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7. The Term Structure of Interest Rates

As indicated earlier, our initial study on the term structure of interest rates was carried out by Reuben Kessel.[1] Subsequent to the completion of Kessel's paper, Jonathan Freudenthal, a student at Swarthmore College, and I conducted further research, partly along lines suggested by Kessel's study. I shall describe some of our findings, although they are still quite incomplete, at the close of this section.

Although Freudenthal's and my work is based in part on foundations laid by Meiselman and Kessel, our conclusions are not always in agreement with those of the earlier studies. Since there has not yet been time to seek a resolution of these differences we shall let each paper stand on its own feet in this summary, indicating points of difference by footnotes.

First I shall give the background for Kessel's study, and then summarize his findings, as well as his interpretation of them.

Background

Among scholars by far the most widely accepted explanation of the term structure of interest rates is based on the expectations hypothesis or a modified version of it. The unmodified version of this theory runs essentially as follows. If one-year rates are now 1 per cent and are expected to be 3 per cent next year, then two-year rates today will have to be in the neighborhood of the one-year average, that is, 2 per cent. Only such a relationship can equalize returns for a two-year investment by the two avenues available: the purchase of a two-year security, or investment in a one-year security followed by reinvestment in another one-year security one year later. Though individuals may

[1] *The Cyclical Behavior of the Term Structure of Interest Rates,* Occasional Paper 91, New York, National Bureau of Economic Research, 1965.

not all be able to invest for the full two-year period, speculators will force the approximate equality.

This example may be generalized by stating that long-term rates will tend to be an "average" of expected short-term rates over the intervening period. Because of compounding, this is a complex kind of weighted average, and hence we place the term in quotes. It should be noted from the derivation of our generalization that it implies that expected yields over any given holding period, including capital gains or losses, must be equal on securities of different term to maturity. If expectations are uniform and held with perfect confidence, securities of different term become perfect substitutes for one another. One consequence is that under this assumption a change in the mixture of outstandings between longs and shorts will not affect the term structure unless it changes expectations. Another implication of this theory is that from the yield curve at a given time it is possible to derive the future short-term rates expected up to the maturity of the longest security on the yield curve.

The fundamental difficulty in testing this hypothesis is that of determining expectations empirically. In the face of this problem, attempts to test the theory have usually sought an answer to a question like this: How close do actual short-term rates come to those which the hypothesis would reveal as expected at an earlier date by reading the yield curve of that time? A fundamentally similar test has been to examine whether holding period yields do in fact turn out to be approximately equal on securities of different term. Both of these tests reveal that the forecasts implied by the expectations hypothesis are not in fact borne out. But a weakness of both tests is that they fail to show whether the difficulty lies in bad theory or bad forecasts on the part of the market.

The significant contribution of David Meiselman to this question was that in testing this theory he used an independent hypothesis about the formation of expectations.[2] His hypothesis did not permit determination of market expectations, but it did provide a means of determining from measurable market phenomena how expectations would change from period to period if his hypothesis were valid. His assumption was that the expected level of any future short-term rate

[2] David Meiselman, *The Term Structure of Interest Rates*, Englewood Cliffs, N. J., 1962.

would rise (or fall) by some stable proportion of one's error in previous forecasts of short-term rates. Thus if last year I expected this year's one-year rate to be 3 per cent and it turned out to be 3½ per cent, I would revise my expectation of next year's one-year rate by some constant fraction of the ½ per cent error. Similarly I would revise my expectation of the short-term rate for ten years hence by some other (smaller) fraction of my ½ per cent error. Mathematically, for each future expected short-term rate an equation could be written:

Change in expected rate = b (former error in forecasting today's rate).

Meiselman's hypothesis did not tell him just what the constant fractions referred to (i.e., b in this equation) would be, but this is where the expectations hypothesis entered. Assuming the expectations hypothesis to be valid, it is possible to determine the future rates expected at any moment by study of the yield curve at that moment. By examining yield curves in successive years Meiselman could measure the errors of the previous year's forecast for one-year rates, and he could also determine by how much other expectations were modified. He therefore wrote the following equation:

Change in expected rate = $a + (b)$ (former error).

This equation is more general than the expression for his hypothesis as shown above, because he wished to let the data determine whether $a = 0$ as implied by that hypothesis. His procedure was then to examine the Durand basic yield curves for corporate bonds from 1900 to 1954. Using each year as an observation he could enter values for each of the variables (change in expectations and former error), and then solve for the parameters a and b. It was his judgment that if the equation fitted the data closely for expectations of all "length" into the future, and if the a coefficient proved to be zero, there would be strong confirmation of both the hypotheses with which he was working. The fit turned out to be quite good, and the a values were very close to zero.

Kessel in his studies for this project accepts the appropriateness of Meiselman's general procedures. But Kessel proves algebraically that Meiselman's findings are just as consistent with a modified form of the expectations hypothesis as with the unmodified version described above. The modification is one proposed long ago by Hicks. This modified approach assumes that people are not indifferent to risk, and hence they may demand (or offer) a premium in the form of higher (or lower) yields in return for holding long-term securities. This risk exists because the capital values of longs may change in unexpected, drastic amounts if interest rates do not behave as expected. A positive risk premium might imply that people demand a reward for holding longs, thereby accepting the risk of capital loss between the time of investment and maturity; or it might imply that they demand this reward because they would otherwise prefer to hold shorts on the gamble that rates may rise, permitting reinvestment at a better return. A negative risk premium might imply that people prefer uncertainty with respect to capital values and will pay a price for it (i.e., accept a lower yield). After all, as uncertainty increases, the chance of unexpected gain goes up along with the chance of unexpected loss. Or it might imply that investors intend to hold to maturity and are not concerned with intervening capital values, but do wish to be sure of receiving the current rate of return for a long time into the future.

Kessel's major task was to explore whether such a modified expectations hypothesis is consistent with the observed facts, and if so whether the risk premium on longs is positive or negative, stable or variable. In order to understand his empirical explorations one further background comment is required. The mathematics of Kessel's (Hicksian) hypothesis is that long-term rates are not an "average" of expected future short-term rates, but an "average" in which each short is modified by the addition of a risk premium. In order to discuss Kessel's analysis we must now distinguish between expected rates and this composite of "expected rates plus risk premium." It is conveniently true that this composite, if calculated according to the Hicksian hypothesis, is precisely the same as the forward rate for a short loan. In summary, then:

1. Today's long-term rate equals the "average" of today's short-term rate and today's forward rates for short-term loans over the life of the long. This statement follows from the definition of forward rates and is therefore independent of any particular theory.

2. Any forward rate for year i equals the expected future rate for year i plus a risk premium to compensate for the risk of making a

forward loan without really knowing future rates and, correspondingly, future changes in capital values. This risk premium will be negative if people prefer certainty of income from interest payments at going rates, or if they prefer risk with respect to prematurity capital values; otherwise the risk premium will be positive. This statement is an hypothesis.

3. The implication of paragraphs 1 and 2 above is that the short-term rates derived from yield curves are forward rates, not expected rates. To determine expected rates, it is necessary to derive an estimate of risk premiums.

4. Since risk premiums are zero under the unmodified expectations hypothesis, forward and expected rates are then considered equal. But the distinction becomes essential under Kessel's assumption of a nonzero risk premium.

Procedures and Findings

At this point it will be useful to introduce a different terminology which will bring us closer to Kessel's own presentation. I have written of risk premiums as if somehow "true" interest rates were those on shorts, and additional payments had to be made to holders of longs (assuming positive risk premiums). Kessel's treatment more nearly assumes that long-term rates provide a base, and that holders of shorts earn a "liquidity premium"—a nonpecuniary return—in addition to their pecuniary return. Thus in a situation where I might say that risk premiums rise as the term of the security increases, Kessel would state that liquidity premiums fall as the term of the security increases. These are, of course, two ways of saying the same thing. Although the mathematical derivation of these premiums is seen most simply in the Hicksian type of structure where they are viewed as risk premiums on longs, the following exposition will be somewhat simpler in many places if we accept Kessel's frame of reference and refer to them as liquidity premiums on shorts. Both terms will be used according to the context.

Kessel's work on the term structure included a variety of empirical studies on a series of related questions whereby we might fill out and test a modified expectations hypothesis. The major questions will be presented in sequence.

