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We examine the determinants of yields on risky bonds and, in particular, the sources of comovement between these yields, Treasury yields, and equity returns. The framework for our analysis is the equilibrium model in Gennotte and Marsh (1993) in which these variables are jointly determined.

The yield on a zero-coupon corporate bond[1] is a function of both the term structure of interest rates and the bond's credit risk. While it is quite common today to find sophisticated models of the term structure used in practice, credit risk is still often dealt with summarily---for example, by simply adding a fixed spread to the Treasury yield curve. Yet this quick fix is at odds with the evidence: risk premiums for long-term and short-term corporate debt differ, and their relative value appears to change over time (Van Horne (1970)); and the yield spread on junk bonds---as well as the slope of the term structure---covaries with business cycle variables like consumption growth and GNP (Breeden (1974), Estrella and Hardouvelis (1991), Friedman and Schwartz (1963), Friedman and Kuttner (1992), Harvey (1988), and Kessel (1965), among others).

Black and Scholes (1973) and Merton (1974) showed how the default risk could be modelled in terms of call and put options on the underlying assets; the options approach produces what Merton (1974) described as a "risk structure of interest rates" on corporate bonds with different maturities. In Merton (1974), the contingent claims valuation of credit risk is done in a partial equilibrium framework, i.e. credit risk is evaluated for exogenously specified interest rates and volatility of corporate asset value. This allows only comparative static analyses of the effect of changes in the term structure and in the parameters of the distribution of asset returns. Here, in contrast, we analyze credit risk changes in an environment where the term structure and the riskiness of corporate cash flows are stochastic and endogenously determined.

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[1] We ignore any possible imbedded option, e.g. put rights, sinking fund options, and the like.

To abstract from firm-specific events (which might, say, cause one corporation's bond rating to change from AA to A), our model is formulated at the level of "the economy." That is, it describes the interactions between interest rates and returns on portfolios of equities and risky bonds in which all but economy-wide risk is diversified away. This economy-level focus is consistent with the view that "...[t]he primary variable that will impact junk bonds is the performance of the economy."[2] Also, "[o]ne aspect of risk in international lending that deserves more attention is the risk of country-wide factors...that are diversifiable and therefore seriously affect the creditworthiness of private sector borrowers" (Junge and Schieler (1993)).

With respect to the current literature, our analysis is in the same spirit as Litterman and Iben (1991)'s account of a Goldman-Sachs model for the term structure of credit risk. They describe how default probabilities are superimposed on a binomial ("tree") model of Treasury rate movements; the binomial tree is then calibrated using observed Treasury security prices, and the default probabilities using corporate bond prices. However, while tying movements in default risk to movements in interest rates makes the calibration task tractable, default risk changes in response to factors other than interest rates, viz. on account of changes in the expectations and the riskiness of corporate cash flows.[3] Kim, Ramaswamy, and Sundaresan (1992) also allow for stochastic interest rates in valuing corporate bonds. However, as they focus on firm-level valuation, interest rate behavior is given exogenously, and the rates are assumed to have a constant

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[2] Neal Litvack, Fidelity Fund, Wall Street Journal, June 6, 1989, as quoted in Cornell and Green (1991, p. 40).

[3] There is also a general inconsistency in the practice of fitting the tree diagram using observed bond prices in one period while not accounting for the dynamics of movement from the tree diagram in one period to the next (just as it is not fully consistent to use the Black-Scholes model to calculate period-by-period implied volatilities by fitting the model---which inherently assumes constant volatilities---anew in each period).

correlation with a firm's asset value. In our analysis, variations in interest rates are endogenous, and their correlation with asset values can change over time.[4]

Our model provides a benchmark to use in examining the pricing of low grade ("junk") bonds. In empirical studies, Cornell and Green (1991) and Blume, Keim, and Patel (1991) find that the measured premium on junk bonds is quite sensitive to the period studied, e.g. Blume, Keim, and Patel find that the average rate of return on a portfolio of low grade bonds exceeded the average rate of return on a portfolio of high grade bonds by 2.06% over the period 1977-1988, while Cornell and Green find that the measured returns are about equal if the year 1989 is added to the sample. Running our model using parameters estimated from a longer sample of *equity* returns, we estimate the yield premium to be about 1.07% (1.83%) per annum on a 20 year zero coupon bond with a promised debt-value ratio of 50% (80%); it is empirically difficult to estimate this systematic risk premium using corporate bond data because of short time series, nontrading, survivorship biases, the difficulty of properly computing option-adjusted yields, and the like.

Finally, our analysis offers an interesting interpretation of "flight to quality," the description given to the widening in term structure spreads and risky bond yield premiums in times of financial crisis. Friedman and Schwartz (1963) reported this 1930s depression-era phenomena in their *Monetary History of the United States*: "...yields on long-term government bonds were low after 1933 by earlier standards...however, rates on short-term securities...were lower still by those standards" and "[a]mong corporate bonds, yields on lower-grade bonds had fallen decidedly less from 1929 to 1936 than yields on high-grade bonds had, again suggesting a shift of preference to the more certain" (p. 455). In our model, preferences are constant, but the Government term structure and risky bond yield premiums behave in exactly this way because of the change in the fundamentals.

2. Equilibrium Model

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[4] As we report below, the correlation between interest rates and percentage changes in asset value turn out to be approximately constant for the parameter estimates in our model.

To obtain our results, we apply an equilibrium model of asset returns developed in Gennotte and Marsh (1993). Equity market returns and the term structure of interest rates are jointly determined by changes over time in corporate dividends[5] and in the uncertainty about corporate dividends. As described in the next section, the evidence seems to point to shifts in dividend uncertainty as an important determinant of changes in risky bond yields.

In particular, we assume that variation over time in the economy's aggregate dividend is characterized by the following subordinated process:

$$dD_t = D_t\ m\ dt + D_t \sqrt{\Omega_t}\ dZ_t \tag{1}$$

where changes in the instantaneous variance of dividends Ω_t are given by:

$$d\Omega_t = \beta(\Omega_\infty - \Omega_t)\ dt + \sqrt{\Omega_t}\ \alpha\ dZ_2 \tag{2}$$

In (1) and (2) the parameter m is the expected (geometric) rate of growth in dividends; β determines how quickly the variance of the rate of growth in dividends, Ω_t, reverts back to its long-run steady state Ω_∞; and the diffusion coefficient α determines the degree of variation in the dividend volatility. We allow the Brownian motions dZ_1 and dZ_2 to be correlated, where the coefficient of correlation is defined to be π.

The continuous stream of dividends is paid to investors whom, we assume, can be characterized in aggregate in terms of a representative investor. The representative

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[5] Our model does not differentiate between corporate dividends, earnings, and net cash flows.

investor is assumed to have isoelastic utility of consumption with coefficient of relative risk aversion γ. In equilibrium, the representative investor consumes the dividend stream and holds a claim on all future dividends. In this economy, the price of any financial asset is then equal to the sum (or integral) over all future dates of the expectation of the payoffs at date s multiplied by the ratio of the date s marginal utility to the current one.

