"What factors have been proposed to explain the variations in corporate bond yields?"

Section 1 – Essay:

Corporate bond yields are typically defined as interest rate payments given by a corporation on its bonds. Initially, corporate bonds (more specifically investment-grade) seem more attractive to invest in, other than the likes of a Treasury bond, due to their attractive yield rates despite carrying some credit risk (Huang et al, 2012). However, as suggested by Campbell et al (2003), a series of reasons such as expectation, equity volatility or changes to the characteristics of the bond could fluctuate the yield of a corporate bond. The question is, how influential are these factors in changing corporate bond yields? This essay aims to determine what three key variables correlate with corporate bond yields and how much of an impact they make, by utilising the "Equity Volatility and Corporate Bond Yields" paper by (Campbell et al, 2003).

Throughout the paper mentioned above, Campbell and Taksler attempt to convey that equity market volatility is a driver, if not primary, that explains the movements of corporate yields, by considering factors such as risk perception, investor behaviour and macroeconomic conditions. It starts by mentioning the effects of higher total firm volatility[1] on equity and bondholders from (Merton, 1974) which is what inspired the investigation of the paper. It is important to take note of this because the two volatilities have different natures: when idiosyncratic volatility has a positive trend, systematic volatility only has temporary fluctuations (Campbell et. al, 2001).

It continues by exploring how corporate yields relate to pricing of corporate bonds through the two classical credit risk structures: structural and reduced form models, which document the limitations/flexibility of a structural/reduced model (respectively). This paper is quite unique in terms of it questioning areas which have been overlooked by other literature as it explores the effect of equity volatility on cross-sectional variation, long-term time-series behaviour, and recent movements of corporate yields. It has been shown when looking at long term time-series data that equity volatility has equivalent causation power to credit ratings; both explaining about two-thirds of the variation in corporate bond yield spreads (Campbell et al, 2003). Additionally, it identifies that movements in idiosyncratic volatility help to explain movements in average yields.

[1] – Total Firm Volatility includes idiosyncratic volatility and market-wide volatility

It proceeds to present statistical evidence that shows increasing equity volatility will have a high correlation to the cost of borrowing, i.e. interest, which in turn has an endogenous effect on yields. The regressions (where some will be analysed later in more detail) find that including equity volatility as an explanatory improves outputs and using this variable in combination with credit ratings create a better explanation for yield spreads. Another note to highlight is that this paper consistently compares corporate yields to treasury yields, hence providing us with yield spreads as opposed to just yields.

The remainder of the paper reinforces the consideration of equity volatility by looking at different scenarios such as analysing various interaction terms, redefining idiosyncratic risk with Nelson-Siegel Yield Spreads, investigating the impacts of idiosyncratic volatility or by looking at time-series data to determine whether the important of equity volatility was an anomaly in the time period (late 90's) that was being observed throughout the paper.

A key factor that explains the change in corporate yields are macroeconomic conditions. From interest rates to exchange rates (Sianturi et al, 2020) to where an economy is positioned in the business cycle, evidence of this can be seen from Gilchrist et al (2012) where they find if expansionary monetary policy needs to be used, it typically means that there was a sharp decline in long-term Treasury yields which directly effects prices on the stock market. This chain effect can explain the expectations of investors. Although bond yields don't see as much change as stock prices, Campbell et al (2003) suggests that if investors speculate that there will be a boom in the economy, they will have positive outlook on corporate profits and so their expected probability of default will be lower, hence increasing stock prices, but decreasing the bond's yield. The reason for this is due to the increase in animal spirits: investors are more willing to accept lower yields on corporate bonds due to higher future probability and stability. The opposite will occur if investors anticipate for a recession.

Macroeconomic conditions also play a large part in determining corporate bond prices, which inevitably affect corporate bond yields. Campbell et al (2003) mentions two common pricing models which attempt to understand the credit puzzle[2] are the structural and reduced form models. In the (Black and Scholes, 1973) structural model, corporate bond prices typically incorporate macroeconomic factors endogenously to determine bond yields (Anderson et al, 2000). There is an underlying assumption that macroeconomic conditions affect the fundamental factors that impact

[2] – It is a puzzle because there are lots of literature which claim that observed spreads between yields on corporate bonds and risk-free securities cannot be explained by structural models of default (Bai et al, 2021)

bond prices such as default risk. However, as said by Campbell et al (2003), the probability of an investment-grade corporate bond defaulting is very rare; and this is supported by Elton et al. (2001) and Huang et al (2000).

