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A 99-Year Prospective Test of an Interest-Rate Theory

by Daniel F. Case

Editor's Note: *This article describes a theory of long-term interest-rate trends that was propounded in 1899 by an actuary, Charlton T. Lewis. The article then presents a preliminary examination of how well that theory stands up in the light of 20th-century experience. The purpose is to invite more thorough evaluation by any experts who find the theory possibly useful.*

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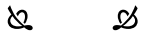
If one wishes to develop, interpret, or evaluate a 100-year term structure of interest rates, one needs a notion of how interest rates may behave over the next 100 years or so. In forming such a notion one may take a look at the ability of some theories, including perhaps some mathematical models, to explain interest-rate trends that have occurred in the past.

In addition to seeing how well a theory explains the past, it is helpful to see how well it has predicted the future. We cannot observe a l00-year future, of course, in the case of theories that were propounded only recently. In the case of a theory that was published 100 years ago, however, we can observe its predictive success over a period of 100 years.

This article will discuss a theory that was published in 1899. The approach of this paper will, accordingly, differ from that of a typical research paper. Rather than develop a theory on the basis of observed facts, this paper will briefly describe the previously developed theory and then discuss how well it appears to have stood up since it was published. For a better understanding of the theory than can be gained from this paper, readers can consult the 1899 paper.

The paper in question is "The Normal Rate of Interest" by Charlton T. Lewis, a member of the Actuarial Society of America [1]. That paper, besides presenting a theory, gave both a medium-term and a long-term prediction of interest-rate trends. The medium-term prediction was evaluated thus at a 1919 meeting of the American Institute of Actuaries:

You will perhaps recall that just about 20 years ago, one of the large life insurance companies published letters from distinguished financiers on the future course of the interest rate. Those letters were almost unanimous, if I read the matter correctly, in predicting further decline in the interest rate, as it had been declining for some 30 years. The one man who stood out against that view was Mr. Charlton T. Lewis, in his very scholarly paper. Anyone interested in this subject should certainly read and re-read that paper. You know the facts are that Mr. Lewis was right [2].

Lewis elaborated on (or clarified) his theory a bit in a second paper, published in 1904 [3]. In addition to the two papers, the discussions of them, and the above-cited 1919 comments, extensive comments on Lewis' work were made at a 1920 meeting of the Actuarial Society [4]. There is a further brief reference dating from 1934 [5].

Materials and Methods

The materials for this study are the two Lewis papers cited above (which will be briefly summarized here) and some interest-rate and other data from years following their publication. The method will be first to compare Lewis' interest-rate predictions with rates and trends subsequently experienced. Then a preliminary test of the central assertion of Lewis' theory will be presented.

LEWIS' THEORY

Lewis' 1899 paper sets forth his theory and contains his predictions. The theory pertains to long-terms trends and may be summed up by the following two sentences: "On the contrary, all experience proves that the demand for capital finds its supreme stimulus in the expectation of productiveness. This expectation is excited chiefly by discovery and invention." [6]

In the foregoing excerpt, "On the contrary" refers to assertions by many economists (six of whom Lewis named) that increased wealth and economic progress of themselves lower interest rates. Lewis found no evidence, in the historical trends outlined in his paper, that increases in wealth (bringing increases in the supply of capital) are not accompanied by corresponding increases in the demand for capital.

Lewis also challenged, with respect to long-term trends, the theory that "abundance of money in itself makes interest low." [7] To refute that theory he offered an example of a marked, sustained rise in interest rates following dramatic discoveries of gold in California and Australia.

Lewis analyzed interest-rate trends in terms of forces of two types (not sharply distinguishable from each other): "wave" forces, "which act within definite and often narrow limits of space or time," and "tidal" forces, "which act for long periods and upon the markets of the world." [8] Among "wave" forces, he mentioned government manipulations of the supply and value of money and "substitutes for money," wars and rumors of wars, changes in government spending, seasonal demands for money or credit, and the like.