The equilibrium price P_t of a claim on the dividend stream (a "market" share) at time t, when aggregate dividends are D_t and the level of uncertainty about dividends is Ω_t, is $P_t = D_t\, \nu(\Omega_t)$, where:

$$\nu_t = \int_0^\infty e^{-\phi s}\, e^{[(1-\gamma)m+\Omega_\infty \beta B_1]s}\, Z^{\frac{2\beta\Omega_\infty}{\alpha^2}}\, e^{B_2(1-Z)\Omega_t}\, ds \tag{3}$$

and B_1, B_2 and Z are given by the following functions:

$$B_1 = \frac{(\beta+(\gamma-1)\alpha\pi) - [(\beta+(\gamma-1)\alpha\pi)^2-\alpha^2\gamma(\gamma-1)]^{\frac{1}{2}}}{\alpha^2} \tag{4}$$

$$B_2 = \frac{(\beta+(\gamma-1)\alpha\pi) + [(\beta+(\gamma-1)\alpha\pi)^2-\alpha^2\gamma(\gamma-1)]^{\frac{1}{2}}}{\alpha^2} \tag{5}$$

$$Z(s) = \frac{B_2 - B_1}{B_2 - B_1\, e^{-\frac{1}{2}\alpha^2 (B_2 - B_1)s}} \tag{6}$$

The price to dividend ratio, v_t, depends: on the stochastic process for the instantaneous variance Ω of the rate of change in dividends, through the parameters $\alpha, \beta, \Omega_\infty$, and π; on the relative risk aversion coefficient γ; and on the rate of time preference ϕ[6].

The value of a zero coupon bond with time-to-maturity T is equal to the term under the integral in (3) after replacement of γ with $\gamma + 1$:

$$PDB_t(T) = e^{-\phi T} e^{[-\gamma m + \Omega_\infty \beta C_1]T} X^{\frac{2\beta\Omega_\infty}{\alpha^2}} e^{C_2(1-X)\Omega_t} \tag{7}$$

and C_1, C_2 and X are given by the following functions:

$$C_1 = \frac{(\beta + \gamma\alpha\pi) - [(\beta + \gamma\alpha\pi)^2 - \alpha^2\gamma(\gamma+1)]^{\frac{1}{2}}}{\alpha^2} \tag{8}$$

$$C_2 = \frac{(\beta + \gamma\alpha\pi) + [(\beta + \gamma\alpha\pi)^2 - \alpha^2\gamma(\gamma+1)]^{\frac{1}{2}}}{\alpha^2} \tag{9}$$

$$X(T) = \frac{C_2 - C_1}{C_2 - C_1 e^{-\frac{1}{2}\alpha^2 (C_2 - C_1) T}} \tag{10}$$

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[6] A differential equation similar to the one whose solution is given in (3) arises for any dividend process. However, the process defined in (1) and (2) and isoelastic preferences lead to a simpler empirical analysis. If the dividend growth rates were a function of the dividend level and preferences, the differential equation underlying (3) would become a partial differential equation with respect to Ω and D.

The intuition for this result is that the zero coupon bond has a unique payoff of 1 at the maturity date instead of the asset's dividend stream. The aggregate dividend being equal to consumption and preferences being isoelastic, it is as if the coefficient of risk aversion were modified.

The yield to maturity for a T period discount bond is:

$$Y_t(T) = -\frac{Ln(PDB_t(T)}{T} = (-\phi-\gamma m+\Omega_\infty \beta C_1)T + \frac{2\beta\,\Omega_\infty Ln(X)}{\alpha^2} + C_2(1-X)\Omega \quad (11)$$

while the riskless rate is:

$$r_t = \phi + \gamma m - \frac{1}{2}\gamma(\gamma+1)\Omega_t$$

In Gennotte and Marsh (1993), the parameters of (3) were estimated by using the method of simulated moments applied to value-weighted NYSE returns over the period January 1926 to December 1985. We *did not* use term structure data to estimate the model, so our use of the equity-returns-based estimates in the term structure analysis here makes it an out-of-sample fit of the model.

Our MSM estimate of γ, the coefficient of relative risk aversion, was 1.19. However, consistent with previous studies, the estimate of γ is not sharp--its standard error is 1.065. Also, the estimate of π, the correlation between the level of aggregate corporate cash flows and uncertainty about those cash flows, is -0.137, with a standard error of 0.072. That is, a higher level of dividend (cash flow) uncertainty is on average associated with lower dividends. The magnitude of this negative correlation is sufficient to produce a negative correlation between realized stock returns and changes in uncertainty.

The parameters β, Ω_∞, and α determine the instantaneous volatility of dividends. We found their point estimates and standard errors to be, respectively, 0.451 (0.215), 0.038

(0.017), and 0.158 (0.051). Parameters are stated in annualized units, so the 0.038 estimate for Ω_∞, for example, corresponds to a standard deviation of the dividend growth rate of approximately 20% per annum (i.e. a variance of $0.2^2=0.04$).[7] The point estimate of β implies a half life for regressivity of the dividend uncertainty parameter of approximately 1.54 years, while the half life would be 33 years (0.78 years) if β were two standard errors below (above) its point estimate.

3. The Term Structure of Riskless Bond Yields and Premiums on Risky Bonds

In this section, we derive the term structures of riskfree and risky bond yields implied by our model. We analyze the changes which occur in these term structures as dividends and dividend uncertainty change over time.

To compute the term structure and risky bond yields, we use the MSM estimates computed *from equity returns over the period January 1926 to December 1985*. That is, the term structure and bond yields are fit with estimates which are out-of-sample. Beside emphasizing the cross-asset nature of the analysis, this use of equity return-based estimates has at least two advantages. First, it is difficult to obtain a series of riskless or risky bond returns extending back to 1926, as do the equity returns. Second, in examining real interest rates and equity returns from 1800-1990, Siegel (1992a,b) reports that real interest rates have been unusually low in the twentieth century, at least up until the 1980s. Thus, even if data did exist back to 1926, estimates based on that data would provide us with bond returns that are possibly unrepresentative of the long-run steady-state. At the

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[7] Given our parameter estimates, the 0.038 estimate of the variance of the dividend growth rate corresponds to a variance of cum-dividend asset returns of approximately 0.041. (Note: in Gennotte and Marsh (1993, p. 1033), we say that the variance of asset returns "...is roughly twice...the dividend variance" for the estimates of our model. This ratio was in derived using an early approximation for the v(.) function, and turns out to be incorrect for the estimates given in our paper).

same time, Siegel found that real equity returns exhibit no apparent difference over the nineteenth and twentieth centuries, so that bond returns calibrated from this century's equity returns do stand some chance of representing long-run behavior.

