha and Masmoudi 2021). Although it is not possible to eliminate interest rate risk, investors and companies like to keep that risk at a minimum (Hachicha, Hachicha and Masmoudi 2021). Therefore, identifying and measuring the beta on debt that has a cost to the funds is another way to measure the risk.

There can be implications of a high debt beta. When the debt beta is high, the cost of equity and the equity beta can decline, implying that the cost of equity does not continue to increase with the debt to capital ratio (Bodmer n.d.). Since the cost of equity does not continue to increase, the lenders end up taking on more risk while more benefit is provided to the company.

# CHAPTER III: THEORY

Beta is a calculation that determines the market risk of individual companies within a group of companies or a portfolio. To determine the risk of an individual company, one must measure its sensitivity to changes in the market. Measuring an individual company's risk that is not in conjunction to the market tells nothing about how the company will react to any changes occurring within the market. A beta over one is likely to react more than the market change. A beta of less than one will likely react less than the changes within the market. Calculating the amount of change for an individual company when compared to the market is important because when a portfolio is diversified, the risk that remains lies within the market.

For the current research, two different time frames are examined and denoted by $t$ where $t$ represents either 60 months or 260 weeks. Two market values are examined to estimate beta denoted by $m$ representing either the thirty-year treasury rate or S&P 500 index. Finally, four companies are examined and denoted by $i$, representing either three public traded firms of ConAgra, John Deere, and ADM and one privately held company, Cargill. Thus, interest lies in the relationship between the individual company return ($R_{imt}$) denoting firm $i$ relative to market $m$ over timeframe $t$ and market return ($R_{mt}$) denoting market $m$ over timeframe $t$.

The calculation for beta of an individual firm is shown in equation 3.1, where $\sigma_{imt}$ is the covariance for firm $i$ relative to market $m$ over timeframe $t$ between the company returns and the market returns. The variance of the returns of market $m$ over timeframe $t$ is represented by $\sigma^2$. Beta is estimated following equation 3.2 where $\alpha_{imt}$ is the intercept for firm $i$ relative to market $m$ over timeframe $t$ and $\beta_{imt}$ is estimated for firm $i$ relative to market *m* over timeframe *t,* the individual company price change (R*it*) with the market price change (R*imt*).

(3.1) $\beta imt = \sigma imt / \sigma^2_{mt}$, *estimated from the regression equation*

(3.2) $Rimt = \alpha imt + \beta imt \times Rmt$

Similarly, the debt beta is determined by estimating the individual company bond prices with the S&P 500 adjusted close prices or with the 30-year treasury bill prices from the St. Louis Federal Reserve Bank. Sixty intervals of prices will be used for the past four years on a monthly basis and 260 intervals on a weekly basis over four years. Using this data, the debt beta is measured to determine the market risk of a levered publicly and non-publicly traded company. Linear regressions are used for the estimation to determine beta using equation 3.2.

The same process will be used to find equity beta by using the S&P 500 adjusted close prices in conjunction with the market adjusted close prices of the three publicly traded companies. These calculations will be made from both monthly and weekly data to determine variability within the different cadences of time. It is hypothesized that there will be limited differences between the weekly and monthly data. The R-squared is also analyzed to determine the proportion of the total variance within the company returns that lies within the market versus that individual company's specific risk. It is hypothesized that in each beta calculation there will be moderate stability within the calculations.

It is hypothesized that the systematic risk shown in the beta calculations for each individual company will show effects on how the individual company reacts to any changes within the market. It is also hypothesized that the risk premium for each individual company will directly vary in accordance with beta. This is due to hypothesizing the capital asset pricing model (CAPM) applies to beta and the movement of the market. The risk premium calculated for each company further affects the risk appetite for specific returns. A higher risk premium could lead to higher returns further increasing the markets willingness to borrow at a higher rate.

Overall, it is believed that having a debt beta will be useful in determining the relative risk between publicly and privately held food and agriculture companies. It is hypothesized that privately held companies may have to pay more interest to obtain the same amount of capital when looking to expand or grow their operations.

Kovner and Wei discuss that spreads are thirty basis points higher for public bonds of private companies than for public bonds of public companies even after controlling all the observable differences (Kovner and Wei 2012 revised 2014). When analyzing privately held agricultural companies, it may be possible that more risk lies within private companies due to their inability to raise equity funds as easily as publicly traded companies. Analyzing the debt beta will show if the differences in the cost of debt is from systematic or unsystematic risk for these entities, especially for the one non-publicly traded company analyzed.

There is little to no information on this topic available. The focus of this thesis on debt and equity beta analysis will provide information about risk being held by public and non-public companies. The methods as well as the data and results covering the debt and equity beta will be discussed within the next two chapters.

# CHAPTER IV: METHODS

In this chapter, the data and analytical methods are introduced that are used for calculating debt and equity betas. Using this data, with the estimated beta on debt and equity, the market risk of different public and non-public companies are estimated. By using these methods, the level of risk that privately held companies are taking on by borrowing using bonds is determined. Once the regressions have been estimated, the betas are compared between companies. Using these methods helps to understand the difference in risk between publicly and non-publicly traded companies.

## 4.1 Calculating Debt Beta

Thirty-year bond yields and prices were estimated for each of the evaluated companies using Bloomberg data. The four companies evaluated were ADM, Cargill, ConAgra, and John Deere. Cargill is the only privately held company in the dataset.

Every weekly trade from December 5$^{th}$, 2014, through September 22$^{nd}$, 2023 was downloaded in Excel for each company and then the data were sorted by month. To sort the data by month, the weekly data were put into a pivot table with the minimum date for each month in the value field of the table. The VLOOKUP formula in Excel was used to copy the price and yield from the master weekly list based on the date first recorded in the month. All monthly data points are from the first seven days within the month with the exception of Cargill's dataset. Cargill had eight months where the first trade date in the month fell between the eighth and tenth day. The individual company datasets were used to calculate both the weekly and monthly beta, intercept and R-squared.

Other data needed to calculate debt beta in addition to the individual company bond prices were the thirty-year treasury bill bond price and the adjusted close prices for the

S&P 500. To get the price for the thirty-year bond, the historical yields were downloaded from the St. Louis Federal Reserve Bank that matched the individual company bond yield and price dates. A calculation was made using equation 4.1 to get the present value that resulted in the bond price. The S&P 500 historical data was downloaded to Excel for the same time period as the thirty-year treasury bill and the individual company bond prices. The adjusted close price was used for the calculations as presented. A debt beta was calculated with the individual company bond prices in relation to the S&P 500 to show the correlation with the "market" that carries a beta of one and with the thirty-year treasury that has a beta of 0.

(4.1) Bond Price= PV (*Bond yield*/2, 60, $*Bond Yield*/2*1000, 1000)

A change in price for the S&P 500, 30-year treasury bill, and each company bond price was calculated by using the formula below for monthly change:

(4.2) Change in Bond Price= ((*Current months trade price/ previous months trade price*) - 1) *100

Following equation 4.2 a similar computation was undertaken for the weekly change in bond price. To calculate $\beta_{imt}$, the formula used in Excel is displayed in equation 4.3. The coefficient (i.e., slope) formula was used because if a line of best fit was put through the 60 months or 260 weekly observations used and the coefficient was calculated for each month in the example of the monthly model.

(4.3) $\beta_{imt}$ = SLOPE function in Excel for recursive computation from January 2020 through December 2023 over a 60-month period

These individual betas were calculated within the most recent four years in the dataset. The four-year time period was then graphed. This time frame shows a cycle of data. The graphs show the beta on the vertical axis and time on the horizontal axis.

### 4.2 Calculating Equity Beta

Calculations for the equity beta were derived the same way as the debt beta and beta calculations with one exception. The dependent variable ($R_{imt}$) of equation 4.3 is the adjusted market close prices for each of the three public traded companies (i.e., *i* = ConAgra, John Deere, or ADM) with data from Yahoo Finance. The independent variable ($R_m$) is only the S&P 500 (i.e., *m)* change in price. The individual company historical adjusted close prices were downloaded from Yahoo Finance for the same time period that was used for the debt beta calculation.

### 4.3 Calculating R-squared

The R-squared value determines how much the dependent variable varies based on the independent variable and shows the statistical significance for each regression. Equation 4.4 below was used to calculate the R-squared for both the weekly and monthly data points for each individual company. This was calculated for the debt beta and beta when looking at the bond price with the thirty-year treasury and bond price with the S&P 500, and the market price of each public company with the S&P 500.

