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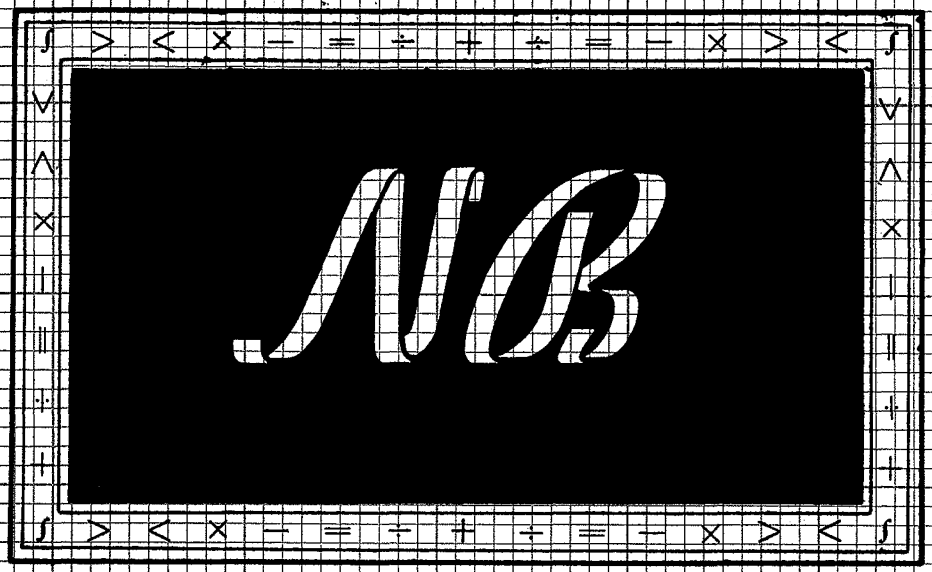

BASIC YIELDS OF CORPORATE BONDS 1900-1942

DAVID DURAND

TECHNICAL PAPER

3

Basic Yields of Corporate Bonds 1900-1942

DAVID DURAND

Technical Paper 3: June 1942

NATIONAL BUREAU OF ECONOMIC RESEARCH

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I WISH to take this opportunity to express sincere gratitude to all individuals and organizations who contributed data or inspiration to this study, or who otherwise assisted in its preparation. At the same time, I do not wish to make any one responsible for my conclusions or my interpretations of statistical data.

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THIS STUDY of basic yields is one of a projected series utilizing the data compiled by the Corporate Bond Project of the Financial Research Program, a Work Projects Administration undertaking sponsored by the Federal Deposit Insurance Corporation, supervised by the National Bureau of Economic Research, and carried on with the cooperation of several public agencies and private investment services. The purpose was to compile a comprehensive statistical record of bond market experience from 1900 to 1938. The record includes data on prices and yields, quality ratings and performance, default experience, bond characteristics such as callability and type of lien, and many other pertinent matters. For those who wish a more detailed description of the Project, the National Bureau has prepared a special mimeographed booklet which may be had on application for fifty cents.

The basic yield study was conducted for two distinct purposes. The first was to solve a technical problem encountered by the Project. The Project desired some method of measuring what may be called the 'market rating' of bonds, for comparison with the quality ratings of the investment services. The market rating of the quality of a bond is the combined opinion of market traders and is reflected somehow in the yield at which the bond is traded. Several methods were discussed and discarded before it was decided that the market rating of any bond should be the difference between its yield and that of the highest grade bonds of similar maturity: a small difference would indicate high quality; a large difference, low quality. The basic yield study was therefore undertaken to provide the necessary standard of comparison: to measure the yield on the highest grade bonds of all maturities. Although these basic yields are not the equivalent of a theoretically riskless rate of return, they probably do represent the closest approximation to that rate of return attainable by empirical observation.

The second purpose was to augment our knowledge of the structure of interest rates, which at present is largely limited to long term bond yields and such short term rates as commercial paper, time and call money, rediscount rates. Additional knowledge of short and medium term bond yields is needed to round out the picture. The basic yield estimates provide factual data germane to several widely different fields of inquiry, e.g., the theoretical discussion of the relation between long and short term interest rates, the analysis of the effects of interest rates

on economic fluctuations, and the problem of an effective arrangement of maturities in investment portfolios.

This present study is the result of the cooperative participation of the economics staff of the Institute for Advanced Study in the Financial Research Program of the National Bureau. Our staff has been keenly interested in this Program from its inception and has actively assisted in the planning and development of the basic research it has undertaken into financial problems. The Institute therefore welcomed the opportunity to make its facilities available to Mr. Durand so that he could develop these basic yield estimates. The materials assembled by the Corporate Bond Project constitute a rich body of data for empirical studies of a vital sector of finance. The Institute hopes that it will be able to cooperate further in their analysis, and so enhance our social knowledge of the functioning of the market for long term capital.

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THE BASIC YIELD was conceived as a practical analogue to that strictly theoretical entity, the pure interest rate. The latter is defined as the rate that would be realized if three hypothetical conditions were fulfilled: (1) if interest and principal were certain to be repaid according to contract; (2) if interest and principal were certain to be repaid in currency of the same purchasing power, which implies a stable price level; (3) if no administrative costs were entailed in making, holding, or marketing investments. The basic yield, however, is defined as the yield of the highest grade bonds actually traded in the market, and it therefore denies all three conditions assumed for the pure interest rate. (1) Although high grade bonds are probably among the safest investments known, at least in terms of contractual repayment, even the best are not absolutely safe. (2) Since high grade bonds offer almost no protection against a rising price level, their market yield should, and probably does, reflect the market's expectations of future price changes. (3) The market yield on high grade bonds is neither the investor's net return nor the borrower's total cost of obtaining funds; the investor must deduct from the market yield enough to cover the incidental expenses entailed in holding his investment, and the borrower must add enough to cover the costs of marketing his securities. This preliminary definition of the basic yield as the yield of the highest grade bonds must be qualified. For one thing, 'highest grade bonds' must be explained. Furthermore, a distinct basic yield must be defined for 30-year bonds, another for 10-year bonds, still another for 1-year bonds, and so on.

Obviously, 'highest grade' refers to the subjective appraisal of traders and investors in the bond market, not to intrinsic bond quality. These traders try conscientiously to determine the intrinsic quality of all issues traded. The opinions they form from analyzing pertinent data and consulting the ratings of the investment services are neither infallible nor unanimous, but are one of the primary forces determining the prices and hence the yields at which issues are traded. A bond has a low yield if most traders think its quality is high; consequently the highest quality bonds, according to market judgment, are those with the lowest yields.

But one should not suppose that a bond is considered high in quality merely because its yield is low, or that a difference in yield between two bonds of the same maturity is entirely attributable to a difference in quality. The yield of any bond may be seriously affected by many extraneous influences having nothing to do with 'quality', in the sense in which that word is commonly used.[1] Often a bond has special features

that make it more or less attractive than it would otherwise be, but that do not alter the fundamental safety of interest and principal: tax-exemption, conversion and warrant privileges, an active sinking fund in some circumstances, provision for call prior to maturity, voting rights.[2] Furthermore, the price of any bond may be artificially raised or lowered by ill advised market action of ignorant traders or by conscious attempts at manipulation.[3] Accordingly, the basic yield must be redefined as *the yield of highest grade bonds free from extraneous influences,* bonds that are non-convertible, non-callable, fully taxable, actively traded, free from manipulation, etc.

Evidently a successful statistical analysis of the basic yield depends upon the possibility of selecting a suitable group of bonds — bonds of superb quality, fully taxable, non-convertible, etc. Such a group can be found only among high grade corporate bonds; for governments, including state and municipal bonds, are almost universally tax exempt, and United States Treasury bonds in particular have, or have had, note issue and discount privileges, etc. This is most regrettable: first, because the quality of the best governments is probably a little higher than that of the best corporates; second, because there seems to be no way of analyzing the yield differential between governments and corporates to determine how much is due to tax exemption or other privileges and how much to the quality differential. Obviously, some corporates are unsatisfactory because of other disturbing influences, but many seem to be satisfactory enough for significant analysis.

Estimates of basic yields serve two interrelated functions: (1) to measure high grade bond yields, (2) to show the relation of high grade long term yields to short term. Since excellent series of long term high grade bond yields have already been constructed, the second function is probably the more important. This paper is concerned mainly with presenting basic yield estimates of corporate bonds of all maturities for the first quarter of each year 1900-42 (see Table 1 and the basic charts), describing their derivation, and pointing out their limitations. Although some attention is given their implications for general interest theory and business cycle problems, serious discussion of these subjects is deferred. Since economic theorists and investment analysts alike are now keenly interested in the relation between long and short term yields, presentation of the estimates alone seems justified at this time.

YIELD DATA FROM CORPORATE BOND PROJECT

The Corporate Bond Project compiled price quotations and computed yields for some 3,000 high grade domestic corporate bonds outstanding at some time between 1900 and 1938.[4] The distribution of these bonds by yield and term to maturity is shown in scatter diagrams on the basic

charts. These 3,000 include most of the larger and more actively traded corporate bonds outstanding in this period. Some of the more important types not included are serials, equipment trusts (serial and nonserial), income bonds, receivers' certificates, domestic bonds primarily payable in foreign currency, bonds of real estate mortgage companies, bonds held entirely by affiliates, and bonds that were never outstanding in amounts of $5,000,000 or more.[5]

Of the total sample of 3,000 bonds, merely a small fraction were actually used in the basic yield analysis. Certain types were omitted

TABLE 1

Basic Yields of Corporate Bonds, First Quarter, 1900-1942, by Term to Maturity[a]

Years to Maturity	*1900*	*1901*	*1902*	*1903*	*1904*	*1905*	*1906*	*1907*	*1908*	*1909*	*1910*
0	4.25†	3.25	3.30*	3.45	3.60	3.50	5.25†	5.75†	5.50†	4.05	4.30
1	3.97†	"	" *	"	"	"	4.75†	4.87†	5.10†	4.03	4.25
2	3.75†	"	" *	"	"	"	4.35†	4.43†	4.80†	4.01	4.21
3	3.58†	"	" *	"	"	"	4.04†	4.15†	4.58†	4.00	4.17
4	3.45†	"	" *	"	"	"	3.81†	3.97†	4.42†	3.98	4.13
5	3.36†	"	" *	"	"	"	3.67†	3.87†	4.30†	3.97	4.10
6	3.30	"	" *	"	"	"	3.59†	3.82†	4.21†	3.95	4.07
7	"	"	" *	"	"	"	3.55	3.80	4.14†	3.94	4.05
8	"	"	" *	"	"	"	"	"	4.09†	3.93	4.03
9	"	"	" *	"	"	"	"	"	4.05†	3.92	4.01
10	"	"	" *	"	"	"	"	"	4.02†	3.91	3.99
12	"	"	" *	"	"	"	"	"	3.98†	3.89	3.96
14	"	"	" *	"	"	"	"	"	3.96†	3.87	3.93
15	"	"	" *	"	"	"	"	"	3.95	3.86	3.92
20	"	"	" *	"	"	"	"	"	"	3.82	3.87
25	"	"	" *	"	"	"	"	"	"	3.79	3.83
30	"	"	" *	"	"	"	"	"	"	3.77	3.80
40	"	"	" *	"	"	"	"	"	"	3.75	3.80
50	"	"	" *	"	"	"	"	"	"	3.75	3.80
60	3.30	3.25	3.30*	3.45	3.60	3.50	3.55	3.80	3.95	3.75	3.80

	1911	*1912*	*1913*	*1914*	*1915*	*1916*	*1917*	*1918*	*1919*	*1920*	*1921*
0	4.10	4.05	4.95	4.70	4.50	2.75	4.05	5.55	5.75	6.25	7.25*
1	4.09	4.04	4.74	4.64	4.47	3.48	"	5.48	5.58	6.11	6.94*
2	4.08	4.03	4.59	4.58	4.45	3.81	"	5.41	5.43	5.99	6.70*
3	4.07	4.02	4.48	4.53	4.43	3.94	"	5.35	5.32	5.89	6.51*
4	4.06	4.01	4.39	4.49	4.41	4.00	"	5.30	5.23	5.80	6.35*
5	4.05	4.00	4.31	4.45	4.39	4.03	"	5.25	5.16	5.72	6.21
6	4.04	3.99	4.25	4.42	4.38	4.05	"	5.20	5.10	5.65	6.09
7	4.03	3.98	4.20	4.39	4.36	"	"	5.16	5.05	5.59	5.98
8	4.02	3.97	4.17	4.36	4.34	"	"	5.12	5.02	5.53	5.89
9	4.02	3.97	4.14	4.34	4.33	"	"	5.08	4.99	5.47	5.81
10	4.01	3.96	4.12	4.32	4.31	"	"	5.05	4.97	5.43	5.73
12	3.99	3.95	4.09	4.28	4.28	"	"	4.99	4.93	5.35	5.60
14	3.98	3.93	4.07	4.24	4.26	"	"	4.93	4.89	5.29	5.50
15	3.97	3.93	4.06	4.22	4.25	"	"	4.91	4.87	5.26	5.46
20	3.94	3.91	4.02	4.16	4.20	"	"	4.82	4.81	5.17	5.31
25	3.92	3.90	4.00	4.12	4.17	"	"	4.77	4.77	5.12	5.22
30	3.90	"	"	4.10	4.15	"	"	4.75	4.75	5.10	5.17
40	3.90	"	"	4.10	4.15	"	"	4.75	4.75	5.10	5.15
50	3.90	"	"	4.10	4.15	"	"	4.75	4.75	5.10	5.15
60	3.90	3.90	4.00	4.10	4.15	4.05	4.05	4.75	4.75	5.10	5.15

TABLE 1 (concl.)