Our model is a non-monetary equilibrium model. Further, the equity returns from which the MSM estimates were derived contain little information about expected inflation rates. Hence, the bond yields derived from the estimates are best thought of as *real yields.* At the same time, Sections 3.1 through 3.4 will show that the behavior of real bond yields in our model is consistent with that observed for nominal yields in practice. Our *modus operandi* is thus similar in spirit to the real business cycle models which don't resort to complicated and arbitrary monetary specifications to explain the time series behavior of economic aggregates. Recent evidence seems to be consistent with the approach. For example, Friedman and Kuttner report that "...the difference between the commercial paper rate and the Treasury billl rate does contain incremental information about real income (but not prices)" (1992, p. 473). We return to the "real versus nominal" issue in Section 3.4.

3.1 Dynamics of the Riskless Term Structure

In Figures 1 and 2, we analyze the shifts in the riskless term structure that occur when the level of uncertainty about dividends changes. In Figure 1, dividend uncertainty is set at 30%, approximately 50% higher than the estimated steady-state level. It seems reasonable to define this high level of uncertainty---and the lower level of dividends with which it is, on average, associated---as characterizing a "recession."[8] In Figure 2, dividend uncertainty is set at 10%, which we can think typifying a "boom."

In both Figures 1 and 2, the term structure shifts are computed for both our model and the lognormal special case of our model. In Figure 1, for example, the lognormal case assumes that investors believe that the dividend uncertainty will remain

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[8] *** Are second moments conventionally used in defining recession?

fixed at the 30% level forever. Being risk averse, investors bid up the price of the riskless asset to where the (real) yield actually becomes negative: about -2.18%. In the Gennotte-Marsh model, the riskless yields range from about 0.00% for one-year bonds to 4.22% for 20-year bonds. The yields are higher because investors anticipate that dividend uncertainty will decrease in the future; thus they don't bid up the prices of the riskless bonds as much as they do in the lognormal model. In this 30% volatility scenario, investors in our model require a risk premium on equity of 11.96%.

Figure 2 contains a plot of the riskless term structures when the dividend volatility has dropped to 10%, a "boom" period. In this case, the default-free yields in both the lognormal and general models have to rise to attract investors into bonds, while the risk premium on equity drops to 1.23%. The riskless yield in the lognormal model, 9.63%, is higher than in our model, where it ranges from about 8.9% at the one-year maturity to 5.8% at the 20-year maturity. If risk averse investors believe that the low volatility state is permanent, as assumed in the lognormal model, they will pay a lower price (require a higher yield) than if they expect the volatility to gradually revert back to a higher steady-state value in the future.

The *shape* of the term structure changes in an interesting way as dividend uncertainty changes. As can be seen from Figure 2, when dividend uncertainty is low---what we've defined as a state of "boom"---the term structure is downward sloping; in Figure 1, where the volatility is 30% in what we call the "recession" state, the term structure is upward sloping. The shape of the riskless term structure for an entire range of values of dividend uncertainty, Ω_t, is plotted in Figure 3. The shape is consistent with the "slices" plotted in Figs. 1 and 2---in general, the term structure is downward sloping in times of greater uncertainty, and vice versa. As we discuss later, term structures do tend to slope upward in periods defined by the National Bureau of Economic Research as recessions, and vice versa.

(INSERT: Forward Rates)

3.2 Steady-State Term Structure of Yields on Risky Bonds

To compute the risky bond yields, we simulate our model by making 100 draws of the innovations dZ_1 and dZ_2 per month for 240,000 months.[9] In our simulations, the model parameters were set equal to the MSM coefficient estimates reported above.

A bond default occurs when the value of assets at maturity are insufficient to repay the promised principal on the bond, i.e. the stockholders let lapse their option to buy back the firm by making the promised debt payment. Prior to maturity, the value of the debt depends, *inter alia*, on the ratio of the present value of the promised debt payment to the value of the asset. Merton (1974) called this the "quasi-debt" ratio[10]. To find the present value of the promised payment, we use the endogenous riskless term structure. In our model, the aggregate market pays a continuous dividend yield, so we also allow for that payout in defining the quasi-debt ratio. If the dividend yield is $d = 1/v$ and the face value of the debt at maturity date T is B_T, then the quasi-debt ratio q is $q = B_T\, PDB_t(T) \,/\, (V_t\, e^{-d(T-t)})$, where V_t is the value of the market at time t and PDB_T is the (endogenous) price of a pure discount bond maturing at time T.

In Fig. 4, we plot the term structure of riskless interest rates and of the yield premium on a bond with a 50% quasi-debt ratio at time 0. The uncertainty about aggregate dividends Ω at time 0 was set equal to its long-run steady-state value Ω_∞. When dividend uncertainty is at its steady-state level, the term structure is slightly downward sloping, with a yield of 5.99% on 1-year riskless bonds and 5.75% on 20-year (zero coupon) riskless bonds. The downward sloping pattern obtains for the empirically

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[9] We verified that, at least when our returns model is restricted to the lognormal special case, .01 of a month is close enough to an "infinitesimal" interval to produce returns whose first two moments accord with those of the (theoretical) continuous lognormal distribution.

[10] Because the quasi-debt ratio is the ratio of the promised payment, valued at the riskless rate, to asset value, it overstates the debt-asset ratio measured using market values.

estimated values of the parameters. For a risk aversion coefficient of 1 ("logarithmic preferences") for example, the term structure is flat. The premium on the risky bond increases monitonically as a function of maturity: it is negligible for the 1-year bond, and increases to about 107 basis points for the 20-year bond.

The term structures of both riskless and risky bond yields are plotted in Fig. 5 for the lognormal special case of our model. It can be seen that the riskless term structure is flat at a yield of 6.06% per annum. This riskless yield is higher than in Fig. 4---where the yield is 5.99% for the 1 year bond--- because, in that case, the "uncertainty about dividend uncertainty" causes risk-averse investors to bid up the price of the riskfree bond.[11] The yield on the risky bond increases as a function of maturity, just as it does in the Gennotte-Marsh model shown in Fig. 4. The yield premium is slightly lower than in our model, however; it increases to 94 basis points at the 20 year maturity in the lognormal model, which is only about two-thirds its size in our's.

The risk premium does not always increase monitonically in maturity, as it does in Fig. 4. For example, in Fig 6, the term structure of risky bond yields is again plotted for the general and special-case lognormal models when dividend volatility is at its steady-state level, but where now the quasi-debt ratio is 80%. For our model, the yield is 7.65% for one-year bonds, peaks at 8.15% for three year bonds, and then declines monotonically to 7.51% for 20 year bonds. For the lognormal model, the yield runs from 7.41% for one year to a peak of 8.02% at four years, and declines to 7.59% at the 20 year maturity.

