Review Essay

Misunderstood Derivatives: The Causes of Informational Failure and the Promise of Regulatory Incrementalism


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INTRODUCTION

New financial products are being introduced throughout the industrialized world at an unprecedented rate. Innovation has been especially striking in the market for over-the-counter (OTC) derivatives, a type of financial contract

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2. The term "derivatives" is more fully defined at infra notes 26-28 and accompanying text.
individually negotiated among major financial institutions and between such institutions and their sophisticated clients. This market serves as a hothouse for world financial innovation; complex, state-of-the-art products of Wall Street "rocket scientists" often emerge here to appear later in standardized form on organized exchanges. The OTC derivatives market has enjoyed enormous growth. On a crude, "notional amount" basis the market for selected OTC derivatives reached four trillion dollars by year-end 1991, eight times its level five years before. The notional amount of outstanding "swaps," one important genus of derivatives, now exceeds the combined value of all shares listed on the New York and Tokyo stock exchanges. Such activities are concentrated in those large, money center financial institutions central to the

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3. While I will be focusing on banks, other financial institutions and even industrial corporations are also dealers in this market. For instance, AIG Financial Products Corporation, a subsidiary of an insurance holding company, offers a variety of interest rate, currency, commodity and equity derivatives. AMERICAN INTERNATIONAL GROUP, 1991 ANNUAL REPORT 28 (1992); Conference Discusses Challenges to Common Regulatory Approach, 6 Int'l Sec. Reg. Rep. (Oceana) 5-6 (1992) (hereinafter Common Regulatory Approach) (noting industrial corporations acting as dealers).

4. Although it has happened rarely, extremely wealthy individuals have participated in this market. See, e.g., Salomon Forex v. Tauber, 795 F. Supp. 768 (E.D. Va. 1992) (individual with over "half a billion dollars" involved in OTC currency options).


6. Broadly speaking, with a derivative, how much one party to the transaction pays to the other party is calculated by reference to, among other things, the "notional amount" or "notional principal amount." For an example using interest rate swaps, see infra note 44. The size of derivatives markets is usually measured in the notional amounts outstanding, more because of the relative availability of such figures than because of their accuracy as proxies for market values. See, e.g., Henry T.C. Hu, Swaps, the Modern Process of Financial Innovation and the Vulnerability of a Regulatory Paradigm, 138 U. Pa. L. Rev. 333, 347-53, 391 (1989) (hereinafter Hu, Regulatory Paradigm) (explaining "notional amount" in swaps context). cf infra 13 (comparing notional amounts and credit risks of certain derivative portfolios).


8. The swap is a form of exchange of future cash flows that was introduced about a decade ago. Hu, Regulatory Paradigm, supra note 6, at 363-64; Miller, supra note 1, at 6. Swaps are more fully defined infra text accompanying notes 43-44.


10. One April 1992 survey found that the ten largest players appear to account for three-quarters of the turnover in OTC currency options. Federal Reserve Bank of New York, supra note 7, at 11. In 1989,
world’s financial system. The size of these markets and the prominence of the market players mean that the stakes in the derivatives game are high. Moreover, because they are novel, complex, and opaque, derivatives activities look risky, certainly riskier than the real estate lending that contributed to the most recent banking crisis.

Thus, it is not surprising that regulatory concern over OTC derivatives activity has grown along with the OTC derivatives market. Specifically, the pioneering 1988 international capital adequacy standards for commercial banks included provisions for the “credit risks” created by these nontraditional financial products. A second round of international regulatory action appears possible, if not imminent. Some industry leaders and regulators worry that

about 70% of the global swap exposure was concentrated in ten United States banks. Louise Ireland, Counting on Your Counterparty, CORP. FIN., Mar. 1989, at 31.


Commodities and securities regulators have moved more slowly on new financial products, although the derivatives activities of investment banks (and their affiliates engaging in OTC derivatives transactions) may eventually also be subject to capital adequacy requirements. See, e.g., Kevin G. Salwen, Safeguards Aim to Avert Another Crash, WALL ST. J., Oct. 16, 1992, at C1; Full Agreement on Capital Rules Eludes IOSCO Members at Annual Meeting, 24 Sec. Reg. & L. Rep. (BNA) 1714 (Nov. 6, 1992); J. Carter Beese, Jr., The Derivatives Debate: Where Do We Go From Here, Remarks at Risk Magazine/C.ATS Software Symposium 2, 8 (Dec. 1, 1992) (unpublished manuscript, on file with author).

OTC derivatives could cause the next great banking crisis, and major governmental studies on the risks posed by derivatives are now under way on three continents. These studies come during a comprehensive rethinking of financial markets, and financial instruments are conspicuous, financial innovation also has important legal implications outside of the “paper economy.” I have previously shown, for instance, the effects of new financial products and the underlying process of financial innovation on the fundamental state corporate law principle that corporations should be run primarily for the benefit of shareholders. See Henry T.C. Hu, New Financial Products, the Modern Process of Financial Innovation, and the Puzzle of Shareholder Welfare, 69 TEX. L. REV. 1273, 1311-12 (1991) [hereinafter Shareholder Welfare]; cf. Joseph A. Grundfest, The Limited Future of Unlimited Liability: A Capital Markets Perspective, 102 YALE L.J. 387, 410-16 (1992) (noting likely effect of financial innovation process on proposed change in state corporate law that would curb limited liability).


the regulation of commercial banks,\textsuperscript{15} investment banks,\textsuperscript{16} and capital markets\textsuperscript{17} in America.

Closer analysis of regulatory concerns leads to a striking puzzle and a corresponding dilemma. Many regulators—as well as some bankers—believe that, too often, bankers know too little about the risks their derivatives pose to the banks themselves.\textsuperscript{18} Indeed, the immediate impetus for massive regulatory efforts came when Gerald Corrigan, the president of the Federal Reserve Bank of New York, warned a group of assembled bankers that they had “all better take a very, very hard look at off-balance sheet activities” and that such activities “must be understood by top management, as well as by traders and rocket scientists.”\textsuperscript{19} This poses the puzzle: how could banks suffer from such

\textsuperscript{15} This rethinking is reflected in both legislation and scholarly analysis. See generally FDIC Improvements Act, supra note 12 (reforms relating to safety and soundness of commercial banks); Risk-Based Capital Standards, supra note 11; LOWELL L. BRYAN, BANKRUPT: RESTORING THE HEALTH AND PROFITABILITY OF OUR BANKING SYSTEM (1991); HELEN A. GARTEN, WHY BANK REGULATION FAILED: DESIGNING A BANK REGULATORY STRATEGY FOR THE 1990S (1991); JAMES L. PIERCE, THE FUTURE OF BANKING (1991); cf SHARON STANGENES, Loyola Economist Has Window to D.C., CHIC. TRIB., Dec. 20, 1992, at C1 (some call FDIC Improvements Act “most important bank legislation since the Depression”).