Years to Maturity	*1922*	*1923*	*1924*	*1925*	*1926*	*1927*	*1928*	*1929*	*1930*	*1931*	*1932*
0	5.35	5.05	5.05	3.30	4.40	4.30	4.05	5.60	4.40	2.35	3.60†
1	5.31	5.01	5.02	3.85	"	"	"	5.27	"	3.05	3.99†
2	5.28	4.98	4.99	4.18	"	"	"	5.04	"	3.45	4.24†
3	5.25	4.95	4.96	4.34	"	"	"	4.89	"	3.67	4.40†
4	5.22	4.92	4.93	4.42	"	"	"	4.79	"	3.81	4.51†
5	5.19	4.90	4.90	4.46	"	"	"	4.72	"	3.90	4.58†
6	5.16	4.88	4.88	4.48	"	"	"	4.67	"	3.95	4.63†
7	5.14	4.86	4.86	4.49	"	"	"	4.64	"	3.98	4.66†
8	5.11	4.84	4.84	4.49	"	"	"	4.61	"	4.00	4.68†
9	5.08	4.82	4.82	4.50	"	"	"	4.59	"	4.02	4.69†
10	5.06	4.80	4.80	"	"	"	"	4.57	"	4.03	4.70
12	5.01	4.77	4.77	"	"	"	"	4.53	"	4.05	"
14	4.97	4.74	4.74	"	"	"	"	4.50	"	4.07	"
15	4.95	4.73	4.73	"	"	"	"	4.49	"	4.08	"
20	4.85	4.68	4.69	"	"	"	"	4.45	"	4.10	"
25	4.77	4.64	4.67	"	"	"	"	4.43	"	"	"
30	4.71	4.61	4.66	"	"	"	"	4.42	"	"	"
40	4.64	4.60	4.65	"	"	"	"	4.40	"	"	"
50	4.61	4.60	4.65	"	"	"	"	4.40	"	"	"
60	4.60	4.60	4.65	4.50	4.40	4.30	4.05	4.40	4.40	4.10	4.70

	1933	*1934*	*1935*	*1936*	*1937*	*1938*	*1939*	*1940*	*1941*	*1942*[b]
0	2.00*	2.00*	.50	.25	.35	.40	.25	.10	.15	.55
1	2.60*	2.62*	1.05	.61	.69	.85	.57	.41	.41	.81
2	3.02*	3.00	1.50	.96	.99	1.21	.86	.67	.64	1.04
3	3.32*	3.23	1.87	1.29	1.25	1.51	1.12	.90	.85	1.24
4	3.53	3.38	2.15	1.59	1.48	1.76	1.35	1.10	1.04	1.42
5	3.68	3.48	2.37	1.86	1.68	1.97	1.55	1.28	1.21	1.50
6	3.79	3.55	2.55	2.09	1.86	2.15	1.72	1.44	1.37	1.71
7	3.87	3.60	2.70	2.28	2.02	2.30	1.87	1.59	1.52	1.84
8	3.93	3.64	2.82	2.43	2.16	2.42	1.99	1.72	1.65	1.96
9	3.97	3.67	2.92	2.55	2.28	2.52	2.09	1.84	1.77	2.07
10	4.00	3.70	3.00	2.64	2.38	2.60	2.18	1.95	1.88	2.16
12	4.03	3.76	3.11	2.76	2.55	2.71	2.33	2.14	2.07	2.31
14	4.06	3.81	3.19	2.84	2.68	2.78	2.45	2.29	2.22	2.42
15	4.07	3.83	3.23	2.88	2.72	2.81	2.50	2.34	2.28	2.47
20	4.11	3.91	3.37	3.04	2.90	2.91	2.65	2.55	2.50	2.61
25	4.14	3.96	3.46	3.14	3.01	2.97	2.72	2.65	2.61	2.64
30	4.15	3.99	3.50	3.20	3.08	3.00	2.75	2.70	2.65	2.65
40	4.15	4.00	3.50	3.26	3.17	3.00	2.75*	2.70*	2.65*	2.65*
50	4.15	4.00	3.50	3.29	3.22*	3.00*	2.75*	2.70*	2.65*	2.65*
60	4.15*	4.00*	3.50*	3.30*	3.25*	3.00*	2.75*	2.70*	2.65*	2.65*

[a] The values in this table are taken at various intervals along a smooth curve; intermediate values can be determined by interpolation.
* More than usually liable to error.
† Figures marked with a (†) indicate one alternative value; the other is equal to the long term yield (see text).
[b] 1942 yields are based on January and February prices.

because they were entirely unsuited for the analysis; others were omitted primarily to save labor, but also because their inclusion would have added little to the significance of the results. The following types were omitted:

Bonds with inadequate price quotations: To be included in the study for any particular year, a bond had to have at least the following fea-

tures in the first quarter: an actual sale price or a bid and an asked quotation in one month, or a bid in each of two months. These minimum requirements were preliminary, and later several bonds satisfying them were found to be inadequate.

Bonds with quality ratings less than A:[6] If a bond had a rating of less than A in some years and A or better in others, it was included whenever its rating was A or better. No distinction by quality was made for 1900-08, when no quality ratings were available;[7] furthermore, a few unrated bonds were admitted in the subsequent years.

All bonds defaulting at any time during 1900-38.

Convertible bonds: All convertible bonds, except those whose conversion privilege had expired.

Bonds selling above call price: Since investors are justly reluctant to buy a bond at much above its call price, the prices of callable bonds do not rise as high as the prices of comparable non-callables, and their yields do not fall as low. For this reason bonds selling at or above call price were considered undesirable for the basic yield analysis, and were omitted for 1900-33. For 1934-42, however, so many bonds were selling above call that they could not be omitted without seriously reducing the number of bonds available for analysis; and in the later years of the period, 1939-42, virtually all long term high grade bonds were selling above call. For callable and non-callable bonds alike, the yields on the charts are the yields to maturity.

The increasing prevalence of bonds selling above call (indicated in the charts for 1934-40) introduces a very undesirable bias into the basic yield estimates for the later years, the effects of which are impossible to measure. The price and yield of a callable bond depend upon the investing public's forecast of when the bond is likely to be called. If an early call is forecast, the bond will sell close to call price; if a remote call, it need not sell close to call price. Obviously, it is impossible to determine what the investing public forecasts for each individual callable bond.

High yield bonds: Judged by the dispersion of their yields, even grade A bonds vary considerably in quality. Since the basic yield is the yield of the lowest yield bonds, the higher yield bonds, whether grade A or better, were not essential for the analysis. It is readily apparent that bonds above a certain yield were not plotted on most of the basic charts. That their omission was no loss to the analysis will be evident when the method used for fitting the basic yield curves is discussed.

Low yield bonds with spurious yields: When a bond sells at a yield far below those of other high grade bonds of the same maturity, the yield usually turns out to be spurious,[8] owing to an active sinking fund or some other disturbing influence. For example, in 1928 the Pittsburgh,

Chicago, Cincinnati & St. Louis Series E 3½'s of 1949 yielded 3.65 per cent, and the Erie Railroad Pennsylvania Collateral Trust 4's of 1951 yielded 3.80 per cent, when other high grades of similar maturity were yielding 4.10 per cent or more; both these bonds had extremely active sinking funds, which presumably caused them to sell at exceptionally low yields. A serious effort was made to exclude all spurious-yield bonds that might affect the basic yield estimates. The clearly spurious yields, like the two mentioned above, were excluded. The questionable ones were sometimes included and sometimes excluded, depending on circumstances; but even when included, they were given little weight.

In compiling price quotations, the Corporate Bond Project divided all bonds into two groups: 'periodic' bonds, for which price quotations were compiled, if available, only at 4-year intervals starting in 1900, and 'periodic and annual' bonds, for which price quotations were compiled, if available, for all years in which the bonds were outstanding. Hence the coverage in 1900, 1904, etc., is better than in other years, but only slightly better because the periodic and annual bonds were usually the more active issues and had more reliable quotations.

For each bond six separate price quotations were sought: the high and the low sales price in each of the first three months in each year of record. When sales prices were unavailable, bid and asked quotations were substituted if available. The yield to maturity was then determined from the average of these six quotations. It was rounded to the nearest twentieth of a per cent below the true yield; that is, all bonds with yields ranging from 3.60 per cent up to but not including 3.65 per cent were rounded to 3.60 per cent; hence the yields in the basic charts are located on the average one-fortieth (.025) of a per cent below their true positions.

OTHER YIELD DATA

The primary data on corporate bond yields were supplemented by four types of secondary data: the yields on United States government obligations; the yields on high grade serial bonds, particularly railroad equipment trust certificates; two previously constructed series of long-term high grade bond yields; and three series of short term money rates.[9] The data on government obligations and on corporate serial bonds have been added to the basic charts. The series of long term bond yields and of short term money rates will be used later for comparison with the basic yield estimates.

THE BASIC YIELD CURVES

The basic yield curves show the relation between yield and term to maturity for the highest grade (lowest yielding) bonds in each year

1900-42. One of these curves appears on each basic chart as a heavy solid line, sometimes curved and sometimes straight. The curves for all years are tabulated in Table 1, where values are given for specified maturities from 0 to 60 years, from which the intermediate values can be readily interpolated. Each basic yield curve is a free-hand trend line so fitted that is passes below most of the yields on the chart but usually above a few isolated low yields. The choice of curves, it will be observed, has been limited to three general types: (1) a horizontal straight line, (2) a smooth curve falling at a decreasing rate until it approaches a horizontal straight line at the long term end, (3) a smooth curve rising at a decreasing rate until it approaches a horizontal straight line.[10] One of these types usually provides a very satisfactory fit, although in a few years the fit is somewhat imperfect.

The fitting of a free-hand trend line to the lowest yield bonds is a radical departure from accepted statistical procedure. Ordinarily the trend line would be designed to show the variation in the *average* yield of bonds of different terms to maturity, and it would be determined by the method of least squares, or perhaps by some simpler method such as the joining of the average yield for 0-1 year bonds with the averages for 1-2 years, 2-3 years, etc. But the traditional approach is not well adapted to the measurement of the basic yield, primarily because of our definition: the yield of the absolutely best bonds, that is, the *minimum* yield. Furthermore, the statistical problem of fitting a trend line to minimum yield is far more clear-cut than fitting a line to average yields. It would be almost impossible to fit a line to the average of all bond yields because the yields of the lower grades vary greatly and sometimes reach astronomical values. It is quite possible to fit a trend line to some arbitrarily defined group of high grade bonds, perhaps Moody's A's or Poor's A**'s; but even such an average is not entirely satisfactory because the average depends upon what group is arbitrarily chosen to be averaged.

Of course, one serious danger is encountered in fitting a curve to the minimum yields — the possibility that the lowest yields may be spurious. We investigated all the lowest yielding bonds, i.e., all those below the basic yield or immediately above it, and eliminated many with spurious yields. Obviously the investigation could not be exhaustive, for it had to be limited to a few succinct and readily accessible sources of information, such as Moody's and Poor's manuals; nevertheless, it did suffice to unearth many clearly spurious yields and some rather questionable ones. We assumed therefore that isolated low yields, substantially below those of other bonds of the same maturity, were especially likely to be spurious; and indeed some were found to be definitely suspect, even though not clearly spurious; for example, a few

inactively traded over-the-counter bonds that repeatedly had isolated low yields.[11] It was because of this danger that the basic yield curves were fitted, not to the absolutely lowest yields, but to the lowest points at which the yields were at all concentrated. Fundamentally, the fitting of the basic yield curves consisted in drawing a boundary between two regions on a chart: an upper region throughout which yields were thickly scattered and a lower region in which they were sparsely scattered or non-existent.

RELIABILITY OF THE BASIC YIELD CURVES

All measurements are subject to error, because of limitations inherent in even the best measuring apparatus, inadequacies of available data, imperfections in technique, and occasional negligence on the part of the investigator. No measurement is significant unless something is known of the nature and amount of the errors to be reasonably expected in it. The potential errors in the basic yield measurements are both numerous and diverse, but a rough estimate of their size is possible.

Errors in the basic yield curves may arise from errors in the individual bond yields. Strictly speaking, these individual errors can arise from only two sources: the rounding of all yields to the nearest .05 per cent below the true yield, which is almost negligible, and the actual miscalculation of yields, which is likely to be rare.[12] Broadly speaking, individual yields may err in other ways. Bond yields, as already pointed out, may be spurious because of all sorts of extraneous influences; and a spurious yield may be properly considered an erroneous yield for the purposes of this study. The size of these errors is hard to estimate. Our practice has been to omit all questionable bonds, such as convertibles, rather than to attempt the almost impossible task of measuring the effect of the disturbing feature upon the particular questionable yield. The omission of questionable yields, however, had to be limited to the more obvious, and many of the less obvious may have been overlooked. Furthermore, all yields probably have at least a small spurious element, an error for our purposes and practically unmeasurable.

Errors may also arise from variations in quality. Although the basic yield estimates are all intended to represent uniformly high grade bonds, both for different years and for different terms to maturity, it is perfectly conceivable that the best bonds of 1940, the lowest yield triple A's, may be a little better or a little worse than the best bonds of 1920, or of any other year; and it is also conceivable that the best 30- to 40-year bonds of 1924 may be considerably better or worse than the best 0- to 5-year bonds or the best 10- to 15-year bonds. There is little evidence to indicate the range of the possible variation in quality between years, but it is probably not wide. However, the variation in quality between maturity groups may be considerable.

Because high grade bonds are not uniformly distributed by maturity, gaps often occur in maturity groups with virtually no high grade bonds. Some are clear and distinct, persisting for years. For example, during the first decade of the century very few high grade bonds were to mature between 1955 and 1990.[13] This gap was considerably narrowed by 1926 with the appearance of some 1955-70 maturities, and it was fairly well closed by 1930. Another gap began to appear about 1935 for bonds maturing in 2000 or later because the longer term bonds were being retired or were going into default during the 'thirties and were being replaced by new shorter term issues. The long term bonds continued to disappear in the next few years, and the gap widened, until by 1940 there were virtually no high grade bonds maturing after 1975, that is, in more than 35 years.