For the example of the monthly (*m) analysis,* the recursive R-squared was computed in Excel as:

(4.4) R-squared = RSQ function in Excel for recursive computation from January 2020 through December 2023 over a 60-month period

Each individual R-squared (R-squared$_{itm}$) calculation spans over 60 months or 260 weeks. These individual five-year R-squared values are graphed over a four-year time period. The graphs show the R-squared$_{itm}$ on the vertical axis and date on the horizontal axis.

**4.4 Calculating Intercept**

The intercept indicates if the regression for calculating beta is consistent with the CAPM theory. When the intercept is zero or close to zero and there is a change in the treasury bill price, one should expect a change for that time period in the individual debt market. When this happens, it is consistent with the CAPM model because the regression line is going through zero. When no change in the market happens, then there is no change for the individual stock. Following from equation 3.2, individual firm intercepts are computed as $\alpha_{imt}$. Equation 4.5 is the Excel function specification used to compute the recursive intercept value as:

(4.5) $\alpha_{imt}$ = INTERCEPT function in Excel for recursive computation from January 2020 through December 2023 over a 60-month period

**4.4 Calculating Average Beta, Intercept and R-squared**

The average was calculated on the entire sample of each of the beta, intercept and R-squared calculations. This was calculated to show what the average Beta, Intercept, and R-squared was over the nine-year period. For the example of the 60-month calculation for β, the calculation was made in Excel over January 2020 to December 2023 by using formula 4.6.

(4.6) $\bar{\beta} = \frac{\sum_{48} \beta_{im}}{48}$ = AVERAGE ( *Beta*)

The computation in equation 4.6 was repeated for the intercept or R-squared.

**4.5 Calculating Standard Deviation of Beta, Intercept and R-squared**

The standard deviation was calculated on the entire sample which includes an eight-year period for the beta, intercept and R-squared calculations. The standard deviation is used to measure the spread of possible outcomes or variance from the mean. For the example of the 60-month calculation for β, the calculation was made within Excel over January 2020 to December 2023 by using equation 4.7.

(4.7) $\sigma = \sqrt{\frac{\sum_{48}(\boldsymbol{\beta}_{im} - \overline{\beta})^2}{48 - 1}} = \text{STD.P}$

# CHAPTER V: DATA AND RESULTS

## 5.1 Beta

Figure 5.1 shows the monthly beta calculated from the individual company bond yield prices and the 30-year treasury bill bond prices. There is little effect on bond price due to systematic risk, with the beta being well under one for the three publicly traded companies (ADM, ConAgra, John Deere) and one non-publicly traded company (Cargill). There is little variability over time for each company's debt beta when looking at both the monthly graph in Figure 5.1 and the weekly graph in Figure 5.2. The companies do not trend in the same direction in the monthly and weekly graphs. On a monthly basis, Cargill has the highest beta of 0.2 followed by ADM. ConAgra and John Deere move close to each other in third and fourth, switching back and forth over time. When looking at weekly Figure 5.2, ADM and Cargill switch spots and ADM now has the highest beta of 0.2. The switch between ADM and Cargill could be happening because of the market needing additional compensation due to Cargill's inability to raise equity capital as easily. Figures 5.1 and 5.2 identify the beta following the debt market.

Table 5.1 displays the average beta from the last four years. Each beta calculation in the last four years, either monthly or weekly, holds five recursive years of data within the individual calculations. The average trends between companies holds consistent with the graphed trends. The standard deviation (SD) for the sample period is close to zero, showing small variations from the average beta.

