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IRVING FISHER AND FINANCIAL ECONOMICS: THE EQUITY PREMIUM PUZZLE, THE PREDICTABILITY OF STOCK PRICES, AND INTERTEMPORAL ALLOCATION UNDER RISK

BY
ROBERT W. DIMAND

Irving Fisher is renowned as the pundit who declared in October 1929 that stock prices appeared to have reached a permanently high plateau and who, having amassed a net worth of ten million dollars in the boom of the 1920s, proceeded to lose eleven million dollars of that fortune in the crash, which, as John Kenneth Galbraith (1977, p. 192) remarked, "was a substantial sum, even for an economics professor." Along with the Dow-Jones index, Fisher's reputation for understanding financial markets declined relative to that of Roger Babson, the stock forecaster, amateur economist, and founder of Babson College, who presciently predicted the stock market crash of autumn 1929 (and, with less prescience, the stock market crashes of 1926, 1927, and 1928, and the stock market recovery of 1930). An editorial in *The Commercial and Financial Chronicle* (November 9, 1929) declared of Fisher: "The learned professor is wrong as he usually is when he talks about the stock market" (quoted by Galbraith 1972, p. 151).

Fisher's reputation within the economics profession has recovered dramatically in recent decades for contributions ranging from the Fisher diagram for intertemporal allocation and consumption-smoothing to the Fisher equation relating real and nominal interest and to the Fisher ideal index number (Dimand and Geanakoplos 2005). But the general public remembers the permanently high plateau of stock prices (*The New York Times Magazine*, October 16, 2005, p. 52, warns that "Boom-time rationalists always run the risk of earning a black mark of infamy like that worn by the Yale professor Irving Fisher"). Despite his spectacular misprediction of 1929, and even though he went to the grave still believing in his "Formulary for Anticipating Short-Time Changes in Market Action" (see Sasuly 1947, p. 272),

Department of Economics, Brock University, St. Catharines, Ontario L2S 3A1, Canada. Presented to the History of Economics Society, Victoria University, University of Toronto, June 2004. I thank two anonymous referees for helpful comments.

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Fisher was by no means always wrong about asset markets and finance. Indeed, he deserves recognition as a pioneer of financial economics. He was also a supporter and promoter of important statistical studies of financial markets by others, such as Norton (1902) and, most notably, Cowles (1933), which contradicted Fisher on the predictability of stock prices, the crucial dividing line between Fisher and modern financial theory.

I. THE EQUITY PREMIUM: STOCKS VERSUS BONDS

"From time immemorial it has been assumed that bonds afford a safer and better investment than stocks," observed Fisher (1925a, p. 230). "In accordance with that idea the laws have been framed to limit trustees to investment in bonds or securities similar in nature." Fisher denied that bonds were a safer and better investment than a portfolio of "well-selected and diversified stocks," rejecting the supposed absence of risk in bonds as mere money illusion, and arguing that, over the long term, stocks had a higher real yield, to a degree out of proportion to differences in risk. A similar empirical finding is now known as the equity premium puzzle (Mehra and Prescott 1985), with the difference that Fisher focused more narrowly on money illusion, in the form of the failure of investors to recognize the inflation risk associated with holding bonds.

The real value of bonds and mortgages changed whenever the purchasing power of money changed, and the real value of "safe" eligible trustee securities (claims to fixed nominal amounts of money) in Germany, Austria, Hungary, Russia, and Poland had been wiped in the hyperinflations following World War I, when the German price level rose to one trillion times its prewar level. Fisher (1928, p. 62) reported "A famous professor at Berlin had made a small fortune from the sale of his books. He invested it in so-called 'safe' bonds with the expectation of living on the income. At the end of the inflation period he found that his whole fortune, the accumulation of a life-time of hard work, would not buy a postage stamp! Yet the bonds were not defaulted." An American workingman who deposited $100 in a savings bank in 1896 would, with a compound interest rate fixed in nominal terms at 4.5 per cent a year, have had $300 in 1920, but with a purchasing power of only eight 1896 dollars, a real loss of twenty 1896 dollars rather than an apparent gain of two hundred dollars (Fisher 1928, pp. 67–70). An asset's risk was not simply the variability of its nominal return. It is no wonder that the year following their study of *The Purchasing Power of Money* (Fisher with Brown 1911), Fisher and his collaborator and former student Harry Gunnison Brown joined with Edwin Kemmerer and others to produce *How to Invest When Prices Are Rising* (Fisher et al. 1912). Citing his own work (dating back to that 1912 volume) and recent statistical studies by Edgar L. Smith (1924)[1] and Kenneth Van Strum (1925), Fisher (1925a, 230) concluded that "during the falling prices following the Civil War stocks and bonds are about