\textsuperscript{16} Some of the activities engaged in by broker-dealer holding companies and affiliates have hitherto been unregulated or loosely regulated. This is beginning to change, prompted in part by the collapse of Drexel Burnham Lambert and by the Market Reform Act of 1990, Pub. L. No. 101-432, 104 Stat. 963 (1990); cf. GENERAL ACCOUNTING OFFICE, SECURITIES FIRMS: ASSESSING THE NEED TO REGULATE ADDITIONAL FINANCIAL ACTIVITIES 2-8 (1992) (calling for study of whether unregulated financial activities of broker-dealer holding companies and affiliates warrant additional regulation). The Securities and Exchange Commission (SEC) has adopted “temporary” rules under Section 17(h) of the Securities Exchange Act of 1934 intended to provide the SEC with information about the affiliates of broker-dealers, including their derivatives activities. Final Temporary Risk Assessment Rules, 57 Fed. Reg. 32,159 (1992) (to be codified at 17 C.F.R. §240.17h-1T to -2T); see also 15 U.S.C. § 78q(h) (Supp. II 1990).


\textsuperscript{18} See, e.g., BANK FOR INTERNATIONAL SETTLEMENTS, 62ND ANNUAL REPORT (1ST APR. 1991-31ST MAR. 1992) 184 (Basle, June 15, 1992) (noting regulators’ worry that participants do not properly understand and manage risks); Common Regulatory Approach, supra note 3, at 6 (quoting chairman of Deutsche Bank as saying “I doubt whether all regulators and indeed all market participants already fully understand the risks related to derivatives.”); Fiske, supra note 13, at 213 (quoting Felix Rohaytn as saying that “[n]ew financial instruments have created unknown risks” and that “[f]ew understand these multiparty, multicountry derivatives”); Hansell & Muehring, supra note 13 (noting how some bankers admit they do not know full scope of potential losses); Hu, Regulatory Paradigm, supra note 6, at 369-70 and 370 n.97 (noting regulatory and banker concerns); Peter Lee, How to Exorcise Your Derivative Demons, EUROMONEY, Sept. 1992, at 36, 37 (noting one derivatives manager suspects even “some of the supposedly sophisticated dealers” may not understand risks); Steven Lipin & William Power, “Derivatives” Draw Warnings from Regulators, WALL ST. J., Mar. 25, 1992, at CI, C9 (“Regulators worry that the latest derivatives, many designed using advanced computer programs, have become so complex that neither regulators nor traders’ bosses fully understand them.”).

systematic informational failures? Banks have put many of their best and brightest to work on these new financial products. How could such knowledgeable sellers, as opposed to investors or consumers, not have adequate information?20

Although there is neither consensus nor conclusive evidence regarding the existence of such structural informational failure on the part of banks, there is no such disagreement regarding regulatory informational failure. Observers agree that regulators know less than the bankers and that they know too little.21 One senior Bank of England official remarked that this knowledge gap is “too great for normal communication.”22 It is difficult for regulators to understand the risks of any individual derivative transaction with certainty, much less the risks of more complex derivative transactions or a bank’s entire portfolio of derivative transactions. If the puzzle is why banks know so little, then the dilemma is how can regulators, who know even less, be effective. How can the blind guide the nearsighted?

A clear understanding of the underpinnings of modern finance theory is necessary for a cogent exploration of the puzzle and the dilemma. With this in mind, I begin this Review Essay with a brief introduction to derivative valuation. I then rely in part on Peter Bernstein’s Capital Ideas, the first detailed account of the emergence of financial science,23 for this young discipline’s historical context. This Essay then proceeds to its basic analytic framework for explaining the puzzle of banker informational failure, beginning with the premise that information is a commodity created from a production process built upon this new financial science.24
To partially explain the puzzle, I analyze banker informational failure from several different perspectives. From an economics standpoint, I apply "inappropriability" and other theories pertaining to commercial scientific research to illuminate allocative problems arising from the production process. From a psychological standpoint, I discuss how cognitive biases might explain underproduction of information relevant to certain kinds of risks, especially legal ones. From the principal-agency perspective, I show how the same theories that would normally imply excessive managerial aversion to risk-taking and underinvestment, could, when applied to the OTC derivatives context, lead to excessive risk-taking and overinvestment.

This Review Essay has the secondary objective of sketching possible pathways to resolving the dilemma. The differences between financial science and traditional science suggest that original government research can only play a limited role. The differences also provide fresh reasons for why information flows unevenly to regulators, and they highlight the concomitant importance of institutionalizing the transfer of financial technology from the private sector to the government.

With these limitations in mind, I conclude by offering four pathways for ameliorating possible banker and regulator informational failures. They are "incrementalist" in the sense that they involve gradual, reversible change, which should help avoid any unintentional destruction of social wealth. My hope is that these proposals will serve as springboards for more extended analysis by regulators, market participants, and academics.

I. THE "DERIVATIVE" AND BANK-SPECIFIC RISK:
SOME NUTS AND BOLTS

A. The Derivative and Clairvoyance

1. The Derivative and its Uses

A "derivative" is simply a contract that either allows or obligates one of the parties (the "end-user") to buy or sell an asset. Naturally, movements in the value of the underlying asset affect the value of such a contract. Indeed, the contract’s defining characteristic is that its value derives from the value of


25. "Inappropriability" is defined in Section II(B)(1) infra.

the "underlying," be it a specific stock, commodity, stock index, interest rate, or exchange rate.

Many derivatives are traded on organized exchanges; an individual can purchase them with a call to a broker. As with the purchase of shares of stock on an exchange, the end-user need not worry about who is on the other side of the transaction. Generally speaking, not only must these exchange-traded derivatives have standardized contractual terms, they also must generate enough trading activity to support a liquid market.

Sophisticated end-users, typically corporations and sovereign entities, can participate in an alternative market. They can negotiate directly with the finance divisions of some industrial corporations, various financial institutions, or, most frequently, money center banks. These contracts comprise the "over-the-counter" or "OTC" derivatives market. Since there are no clearinghouse arrangements in this market, the end-user must be confident that the dealer is creditworthy and will honor its contractual commitments—the price of contractual freedom is a greater risk of default.

From a private perspective, derivatives serve several financial functions.

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29. Private individuals are generally unable to enter into derivative transactions with banks. Cf. supra note 4 (describing Salomon Forex litigation). For example, the average contract size for interest rate swaps at year end 1991 was $30 million. See Arthur Andersen & Co, SC, ISDA - International Swap Dealers Association, Inc. - Market Survey Highlights Year End 1991 (unpublished manuscript, on file with author).

30. Some financial institutions have established highly rated derivatives subsidiaries to enter into transactions with their customers. Merrill Lynch Derivative Products Inc., STANDARD & POOR'S CREDITWEEK, May 18, 1992, at 35. The Chicago Board of Trade has recently moved to allow the Board of Trade Clearing Corporation to guarantee traded swaps. Floyd Norris, Chicago Board Set to Enter Swaps Market, N.Y. TIMES, Jan. 13, 1993, at C5; cf. Hu, Regulatory Paradigm, supra note 6, at 417 n.265 (discussing possibility of clearinghouse arrangements for OTC derivatives); Kenneth M. Raisler, Swaps Clearinghouse: The Next Frontier, FUTURES INDUSTRY, Nov/Dec. 1992, at 15 (same).