Other gaps, less clear and persistent, occurred from time to time. The first quarter of 1926 saw many triple A maturities of 8 to 14 years, but the lowest yields were .25 per cent higher than the lowest yields in other maturities. Was this a quality gap or a genuine variation in the basic yield? Did the 1926 market think that the best 8- to 14-year maturities were a little lower grade than the others, or did it prefer the others for reasons having nothing to do with quality?

The basic yield curves were fitted with a view to filling these gaps by simple, continuous curves. In effect, many of the more questionable basic yields were determined by interpolation or extrapolation from a few well defined points. All during the first part of the century the basic yields for the non-existent 1955-90 maturities were interpolated between the values for the longer and shorter maturities; during the last half of the 'thirties, the basic yields for the non-existent maturities of 40 years or more were extrapolated from the yields of 30-year bonds; and in 1926, as in similar situations, the basic yields for the questionable area between 8 and 14 years were interpolated rather than determined by the lowest yields prevailing in that area. Whether this interpolation is justified is anybody's guess. Certainly it has the advantage of simplicity as well as that of eliminating any small, extraneous variations in quality; but it also has the great disadvantage of concealing genuine variations in the yields of the highest grade bonds.

The potential errors are too numerous and varied to be measured individually and then summed up. What is needed is a single criterion for estimating all errors, and such a criterion can be found, perhaps, in the closeness with which the basic yield curves fit the lowest yield bonds. As already stated, the fitting of the basic yield curves is an attempt to determine a boundary line between two areas on a chart: an area that contains bond yields and an area that does not. In some charts the boundary is clear and distinct; in others it is vague and uncertain. For example, the yields of the lowest 26 bonds in 1928 are confined to a

strip between 4.05 and 4.15 per cent, whereas the yields of the lowest 29 bonds in 1902 are spread over a strip between 2.90 and 3.50 per cent. As a result, the basic yield curve for 1928 can be fitted with ease and considerable confidence, but the curve for 1902 is fitted with difficulty and some uncertainty. The difference, however, is purely one of degree. An element of uncertainty inheres in both curves, but is much greater, perhaps five times greater, for the 1902 curve than for the 1928.

Certainly all the estimates are subject to an error of at least .05 per cent, for an error of this amount could arise from rounding all yields to .05 per cent. Whenever the basic yield is a straight line, it is quoted only to .05 per cent; and whenever it is a curve, the long term end approaches a value quoted to .05 per cent. Of course, values along the curved lines are quoted to .01 per cent, but this is merely for the sake of obtaining a smooth curve; there is no implication whatsoever that the estimates are correct to .01 per cent. An error of only .05 per cent, however, is too tiny to expect except in a few ideal years, such as 1928. In most years .1 per cent is more reasonable, and in one or two years with more scattered yields, such as 1902, .25 per cent is entirely possible. Furthermore, curves that are fairly reliable in general often have areas of considerable uncertainty. In the 1926 curve, for example, where the potential error for most of the curve may be no more than .05 per cent, there is an area between 8 and 14 years where the potential error is probably as large as .25 per cent; and again in all the curves for 1935-42 there are extremely uncertain areas at the long term ends.

The more doubtful estimates of basic yields are indicated on Table 1 by asterisks, which appear on the long term rates after 1931, on some of the short term rates, and for the entire year 1902. On the charts, doubtful sections of the basic yield curves are indicated by broken lines (note some of the short term yields and the long term yields after 1935).

SPECIAL ERRORS IN THE SHORT TERM ESTIMATES

The short term basic yields are subject to numerous special errors in addition to those of the longer term yields. In the first place, price fluctuations of an eighth of a point, the usual limit to which prices are quoted, have an important effect on the yield of a short term bond.[14] For a price range of 99⅞ to 100⅛, the yield range for a 30-year, 4 per cent bond is 3.993 to 4.007 per cent, which is negligible; for a 1-year, 4 per cent bond the range is 3.88 to 4.13 per cent, which is appreciable; and for a 3-month, 4 per cent bond the range is 3.48 to 4.48 per cent, which is considerable. Furthermore, the short term bond yield is often equally sensitive to daily changes in term to maturity. At 101⅛ a 3-month, 6 per cent bond yields 1.48 per cent. If the price remains constant for one week, the yield will be 1.12 per cent; if the price then falls

to 101, the yield will rise to 1.64 per cent. Obviously, if short term yields are to be studied satisfactorily, they can be studied only on a day to day basis. Our practice of determining the yield from a three-month average price is patently unsatisfactory, and is justified by reasons of economy alone.

The sensitivity of short term yields to price fluctuations indicates that brokers' commissions should be taken into consideration. At the time of writing, as it has been for some time in the past, the commission charged non-members trading on the New York Stock Exchange is $2.50 per $1,000 bond,[15] which means that when a bond is traded at 100, the buyer pays 100¼, and the seller receives 99¾. For a 1-year 4 per cent bond, the yield is 3.75 per cent to the buyer, 4.00 per cent at the market price, and 4.25 per cent to the seller. Thus, the broker's commission introduces a very real margin of uncertainty into all short term yield calculations, a margin that increases as the bond approaches maturity.

Short term bond yields are affected also by the exchange privilege. Holders of a maturing bond may be given the option of receiving cash or another security in payment. This privilege may be valuable and have considerable effect on the yield. For the last eight years, maturing Treasury bonds and notes have sold at a negative yield because of the exchange privilege. Consequently, the yields on short term Treasury bonds and notes are a very poor index of short term yields as a whole. To what extent corporate bond yields are similarly affected is hard to say. Ordinarily corporate bond holders do not enjoy the exchange privilege, but sometimes they do; and whenever they are led to expect the privilege, correctly or incorrectly, the yield is likely to be affected.[16] A few bonds were omitted because the yields apparently showed expectation of an exchange option, but such situations cannot be appraised readily.

The determination of short term bond yields is further complicated by the fact that the population of short term bonds is small and continually changing. At any one time it is unusual to find more than about six high grade bonds within a year of maturity, and often no more than one or two. In several charts, there are simply not enough short term bonds from which to estimate the basic yields. A case in point is 1932, where two separate short term estimates are given. One is merely the extension of the horizontal straight line at 4.70 per cent, a reasonable fit in view of the bond yield data available. The other, which starts at 3.60 per cent and rises to 4.70 per cent at 10 years, is fitted to the commercial paper rate of about 3.80 per cent during the first quarter and to two isolated low yields, 4.05 per cent at 1 year and 4.10 per cent at 2 years and 4 months. Although the second estimate is probably better, both are so extremely uncertain that they are indicated by broken lines rather

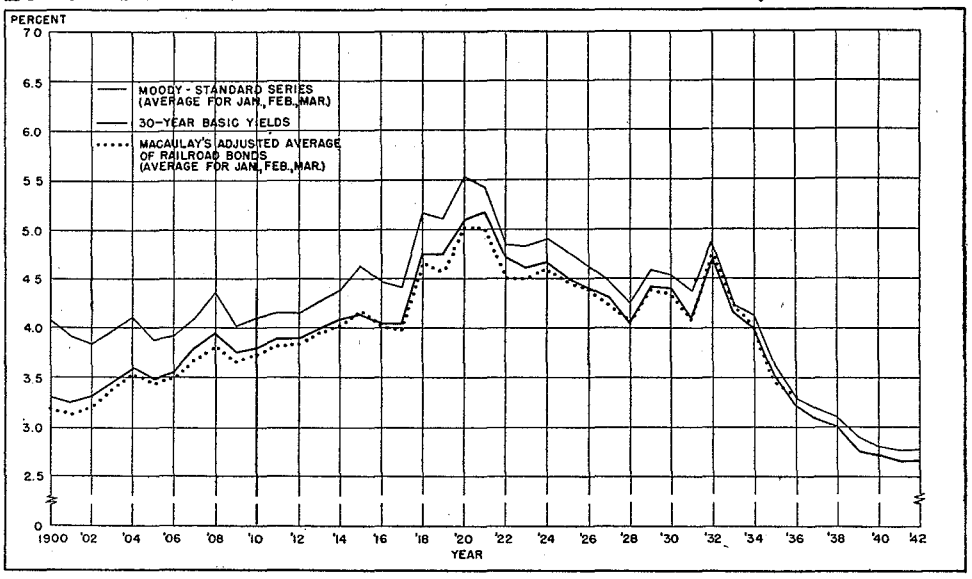
than by the usual solid line. A similar state of affairs is found in 1900, 1906, 1907, and 1908.

If an error of .05 per cent is to be allowed for even the best of the long term basic yields, a much larger error must be allowed for the short term. At 1 year to maturity the basic yield curve is presumably subject to an error of at least .25 per cent; and in the questionable years, such as 1932, an error of 1 per cent would not be surprising. Although the basic yield curves have been extended all the way down to 0 years to maturity, and although values for two and three months can be obtained to .01 per cent by interpolation, there is no implication that these extremely short term estimates are at all precise.

LONG TERM BASIC YIELDS AND OTHER CORPORATE BOND SERIES

The comparison in Chart 1 is not entirely satisfactory, because the basic yield series refers to a fixed, definite term to maturity (30 years), whereas both the Macaulay and Moody-Standard series are averages of long term bonds of widely diverse maturities.[17] One of the most striking features of Chart 1 is the extremely close correlation between the Macaulay series and the basic yields; the maximum deviation is .21 per cent, the average deviation .075 per cent. This is not strange, for the two series were designed to show precisely the same thing — the yield on top grade bonds — although the methods by which they were derived are intrinsically different. The basic yields were nevertheless not derived entirely independently of the Macaulay series. When the first preliminary basic yield estimates were compared with the Macaulay series, several incon-

CHART 1
LONG TERM HIGH GRADE CORPORATE BOND YIELDS, 1900-1942



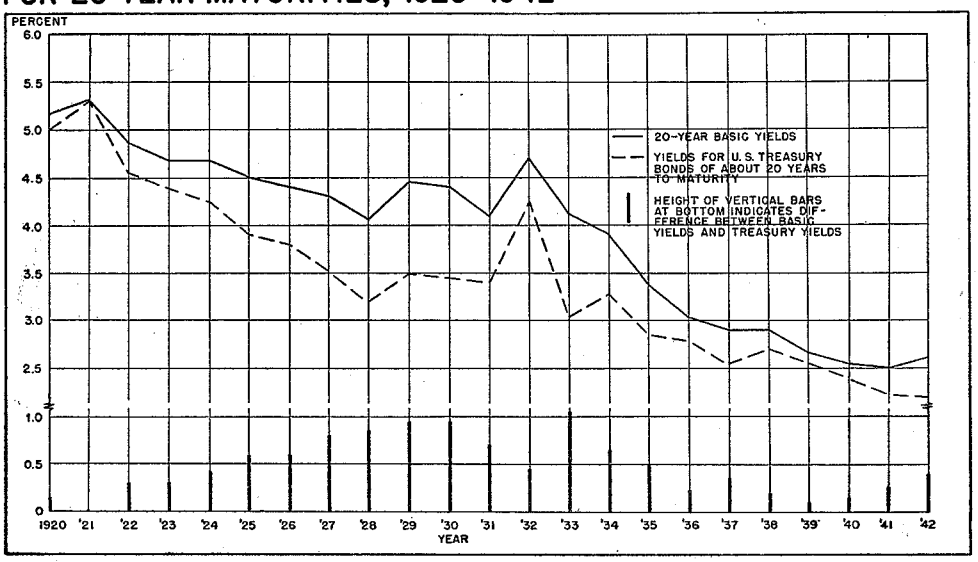
sistencies were discovered: when the Macaulay rose from one year to the next, the basic yields fell, or vice versa. Often these inconsistencies were irreconcilable, the basic yield data being clearly at variance with the Macaulay estimates. But whenever the inconsistencies seemed to be due largely to uncertainties in the basic yield data, the basic yields were revised, usually by .05 per cent, never by more than .10 per cent.

As the Moody-Standard series is based on the average of a group of yields rather than the minimum yield, it naturally is uniformly above the basic yields. The difference ranges from .78 per cent in 1900 to .07 per cent in 1933. But the significance of the comparison is the direction of the year to year changes, not the absolute differences; in 37 of the 42 year to year movements the two series rise and fall together.

