UC San Diego **Economics Roundtable**

- Hosted by the Department of Economics

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Michael Melvin

UC San Diego
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My Journey: Academic to Practitioner to Academic

- Barclays Global Investors: head of currency research & currency hedge funds
- BlackRock: same position & then Exec Group of Multi Asset Strategies
- UCSD: Master of Quantitative Finance program

Investable nuggets from academia?

- Took my team to academic conferences
- Tested interesting ideas
- Not implementable
  - → Data not lagged appropriately—peaking ahead
  - → Ignoring transaction costs
  - → Results not robust outside sample period academic used

Lack of focus on pension funds & retirement outcomes from top researchers

- Too many marginal contributions to popular areas
  - Incentives to work in areas where senior people & editors have focused.
  - Lots of self-referential studies
  - Not easy to be a path breaker with new paradigm
- How do we get leading academics to work on areas of great social importance?

Kroner Center for Financial Research

- Mission: bring power of academia to research on better retirement outcomes
- CIO Advisory Council
  - → GIC, CPPIB, CalStrs, SWIB, BCI, HOOP, OCERA, SDCERA, LACERS, ACERA
- Industry Advisory Council
  - → Gramercy, Morgan Stanley, Meketa, DE Shaw, Obra Capital, AlphaSimplex
- Academic Advisory Council
  - → Allan Timmerman, UCSD; Laura Starks, U. of Texas; Itay Goldstein, Wharton School; Wei Jiang, Emery U.; Greg Brown, U. of N. Carolina; Robert Engle, NYU

KCFR 2020 Topics

- **Strategic Asset Allocation**
  - *(Redouane Elkahmi, U. of Toronto; Jacky S.H. Lee, HOOPP; and Marco Salerno, U. of Toronto)*
  - The authors provide a methodology that incorporates views on the likelihood of economic regimes (e.g., growth and inflation). Using data on equities, bonds and commodities, they show both in simulation and empirically that the approach generates stable portfolio weights and a performance that is minimally affected by forecast errors.
- **Pension Fund Allocations to Private Equity and Portfolio Risk and Return**
  - *(Arthur Korteweg, USC and Stavros Panageas, UCLA)*
  - Pension plan allocations to private equity funds were optimal overall, although the average plan was underexposed to buyout; b) plans invest in PE funds that have higher risk-adjusted performance, but this is because of some pension plans' superior access to successful private equity funds, c) the higher returns obtained by some pension plans in their private equity investments appear to be the result of a higher willingness to take risk rather than a manifestation of timing or selection
- **Diversity and Inclusion and Portfolio Returns: Is there a trade-off?**
  - *(Prashant Bharadwaj, Amanda Bauer, and Frances Lu, UC San Diego)*
  - The authors create a new data set on “emerging managers” returns. Key findings: Importance of diversity is justified theoretically and empirically. When one cannot target diverse firms directly, emerging manager programs are a way to improve diversity. No clear evidence of performance differences; no diversity-returns trade-off. Emerging manager programs deliver on diversity goals.

KCFR 2021 Topics

- **Real Effects of Environmental Activist Investing**
  - *(S. Lakshmi Naaraayanan, London Business School; Kunal Sachdeva, Rice U.; and Varun Sharma, London Business School)*
  - the authors find preliminary results that targeted firms reduce their toxic releases, greenhouse gas emissions, and cancer-causing pollution. Improvements in air quality within a one-mile radius of targeted plants suggest potentially important externalities to local economies.
- **Environmental Externalities of Hedge Fund Activism**
  - *(Pat Akey, U. of Toronto and Ian Appel, Boston College)*
  - they find evidence that activism campaigns are associated with a 17 percent drop in emissions for chemicals at plants of targeted firms. This decline in emissions is present in both chemicals that are known to cause harm to humans and those known to have adverse effects on the environment.
- **The Case for Actively Managed Funds**
  - *(Allan Timmermann, UC San Diego and Russell Wermers, U. of Maryland)*
  - We document significant scale economies in pension plan investments: large plans possess greater bargaining power over their external managers in negotiating fees, and have access to better performing actively managed funds, relative to small plans. Further, switching from external to internal management (within an asset class) is associated with substantially lower per-unit costs for large plans, especially in private assets, reinforcing the enhanced bargaining power conferred by their scale.

KCFR 2022 Topics

- **The Cost of ESG Investing**
  - *(Laura Lindsey, Seth Pruitt, and Christoph Schiller, Arizona State University)*
  - ESG measures do not predict returns, given the rich conditioning information available to investors, so ESG factors can be used as an overlay on benchmark portfolios to downweight poor ESG firms without a reduction in performance.
- **Is There a Performance Penalty to Sustainable Bond Investing**
  - *(Ji Min Park and Neil D. Pearson, University of Illinois)*
  - We use each category, E, S, and G to categorize corporate bonds according to their ESG profiles. We then estimate the abnormal returns of the bonds using different benchmarks. We focus on the degree to which returns vary with the issuers' ESG profile.
- **The Cost of Sustainable Investing**
  - *(Hao Jiang, Michigan State University)*
  - We want to explore how shifts in investor tastes and demand drive the prices and returns of green and brown stocks. We will use global fund flows to estimate the impact of shifts in investors' preferences and price impacts on the two types of stocks.

KCFR 2023 Topics

- **Portfolio Design Issues for Institutional Investors: Asset Allocation in Public and Private Markets, Active Management, and Portfolio Concentration**
  - *Profs Keith Brown, University of Texas, and Christian Tiu, University at Buffalo)*
  - the disparities in the investment problems faced by different asset owner types—defined-benefit pension plans and university endowment funds—lead to different outcomes regarding portfolio design judgments.
- **Choosing Pension Fund Investment Consultants**
  - *(Aleksander Andonov, University of Amsterdam, Matteo Bonetti, De Nederlandsche Bank, and Irina Stefanescu, Federal Reserve Board)*
  - The authors find that pension funds hire consultants for various reasons, including shielding, access to certain investments but not because of superior investments skills. Consultants have an impact on investment allocations.The concentration of consultants has implications for investment flows and performance.
- **The Rise of Alternatives**
  - *(Juliane Begenau, Stanford GSB, Pauline Liang, Stanford GSB) and Emil Siriwardane (Harvard Business School)*
  - The aggregate alternative and alternative-to-risky portfolio share in pension funds has risen in the US since the 2000's, but in a heterogenous way over pension funds. Modern portfolio theory suggests two potential answers – a shift in beliefs that returns will be greater without additional risk (more alpha, but heterogenous beliefs over alpha) or alternatively a desire to take on more risk. Their data work suggests the first offers a simpler explanation.