Financial innovation also has social costs. It may, for example, cause volatility in certain cash markets. Aswath Damodaran & Marti G. Subrahmanyam, The Effects of Derivative Securities on the Markets for the Underlying Assets in the United States: A Survey, FIN. MARKETS, INSTITUTIONS & INSTRUMENTS, Dec. 1992, at 1. There are more subtle social costs as well. For example, financial innovation may contribute to short-termism in managerial behavior and confusion in the application of classic principles of fiduciary duty. Hu, Shareholder Welfare, supra note 12, at 1286-1309. It is also unclear
First, lower transaction costs can mean that the derivative is a cheaper alternative to investing in the underlying asset. Second, end-users may be able to arbitrage differences between the price of the derivative and the price of the underlying asset, or between prices in different capital markets. Third, and perhaps most important, derivatives enable end-users to transfer or modulate their market risks—risks that appear to have been particularly high in recent years. For instance, currency exchange rate volatility increased with the breakdown of the Bretton Woods system in 1973 and increased further in the 1980’s. Similarly, interest rate volatility has reached unprecedented levels, higher than even the period just before 1929. Commodity price volatility in the late 1970’s and 1980’s far exceeded the volatility experienced in the 1950’s and 1960’s.

Derivatives can insulate end-users from exogenous risks—a derivative that rises in value if oil prices fall could protect a sheikdom, while one that rises along with oil prices will insulate an airline. End-users may prefer a world where their market risks have, in effect, gone away. To accomplish this end, they use two basic types of contracts as “building blocks” to create a wide variety of derivatives. “Option-based products” provide price insurance whether it is socially useful to devote so many human and other resources to this one set of activities. See Summers & Summers, supra, at 270-72 (arguing that too many resources are being devoted to financial engineering).

32. See, e.g., Fabozzi & Modigliani, supra note 26, at 181-82 (often futures market is cheapest way to adjust portfolio); OFFICE OF TECHNOLOGY ASSESSMENT, ELECTRONIC BULLS AND BEARS: U.S. SECURITIES MARKETS AND INFORMATION TECHNOLOGY 76-80 (1990) (comparing relative costs of buying stocks of Standard & Poor’s 500 versus corresponding index futures).


34. The traditional explanation for the existence of swaps focuses on the arbitrage of the differences between the capital market for fixed rate borrowing and the capital market for floating rate borrowing. Hu, Regulatory Paradigm, supra note 6, at 350-53.

35. Fabozzi & Modigliani, supra note 26, at 7. It is important not to exaggerate the private benefits of being able to hedge against such market risks. For example, in certain circumstances, well-diversified shareholders do not necessarily benefit when a healthy, publicly held corporation purchases a new financial product that insulates the corporation from interest rates, exchange rates, commodity prices, or other risks. There can be a tension between what is good for the corporate entity and what is good for well-diversified shareholders. See, e.g., Gunter Dufey & S. L. Srinivasulu, The Case for Corporate Management of Foreign Exchange Risk, Fin. Mgmt., Winter 1983, at 54; Hu, Shareholder Welfare, supra note 12, at 1306-09; David Mayers & Clifford W. Smith, Jr., On the Corporate Demand for Insurance, 55 J. Bus. 281 (1982).


37. Id. at 9.


39. Texas has purchased hedges against drops in the price of oil. Anita Raghavan, States Hitting Options Pits to Hedge Risk, WALL ST. J., Sept. 8, 1992, at C1. As of the end of 1991, governments worldwide were party to about $166 billion notional amount of interest rate swaps and $97 billion notional amount of currency swaps. BANK FOR INTERNATIONAL SETTLEMENTS: MONETARY AND ECONOMIC DEVELOPMENT, INTERNATIONAL BANKING AND FINANCIAL MARKET DEVELOPMENTS DURING THE SECOND QUARTER OF 1992 86-87 (Nov. 1992).

giving the owner of the contract the right, but not the obligation, to buy an asset at a specified price.\textsuperscript{41} The obligation is one-sided and the owner of the option pays a fee—the "option price." "Forward-based products" freeze the price of the underlying asset. One party agrees to sell and the other party agrees to buy an asset at a specified price at a specified future time, and neither party pays any fee.\textsuperscript{42}

The type of derivative that has sparked much of the current regulatory concern is a forward-based product called a "swap."\textsuperscript{43} In a swap, one party agrees to provide a sequence of cash flows and in return the other party provides a different sequence of cash flows. Careful specification of the nature, timing, and amount of this swap of cash flows can insulate the end-user from an adverse movement in, say, interest rates; in such a case, the contract is called an interest rate swap.\textsuperscript{44} Similar exchanges may protect against movements in exchange rates, commodity prices, or stock prices.

2. Valuation and the Need for Clairvoyance

In order to demonstrate quickly the difficulty of evaluating the financial risks of OTC derivatives, this Section focuses on the "plain vanilla" option, the simplest of all derivatives and a fundamental building block of many of the more sophisticated derivatives.\textsuperscript{45} Since evaluating the risks associated with this simple derivative is far more difficult than evaluating the risks created by a bank loan, it follows that evaluating the risks of more typical derivatives would usually be even more difficult.\textsuperscript{46}

\begin{enumerate}
\item[41.] Fabozzi & Modigliani, supra note 26.
\item[42.] Id.; SUSAN ROSS MARKI, DERIVATIVE FINANCIAL PRODUCTS 5, 13-16 (1991).
\item[43.] MARKI, supra note 42, at 5; cf. Satyajit Das, Futures strips, CORP. FIN., July 1991, at 12 (noting replication of interest rate swaps via a series of futures contracts); James McNulty, The Pricing of Interest Rate Swaps, 4 J. FIN. SERV. RES. 53, 56 & 61 (1990) (considering swap as package of forward contracts).
\item[44.] Interest rate swaps are individually negotiated agreements between two parties (such as a bank and a corporation) whereby they agree to make periodic exchanges of "interest" on a purely hypothetical—"notional"—principal amount. Assume a corporation has just issued $100,000,000 of floating rate debt securities maturing in five years; subsequent polls show that a Keynesian candidate may win the White House. Concerned about a possible rise in interest rates, the corporation may enter into an "interest rate swap" whereby it agrees to pay to the bank a fixed 7 percent "interest" on a "notional" amount of $100,000,000 every year for five years in return for the bank paying the corporation "interest" on the same notional amount equal to the prime rate every year for five years. Working out the cash flow, one can show that the corporation has effectively converted its floating rate debt to fixed rate debt. See Hu, Regulatory Paradigm, supra note 6, at 347-53.
\item[45.] RICHARD M. BOOKSTABER, OPTION PRICING AND INVESTMENT STRATEGIES viii (3d ed. 1991) ("Options can be created, and once created, they can be combined to give a limitless variety of financial payoffs."); cf. Miller, supra note 24, at 463-64 (options are "more basic and fundamental securities than futures contracts").
\item[46.] But cf. Saul Hansell, The Risk Collectors, INSTITUTIONAL INVESTOR, Sept. 1992, at 57 (noting options can be more difficult to hedge than swaps).
\end{enumerate}
The two most important kinds of risks associated both with OTC derivatives and with traditional bank lending are "credit risk" and "market risk."47 When a bank loans money to a corporation, the "credit risk" is the risk that the corporation will fail to perform its obligations; the "market risk" is the risk that interest rates or other market factors will move adversely. With a loan, the sum of the principal and the accrued interest usually represents the maximum amount that can be lost. Thus, the credit risk is both fairly well defined and constant. Also, the market risk of unfavorable movements can be minimized by bankers; for instance, floating rate loans can be funded by the bank with money obtained on a floating rate basis.