TWO GENERAL TESTS OF THE EXPECTATIONS HYPOTHESIS

Meiselman's work simultaneously tested his own hypothesis on the formation of expectations, and a generalized expectations hypothesis for the explanation of the term structure of interest rates. His analysis was limited to corporate securities, and Kessel decided to apply the same test to governments. Five separate tests were run on Treasury bills between 1959 and 1962. In each case the test involved computing a regression in which the dependent variable was the change in expectations regarding some future short-term interest rate; the independent variable was the error in an earlier prediction of "today's" short-term rate. The five experiments used different combinations of Treasury bills. Different lengths of short-term rates were tried (two-week, four-week, six-week, and eight-week rates); and different time spans were tried from time of forecast to time of forward interest rate. The coefficients of correlation were not uniformly high, ranging from .21 to .85, but all were statistically significant. Kessel concluded that these results give support to both of Meiselman's hypotheses. I agree, but would add that the support is not unqualified. Since no correlation except that for the eight-week bills exceeded .36, it would appear that much remains to be explained with respect to the movements of these series. Kessel did not report the value of the *a* term in these regressions.

Freudenthal ran similar Meiselman-type regressions on longer-term governments with the results shown in Table 10. These correlations are even higher than those found by Meiselman in his study of Durand corporates, but the high *a* terms, all of which are statistically significant, emphasize the incompleteness of Meiselman's hypothesis.

A second experiment intended to test the expectations hypothesis was built upon the seasonal behavior of interest rates. Kessel computed a set of hypothetical seasonal factors for fifty-five-day bills based on the appropriate averages of the actual seasonals on twenty-seven-day bills. The process is analogous to computing a two-year rate on the basis of a known and an expected one-year rate. If forecasts of seasonal variations were perfect and if the expectations hypothesis is valid, then these computed seasonals for fifty-five-day bills should be identical with the actual fifty-five-day seasonals. In fact forecasts cannot be perfect, hence there is the problem of knowing how nearly perfect the match must be to conclude that the expectations hypothesis is con-

TABLE 10

Retest of Meiselman Hypothesis, Using Government Securities, June 1951 to March 1963

Maturity of Security	Regression Coefficient *a*	Regression Coefficient *b*	Correlation Coefficient
1 year	22	.772	.977
2 years	17	.767	.985
3 years	14	.777	.987
4 years	12	.787	.988
5 years	6	.793	.989

Note: The equation is Revision in Forecast = $a + b$ (error in former forecast) Forward rates are here presumed to be forecasts. The time interval between the initial forecast and the revision of that forecast is one year for all securities tested. Units are basis points.

firmed. Kessel's procedure was to compare the correlation between his computed fifty-five-day seasonal and the actual one with two other correlations. One was based on an inertia hypothesis which assumed that the fifty-five-day rate in each period would equal that of the preceding period. Another rested on the assumption that the fifty-five-day seasonal could as well have been computed by averaging the twenty-seven-day seasonals of the current month and the preceding one. The three correlation coefficients were, respectively, .84, .81, and .52. This gives modest support to the expectations hypothesis for the term structure of interest rates, but has no implications regarding Meiselman's hypothesis about the formation of expectations.

IS THERE A RISK PREMIUM ON LONGS, AND IF SO IS IT POSITIVE?

As described earlier it is possible to read forward rates from yield curves. Forward rates, on Kessel's hypothesis, are equivalent to "expected rates plus risk premiums." Unfortunately there is no way to determine with confidence the amount attributable to "expected rate" and the amount attributable to "risk premiums." Kessel's first procedure, based on the assumption of a stable risk premium, was to assume that over a substantial period of time without trend in rates, positive and negative errors in expectations should cancel out. This means that if there were neither trend nor risk premiums, the average yield curve over a substantial time period ought to be horizontal. If there were an upward trend that was correctly forecast the yield curve would have a positive slope. On the other hand, if there were no trend, but if positive risk premiums applied to holding longs, the yield curve would have a positive slope, reflecting these premiums. This means that if we average yield curves over a fairly long period with very little trend, errors in forecast should cancel out and the resulting average curve should depict the average risk premiums on securities of different term to maturity.

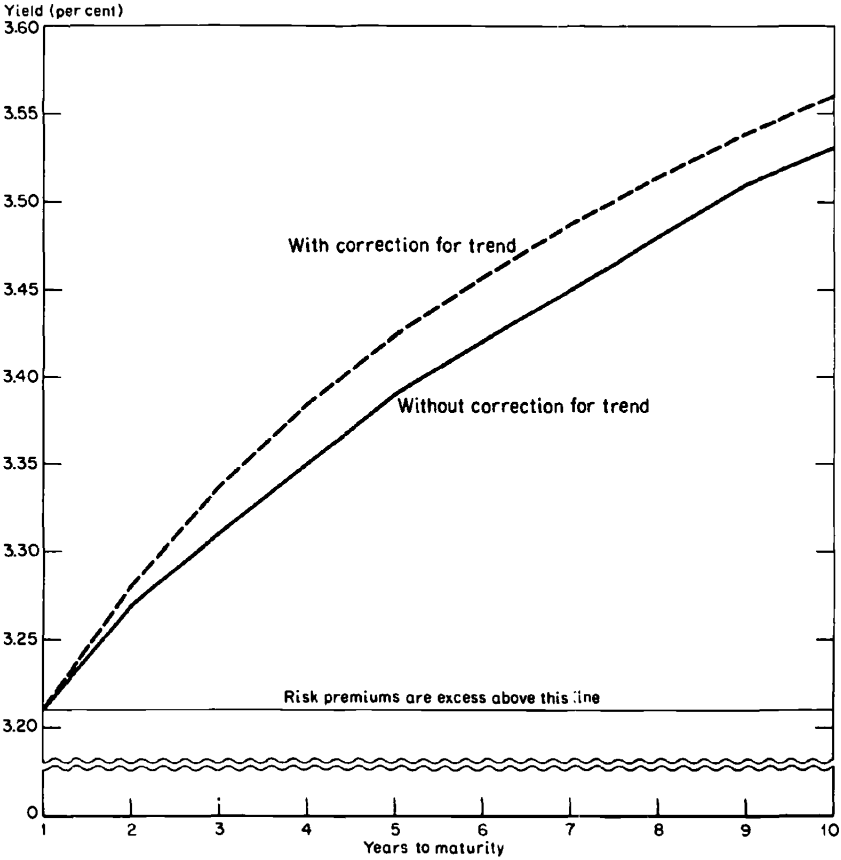
Kessel performed several experiments to find whether, by this analysis, risk premiums are zero, positive, or negative. His first experiment was with the Durand series for corporates, 1900–54. The solid line in Chart 12 is his average yield curve for these data. As he points out there was in fact a negative trend in rates over this period, with the result that this curve is slightly less steep than the true "risk premium curve" would be. I have recalculated the curve to correct for the bias introduced by trend, and the dashed curve is the result. If it is reasonable to presume that the market's forecasting errors cancel out over time, then these experiments confirm the widely held view that risk premiums are indeed positive.[3] It should be noted that the Durand yield curves on corporates are less precisely determined than those on governments, because of the need to allow for another type of risk premium on corporate securities, the risk of default.

A second study included monthly observations of Treasury bills of six different maturities (running from two to thirteen weeks). The time period selected was January 1959 through March 1962, since this was a period without trend but with substantial rate variation. Average forward rates for each type of bill were higher than the actual rates that later materialized, the discrepancy running from twenty basis points on fourteen-day bills to sixty-seven basis points on ninety-one-day bills. If we may assume that errors cancel out over the period, these discrepancies reflect liquidity premiums, and confirmation is given to the presumption that these premiums are positive on Treas-

[3] See opposing interpretation below.

CHART 12

Average Risk Premiums, Corporate Bonds, 1900–54 (Durand Data)



ury bills. A similar study of rates on one-year governments from 1954 to 1958 indicated substantial positive liquidity premiums.

Freudenthal and I subsequently found consistent support for Kessel's view that there is a substantial and persistent liquidity premium on short-term governments. This includes bills of various length, as shown in Kessel's studies, and one-year governments. It appears to include two-year and perhaps three-year securities. However, we do not find consistent evidence of liquidity premiums on longer government securities (e.g., five-year securities), and our study makes us hesitate to conclude that liquidity premiums were persistently positive even at the short end of the Durand yield curve for corporates.