**Figure 5.1: Monthly Beta Over Time with Company Bond Price and 30 Year Treasury**

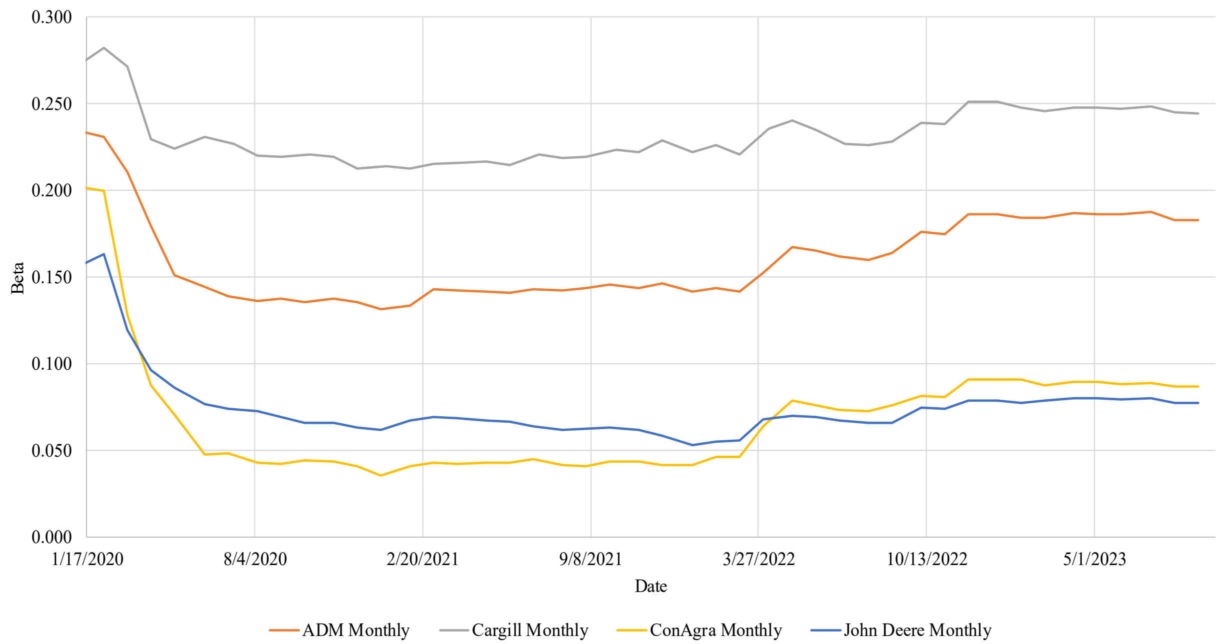



**Figure 5.2: Weekly Beta Over Time with Company Bond Price and 30 Year Treasury**

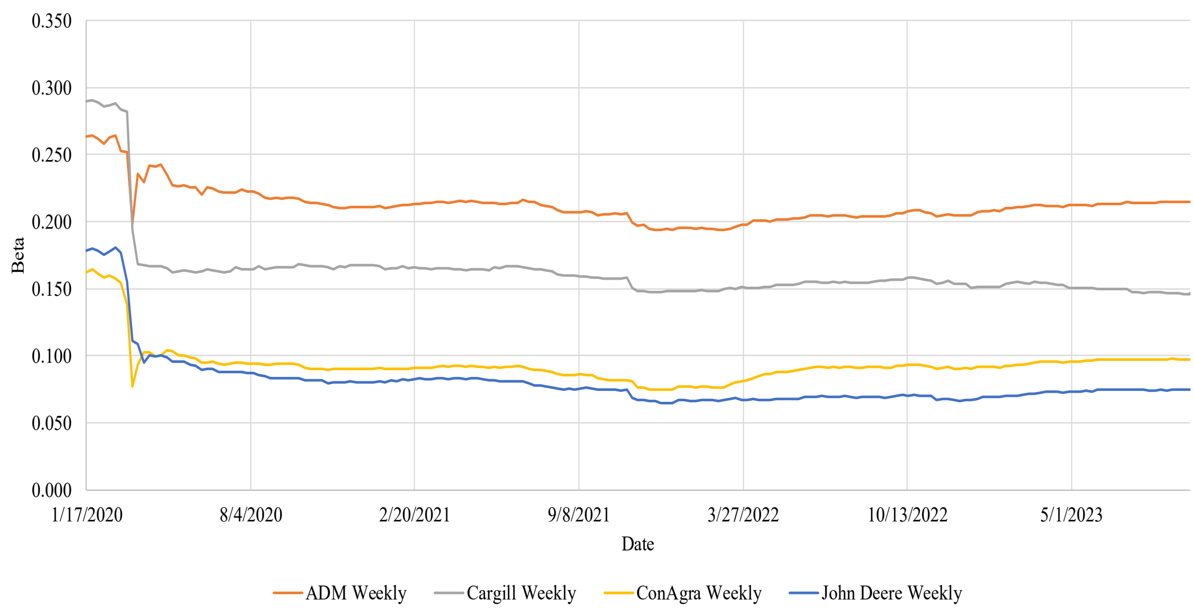


**Table 5.1: Monthly and Weekly Averages Over Time with Company Bond Price and 30 Year Treasury**

| | Avg Beta | Avg Intercept | Avg R-squared | SD Beta | SD Intercept | SD R-squared |
|---|---|---|---|---|---|---|
| ADM Monthly | 0.1615 | 0.0004 | 0.2697 | 0.0256 | 0.0014 | 0.0606 |
| ADM Weekly | 0.2139 | 0.0000 | 0.3331 | 0.0158 | 0.0003 | 0.0177 |
| Cargill Monthly | 0.2324 | -0.0011 | 0.4212 | 0.0163 | 0.0009 | 0.0298 |
| Cargill Weekly | 0.1670 | -0.0002 | 0.2310 | 0.0343 | 0.0003 | 0.0613 |
| ConAgra Monthly | 0.0695 | -0.0005 | 0.0729 | 0.0359 | 0.0016 | 0.0784 |
| ConAgra Weekly | 0.0954 | -0.0002 | 0.1253 | 0.0188 | 0.0003 | 0.0292 |
| John Deere Monthly | 0.0752 | -0.0009 | 0.1555 | 0.0212 | 0.0011 | 0.0574 |
| John Deere Weekly | 0.0273 | 0.0002 | 0.0553 | 0.0273 | 0.0002 | 0.0553 |

Figures 5.3 and 5.4 show the individual company bond yield prices in conjunction with the S&P 500 to calculate debt beta. The monthly debt beta for all companies in figure 5.3 shows a negative debt beta of over -0.05 for the first ~7 years in the data set and then every company comes very close to zero between March and October of 2022. For the remaining year, the debt beta begins to dip back down. There is a complete inverse in order of the monthly debt beta for each company in Figure 5.3 with the S&P 500 from the monthly beta using the thirty-year treasury to Figure 5.1. The monthly order of companies with beta from highest to lowest is John Deere, ConAgra, ADM and Cargill. Figure 5.4 shows a positive weekly debt beta between 0 and 0.08 with John Deere and Cargill tracking similarly and switching between first and second, followed by ConAgra and then ADM. These figures are consistent with the averages shown in Table 5.2. The standard deviation of the debt beta is very small, ranging from 0.01 to 0.02 depending on the company and the monthly versus weekly classification.

The negative debt beta in Figure 5.3 shows that the debt beta moves in the opposite direction of the market meaning that the total risk premium is much lower and would result in the need for lower costs of funds. Early in the period in Figure 5.3, the negative monthly relationship of the companies was much less than the thirty-year treasury bill and then in the last year of the graphed betas, the thirty-year treasury comes together with the companies. Figure 5.4 shows the beta calculated over a weekly timeframe and displays a slightly different trend. The four companies' betas trend closer to zero with a positive beta throughout the entire sample period showing little to no movement with the market. The weekly thirty-year treasury in Figure 5.4 trails between -0.3 and -0.4 lower than the individual company beta.

As the bond yield goes up within the sample period, the S&P 500 would go down because the bond rate would be negatively affected by the increasing interest rate. If the market is to go up, then the bond yield would go down, especially on monthly data. Overtime as people begin thinking that the bond yield is rising, then it could negatively affect the S&P 500.