In order to identify the "tidal" forces, Lewis examined long-term interest-rate trends during the 19th century in the light of economic developments. He found that long periods of rising interest rates were associated with periods of discovery and invention, while long periods of falling interest rates were associated with relative stagnation. He found such periods, each 20 to 30 years long, alternating during the century. He acknowledged that it might be impossible to explain completely what caused "the alternations of enterprise and stagnation in the world of industry and trade," but, clearly, considered it possible to detect evidence of the beginning of a new cycle.[9]

Lewis had in mind a "normal" level about which interest rates oscillate under both wave and tidal forces.

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Following a discussion of capital transactions he wrote, "Since enterprise always stands ready to use capital productively, it is always willing to exchange for the capital available at the earlier date a larger capital of a later date, the addition being limited only by the expected increase of value."[10] Thus he related the normal rate of interest to the average rate of productiveness of capital during a time interval.

Some of Lewis' discussion of the average rate of productiveness seems questionable and was challenged by one or more discussants of his work. Lewis did not, however, use that aspect of his theory in arriving at his estimate of the normal rate of interest. Before turning to that estimate, however, let us look at two elaborations, or clarifications, of the theory that appear in Lewis' 1904 paper.

First, Lewis distinguished capital from property. "Property consists of individual things, each of which can be seen and handled, used and enjoyed; each with its own distinct features of utility. ... Capital consists of dollars or other ideal units of an infinite mass, every one of which is absolutely identical with every other."[11]

Second, Lewis emphasized that the expectation of productiveness of capital "rests upon the nature of man in a progressive society, and not upon the nature of property. Were the spirit of enterprise destroyed and the speculative hazards of fortune ended, the demand for capital in industry would be limited to the amounts needed under old and tried methods of production."[12] Further:

> "Economists have long perceived that periods of invention, discovery and enterprise are those in which the demand for capital is effective and interest high. But the connection between the spirit of enterprise and the increased demand has always been sought in the slow process of absorbing capital in new enterprises, converting the floating supply into fixed forms, and reducing the available stock in the markets. In reality the connection is far closer and the effect upon the rate of interest is much quicker, than this process can explain.

> "The reason is that the demand is determined, not by the experience of past productiveness, but by the hope of future profit."[13]

LEWIS' PREDICTIONS

Lewis used a two-step procedure in developing the medium-term prediction that won praise 20 years later. First, he provided evidence that interest rates were beginning to head upwards from a presumed low point. He then wrote:

> "The forces which have turned the great tidal movement are obvious, and are as wide as the civilized world. Invention and enterprise have taken new life everywhere. ... The rapid development of steam navigation, of railway improvement, of ship canals, of electrical art in a thousand forms, the increase of buildings, furnaces, mills, machinery, the opening of new colonies, in short, the conversion of floating into fixed capital, goes on at an accelerating pace. ... Whenever hitherto such an epoch of invention and enterprise has checked a long-continued accumulation of idle capital and turned the great tidal wave of interest from ebb to flow, the process has been progressive for many years, and has continued to gain force and rapidity long after it had first become conspicuous.

> ... If the world's peace is maintained, there is not in prospect any check to the gradual rise of interest, at least until the average rate shall fully reflect the average yield of productive capital."[14]

Lewis then addressed the question of what that average yield—the normal interest rate—is. He wrote: "The question what that average yield is demands the actuary's methods applied to the data of the economist. My object is to stimulate inquiry, not to dogmatize on its results."[15] What follows in Lewis' paper was, then, perhaps acknowledged by him to be only an expedient.

Lewis wrote: "There could be no better measure of the true normal yield of invested capital than the average percent-

age of interest realized by life insurance companies upon their invested assets."[16] He observed that a little more than 20 years previously that rate had been a full 6% and that it now appeared to have bottomed out at slightly below 5%. He pointed out, in a footnote, that the published rates included realized capital gains and losses, which caused an overstatement of the overall yield when interest yields were falling and an understatement when they were rising. He also, of course, pointed out that the published rates were portfolio, not new-money, yields. He wrote:

> "These considerations must be taken into account, and the effect of each estimated in detail to reach the true average rate of interest. Such an examination would probably prove that the true rate in 1897 was considerably below the apparent rate of 4.92%, and possibly somewhat below 4.5%, but that the average rate for the whole period of declining interest from 1872 to 1897 was above 5.4%.