[1]Keynes (1925), concluding an enthusiastic review of Smith (1924), hoped that "the investment department of one of our great insurance companies" would undertake a similar study of past returns on British shares and bonds, "a task well adapted to the training and mentality of actuaries, and not less important, I fancy, to the future of the insurance industry than the further improvement of life tables." Keynes was chairman of the National

equal as to yield, while during the rising prices since 1896 the real yield on stocks is about four times the real yield on bonds."

Fisher's view was widely rejected, even ridiculed, after 1929: Benjamin Graham (1973, pp. 1–3) cited a "leading authority," Lawrence Chamberlain's 1931 volume on *Investment and Speculation*, as insisting that only bonds could be bought for investment, and a Federal Reserve Board survey of public opinion in 1948 (when the Dow-Jones industrial average closed at 177, compared to its 1929 high of 381) as showing more than ninety percent opposed to buying common stocks, roughly half because stocks were "not safe, a gamble," and about half because they were not familiar with stocks. Despite the disfavor with which common stocks were regarded for at least twenty years after the 1929 crash (justifiably given their returns over those decades), financial theorists now accept Fisher's view that bonds are risky assets in real terms and that common stocks, whose prices can rise in inflationary periods, have a place in portfolios because their risk differs from that of bonds and because of the high real returns on stocks over the long term. Investors in the 1930s and 1940s might, however, have felt moved to recall Keynes's comment that in the long run we are all dead.

II. INTERTEMPORAL ALLOCATION UNDER RISK

Fisher's emphasis on the high real return to a *diversified* stock portfolio over the long term is also noteworthy. Peter Bernstein (1992, pp. 47–49) recounts how, before Harry Markowitz's 1952 dissertation on portfolio selection, such authorities as John Maynard Keynes and the best-selling Wall Street pundit Gerald Loeb opposed portfolio diversification, quoting Loeb as writing "Once you obtain confidence, diversification is undesirable. . . . Diversification [is] an admission of not knowing what to do." When, in 1919, the Chief Officer of the National Mutual Life Assurance Society explained to his new board member, Keynes, the conventional practice of distributing the society's assets among money at call, government bonds, loans and mortgages, debentures and reversions in fixed proportions, with no ordinary shares (except for one block of Prudential Assurance shares), "Maynard listened with amazement. 'Incredible!' he said. 'I would have thought that the right investment policy for the National Mutual would be to hold one security only and change it every week at the board meeting'" (Davenport 1975, p. 225).

The Dividend Discount Model of John Burr Williams's 1937 Harvard Ph.D. dissertation (published as Williams 1938) implied that a rational investor should buy only the security with the highest expected return. Bernstein (1992, p. 55) notes briefly that "Only a few scholars had even mentioned . . . in passing" the risk/return trade-off in portfolio selection before Markowitz: Irving Fisher, J. R. Hicks, and the Cowles Commission's Dickson Leavens (1945). Bernstein's bibliography does not include any works by Fisher or Hicks (see Hicks 1935 for his first contribution to portfolio theory, and see Chambers 1934 and Maes 1991 for a related contribution unmentioned

Mutual Life Assurance Society from 1921 to 1938, and pressed the actuary who was the Society's Chief Officer to invest some of the Society's funds in ordinary shares (Davenport 1975).

by Bernstein), and nothing is said about the nature of these contributions, except that they did not provide the full systematic treatment of Markowitz (1952). Crockett (1980) and independently (without mention of Crockett) Stabile and Putnam (2002) have rediscovered the means-variance analysis of risk and return in Fisher's *The Nature of Capital and Income* (1906), which went much further than a mere mention in passing. Fisher's contribution to risk analysis was once well known: Charles Hardy (1923, pp. 1, 393) quoted a five-sentence passage from Fisher (1906, pp. 265–66) on the first page of *Risk and Risk-Bearing*, and listed *The Nature of Capital and Income* first in his appendix "References for Further Reading."