**Figure 5.3: Monthly Debt Beta Over Time with Company Bond Price and S&P 500**

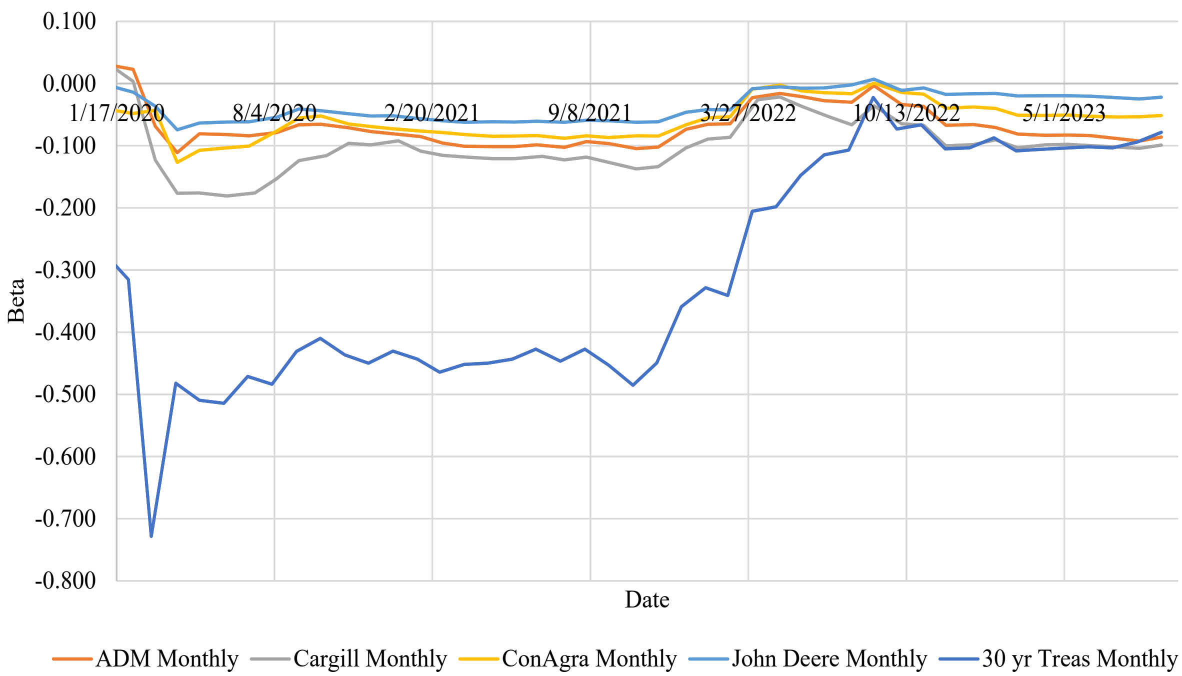


**Figure 5.4: Weekly Debt Beta Over Time with Company Bond Price and S&P 500**

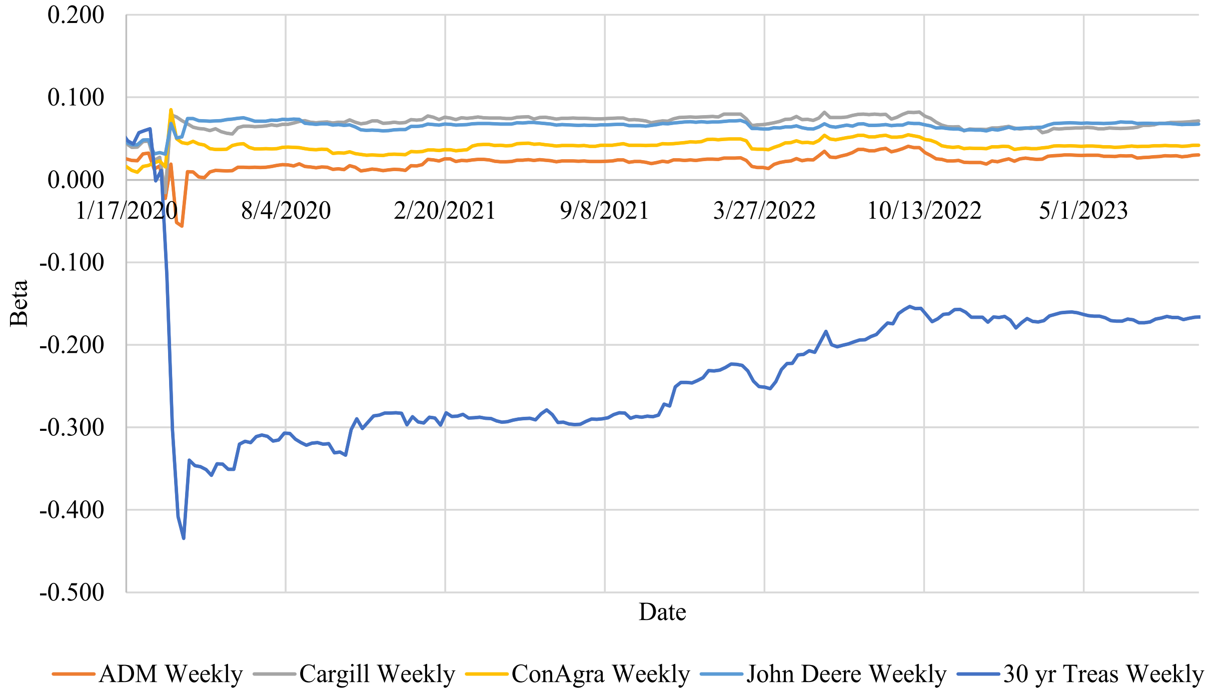



**Table 5.2: Monthly and Weekly Averages Over Time with Company Bond Price and S&P 500**

| | Avg Beta | Avg Intercept | Avg R-squared | SD Beta | SD Intercept | SD R-squared |
|---|---|---|---|---|---|---|
| ADM Monthly | -0.0687 | 0.0019 | 0.0202 | 0.0333 | 0.0022 | 0.0118 |
| ADM Weekly | 0.0221 | 0.0002 | 0.0021 | 0.0107 | 0.0005 | 0.0014 |
| Cargill Monthly | -0.0991 | 0.0011 | 0.0307 | 0.0444 | 0.0022 | 0.0200 |
| Cargill Weekly | 0.0679 | -0.0001 | 0.0190 | 0.0114 | 0.0005 | 0.0057 |
| ConAgra Monthly | -0.0583 | 0.0004 | 0.0193 | 0.0295 | 0.0021 | 0.0156 |
| ConAgra Weekly | 0.0399 | -0.0001 | 0.0114 | 0.0090 | 0.0004 | 0.0051 |
| John Deere Monthly | -0.0365 | -0.0001 | 0.0158 | 0.0230 | 0.0016 | 0.0131 |
| John Deere Weekly | 0.0650 | -0.0003 | 0.0463 | 0.0074 | 0.0003 | 0.0132 |
| 30 yr Treas Monthly | -0.3074 | 0.0087 | 0.0396 | 0.1770 | 0.0071 | 0.0339 |
| 30 yr Treas Weekly | -0.2250 | 0.0019 | 0.0276 | 0.0954 | 0.0015 | 0.0161 |

When analyzing the equity beta that uses the adjusted market close prices from Yahoo Finance for each publicly traded company and the S&P 500, the beta shows much more systematic risk than in the beta and debt beta scenario above. John Deere has the highest monthly equity beta of just over one followed by ADM then ConAgra. The weekly equity beta shows the same cadence of companies as the monthly equity beta with the difference being that all betas are ~0.2 higher. There is also slightly more variability in the monthly beta shown in Figure 5.5 when compared to the weekly beta in Figure 5.6 that is on a flatter line. These figures are consistent with the averages shown in Table 5.3. The standard deviation of the equity beta is still very small, ranging from 0.03-0.14 for all companies on a monthly and weekly basis, but this is the highest standard deviation on beta between all betas analyzed.

There is more systematic risk shown with the equity beta simply because an equity position is riskier than a debt position. There is less risk with the debt position because debt would likely be paid off before equity when in financial distress like bankruptcy. When it is assumed that the debt beta is zero, it is not correct because there still is some systematic risk with debt, even though it is much less than equity.

**Figure 5.5: Monthly Equity Beta Over Time with Company Market Price and S&P 500**

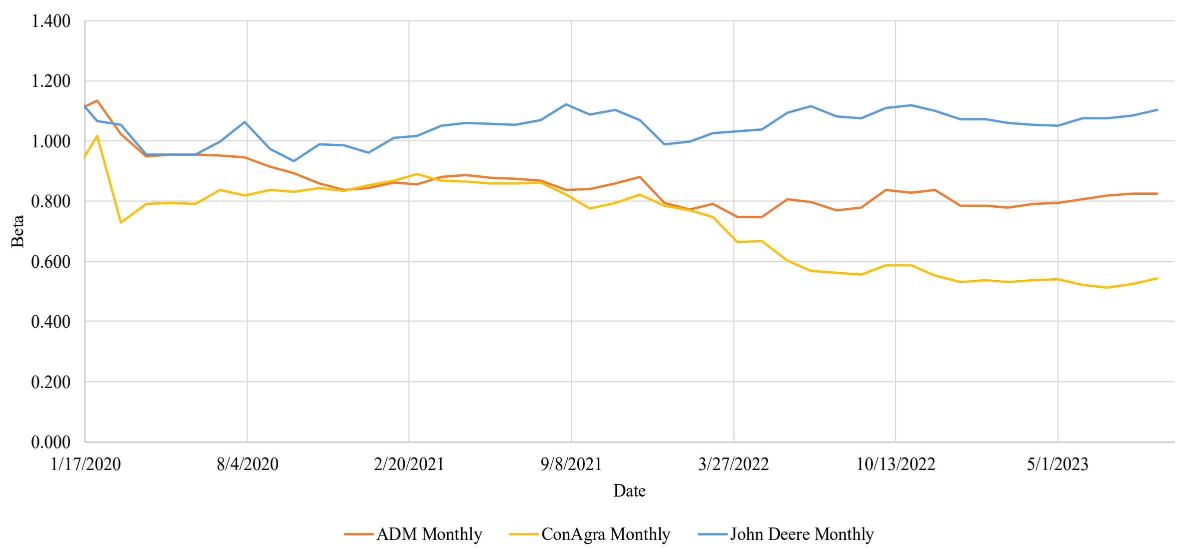


**Figure 5.6: Weekly Equity Beta Over Time with Company Market Price and S&P 500**

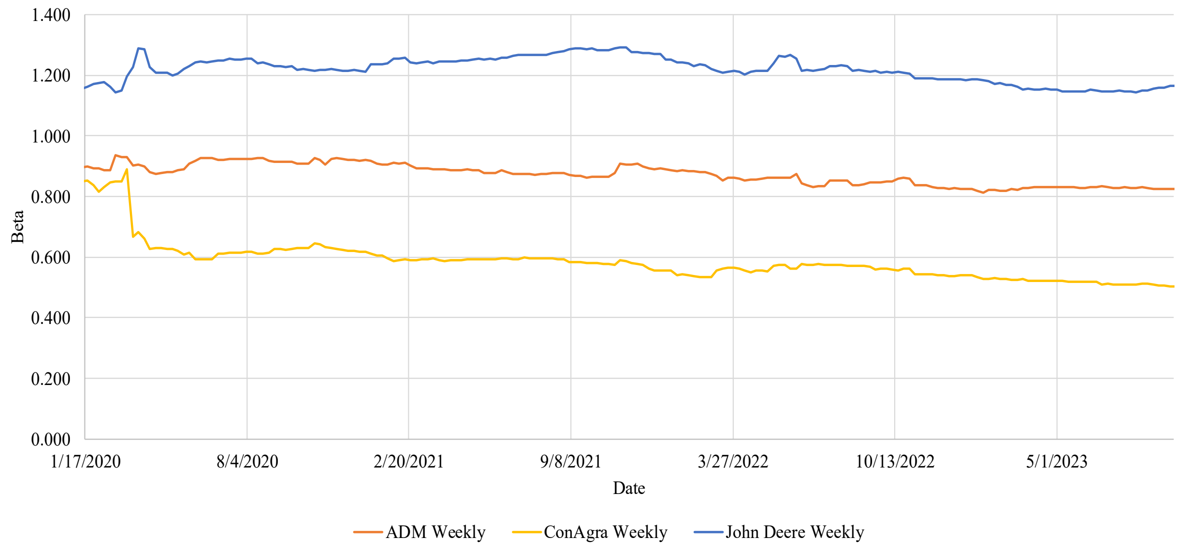



**Table 5.3: Monthly and Weekly Averages Over Time with Company Market Price and S&P 500**

| | Avg Beta | Avg Intercept | Avg R-squared | SD Beta | SD Intercept | SD R-squared |
|---|---|---|---|---|---|---|
| ADM Monthly | 0.8574 | 0.0025 | 0.3747 | 0.0826 | 0.0058 | 0.0332 |
| ADM Weekly | 0.8729 | 0.0006 | 0.3984 | 0.0342 | 0.0013 | 0.0389 |
| ConAgra Monthly | 0.7236 | -0.0015 | 0.1607 | 0.1410 | 0.0033 | 0.0375 |
| ConAgra Weekly | 0.5920 | 0.0000 | 0.1297 | 0.0784 | 0.0005 | 0.0127 |
| John Deere Monthly | 1.0482 | 0.0123 | 0.3679 | 0.0525 | 0.0033 | 0.0439 |
| John Deere Weekly | 1.2170 | 0.0026 | 0.4576 | 0.0422 | 0.0007 | 0.0406 |

## 5.2 R-squared

The R-squared shows the proportion of a company's total risk that comes from movement in the market versus risk that is firm specific and diversifiable. The R-squared is shown below for the monthly and weekly debt and equity betas in Figures 5.7-5.12. There is varying statistical significance for the variables used in the debt and equity betas within each figure on a monthly and weekly basis.