The situation is more complicated when a bank sells an option to a corporation. Suppose the corporation buys a call option; what it is purchasing is the right to buy an asset at a specific price at any time before the expiration date.48 Since the contractual obligations run solely in favor of the buyer, the corporation has to pay the bank for the privilege of entering into the transaction; the price paid is the option premium.

What are the primary risks for the buyer of an option? For the buyer, the primary risk to be quantified is credit risk: the buyer must worry about whether the seller—or "writer"—will fail to perform. At a minimum, the credit risk would be equal to the amount the buyer could realize from immediately exercising the option. This is, rather confusingly, referred to as the "intrinsic value"49 of the option.

In fact, the value of the option, and thus the buyer's credit exposure, is higher because the buyer has the additional right simply to wait to see if the underlying's value continues to change. This additional right accounts for the "time value" of the option, an amount that is extremely difficult to quantify. Determining the value of the option is impossible without knowing the probability distribution of the possible prices for the underlying at maturity or the appropriate risk-adjusted interest rate to use in discounting the expected payoff on the option.50 In sum then, the buyer of the option is subject to a credit risk equal to the market value of the option, but, unless one knows the...

47. There are also other risks associated with bank activities, such as liquidity risk. See, e.g., Securities Derivatives: Risks and Opportunities, MOODY'S SPECIAL COMMENT, Jan. 16, 1991 (discussing management, regulatory, and liquidity risks associated with derivatives); Credit Implications for Firms That Use Derivatives, MOODY'S SPECIAL COMMENT, Nov. 1991 (same); see infra notes 254-63 and accompanying text (discussing Mertonian universalism and liquidity); see also infra note 126.

48. Colloquially, this is known as an "American-style option." With a "European-style option," the corporation would only be able to exercise the option on the expiration date itself. For an excellent and brief introduction to options, from which the sketch in the text is primarily drawn, see James B. Bittman, Fundamentals of Options, in OPTIONS: ESSENTIAL CONCEPTS AND TRADING STRATEGIES 29 (The Options Institute ed., 1990).

49. In the options context, unlike the common stock context, the "intrinsic value" does not refer to its "true value" or "fundamental value."

50. See, e.g., Stephen Figlewski, Theoretical Valuation Models, in FINANCIAL OPTIONS: FROM THEORY TO PRACTICE 77-78 (Stephen Figlewski et al. eds., 1990) (noting that difficulty of valuing options was inability to calculate either probability distribution of future price or appropriate discount rate).
future, it appears impossible to quantify the "time value," and hence, the market value of the option.

What are the primary risks for the seller of the option? For the seller, the primary risk is not credit risk, but market risk. In fact there is no credit risk, because the holder of the option has no obligations to the writer of the option. There is, however, an immense market risk, which is the risk that the value of the underlying asset will move in the wrong direction; losses are potentially unlimited. Historically, this risk has proven disastrous for some sellers.51

It is extremely risky for a seller to absorb the entire market risk of writing an option. In the case of currency options, it would be akin to gambling on the direction of currency prices; given the threat of unlimited losses, one cannot afford to be wrong. Banks usually attempt to hedge market risks. The easiest strategy is for the bank simply to purchase an option identical in all attributes to the one the bank wrote. Unfortunately, this approach leaves little room for profit (except commissions).52 Absent reliance on such a low-profit strategy, the bank would seem hard pressed to quantify or to hedge properly the market risk of an option.

Without the conceptual breakthrough that allowed the OTC derivatives market to emerge, there would be large obstacles to a bank's engaging in a broad range of derivative transactions.53 A bank seeking to buy or sell an option would not know what price to pay or to charge; nor would it have had a viable hedging strategy. Acting as a derivatives dealer would appear even more difficult in the real world. Bank customers may demand derivatives far more sophisticated than the "plain vanilla" option described above. The risks of these instruments could be yet more difficult to quantify. Moreover, banks would not be parties to only a single derivative transaction, but would have hundreds or thousands of such transactions in their portfolios. The overall credit and market risks of a portfolio are by no means equal to the sum of the credit and market risks associated with each of the transactions within it.54

To begin systematically offering a broad range of derivatives, banks needed a conceptual breakthrough. In 1973, Fischer Black and Myron Scholes provided the breakthrough with their option pricing model. Grounded in certain assumptions about arbitrage, their option pricing model generated an exact

51. In March 1991, a British conglomerate sold dollar call/sterling put options in anticipation of the dollar weakening. Instead, the following month the dollar strengthened, leading to a 147 million pound foreign exchange loss. Simon Brady, Allied-Lyons' Deadly Game, EUROMONEY, Apr. 1991, at 22; Ed Rambach, Naked and Unashamed, RISK, June 1992, at 45.
52. STUDY GROUP ESTABLISHED BY THE CENTRAL BANKS OF THE GROUP OF TEN COUNTRIES, supra note 24, at 77.
53. Other OTC derivatives create analogous credit and market risks. For discussion of these issues, see James Bicksler & Andrew H. Chen, An Economic Analysis of Interest Rate Swaps, 41 J. Fin. 645 (1986); Ian A. Cooper & Antonio S. Mello, The Default Risk of Swaps, 46 J. Fin. 597 (1991); Hu, Regulatory Paradigm, supra note 6, at 357-63; Robert H. Litzenberger, Swaps: Plain and Fanciful, 47 J. Fin. 831 (1992).
54. See infra notes 136-37 and accompanying text.
theoretical price for the market value of options. Whatever the model’s accuracy, it finally provided a rational basis for pricing options. However, I am getting ahead of my story. The central focus of this Review Essay is informational failure regarding credit and market risks. Simply understanding the current menu of pricing models and associated hedging strategies is not enough. In fact, historical factors play an important role; the recent emergence of finance as a science and the peculiarities of this science have helped create the conditions for informational failure. I turn briefly to the story of this emergence, some characteristics that make modern finance inaccessible, and then return to option pricing theory.

B. Finance as a Science

1. The Emergence of Financial Science

The theories at the core of the new financial science grew out of work begun in the 1950’s.55 The intellectual history of this period is an important one, recounted with wit and elegance in Peter Bernstein’s Capital Ideas: The Improbable Origins of Modern Wall Street.56 The first comprehensive history of modern finance,57 the book is useful for lay readers and academics alike. Indeed, one of its most remarkable qualities is its accessibility to lay readers; there is little jargon and only one mathematical equation. Moreover, by his focus on the personalities and backgrounds of the individuals who populate his story, the author makes the reader a vicarious participant in the development of these theories. This style not only enlivens the book, but also enables lay readers to follow the development of various financial theories much as they would follow the story line of a novel.