KCFR 2024 Topics

- **Benchmarking Benchmarks in the Pension Fund Industry**
  - *(Richard Evans, University of Virginia, Juan-Pedro Gomez, IE University, Linlin Ma, Peking Univeristy, Yuehua Tang, University of Florida)*
  - Benchmarks enable the assessment of pension fund performance by retirees, regulators, elected officials and other stakeholders. These benchmarks are an important ingredient in determining the compensation of pension fund chief investment officers (CIOs), staff, and external fund managers, and therefore, of their associated managerial incentives. This work examines the benchmarks used by pensions.
- **Rethinking Private Markets as an Asset Class**
  - *(Gregory Brown, Christian Lundblad, UNC Chapel Hill)*
  - the authors examine different approaches to estimating fund risk adjusted returns to examine the costs and benefits of the approaches.
- **Designing ESG Benchmarks**
  - *(Anil Kashyap, University of Chicago, Natalia Kovrijnykh, Arizona State University, and Anna Pavlova, London Business School)*
  - The authors study an optimal design of benchmarks with an application to ESG benchmarks. They consider different motivations for ESG investing (either as returns maximization because these industries are expected to do well in the future or alternatively via a judgement of the harm the firm might be doing).

You have doubts about the value of academic research to practitioners?
Greatest Hits of Academia

- Academic research that changed practice
- Enduring contributions
- Giants of the profession
- *Listener beware: this is my personal list & others may have different views*

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PORTFOLIO SELECTION*

HARRY MARKOWITZ
The Rand Corporation

THE PROCESS OF SELECTING a portfolio may be divided into two stages. The first stage starts with observation and experience and ends with beliefs about the future performances of available securities. The second stage starts with the relevant beliefs about future performances and ends with the choice of portfolio. This paper is concerned with the second stage. We first consider the rule that the investor does (or should) maximize discounted expected, or anticipated, returns. This rule is rejected both as a hypothesis to explain, and as a maximum to guide investment behavior. We next consider the rule that the investor does (or should) consider expected return a desirable thing *and* variance of return an undesirable thing. This rule has many sound points, both as a maxim for, and hypothesis about, investment behavior. We illustrate geometrically relations between beliefs and choice of portfolio according to the "expected returns—variance of returns" rule.

One type of rule concerning choice of portfolio is that the investor does (or should) maximize the discounted (or capitalized) value of future returns.[1] Since the future is not known with certainty, it must be "expected" or "anticipated" returns which we discount. Variations of this type of rule can be suggested. Following Hicks, we could let "anticipated" returns include an allowance for risk.[2] Or, we could let the rate at which we capitalize the returns from particular securities vary with risk.

The hypothesis (or maxim) that the investor does (or should) maximize discounted return must be rejected. If we ignore market imperfections the foregoing rule never implies that there is a diversified portfolio which is preferable to all non-diversified portfolios. Diversification is both observed and sensible; a rule of behavior which does not imply the superiority of diversification must be rejected both as a hypothesis and as a maxim.

* This paper is based on work done by the author while at the Cowles Commission for Research in Economics and with the financial assistance of the Social Science Research Council. It will be reprinted as Cowles Commission Paper, New Series, No. 60.

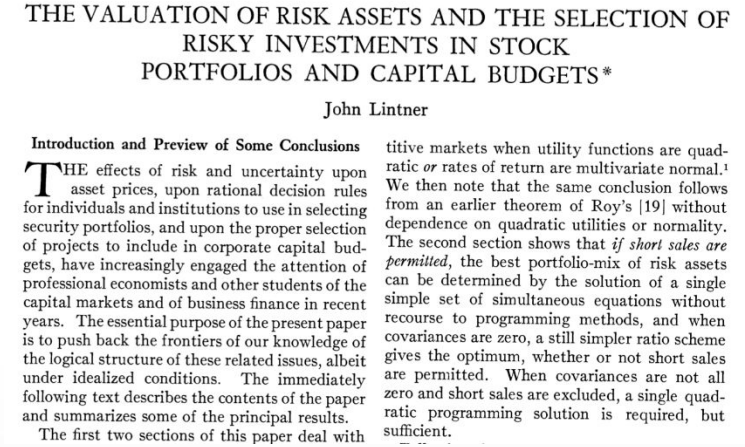
1. See, for example, J. B. Williams, *The Theory of Investment Value* (Cambridge, Mass.: Harvard University Press, 1938), pp. 55–75.

2. J. R. Hicks, *Value and Capital* (New York: Oxford University Press, 1939), p. 126. Hicks applies the rule to a firm rather than a portfolio.

Markowitz, "Portfolio Selection," *Journal of Finance* (1952).

Mean–variance portfolio theory & the efficient frontier

- Major impact on portfolio construction
  - → Volatility matters
  - → Diversification—the “free lunch”
- Harry Markowitz: “father of modern finance”



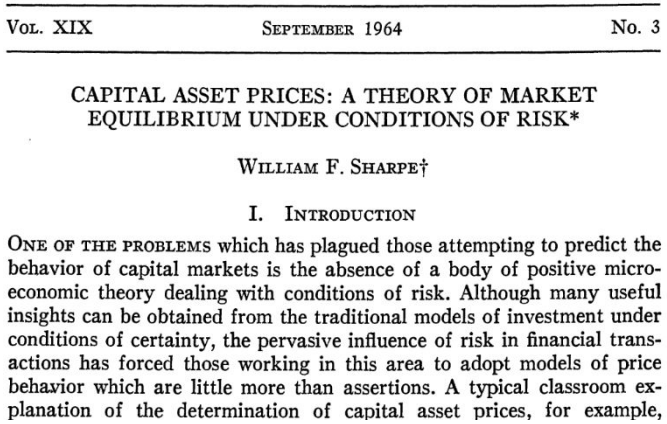
THE VALUATION OF RISK ASSETS AND THE SELECTION OF RISKY INVESTMENTS IN STOCK PORTFOLIOS AND CAPITAL BUDGETS*

John Lintner

Introduction and Preview of Some Conclusions

THE effects of risk and uncertainty upon asset prices, upon rational decision rules for individuals and institutions to use in selecting security portfolios, and upon the proper selection of projects to include in corporate capital budgets, have increasingly engaged the attention of professional economists and other students of the capital markets and of business finance in recent years. The essential purpose of the present paper is to push back the frontiers of our knowledge of the logical structure of these related issues, albeit under idealized conditions. The immediately following text describes the contents of the paper and summarizes some of the principal results.