Fisher wrote *The Nature of Capital and Income* as a companion to *The Rate of Interest* (1907), later amalgamating the two works into *The Theory of Interest* (1930). Fisher (1907, p. 409) presented the now-celebrated two-period "Fisher diagram" for the optimal timing of consumption, subject (given perfect credit markets) to the budget constraint that the present discounted value of the stream of consumption cannot exceed the present discounted value of the stream of expected income. This is the foundation of subsequent analysis of intertemporal allocation, such as the permanent income and life-cycle theories of consumption and saving, and the implied pattern of saving gives the supply of loanable funds (periods of dis-saving by consumers, together with Fisher's analysis of the rate of return over cost as the measure of investment opportunity, combine to give the demand for loanable funds). The Fisher diagram finds the optimum where a linear consumption possibility frontier is tangent to an indifference curve that is convex to the origin, implying consumption smoothing across time periods. If the axes represented states of the world instead of time periods, the convexity of the indifference curves to the origin would represent risk aversion and lead to smoothing of consumption across states of the world. *The Nature of Capital and Income* emphasized the present discounted value of expected income flows, treating the time pattern of income and spending (rather than a stock of capital or wealth) as fundamental, an emphasis embraced by accounting and property appraisal (Chambers 1971, Burton 1980). Fisher began by abstracting from risk:

> The rate of interest acts as a link between income-value and capital-value, and by means of this link it is possible to derive from any given income-value, its capital-value, i.e. to "capitalize" income. To do this we assume that the expected income is foreknown with certainty, and that the rate of interest (in the sense of an annual premium) is foreknown, and also that it is constant during successive years (1906, p. 202).

However, Fisher was very conscious that future income flows and rates of returns are expectations, not known with certainty:

> Up to this point we have ignored the element of chance, by assuming that the entire future income-stream, or at any rate, such portions of it as needed to influence present choice, are foreknown and mapped out in advance . . . This assumption, like the assumption that bodies fall *in vacuo*, in the ordinary presentation of the theory of gravitation, has enabled us to complete our formal statement of the theory more easily, although at the expenses of exact conformity to actual historical fact; for, in the concrete world, the most conspicuous characteristic of the future is its uncertainty (1907, p. 207).

He said, "If we take the history of the prices of stocks and bonds, we shall find it chiefly to consist of a record of changing estimates of futurity, due to what is called chance" (1906, p. 265). Fisher's analysis stressed three elements: expected return (the mean of the distribution of percentage dividend paid on a stock), risk, measured by the standard deviation of a subjective probability distribution over possible outcomes (Fisher 1906, pp. 406–408, appendix on "Variability about a Mean, as measured by the 'Standard Deviation'"), and an individual's attitude towards risk, measured by what Fisher term the coefficient of caution.

As Crockett (1980) and Stabile and Putnam (2002) both stress, Fisher emphasized the subjective, rather than frequentist, nature of an individual's probability distribution over future outcomes:

> Of course the actual statistical record may afford an important and sometimes the only basis for our degree of knowledge and ignorance. Practically it therefore often happens that we derive our estimate of chances from the behavior of events "in the long run.: . . . But while statistics supply data for the forming of subjective estimates of chance, they do not, themselves, constitute chances (1906, p. 268).

Fisher (1906, pp. 276–77) defined an individual's coefficient of caution as the ratio of the "commercial value" of an uncertain return (what the person is willing to pay for it) to the "mathematical value" of that uncertain return (the product of the income multiplied by the probability of receiving it).[2] Gamblers have coefficients of caution greater than one, but most people are risk averse, with coefficients of caution less than one. A gambler is:

> a person who will pay more than the mathematical value of the chance. At Monte Carlo, the "bank" makes its profit in this way, although its victims know full well that they are paying more than the mathematical value of their chances. The consequence, of course, is ruin to most of them. Fortunately, persons who deliberately gamble are in most communities in the minority. The ordinary man is unwilling to pay even the full mathematical value of the chance. He is reluctant to assume any risks, and is, on the contrary, willing to make sacrifices to rid himself of them (Fisher 1906, pp. 275–76).