> "It seems reasonable to believe that this last-named average, taken through a period of declining rates, fairly represents the permanent average income from safe investments." [17]

We may regard 5.4% as Lewis' estimate of the normal interest rate by his selected measure. We may regard his medium-term prediction as being that; in the absence of war, the rate realized by life insurers on their invested assets would rise to at least 5.4%.

Lewis acknowledged that further examination was needed; he regarded his conclusions as a "working hypothesis."[18]

METHOD OF COMPARING PREDICTED WITH ACTUAL

Lewis' medium-term interest-rate prediction will be compared with various published rates of interest relating to the

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period 1899–1921. His estimate of the "permanent average income from safe investments" will be compared with a 99-year average taken from insurers' portfolio yields during the period 1899–1919 and Moody's Aaa corporate bond yields during the period 1920–97. Lewis' underlying theory—that the primary "tidal" force is the expectation of productiveness—will be tested by comparing year-by-year new-money yields with the yearly percent changes in the numbers of U.S. patents and trademarks issued and in the gross domestic product, measured in constant dollars.

Discussion

A good test of Lewis' estimate of the "average yield of productive capital" might be a comparison of 5.4% with life insurers' average new-money investment yields during the twentieth century. As an approximation, portfolio yields might be used instead. Of course, it might be difficult or impossible to ascertain precisely how such published numbers were derived at each time during the century. Also, as the mix of investments in insurers' portfolios changed over time, a history of their overall yields might lose meaning as an indicator of interest-rate trends. The corporate-bond yields used in this article have the advantages of being new-money rates and being, presumably, consistent from year to year.

As for Lewis' theory, one may ask to what extent Lewis' 1899 predictions represent an application of his theory as such. His paper, presented in October 1899, was evidently written that year. By that time, according to the paper, new-money interest rates had already started to rise, and economic expansion was already well underway. Presumably, the then current period of discovery and invention had been going on for some time. One might say, therefore, that Lewis' paper in effect states that there was evidence that a period of discovery and invention had begun at some recent time and that his theory predicted that the period would continue for a good while longer and carry with it a continuing rise in interest rates. When that period began, how its beginning might have been detected, and how to determine whether it was still in progress are not stated.

A good test of Lewis' underlying theory would analyze trends in the level of expectation of productiveness. As indicated previously, Lewis asserted that this expectation is excited chiefly by discovery and invention. Certainly, the numbers of patents and trademarks issued each year, discussed later in this paper, are at best a crude measure of the level of discovery and invention. The present writer, however, is not knowledgeable in the matters that would have to be analyzed in order to get a better measure. The writer hopes that any experts who are interested in Lewis' theory will look for ways to test it more soundly and thoroughly.

The numbers on gross domestic product are included below as a possible indication of the productiveness that may have been expected some years before. Gross domestic rather than gross national product is used because it focuses on capital located in the U.S., rather than on capital owned by U.S. interests.

By 1920 it was being suggested that there is a strong connection between inflation and interest rates. In a discussion of Lewis' papers in 1920, R.W. Huntington remarked, "Mr. Lewis did not have in his mind any clear idea of inflation as a cause of increasing the interest rates."[19] Lewis' 1899 paper did mention inflation, as follows: "Each large issue of such currency causes violent fluctuations, first for a very short time in rates of interest on temporary loans, and then more lastingly in the nominal prices of goods…"[20] The issuing of currency was classed by Lewis as one type of wave force. Accordingly, Lewis treated inflation as a product of a wave force. He may or may not have regarded inflation as itself a force that acts upon interest rates. In any case, since he did not include inflation in his discussion of tidal forces, the following tests of his predictions and theory have not been designed to reflect inflation.