Another method for dealing with the credit puzzle is the reduced-form model. It is considered to be better than a structural model as it empirically estimates the relationship between bond yields and observable variables without creating a causal link to macroeconomic variables. Cathcart (2024) stated that reduced models embrace the hypothesis of incomplete information and neglect any knowledge about the capital structure of a firm. Although not included endogenously (Campbell et al, 2003), they are typically included as explanatory variables to capture their influence on bond yields. Dionne et al (2011) had similar findings with their model, with results suggesting that sometimes spread levels are sensitive to macroeconomic factors, whilst other times, drastic increases in yield spreads weren't necessarily linked to macroeconomic variables. As (Campbell et al, 2003) states, reduced-form models allow for default risk to have a higher degree of impact on the pricing of corporate bonds because macroeconomic variables have taken a step back and been considered exogenously.

In Cathcart (2024) Credit Risk Masterclass, they mention a new model being formed called the hybrid model, which aims to bring the strengths of a structural and reduced-form model to combine something more mathematically accurate and reliable patterns for finding credit spreads. More information about these methods can be found in the Appendix (A). Nevertheless, from analysing these intricate models, we observe that macroeconomic factors indeed have a degree of impact on yield spreads regardless of whether we evaluate bond pricing using a structural or reduced-form model.

Campbell et al (2003) also alludes to the importance of credit ratings and equity volatility. To initiate this point, I would like to mention the importance of credit ratings; a factor that is directly linked to corporate bond yields. A bond with a higher credit rating level (such as Moody's Aaa) can shorten a yield spread, as said by Chang et al (2020), because they received this rating through having a low probability of default (Cantor et al, 1995) and aren't strongly swayed by a change in market conditions, as found by Binici et al (2018). Therefore, a corporate bond with a high credit rating is less likely to be impacted by equity volatility compared to a low credit (Hibbert et al, 2011).

With that being said, another component that explains variation in corporate bond yields is equity volatility; accounting for a third of the variation in yield spreads (Campbell et al, 2003). As said by Campbell et al (2003), a firm which has more volatile equity has a higher probability of defaulting and because of this, investors typically demand for a higher yield (compared to the risk-free rate, r_f, which in our case is the 5-year US Treasury). It is suggested, however, that a change in yield spread is caused by the change in expected payoff on corporate debt which in turn leads to the effect occurring; regardless of if there is a change in expected return or not. Thus, we see that equity volatility contributes larger to the variation in corporate bond yields but again, it is an endogenous effect (similarly found by Chen et al, 2022).

Campbell et al (2003) presents strong statistical evidence that equity volatility plays a large part in the change of yield spread points. Referring to Table II (which can be found in Appendix B1) from the paper, we see OLS regressions being estimated (shown below): with the dependent variable being yield spread and several different key explanatory variables (the full list can be found in Appendix B2). It shows a total of 8 regressions being composed: with four that included equity volatility and four that didn't.

$$yield\_spread_i = \beta_0 + \beta_1 equity\_vol_{it} + \gamma\alpha_{it} + u_{it}$$

Upon initial examination of the results reported by Campbell et al (2003), we see evidence with each regression that the presence of equity volatility led to an increase in the adjusted R^2 values (shown on Figure I). This suggests that this explanatory variable adds meaningful value to the regression analysis.

Explaining Corporate Bond Yield Spreads: odd-numbered regressions are our restricted models and even-numbered regressions are our unrestricted models (for equity volatility).

Regression	1	2	3	4	5	6	7	8
Adjusted R^2	0.258	0.362	0.343	0.408	0.276	0.370	0.348	0.410

Figure I – Adjusted R^2 values taken from Campbell et al (2003)

Moreover, Campbell et al (2003) found that when including both equity volatility and credit ratings as explanatory variables, it improves explaining bond spreads, similarly found by Collin-Dufresn et al (2020) and is statistically shown by the increase in the adjusted R^2 value (shown in bold on Figure I). With prior explanations, this makes sense since higher (Moody's) credit ratings suggest more stability to exogeneous shocks which means that investors won't demand for as high of a yield

compared to the US Treasury (vice versa), with the addition of low equity volatility, they reinforce each other's reasons for impacting on corporate bond yield spreads.