Figure 5.7 and 5.8 displays the R-squared for the beta that uses the individual company bond price and thirty-year treasury correlation. In the monthly figure, Figure 5.7, ConAgra has a low R-squared value ranging from 0-0.1 while Cargill has moderate reliability on movement of the market within the monthly model and tracks between 0.4 and 0.5. ADM and John Deere fall in second and third, respectively. On a weekly basis, shown in Figure 5.8, ADM and Cargill switch places. This switch mimics the change that happened within the beta between Figures 5.1 (monthly) and 5.2 (weekly) that used the same data points as this R-squared calculation. These numbers are consistent with the averages shown in Table 5.1. The standard deviation of the R-squared of the entire sample period when looking at the company bond price and thirty-year treasury correlation is very low ranging from 0.01 to 0.07.

**Figure 5.7: Monthly R-squared Over Time with Company Bond Price and 30 Year Treasury (Beta $R^2$)**

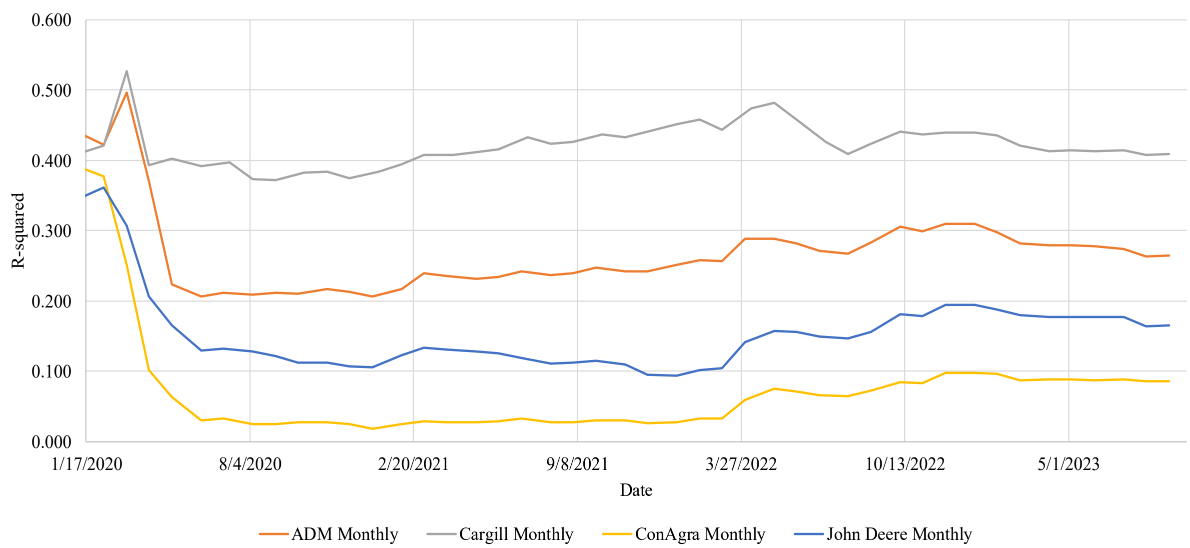
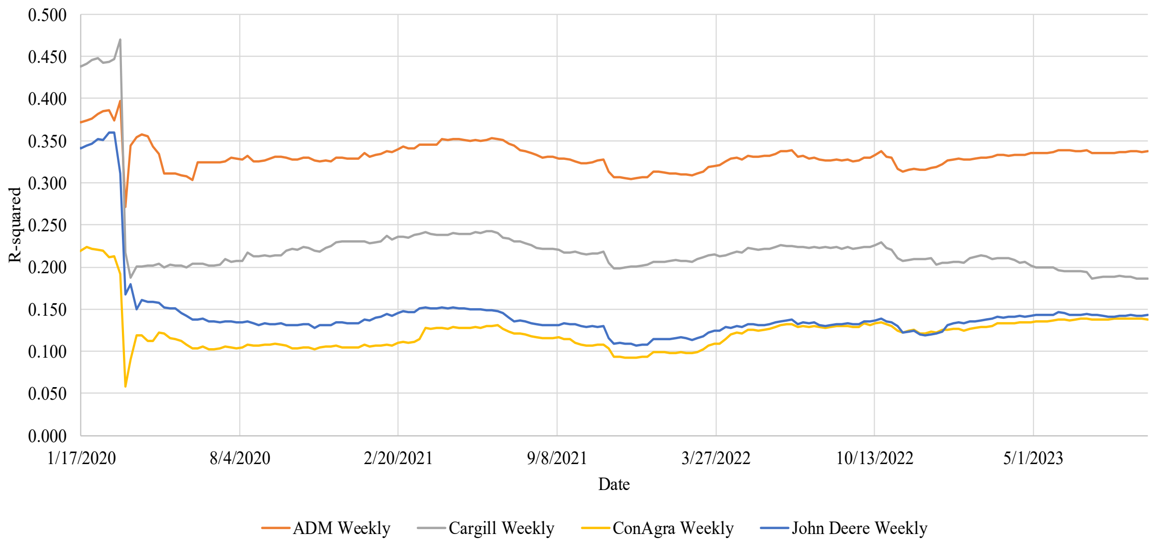


**Figure 5.8: Weekly R-squared Over Time with Company Bond Price and 30 Year Treasury (Beta $R^2$)**




The calculated R-squared value for the individual company bond prices with the S&P 500 tell a different story in Figures 5.9 and 5.10. There is some change over the eight-year time period but overall, the R-squared is very close to zero, meaning that only a small proportion of the variability in the company's bond price movement can be explained by the market. These numbers are consistent with the averages shown in Table 5.2. The standard deviation of the entire sample period when looking at the company bond price and S&P 500 on a monthly and weekly basis is very low ranging from 0.0014-0.34.