Results

LEWIS' INTEREST-RATE PREDICTIONS

The following was stated by Douglas H. Rose in the 1920 discussion mentioned above:

> "The Spectator Company is in the habit of publishing annually in its *Year Book* the rate of interest earned on mean invested funds of a limited number of life companies. Going back 40

years, the averages for five-year periods are as follows:

1880–1884	5.50%
1885–1889	5.37%
1890–1894	5.15%
1895–1899	4.88%
1900–1904	4.66%
1905–1909	4.77%
1910–1914	4.80%
1915–1919	4.87% [21]

Yields on Moody's Aaa-rated corporate bonds for the period 1919 (the earliest year for which such a figure was found) through 1997 are shown in Table A.

We can calculate a 99-year average interest rate from the data shown above and in Table A by using for 1899 the Spectator Company's number for 1895–1899, using the 1900–1919 Spectator numbers as if they were new-money rates for those years, and using the Moody yields for the years 1920–97. The justification for using portfolio rates for 1899-1919 is that new-money rates began that period somewhat below the portfolio level and ended the period somewhat above it.

The resulting 99-year average is 5.65%, a rate slightly above Lewis' estimated normal interest rate of 5.4%. It must be noted again, of course, that the Moody yields do not represent the measure that Lewis had in mind. Also, interest rates were considerably higher in 1997 than in 1895–99. If interest rates do not decline significantly during the 10 years following 1997, an average over the years 1909–2007 will be higher than the above 5.65% average for 1899–1997.

The Moody's Aaa yield for 1919, as shown in Table A, is 5.49%, while the insurers' portfolio yield for the years 1915–19, shown above, is 4.87%. In order to guess what the insurers' new-money yield was in 1919, we may note that the yield on municipal high-grade bonds rose quite steadily from 3.12% in 1900 (the earliest year for which such a figure was found) to

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4.50% in 1918, dropping to 4.46% in 1919 and rising again to 4.98% in 1920.[22] One may guess that a portfolio of high-grade municipals would have earned somewhat under 4% in 1919— that is, a bit more than 50 basis points less than the 1919 new-money rate on those bonds. One may, correspondingly, guess that the insurers' overall new-money rate in 1919 was a bit more than 50 basis points above their overall portfolio rate—hence in the neighbor-hood of the Moody's Aaa rate of 5.49% for that year. Accordingly, the Moody's Aaa yields may be a reasonable proxy for insurers' overall new-money yields of that time.

We cannot, of course, guess from the data presented here what differences there were between Moody's Aaa yields and the insurers' overall yields in years subsequent to 1919. To the present writer, however, the closeness of Lewis' 5.4% estimate to the 5.65% 99-year average calculated here is remarkable.

Lewis estimated the normal rate of interest, but did not attempt to estimate a likely range of fluctuation. He wrote, "All fluctuations are governed by the familiar law of marginal utility; so that, as soon as an actual deficiency of capital is revealed, extreme needs begin to assert themselves in violent competition, and the rate may rise indefinitely."[23]

As for Lewis' medium-term prediction, it called for insurers' new-money yields to rise to at least 5.4% during the tidal period then underway. Moody's Aaa yields topped 6.1% in 1920, but they dropped below 5.2% in 1922 and remained below that level for over three decades. We have the question of to what extent the high yields of 1919–1921 were the result of wave forces, such as war and inflation, and not the culmination of a tidal movement.

Not knowing the Moody's Aaa yields for years before 1919, we cannot judge from them the size of the wave. We may note, however, that the yields on high-grade municipals for the years 1916–1922 were 3.94%, 4.20%, 4.50%, 4.46%, 4.98%, 5.09%, and 4.23%, and the un-adjusted index of yields of American railroad bonds for the same years was 4.49%, 4.79%, 5.23%, 5.29%, 5.81%, 5.57%, and 4.85%.[24] From those numbers we may guess that wave forces increased

interest rates by more than a percentage point above what the tidal forces alone would have produced. It appears that Lewis' medium-term prediction was not genuinely fulfilled.