Despite their strengths when complimenting each other, many have argued that credit ratings don't necessarily change the yield spreads of corporate bonds because investors anticipate the change in ratings (Ederington et al, 1987). Kliger et al (2000) agree with this point by stating that ratings change due to economic events, it is ambiguous to determine whether a change in bond pricing (thus triggering a change in investor's yield demand) is due to the rating announcement and how much is from economic shocks. One may conclude that it depends on when an investor changes their yield spread expectation. Kliger et al (2000) discovered that even though credit ratings reacted to a change in prices, the price of stocks move again after reacting to new (Moody's) credit rating information. This can be evident with the rating procedure noted in Weinstein (1977) from Ross (1976): "unless bonds are continuously rated, a rating change will always lag the information that led to the change".

To reiterate, we learn that equity volatility is an overlooked area but should not be as, with statistical evidence, it provides a strong explanation as to why corporate bond yield spreads change; especially when it is complemented with credit ratings.

Another key point which Campbell et al (2003) mentions are the significance of industrial challenges (i.e. time periods) and idiosyncratic volatility/risk. Campbell et al (2003) explores the significance of time periods and how they impact on yield spreads by providing a visual representation of the time period between January 1963 and December 1999 (shown on Figure II): by reflecting higher yields when there is ambiguity in investment returns and lower yields during times of lower uncertainty.

Figure II accurately represents why time periods are crucial to determining yield spreads. If we specifically look between Jan95 to Jan00, the rise of the dot com bubble, we see that yield spreads dropped drastically to approximately 80 base points. This large drop can be interpreted by the large volumes of investment activity into the technological industry and products. This meant that animal spirits were high, thus having much narrower yield spreads and lower idiosyncratic risk (similarly suggested by Morris et al, 2008). Campbell et al (2003) emphasise on the importance of time frames through the regression results on Table VI (find full results in Appendix C), which presents us with findings from two separate samples: one being S&P rated corporate bonds and the other being Moody's rated corporate bonds. We must notice that S&P reports higher yield spreads compared to Moody's and this is due to their consideration of industrial issues in the measured time period.

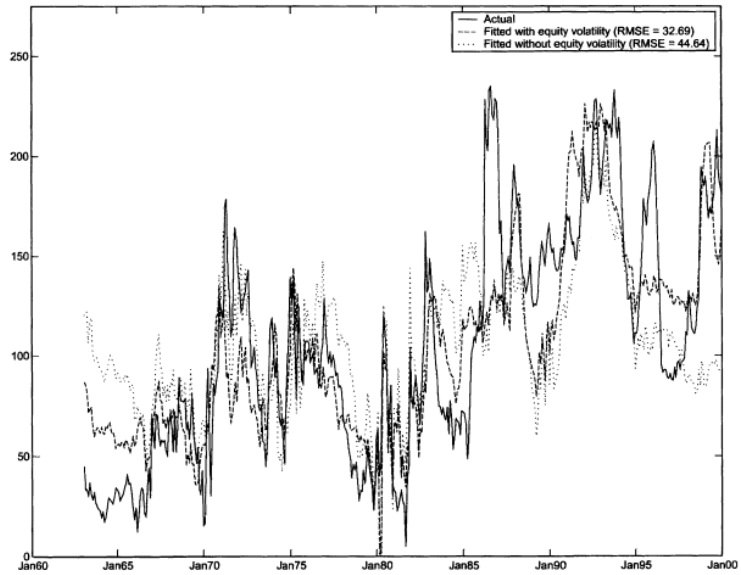

Figure II – Yield Spreads of S&P based credit ratings (specifically for A-rated corporate bonds): Taken from Campbell et al. (2003)

To explain this, we should take the results found by Campbell et al (2003) and the financial context of this time period. We know that many technological-based companies used high yield bonds in order to develop their product, which in turn led them to fail (Gvozdeva, 2020). As a result, industrial challenges increased overall volatility (since firm volatility includes both idiosyncratic volatility and market volatility) for all firms since other industries would have experienced knock-on effects (Becattini, 2002). Thus, the S&P yields were higher because it took the dot com bubble crisis into consideration.