Kessel's evidence is so complete on short-term governments that further comment is hardly necessary. It may be of interest to note, however, in support of his view, that in December 1959, when the market's response to the magic fives made clear its doubt that further rate increases could be expected, yield curves indicated higher forward than current rates on one-year governments. It is difficult to explain this observation without the assumption of a liquidity premium on one-year securities. As would be expected, the yield curve at the same time appropriately indicated an expectation of falling rates on five-year securities.

Our uncertainty regarding the existence of liquidity premiums on longer-term governments is suggested by the following test. Mean "forecasting errors" were calculated for the period January 1959 through March 1962. These calculations were based on the assumption that forward rates indicated expected rates. The mean error for three-month bills was +67 basis points; for one-year securities it was +31 basis points; for five-year securities it was −8 basis points. A study over the entire period, June 1951 through March 1963, indicated a mean "forecasting error" of +38 basis points for one-year securities and of only +3 basis points for five-year maturities. If these are corrected for the typically wider fluctuations in shorts, by dividing through each mean error by the standard deviation of the yields on the security being measured, the implications are not significantly changed: the normalized "mean error" is +.40 on the one-year securities and +.04 on the five-year obligations. These findings suggest that the liquidity premiums may diminish rapidly as maturities extend beyond three to five years. Put otherwise, the curve of risk premiums on governments may rise quite steeply on the left and then flatten fairly quickly. Further testing is needed before we would want to make a confident generalization.

Our studies of the Durand yields on corporates (extended to 1962) raise considerable doubt concerning the widely held presumption that there is a persistent tendency for positive risk premiums to exist on corporates of one year or more. We have examined especially the possibility of such a premium on one-year maturities, since it is at the short end that these premiums would show up most if they exist. As indicated above, Kessel did find indication of a positive risk premium when he averaged Durand yield curves over the entire period from 1900 to 1954. But there is a genuine difficulty in knowing how to interpret this finding. Surely the entire period of the Great Depression and of the wartime and postwar peg on government long-term securities represent seriously abnormal times for interest rates. If the market expected rising rates from these unusually low levels a positive bias in the yield curve would occur without any implication of a positive risk premium. If, on Kessel's assumption that errors cancel out over time, we calculate the average yield curve for the periods 1900–29 and 1951–61, which omits the period of the depression and the peg, we obtain an average risk premium of −7.5 basis points. Alternatively, if we select various trendless periods of fifteen years or more, we obtain average risk premiums ranging from −16 basis points in 1900–17 to +32 basis points for the period 1931–61. If the Hicksian hypothesis on which we are operating is correct, then either errors fail seriously to cancel out over periods even as long as fifteen years or the risk premium has frequently been negative over substantial stretches during this century. Kessel could be entirely correct in his suggestion that there may have been a basic change at the end of the twenties, before which most of the negative premiums appeared, but it is surprising to note that even during most of the fifties the premiums were negative if calculated by Kessel's method. This conclusion may sound surprising in view of the well-known positive slopes of yield curves during most of this time. But if we assume that errors cancel out, then the yield curve will be positively sloped during a time of rising rates even if risk premiums are zero.

The upper part of Chart 13 shows the values of "risk premiums + error" for one-year Durand securities, 1900–62. This is calculated as the difference between the one-year forward rate and next year's spot rate, both for one-year securities (see text below).

Our reluctance to accept the common view that empirically there is a compelling case for the persistence of positive liquidity premiums over time (except for short-term governments) may be disturbing to many, but there is at least one sense in which this conclusion may be consistent with an important fact about the capital market. Kessel's

CHART 13

One-Year Rates, Forward One-Year Rates, and RP + E, Corporate Bonds, 1900–62

paper contains an excellent discussion of the many institutions which might normally prefer to lend long. In view of that evidence, why may risk premiums not be negative, at least beyond the short end of governments? It has never seemed to me convincing that those who prefer to lend short are sufficiently predominant that one could assume persistent positive risk premiums. A more neutral finding may be somewhat easier to tally with these institutional facts.

ARE RISK PREMIUMS CONSTANT OR A FUNCTION OF THE LEVEL OF RATES?

The averaging process first used by Kessel to estimate the values of risk premiums was based on the presumption that these premiums may be fairly stable over time. Kessel has explored the question whether these premiums are not constant, but are a function of the level of rates. Mathematically, the hypothesis to be tested may be expressed as follows:

$$\text{Risk premium (hereafter } RP) = a + b \text{ (level of interest rates).} \tag{1}$$

Data for *RP* cannot be obtained, since we have no way of separating the true *RP* from the true expected rate in any given forward rate. We can, however, obtain data for "error + *RP*" as follows, letting the word "rate" stand for "one-year" rate, or "short" rate.

$$\begin{aligned}&\text{Last year's forward rate minus today's actual rate}\\ &\quad = \text{(Last year's expected rate plus } RP\text{) minus today's actual rate}\\ &\quad = \text{(Last year's expected rate minus today's actual rate) plus } RP\\ &\quad = \text{Last year's error of forecast plus } RP\end{aligned} \tag{2}$$

The components of the first expression in (2), "last year's forward rate minus today's actual rate," can be observed from yield curves. Thus we can obtain data for its equivalent—last line of (2)—"$RP + E$." If we now assume that errors are unrelated to the level of interest rates and that they average zero over any substantial period of time, they should not affect the estimated values of a and b in the regression equation. Hence data for the left side of equation (1)—an approximation of *RP*—may be obtained by subtracting the actual rate for year t from the preceding year's forward rate for year t. Kessel ran three tests of this kind. One was with twenty-eight-day bills, covering the period October 1949 through April 1958. Another was for ninety-one-day bills over the period April 1958 through March 1961. A third was for one-year governments over approximately the same time period. The coefficients of correlation were all significant and positive, ranging from about .41 to .86.

A second kind of test was an attempt to see whether this influence of levels of rates on risk premiums was really a mask for the influence of the phase of the business cycle. Over three cycles from 1949 through 1961 Kessel found a positive trend in risk premiums as well as in interest rates on twenty-eight-day bills, supporting the view that the level of rates does have an influence on $RP + E$ independent of the phase of the cycle, at least for these very short-term governments.

Kessel rationalizes the positive correlation he found between risk premiums and interest rates as follows:

> Economists customarily think of a rise in interest rates as implying an increase in the cost of holding money. By parity of reasoning, an increase in interest rates should also imply an increase in the cost of holding money substitutes. Since 28-day bills are better money substitutes than 56-day bills, a rise in interest rates implies that the opportunity costs of holding the former should rise relative to that of holding the latter. For this condition to be satisfied, yields of 56-day bills must rise relative to 28-day bills. Such a rise implies an increase in liquidity premiums, i.e., an increase in the spread between forward and actual 28-day rates.[4]

Freudenthal's and my studies raise some question about the generality of the view that risk premiums are positive functions of the level of rates, though they do not contradict Kessel's finding with respect to Treasury bills. As Kessel recognizes, the positive correlation between $RP + E$ and R can demonstrate a relation between RP and R only if it can be shown that the E term (error) cannot account for the relationship. Unfortunately there is no reliable statistical way to separate E from RP, and hence we are forced to make the best inference we can, even though that may not be entirely compelling, regarding the role played by E in Kessel's regressions. A method of separation that Freudenthal and I used, by means of a proxy for E, is explained in the appendix to this chapter. The results suggest that E is positively correlated with R for all securities studied by Kessel and by us. It appears that $RP + E$ is probably more closely correlated with R than is the error term in the case of twenty-eight-day bills and ninety-one-day bills, giving mild support for Kessel's conclusions with respect to these securities. None of the correlations is high enough to give much confidence in the results, but some further support is provided by Kessel's second test, whereby a positive correlation is found between $RP + E$ on twenty-eight-day bills and the rising trend of rates between 1949 and 1961. It should be added that our indication

[4] *Cyclical Behavior of the Term Structure of Interest Rates,* p. 25.

of a positive correlation between E and the level of rates, while not contradicting Kessel's conclusion, does suggest a much smaller influence of R on RP than he inferred from his procedures, which abstracted from any effects of E.

The test Freudenthal and I employed gave exactly the opposite results in the case of longer term securities, where the time span of forecasts was a year. Both one-year governments and five-year governments yielded a very high correlation between $RP + E$ and our proxy for the error term. To the extent that this test can be trusted, it would appear that the correlation between the error term and the level of rates may well exceed that between $RP + E$ and the level of rates, casting some doubt on the advisability of using $RP + E$ to derive a relationship between the true risk premium and the level of rates. We do not take the numbers that literally, but they do seem to us to leave "unproven" the existence of a positive relation between risk premiums and the level of interest rates.