The "humped" pattern of risky bond yields as a function of maturity, like that in Fig. 6, occurs when the quasi-debt ratio is "high" but less than unity (see Merton (1974, Fig. 3), Lee(1981), and Pitts and Selby (1983)). Sarig and Warga (1989) report that, empirically, yields on BB-rated corporate discount bonds did seem to display such a hump-shaped pattern over their sample period---February 1985 to September 1987.

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[11] See the discussion in Gennotte and Marsh (1993, pp. 1025-1026).

We emphasize that the uncertainty about dividends---"economic uncertainty"---changes *exogenously* over time in our model. In firm-level models of bond pricing, incompleteness in covenants can allow managers to change the composition of a firm's assets and thus their volatility. This moral hazard source of change in the uncertainty of bond collateral is *not* in our model, and it is obviously of a quite different genre to the economy-wide shifts in dividend uncertainty on which we focus. Moreover, there is no trading or explicit market in our model---thus we can't deal with illiquidity in the collateral or other bankruptcy costs.

3.3 Jointly Endogenous Changes in the Term Structure and Risky Bond Yield Premiums

When the shape of the term structure changes as dividend uncertainty changes, so does the structure of the spreads between risky and riskless bond yield spreads.

When the volatility is 10% in our model with mean-reverting dividend uncertainty, and the term structure is downward sloping, the spread between the risky bond (with 80% quasi-debt ratio) and the riskless yields is negligible at the one-year maturity, and 1.73% at the twenty-year maturity. It is graphed for all maturities in Figure 7. In the lognormal model, the yield spread (not shown) is 5 basis points for the 1-year bonds, and 53 basis points for the 20-year bonds.

When the volatility increases to 30% in our model, the spread is 7.86% for the 1-year bonds and 3.17% for the 20-year bonds, as can be seen from Figure 8. For the lognormal model, it is 5.129% for the 1-year bonds and 2.18% for the 20-year bonds.

In our model, increased dividend uncertainty is, on average, associated with a decrease in the level of dividends. This is one reason why we have associated increases in uncertainty with "recessions." Given this characterization, the credit spread *widens* when the economy goes into recession. When the volatility rate is higher, defaults are more common, which would *per se* push bond prices down (promised yields up); however, bonds as a class are more valuable, pushing prices up and yields down. On net, risky bond yields *fall* as dividend uncertainty increases. However, riskless bond yields fall even faster, so the spread between risky and riskless bond yields actually widens. As we contended in the introduction, this behavior of relative yields is consistent with the Friedman and Schwartz observation that "[a]mong corporate bonds, yields on lower-grade bonds [fell] decidedly less from 1929 to 1936 than yields on high-grade bonds," so long as we accept that economic uncertainty did increase in the early 1930s; certainly output dropped in the 1930s. Of course, the behavior of the yields in our model follows from a combination of investor preferences and technology; here, the behavior is in effect attributed to shifts in technology for given investor preferences, not just to shifts in preferences as is implied in Friedman and Schwartz.

We have also compared the magnitudes of the premium spreads in Figures 7 and 8 with the evidence presented in Van Horne (1979, Table 1). He reports that average commercial paper (short term) spreads were 1.02% and average commercial spreads were 1.74% at the beginning of 1972. Interpreting this as a time of low volatility, we see that the short-term and long-term spreads are about zero and 1.73% respectively. Thus, our model understates the short-term spread, but gets the long-term spread about right. It seems to fit the "boom" data better than the lognormal model. In 1974, quarter 4, Van Horne reports the long-term and short-term spreads to be 3.82% and 2.16%, while we get 7.86% and 3.17% respectively. The lognormal model spreads are 5.12% and 2.18% respectively. Thus our model overstates the short-term premium relative to that observed in 1974. Part of the explanation is possibly that the default risk of the commercial paper issuers in Van Horne's sample is well below that implied by the 80% quasi-debt ratio used in deriving Figures 6 and 7, but it's not clear why this wouldn't also be the case in 1972.

3.4 Changes in the Term Structure and Real Economic Activity

In our model, an increase in dividend uncertainty causes both long-term and short-term interest rates to fall as investors bid up the prices of bonds. However, short-term yields fall more, so the slope of the yield curve increases. Further, increases in uncertainty are, on average, associated with a decline in the rate of growth of dividends. Thus, the slope of the yield curve is higher (lower) when dividends are growing less rapidly, i.e. in a "recession."

Empirically, term structure spreads do tend to increase in recessions. Fig. 8, which is reproduced from Huh (1993), shows the behavior of the term structure spread from 1959 to 1992 during NBER-defined recessions, which are shaded. In all the classified recessions of 1960, 1970, 1975, 1980, 1982, and 1990, the slope of the term structure increased. Also, Fig. 9 reproduces Chart 35 from Friedman and Schwartz (1963, p. 454), which graphs the increase in the term structure spread during the 1930s depression, which displays similar behavior. Breeden (1984) also shows that annual returns on the junk bond spread over the period 1929-1983 were positively correlated with per capita changes in the consumption of nondurables.[12]

At the same time, there is evidence that, on average, the term structure predicts *future* economic activity. Using quarterly data from 1955 through 1988, Estrella and Hardouvelis (1991), report that the term structure spread explains more than a third of the four-quarter-ahead variation in real GNP growth rates. Harvey (1988) shows that real yield spreads tend to be positively correlated with subsequent two and three quarter growth rates in per capita consumption over the period 1972-1987. Kessel (1965) and Friedman and Kuttner (1992) report similar results. Of course, given covariance stationarity of the interest rate spread and GNP growth rates, the predictive property of the spread is just the flip-side of the result that spreads increase in recessions---since recessions are defined *ex post* by the NBER to end when GNP growth rates increase.

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[12] Note that an increase (decrease) in the yield spread is the same as negative (positive) returns, i.e. the evidence is that *the yield spread* is negatively related to changes in consumption.

A number of explanations have been offered for these empirical results. For example, it has been suggested that a tightening of monetary policy forces up short term interest rates (relative to long-term rates on which monetary policy can have little effect), while at the same time it leads to a lagged contraction in GNP growth rates. Explanations of the channel through which monetary policy has these effects on output and interest rates include traditional or modified "LM" stories, supply effects on the bond market, and bank lending/"credit channel" constraints. Friedman and Schwarz (1963) studied the composition of bank security holdings and, as already mentioned, posited that a shift in banks' preferences for liquid securities in the early 1930s drove down short term yields. On the "IS" side, business cycle models with real-investment specifications (e.g. the "time-to-build" model of Kydland and Prescott (19??)), generally produce a positive correlation between real interest rates and real output which is also consistent with the stylized empirical facts.