The first two sections of this paper deal with titive markets when utility functions are quadratic *or* rates of return are multivariate normal.[1] We then note that the same conclusion follows from an earlier theorem of Roy's [19] without dependence on quadratic utilities or normality. The second section shows that *if short sales are permitted*, the best portfolio-mix of risk assets can be determined by the solution of a single simple set of simultaneous equations without recourse to programming methods, and when covariances are zero, a still simpler ratio scheme gives the optimum, whether or not short sales are permitted. When covariances are not all zero and short sales are excluded, a single quadratic programming solution is required, but sufficient.



The Journal of FINANCE

VOL. XIX SEPTEMBER 1964 No. 3

CAPITAL ASSET PRICES: A THEORY OF MARKET EQUILIBRIUM UNDER CONDITIONS OF RISK*

WILLIAM F. SHARPE†

I. INTRODUCTION

ONE OF THE PROBLEMS which has plagued those attempting to predict the behavior of capital markets is the absence of a body of positive microeconomic theory dealing with conditions of risk. Although many useful insights can be obtained from the traditional models of investment under conditions of certainty, the pervasive influence of risk in financial transactions has forced those working in this area to adopt models of price behavior which are little more than assertions. A typical classroom explanation of the determination of capital asset prices, for example,

Sharpe, "Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk," *Journal of Finance* (1964).

Lintner, "The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets," *Review of Economics and Statistics* (1965).

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Capital asset pricing & performance measurement

- Harry Markowitz: Decomposition into market returns & idiosyncratic returns
  - → Is it alpha or beta?
- William Sharpe,…

Common risk factors in the returns on stocks and bonds*

Eugene F. Fama and Kenneth R. French
University of Chicago, Chicago, IL 60637, USA

Received July 1992, final version received September 1992

This paper identifies five common risk factors in the returns on stocks and bonds. There are three stock-market factors: an overall market factor and factors related to firm size and book-to-market equity. There are two bond-market factors, related to maturity and default risks. Stock returns have shared variation due to the stock-market factors, and they are linked to bond returns through shared variation in the bond-market factors. Except for low-grade corporates, the bond-market factors capture the common variation in bond returns. Most important, the five factors seem to explain average returns on stocks and bonds.

1. Introduction

The cross-section of average returns on U.S. common stocks shows little relation to either the market βs of the Sharpe (1964)–Lintner (1965) asset-pricing model or the consumption βs of the intertemporal asset-pricing model of Breeden (1979) and others. [See, for example, Reinganum (1981) and Breeden, Gibbons, and Litzenberger (1989).] On the other hand, variables that have no special standing in asset-pricing theory show reliable power to explain the cross-section of average returns. The list of empirically determined average-return variables includes size (ME, stock price times number of shares), leverage, earnings/price (E/P), and book-to-market equity (the ratio of the book value of a firm's common stock, BE, to its market value, ME). [See Banz (1981), Bhandari (1988), Basu (1983), and Rosenberg, Reid, and Lanstein (1985).]

Correspondence to: Eugene F. Fama, Graduate School of Business, University of Chicago, 1101 East 58th Street, Chicago, IL 60637, USA.

*The comments of David Booth, John Cochrane, Nai-fu Chen, Wayne Ferson, Josef Lakonishok, Mark Mitchell, G. William Schwert, Jay Shanken, and Rex Sinquefield are gratefully acknowledged. This research is supported by the National Science Foundation (Fama) and the Center for Research in Securities Prices (French).

0304-405X/93/$05.00 © 1993—Elsevier Science Publishers B.V. All rights reserved

Fama & French, "Common Risk Factors in the Returns on Stocks and Bonds," *JFE* (1993).

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Multi-factor asset pricing & risk models

- Sources of risk & return
  - → Size, momentum, value, …
- Eugene F. Fama; Kenneth R. French; Stephen A. Ross; Barr Rosenberg

The Pricing of Options and Corporate Liabilities

Fischer Black
University of Chicago
Myron Scholes
Massachusetts Institute of Technology

If options are correctly priced in the market, it should not be possible to make sure profits by creating portfolios of long and short positions in options and their underlying stocks. Using this principle, a theoretical valuation formula for options is derived. Since almost all corporate liabilities can be viewed as combinations of options, the formula and the analysis that led to it are also applicable to corporate liabilities such as common stock, corporate bonds, and warrants. In particular, the formula can be used to derive the discount that should be applied to a corporate bond because of the possibility of default.

Introduction

An option is a security giving the right to buy or sell an asset, subject to certain conditions, within a specified period of time. An "American option" is one that can be exercised at any time up to the date the option expires. A "European option" is one that can be exercised only on a specified future date. The price that is paid for the asset when the option is exercised is called the "exercise price" or "striking price." The last day on which the option may be exercised is called the "expiration date" or "maturity date."

The simplest kind of option is one that gives the right to buy a single share of common stock. Throughout most of the paper, we will be discussing this kind of option, which is often referred to as a "call option."

Received for publication November 11, 1970. Final version received May 9, 1972. The inspiration for this work was provided by Jack L. Treynor (1961*a*, 1961*b*). We are grateful for extensive comments on earlier drafts by Eugene F. Fama, Robert C. Merton, and Merton H. Miller. This work was supported in part by the Ford Foundation.