This skepticism is not allayed by Kessel's finding that in the Durand series of corporates the correlation between $RP + E$ and R, though positive, was not statistically significant ($t = 1.5$). Even if it were accepted, it would indicate an "explanation" of only 4 per cent of the movement of $RP + E$ by the variation of R.

LIQUIDITY PREMIUMS AND TURNAROUND COSTS

Turnaround costs on long-term securities are substantially higher than on shorts. How far does this go to explain the differentials that we have been attributing to risk premiums? This question is difficult to answer in quantitative terms, partly for technical reasons about the markets but even more significantly because it depends upon how long securities of different term are held. For example, a 1 per cent excess of long government yields over bill yields would just compensate for differences in transaction costs if bills were bought at auction and bonds were bought through a dealer, held for three months, and sold through a dealer. But those who hold bonds for one year would require a differential of only ¼ per cent to cover differentials in transaction costs. After a careful study Kessel provides evidence that the observed risk premiums are too large to be explained away as mere reflections of these transaction costs.

DOES THE MARKET FORECAST FUTURE RATES SUCCESSFULLY?

It will be remembered that the weakness of some tests of the expectations hypothesis is their inability to indicate whether they are really testing this hypothesis or the accuracy of the market's forecast of future rates. This weakness is serious, but it does not justify total disregard of such tests. It may be quite meaningful to examine the differences between actual rates and those which the expectations hypothesis implies to have been predicted by the market. One may then be able to judge whether it is plausible to believe that the market could predict as badly or as well as this comparison suggests. It is also possible to see whether the predictions implied by the expectations hypothesis are better or worse than predictions that might be made by more simple procedures. Kessel has tested the forecasting ability implied by the expectations hypothesis against that of two "inertia" hypotheses. In one of these it is assumed that rates will be the same in period t as in period $t-1$. In another it is assumed that rates will continue to rise (or fall) at the same rate as over the immediately preceding time period.

For 138 predictions of ninety-one-day bill rates from January 1959 through March 1962, the expectations hypothesis "explained" 58 per cent of the observed variation. Each of the two inertia hypotheses "explained" 48 per cent of the variance. Since interest rates were roughly stable except for the year from mid-1959 through mid-1960 the inertia hypotheses would show a much better record than they would during times of sharp interest rate fluctuations; yet prediction is most needed when rates are not stable. Kessel therefore ran the same test for the year of active rate movements (1959–60). Neither hypothesis performed as well as before, but the expectations hypothesis explained 48 per cent of the variance this time, against 30 per cent for the inertia hypotheses. A further statistical test indicates that these differences are significant and supports the conclusion that the expectations hypothesis does have predictive content for ninety-one-day bills that cannot be attributed to inertia. No adjustment for liquidity premiums was made in this test.

A study of twenty-eight-day rates was conducted in which allowance was made for risk premiums. The equation showing $RP+E$

as a function of the level of rates on twenty-eight-day bills was derived from data for October 1949 to April 1958. On the basis of this function risk premiums were computed for twenty-eight-day rates during the succeeding cycle. These premiums were subtracted from forward rates to give expected rates. The correlation between these expected rates and subsequently realized rates is .93, compared with a correlation of .91 between the prediction of an inertia model and subsequently realized rates.

A similar test on one-year governments over the same period suggested superiority of the forecast of the expectations model, especially after allowing for liquidity premiums. The standard error of forecast was 2.09 percentage points for the inertia model, 1.91 for uncorrected forward rates, and .91 for the expectations model corrected for risk premiums. A different type of test, which consisted of regressing the subsequently observed one-year rate on the previous forward and spot one-year rates for the years 1958 through 1961, failed to show statistically significant evidence that forward rates are better predictors than an inertia model.

Another test of forecasting ability is implicit in the study of seasonal factors described above. The high correlation between actual seasonal factors on fifty-five-day rates and the fifty-five-day seasonal factors implied by twenty-eight-day rates (.84) was described earlier as evidence in support of the expectations hypothesis. Since the market was beginning to be aware of seasonal patterns by the time of these observations (1959–62) this correlation may also be advanced to support the view that market forecasting does take place and is reflected in the term structure of rates. But it should be remembered that the inertia hypothesis provided a correlation of .81.

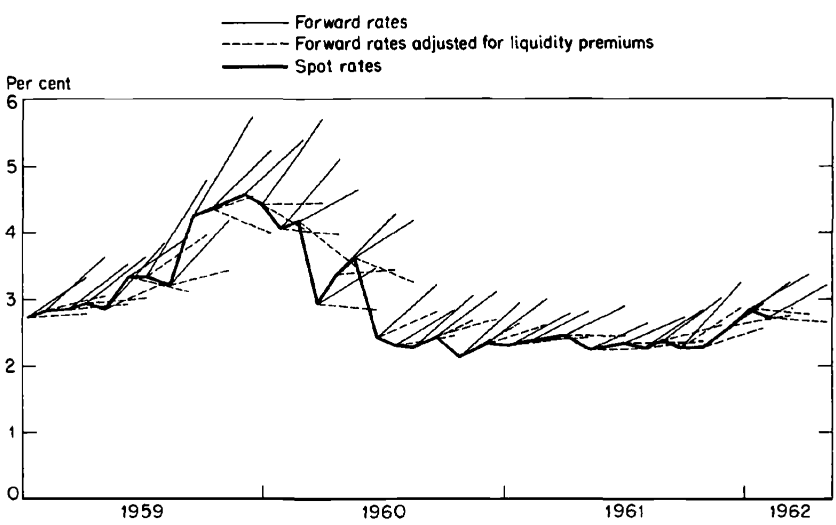
Extreme historical episodes also indicate market forecasting embedded in the rate structure. In 1920 and 1929, when Treasury shorts yielded more than longs, the negative slope of the yield curve implied, according to the expectations hypothesis, that rates would fall sharply. The severe succeeding drop in rates is well known. In the period since World War II, the government yield curve was negatively sloped in 1957 and 1959, after both of which times rates fell sharply.

These comments are not intended to suggest that market forecasts as implied by the expectations hypothesis are consistently good or quantitatively close. They are much better when allowance is made for risk premiums, but they are still far from satisfying. Chart 14 taken from Kessel's paper is indicative. All that Kessel concludes is that this approach does suggest "some predictive content" in the market's behavior.

Subsequent work by Freudenthal and me gives support to Kessel's conclusion as stated in the preceding paragraph. I should like to make

CHART 14

Market Expectations of Future Ninety-One-Day Bill Rates, First Observations of Continuous Four-Week Periods, 1959–62



a few additional comments, however, some of which will emphasize the other side of the same coin: the extent to which predictive power, though present, was often very poor.

It is interesting to note from Kessel's findings that the correlation tests indicated very high predictive power for twenty-eight-day forecasts of twenty-eight-day rates (.93), somewhat lower predictive ability on ninety-one-day rates over a ninety-one-day span of forecast (.76), and statistically insignificant forecast ability on one-year governments. Another fact mentioned by Kessel is that he found the expectations model inferior to the inertia model in the Durand series of one-year corporates. While Kessel has demonstrated that the expectations model in certain cases predicts better than the inertia model, it is clear that the forecasts implicit in the expectations model themselves embody a very large element of inertia. This is consistent with the observation that the tests come out best over very short periods of forecast span when rates have had little time in which to change greatly.

In the case of one-year governments the superiority of an expectations model over an inertia model during the years 1958–61 is damning with rather faint praise. It would be difficult to think of a weaker standard than inertia with which to make comparison in a period when the cyclical pattern places current and forecast rates at opposite extremes of the cycle. And a standard error of 91 basis points even after adjustment for liquidity premium is substantial, as Kessel fully recognizes.

A slightly different way of looking at the market's forecast capacity is to compare holding period yields over defined time-spans for short- and long-term securities. It is obvious that a perfect forecaster could have made great profits by appropriate portfolio shifts whenever these holding period yields were significantly out of line with one another. It is equally clear that if the market generally exercised perfect forecasting ability, adjustments in prices would take place until differences in holding period yields vanished except for differentials imposed by transactions costs. Thus the presence of significant differences between the holding period yields of longs and shorts indicates either that the market is forecasting imperfectly or that it does not have sufficient confidence in its forecasts to operate on them. Note that this statement rests on the mathematics of rate relations and does not depend, as much in this paper has, on some theory of rate structure.