Fisher (1906, pp. 277, 409) credited his younger colleague and former student John Pease Norton, in personal correspondence and Norton (1904), with the insight that individuals become less cautious with increasing capital (in modern terms, if Arrow-Pratt relative risk aversion is constant, the degree of absolute risk aversion decreases as wealth increases). An individual investor would use his or her "coefficient of caution" to determine the "commercial value" of a possible investment (multiplying the mathematical value by the coefficient of caution), and would buy the asset if its price was no more than this commercial value. Fisher (1906, pp. 282–83, 410) admitted that such application of probability theory outran the present exigencies of practice, but cited Norton (1902) as offering hope that "the time may come when practical brokers will make use of probability computations in the same way they now make use of bond tables." While by no means the first economist, or even the first American economist, to discuss risk (see Haynes 1895, Ross 1896, Willett 1902), Fisher (1906) was a pioneer in proposing a measure of risk aversion.

[2]Less fruitfully, Fisher (1906) also defined a "riskless value," which was meaningful only if there were only two possible outcomes, receipt either of a unique amount of money (the riskless value) or nothing.

Fisher (1930b, p. 206) argued that, through portfolio diversification, investment trusts "managed to get a higher average return from investments which individually would have proved quite risky, while at the same time they have extracted from them largely their elements of risk" (quoted by Stabile and Putnam 2002, p. 200, cf. Stabile 2005). Fisher had served as an adviser to investment trusts in the 1920s, and by 1930 he was (like Keynes as Chairman of the Independent Investment Trust, which invested in American investment trusts and utilities) painfully aware that even the diversified stock portfolios of investment trusts were vulnerable to shocks that affected the stock market as a whole (Galbraith 1972, p. 60, Davenport 1975, p. 227). Fisher did not formalize the reduction in the standard deviation of the average return on a portfolio that could be achieved through diversification, a result obtained empirically by Dickson Leavens (1945) and extended by Harry Markowitz to derivation of efficient portfolios, minimizing risk for a given expected return. Ironically, he could have done so by borrowing from his own treatise on *The Making of Index Numbers* (1922, pp. 336–40), where he had explored how the variation in a price index resulting from the fluctuation of individual prices, measured by the standard deviation, decreased as the number of prices in the index increased (Stabile and Putnam 2002, p. 199). Fisher concluded:

> Seldom, however, are index numbers of much value unless they consist of more than 20 commodities; and 50 (the number of *classes* used by the War Industries Board) is a much better number. After 50, the improvement obtained from increasing the number of commodities is gradual and it is doubtful if the gain from increasing the number beyond 200 is ordinarily worth the extra trouble and expense (1922, p. 340).

As the inclusion of additional commodities reduces the standard deviation of a price index, so the inclusion of additional assets in a portfolio reduces the standard deviation of the return on the portfolio. Portfolio choice, once viewed as selecting the fraction of wealth to invest in a particular asset, emerged as a natural extension of index number theory: the problem in each case was to choose the appropriate weights for an index.

III. INDEXED BONDS

Fisher also took the lead in creating a new financial instrument, the indexed bond, which followed naturally from his approach to monetary economics and index numbers. In *Appreciation and Interest* (1896), Fisher identified the expected rate of appreciation of one standard in terms of another (gold, silver, wheat, a bundle of goods) as the difference between interest rates expressed in the two standards. In *The Purchasing Power of Money* (Fisher with Brown 1911) and many later works, he advocated a "compensated dollar," stabilizing real economic activity by conducting monetary policy to stabilize a price index, rather than stabilizing the dollar price of a single commodity, gold. Money illusion, the public confusion of real and nominal magnitudes, would not matter if the purchasing power of money did not change. In *The Making of Index Numbers* (1922), Fisher proposed the geometric mean of the Paasche and Laspeyres indices as the ideal index for that and all other purposes. The next step was that Fisher's Index Visible, Inc., paid its employees wages tied