Furthermore, idiosyncratic risk is a crucial factor to determining corporate bond yield spreads as they move much more actively compared to market risk. This is because when investors assess credit risk associated with corporate bonds, they consider factors such as financial health, future business prospects and probability of default. Campbell et al (2003) implies that lagged idiosyncratic risk has a higher weighting in predicting risk in future time periods. Bekaert et al (2012) found that (with a degree of certainty) in the 1990s time period, higher idiosyncratic volatility correlated with firms that had low stock prices, which further suggests higher bond yields due to the ambiguity of performance surrounding lower prices. It has been proven by Campbell et al (2003), and similarly by Kalimipalli et al (2013), where both found that when including idiosyncratic volatility as an explanatory variable, the adjusted R^2 values increase by relatively large percentage points. To note, as found in the aforementioned point, equity volatility adds considerable explanatory power to determining corporate bond yield spreads because Campbell et al (2003) find that adjusted R^2 increase by approximately 30% without equity volatility, as opposed to a 50-55% increase when

equity volatility is included (R^2 values shown on Figure III). A chart from Campbell et al (2003) of the difference in yield spreads with and without equity volatility can be found in Appendix D.

Bold shows the regressions that ran with equity volatility included as an explanatory variable.

	(S&P) Ratings			Moody's Ratings		
Regression	1	**2**	**3**	4	**5**	**6**
Adjusted R^2	0.370	**0.661**	**0.719**	0.086	**0.145**	**0.159**
% Change (3SF)	N/A	**+78.6%**	**+8.77%**	N/A	**+68.6%**	**+9.66%**

Figure III

Therefore, we learn that when we consider time periods which face industrial challenges to fluctuate the corporate bond yield spread as many factors change an investor's level of confidence, thus causing a change in idiosyncratic risk.

In conclusion, this analysis provided three key areas which explain a variation in corporate bond yield spreads, using the paper: Equity Volatility and Corporate Bond Yields by Campbell et al (2003) as the backbone. We discussed how economic conditions; equity volatility and idiosyncratic volatility (complemented with industrial challenges) can contribute to explaining a change in corporate bond yield spreads. Ultimately, the key take from this paper is that there are many factors that can influence corporate bond yield spreads, such as the aforementioned points and investor confidence. However, significant points which are commonly overlooked on are equity volatility and idiosyncratic risk. Through the regressions performed, we get a clear insight that they do indeed impact on explanatory power: especially idiosyncratic risk as its influence on yield spreads still contribute to explanatory power even when credit ratings are included. Moreover, despite the lack of formal econometric structure that was presented in the paper, we explored different mathematical models related to bond pricing in order to provide a more holistic (to cover both qualitative and quantitative aspects) approach to determinants of corporate bond yield spreads.

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Section 3 - Appendix:

Appendix A – Lara Cathcart Masterclass

In Dr Cathcart's we were taught about three models: Structured, Reduced-Form and Hybrid Model. "Structural models on the approach of Black-Scholes and Merton. Structural models evaluate the risk of default of a firm issuing a debt based on one or more variables related to its capital structure; a firm goes bankrupt only if it is in financial distress. Structural models are built on the hypotheses that firm's assets follow a diffusion process, and investors are able to observe the true distance to default. In practice, the hypothesis of complete information is often violated, and investors ask for a premium to compensate for the risk of non-predictable default. Therefore, structural models underestimate short-term credit spreads.

Reduced models can be defined as the mechanism that triggers default. It fully embraces the hypothesis of incomplete information and neglects any knowledge about the capital structure of a firm: bankruptcy occurs as the first jump of a counting process. This model considers the default event as exogeneous and latent variables as dependent. Cathcart (2024) also provided us with a formula to calculate the value of the defaultable bond:

$$V_t = E_t^Q(\exp\,[\int_t^T R_s\, ds]f(X\_T))$$

"Where $f(X_T)$ represents a function for maturity, E_t^Q is an expectation and R_s is the discount rate. The main idea of this is that at any moment, there is a chance that issuer of the claim will default and in this case V_t will equal zero." This is quite interesting to see as we see other potential factors which may play into corporate bond yield spreads by deriving the value of a defaultable bond, as we already know that higher default probability will most likely lead to an increase in yield spread due to uncertainty.