TREASURY BONDS AND BASIC YIELDS

In 1921 the yield of Treasuries was only about .07 per cent below the basic yield; in 1929, 1930, and 1933 the difference was about 1 per cent; by 1939 it had narrowed to about .1 per cent; and by 1940 it had widened to .4 per cent. Conceivably this difference could be due to a variation in the quality differential between governments and corporates; if so, the significance of the basic yield estimates would be considerably reduced. Fortunately, however, there is good reason to believe that at least some of the difference is due to other factors. For example, the retirement of Treasuries during the late 'twenties would help to explain their low yield relative to that of corporates. Moreover, any change in income tax rates is likely to affect the value of the tax-

CHART 2
BASIC YIELDS AND UNITED STATES TREASURY BOND YIELDS FOR 20-YEAR MATURITIES, 1920-1942

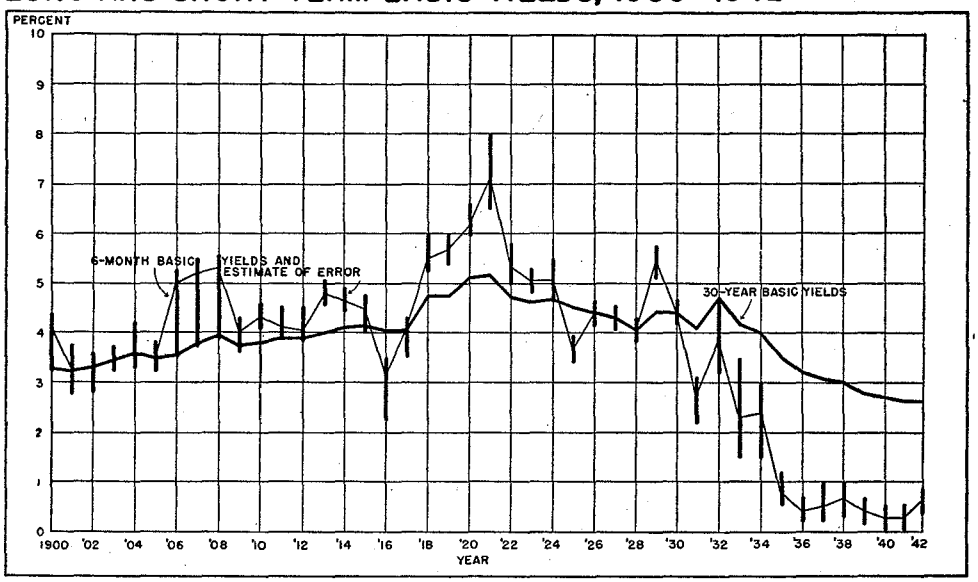


exemption privilege. To explain why there is a difference between the yield of Treasuries and the basic yield or why it fluctuates widely is beyond the scope of this paper. We merely call the reader's attention to Chart 2, where the movements of the 20-year basic yields and the yields of similar Treasury bonds are traced.[18]

LONG AND SHORT TERM BASIC YIELDS

Despite large errors inherent in the short term estimates, Chart 3 shows clearly that the short term yields are far more unstable than the long term; for the fluctuations of the short term estimates are too violent to attribute to errors alone.[19] In periods of pronounced stress the short term yields rise higher, and in periods of extreme easy money they fall lower. This greater instability of the short term yields is shown in another manner in Chart 4, where all the basic yield curves for 1900-42 have been superimposed on a single chart.

CHART 3
LONG AND SHORT TERM BASIC YIELDS, 1900 - 1942



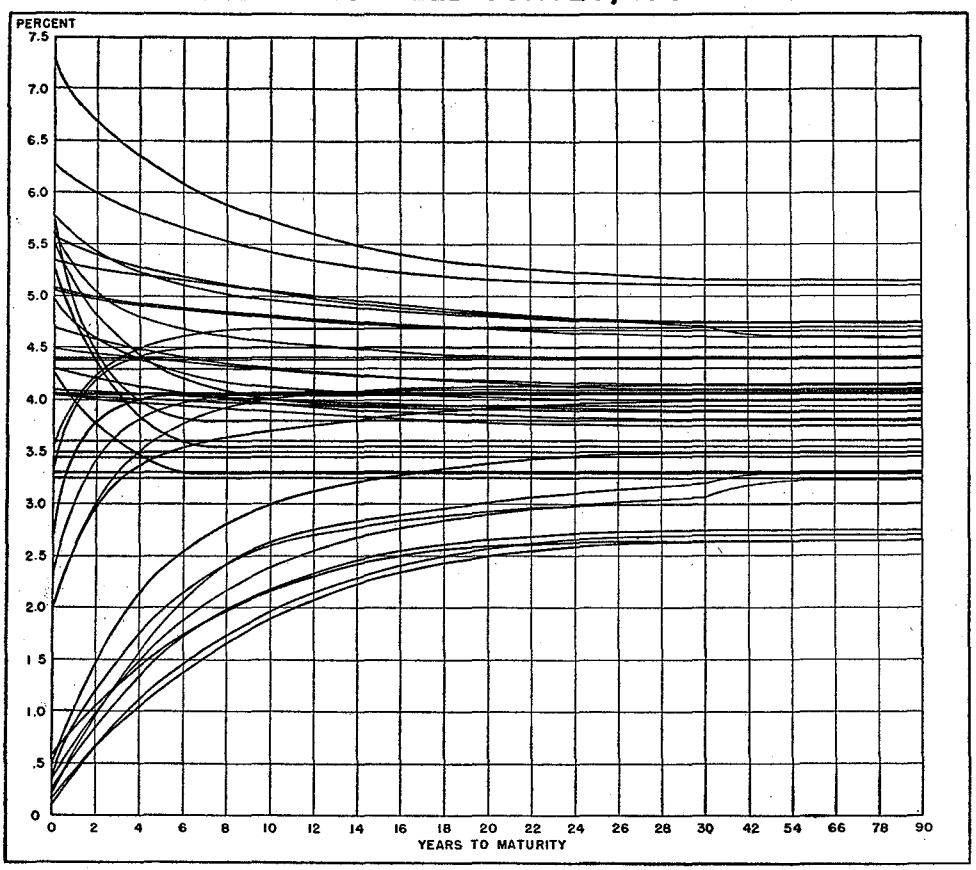
SHORT TERM BASIC YIELDS AND OTHER SERIES

Many investigators have concluded that bond yields are not closely linked to short term money rates. One reason is that long term bond yields have usually been used. A more pertinent comparison, made possible by the basic yield estimates, is between short term money rates — commercial paper, time money, and call money — and short term bond yields (Chart 5).[20] While all four series diverge frequently and sometimes widely, they nevertheless tend to correspond in their major movements. For 1900-08 the interrelationships are somewhat confusing,

but after 1908 the correspondence is marked. All four series move up and down together from 1909 to 1916: commercial paper at about the same level as the basic yield, time money a little lower, and call money still lower. In 1916 each series was either at, or very close to, its low for the first sixteen years of the century. From these lows all four series rose sharply to their highs of the early 'twenties, call and time money reaching theirs in 1920, and commercial paper and the basic yield reaching theirs in 1921. From 1922 to 1928 all four series moved closely together. All four then rose to new peaks in 1929; the basic yield and commercial paper moderately, time and call money sharply. The series then fell together to their extreme low levels of 1935-42.

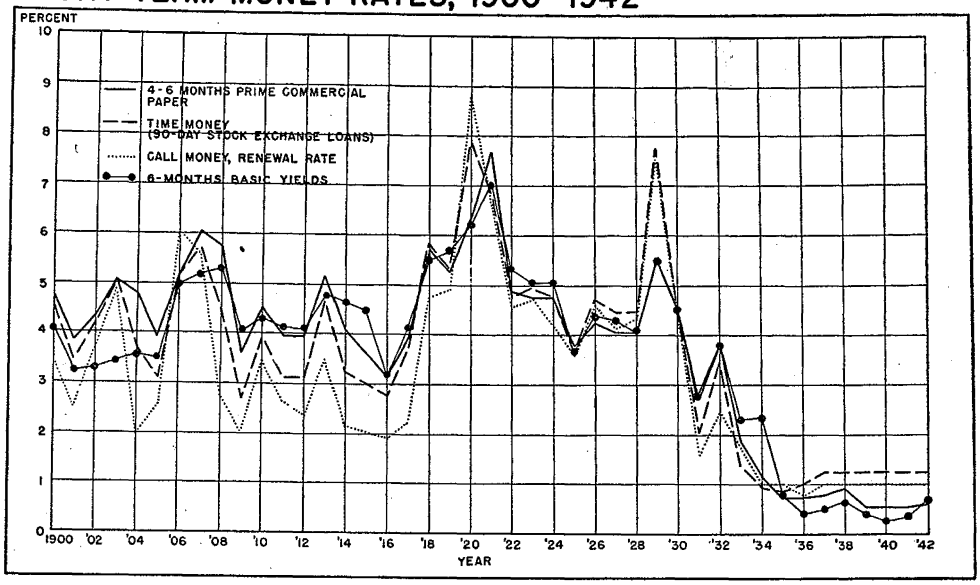
The relations depicted in Chart 5 must be reviewed in the light of the fundamental weaknesses of the short term basic yields. All the short term estimates are subject to an appreciable error, some to a considerable error. In several years, when short term high grade bonds were too few for an accurate estimate of the basic yield, the estimate was partly determined by the commercial paper rate. In years like 1900, 1906-08, or 1932, we simply do not know what the basic yield was for

CHART 4
SUPERIMPOSED BASIC YIELD CURVES, 1900-1942



short terms; it may have been close to the commercial paper rate, as we assumed, or it may have been quite different. Consequently we do not attempt to decide whether short term bonds agree more closely with commercial paper, time money, or call money; we content ourselves with the conclusion that short term bond yields are a good deal more closely related to short term money rates than are long term bond yields.

CHART 5
SHORT TERM MONEY RATES, 1900 - 1942



IMPLICATIONS OF THE BASIC YIELD ESTIMATES

This paper is concerned with a single function: to present the basic yield estimates and explain how they were derived. Nothing has been said about their implications for current economic and financial problems, and very little about their relevance to interest theory. An exhaustive exploration of their significance would be out of place here; we merely mention a few specific questions that deserve serious consideration in the future.

THE RELATION BETWEEN LONG AND SHORT TERM BOND YIELDS

The basic yield estimates do not reveal any simple fundamental relation between long and short term yields. During the last 43 years, short term yields have been sometimes above, sometimes equal to, and sometimes below long term. The pattern, furthermore, is quite irregular. During the last decade they have been consistently below long term, which suggests that a low short term yield may be the normal state for present day financial conditions. Prior to 1931, however, the low short term yield was exceptional. In general, short term yields were equal to or slightly

greater than long, and in periods of extremely tight money, such as 1929, 1918-21, and possibly 1906-08, they were considerably above long.

One pertinent extension of the basic yield analysis would be to make estimates for the other three quarters. If monthly estimates were feasible, they also would be extremely useful.

The relation between long and short term yields is intriguing to modern economic theorists, who have advanced several theories to explain it. One explanation relates long term yields to the expected course of future short term yields; if short term yields are expected to rise substantially, long yields will be greater than short, and vice versa. Another explanation is Mr. Keynes' doctrine of liquidity preference, by which short term bonds normally yield less than long. Finally, the relation between long and short yields is sometimes explained by institutional forces. The market for short term funds is conceived as intrinsically different from that for long term; different groups of institutions, with different needs and trading practices, operate in each market; and the prices and yields in each market are set by the conditions of supply and demand within it.

BOND YIELDS AND BOND PRICES

Throughout this study we have dealt with bond yields, to the exclusion of bond prices. This is perfectly sound according to economic theory, which is interested in prices and price movements only so far as they determine yields and yield movements; but it is not so sound according to practical finance. Bonds are quoted on the exchanges in terms of price, not yield. They are bought and sold by persons who are vitally concerned with price movements: by speculators hoping to realize a quick profit; by long term investors who must face the possibility of forced liquidation at unfavorable market prices; by institutional investors, who must have regard for the market price when making out their annual statements. To the economic theorist, a fall in price of a 30-year 3 per cent bond from 100 to 90 means a rise in yield from 3 to about 3.5 per cent; to the bond holder it means a 10 per cent capital loss. Because bonds are bought and sold by persons acutely aware of price movements, a comprehensive study of bond yields should go behind the yields themselves and consider prices. Perhaps a yield-maturity curve that cannot be explained in terms of yield alone, is quite explainable in terms of market price behavior.

While we do not propose to explore this important subject of price, we have nevertheless converted four of the basic yield series in Table 1 into equivalent basic price series in Table 2. One of the yield series, 1930, has equal yields for all terms; one, 1929, has higher short term yields; and the last two, 1941 and 1942, have lower short term yields.

From these basic price curves a few general observations can be made. When the basic yield curve is a horizontal straight line, as in 1930, a top grade bond with a coupon rate greater than the basic yield sells at a premium that gradually decreases as it approaches maturity, and a bond with coupon rate less than the basic yield sells at a discount. When the basic yield is a curve that either rises or declines continuously, the corresponding price curve may rise for a while, then decline, as does the 2⅝ bond in 1942. Especially interesting behavior is shown by the price curves for 3 per cent bonds in 1941 and 1942; the price is almost constant (about 109 in 1941 and 107 in 1942) for all maturities longer than 6 years; for shorter maturities the price rapidly declines to par.

TABLE 2

Basic Prices of Corporate Bonds Corresponding to Basic Yields
First Quarter, 1929-30 and 1941-42, by Term to Maturity

	1929			*1930*			*1941*		*1942*		
Years to Maturity	*3% Coupon*	*4% Coupon*	*5% Coupon*	*3% Coupon*	*4% Coupon*	*5% Coupon*	*3% Coupon*	*4% Coupon*	*2⅝% Coupon*	*3% Coupon*	*4% Coupon*
0	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1	97.82	98.78	99.74	98.64	99.61	100.58	102.58	103.58	101.80	102.18	103.17
2	96.17	98.05	99.92	97.35	99.24	101.14	104.68	106.67	103.13	103.87	105.84
3	94.79	97.55	100.31	96.11	98.89	101.67	106.36	109.31	104.07	105.17	108.10
4	93.55	97.16	100.75	94.92	98.55	102.18	107.66	111.57	104.67	106.12	110.00
5	92.42	96.83	100.24	93.78	98.22	102.67	108.66	113.50	105.05	107.20	112.00
6	91.35	96.53	101.71	92.69	97.91	103.13	109.36	115.10	105.20	107.33	113.01
7	90.30	96.21	102.13	91.64	97.61	103.58	109.79	116.41	105.13	107.59	114.13
8	89.33	95.96	102.58	90.64	97.33	104.01	110.08	117.54	104.91	107.62	115.04
9	88.39	95.69	102.99	89.69	97.05	104.42	109.23	118.48	104.54	107.61	115.77
10	87.51	95.46	103.42	88.77	96.79	104.81	110.17	119.24	104.16	107.52	116.47
12	85.90	95.14	104.42	87.06	96.30	105.55	109.74	120.41	103.28	107.19	117.63
14	84.54	94.85	105.15	85.48	95.85	106.22	109.34	121.32	102.42	106.86	118.67
15	83.87	94.69	105.52	84.75	95.64	106.54	108.97	121.74	101.93	106.61	119.08
20	80.93	94.08	107.23	81.51	94.72	107.93	107.83	123.50	100.23	106.03	121.55
25	78.52	93.44	108.56	78.90	93.97	109.04	107.13	125.41	99.73	106.56	124.77
30	76.53	93.06	109.58	76.80	93.37	109.94	107.21	127.82	99.48	107.21	127.82
40	73.76	92.50	111.25	73.76	92.50	111.25	108.60	133.17	99.38	108.60	133.17
50	71.79	91.94	112.09	71.79	91.94	112.09	109.67	137.28	99.31	109.67	137.28
60	70.52	91.58	112.64	70.52	91.58	112.64	110.49	140.45	99.23	110.49	140.45

COUPON RATE AND ITS EFFECT ON YIELD

At present, many interest theorists assume that bonds having the same quality and maturity should sell at the same yield. But alert bond traders, especially traders in United States Treasury bonds, draw a distinction between bonds with different coupon rates; ordinarily a low coupon bond is preferred to a high coupon bond of the same maturity, and it may sell at an appreciably lower yield. One commonly heard explanation is that low coupon bonds are preferable for income tax purposes. Another is that a high coupon bond, which must be purchased at a substantial premium, is far more likely to decline drastically in price than a low coupon bond, which is purchased at a small premium; traders

seem to feel that in a declining market, prices fall fairly freely until they approach par, at which point they meet resistance to further decline.