**Figure 5.9: Monthly R-squared Over Time with Company Bond Price and S&P 500 (Debt Beta $R^2$)**

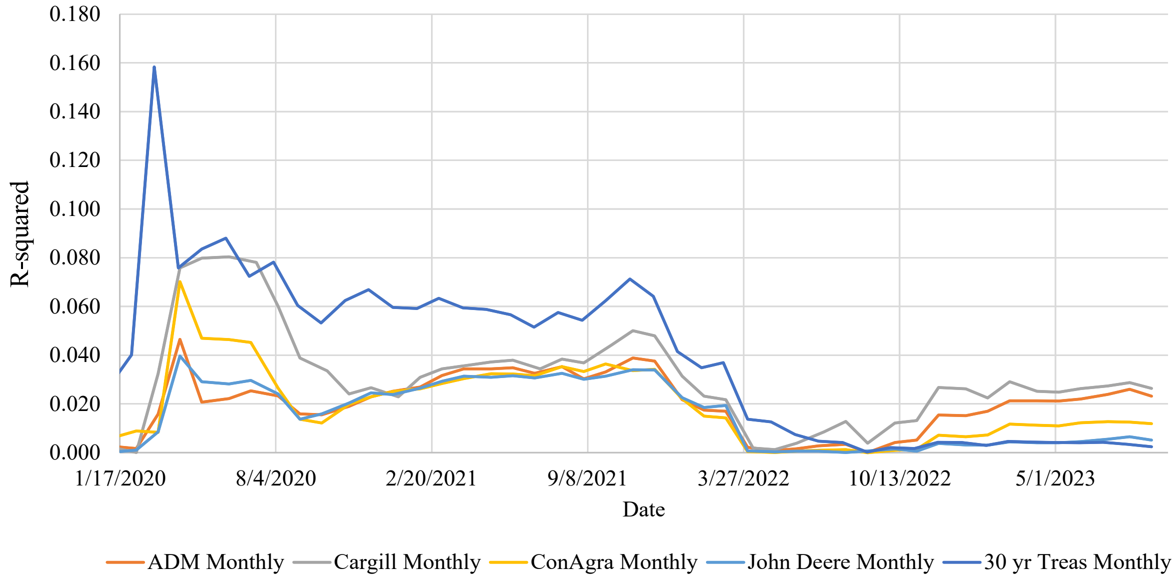
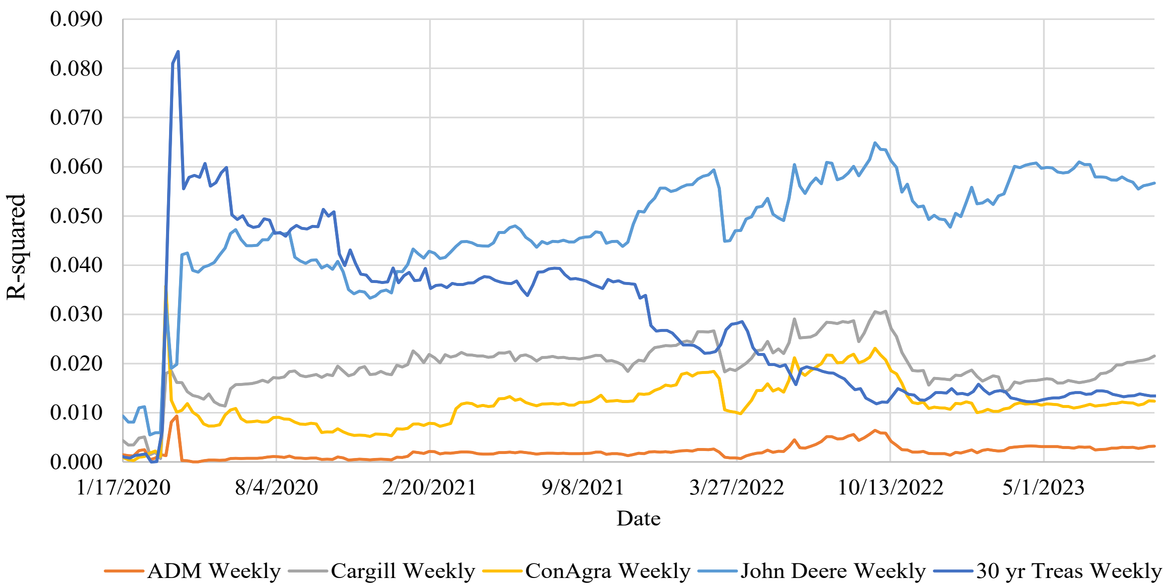



**Figure 5.10: Weekly R-squared Over Time with Company Bond Price and S&P 500 (Debt Beta $R^2$)**




When looking at the R-squared utilizing the company market price from Yahoo Finance and S&P 500 there is, once again, moderate reliability on market movement. Cargill is not included because it is a privately held company and not traded on the public exchange. ADM and John Deere track close to one another in both the monthly and weekly

R-squared shown in Figures 5.11 and 5.12 with R-squared values ranging from 0.3-0.5. ConAgra follows with the lowest R-squared value between 0.1 and 0.2. These numbers are consistent with the averages shown in Table 5.3. The standard deviation of the entire sample period when looking at the company market price and S&P 500 on a monthly and weekly basis is low ranging from 0.01-0.04 showing little variation from the mean.

**Figure 5.11: Monthly R-squared Over Time with Company Market Price and S&P 500 (Equity Beta $R^2$)**

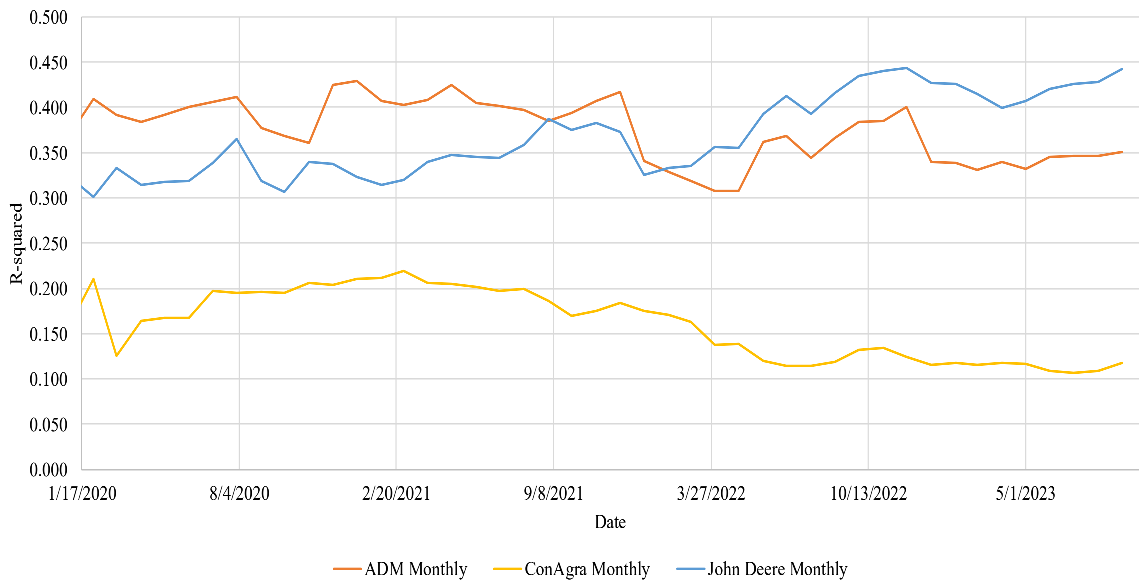
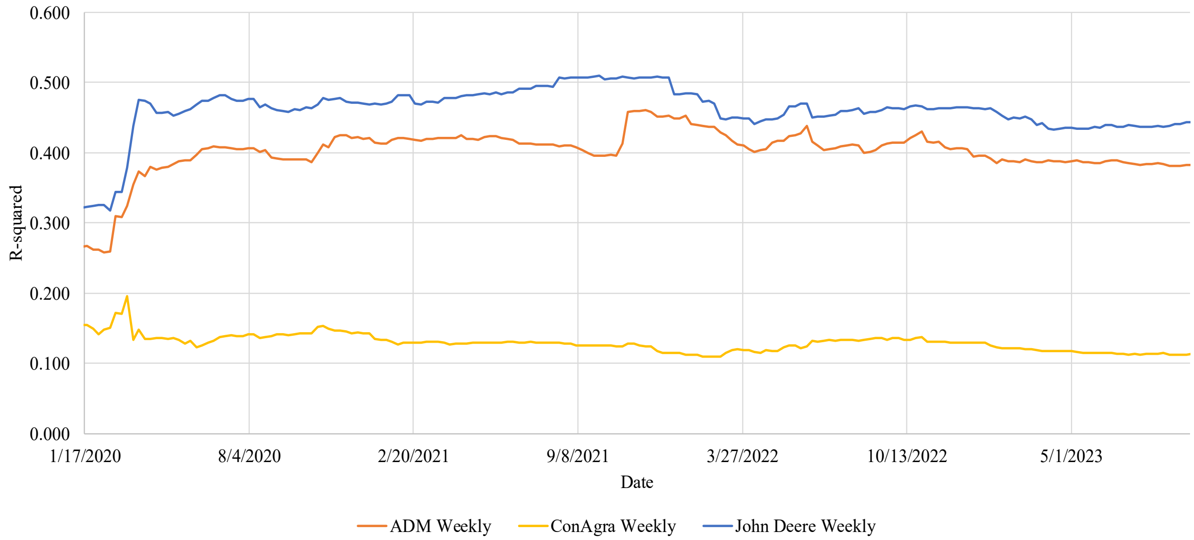


**Figure 5.12: Weekly R-squared Over Time with Company Market Price and S&P 500 (Equity Beta $R^2$)**




## 5.3 Intercept

The intercept for each individual company was calculated for the company bond price with the S&P 500, the company bond price with the thirty-year treasury and the company market price with the S&P 500. Each instance showed an intercept very close to zero. Due to the intercept being very close to zero, it is understood that this analysis follows the capital asset pricing model. As shown in Tables 5.1, 5.2 and 5.3, the standard deviation on the intercept is very close to zero in each table showing that the intercept does not vary from its near zero averages.