Our simple general equilibrium model, which is driven by the intertemporal consumption smoothing demands of risk-averse investors, shows that it is possible to explain the empirical results without having to appeal to the more complicated specifications. Unfortunately, these specifications are often observationally equivalent. But even when they are not, so that structural hypothesis testing is feasible, there is every reason to suspect that some of the macro-relationships are not stable, especially the monetary policy ones (e.g. the discussion in Friedman and Kuttner (1992)).[13]

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[13] We offer two examples: (1) Sims (1972) and Litterman and Weiss (1985) presented evidence that, once interest rates were taken into account as predictors of output, money has little if any additional predictive power. McCallum (1983) suggested that this result might just mean that interest rates contain more information about monetary policy than money growth rates themselves; (2) Black (1972) and real business cycle theorists have written down structural models like our's in which money is completely endogenously determined. In short, there is almost always a structural macro model that can be used to buttress any desired interpretation of money, interest rate, and production rate behavior. We are simply arguing that our simple non-monetary equilibrium model also seems to explain the stylized facts.

Our model doesn't leave a lot of latitude to explain the association between term structures and *subsequent* GNP growth rates. The *expected* growth rate of dividends is constant in our model. Thus if a shock causes, say, an increase in the term structure spread and a decrease in the GNP growth rate "today," the expected growth rate "tomorrow" remains constant at m. Albeit, m is by definition above the "low" GNP growth rate today, and thus today's term structure slope is positively correlated with the change from today's to tomorrow's expected growth rates, which is consistent with the evidence. But there is little room for interesting dynamics here.[14] On the other hand, the empirical evidence uses *ex post* classifications of recessions, so perhaps some of the observed dynamics simply reflects on the ex post sample selection of sequences of unexpected shocks.

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[14] The level of future output will be smaller relative to that expected before a shock when the shock decreases the long bond yield, so shocks to yields are positively correlated with revisions in the level of future output.

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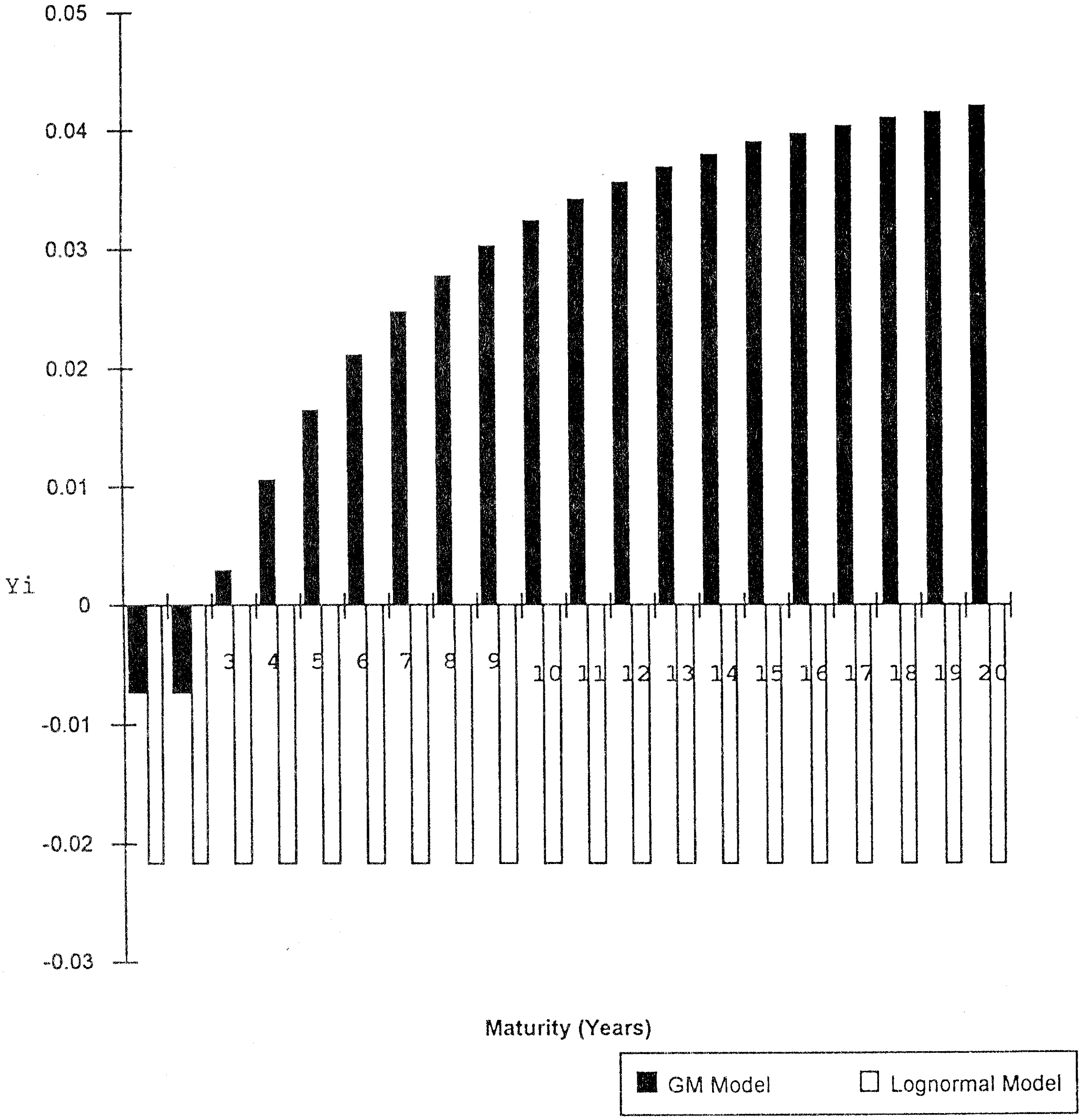
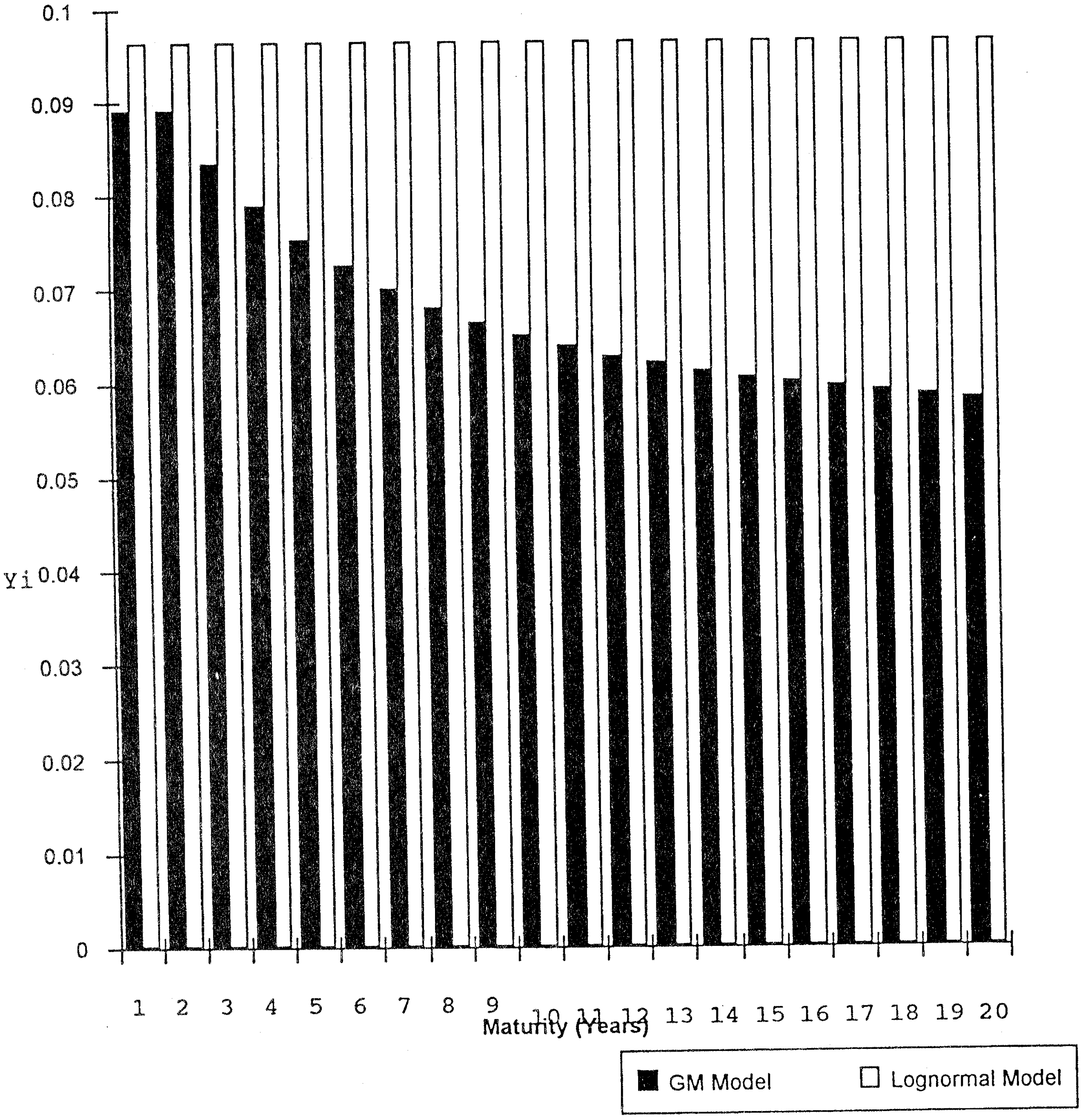