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to the weekly wholesale price index compiled by Fisher's Index Number Institute (located in Fisher's home at 460 Prospect Street, New Haven, Connecticut). Several companies and the American Association for Labor Legislation, of which Fisher was a former president, also adopted such index number wages (see Fisher 1925b for a list of such companies). Then, the merger of Index Visible with the Rand Kardex Companies (latter Remington Rand, later Sperry Rand, later Unisys) on July 1, 1925, led to the issue of $350,000 of thirty-year "stabilized bonds," paying seven percent per year "safeguarded as to purchasing power of both principal and interest," which were increased or decreased in proportion to the rise or fall of the index number, a new financial instrument planned by James H. Rand, Jr., President of Rand Kardex, and Fisher, as Chairman of the Board of Index Visible (Fisher 1925b). A further merger with the Library Bureau later the same year led to retirement of all the company's bonded debt, and, when the United States left the gold standard, such bonds in standards other than the dollar were prohibited, Fisher's "stabilized bond" of 1925 stands as a precursor of Britain's index-linked government bonds (issued since 1985), the US Treasury's TIPS (Treasury inflation-protected securities, introduced in 1997), and Canada's Real Return Bonds, with the distinction that these securities are all issued by governments rather than by private corporations.

IV. STUDYING STOCK AND MONEY MARKETS: NORTON TO COWLES

Fisher promoted the application of modern statistical methods to financial markets, starting with *Statistical Studies in the New York Money Market* (Norton 1902), the 1901 Yale Ph.D. dissertation of J. Pease Norton, citing Norton four times in *The Nature of Capital and Income* (1906), three times in *The Rate of Interest* (1907), twice in *The Purchasing Power of Money* (1911), and once in *The Theory of Interest* (1930). Ten years younger than Fisher, Norton did both his undergraduate and postgraduate studies at Yale, and then taught there as an instructor in political economy from 1901 to 1905 and then as assistant professor of political economy and railroads from 1905 to 1910, before becoming executive secretary (1910–11) of the Committee of One Hundred for Establishing the National Department of Health, an organization founded and led by Fisher (and of which Norton had been an executive committee member since 1906).[3] Norton paid close attention to Fisher's statistical studies of the velocity of circulation of money (Norton 1902, pp. 2, 6, 7, 11). Norton, an actuary, was the only Yale economist of the time whose technical sophistication was comparable to that of Fisher: Robert Loring Allen (1993, p. 70) was mistaken in listing Norton as an example of Yale colleagues who "did not really understand or sympathize much" with Fisher's research. Norton's handful of post-dissertation publications were on themes closely linked to Fisher: Norton (1906), writing in the

[3]Norton's subsequent career was sporadic: an expert on railway credit in western states in railway rate cases 1915–1918, a statistical expert for the oil division of the US Fuel Administration in 1918 and 1920. While teaching at Yale, he was also an actuary for Fisk and Robinson from 1904. The 1933 edition of *American Men of Science* lists him as retired, living in West Haven, Connecticut, and "conducting investigations at private labs" (perhaps the Karsten Statistical Laboratory or Fisher's Index Number Institute?).

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Yale Review (edited by Fisher), recommended a tabular standard to replace the gold standard, while Norton (1910) considered the best form of index number to measure the rise in the price level. Norton, identified as Vice-President of the American Association for the Advancement of Science, wrote a chapter advocating "Stocks as an Investment When Prices Are Rising" for *How to Invest When Prices Are Rising* (Fisher et al. 1912, pp. 77–104).

In contrast to the descriptive and historical approach to speculation on stock and produce markets taken by Yale faculty member Henry C. Emery's Columbia Ph.D. dissertation (1896) (and independently of Louis Bachelier's 1900 Paris dissertation on the theory of speculation as a theory of stochastic processes, translated in Cootner 1964), Norton (1902) tried to "reduce all this field of finance to an exact science" (1902, p. 86), and is now recognized as a landmark in the history of time-series analysis:

> one of the first to use serial differences in statistical analysis . . . attempts to subject data from the New York money market to the frequency distribution and correlation analysis that Karl Pearson had applied in biology. . . . Norton's use of first differences in the study of the seasonal variation of reserves, deposits and loans [and the Call Discount Rate on the New York Stock Exchange] based on weekly data from 1879 to 1900 was quite sophisticated (Klein 1997, p. 65).