**Figure 5.13: Monthly Intercept Over Time with Company Bond Price and 30 Year Treasury (Beta Intercept)**

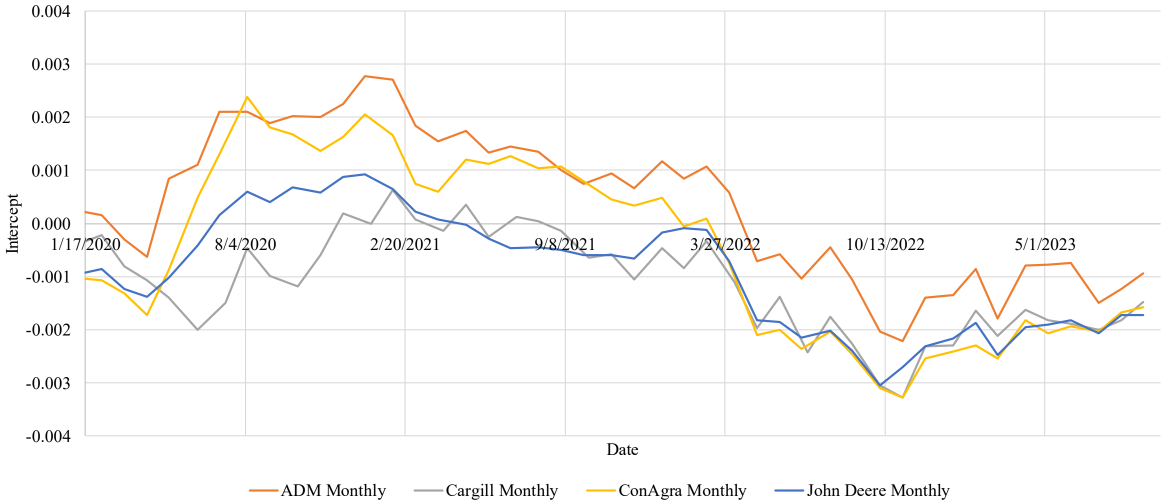



**Figure 5.14: Weekly Intercept Over Time with Company Bond Price and 30 Year Treasury (Beta Intercept)**

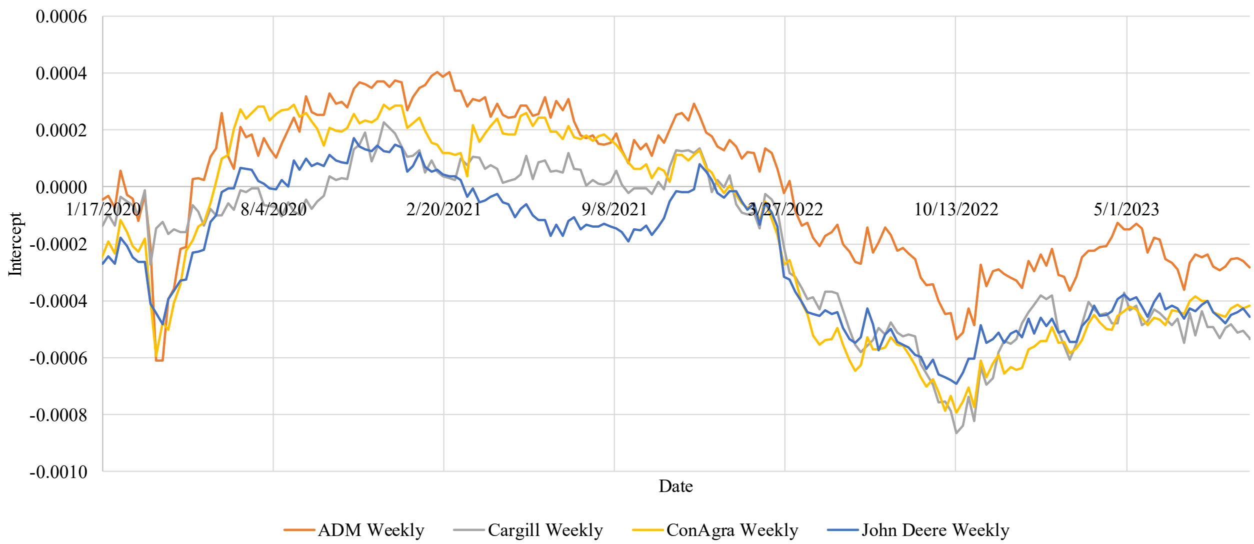


**Figure 5.15: Monthly Intercept Over Time with Company Bond Price and S&P 500 (Debt Beta Intercept)**

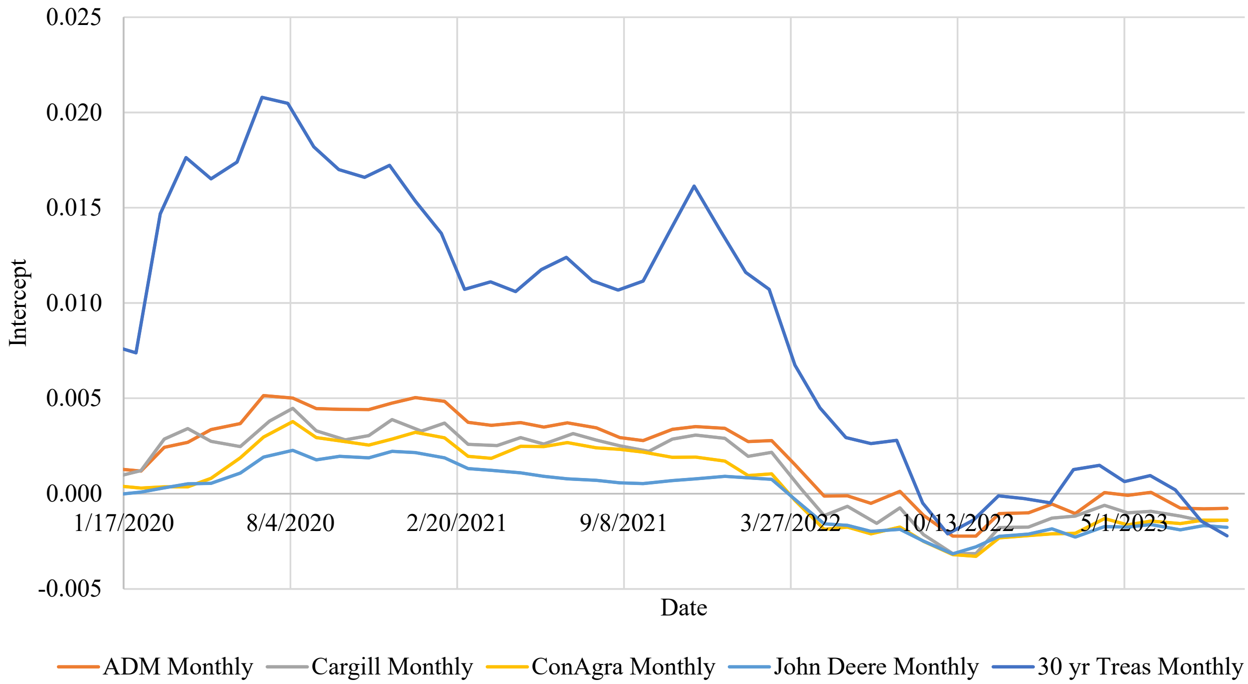



**Figure 5.16: Weekly Intercept Over Time with Company Bond Price and S&P 500 (Debt Beta Intercept)**

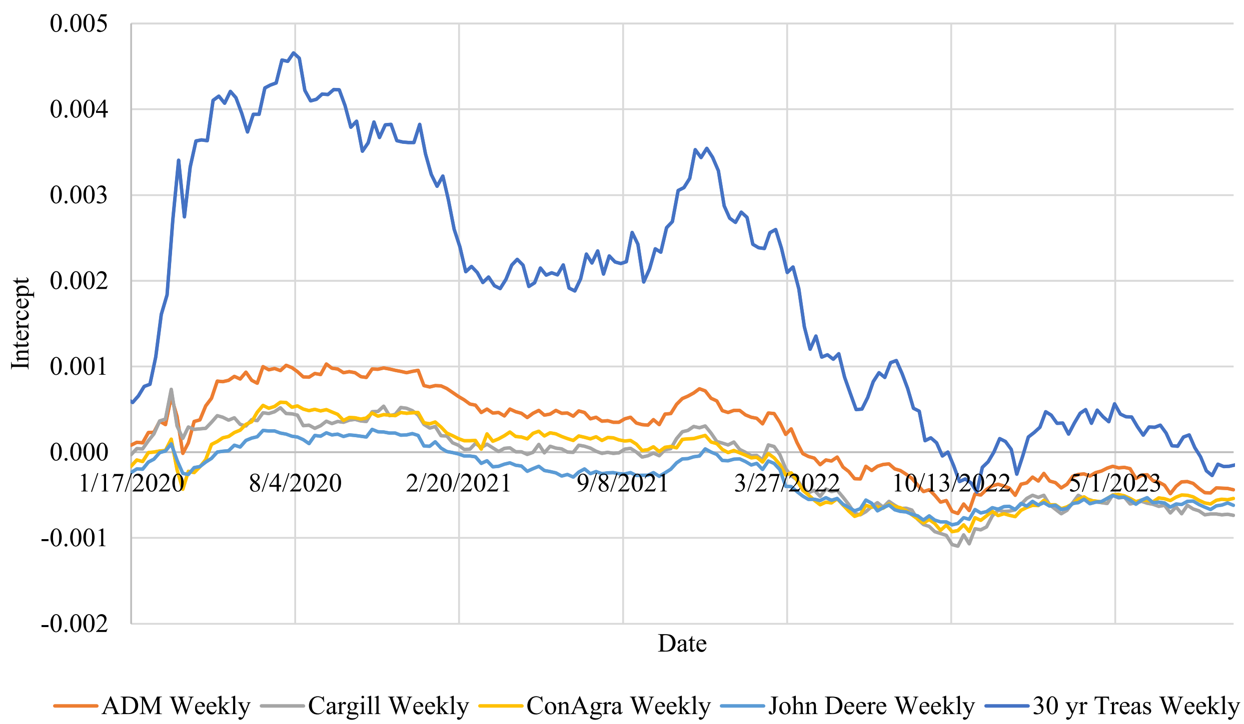


**Figure 5.17: Monthly Intercept Over Time with Company Market Price and S&P 500 (Equity Beta Intercept)**

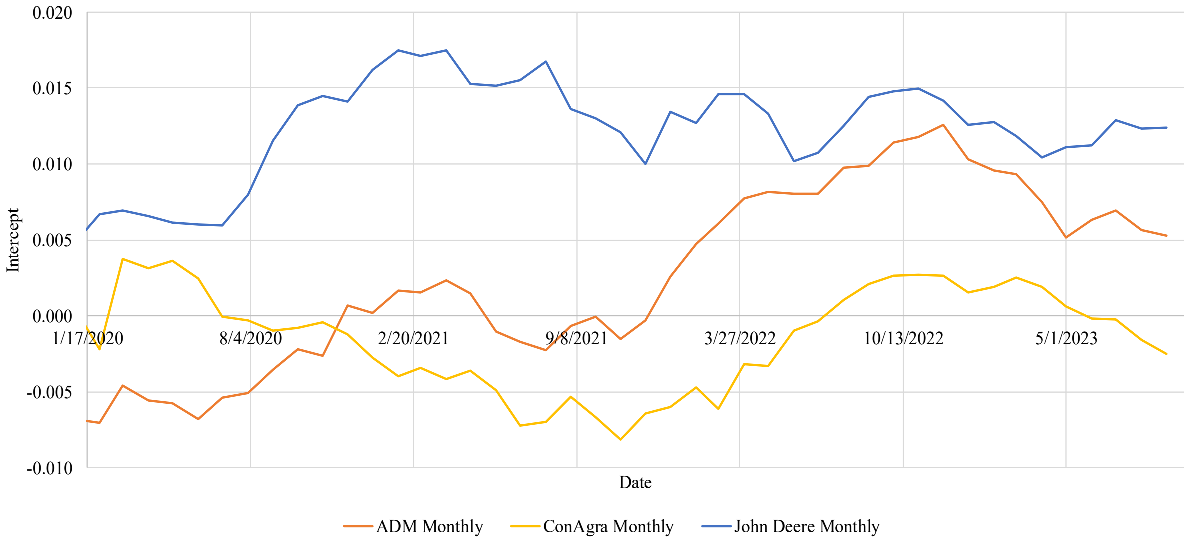
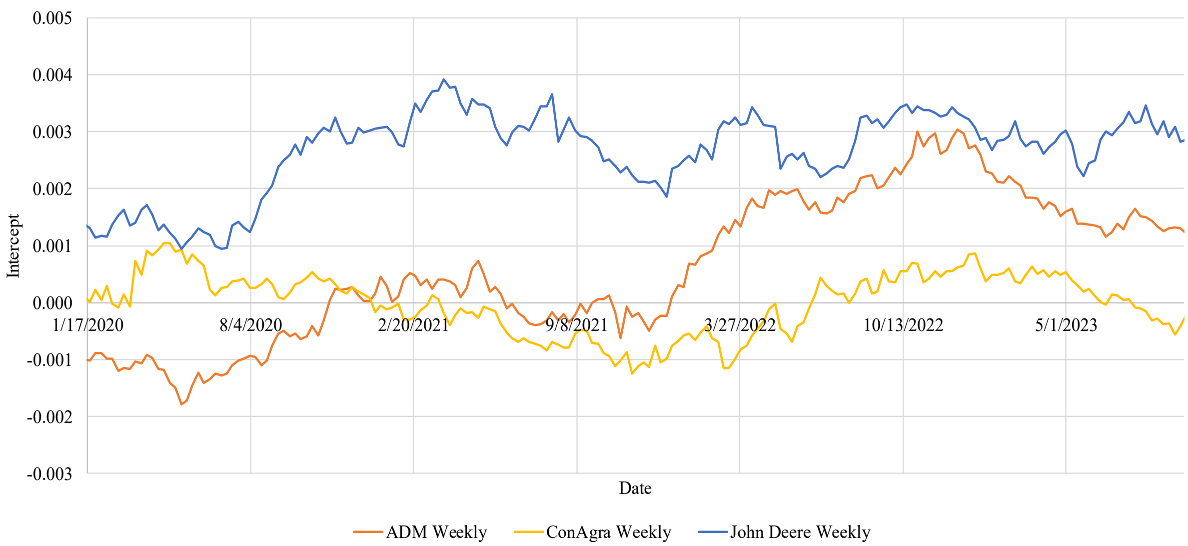



**Figure 5.18: Weekly Intercept Over Time with Company Market Price and S&P 500 (Equity Beta Intercept)**



# CHAPTER VI: SUMMARY AND CONCLUSIONS

## 6.1 Summary

The objective of this study was to conduct an analysis on the beta, debt beta and equity beta for a select group of agricultural firms that are both publicly and non-publicly traded and are frequently traded in the bond market and on the public exchange. By using these methods, the level of risk that privately held companies are taking on by borrowing using bonds is determined. Phrased as a question; is there a difference in risk between companies that borrow funds using bonds versus debt that is funded through public exchange? With limited information available on this type of analysis, this study was used to form assumptions with the public and nonpublic companies when acquiring debt capital by showing that the debt beta can indicate relative riskiness of a privately held company. Overall, it is believed that having a debt beta will be useful in determining the relative risk between publicly and privately held food and agriculture companies.