Black & Scholes, "The Pricing of Options and Corporate Liabilities," *JPE* (1973).

Option pricing, implied volatility & Greeks

- Huge impact on practice
  - → Option pricing models
  - → Delta, gamma, …
- Fischer Black; Myron S. Scholes; Robert C. Merton

Econometrica, Vol. 57, No. 2 (March, 1989), 357–384

A NEW APPROACH TO THE ECONOMIC ANALYSIS OF NONSTATIONARY TIME SERIES AND THE BUSINESS CYCLE

BY JAMES D. HAMILTON[1]

This paper proposes a very tractable approach to modeling changes in regime. The parameters of an autoregression are viewed as the outcome of a discrete-state Markov process. For example, the mean growth rate of a nonstationary series may be subject to occasional, discrete shifts.

The econometrician is presumed not to observe these shifts directly, but instead must draw probabilistic inference about whether and when they may have occurred based on the observed behavior of the series. The paper presents an algorithm for drawing such probabilistic inference in the form of a nonlinear iterative filter. The filter also permits estimation of population parameters by the method of maximum likelihood and provides the foundation for forecasting future values of the series.

An empirical application of this technique to postwar U.S. real GNP suggests that the periodic shift from a positive growth rate to a negative growth rate is a recurrent feature of the U.S. business cycle, and indeed could be used as an objective criterion for defining and measuring economic recessions. The estimated parameter values suggest that a typical economic recession is associated with a 3% permanent drop in the level of GNP.

KEYWORDS: Switching regression, segmentation, nonstationary, business cycle, nonlinear filtering, regime changes.

1. INTRODUCTION AND SUMMARY

A NUMBER OF RECENT STUDIES have sought to characterize the nature of the long term trend in GNP and its relation to the business cycle. Researchers such as Beveridge and Nelson (1981), Nelson and Plosser (1982), and Campbell and Mankiw (1987a, b) explored this question using ARIMA models or ARMA processes around a deterministic trend. Others, such as Harvey (1985), Watson (1986), and Clark (1987) based their analyses on linear unobserved components models. A third approach employs the co-integrated specification of Engle and Granger (1987), whose relevance for business cycle research is examined in a fascinating paper by King, Plosser, Stock, and Watson (1987).

These approaches are based on the assumption that first differences of the log of GNP follow a linear stationary process; that is, in all of the above studies, optimal forecasts of variables are assumed to be a linear function of their lagged values. In this paper I suggest a modest alternative to these currently popular approaches to nonstationarity, exploring the consequences of specifying that first differences of the observed series follow a nonlinear stationary process rather than a linear stationary process. A variety of parameterizations for characterizing nonlinear dynamics have recently been proposed, and there has now accumulated

[1]I am indebted to John Cochrane, Angus Deaton, Robert Engle, Marjorie Flavin, Kevin Hassett, and anonymous referees for comments on earlier drafts of this paper. This material is based upon work supported by the National Science Foundation under Grant No. SES-8720731. The Government has certain rights to this material.

Hamilton, "A New Approach to the Economic Analysis of Nonstationary Time Series and the Business Cycle," *Econometrica* (1989).

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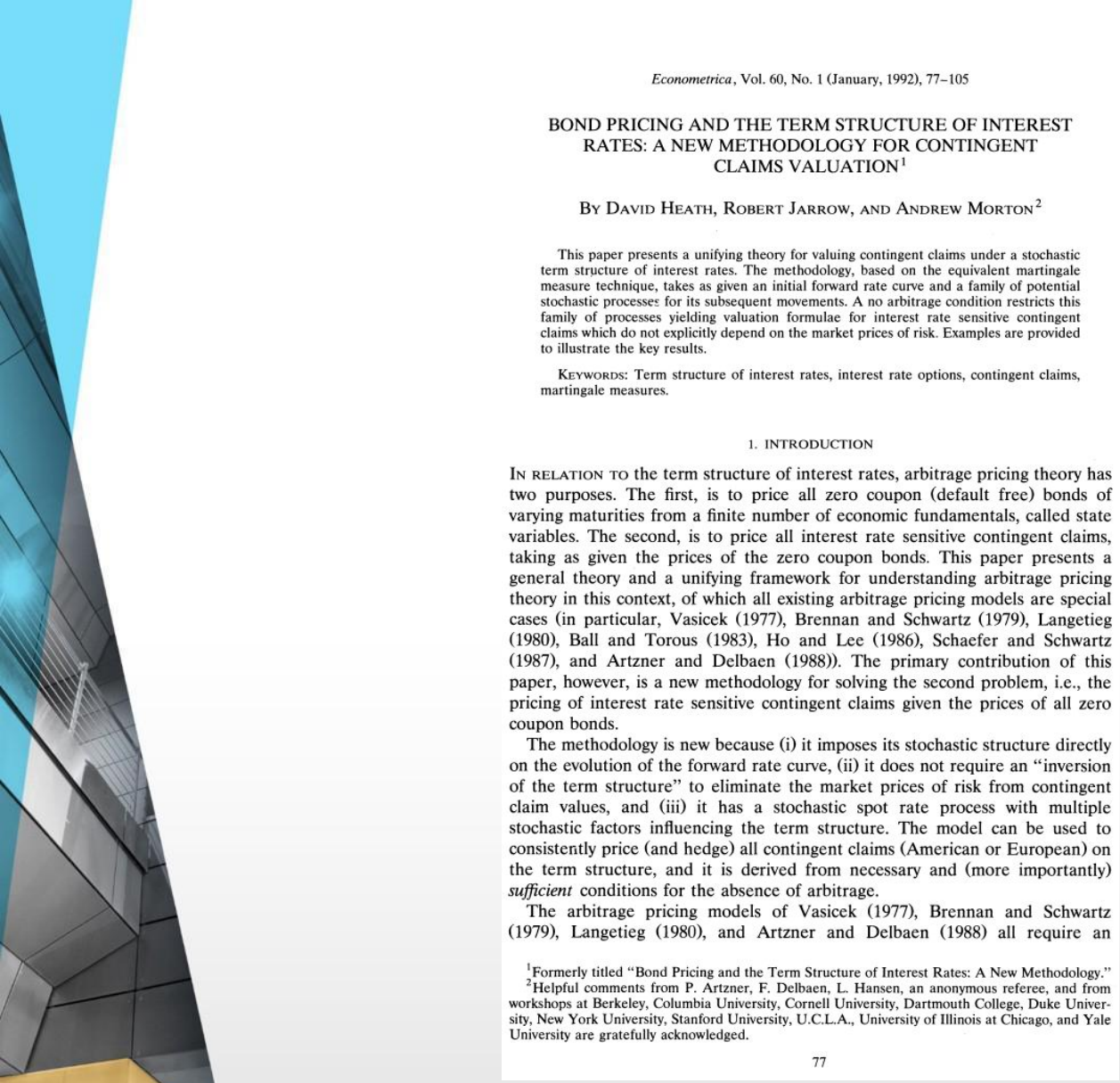
Regime Switching / State-Dependent Dynamics