Studying the first differences of deviations from the "growth axis" to de-trend financial time series, Norton (1902) decomposed series into trend, cycles, and irregular elements (Klein 1997, pp. 113–18, 236–40). A. L. Bowley (1902, p. 517), reviewing Norton in the *Economic Journal*, judged that "the intention and general scheme of the work are sound and original and the results interesting and important." However, despite Fisher's sponsorship and Norton's confidence that "The phenomena of economics lend themselves far more readily to the possibility of prediction than do the phenomena of meteorology" (Norton 1902, p. 104), Norton's attempt to reduce finance to an exact science was not followed up either by Norton or by others. Judy Klein (1997, p. 302a) notes that Norton (1902) was even overlooked by the International Statistical Institute's very comprehensive 1965 *Bibliography on Time Series and Stochastic Processes*.

In his presidential address to the American Statistical Association and the Econometric Society, Fisher acknowledged:

> It was because practically all the would-be economic forecasters have for the last four years failed dismally to tell the business man what to expect that a business man, Mr. Alfred Cowles, III, has stepped forward to finance the Econometric Society in the hope that out of it might grow scientific prediction. He has also organized a statistical laboratory where he is trying to make use of the most promising methods. He has a paper to present here at a joint session of the Statistical Association and the Econometric Society on some of the failures of recent economic predictions. It is well that we face these failures and that, when we fail, we confess it with due humility. I confess it. (1933, pp. 9–10).

Notice Fisher's unwarranted assumption that Cowles shared the goal of Fisher and Norton: scientific prediction of stock prices, and his failure to absorb Cowles's argument that anyone who could predict stock prices would act on the prediction, not publish it.

Humility about forecasting business conditions was justified: the 1930 revised edition of Garfield Cox's *Appraisal of American Business Forecasts* is rather different in tone from the 1928 edition. But just what failure of prediction did Fisher confess with such due humility? "It is true that in September, 1929, I publicly stated my belief that we were 'then at the top of the stock market' and that there would be a recession, this forecast being largely on the strength of the elaborate correlation work of Karl Karsten. And this proved true. But unfortunately I also stated my belief that the recession would be slight and short; and this proved untrue" (Fisher 1933, p. 10; cf. Karsten 1931). To this unlikely recollection, one may contrast the transcript of Fisher's address to the District of Columbia Bankers Association on the evening of Wednesday, October 23, 1929 (Fisher 1997, 10, pp. 3–26), in which, although "I understand there was quite a break today at the last hour," Fisher concluded by predicting that "we shall not see very much further, if any, recession in the stock market, but rather a ragged stock market in the next few weeks, and then, after the first of the year, a resumption of the bull market, not as rapidly as it has been in the past, but still a bull rather than a bear movement."

Fisher (1933, p. 10) did, however, make an important point in defense of his failure to predict a deep depression: he had not realized how Benjamin Strong's death in 1928 had weakened the Federal Reserve's understanding of and commitment to stabilization policy through open market operations. Dominguez, Fair, and Shapiro (1988) conclude, applying modern statistical techniques to available time series data, that the Great Depression could not have been predicted by Fisher or anyone else, since it resulted from unforecastable policy mistakes, such as Federal Reserve monetary policy that allowed the U.S. money supply to shrink by a third and an anti-deficit fiscal policy that increased the maximum U.S. income tax rate from twenty-four percent to sixty-three percent in 1932 (although, as a referee points out, it can be argued that the Federal Reserve's response was a predictable consequence of commitment to a version of the real bills doctrine). McGrattan and Prescott (2004) even adopt the subtitle "Irving Fisher Was Right" (with an exclamation mark in the 2001 NBER working paper version), defending Fisher's notorious bullishness about stocks, given the high long-term returns on common stocks.