LEWIS' THEORY

Finally, how does Lewis' theory look in the light of 20th century experience to date? As a preliminary inquiry into that question, we can try to identify patterns in the accompanying Figure 1, which plots bond yields and the percent changes in three other measures: the number of U.S. patents issued each year for inventions (which constitute the overwhelming majority of total U.S. patents issued), the number of trademarks registered each year, and the gross domestic product (GDP) as measured in constant dollars (in "chained" dollars in recent years). Since the numbers of patents issued and trademarks registered have been highly volatile, the percent changes shown for them in Figure 1 are equal to 1/10 of the actual percent changes. The interest-rate numbers for years before 1919 are derived from the unadjusted index of yields of American railroad bonds by ratioing those numbers up so that the number for 1919 equals the Moody's corporate Aaa rate for that year. The rates of change for the GDP for years before 1920 are derived from published five-year groupings; the writer does not know how volatile from year to year those rates were in fact.

The sources for the numbers in Figure 1 are:

- U.S. patents issued for inventions and trademarks registered—for the years through 1970, U.S. Dept. of Commerce, Bureau of the Census, *Historical Statistics of the United States, Colonial Times to 1970, Bicentennial Edition, Part 2*, 1975, 957–9, Washington, D.C.; for later years, U.S. Dept. of Commerce, Bureau of the Census, *Statistical Abstract of the United States*, various years, Washington, D.C.

- Bond yields—the same sources as were used for Table A, with the first source listed there being used for years prior to 1919.

TABLE A
Corporate Aaa
(Moody's Seasoned Bond Yields
1919 to 1997
(Percent per Annum)

Year	Yield	Year	Yield
1919	5.49		
1920	6.12		
1921	5.97	1961	4.35
1922	5.10	1962	4.33
1923	5.12	1963	4.26
1924	5.00	1964	4.40
1925	4.88	1965	4.49
1926	4.73	1966	5.13
1927	4.57	1967	5.51
1928	4.55	1968	6.18
1929	4.73	1969	7.03
1930	4.55	1970	8.04
1931	4.58	1971	7.39
1932	5.01	1972	7.21
1933	4.49	1973	7.44
1934	4.00	1974	8.57
1935	3.60	1975	8.83
1936	3.24	1976	8.43
1937	3.26	1977	8.02
1938	3.19	1978	8.73
1939	3.01	1979	9.63
1940	2.84	1980	11.94
1941	2.77	1981	14.17
1942	2.83	1982	13.79
1943	2.73	1983	12.04
1944	2.72	1984	12.71
1945	2.62	1985	11.37
1946	2.53	1986	9.02
1947	2.61	1987	9.38
1948	2.82	1988	9.71
1949	2.66	1989	9.26
1950	2.62	1990	9.32
1951	2.86	1991	8.77
1952	2.96	1992	8.14
1953	3.20	1993	7.22
1954	2.90	1994	7.97
1955	3.06	1995	7.59
1956	3.36	1996	7.37
1957	3.89	1997	7.26
1958	3.79		
1959	4.38		
1960	4.41		