After running the regressions for debt beta and equity beta. It was found that the debt beta was smaller than the equity beta. Cargill, the only privately held company in the dataset, and ADM separated themselves with a higher debt beta than ConAgra and John Deere. There will be more effect on these companies that borrow using bonds when there are any shifts within the market. Cargill is always riskier than ConAgra or John Deere which coincides with the original hypothesis.

As hypothesized, there is more systematic risk with the equity market than the debt market. The debt beta shows how the long-term bonds move with the S&P 500 and it was found that they move closely together more so than the equity beta. So, in turn, the long-term bonds follow the debt market well. As the bond yield goes up within the sample period, the S&P 500 would go down because the bond rate would be negatively affected by the increasing interest rate. There is more systematic risk shown with the equity beta because an equity position is riskier than a debt position. There is less risk with the debt position because debt would likely be paid off before equity when in financial distress.

The original hypothesis that the capital asset pricing model applies to beta and the movement of the market is shown to be true. The intercept indicated that the regressions are consistent with the capital asset pricing model theory with it being so close to zero with each beta calculation. When no change in the market happens, there is no change for the individual stock.

**6.2 Conclusion**

In conclusion it is important to consider debt beta on both publicly and non-publicly traded companies. This is important because the debt beta does show some movement with the market, even though it is a small amount. While there may be less risk associated with the debt beta over the equity beta due to the idea that debt will likely be repaid first before equity in the case of a default, it does still display some movements and risk from the market.

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