- Introduces Markov-switching (state-dependent) models for macro/financial time series.
- Widely applied in finance for regime-dependent returns/volatility and risk management
  - Think “risk on” and “risk off”
  - Rising and falling rates (inflation, growth,…)



Econometrica, Vol. 60, No. 1 (January, 1992), 77–105

BOND PRICING AND THE TERM STRUCTURE OF INTEREST RATES: A NEW METHODOLOGY FOR CONTINGENT CLAIMS VALUATION[1]

BY DAVID HEATH, ROBERT JARROW, AND ANDREW MORTON[2]

This paper presents a unifying theory for valuing contingent claims under a stochastic term structure of interest rates. The methodology, based on the equivalent martingale measure technique, takes as given an initial forward rate curve and a family of potential stochastic processes for its subsequent movements. A no arbitrage condition restricts this family of processes yielding valuation formulae for interest rate sensitive contingent claims which do not explicitly depend on the market prices of risk. Examples are provided to illustrate the key results.

KEYWORDS: Term structure of interest rates, interest rate options, contingent claims, martingale measures.

1. INTRODUCTION

IN RELATION TO the term structure of interest rates, arbitrage pricing theory has two purposes. The first, is to price all zero coupon (default free) bonds of varying maturities from a finite number of economic fundamentals, called state variables. The second, is to price all interest rate sensitive contingent claims, taking as given the prices of the zero coupon bonds. This paper presents a general theory and a unifying framework for understanding arbitrage pricing theory in this context, of which all existing arbitrage pricing models are special cases (in particular, Vasicek (1977), Brennan and Schwartz (1979), Langetieg (1980), Ball and Torous (1983), Ho and Lee (1986), Schaefer and Schwartz (1987), and Artzner and Delbaen (1988)). The primary contribution of this paper, however, is a new methodology for solving the second problem, i.e., the pricing of interest rate sensitive contingent claims given the prices of all zero coupon bonds.

The methodology is new because (i) it imposes its stochastic structure directly on the evolution of the forward rate curve, (ii) it does not require an "inversion of the term structure" to eliminate the market prices of risk from contingent claim values, and (iii) it has a stochastic spot rate process with multiple stochastic factors influencing the term structure. The model can be used to consistently price (and hedge) all contingent claims (American or European) on the term structure, and it is derived from necessary and (more importantly) *sufficient* conditions for the absence of arbitrage.

The arbitrage pricing models of Vasicek (1977), Brennan and Schwartz (1979), Langetieg (1980), and Artzner and Delbaen (1988) all require an

[1]Formerly titled "Bond Pricing and the Term Structure of Interest Rates: A New Methodology."

[2]Helpful comments from P. Artzner, F. Delbaen, L. Hansen, an anonymous referee, and from workshops at Berkeley, Columbia University, Cornell University, Dartmouth College, Duke University, New York University, Stanford University, U.C.L.A., University of Illinois at Chicago, and Yale University are gratefully acknowledged.

Heath, Jarrow & Morton, "Bond Pricing and the Term Structure of Interest Rates: A New Methodology," *Econometrica* (1992).

Term-structure modeling (yield curves)

- Frameworks to construct **arbitrage-free yield curves** and price interest-rate products
- Consistent pricing/hedging across the curve

Econometrica, Vol. 50, No. 4 (July, 1982)

AUTOREGRESSIVE CONDITIONAL HETEROSCEDASTICITY WITH ESTIMATES OF THE VARIANCE OF UNITED KINGDOM INFLATION[1]

BY ROBERT F. ENGLE

Traditional econometric models assume a constant one-period forecast variance. To generalize this implausible assumption, a new class of stochastic processes called autoregressive conditional heteroscedastic (ARCH) processes are introduced in this paper. These are mean zero, serially uncorrelated processes with nonconstant variances conditional on the past, but constant unconditional variances. For such processes, the recent past gives information about the one-period forecast variance.

A regression model is then introduced with disturbances following an ARCH process. Maximum likelihood estimators are described and a simple scoring iteration formulated. Ordinary least squares maintains its optimality properties in this set-up, but maximum likelihood is more efficient. The relative efficiency is calculated and can be infinite. To test whether the disturbances follow an ARCH process, the Lagrange multiplier procedure is employed. The test is based simply on the autocorrelation of the squared OLS residuals.

This model is used to estimate the means and variances of inflation in the U.K. The ARCH effect is found to be significant and the estimated variances increase substantially during the chaotic seventies.

1. INTRODUCTION

IF A RANDOM VARIABLE y_t is drawn from the conditional density function $f(y_t|y_{t-1})$, the forecast of today's value based upon the past information, under standard assumptions, is simply $E(y_t|y_{t-1})$, which depends upon the value of the conditioning variable y_{t-1}. The variance of this one-period forecast is given by $V(y_t|y_{t-1})$. Such an expression recognizes that the conditional forecast variance depends upon past information and may therefore be a random variable. For conventional econometric models, however, the conditional variance does not depend upon y_{t-1}. This paper will propose a class of models where the variance does depend upon the past and will argue for their usefulness in economics. Estimation methods, tests for the presence of such models, and an empirical example will be presented.