FIGURE 1—Bond Yields vs. Changes in Other Measures
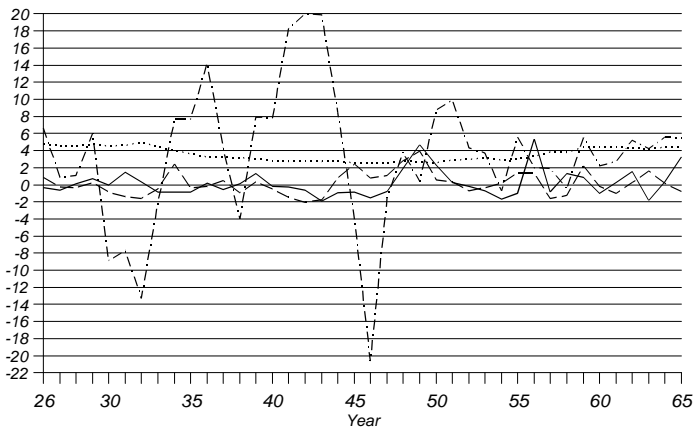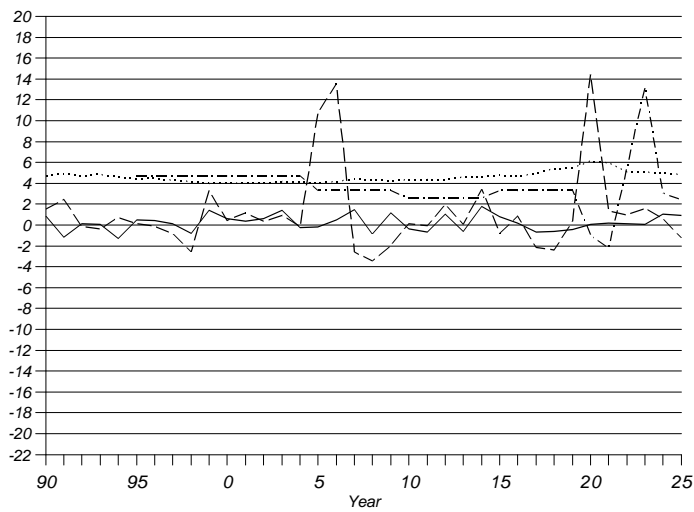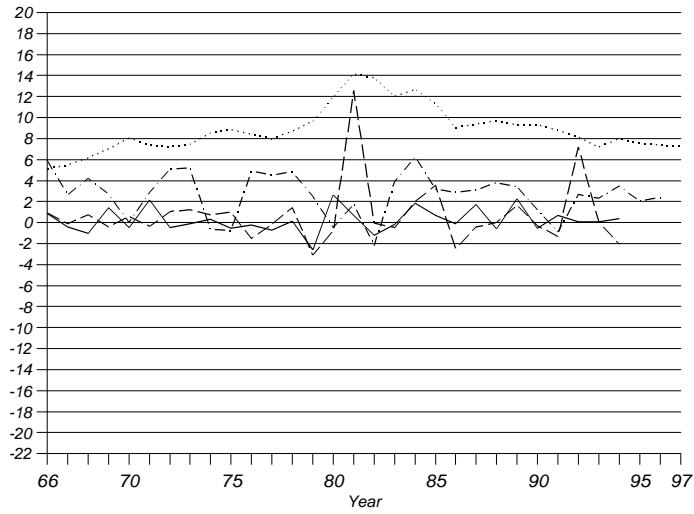
——— .1x Patents	– – – .1x Trademarks	
·········· Bond Yield	–·–·– GDP (Real)	

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- GDP—for years through 1928, *Historical Statistics of the United States, Colonial Times to 1970, Bicentennial Edition, Part 1*, 232; for the years 1929 through 1958, U.S. Dept. of Commerce, Bureau of Economic Analysis, *National Income and Product Accounts of the United States, Volume 1, 1929-58*, 1993, 3, and *Volume 2, 1959–88*, 1992, 4, Washington, D.C.; for subsequent years, *Statistical Abstract of the United States*, various years.

We may first observe the rising interest-rate trend heralded by Lewis, which lasted through 1920. We see that in 1899 the levels of patent and trademark approvals improved slightly, and if the upsurge of trademark approvals in 1905 and 1906 represented in part an effort to reduce a heavy backlog of applications, trademark activity must have been lively during the first few years of the century. A similar backlog of trademark applications may have developed during World War I. Overall, patent issues for inventions increased from 20,377 in 1898 to 43,892 in 1916, and trademark registrations increased from 1,238 in 1898 to 6,791 over the same period.[25] If patent and trademark approvals are a good indication of the level of discovery and invention and hence of expectations of productiveness, that pattern offers support for Lewis' theory.

On the other hand, real GDP was increasing at a lower rate during the last 15 years of Lewis' upward tidal period than its rate for many years preceding 1905. If that pattern reflects people's expectations of productiveness during the period of the interest-rate increase, it is evidence against Lewis' theory.