Judges and practitioners will find the book useful since they, of necessity, have become familiar with the cornerstone theories of modern finance Bernstein discusses. The “efficient markets” hypothesis, with its description of how share prices reflect publicly available information, underlies much of securities regulation.58 “Portfolio theory,” which explains how risks of individual investments tend to offset each other, facilitates rational application of the prudent investor rule.59 Distinctions between systematic and

55. Harry Markowitz’s 1952 article on portfolio effects marks the beginning of modern finance theory. Harry Markowitz, Portfolio Selection, 7 J. Fin. 77 (1952); cf. BERNSTEIN, supra note 23, at 41 (referring to the article as “[t]he most famous insight in the history of modern finance”).
56. BERNSTEIN, supra note 23.
unsystematic risk under the “capital asset pricing model” implicate the core fiduciary principles of corporate management.60 “Option pricing theory” helps lawyers interpret new rules on disclosure of executive compensation61 and explain and channel managerial behavior.62 Bernstein’s book, then, can serve as an accurate guide to many financial theories that are important to the formulation and application of law.63

Capital Ideas should be useful to academics as well.64 Though he was present at the revolution—as an investment counselor and as the first editor of the Journal of Portfolio Management—Bernstein does not rely solely on his personal experience and knowledge of theory; his extensive interviews with most of the academics central to the revolution in finance65 yield a number of fascinating insights into the heart of the creative process.66

Bernstein’s work illuminates two of the features of modern financial science that are relevant to understanding the informational failures at the core of this Review Essay. First, the mathematical sophistication that informs work

62. See, e.g., Hu, Fiduciary Principles, supra note 60, at 327-29.
63. My substantive concerns about Capital Ideas relate primarily to its omission of certain topics. Discussion of two particular topics would have been useful to lawyers. “Agency theory,” the analysis of incentive conflicts in contractual relationships, is a prominent issue in the legal literature of contracts and corporate governance. Cf. Clifford W. Smith, Jr., The Theory of Corporate Finance: A Historical Overview, in THE MODERN THEORY OF CORPORATE FINANCE 4 (2d ed. Clifford W. Smith ed., 1990) (naming option pricing theory along with efficient markets theory, agency theory, portfolio theory, and capital asset pricing theory as the “major building blocks of the modern theory of financial economics”). From a legal perspective, the key article is Michael C. Jensen & William H. Meckling, Theory of the Firm: Managerial Behavior, Agency Costs, and Ownership Structure, 3 J. Fin. Econ. 305 (1976); see also infra Section II(D).
I also think Bernstein should have dealt with “informational asymmetry,” which occurs when agents in the economy are differentially informed. See, e.g., Stewart C. Myers & Nicholas S. Majluf, Corporate Financing and Investment Decisions When Firms Have Information That Investors Do Not Have, 13 J. Fin. Econ. 187 (1984); see also infra note 239.

More generally, Bernstein should also have devoted more attention to theoretical developments relating to the bond market. Bernstein recognized this and has promised to “make up for that omission on an early occasion.” Bernstein, supra note 23, at x. For an introduction to these developments, see, e.g., FIXED INCOME ANALYTICS: STATE-OF-THE-ART DEBT ANALYSIS AND VALUATION MODELING (Ravi E. Dattatreya ed., 1991).
65. Bernstein interviewed such notable academics (or former academics) as Fischer Black, Eugene Fama, Hayne Leland, Harry Markowitz, Robert C. Merton, Merton Miller, Franco Modigliani, Barr Rosenberg, Mark Rubinstein, Paul Samuelson, Myron Scholes, William Sharpe, and James Tobin. Bernstein, supra note 23, at ix.
66. See, e.g., Bernstein, supra note 23, at 55-57 (interview with A. D. Roy who published article on portfolio effects three months after Markowitz); id. at 60 (describing Markowitz’s difficult defense of his dissertation); id. at 130 (recounting MIT’s rejection of actual stock exchange tape of every transaction from 1900 onwards because paper would have filled faculty lounge).
in the physical sciences and in economics has finally touched finance.\textsuperscript{67} Thirty years ago, even the grossest descriptive statistics about common stock movements were unavailable. For example, there was no comprehensive measurement of the long-term returns of equities on the New York Stock Exchange until James Lorie and Lawrence Fisher published their famous 1964 article.\textsuperscript{68} Academics and practitioners had assumed the returns were far lower than the nine percent they found. In addition, there were no quantitative analyses of the actual value added by investment professionals. As late as 1968, one prominent money manager believed that investment advisors could "get better than average results over a fairly long period of time—consistently."\textsuperscript{69} It was considered bizarre to believe that "beating the market" was difficult because stock prices rapidly assimilated all available information.\textsuperscript{70}

Second, the level of conceptualization in financial methodology, quite aside from mathematical sophistication, has increased drastically. Prior to the 1960's, most courses in graduate schools of business did not use theoretical models,\textsuperscript{71} and most of the articles published in finance journals were descriptive, relying on ordinary language and reasoning.\textsuperscript{72} There was little distinction between the articles written by academics and those written by practitioners; officers of the American Finance Association were employed by both universities and financial institutions.\textsuperscript{73}

\begin{itemize}
\item \textsuperscript{69} \textit{Bernstein, supra} note 23, at 133.
\item Bernstein noted that investment professionals used to joke that they were social workers to the rich. Bernstein, \textit{supra} note 23, at 10. Today, with chastening empirical evidence of the actual performance of investment professionals, some sophisticated observers have begun to explain the existence of such professionals on the basis of their schmoozing services. See Josef Lakonishok et al., \textit{The Structure and Performance of the Money Management Industry}, BROOKINGS PAPERS ON ECON. ACTIVITY: MICROECONOMICS 339, 375 (1992).
\item \textsuperscript{71} Whiteley, \textit{supra} note 57, at 173.
\item \textsuperscript{72} \textit{Id.} at 172. Bernstein reports that he could find no more than five articles that could be classified as theoretical rather than descriptive in the issues of the 	extit{Journal of Finance} up to 1959. Bernstein, \textit{supra} note 23, at 42; cf. Terry L. Zivney & William J. Bertin, \textit{Publish or Perish: What the Competition is Really Doing}, 47 J. Fin. 295, 305 (1992) (referring to \textit{Journal of Finance} as one of the top three finance journals).
\item \textsuperscript{73} Whiteley, \textit{supra} note 57, at 173.
\end{itemize}
Today, all directors and officers of the American Finance Association are academics. The articles in the finance journals are now more abstract and restricted to those with academic training in theory and mathematics. Finance scholars work on problems that have attracted the best economists, and they have even received the Nobel prize. In sum, the world of finance now looks quite different; it is more abstract, more theoretical, and more arcane.

2. The Breakthrough: Option Pricing Theory

In 1900, Louis Bachelier, a young French mathematician, completed his doctoral dissertation at the Sorbonne. Bachelier not only derived the first theoretical valuation of options, but, in the process, derived much of the mathematics of probability diffusions, five years before Einstein developed the mathematical theory of Brownian motion.

Bachelier was a frustrated unknown in his time, teaching not at the Sorbonne but at the provincial university at Besancon, which was “about as provincial as provincial France can get.” Among academics, Bachelier’s work was not noticed until it was rediscovered by accident in the 1950’s.

Even by the mid-1960’s, financial theory had not trickled down to Wall Street practice. Bernstein recalls that his own investment counseling firm began using options markets when it set up a speculative mutual fund for its clients. Bernstein did not know that the MIT faculty was studying the scientific principles for valuing options. He states:

In those days, nobody thought very much about how to value options in any systematic manner. Rules of thumb sufficed.