Figure 1 : Riskless Bond Yields for the Lognormal Model and Gennotte-Marsh Model when volatility is 30% ("Recession")

Figure 2.: Riskless Bond Yields for the Lognormal and Gennotte-Marsh Models when Volatility is 10% ("Boom")



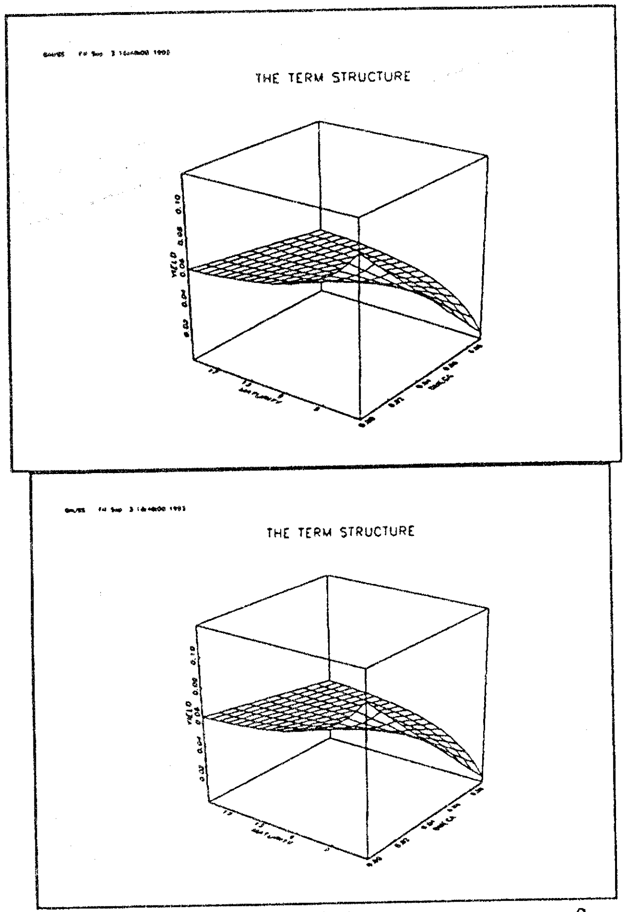


Figure 3: The shape of the term structure for alternative values of dividend uncertainty