Consider initially the first-order autoregression

$$y_t = \gamma y_{t-1} + \epsilon_t$$

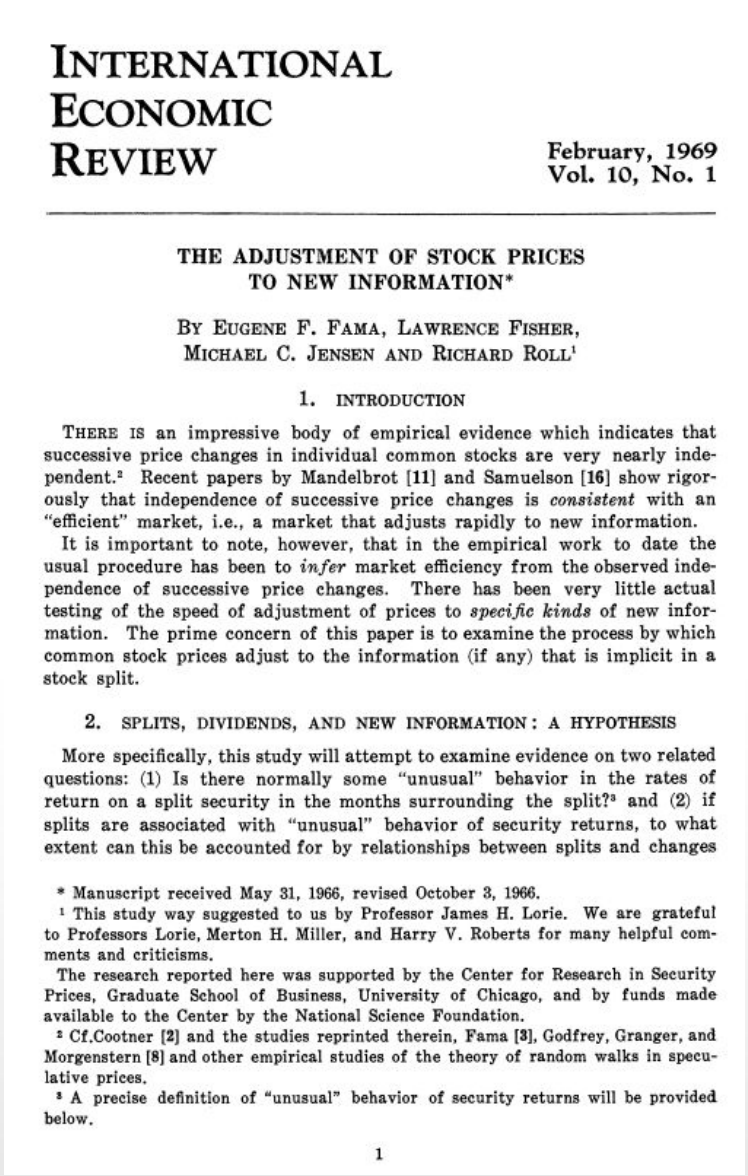
where ϵ is white noise with $V(\epsilon) = \sigma^2$. The conditional mean of y_t is γy_{t-1} while the unconditional mean is zero. Clearly, the vast improvement in forecasts due to time-series models stems from the use of the conditional mean. The conditional

[1]This paper was written while the author was visiting the London School of Economics. He benefited greatly from many stimulating conversations with David Hendry and helpful suggestions by Denis Sargan and Andrew Harvey. Special thanks are due Frank Srba who carried out the computations. Further insightful comments are due to Clive Granger, Tom Rothenberg, Edmond Malinvaud, Jean-Francois Richard, Wayne Fuller, and two anonymous referees. The research was supported by NSF SOC 78-09476 and The International Centre for Economics and Related Disciplines. All errors remain the author's responsibility.

Engle, "Autoregressive Conditional Heteroskedasticity with Estimates of the Variance of U.K. Inflation," *Econometrica* (1982).

Volatility modeling

- Used in many practical applications
  - → VaR, portfolio construction, variance swaps,…
- A generation of UCSD PhD students worked in this area



INTERNATIONAL ECONOMIC REVIEW

February, 1969
Vol. 10, No. 1

THE ADJUSTMENT OF STOCK PRICES TO NEW INFORMATION*

BY EUGENE F. FAMA, LAWRENCE FISHER, MICHAEL C. JENSEN AND RICHARD ROLL[1]

1. INTRODUCTION

THERE IS an impressive body of empirical evidence which indicates that successive price changes in individual common stocks are very nearly independent.[2] Recent papers by Mandelbrot [11] and Samuelson [16] show rigorously that independence of successive price changes is *consistent* with an "efficient" market, i.e., a market that adjusts rapidly to new information.

It is important to note, however, that in the empirical work to date the usual procedure has been to *infer* market efficiency from the observed independence of successive price changes. There has been very little actual testing of the speed of adjustment of prices to *specific kinds* of new information. The prime concern of this paper is to examine the process by which common stock prices adjust to the information (if any) that is implicit in a stock split.

2. SPLITS, DIVIDENDS, AND NEW INFORMATION: A HYPOTHESIS

More specifically, this study will attempt to examine evidence on two related questions: (1) Is there normally some "unusual" behavior in the rates of return on a split security in the months surrounding the split?[3] and (2) if splits are associated with "unusual" behavior of security returns, to what extent can this be accounted for by relationships between splits and changes

* Manuscript received May 31, 1966, revised October 3, 1966.

[1] This study way suggested to us by Professor James H. Lorie. We are grateful to Professors Lorie, Merton H. Miller, and Harry V. Roberts for many helpful comments and criticisms.

The research reported here was supported by the Center for Research in Security Prices, Graduate School of Business, University of Chicago, and by funds made available to the Center by the National Science Foundation.