Fisher's incautious bullishness in the 1920s reflected his belief that breakthroughs in technology and organization had created a "New Economy" that could not be judged by past standards, a belief also prevalent in the British railroad boom of the 1840s, in the first years of the twentieth century, in the 1960s, and the dot-com boom of the 1990s. It is always going to be different this time, as with the 120 Dutch investors who recently invested and lost at least 100,000 euros each, for a total of 85.2 million euros, in NovaCap Florales Future Fund, a venture-capital fund for development of new varieties of tulips to be sold through a now-defunct tulip market-maker (Bickerton 2003, Forsyth 2003).

Max Sasuly (1947, pp. 271–72), who took Karsten's place as the statistician working most closely with Fisher,[4] provided, in his memorial article on Fisher, an account of collaborating with Fisher on unpublished research on stock prices that is startling in its imperviousness both to Cowles's findings and to Fisher's own market experience.

[4]Sasuly worked for Fisher's Index Number Institute, and his Brookings study (Sasuly 1934) built on Fisher's work on distributed lags and smoothing of time series.

A number of interesting results have been obtained during the three years of intense work on the analysis of industrial common-stock trends of 1924–28 and earlier. A systematic write-up remains to be done on this material, in aspects that have not been elicited in subsequent work by others on stock prices, such as that of the Cowles Commission [Cowles and Associates 1939]. A continuous record was obtained of the weekly prices of each security on the Board during the period of study and for several years preceding. The weekly *p*, *q* were based on daily recordings of prices and sales. The record is fairly complete with respect to prices, sales, dividends, and capital-structure changes, such as stock split-ups. Several studies made during this period, awaiting publication, are of continuing interest. Among these is an interesting "Formulary for Anticipating Short-Time Changes in Market Action." Most of its elements were derived by Fisher on the basis of long familiarity with the trading of seasoned Wall Street investors and speculators. Difficult as it may be for some to believe, this formulary actually worked out with a definitely favorable statistical margin. We succeeded in eliciting certain definite statistical regularities in the behavior of traders on the Board in industrial common stocks during the period 1925–28.

Presumably the changes of subsequent years, especially under the regulations of the Securities and Exchanges Commission, would require a modification of the details of the formularies. The principles, capable of wider application, appear quite likely to stand. There are strong indications of similar regularities of behavior of the trading public in other markets. A promising field of research appears to be indicated here to advance the general welfare.

Sasuly (1947, p. 272 n. 64) added in a footnote that "Made known—for public use—during the life of the National Recovery Administration, these principles were eagerly received by some of the statisticians come from Wall Street to 'help' in the Recovery effort. It appears that the procedure was later used with success in stock-market trading." As with Fisher's claim to have predicted the stock market slump and subsequent recession based on Karsten's correlations, "Difficult as it may be for some to believe" is an understatement with regard to Sasuly's report of the efficacy of Fisher's formulary (no copy of which can be found in the Fisher Papers at Yale).

In contrast to the belief of Fisher and Sasuly in their ability to predict stock price movements, Alfred Cowles 3rd (1933) answered the question "Can Stock Market Forecasters Forecast?" in the negative. A wealthy investor, Yale graduate (class of 1913), and, like Fisher, a tuberculosis survivor, Cowles became disillusioned with stock forecasters and in 1931 began to research their record. He wrote to Fisher (a friend of Cowles's father and uncle since they were Yale undergraduates) offering to fund the fledgling Econometric Society, its journal, and an institution for econometric research, the Cowles Commission (Bernstein 1992, pp. 29–38), as a by-product of his pet project to show the futility of stock market prediction. Beyond funding, Cowles also served as circulation manager for *Econometrica* and as secretary-treasurer of the Econometric Society, undertook a major work of data compilation on stock prices (Cowles and Associates 1939), published on stock market forecasts in *Econometrica* (Cowles 1933, 1944, 1960, Cowles and Jones 1937), and presented his research at Cowles Commission summer conferences (Cowles 1936). Remarkably, despite his very negative findings on stock market forecasts and notably on the Dow Theory (see Walter 1999), Cowles managed to work closely and amiably with Fisher, renowned for mistaken stock market prediction, and to remain a good friend of his Colorado Springs neighbor Robert Rhea, the leading defender of William Peter Hamilton's version of the Dow Theory (Rhea 1932). Cowles's sponsorship of the Econometric Society, *Econometrica*, and the Cowles Commission would not have happened without his willingness to use his wealth to pursue his claim that stock market forecasting was futile. Equally, it would not have happened without Fisher, and the link through Fisher's longstanding friendship with Cowles's father and uncle. The institution-building of Cowles and Fisher advanced the spread of formal mathematical and statistical technique in economics, and, following on Cowles's own research, the concept of efficient financial markets in which current asset prices already reflect any information that technical analysis could extract from filtering past price data (Dimand 2005).