William H. Brown has prepared Chart 15 to show comparisons of holding period yields on selected long and short governments. The extreme divergences between the two curves in the first panel of Chart 15 is dramatic evidence of imperfect forecasts or imperfect application of forecasts in market behavior. In evaluating these differences it should be recognized, however, that very substantial changes in yield on short holding periods can result from relatively slight price changes on securities. A small unexpected price change could produce the appearance of a sizable error of forecast. But even taking this fact into consideration the spreads reflect impressively poor implied market forecasts. The second and third panels of Chart 15 present what might be regarded as a fairer test, since the holding periods assumed here are of one-year and two-year duration, greatly reducing the changes in yield resulting from given price changes. Even in these cases, however, the divergences seem quite substantial.

Freudenthal ran a regression of actual changes in rates on the changes implied by forward rates over the entire period June 1951 through March 1963. He found that the actual change in rates averaged three times the "predicted" change in rates on both one-year and five-year governments. During the period that Kessel concentrated upon, April 1958 through February 1961, the actual changes in rates were 4.6 times the predicted changes on one-year governments and 5.8 times greater on five-year governments. In all cases the span of forecast was one year. Underestimation of change seems common to many types of forecast, but these differences are extremely large.[5]

In summary, forward rates corrected for risk premiums do have an element of predictive power. But this predictive power appears to be so bad that some explanation not provided by the present expectations hypothesis still seems required. This was a central point made by Hickman in his criticism of the expectations hypothesis. In the section below Freudenthal and I propose some possible, or partial, solutions to this problem.

Implications

Implications of findings have been suggested throughout the preceding discussion, but we shall attempt here to weave them into Kessel's broad theoretical conclusions.

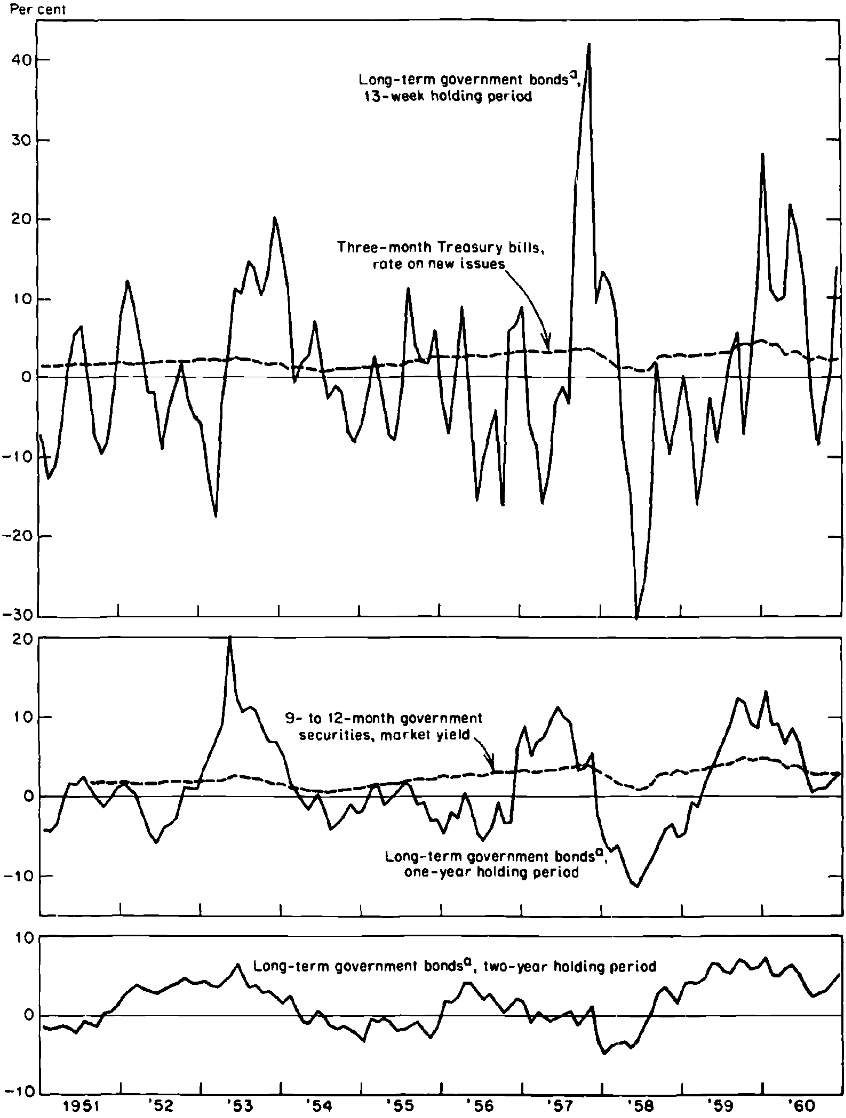
These studies support the view that without the introduction of risk premiums the expectations hypothesis seems implausible: it is contradicted by the tendency of yield curves to slope positively and by other evidences of market predictions that seem too bad to persist in the real world. The introduction of liquidity premiums provides a theory in which these objections are softened, and one which explains many observed interest rate phenomena.

Kessel's analysis of risk premiums provides an easy bridge to Keynes-

[5] See Victor Zarnowitz' report on the accuracy of short-term economic forecasts, *Forty-Fifth Annual Report*, National Bureau of Economic Research, New York, 1965.

CHART 15

Holding Period Yields on Short- and Long-Term Governments, 1951–60



a 2½ per cent, due 9/15/72, callable 9/15/67.

ian liquidity preference theory. Just as Keynes said that liquidity preference would give an advantage to cash over bonds (especially in times of low rates), so Kessel expands this concept to say that liquidity preference provides an advantage to short-term securities over long, as a result of which holders demand a smaller pecuniary reward for holding shorts. Kessel suggests that his studies indicate the need to marry the liquidity preference theory to the expectations hypothesis. We may summarize some of the implications of this marriage.

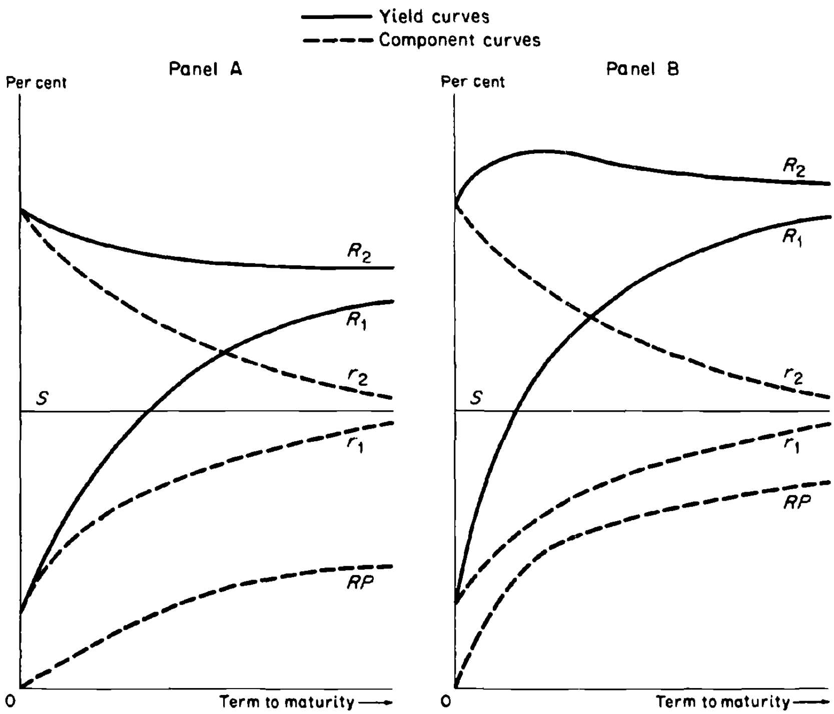
MERGER OF EXPECTATIONS HYPOTHESIS AND LIQUIDITY PREFERENCE THEORY

Chart 16 illustrates the way interest rates might reflect the combined forces of expectations hypothesis and liquidity preference. The risk premium (*RP*) curve is shown rising monotonically with term to maturity as did the empirically derived *RP* curves in Chart 12. This component of observed interest rates could, conceptually, slope either positively or negatively, and may change from one period to another. The r_1 and r_2 curves represent the yield curve as it would be under an unmodified expectations hypothesis, the first when current short-term rates are low and the other when they are high. As portrayed, this r curve would respond to changing levels of short-term rates by taking positive and negative slopes so that an over-all composite over a trendless period of evenly undulating rates would be a horizontal line like *S*. Such a horizontal added to the *RP* curve derived from the Durand data gives the dashed curve in Chart 12.