Options on a small number of big stocks traded over-the-counter at that time, with prices set largely by seat-of-the-pants negotiations . . . . As we were winging it in the over-the-counter options market,

74. See the inside front cover of the June 1992 issue of the Journal of Finance.
75. Whitley, supra note 57, at 173.
79. Professor Robert Merton quotes Paul Samuelson as favorably comparing Bachelier’s methods with Einstein’s. MERTON, supra note 78, at 330 n.1.
80. BERNSTEIN, supra note 23, at 20 (attributing Bachelier’s obscurity to mathematical error in subsequent paper and to way his thought defied pigeonholing).
81. Id.
82. In the 1950’s, while rummaging through a library, Leonard Savage of the University of Chicago happened upon a small book by Bachelier published in 1914. He sent postcards to his economist friends asking if they had “ever heard of this guy?” Paul Samuelson could not find the book in MIT’s library, but did locate and then read a copy of Bachelier’s doctoral thesis. Id. at 23.
83. Id. at 206.
we had little theoretical basis for the prices at which we made our transactions. The only considerations we explicitly factored in were time and the rate of interest. The longer the owner of the call enjoyed the right to buy a stock from us, the higher the price we charged. Because the call could be exercised at any moment during that time, we had to be ready to provide the shares to the option-owner when the call came. This tied up our money and cost us interest income, while the option-owner kept earning interest on his money right up to the moment he decided to exercise the option. The premium we received had to compensate us for that lost interest.84

This approach was typical. Supply and demand operated without any convention for quantifying an option’s value.85 The absence of a suitable theory caused wide bid-ask spreads and illiquidity.86

Finally, Fischer Black and Myron Scholes developed their theory of option pricing in 1970.87 Both of the journals to which they initially sent the article rejected it; neither even sent it out for peer review. Eventually, with the intervention of Eugene Fama and Merton Miller, two prominent University of Chicago professors, Chicago’s Journal of Political Economy published the piece in 1973.88 The timing turned out to be perfect. The article came out just as the Chicago Board Options Exchange began an experiment in trading listed options.89 That moment marked the start of the current wave of financial innovations involving derivatives.90 Although traditional pricing methods did not disappear overnight,91 within six months of publication, Texas Instruments took a half-page advertisement in the Wall Street Journal to say, “Now you can find the Black-Scholes value using our... calculator.”92 Mark Rubinstein

84. Id. at 207.
87. Fischer Black, How We Came up with the Option Formula, J. PORTFOLIO MGMT., Winter 1989, at 4, 6-7. In addition to his own path-breaking contributions to finance theory, Robert C. Merton offered important suggestions to Black and Scholes in connection with the derivation of the formula. Id.
89. Cf. Merton, supra note 78, at 331 n.3 (discussing importance of timing).
90. Id. at 467.
91. One prominent trader reports his experience in the early 1970’s as follows:

[You] have to understand that, at the time, equity options trading at Salomon was highly nonquantitative. In fact, when I think back on it now, it seems almost amazing, but I don’t believe anybody there even knew what the Black-Scholes model was. Sidney would come in on Monday morning and say, “I went to buy a car this weekend and the Chevrolet showroom was packed. Let’s buy GM calls.” That type of stuff.

SCHWAGER, supra note 86, at 23 (interview with Bill Lipschutz).
92. Bernstein, supra note 23, at 227. One trader recalls that in 1975 he crammed the Black-Scholes formula into a TI-52 hand-held calculator, which could give one option price in about thirteen seconds,
of Berkeley has referred to the Black-Scholes option pricing model as "the most important discovery ever made in financial economics," while Stephen Ross of Yale has called it "the most successful theory not only in finance but in all economics." It is the central theory underlying modern financial innovation.

If certain assumptions hold, Black-Scholes type models purport to offer a precise theoretical value for the option, even though the probability distribution of the future price of the underlying is unknown. For example, the leading model for currency options requires only five independent variables:

1. the current spot price of the foreign currency;
2. the exercise price;
3. the maturity date;
4. the domestic and foreign interest rate levels; and,
5. the anticipated volatility of the currency pair.

Items (2) and (3) will emerge from negotiations between the buyer and writer of the option. Items (1) and (4) can be drawn from the newspaper or a computer monitor. The sole item that requires judgment is item (5), the anticipated volatility of the exchange rate. This could be estimated by, among other things, looking at the historical data and inferences drawn from the market price itself. Significantly, the model does not require knowledge of the future price of the underlying asset.

The importance of the Black-Scholes option pricing model is three-fold. First, the theoretical value gives the bank a way to price options. Second, banks can better gauge both credit risk and market risk. For instance, as we have seen, the credit exposure of a buyer of an option is equal to the market value of the option. Third, the bank can hedge the market risks in a sophisticated way. It is not be restricted simply to purchasing an option

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after he had hand-inserted all the other variables. He stated: "It was pretty crude, but in the land of the blind, I was the guy with one eye." SCHWAGER, supra note 86, at 352 (interview with Joe Ritchie).

95. One prominent Wall Street rocket scientist has equated financial innovation with the application of option pricing theory. BOOKSTABER, supra note 45, at viii.
97. Estimating volatility is far from a science. See infra notes 109-113 and accompanying text. See generally Stephen J. Brown, Estimating Volatility, in FINANCIAL OPTIONS: FROM THEORY TO PRACTICE 516 (Stephen Figlewski et al. eds., 1990). Nonetheless, the volatility estimates may be easier to make than guesses about future value.
identical in all attributes to the one it wrote. Instead, under certain circumstances, the bank can utilize such associated techniques as "delta hedging" to insulate itself from movements in market prices.

The theoretical foundation for the pricing, risk assessment, and hedging of a broad spectrum derivatives had been laid. The modern derivatives industry had become possible.

II. MARKET PRODUCTION OF BANK-SPECIFIC RISK INFORMATION

A. The Need for Investment in Bank-Specific Risk Information

Broadly construed, the term "investment" comprehends any use of current resources to achieve a future return. While banks do not separately report research and development (R & D) and related expenditures, they devote substantial resources to financial R & D, and these investments do produce benefits.

Derivatives houses pour much of this investment into human capital. Salomon reportedly paid the youngest managing director it had ever had, Lawrence Hillibrand, in excess of twenty million dollars in one year. Foreign financial institutions establishing OTC derivatives operations have hired American traders at seven-figure salaries. In fact, world-class academics are particularly useful and well compensated.

Elaborate computer systems are also essential to OTC derivatives dealers. To be competitive, they need real-time data feeds and large databases. Computer simulations help dealers evaluate the quality of alternative mathematical models. One company gave computers to its developers and

98. For a description of delta hedging, see CLASING ET AL., supra note 96, at 10-11; Figlewski, supra note 50, at 105-108. Delta is a measure of how sensitive the price of an option is to changes in the price of the underlying asset.


103. Schmerken, supra note 101.

traders to let them “do in four minutes what it takes competitors four to eight hours [to do].”

Such expenditures can pay off. In the options area, “[a] very good model will make you money. An excellent model will make you more money.”

In the late 1980’s, some swaps dealers gained a material advantage by realizing that the “zero coupon” method of valuing swaps was more accurate than the older “par yield” method and also could accommodate more features in the product. But if theoretical models like the Black-Scholes option pricing model provide precise values, why is there any such investment at all?

There are two primary reasons for investing in financial R & D. One may be to develop new products. Another may be to improve pricing models for existing products or to develop more effective techniques for hedging the market risks created by these products. I focus on the latter type of research because it is more relevant to the informational failures addressed by this Review Essay.

The first major factor undermining the accuracy of Black-Scholes models is the fundamental fact that they have not eliminated the need to forecast the future. Although it is no longer necessary to know the future price of the underlying, the formula explicitly requires the anticipated volatility of the underlying. Modern option pricing models substitute the need to know future volatility for the need to know future prices.