"Hybrid models bring the strengths of both a structural and reduced model together. In development by Cathcart et al, it has found to have several advantages: mathematical tractability, it can produce high short-term spreads & has a structural definition of default. The model allows for expected and unexpected defaults in a single framework. The stochastic hazard rate process captures the likelihood of the issuer defaulting over the next instant with no prior warning. Default can also occur in an expected manner for a particular low value of the signalling variable. An unexpected default can be triggered by numerous events, such as: unexpected devaluation, interest rate movements, outcome of lawsuits and etc."

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Appendix B1 – Table (II)

Table II

Explaining Corporate Bond Yield Spreads

Using panel data between 1995 and 1999, we regress corporate bond yield spreads over the closest benchmark Treasury against the variables listed below. Eleven month dummies are included in the regressions but omitted from this table. All equity data is for the 180 days preceding each bond trade. OLS *t*-statistics appear in parentheses. Bold denotes significance at the 0.1 percent level.

	Regression							
	1	2	3	4	5	6	7	8
Equity volatility								
Std. dev. of daily excess return (percent)		**221.81**		**189.16**		**238.14**		**199.24**
over preceding 180 days		**(39.42)**		**(34.52)**		**(39.93)**		**(34.00)**
Std. dev. of daily index return (percent)		29.17		46.07		7.24		36.44
		(1.52)		(2.49)		(0.38)		(1.96)
Mean daily excess return (percent)		**−32.07**		**−34.22**		**−31.50**		**−33.31**
		(−15.13)		**(−16.74)**		**(−14.85)**		**(−16.22)**
Mean daily index return (percent)		**−105.03**		**−102.92**		**−108.66**		**−104.88**
		(−14.13)		**(−14.37)**		**(−14.69)**		**(−14.65)**
Market capitalization relative to CRSP-value		**−30.30**		**−10.48**		**−26.21**		**−9.88**
weighted index (percent)		**(−21.32)**		**(−7.17)**		**(−17.65)**		**(−6.54)**
Credit ratings								
A or worse (relative to AA)			**17.74**	**13.37**			**17.91**	**13.18**
			(18.11)	**(13.98)**			**(18.17)**	**(13.65)**
BBB or worse (relative to AA)			**32.99**	**26.58**			**32.33**	**26.19**
			(43.52)	**(35.44)**			**(40.75)**	**(33.59)**
Accounting data								
Pretax interest coverage < 5					**8.65**	0.72	3.84	−1.36
					(5.58)	(0.49)	(2.60)	(−0.96)
5 ⩽ pretax interest coverage < 10					−2.49	**−6.52**	3.53	−1.60
					(−1.66)	**(−4.63)**	(2.46)	(−1.17)
10 ⩽ pretax interest coverage < 20					−2.62	**−7.97**	**5.57**	−2.21
					(−1.55)	**(−4.97)**	**(3.45)**	(−1.42)
Pretax interest coverage ⩾ 20					0.37	**−12.86**	5.73	−7.22
					(0.14)	**(−5.09)**	(2.24)	(−2.94)
Operating income to sales (percent)					**−13.41**	**−20.93**	**−9.79**	**−17.55**
					(−4.85)	**(−7.99)**	**(−3.73)**	**(−6.92)**
Long-term debt to assets (percent)					**31.18**	**19.46**	−1.69	−3.64
					(8.59)	**(5.72)**	(−0.48)	(−1.09)
Total debt to capitalization (percent)					**9.76**	**−8.85**	**22.80**	5.86
					(3.61)	**(−3.46)**	**(8.83)**	(2.34)
Macroeconomic and other variables								
Closest benchmark Treas. rate (percent)	**−31.07**	**−24.21**	**−31.90**	**−25.16**	**−30.98**	**−24.58**	**−31.68**	**−25.30**
	(−38.41)	**(−29.80)**	**(−41.89)**	**(−32.13)**	**(−38.71)**	**(−30.38)**	**(−41.70)**	**(−32.30)**
10 yr.–2 yr. Treasury (percent)	**−12.77**	2.37	−4.09	6.21	**−9.12**	2.62	−3.51	5.48
	(−5.06)	(0.83)	(−1.72)	(2.27)	**(−3.64)**	(0.93)	(−1.47)	(2.00)
30-day Eurodollar–Treasury (percent)	**25.28**	**12.53**	**24.52**	**12.34**	**25.18**	**12.41**	**24.34**	**12.29**
	(15.62)	**(7.48)**	**(16.11)**	**(7.64)**	**(15.75)**	**(7.45)**	**(16.04)**	**(7.62)**
Issue size (log)	**−2.54**	0.47	0.01	0.51	**−1.90**	0.43	0.28	0.60
	(−6.17)	(1.15)	(0.04)	(1.30)	**(−4.61)**	(1.04)	(0.71)	(1.50)
Years to maturity	**2.36**	**2.10**	**2.28**	**2.12**	**2.35**	**2.09**	**2.30**	**2.12**
	(47.29)	**(44.71)**	**(48.51)**	**(46.73)**	**(47.52)**	**(44.48)**	**(48.92)**	**(46.54)**
Coupon rate (percent)	**7.41**	**8.77**	**5.43**	**7.14**	**7.21**	**8.32**	**5.67**	**7.03**
	(22.64)	**(28.68)**	**(17.49)**	**(23.97)**	**(22.14)**	**(27.22)**	**(18.22)**	**(23.56)**
Industrial (relative to Utility)	**−8.27**	**−10.70**	**−9.64**	**−13.38**	−1.57	**−9.18**	**−8.02**	**−13.80**
	(−5.03)	**(−6.89)**	**(−6.21)**	**(−8.91)**	(−0.95)	**(−5.84)**	**(−5.07)**	**(−9.01)**
Financial (relative to Utility)	**−7.88**	**−10.19**	−1.41	**−4.97**	3.09	−2.71	−0.55	−4.23
	(−4.61)	**(−6.38)**	(−0.87)	**(−3.21)**	(1.53)	(−1.43)	(−0.29)	(−2.31)
Constant	**250.49**	**120.53**	**191.31**	**115.66**	**221.28**	**128.53**	**174.83**	**120.63**
	(26.73)	**(12.14)**	**(21.47)**	**(12.08)**	**(22.91)**	**(12.69)**	**(18.91)**	**(12.29)**
Number of transactions	21568	21568	21568	21568	21568	21568	21568	21568
Adjusted R^2	0.258	0.362	0.343	0.408	0.276	0.370	0.348	0.410
F	395.44	511.26	537.01	572.80	317.03	408.78	411.84	454.33