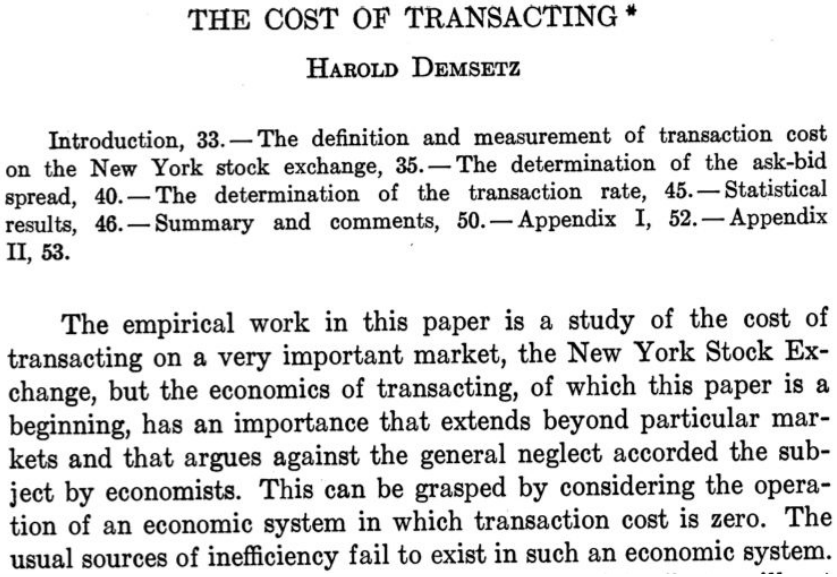
[2] Cf.Cootner [2] and the studies reprinted therein, Fama [3], Godfrey, Granger, and Morgenstern [8] and other empirical studies of the theory of random walks in speculative prices.

[3] A precise definition of "unusual" behavior of security returns will be provided below.

Fama, Fisher, Jensen & Roll, "The Adjustment of Stock Prices to New Information," *International Economic Review* (1969).

Event-study methodology

- Price impact of surprises
  - → News releases, firm filings, policy changes,…
- Eugene F. Fama; Michael C. Jensen; Richard Roll

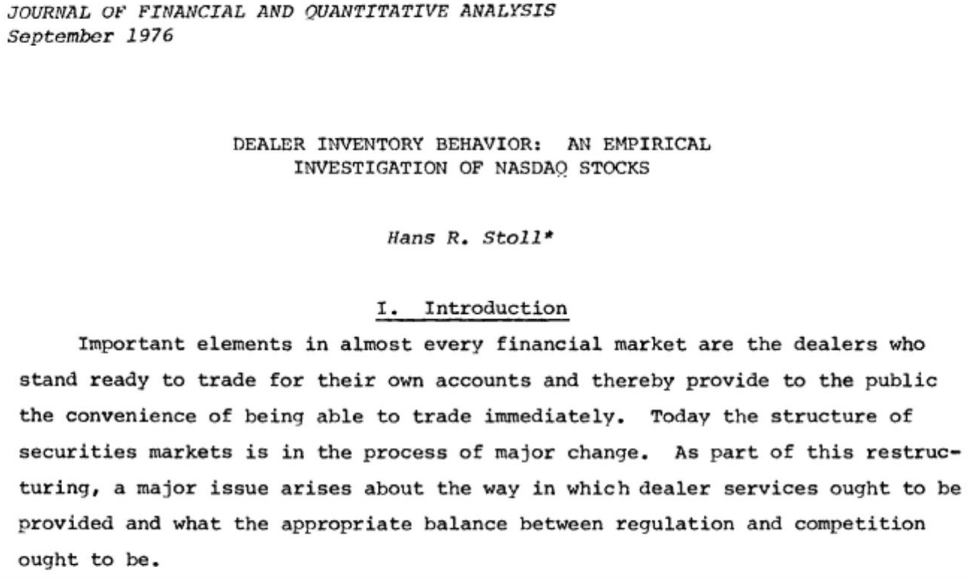


THE COST OF TRANSACTING *

HAROLD DEMSETZ

Introduction, 33. — The definition and measurement of transaction cost on the New York stock exchange, 35. — The determination of the ask-bid spread, 40. — The determination of the transaction rate, 45. — Statistical results, 46. — Summary and comments, 50. — Appendix I, 52. — Appendix II, 53.

The empirical work in this paper is a study of the cost of transacting on a very important market, the New York Stock Exchange, but the economics of transacting, of which this paper is a beginning, has an importance that extends beyond particular markets and that argues against the general neglect accorded the subject by economists. This can be grasped by considering the operation of an economic system in which transaction cost is zero. The usual sources of inefficiency fail to exist in such an economic system.



JOURNAL OF FINANCIAL AND QUANTITATIVE ANALYSIS
September 1976

DEALER INVENTORY BEHAVIOR: AN EMPIRICAL INVESTIGATION OF NASDAQ STOCKS

*Hans R. Stoll**

I. Introduction

Important elements in almost every financial market are the dealers who stand ready to trade for their own accounts and thereby provide to the public the convenience of being able to trade immediately. Today the structure of securities markets is in the process of major change. As part of this restructuring, a major issue arises about the way in which dealer services ought to be provided and what the appropriate balance between regulation and competition ought to be.

Harold Demsetz (1968), “The Cost of Transacting,” Quarterly Journal of Economics.
Hans R. Stoll (1976), “Dealer Inventory Behavior: An Empirical Investigation of NASDAQ Stocks,” Journal of Financial and Quantitative Analysis.

UC San Diego
RADY SCHOOL OF MANAGEMENT

Market microstructure & optimal execution

- High frequency trading strategies
  - Spreads
  - Transaction costs
  - order execution
  - algorithmic trading

SESSION TOPIC: STOCK MARKET PRICE BEHAVIOR

SESSION CHAIRMAN: BURTON G. MALKIEL

EFFICIENT CAPITAL MARKETS: A REVIEW OF THEORY AND EMPIRICAL WORK*

EUGENE F. FAMA**

I. INTRODUCTION

THE PRIMARY ROLE of the capital market is allocation of ownership of the economy's capital stock. In general terms, the ideal is a market in which prices provide accurate signals for resource allocation: that is, a market in which firms can make production-investment decisions, and investors can choose among the securities that represent ownership of firms' activities under the assumption that security prices at any time "fully reflect" all available information. A market in which prices always "fully reflect" available information is called "efficient."