The basic yield estimates were all made without regard to coupon, no distinction being drawn between 2 and 7 per cent bonds. This failure to distinguish between low and high coupons is certainly a shortcoming, though it may not be serious. Corporate bonds are affected by so many disturbing influences, and their yields vary so widely that the particular effects of different coupon rates are probably unmeasurable. In a study of Treasury bonds, however, a distinction by coupon would be far more feasible, and certainly desirable; one yield-maturity curve could be constructed for 2 per cent bonds, another for 2½ per cent bonds, etc.

INVESTMENT POLICY

One of the problems facing investors today is the proper arrangement of maturities within their portfolios. Because of the low yield on short term bonds, liquidity can be obtained only at the expense of income. How can one portfolio be designed to provide both adequate liquidity and a substantial income? One solution is to stagger maturities so that regular amounts come due at regular intervals. Another is to buy medium term bonds, hold them for a while, then sell them a few years before maturity. This procedure will produce an extraordinarily high yield for a medium term portfolio as long as the present structure of bond yields continues unchanged. For example, a 2⅛ per cent bond is bought at about 99¾ to yield 2.16 per cent, which is the basic yield in 1942; after five years it is sold at 102½ to yield 1.57 per cent, again the basic yield in 1942. For the five-year period, the yield from interest and price appreciation amounts to 2.65 per cent, which is as high as the basic yield on the longest term bonds. Although we took as an illustration a low coupon bond selling at approximately par, the results would have been the same for a high coupon bond selling at a substantial premium.

THE MARKET RATING

One of the primary functions of the basic yields was to serve as a standard with which the yield of any bond could be compared. The difference between the yield of any particular bond and the basic yield was conceived as a possible measure of the bond market's appraisal of risk. If a bond is considered extremely safe, its yield should approximate the basic yield; if it is considered risky, its yield should differ from the basic yield by an amount depending upon how risky it seems. Whether this yield differential will provide a useful tool in the analysis of bond quality remains to be seen.

Notes

[1] In ordinary investment usage 'quality' refers to the likelihood that a bond's contracted payments of principal and interest will not default, and as such it does not refer to the attractiveness of the bond as an investment or a speculation; for a high quality bond will be unattractive if the price is too high, and almost any low quality bond is a speculative bargain at some price. The conversion privilege, or any other special feature, may make a bond of any quality attractive when it would otherwise not be. Convertibles frequently sell at a price to yield little or nothing or even less than nothing to maturity; and they do so not because they are desirable obligations for conservative investors, which they may or may not be, but because they represent a speculative value for those who want to convert. Evidently the yield of a convertible bond is composed of at least three parts: the basic yield or high grade bond element, plus a premium for low quality if the bond is less than top grade, *minus* an amount representing the value of the conversion privilege. The same general analysis holds for bonds with other special features.

[2] It will be argued, and rightly, that a sinking fund usually improves the quality of a bond. Under some circumstances, however, it may support the price of a bond without appreciably affecting its quality. For example, if a bond is adequately covered, and has a sinking fund providing for the calling of a substantial number of bonds each year at a premium, say 110, its attractiveness derives from retirement at 110 instead of par, not from the periodic reduction of the company's indebtedness.

[3] The word 'artificial' may not be entirely appropriate in this context. The intended implication is that the true price of a bond is the price at which well informed traders are willing to buy or sell it. Obviously the market price may temporarily deviate from the true price, thus defined, by the mistakes of ill advised traders, who do not know what the true price is, or by the machinations of manipulators, who do.

[4] The Corporate Bond Project dealt exclusively with bonds outstanding at some time between January 1, 1900 and December 31, 1938; however, it did obtain the prices and yields for 1939 and 1940 of bonds outstanding at the close of 1938. The data for the 1939 and 1940 estimates therefore do not include the yields of bonds offered during 1939 or the first quarter of 1940.

The data for the 1941 and 1942 estimates were compiled after the Corporate Bond Project had closed. First, the Project's list of bonds for 1940 was consulted, and about 100 of the higher grade, lower yield bonds were selected; then about 50 other bonds, including some that had been issued since 1938 and some that had improved in rating, were added. The list consisted almost exclusively of bonds traded on the New York Stock Exchange or the New York Curb. The data for 1942 were based on only January and February prices, because March prices could not be compiled before the publication date.

[5] The Project obtained a 10 per cent sample of these smaller bonds, which numbered about 1,500; but since price data were usually missing, this sample was not used in the basic yield analysis.

[6] The rating system used here is a composite based on the median average of the ratings by four prominent investment services. When some of these ratings were not available, as they frequently were not, the composite was determined from those that were.

[7] The first bond quality ratings, Moody's railroads, appeared in 1909.

[8] Like 'artificial', 'spurious' may not be entirely appropriate in this context. The implication is that the yield to maturity, which is what we are dealing with exclusively, is sometimes a spurious measure of the expected investment return. Ordinarily the investing public expects that a high grade bond will be paid at par on the maturity date; but sometimes the public feels confident that the bond will be paid before maturity and at a premium.

An excellent illustration of a spurious yield is afforded by the Erie Railroad Pennsylvania Collateral Trust 4's of 1951. Every year a sum of money, depending upon the amount of coal mined by the Pennsylvania Coal Company, had to be set aside for a sinking fund. The fund was

to be used to buy bonds in the open market if they could be bought at 105 or less; otherwise the bonds were to be called by lot at 105. The fund operated so rapidly that the entire issue had been retired by 1938.

In 1928 the bond holder must have realized that his bond was worth more than its face value. He did not expect to receive exactly par for his bond 23 years hence, which would provide a yield of 3.80 per cent at market prices; he could reasonably expect to receive 105 in much less than 23 years, which would provide a yield of substantially more than 3.80 per cent. It is in this sense that 3.80, the yield to maturity, is considered spurious.

[9] Henry C. Murphy of the United States Treasury very kindly lent the National Bureau a set of curves showing the relation between yield and term to maturity for government securities. These curves, which were prepared by Virginia Eyre from price data as of the end of January each year, were used as models for a similar set reproduced here in the basic charts. In drawing her curves, Miss Eyre plotted the yield of each security individually; she used a separate curve for long term bonds and short term notes; and she left spaces where there were no yields. This procedure was admirable when the curves were plotted on charts by themselves, but it would have added unnecessary confusion to the already complicated charts used in this study; hence our curves are greatly simplified imitations of Miss Eyre's originals.

Theoretically, serial bonds are ideally suited to the study of the yield-maturity relation. Actually they are rather unsatisfactory because of the difficulty of obtaining comprehensive price quotations. We have, however, been able to compile some satisfactory data on serials from three sources and have used them to supplement the more extensive data on non-serials.

Stroud & Co. permitted us to use their periodic valuations of railroad equipment trust certificates. Based on market prices and other pertinent information, these valuations represent Stroud's estimate of conservative investment value for each maturity of all the important equipment trust certificates outstanding. The Corporate Bond Project computed yields corresponding to Stroud's price valuations for the highest grade issues. From among these one issue was chosen for each year 1934-40, the choice having two ends in view: (1) that the yield should be as low as possible; (2) that there should be as long a series of maturities as possible.

A search was made for data on high grade equipment trust offerings. Offerings during January, February, and March were preferred, but when these were not available, others were taken. The sources were advertisements in the *Commercial and Financial Chronicle*, circulars from underwriting houses, and occasionally Moody's and Poor's manuals. For about half the offerings investigated, the prices and yields for the individual maturities could be determined; for the remainder, the prices were an average for all maturities. When data on several offerings were available for one year, only one was chosen, except when several issues were offered at precisely the same prices. The choice was made with a view to obtaining a high grade, low yield issue with as many maturities as possible. Offerings were not always plotted, even when available, because they would have added little to the analysis. Before about 1929 both long and short term equipment trusts were usually offered at substantially the same yield.

In 1941 and 1942 the United States Steel Corporation had a large issue of serial debentures outstanding, to mature semi-annually until 1955. They were listed on the New York Stock Exchange and actively traded. The yields of these debentures, plotted distinctively on the basic charts, provided excellent material for the analysis.

[10] An occasional cusp in the basic yield curves at the 30-year point is due entirely to the change in scale at that point.

[11] Chief among these were the United New Railroad and Canal 3½s of 1951 and the Morris and Essex 3½s of 2000, both of which repeatedly had very low yields. In addition, low yields were occasionally shown by the Michigan Central 3½s of 1952 (low in 1903), the Philadelphia, Baltimore and Washington 4s of 1943 (low in 1907 and 1915), and the Philadelphia and Reading 4s of 1947 (low in 1919).

[12] Bond Project procedure provided that all price transcriptions and yield calculations be thoroughly checked once, and that many be spot-checked in addition. This in itself would be sufficient to assure considerable reliability. But during the basic yield study, all low yield bonds were analyzed to determine whether their yields were spurious, and this analysis included a further check of the price transcriptions and the yield calculations.

[13] Tables prepared from the Corporate Bond Project data shed further light on these gaps. One, summarized below, shows the distribution of railroad, public utility, and industrial offerings of $5,000,000 or more, of all grades, by term to maturity (term measured from offering date). Evidently offerings maturing in 50 to 75 years have never been popular, and since 1920 all long term bonds, that is, those of more than 30 years, have become much less popular.

	Less than 30 years	*30-50 years*	*50-75 years*	*75 years and over*	*Total offerings covered*
1900-09	46.3%	43.5%	0.7%	9.5%	1,595
1910-19	64.7	31.5	0.8	3.0	1,903
1920-29	83.2	13.8	1.0	2.0	2,098
1930-38	83.6	13.7	1.6	1.1	999

[14] This does not mean to imply that bond prices are not occasionally quoted to 1/16 or even 1/32.

[15] Of course, the commission charged members of the Exchange for their own account is less than $2.50. As a result, no analyst can determine what commissions were charged on any particular transaction, but he cannot therefore forget commissions. Just before this paper went to press, the commissions on small transactions were increased.

[16] Even when no exchange privilege is provided in the bond indenture, an exchange may be offered to facilitate refunding. For example, about 1900 J. P. Morgan and Co. undertook to market for the New York Central a large issue of 3½s maturing in 1997. These 3½s were issued from time to time for refunding and other purposes. When the New York and Hudson River 6s and 7s of 1903 came due, Morgan offered the new 3½s in exchange.

[17] See *Some Theoretical Problems Suggested by the Movements of Interest Rates, Bond Yields and Stock Prices in the United States since 1856,* by Frederick R. Macaulay (National Bureau of Economic Research, 1938). The chart shows an average for January, February, and March of the series of adjusted railroad bond yields in Table 10, pp. A 141-61.

The Moody-Standard series is a composite based on Standard Statistics' series of high grade railroad bond yields from 1900 to 1919, Moody's Aaa railroad bond yields from 1920 to 1930, Moody's Aaa public utilities from 1931 to 1942. The chart shows averages for January, February, and March.

[18] The Treasury bond yields here plotted are determined from the Treasury bond yield curves on the basic charts. The value of the curve for 20-year maturities is the value used in Chart 2.

[19] The 6-month basic yields were determined graphically from the curves on the basic charts. They can also be interpolated between the values for 0 years and 1 year in Table 1.

The vertical bars on Chart 3 represent a very subjective appraisal of the errors to be allowed for in the short term estimates. The considerations entering into this appraisal can be roughly described. An error of .25 per cent, the absolute minimum, was accepted whenever several well clustered short term yields were available. When the short term yields were few or missing, and when they were greatly scattered, a larger estimate was taken, the amount depending on the number of yields and the scatter.

[20] For 1900-36, figures for commercial paper, time money, and call money are those given by Frederick R. Macaulay (*op. cit.*) Table 10, pp. A 141-61; for 1937-42, figures are from the *Federal Reserve Bulletin.* All figures are averages for January, February, and March. The six-month basic yields were determined graphically from the curves on the basic charts.