A downward interest-rate trend began in about 1922 and continued through 1946. We see that patent approvals for inventions were relatively flat from 1921 (37,798 issues) through 1941 (41,109 issues),[26] decreasing from 1942 through 1947, and then increasing fairly vigorously in 1948–50. Presumably, the war influenced the pattern from 1942–50. The long, rather flat period through 1941, however, seems to support Lewis' theory. As for trademark activity, registrations continued to increase through 1923 (14,834 registrations), were flat from then through 1930 (13,246 registrations), and then declined through 1941 (8,530

registrations). [27] That pattern seems to offer additional support.

Real GDP was highly volatile during most of the 1923–1951 period, and the present writer hazards no speculations about it.

An upward interest-rate trend began in 1951 and lasted until about 1982. Both patent issues for inventions and trademark registrations were on the upswing during that period. The patent issues increased from 43,040 in 1950 to 65,800 in 1981. Over the same period, trademark registrations increased from 16,817 to 42,700.[28] Those patterns seem to support Lewis' theory quite strongly.

There were reasonably healthy increases in GDP during most of the 1951–1982 period.

A downward interest-rate trend began in about 1983 and may or may not be still in progress as of 1998. The trend in patents has been from 65,800 in 1981 to 101,700 in 1994, and the trend in trademarks over the same period has been from 42,700 to 63,900.[29] Those patterns offer evidence against Lewis' theory.

Also with respect to real GDP, the trend from 1981 to 1996 looks not much different from the trend during the preceding period.

Conclusions

The present writer has not attempted a thorough investigation of whether Lewis' interest-rate theory holds up under 20th century conditions. Preliminary findings seem, however, somewhat encouraging. Interest rates (Moody's Aaa corporate bond yields) have continued to follow Lewis' observed pattern of "tidal" trends. The lengths of those trends (excluding the downward trend that began in 1982 or 1983 and may or may not still be continuing) have been within or close to Lewis' observed 19th century lengths of 20–30 years. As for Lewis' theory that the primary tidal force influencing interest rates is the expectation of productiveness, the evidence shown in this paper with regard to patent and trademark approvals seems to support the theory, in varying degrees, with regard to three of the four tidal interest-rate trends discussed here, but definitely not with regard to the trend that began in about 1983.

Lewis' estimate of the normal rate of interest seems, on the basis of 99 years of

subsequent experience, to have come quite close to the mark. His medium-term prediction regarding a tidal trend beginning in about 1898 seems to have been fulfilled with regard to its duration, but not genuinely with regard to the level it would reach.

The present writer hopes that Lewis' papers will kindle an interest in further investigations along the lines of his theory, with modifications and/or refinements as may appear appropriate in the light of 20th century experience and thought.

End Notes

1. Lewis, Charlton T., "The Normal Rate of Interest," Actuarial Society of America *Papers and Transactions,* 1899–1900, Volume VI, Nos. 21, 22, 23, and 24, pp. 158–171.

2. American Institute of Actuaries *Record,* 1919, Volume VIII, pp. 309–311.

3. Lewis, Charlton T., "Notes on a Factor, Hitherto Overlooked, of the Rate of Interest," Actuarial Society of America *Transactions,* 1904, Volume VIII, Nos. 31, 32, pp. 8–16.

4. "Abstract of Discussion of ('Some Influences Affecting the Interest Rate,' by Wendell M. Strong)," Actuarial Society of America *Transactions,* May 20 and 21, 1920, Vol. XXI, Part One, No. 63, pp. 437–451.

5. American Institute of Actuaries *Record,* 1934, Volume XXIII, p. 134.

6. Lewis, Charlton T., "The Normal Rate of Interest," op. cit., 165.

7. Ibid., 164.

8. Ibid., 161.

9. Ibid., 166.

10. Ibid., 160.

11. Lewis, Charlton T., "Notes on a Factor, Hitherto Overlooked, of the Rate of Interest," op. cit, 9.

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12. Ibid., 12.