Observed yields at any point in time would be the sum of the appropriate *RP* and r curves. The result of the configuration in panel A of Chart 16 is that yield curves could take shapes between R_1 and R_2, a majority being positively sloped in this panel because of the positively sloped *RP* here assumed. But in times when rates are very high relative to historical standards the dominance of the expectations component may produce negatively sloped curves like R_2 even if *RP* does exhibit positive slope. Panel B of Chart 16 presents an alternative possibility. If the *RP* curve is much more sharply curved at short maturities and then flattens rapidly, and if the r curve resembles r_2, the combination may well produce a hump in the intermediate to short-term range. As stated earlier, such curves have been observed on

CHART 16

Hypothetical Components of Yield Curves, Expectations Hypothesis and Liquidity Preference Hypothesis Combined



NOTE: When short-term rates are low, $R_1 = RP + r_1$; when short-term rates are high, $R_2 = RP + r_2$.

governments at times of high rates in the post-World War II period.

A composite theory of this kind is supported by both Meiselman's and Kessel's studies of the implications of combining the expectations hypothesis with Meiselman's hypothesis on the determination of expectations. It is given some support from Kessel's tests of the forecasting ability of the market, which looks much more reasonable when risk premiums are admitted to the theory. Finally it is consistent with the logic of equilibrium relations on which the expectations hypothesis was initially founded. The findings of Freudenthal, which seem to indicate a fairly sharp slope in the government RP curve up to about three years, but relatively little slope if any for longer maturities, provides support for just the kind of amalgam to give humped curves as in panel B and in the real world.

The only conclusion in this discussion which Freudenthal and I question is the appropriateness of generalization regarding *RP* from the average curve, based on the Durand data (Chart 12), which is greatly influenced by the period of depression and the pegs on government long-terms. This question would not alter the analysis, but would suggest less confidence in the long-run predominance of yield curves with positive slope beyond maturities of five years or so. Our views are summarized above.

An objection to the logic of the expectations hypothesis is often raised by financial practitioners, who rightly point out that they make no attempt to predict short-term rates over extended periods into the future, and who suggest that this makes nonsense of a theory which says the market makes long-term rates equal to an average of such expected short-term rates. Expectations theorists would make the following rejoinder. It is not required by the theory that investors consciously think in terms of present and future short-term rates. It is only necessary that the market observe when past movements in the term structure made it obviously absurd to have held one term instead of another. If the market only attempts to bring expected holding period yields into some kind of conformity it will be exerting the kind of influence the expectations hypothesis asserts. Although holding period yields on longs and shorts have varied widely, as shown above, it is difficult to believe that there are not elements in the market attempting to take advantage of such potential discrepancies to the extent that their best forecasting ability permits. If this is true, then the expectations hypothesis provides a partial explanation of the term structure.

THE TERM STRUCTURE AND THE SUPPLY MIX

Admitting risk premiums to the expectations hypothesis destroys the view that securities of different term are perfect substitutes and provides instead the picture of a partly segmented market. It is generally presumed that some institutions, like life insurance companies, are not primarily concerned with changes in capital value over the life of their investment since they plan to hold most issues to maturity anyhow. They prefer to avoid the trouble and cost of frequent reinvestment. This view is given support by Cohan's finding that, in direct placements, longs tend to yield less than shorts; that is, the risk premium on longs is negative for insurance companies and pension funds. Guttentag's study of the mortgage market gives some, though not unqualified, support to this view. Other investors may take the attitude toward risk implied by positive risk premiums on longs. As the mixture of longs and shorts supplied to the market changes, the market's equilibrium risk premiums will shift. If there were very few longs their prices might be forced up until the risk premiums reflected the preferences of those most wanting these securities: average yield curves would tend to be negatively sloped. Similarly a much larger supply of longs on the market would cause positively sloped yield curves.

The conclusion that supply can alter the term structure is consistent with market observations and may make the combined theory proposed here much more acceptable to financial practitioners than the unmodified expectations hypothesis.

THE ROLE OF SPECULATORS AND A FURTHER MODIFICATION OF THE THEORY

Even though we grant that many institutions may have special preferences preventing them from moving across the term structure for maximum expected return, it has been argued above that speculators will appear who will seek to take advantage of expected differences in future yields for given holding periods. This is one of the means by which segmentation is partly overcome and by which the forces of the expectations hypothesis tie markets for longs and shorts together. The question arises, why do not these speculators eliminate the average risk premiums our studies detect? It is their function to maximize the mathematically expected gains without showing preference either to take or avoid risk.

Our proposed answer is that if the cost of operating for speculators were zero, and if there were enough of them, this is exactly what would happen. But there are costs in these activities, and costs may even increase with the level of operations. Also, each may be reluctant to go beyond some over-all commitment, and the number of available speculators in the market at any particular time may be limited. Thus the equilibrium risk premiums revealed in the market will depend not only upon the attitudes of all primary demanders and suppliers of funds, but also upon the cost behavior, the commitment limits, and the number of speculators.

Further Research

Studies by Freudenthal and me have suggested a slight modification in the expectations hypothesis as described above and a major modification in Meiselman's hypothesis for the formation of expectations. Our work is not completed and these suggestions should not be regarded as firmly held at this time. Some elements of our findings seem well supported, and we presume that in a "Progress Report" it may be appropriate to indicate the implications of ideas still under test. First, with respect to the expectations hypothesis, a major dilemma has always been the wide difference between forward rates and subsequently realized rates. It did not sem plausible that the market could predict so badly. Nor did it seem plausible that the market would fail to take advantage of great possibilities of profit available to any who could give better predictions than forward rates implied. Kessel's use of the Hicksian model, with his demonstration of liquidity premiums at the short end of governments, provides a plausible explanation of the very high forecasts implied by those forward rates. Freudenthal's finding and mine that there is far less evidence, if any, of a similar systematic liquidity premium on corporate securities seems surprising, but it is consistent with the presumption that such premiums would be especially great on actively used money substitutes. By all odds the most frequently used substitutes for money are government shorts. Private debt may serve similarly in the form of commercial paper, but not much in the form of bonds one year from maturity.

We suggest that the remaining failure of forecasts as implied by the term structure may seem less strange if predictions are seen, not as single-valued "most probable" expectations, but as the mean of a distribution of possible outcomes. The market's ability to predict turning points has been notoriously bad. For this reason it is not surprising that the market would want to hedge its best guess with quite different possibilities. A model based on this assumption can yield a set of expected future rates quite similar to those implied by forward rates (adjusted for risk premiums where appropriate). Such a model would give forward rates fairly close to current rates, but not identical with them. Whatever difference would exist between current and forward rates (aside from risk premiums) would be explained by considerations determining the market's expectations. Our study suggests two major considerations of this kind. One is the excess of current rates over some concept of "normal" rates. When this excess is great it is reasonable to expect a decline. A second consideration is the speed at which rates are currently changing. Some momentum would usually be expected, with the prospect of rates continuing in the same direction. Obviously the effect of these two factors on expectations may not be in the same direction, but some combination of the two may provide a major part of the determination of whether forward rates are above or below current rates. We suggest also that the rate of change of rates may have much more influence on very short predictions (e.g., twenty-eight-day rates and possibly ninety-one-day bills), but the relation between current and "normal" rates may dominate predictions of a year or more. Most of our testing thus far has been on the influence of the relation between current and "normal" levels of rates. As a crude first try we have used a fitted trend value of rates as an estimate of "normal." Fortunately a linear regression seemed appropriate over the fifties and early sixties, which was the period tested. We must still seek a more generally applicable measure of "normal," but results even with this standard have been uniformly favorable.