Figure 6: Riskless Bond Yield and Risky Bond Yield
for Equilibrium Model

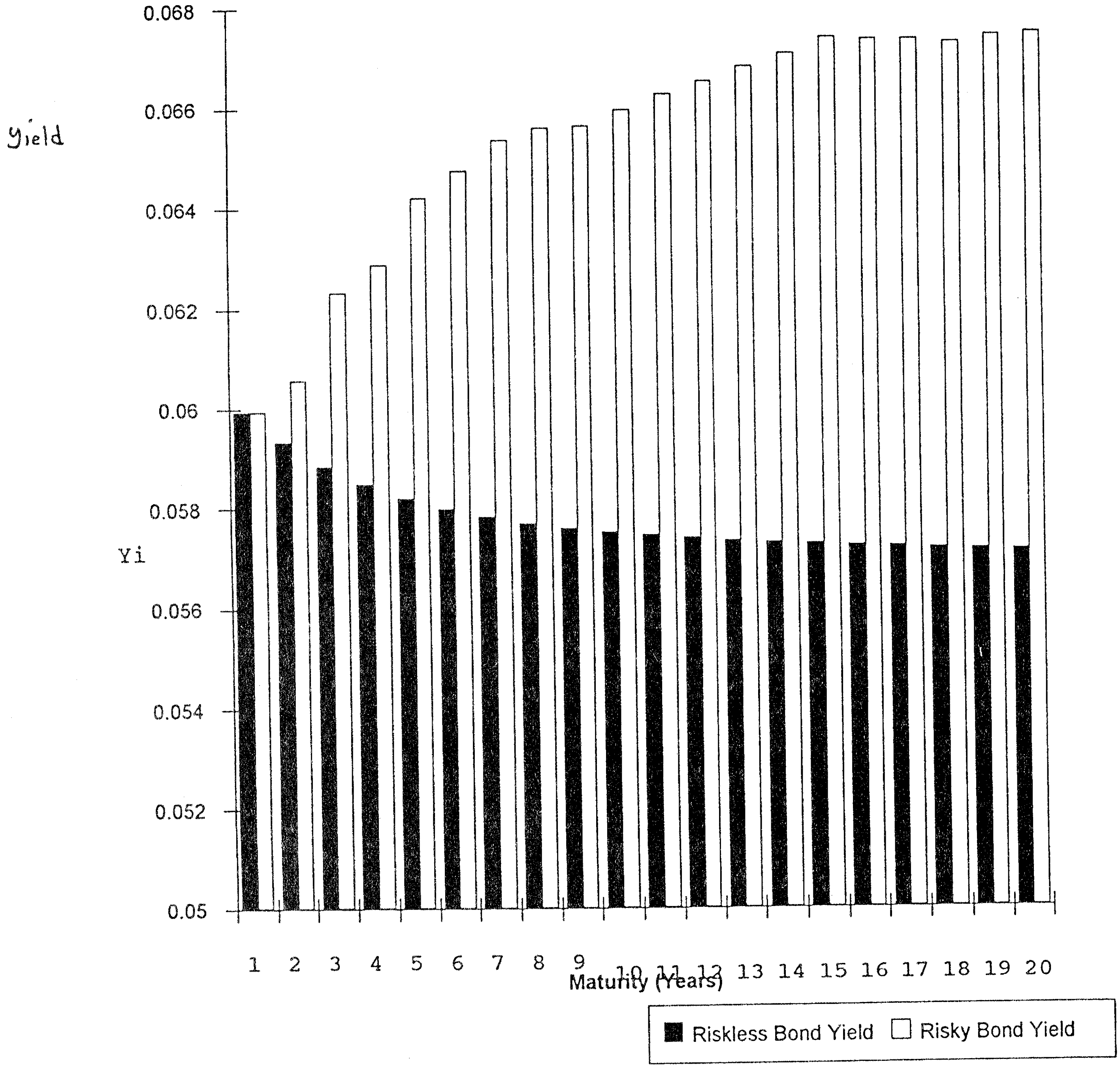


Figure 5: Risky Bond Yield and Riskless Bond Yield for the Lognormal Model of Corporate Dividends

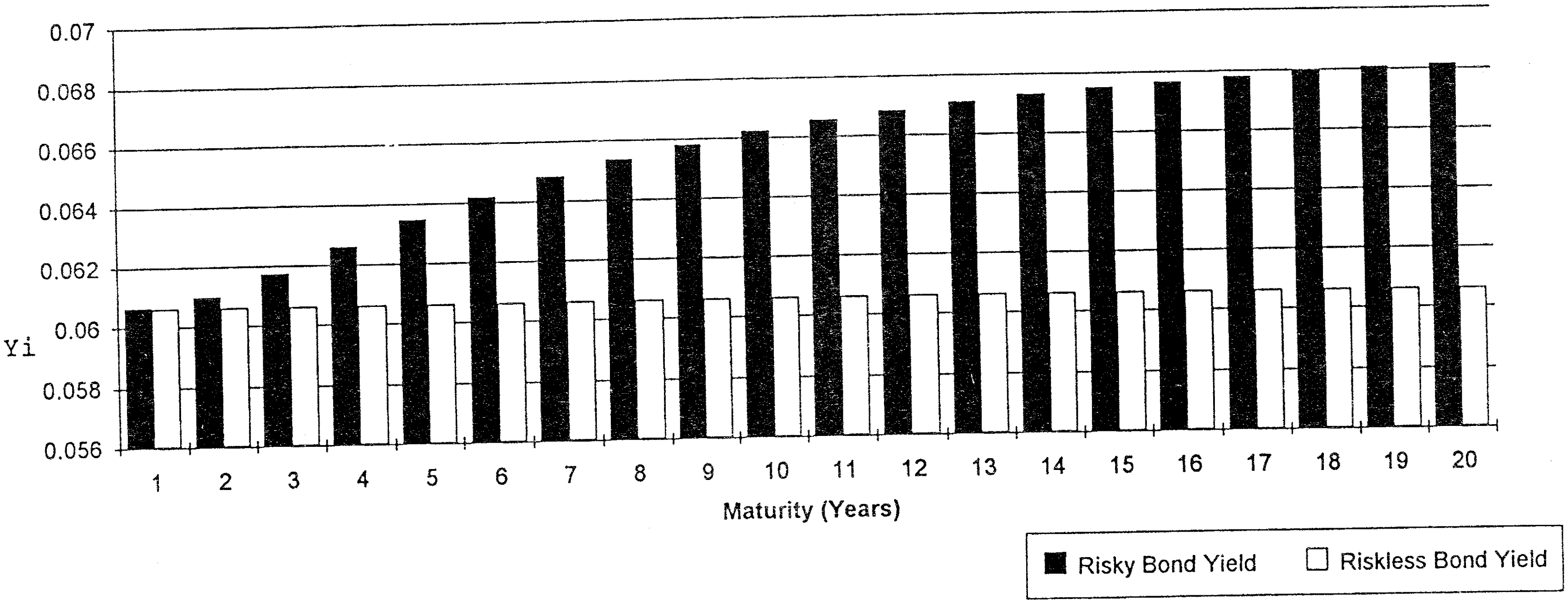


Fig. 6 : Risky Bond Yield Structures for the Gennotte-Marsh and Lognormal Models when Volatility is at steady-state (19.4%) and Quasi-debt ratio is 80%