13. Ibid., 15–16.

14. Lewis, Charlton T., "The Normal Rate of Interest," op. cit., 168.

15. Ibid., 169.

16. Ibid., 169.

17. Ibid., 170.

18. Ibid., 171.

19. "Abstract of Discussion of ... ('Some Influences Affecting the Interest Rate,' by Wendell M. Strong)," op. cit., 441.

20. Lewis, Charlton T., "The Normal Rate of Interest," op. cit., 161.

21. "Abstract of Discussion of ... ('Some Influences Affecting the Interest Rate,' by Wendell M. Strong)." op. cit., 440.

22. U.S. Dept. Of Commerce, Bureau of the Census, *Historical Statistics of the United States, Colonial Times to 1970, Bicentennial Edition, Part 2,* 1975, 1003, Washington, D.C.

23. Lewis, Charlton T., "The Normal Rate of Interest," op. cit., 161.

24. U.S. Dept. Of Commerce, Bureau of the Census, *Historical Statistics of the United States, Colonial Times to 1970, Bicentennial Edition, Part 2,* op. cit., 1003.

25. Sources cited for Figure 1.

26. Ibid.

27. Ibid.

28. Sources cited for Figure 1.

29. Ibid.

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Review of Financial Journals

Reviewed by Edwin A. Martin

Term Structure and Interest Rates

The low Treasury rates and widening spreads that we've experienced lately have many of us thinking about the yield curve. We reviewed several articles related to interest rates and the yield curve.

- **"Recovery and Implied Default in Brady Bonds" by Karan Bhanot,** *Journal of Fixed Income,* **June 1998**

  The author demonstrates that implied default probabilities in Brady bonds are significantly higher than a zero-recovery model would suggest. The analysis has an impact on the valuation of spreads on foreign debt and duration calculations. The numerical example on Argentine bonds supports the author's conclusion.

- **"Term Premium Estimates from Zero-Coupon Bonds: New Evidence on the Expectations Hypothesis" by Upinder S. Dhillon and Dennis J. Lasser,** *Journal of Fixed Income***, June 1998**

  This article is very interesting because of its inconsistency with prior research. The authors use zero-coupon Treasuries to provide strong evidence for liquidity premiums in the term structure and show that the liquidity premiums increase with ma-

turity. In additional, they find that current forward rates can be used to forecast quarterly interest rates.

- **"Rewards to Extending Maturity" by Dale L. Domian, Terry S. Maness, and William Reichenstein,** *Journal of Portfolio Management,* **Spring 1998**

  This article discusses the risks and benefits of extending the maturity of fixed-income investments to increase yield as well as support for different term-structure theories and might be of use to actuaries developing interest rate crediting strategies.

- **"An Approach to Scenario Hedging" by Charles F. Hill and Simon Vaysman,** *Journal of Portfolio Management,* **Winter 1998**

  This article discusses a method of optimizing a bond portfolio versus fixed-rate liabilities using only a handful of scenarios selected using principal components analysis. Factors are developed based on three yield curve shape changes (shift, twist, and butterfly) and permutations of those basic shape changes. They are used to optimize the portfolio with better results than duration matching or key-rate matching.

- **"What Really Happened to U.S. Bond Yields" by Peter Best,**

Alistair Byrne, and Antti Ilmanen, *Financial Analysts Journal,* **May/June 1998**

The authors study the fixed-income yields over the last 15 years as well as several explanatory factors: bond risk premium, expected inflation, and real short-term rates. The study finds that all three factors have contributed to the decline in interest rates over the study period.

Equity-Indexed Annuities

Two articles on option valuation may be of interest to those involved with equity-indexed annuities. The first is "A Frequency Distribution Method for Valuing Averaging Options," *ASTIN Bulletin*, November 1997. The author, Edwin H. Neave, finds pay-off frequency distributions to value American and European averaging options. The author uses a discrete time, recombining binomial asset price process. Both geometric and arithmetic averaging options are analyzed.

The second article is "A Closed-Form Approximation for Valuing Basket Options," *Journal of Derivatives,*