In devising the parameter for volatility, one can look at historical data. But for how many years? If there have been significant shifts in volatility, what then? The data on stock market volatility in the year prior to October 19, 1987 would have given a radically incorrect estimate of the immediately ensuing volatility. Past may be prologue, but which past? Instead of examining historical data, one might use market prices to gauge the market’s estimate of future volatility.

The market can, of course, also be wrong. Indeed, studies have shown that market views on volatility—like market views on the value
of stocks—can be irrational.\textsuperscript{111} As an empirical matter, uncertainty in estimating volatility creates "wide margins of error" in pricing and hedging.\textsuperscript{112} This is not surprising, for derivatives experts admit that "[m]uch depends on judgement and personal opinion about what the future will look like."\textsuperscript{113}

Second, theoretical models, including Black-Scholes, all depend on unrealistic assumptions.\textsuperscript{114} Indeed, they are unrealistic enough that Fischer Black recently wrote an article entitled, \textit{How to Use the Holes in Black-Scholes}.\textsuperscript{115} Newer, fancier models that relax these assumptions are regularly developed.\textsuperscript{116} Even now, most option models are based on an arbitrage assumption that simply does not hold in the real world.\textsuperscript{117} Currency options illustrate the problems generated by unrealistic assumptions. The leading model assumes that prices of the underlying currencies follow a "lognormal" probability distribution,\textsuperscript{118} but studies have shown that the historical distribution is different, especially for minor currencies. They have "fat tails."\textsuperscript{119} Also, the models assume constant volatility, even though currency volatility changes over time.\textsuperscript{120} The fall 1992 European currency crisis further demonstrates that unrealistic assumptions undermine the quality of currency options pricing models. Shortly before the French referendum on the Maastricht treaty, none of the usual assumptions about price distribution, transactions costs, and the ability to hedge continuously held true.\textsuperscript{121} As a
consequence, the models were "totally inappropriate" for valuing options on European currencies.\textsuperscript{122}

Third, the sophisticated hedging techniques associated with option pricing models are imperfect, especially in chaotic market conditions.\textsuperscript{123} As we have seen, it is not profitable to hedge market risks of options by purchasing mirror images. Rather, dealers hedge market risks in other ways, often through "delta hedging."\textsuperscript{124} This technique depends on just the right balance of exposure between the underlying and the option; as long as exchange rate shifts are small, changes in the value of the dealer's underlying neutralize changes in the value of the option, thereby minimizing market risk. Unfortunately, this technique requires repeated readjustments, and the transactions costs in the currency market can prove expensive even in normal market conditions.\textsuperscript{125} Discontinuous, illiquid market conditions—such as those that existed during the fall 1992 European currency crisis—may render the necessary readjustments impossible or prohibitively expensive.\textsuperscript{126}

Fourth, product complexity further reduces the efficacy of the models. To stay competitive, banks constantly introduce new financial products\textsuperscript{127} because margins on products decline quickly.\textsuperscript{128} This leaves little time to assess the proper pricing and hedging of the product.\textsuperscript{129} With currency options, for instance, dealers now offer compound options (an option to purchase or sell another option at a prespecified premium), look back options

\textsuperscript{122} Id.


\textsuperscript{124} Stapleton & Thanassoulas, supra note 119, at 312; supra note 98 and accompanying text.

\textsuperscript{125} See, e.g., Clasing et al., supra note 96, at 41-42; Stapleton & Thanassoulas, supra note 119, at 312.


\textsuperscript{127} See Hu, Shareholder Welfare, supra note 12, at 1275; Hal Lux, Product Envy, Investment Dealers' Dig., May 13, 1991, at 22. This can be costly. In a series of interviews in 1988, investment bankers estimated that the cost of developing a new financial product required investments of $50,000 to $5,000,000. See Peter Tufano, Financial Innovation and First-Mover Advantages, 25 J. Fin. Econ. 213 (1989); Miller, supra note 23, at 468 (stating Chicago Board of Trade and Chicago Mercantile Exchange invested combined total of $5 to $6 million on two over-the-counter index contracts).

\textsuperscript{128} See Hu, Regulatory Paradigm, supra note 6, at 365 n.82 (declining profit margins of swap dealers); Ivy Schmerken, Learning the Susquehanna Way, Wall St. & Tech., June 1992, at 57 (noting declining margins in foreign exchange market and higher margins in "exotic" currency options).

\textsuperscript{129} This is not to say that banks—or anyone else—even fully understand all well-established, plain vanilla derivatives. For instance, Professor Litzenberger has pointed out that "[n]o existing theory or combination of theories" entirely explains certain key features of the interest rate swap market. Litzenberger, supra note 53, at 832.
(capturing the highest or lowest cash price during its term), and money back options (which cost the buyer nothing unless the option expires in the money). The pricing and hedging of such variants can be demanding exercises.

The complexity can overwhelm even experts. In one ironic case, a bank mistakenly analyzed a transaction as a complicated swap instead of an outright loan. Some early dealers appear to have found exotic currency options more costly to hedge than anticipated. Some banks compound the problem by offering a full range of innovative financial products, whether or not they entirely understand the risks. In the early days of the swap market some institutions did not even recognize swaps as having any credit risk at all. Today, there is concern that some dealers do not understand the full risks associated with “diff swaps” and equity derivatives.

Finally, the complexity of individual transactions is dwarfed by the complexity of entire portfolios. The portfolio effects tend to make the total credit and market risks less than the sum of the risks of individual derivative transactions. For instance, some of these transactions may be with the same customer; if so, and if the “netting” arrangements are legally enforceable, the credit risks will be lower than one would think from examining the individual derivative transactions with that customer. Also, the market risks of individual derivative transactions may offset each other and thus reduce overall market risk.

In sum, the uncertain state of the world and of the Black-Scholes models and associated hedging strategies means that financial R & D generates payoffs. Yet, if financial R & D has benefits, then why cannot banks be


131. See, e.g., Stapleton & Thanassoulas, supra note 119, at 305 (describing difficulty of hedging market exposure on contingent currency options).


136. See, e.g., Daniel F. Cunningham & William P. Rogers, Jr., Netting is the Law, in ADVANCED SWAPS AND DERIVATIVE FINANCIAL PRODUCTS 177 (PLI Corp. L. and Practice Course Handbook Series No. 746, 1991) (discussing netting).


138. I have focused on each bank producing its own information. The bank could, of course, purchase or otherwise acquire such information from other banks or independent third-party vendors. This creates
counted on to invest in enough financial R & D so as to produce an efficient amount of risk information on the derivatives they offer? This is the puzzle presaged in the Introduction. I now turn to certain economic, psychological, and principal-agency factors that may explain it.

B. **The Effects of Inappropriability**

1. **The Concept of Inappropriability**

When a corporation decides to invest in a project, it looks at the expected marginal benefit it will accrue from undertaking the project; the corporation does not consider the benefits the project may bring to other entities. One feature of investment in scientific R & D that distinguishes it from other kinds of investment is that the corporation cannot capture or "appropriate" all of the benefits of such projects. Empirical studies confirm that a substantial portion of the benefits simply spill over to other corporations, which use the knowledge without payment of any kind. At least theoretically, large spillover effects will result in less R & D investment than would be socially optimal.