Empirical support for these hypotheses is suggested both by Durand corporates and by governments (since World War II). Chart 13 suggests relevant characteristics of the Durand series. The solid curve shows one-year rates for the year indicated. The dots show the forward rates as seen in that year for the next. For example in 1915 one-year rates were $4\frac{1}{2}$ per cent, and the forward rate for 1916 was the same (the dot lies on the curve). But the solid curve for 1916 turns out to be only $3\frac{1}{2}$ per cent. Therefore the 1915 forward rate was 1 per cent too high, which could be attributed to some combination of liquidity premium or error of forecast. The corresponding point in the top panel for 1915 shows this as a positive $RP + E$ of 1 per cent.

Study of the bottom panel reveals for all periods except the depression and part of the period of pegged rates on long governments a very general tendency for forward rates to hug current rates, as hypothesized above. Furthermore, if one draws a trend line he will note a tendency for forward rates to hug current rates especially closely when rates are near their trend value. When current rates lie above or below that trend line, forward rates usually lie on the trend side of current rates.

The reference to these charts is suggestive only. However, Freudenthal has found confirmation of this hypothesis in statistical studies of governments in the postwar period. These studies are as yet too limited in scope to justify any firm acceptance of our hypotheses, but two or three illustrations may be indicative of our procedures and findings.

In one test Freudenthal derived the simple correlations between the expected change in rates (based on forward rates) and the excess of actual rates over the trend value at that time. He examined forward rates on one- to five-year government securities for the period from June 1951 through March 1963. For all maturity classes, the forward rate was the rate pertaining to a date one year from the date of prediction, i.e., the forecast span was one year. The correlations were all significant and negative as his hypothesis would presume, the smallest being $-.598$ for one-year obligations, the largest being $-.895$ for five-year maturities. When he examined predictions over a shorter forecast span, however, using twenty-eight-day bills and ninety-one-day bills, he found the correlations positive, indicating that an excess of current rates over "normal" does not necessarily lead to expectations of a quick movement toward "normal." This seems reasonable.

We explored the notion that the immediately past change in rates might lead to expectations of further changes in the same direction. The correlation between the one-year "expected" change in five-year rates implied by forward rates and the preceding actual monthly change in five-year rates is virtually zero (.001). But when the variable for recent change in rates was included in a multiple regression equation which also included both the level of rates relative to normal and the uncorrected level of rates, the b-coefficient for recent change was positive and significant (t-value, 5.10). Furthermore, the addition of this variable raised the t-values of all the other variables in the equation, and increased the multiple correlation coefficient to .948. While the level of rates relative to the "normal" rate appears to be the dominant variable determining the expected change in one- and five-year rates within the coming year, the direction of recent rate movement is also a relevant factor in the formation of expectations.

Another experiment was intended to test the hypothesis that forward rates represent the mean of a probability distribution of expectations rather than a single-valued "most-expected" future rate. Freudenthal set up a crude model assuming such a probability distribution, with the weights of "expected increase" and "expected decrease" dependent upon both the excess of current rate over the trend value of the rate and the previous rate movement. This model displayed the following characteristics.

1. Forward rates hugged current rates fairly closely but diverged from these in much the way that observed rates do.

2. Predictions on one-year rate changes were quite good indications of the direction of change, but they seriously underestimated actual changes. We have shown that relations like these characterize empirically observed rate behavior.

3. As a result of the large element of inertia in this model, $RP + E$ is highly and negatively correlated with subsequent changes in rates, reflecting the error of forecast that occurs whenever immediately subsequent rate changes are large. This is consistent with our interpretation of the empirical data in the appendix to this chapter.

4. Long and short rates reached their peaks and troughs together. This meets an objection sometimes raised against the conventional expectations hypothesis, according to which longs should lead shorts (since the long-term rates are treated as an average of current *and future* short-term rates). In fact, more often than not, longs have lagged behind shorts, though increasing synchronization has occurred in recent years, as pointed out in our summary of Cagan's work.

It must be recognized that the hypothesis here outlined is quite different from Meiselman's. He obtained high correlations between changes in forward rates (expectations in his model) and the preceding error of forecast. It can be shown that Meiselman's high correlations could as well be explained by the inertia elements we have described as by the behavior of expectations which he postulates. Indeed, it is interesting to note that our model, although it implies no influence of frustrated expectations on change of forecast, gives a correlation of .98 for Meiselman's test, i.e., the correlation between changes in expected rates and preceding error of forecast.

It is obvious that we must do much more work before we place confidence in the hypothesis outlined here, and in the process we hope to refine it greatly. But the hypothesis does look promising, and it seems to us somewhat more plausible than Meiselman's as an interpretation of businessmen's thought processes. This does not mean that financiers calculate probabilities numerically and then derive mathematical expectations. It means only that they form judgments about the probable direction of rate movements and hedge considerably regarding the size of these changes. However, Meiselman's behavioral postulate may also operate, and there is no reason to presume that a more adequate theory may not recognize elements of both.

Appendix to Chapter 7

Study of both Durand data and Treasury securities suggests that forward rates hold very close to current rates. The difference is important and suggests a good deal about the term structure, but for the moment we note only the large element of inertia in forward rates. This means that if changes in rates (ΔR) are large, as they often are over a year or more, the difference between forward rates and realized rates will be roughly equal to (but opposite in sign from) the change in rates. But this difference is, as we have shown, $RP + E$ in the Hicksian type model with which we are working. The problem is to determine how far these derived values of $RP + E$ represent error, and how far they represent risk premiums.

It is our judgment that insofar as $RP + E$ fluctuates with ΔR its movement may be attributed chiefly to error. Our logic is as follows: (1) The relationship could hardly reflect RP, because the subsequent change in rates is not known when the forward rate is established with its RP component. (2) The relationship could plausibly reflect error, since the large amount of inertia in the model must, as shown above, imply a large component of error whenever rates change substantially.

On the basis of these considerations we presume that any correlation found between $RP + E$ and ΔR would largely represent a correlation between error and ΔR. The results may be seen in Table 11. Thus if our logic is correct, ΔR would "explain" 96 per cent or more

TABLE 11

Regression of RP + E on ΔR

Maturity	Time Span of Forecast	Correlation Coeff. r	r^2	b-Coeff. for ΔR	Time Period
28 day	28 days	-.606	.367	-.49	Apr. 58-Feb. 61
3 month	3 months	-.890	.792	-.86	Jan. 59-Feb. 61
1 year	1 year	-.993	.986	-.84	Apr. 58-Feb. 61
5 year	1 year	-.996	.992	-.88	Apr. 58-Feb. 61
28 day	28 days	-.591	.349	-.56	Jun. 51-Feb. 61
3 month	3 months	-.791	.626	-.91	Jan. 59-Jan. 64
1 year	1 year	-.979	.958	-.86	Jun. 51-Mar. 63
5 year	1 year	-.986	.972	-.90	Jun. 51-Mar. 63