Basic Charts

Distribution of Bonds by Yield and Term to Maturity, and Estimated Basic Yield Curves, 1900-1942

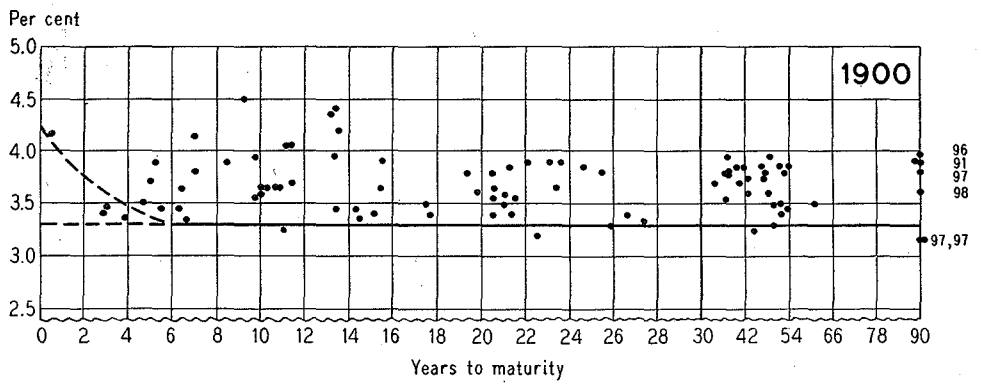
THE BASIC CHARTS present the distribution of corporate bonds by yield and term to maturity for the first quarter of each year, 1900-42. The estimated basic yield curve is represented on each of the 43 charts by a heavy smooth curve, often a straight line. A broken line indicates that the basic yield curve is considered highly uncertain. In 1900, 1906, 1907, 1908, and 1932, for example, the yield for the shorter term bonds is represented by two curves, both broken lines. Likewise, the curve for long term bonds for 1935 to 1942 is broken to indicate uncertainty.

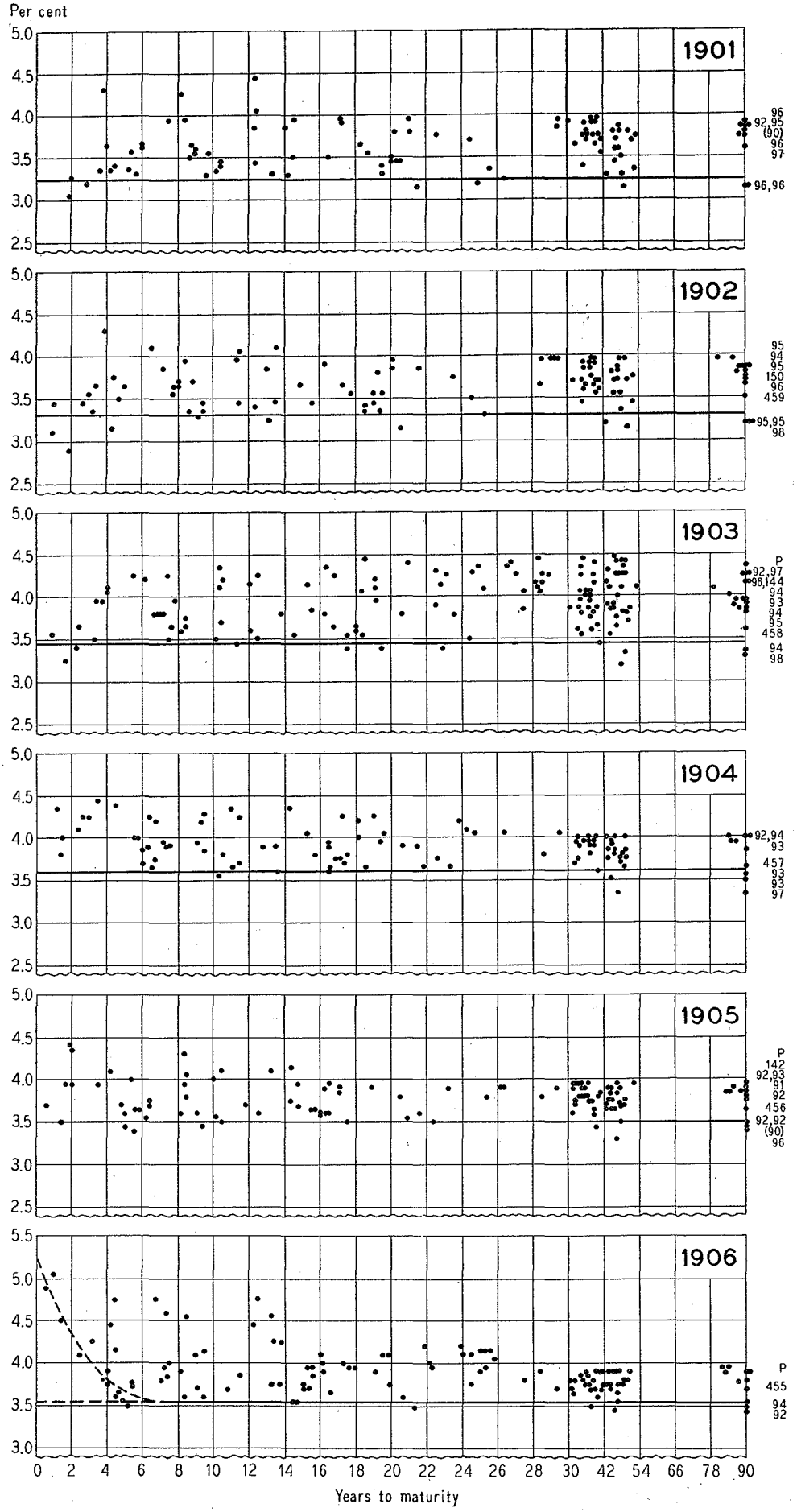
All bonds are represented by a solid dot (•) prior to 1909 and for 1941 and 1942.* In other years, a dot is used only for triple A bonds, and a cross (x) is used for double A, A, and a few unrated bonds. In the charts for 1934 to 1940 a circle (o) is used for bonds selling above call price, which were excluded from all preceding charts.

The horizontal scale on the charts, representing term to maturity, covers all values from 0 to 90 years. Bonds of more than 90 years are plotted at the 90-year point, but their true maturities are indicated in the right-hand margin by a figure, or by the letter P in case of a perpetuity. There is a change of scale at the 30-year point. The first section of the chart, representing maturities from 0 to 30 years, covers three times as much space as the second section, representing maturities from 30 to 90 years. As a result, some of the basic curves have a cusp at the 30-year point.

In several years the charts have additional curves showing the relation between yield and term to maturity for United States government securities and for certain high grade railroad equipment trust certificates.

* See note 4. The task of determining call provisions for 1941 and 1942 and a special set of average ratings comparable to the Bond Project ratings seemed unwarranted.