Brown, Goetzmann, and Kumar (1998, pp. 1330–31) report that Cowles's 1933 "analysis of the Hamilton record is a watershed study that led to the random walk hypothesis, and thus played a key role in the development of the efficient market theory. Ever since Cowles' article, 'chartists' in general, and Dow theorists in particular, have been regarded by financial economists with scepticism." However:

> A review of the evidence against William Peter Hamilton's timing abilities suggests just the opposite—his application of the Dow Theory appears to have yielded positive risk-adjusted returns over a 27-year period at the beginning of the century . . . Whether this means that his interpretation of the Dow Theory is correct, or whether it simply means that Hamilton was one lucky forecaster among many market analysts, is still an open question. . . . Our replication of Cowles' analysis yields results contrary to Cowles' conclusions.[5] At the very least, it suggests that more detailed analysis of the Hamilton version of the Dow Theory is warranted. In broader terms it also suggests that the empirical foundations of the efficient market theory may not be as firm as long believed.

V. CONCLUSION

Irving Fisher's New Economy bullishness in October 1929 and his subsequent financial losses brought him notoriety and ridicule, while Maynard Keynes is remembered as "an outstanding portfolio manager, 'beating the market' by a wide margin" in risk-adjusted rates of return (Chua and Woodward 1983, p. 154). Had Fisher died in early 1929, or Keynes in 1938, their financial records would have been very different. The confidence of Fisher and Sasuly in their formularies for predicting short-term stock market movements was misplaced, and sets them apart from the efficient markets view of modern financial theory (anticipated by Bachelier, Cowles, and Holbrook Working). Nonetheless, Fisher was an important innovator in financial economics, as in other areas of economics. His diagrammatic analysis of intertemporal allocation under certainty was complemented with an extension to risky situations, including

[5]Brown, Goetzmann, and Kumar (1998, p. 1315) emphasize that "Of course, we cannot blame Cowles for not knowing in 1934 how to calculate Jensen's alpha, nor should we have expected him fully to appreciate the subtleties of conditioning in nonparametric tests. Nevertheless, a close look at the Cowles evidence suggests that the Dow Theory, as practised by William Peter Hamilton, merits reconsideration."

Fisher's proposed measure of risk aversion, the coefficient of caution. A strong proponent of portfolio diversification, Fisher held that the real return on common stocks over the long term was higher than justified by the relative risk of stocks and bonds (what was later known as the equity premium puzzle), because bonds carry the risk of fluctuations in the purchasing power of money. Financial economics later advanced beyond Fisher by interpreting the Fisher diagram as portraying allocation over two states of the world, rather than two time periods, and identifying the problem of choosing optimal weights in a portfolio with the problem of choosing optimal weights in an index number. Fisher was a pioneer in the creation of a stabilized bond, indexed to the price level, sixty or seventy years ahead of his time. From John Pease Norton (1902) to Alfred Cowles (1933, 1944), Fisher was an indefatigable promoter and supporter of the application of mathematical statistics to the scientific study of financial markets, cheerfully undismayed when Cowles presented findings that contradicted Fisher's beliefs about the predictability of stock prices (and that, upon replication, turn out to be doubtful). Some of Fisher's doctoral students contributed to the study of financial markets (Norton 1902, Norton and Harry G. Brown in Fisher et al 1912) and then moved on, but Fisher's institution-building collaboration with Cowles, occasioned by Cowles's disillusionment with stock market forecasters, had lasting impact.

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