This paper reviews the theoretical and empirical literature on the efficient markets model. After a discussion of the theory, empirical work concerned with the adjustment of security prices to three relevant information subsets is considered. First, *weak form* tests, in which the information set is just historical prices, are discussed. Then *semi-strong form* tests, in which the concern is whether prices efficiently adjust to other information that is obviously publicly available (e.g., announcements of annual earnings, stock splits, etc.) are considered. Finally, *strong form* tests concerned with whether given investors or groups have monopolistic access to any information relevant for price formation are reviewed.[1] We shall conclude that, with but a few exceptions, the efficient markets model stands up well.

Though we proceed from theory to empirical work, to keep the proper historical perspective we should note to a large extent the empirical work in this area preceded the development of the theory. The theory is presented first here in order to more easily judge which of the empirical results are most relevant from the viewpoint of the theory. The empirical work itself, however, will then be reviewed in more or less historical sequence.

Finally, the perceptive reader will surely recognize instances in this paper where relevant studies are not specifically discussed. In such cases my apologies should be taken for granted. The area is so bountiful that some such injustices are unavoidable. But the primary goal here will have been accomplished if a coherent picture of the main lines of the work on efficient markets is presented, along with an accurate picture of the current state of the arts.

* Research on this project was supported by a grant from the National Science Foundation. I am indebted to Arthur Laffer, Robert Aliber, Ray Ball, Michael Jensen, James Lorie, Merton Miller, Charles Nelson, Richard Roll, William Taylor, and Ross Watts for their helpful comments.

** University of Chicago—Joint Session with the Econometric Society.

1. The distinction between weak and strong form tests was first suggested by Harry Roberts.

Fama, "Efficient Capital Markets: A Review of Theory and Empirical Work," *Journal of Finance* (1970).

Passive investing & the efficient-markets view

- 1970s view: price is correct, reflects all info
- Implications for portfolio construction
- How practitioners implement
  - → Should pension funds have active managers?
  - → Use ETFs/index funds; manage tracking error, turnover
- When active can add value
  - → Less-efficient segments, constraints/illiquidity, structural frictions
  - → performance must survive fees and trading costs

ECONOMETRICA
VOLUME 47 MARCH, 1979 NUMBER 2

PROSPECT THEORY: AN ANALYSIS OF DECISION UNDER RISK

BY DANIEL KAHNEMAN AND AMOS TVERSKY[1]

This paper presents a critique of expected utility theory as a descriptive model of decision making under risk, and develops an alternative model, called prospect theory. Choices among risky prospects exhibit several pervasive effects that are inconsistent with the basic tenets of utility theory. In particular, people underweight outcomes that are merely probable in comparison with outcomes that are obtained with certainty. This tendency, called the certainty effect, contributes to risk aversion in choices involving sure gains and to risk seeking in choices involving sure losses. In addition, people generally discard components that are shared by all prospects under consideration. This tendency, called the isolation effect, leads to inconsistent preferences when the same choice is presented in different forms. An alternative theory of choice is developed, in which value is assigned to gains and losses rather than to final assets and in which probabilities are replaced by decision weights. The value function is normally concave for gains, commonly convex for losses, and is generally steeper for losses than for gains. Decision weights are generally lower than the corresponding probabilities, except in the range of low probabilities. Overweighting of low probabilities may contribute to the attractiveness of both insurance and gambling.

1. INTRODUCTION

EXPECTED UTILITY THEORY has dominated the analysis of decision making under risk. It has been generally accepted as a normative model of rational choice [**24**], and widely applied as a descriptive model of economic behavior, e.g. [**15**, **4**]. Thus, it is assumed that all reasonable people would wish to obey the axioms of the theory [**47**, **36**], and that most people actually do, most of the time.

The present paper describes several classes of choice problems in which preferences systematically violate the axioms of expected utility theory. In the light of these observations we argue that utility theory, as it is commonly interpreted and applied, is not an adequate descriptive model and we propose an alternative account of choice under risk.

THE UTILITY OF WEALTH[1, 2]

HARRY MARKOWITZ
The RAND Corporation

1.1. Friedman and Savage[3] have explained the existence of insurance and lotteries by the following joint hypothesis:

(1) Each individual (or consumer unit) acts as if he (*a*) ascribed (real) numbers (called utility) to every level of wealth[4] and

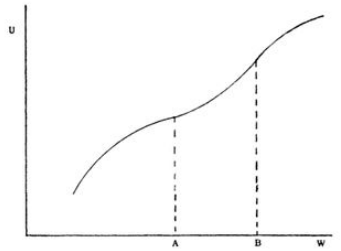


FIG. 1

(*b*) acts in the face of known odds so as to maximize expected utility.

(2) The utility function is as illustrated in Figure 1. We may assume it to be a continuous curve with at least first and second derivatives.[5] Let U be utility and W be wealth. Below some point A, $(\partial^2 U)/(\partial W^2) < 0$; between A and B, $(\partial^2 U)/(\partial W^2) > 0$; above B, $(\partial^2 U)/(\partial W^2) < 0$.

To tell geometrically whether or not an individual would prefer W_0 with certainty or a "fair"[6] chance of rising to W_1 or falling to

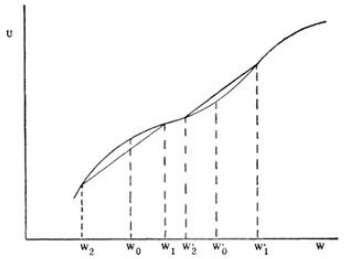


FIG. 2

Kahneman & Tversky (1979, *Econometrica*) "Prospect Theory: An Analysis of Decision under Risk"

Markowitz (1952) "The Utility of Wealth"

Behavioral Finance

- Markowitz: “grandfather of behavioral finance”
- Implications for portfolio construction
  - → rule-based rebalancing to curb the disposition effect.
- How practitioners implement
  - → Defaults (auto-enroll, dollar cost averaging), simple guardrails and alerts to prevent panic trades & overreaction.
- Should pension funds add behavioral design?
  - → Yes—glidepaths, auto-rebalancing, and member comms
- Efficient market theory inconsistent with too many real-world examples

You have doubts about the value of academic research to practitioners? not any more, I hope

- Lots of marginal, unimportant work, but…..
- The “home runs” of academia have changed practice & benefited society
- There will be more home runs in the future & industry will adopt them