Per cent
1901
96
92,95
(90)
96
97
96,96
1902
95
94
95
150
96
459
95,95
98
1903
P
92,97
96,144
94
93
94
95
458
94
98
1904
92,94
93
457
93
93
97
1905
P
142
92,93
91
92
456
92,92
(90)
96
1906
P
455
94
92
5.0
4.5
4.0
3.5
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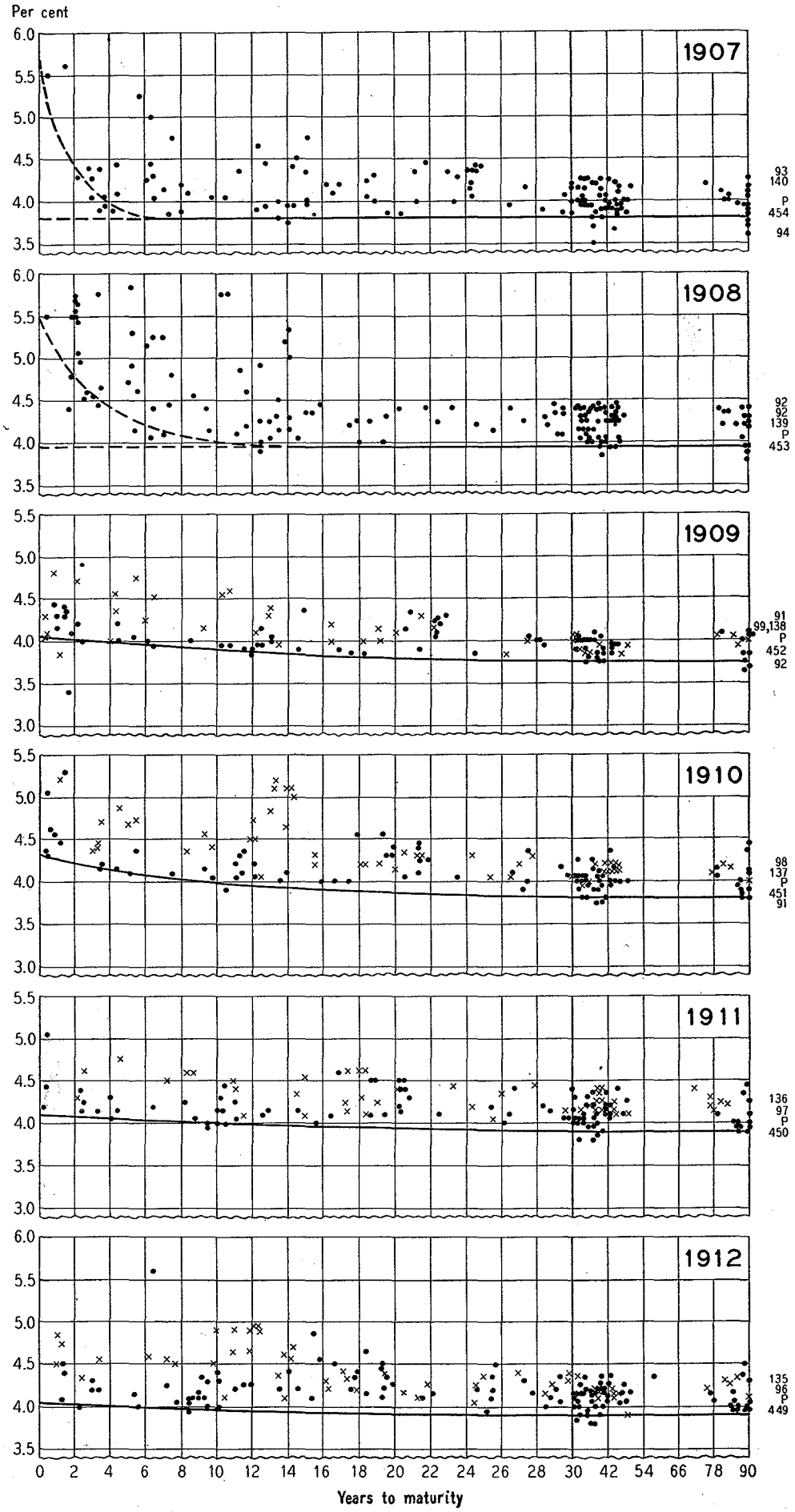
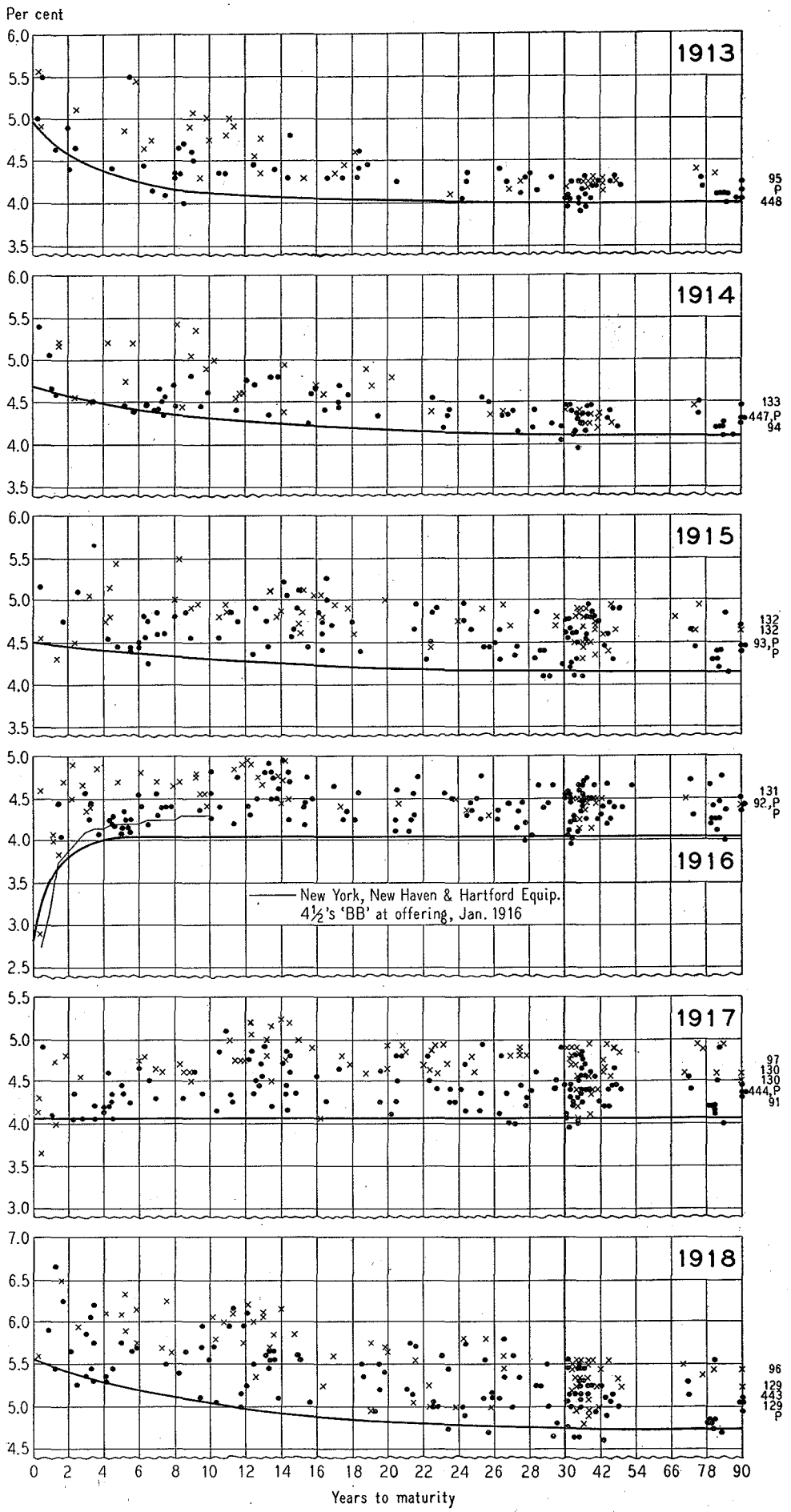
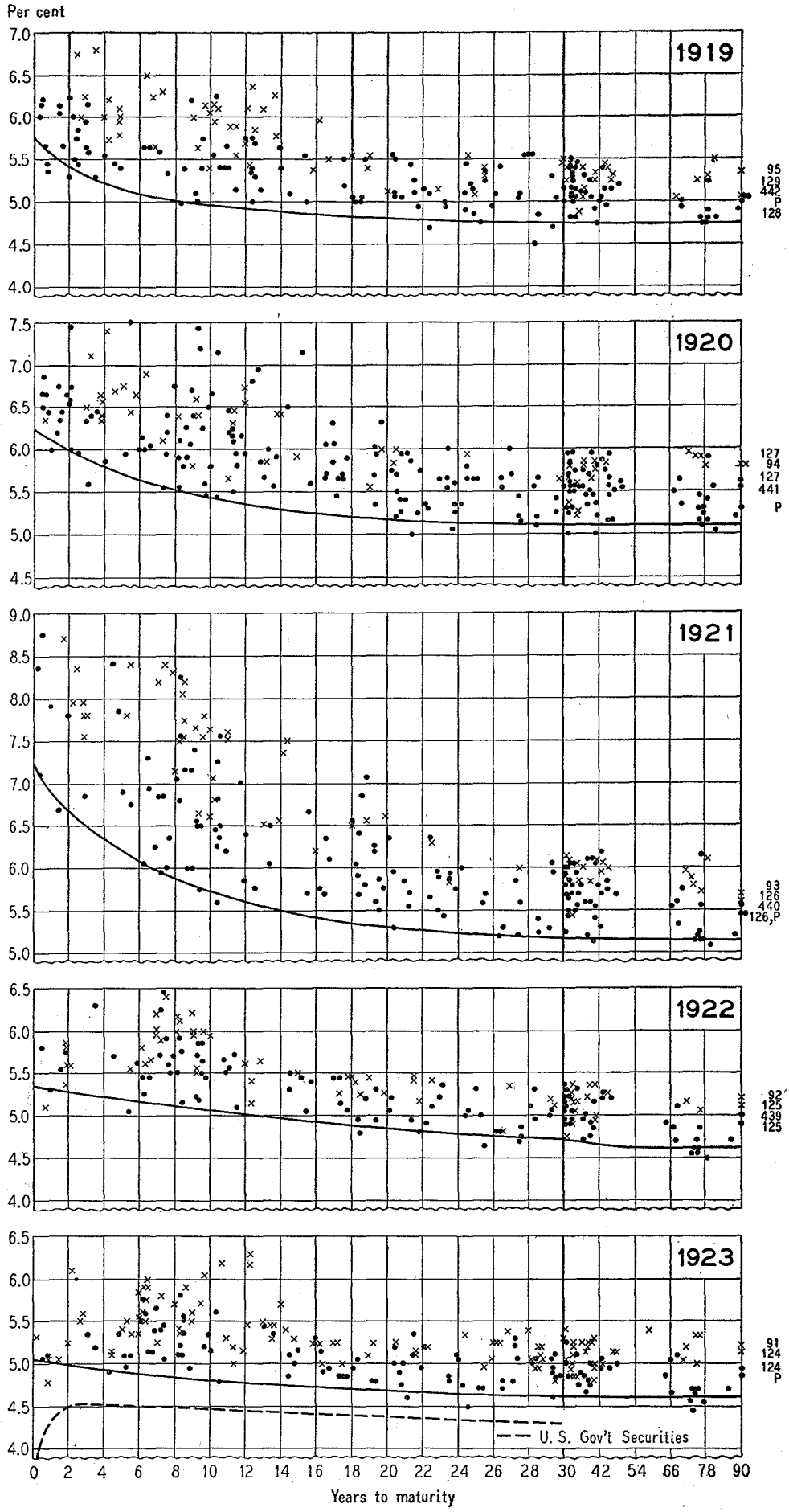
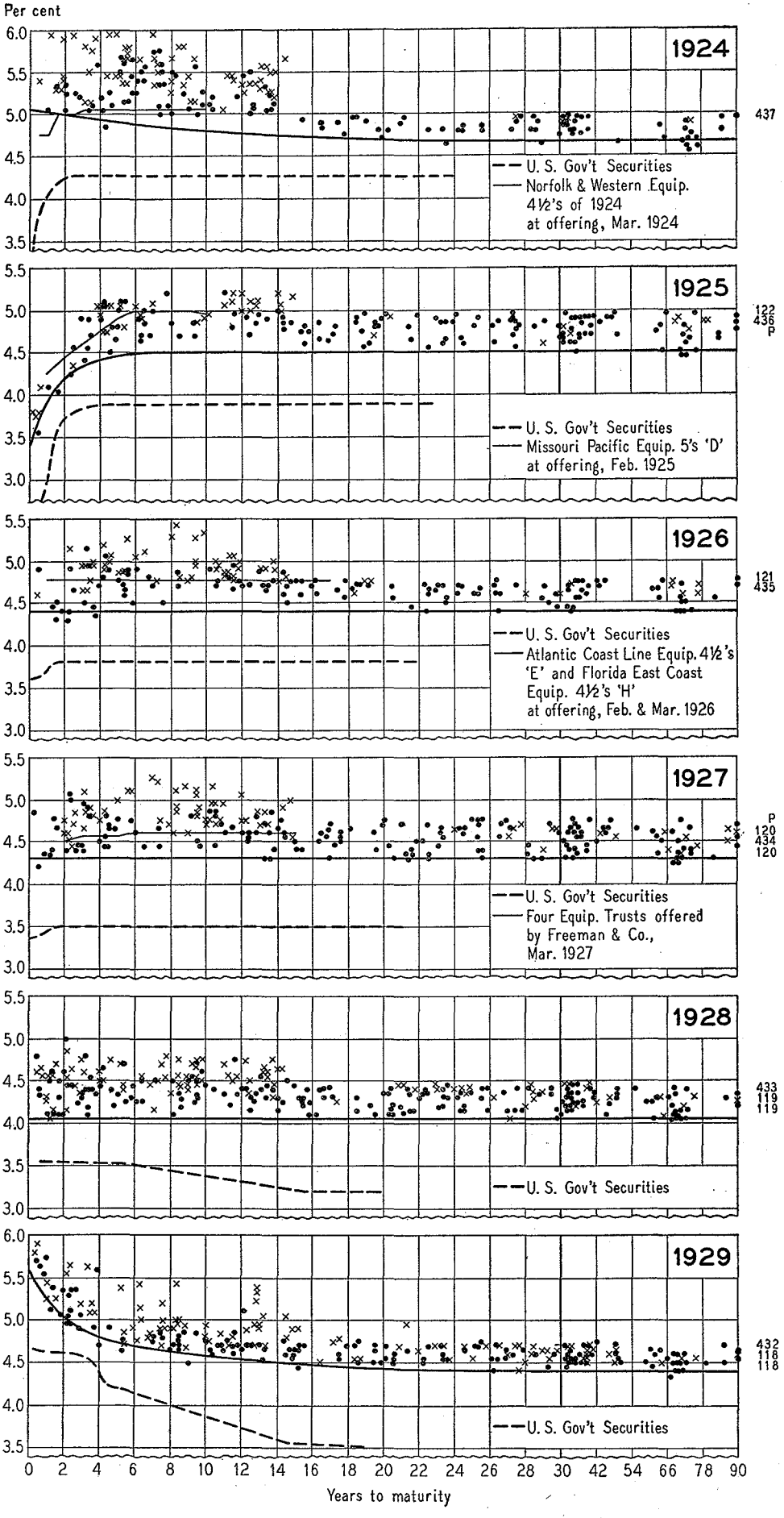
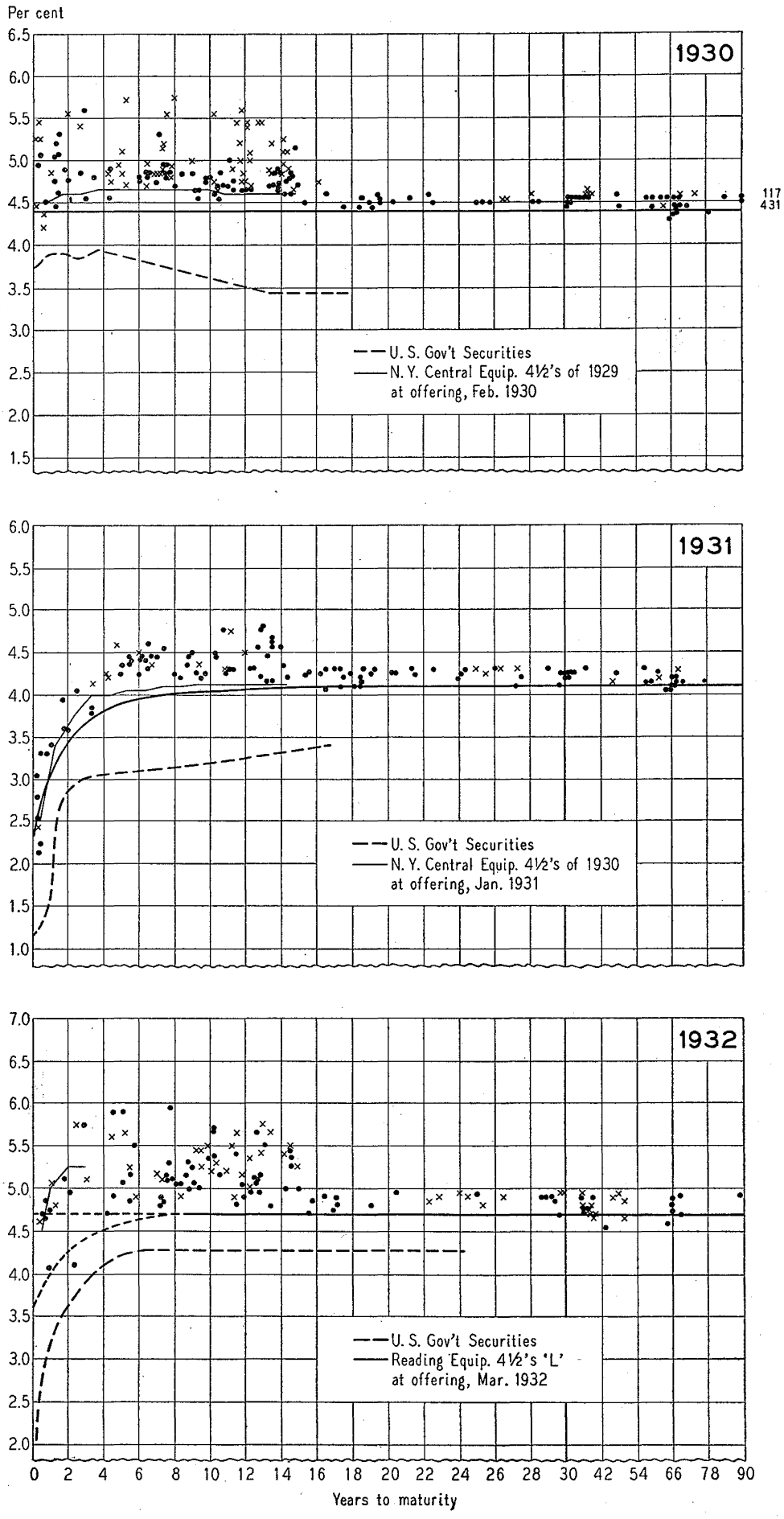
2.5
5.5
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 42 54 66 78 90
Years to maturity