TABLE 12

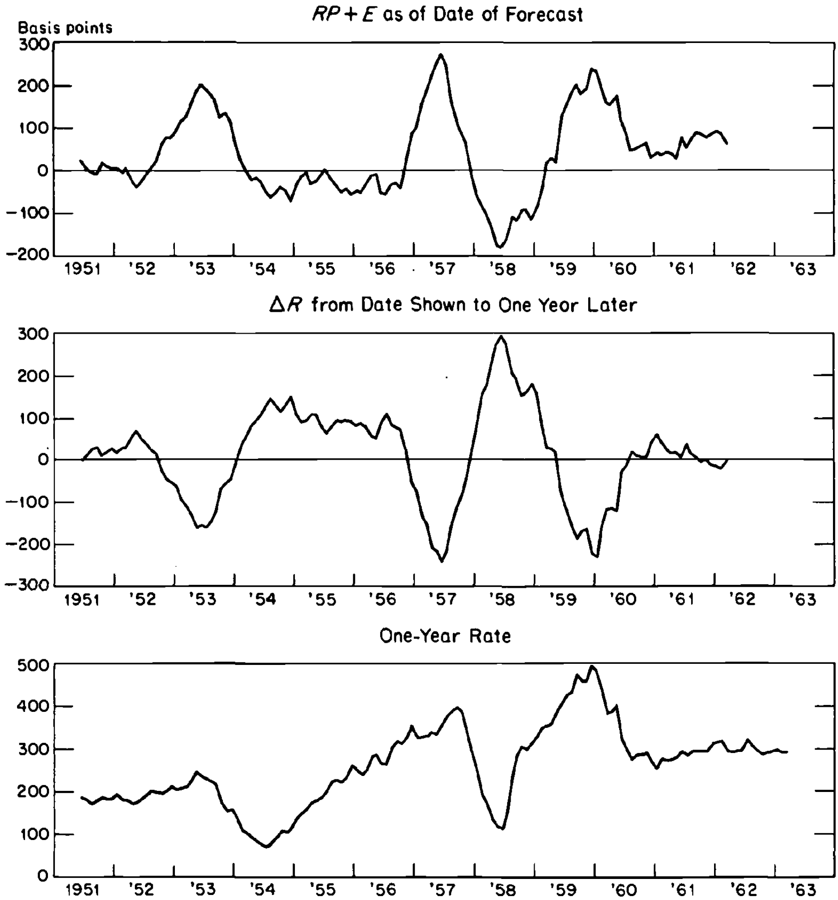
Regression of ΔR on R

Maturity	Time Span of Forecast	Correlation Coeff. r	r^2	Time Period
28 day	28 days	-.368	.135	Apr. 58-Feb. 61
3 month	3 months	-.386	.149	Jan. 59-Feb. 61
1 year	1 year	-.902	.814	Apr. 58-Feb. 61
5 year	1 year	-.922	.850	Apr. 58-Feb. 61
28 day	28 days	-.249	.062	Jun. 51-Feb. 61
3 month	3 months	-.349	.122	Jan. 59-Jan. 64
1 year	1 year	-.600	.360	Jun. 51-Mar. 63
5 year	1 year	-.495	.245	Jun. 51-Mar. 63

of the movements of the error term on one-year forecasts for one-year and five-year securities, as indicated for both of the time periods reviewed in that table (i.e., the square of the smallest correlation coefficient for these securities is .958, or 96 per cent). Regressions for the same securities also showed that the correlation between ΔR and R was high enough for one to "explain" 81 per cent of the movement of the other during the period 1958–61 (Table 12). Because of the peculiar cyclical movement during this period, which is one of those tested

CHART 17

RP + E, ΔR, and R, One-Year Government Rates, 1951–63



by Kessel, it can readily be shown that a high correlation of this kind is plausible; the cycle length was such that a one-year time span would move rates from peak to trough, so that the higher the positive level of rates, the greater was the subsequent one-year fall in rates. This argument is weaker when applied to a study of the entire decade because of variations in the length of cycles, and the correlation is also weaker then. Time series for $RP + E$, ΔR, and R for one-year rates are presented in Chart 17.

TABLE 13

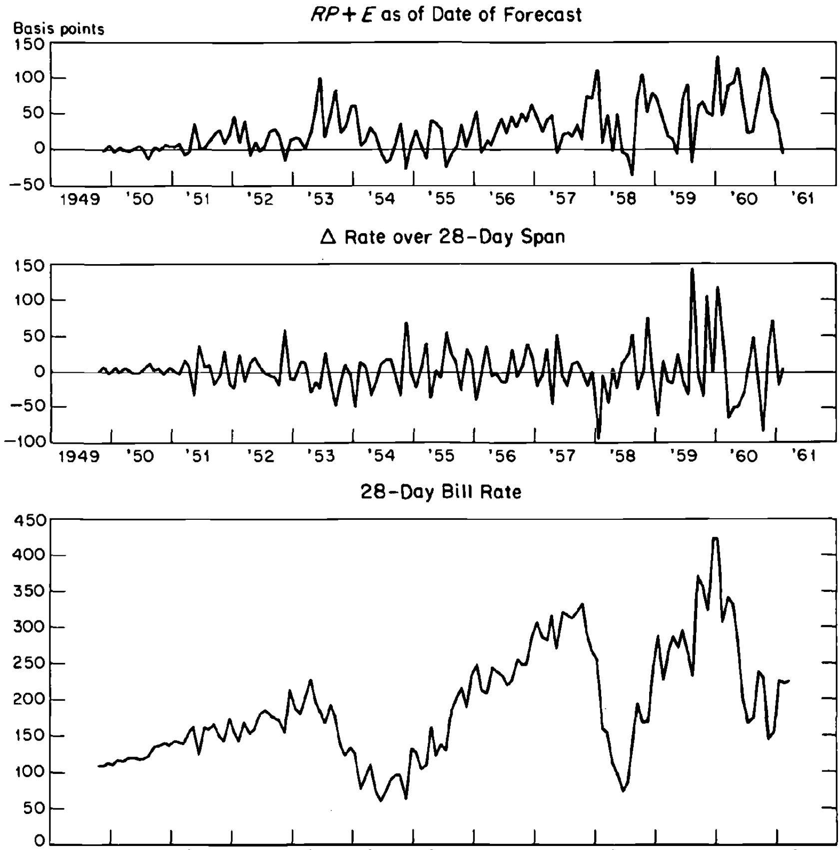
Regression of RP + E on R

Maturity	Time Span of Forecast	Correlation Coeff. r	r^2	b-Coeff. for R	Time Period
28 day	28 days	.416	.173	.19	Apr. 58-Feb. 61
3 month	3 months	.440	.194	.38	Jan. 59-Feb. 61
1 year	1 year	.860	.740	1.08	Apr. 58-Feb. 61
5 year	1 year	.891	.794	1.14	Apr. 58-Feb. 61
28 day	28 days	.458	.210	.20	Jun. 51-Feb. 61
3 month	3 months	.374	.140	.34	Jan. 59-Jan. 64
1 year	1 year	.581	.338	.59	Jun. 51-Mar. 63
5 year	1 year	.446	.199	.35	Jun. 51-Mar. 63

By putting these correlations together, say, for one-year governments for 1958–61, the inference may be drawn that R explains 81 per cent of ΔR, which in turn explains 99 per cent of movements of E, so that R may explain 80 per cent of the movements of E (81 per cent of 99 per cent = 80 per cent). But Kessel's type of regression implies that R explains about 74 per cent of the movement of $RP + E$ (Table 13). Thus the part of the movement of $RP + E$ attributable to R can be wholly explained by movement of E, and there is no basis for inferring that risk premiums are correlated with the level of rates on forecasts of a year. Similar results are obtained for 1951–63 and for five-year securities. This line of reasoning, linking $RP + E$ to R through ΔR (error), is not supported as strongly by the data for the very short-term securities with which Kessel worked. The relevant correlations for one- and three-month rates are considerably lower than those for one- and five-year rates. Time series for $RP + E$, ΔR and R for twenty-eight-day rates are presented in Chart 18. The chart reveals a clear upward trend in $RP + E$ over the period as a whole, a trend that is difficult to attribute to the error term (especially since it is absent from ΔR), but may be related to the upward trend in rates. For these short rates, therefore, the evidence that risk premiums are posi-

CHART 18

$RP + E$, ΔR, and R, Twenty-Eight-Day Government Rate Adjusted for Bankers' Discount, 1949–61



tively associated with the level of rates is stronger than for the longer-term rates.

Another test intended to check these findings was a multiple correlation between $RP + E$ as the dependent variable and both R and ΔR as independent variables (Table 14). It will be noticed that when

TABLE 14

Regression of RP + E on R and ΔR

Maturity	Time Span of Forecast	b-coefficient for R	b-coefficient for ΔR	t for R	t for ΔR	Time Period
28 day	28 days	.103	-.423	+1.53	-3.58	Apr. 58 - Feb. 61
3 month	3 months	.098	-.806	+1.06	-7.85	Jan. 59 - Feb. 61
1 year	1 year	-.238	-.984	-5.81	-35.50	Apr. 58 - Feb. 61
5 year	1 year	-.231	-1.03	-6.77	-43.63	Apr. 58 - Feb. 61
28 day	28 days	.142	-.479	+4.62	-7.11	Jun. 51 - Feb. 61
3 month	3 months	.100	-.870	+1.28	-8.67	Jan. 59 - Jan. 64
1 year	1 year	-.010	-.860	-.436	-43.73	Jun. 51 - Mar. 63
5 year	1 year	-.044	-.927	-3.46	-62.36	Jun. 51 - Mar. 63

ΔR is held constant, the influence of R on $RP + E$ becomes negative on securities observed over a one-year span of forecast. It is positive on Treasury bills, in accord with Kessel's findings, but is statistically significant in only one instance.

We recognize some genuine problems in these tests, including the probability of spurious correlation in some of the regressions. But we know of no better way to tackle the knotty problem of separating error from risk premium, and we do not believe the problems of our procedure are severe enough to negate the implications of the study so long as the numbers are not taken too precisely.