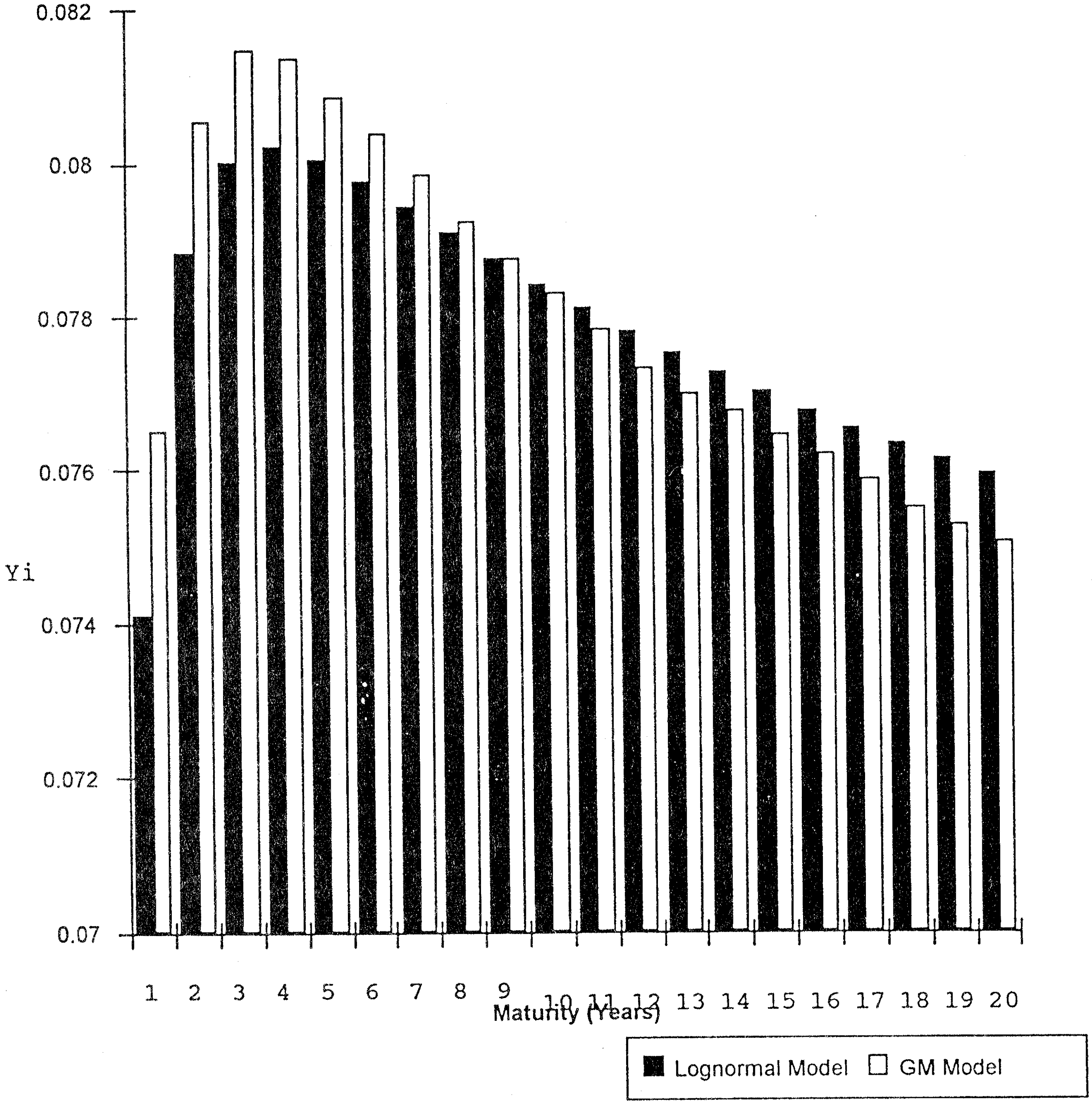


Figure 7: Riskless and Risky Bond Yield Structures:
80% Quasi-Debt Ratio; 10% Volatility

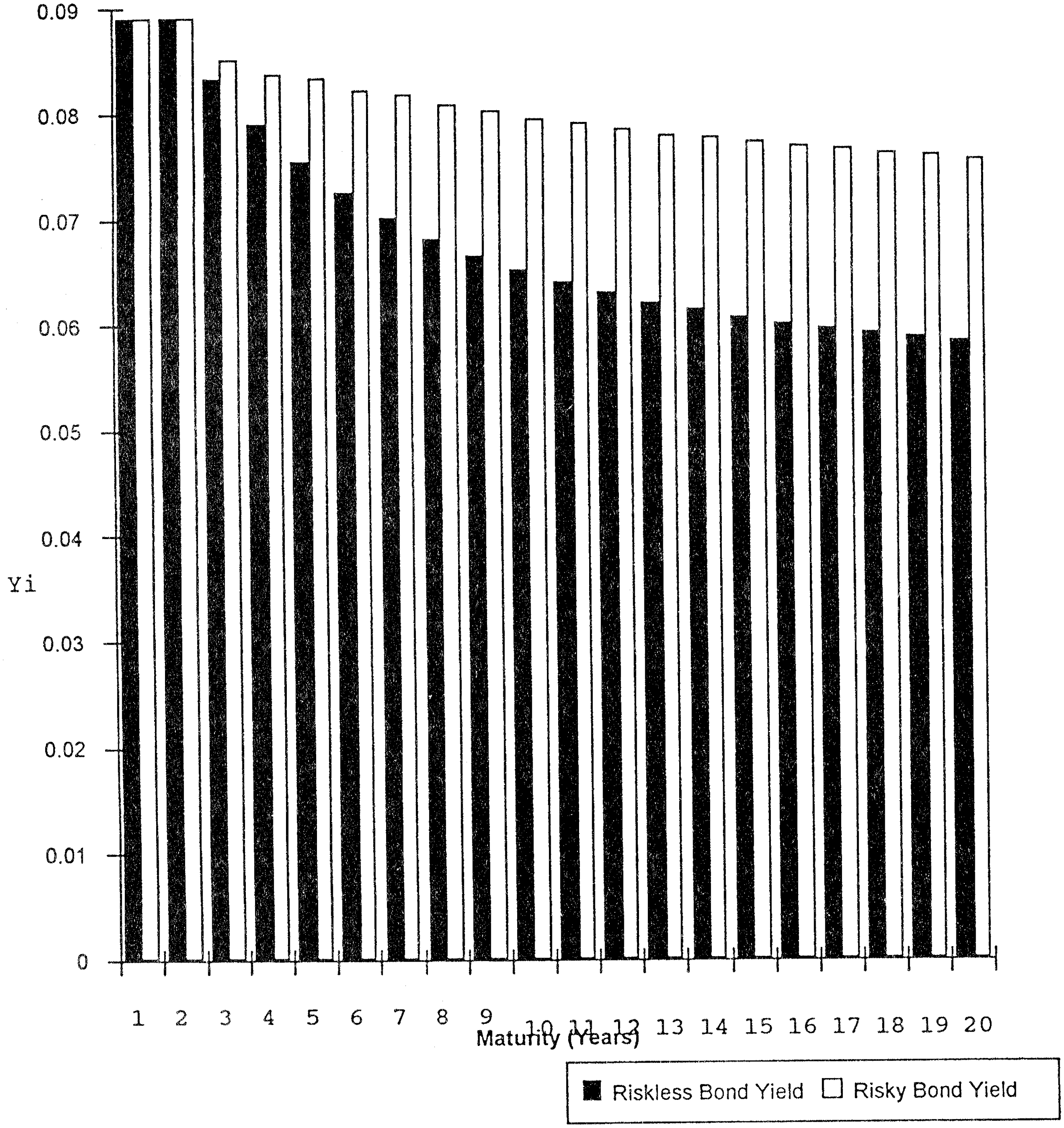


Figure 8: Riskless and Risky Bond Yield Structures:
80% Quasi-Debt Ratio; 30% Volatilty