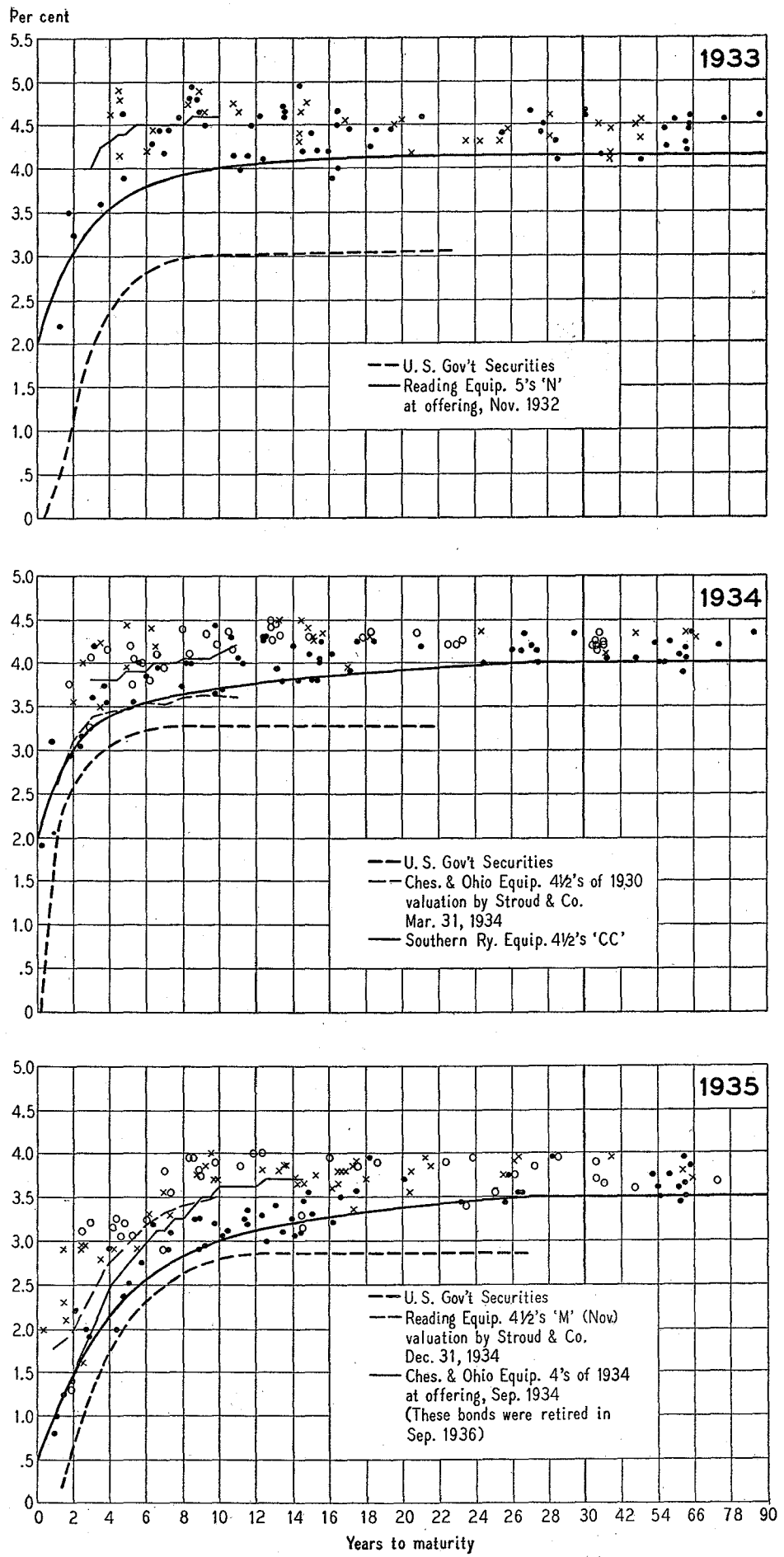

Per cent
1907
1908
1909
1910
1911
1912
Years to maturity
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 42 54 66 78 90
93 140 P 454 94
92 92 139 P 453
91 99,138 P 452 92
98 137 P 451 91
136 97 P 450
135 96 P 449

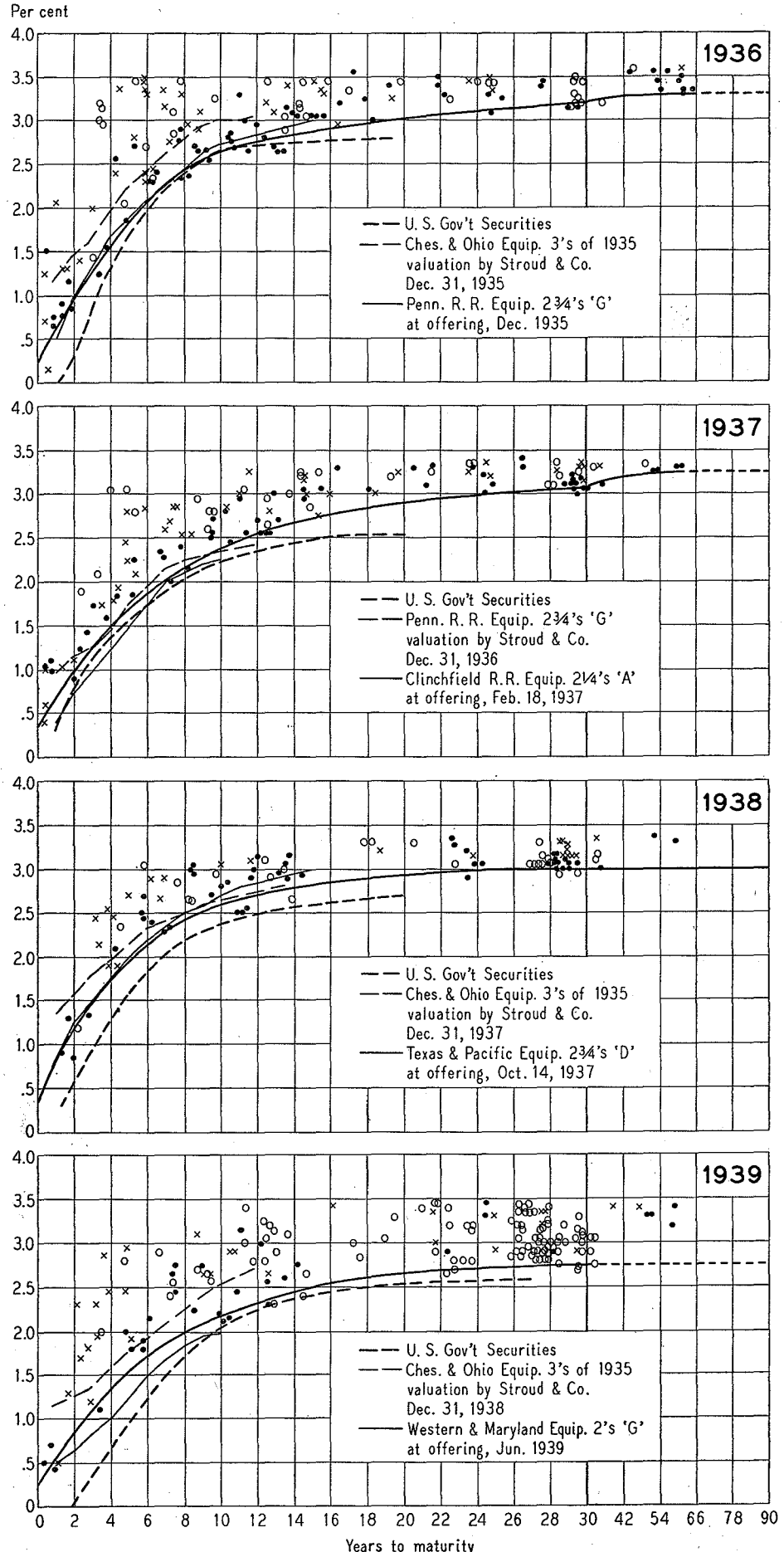

Per cent
1913
95
P
448
1914
133
447,P
94
1915
132
132
93,P
P
1916
131
92,P
P
New York, New Haven & Hartford Equip.
4½'s 'BB' at offering, Jan. 1916
1917
97
130
130
444,P
91
1918
96
129
443
129
P
Years to maturity

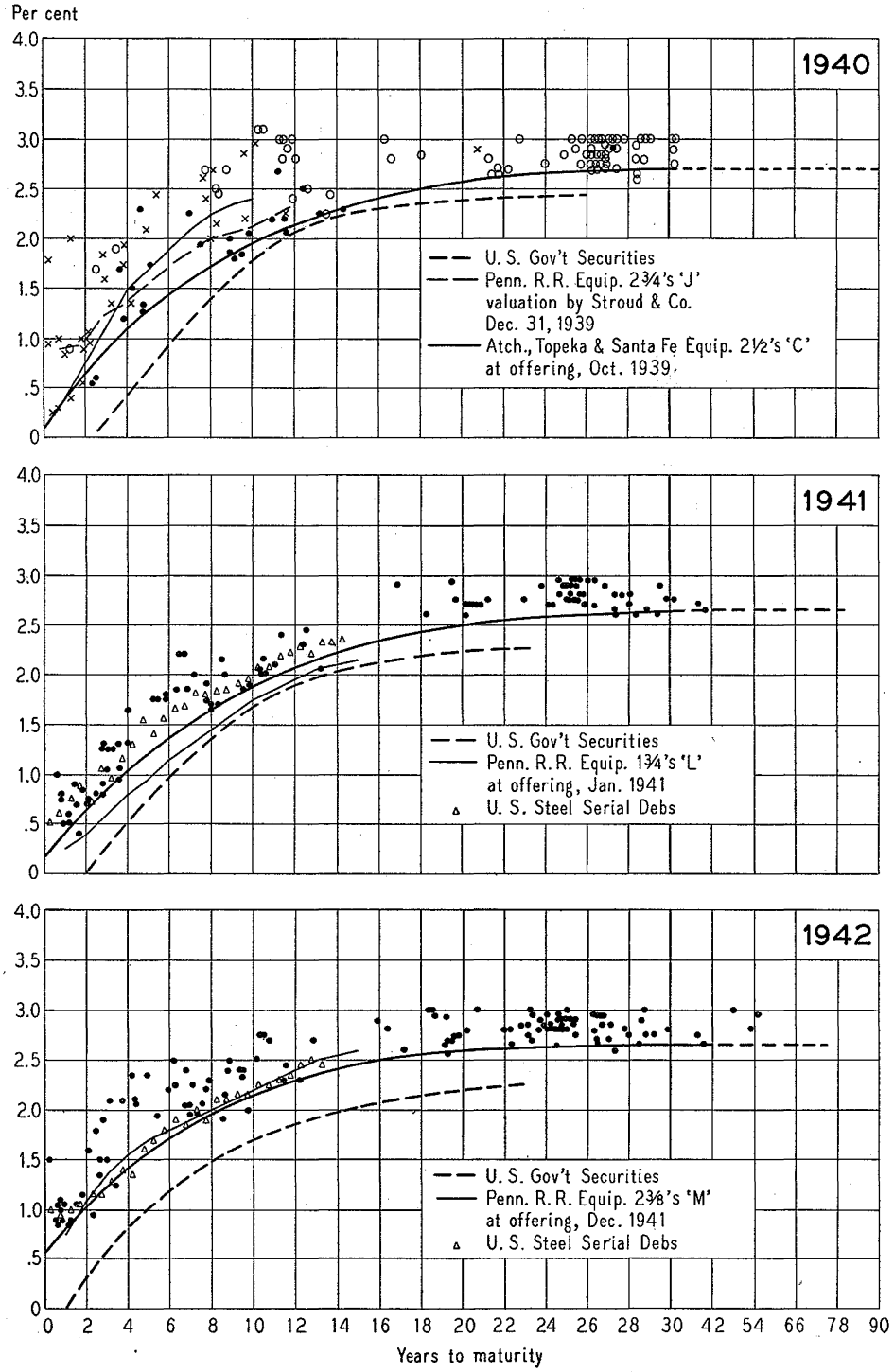

Per cent
1919
95
129
442
P
128
1920
127
94
127
441
P
1921
93
126
440
126,P
1922
92
125
439
125
1923
91
124
124
P
U. S. Gov't Securities
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 42 54 66 78 90
Years to maturity


Per cent
1924
437
U. S. Gov't Securities
Norfolk & Western Equip. 4½'s of 1924 at offering, Mar. 1924
1925
122
436
P
U. S. Gov't Securities
Missouri Pacific Equip. 5's 'D' at offering, Feb. 1925
1926
121
435
U. S. Gov't Securities
Atlantic Coast Line Equip. 4½'s 'E' and Florida East Coast Equip. 4½'s 'H' at offering, Feb. & Mar. 1926
1927
P
120
434
120
U. S. Gov't Securities
Four Equip. Trusts offered by Freeman & Co., Mar. 1927
1928
433
119
119
U. S. Gov't Securities
1929
432
118
118
U. S. Gov't Securities
Years to maturity


Per cent
1930
117
431
U. S. Gov't Securities
N. Y. Central Equip. 4½'s of 1929 at offering, Feb. 1930
1931
U. S. Gov't Securities
N. Y. Central Equip. 4½'s of 1930 at offering, Jan. 1931
1932
U. S. Gov't Securities
Reading Equip. 4½'s 'L' at offering, Mar. 1932
Years to maturity


Per cent
1933
U. S. Gov't Securities
Reading Equip. 5's 'N'
at offering, Nov. 1932
1934
U. S. Gov't Securities
Ches. & Ohio Equip. 4½'s of 1930
valuation by Stroud & Co.
Mar. 31, 1934
Southern Ry. Equip. 4½'s 'CC'
1935
U. S. Gov't Securities
Reading Equip. 4½'s 'M' (Nov.)
valuation by Stroud & Co.
Dec. 31, 1934
Ches. & Ohio Equip. 4's of 1934
at offering, Sep. 1934
(These bonds were retired in
Sep. 1936)
Years to maturity


Per cent
4.0
3.5
3.0
2.5
2.0
1.5
1.0
.5
0
1936
U. S. Gov't Securities
Ches. & Ohio Equip. 3's of 1935 valuation by Stroud & Co. Dec. 31, 1935
Penn. R. R. Equip. 2¾'s 'G' at offering, Dec. 1935
1937
U. S. Gov't Securities
Penn. R. R. Equip. 2¾'s 'G' valuation by Stroud & Co. Dec. 31, 1936
Clinchfield R.R. Equip. 2¼'s 'A' at offering, Feb. 18, 1937
1938
U. S. Gov't Securities
Ches. & Ohio Equip. 3's of 1935 valuation by Stroud & Co. Dec. 31, 1937
Texas & Pacific Equip. 2¾'s 'D' at offering, Oct. 14, 1937
1939
U. S. Gov't Securities
Ches. & Ohio Equip. 3's of 1935 valuation by Stroud & Co. Dec. 31, 1938
Western & Maryland Equip. 2's 'G' at offering, Jun. 1939
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 42 54 66 78 90
Years to maturity


Per cent
4.0
3.5
3.0
2.5
2.0
1.5
1.0
.5
0
1940
U. S. Gov't Securities
Penn. R.R. Equip. 2¾'s 'J' valuation by Stroud & Co. Dec. 31, 1939
Atch., Topeka & Santa Fe Equip. 2½'s 'C' at offering, Oct. 1939
1941
U. S. Gov't Securities
Penn. R.R. Equip. 1¾'s 'L' at offering, Jan. 1941
U. S. Steel Serial Debs
1942
U. S. Gov't Securities
Penn. R.R. Equip. 2⅜'s 'M' at offering, Dec. 1941
U. S. Steel Serial Debs
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 42 54 66 78 90
Years to maturity