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Appendix B2 – Full Regression (Table II)

$$yield\_spread_i = \beta_0 + \beta_1 equityvol_{it} + \beta_2 creditrating_{it} + \beta_3 accountingdata_{it} + \beta_4 macrovariables_{it} + u_{it}$$

Appendix C – Table (VI)

	Standard and Poor's (S&P)			Moody's		
	1	2	3	4	5	6
Equity volatility		**9.15**	**5.56**		**2.58**	1.32
Idiosyncratic risk		**(19.19)**	**(9.13)**		**(3.66)**	(1.34)
Market risk		14.86	51.04		**174.10**	**179.94**
		(0.48)	(1.78)		**(3.77)**	**(3.89)**
Macroeconomic and other variables	0.36	**– 2.42**	**– 8.44**	**5.51**	**4.42**	**5.41**
10-year Treasury rate (percent)	(0.42)	**(– 3.75)**	**(– 9.30)**	**(5.73)**	**(4.63)**	**(3.70)**
10-year minus 2-year Treasury (percent)	**49.98**	**29.37**	**22.87**	**11.41**	6.06	4.83
	(16.20)	**(11.68)**	**(9.56)**	**(3.29)**	(1.63)	(1.26)
Aggregate ratio of corporate bonds to assets (percent)			**3.01**			– 1.37
			(6.65)			(– 1.87)
Debt turnover (percent)			**5.88**			4.88
			(5.35)			(2.76)
Constant	**0.81**	**– 0.40**	**– 0.30**	**0.60**	0.21	**0.51**
	(11.82)	**(– 5.00)**	**(– 3.20)**	**(7.83)**	(1.82)	**(3.36)**
Number of observations	444	444	444	444	444	444
Adjusted R^2	0.370	0.661	0.719	0.086	0.145	0.159
F	131.23	216.78	189.88	21.74	19.74	14.92

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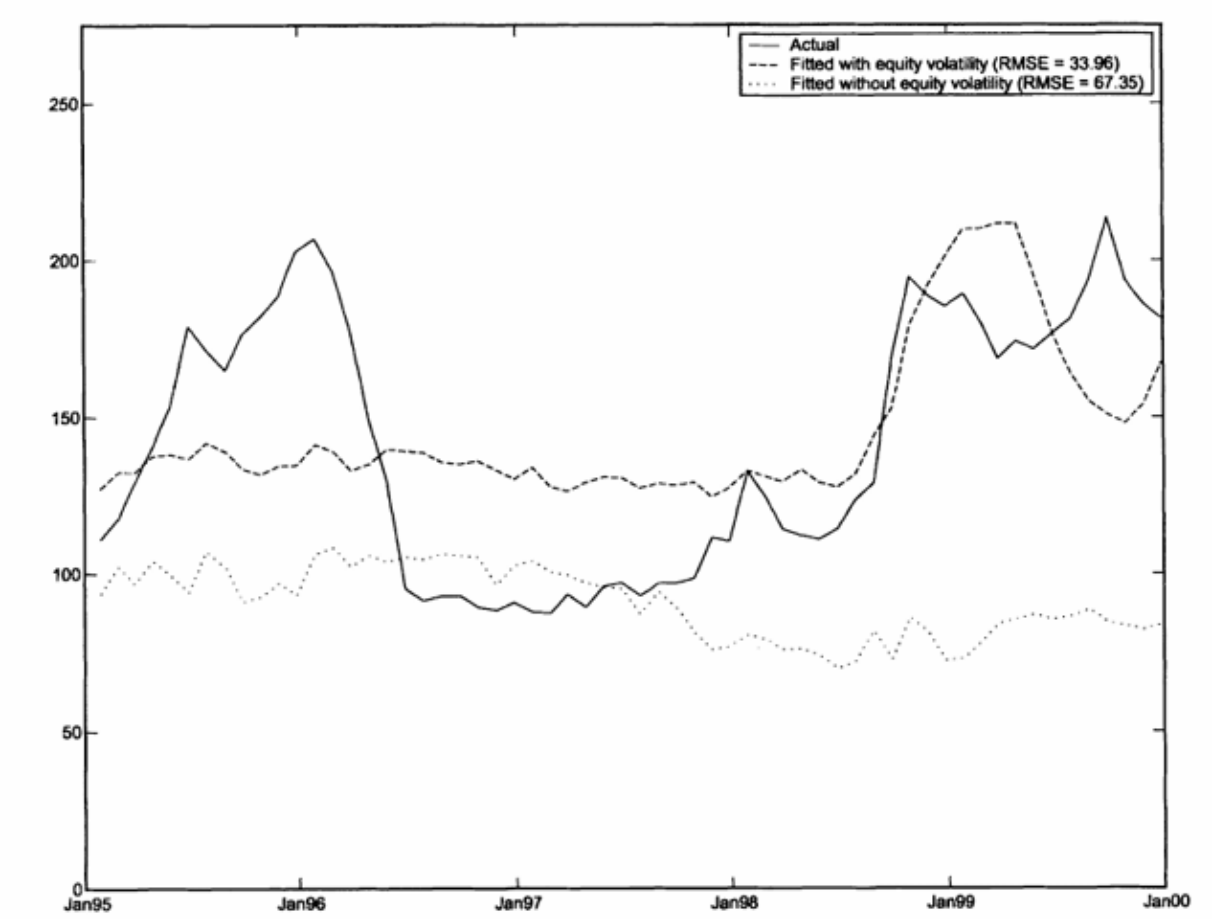
Appendix D – S&P fitted yield spreads for A-rate corporate bonds (with and without equity volatility)



The solid line represented the actual yield spreads, the thicker dotted line represents yield spreads with equity volatility and the fainter dotted line represents yield spreads without equity volatility