Inappropriability effects help explain at least one key feature of industrial R & D. One would expect that inappropriability would have a particularly manifest impact on the funding of basic research—research that advances scientific objectives but does not have specific commercial applications—as opposed to applied research. Consistent with this

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139. This question is different from the question of whether, from a private or social perspective, there is too much investment in financial R & D generally. See supra note 108 and accompanying text.


141. See, e.g., id. at 265; Edwin Mansfield et al., Social and Private Returns from Industrial Innovations, 91 Q. J. Econ. 221 (1977); see also OFFICE OF TECHNOLOGY ASSESSMENT, HOUSE COMM. ON SCIENCE AND TECHNOLOGY, 99TH CONG., 2D SESS., RESEARCH FUNDING AS AN INVESTMENT: CAN WE MEASURE THE RETURNS? 12-13 (Comm. Print 1986); Alvin Ulrich et al., Public and Private Returns from Joint Venture Research: An Example from Agriculture, 101 Q. J. Econ. 103 (1986).

142. Each corporation looks only at the marginal benefits to it, rather than the far larger social benefits. David C. Mowery, Economic Theory and Government Technology Policy, 16 Pol'y Sci. 27, 28-31 (1983); Brian Wright, The Economics of Invention Incentives, 73 Am. Econ. Rev. 691 (1983).

For criticisms of the argument that inappropriability leads to underinvestment in R & D, see, e.g., Jack Hirshleifer, The Private and Social Value of Information and the Reward to Inventive Activity, 61 Am. Econ. Rev. 561, 573 (1971) (noting that standard appropriability analysis overlooks certain market mechanisms that capture fruits of research); Levin et al., supra note 138, at 788; Richard R. Nelson, Government Support of Technical Progress: Lessons from History, 2 J. Pol'y Analysis & Mgmt. 499, 500-501 (1983) (noting how patents can lead to restrictions on innovation). For a defense of the inappropriability argument in face of such criticisms, see Thomas M. Jorde & David J. Teece, Innovation, Cooperation and Antitrust, 4 High Tech. L.J. 1, 7 n.11 (1989).

143. The National Science Foundation defines basic research as follows:
expectation, corporations do relatively little basic research. Relying on this fact and other rationales, government support of R & D is relatively higher with respect to basic research.

The direct social consequences of the inappropriability of financial R & D do not seem as worrisome as those created by the inappropriability of traditional research in physics, chemistry, and biology. Though international competitiveness issues are implicated, it is unlikely anyone would argue for federal government tax incentives and research grants for Wall Street R & D. Still, we should be concerned about whether inappropriability would lead a bank to underinvest in research on the proper pricing, risk assessment, and hedging of the derivatives it actually offers. Such banker informational failure could lead to failure of the entity, which clearly is a social concern.

As I have framed the inappropriability problem, then, there are two issues. Are some of the fruits of financial R & D inappropriable? If they are, could their inappropriability lead to underinvestment in financial R & D and hence banker informational failure?

2. The Appropriability of Research Relating to Bank-Specific Risk Information

Several factors would suggest initially that the gains of developing better pricing models and hedging techniques are highly appropriable. First, there is market evidence: banks currently devote significant human and capital resources to such research. If they could not appropriate the benefits, then they would not do the research. Second, in some circumstances, intellectual property

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Basic research has as its objective a fuller knowledge or understanding of the subject under study, without specific applications in mind. In industry, basic research is defined as research that advances scientific knowledge but does not have specific commercial objectives, although such investigations may be in fields of present or potential interest to the reporting company.


144. See, e.g., Richard R. Nelson, Simple Economics of Basic Scientific Research, 67 J. POL. ECON. 297 (1959) (noting increasing inappropriability toward basic end of R & D spectrum).

145. NATIONAL SCIENCE BOARD, supra note 143, at 93.


147. If, as some believe, basic research is riskier than applied research, and private corporations are more risk-averse than would be socially optimal, then this might also cause the current volume of basic research to be too low. Cf. KENNETH J. ARROW, Economic Welfare and the Allocation of Resources, in 5 COLLECTED PAPERS OF KENNETH J. ARROW: PRODUCTION AND CAPITAL 104, 114 (1985); P. Dasgupta & Joseph E. Stiglitz, Uncertainty, Industrial Structure and the Speed of R & D, 11 BELL J. ECON. 1 (1980) (market may be unduly biased against risky research programs). But cf. Hu, Fiduciary Principles, supra note 60, at 318-32, 352-54 (noting that it is unclear whether profit-maximizing corporations take too much or too little risk from a social perspective).

148. NATIONAL SCIENCE BOARD, supra note 143, at 93.

law may increase such appropriability. If available, a patent provides the broadest intellectual property protection mechanism, as it excludes others from making, using, or selling an equivalent product for the seventeen-year term of the patent.\textsuperscript{150} Merrill Lynch, for example, initiated a patent infringement suit against Paine Webber for infringement of its “Cash Management Account” system.\textsuperscript{151}

The Supreme Court has held that scientific truths and abstract intellectual concepts like $E=mc^2$ are not patentable.\textsuperscript{152} Thus, an improved option pricing model or a new strategy for hedging market risks might not be patentable subject matter.\textsuperscript{153} However, a derivative house might achieve the functional equivalent with a patent for a computer system embodying such a model or strategy; computer systems are patentable and, if a patent is granted, other companies seeking to deal in a competitive product would either have to pay royalties or do the computations by hand.\textsuperscript{154} This means of avoiding the unpatriotability problems associated with scientific truths may take on additional importance if the Federal Circuit continues to dilute the subject matter requirement of the patent laws.\textsuperscript{155} Patents already have been granted for a computer system that involves hedging against a future liability of uncertain value\textsuperscript{156} and an option accounting and marketing system.\textsuperscript{157}

\begin{itemize}
\item[\textsuperscript{151}] Paine, Webber, Jackson & Curtis, Inc. v. Merrill Lynch, Pierce, Fenner & Smith, Inc., 564 F. Supp. 1358 (D. Del. 1983). Reportedly, the suit was settled on terms favorable to Merrill Lynch. Foudree & Trzyna, supra note 150, at 274-75.
\item[\textsuperscript{152}] “Phenomena of nature, though just discovered, mental processes, and abstract intellectual concepts are not patentable, as they are the basic tools of scientific and technological work.” Gottschalk v. Benson, 409 U.S. 63, 67 (1972); cf. Diamond v. Chakrabarty, 447 U.S. 303, 309 (1980) (“The laws of nature, physical phenomena, and abstract ideas have been held not patentable.”). Thus “Einstein could not patent his celebrated law that $E=mc^2$.” Diamond, 447 U.S. at 309. 35 U.S.C. § 101 (1988) (limiting patentability to any “process, machine, manufacture, or composition of matter, or ... improvement thereof . . .”). Some intellectual property specialists have argued that a mathematical model like the Black-Scholes option pricing model would be patentable because of its dependence on various assumptions, which takes it out of the category of “universal truth.” See Petruzzi et al., supra note 150, at 69-70.
\item[\textsuperscript{153}] Even if the subject matter hurdle is surmounted, the utility, novelty, and nonobviousness requirements would still have to be met.
\item[\textsuperscript{154}] Foudree & Trzyna, supra note 150, at 274-75.
\item[\textsuperscript{155}] In the recent landmark decision of Arrhythmia Research Tech. v. Corazonix Corp., 958 F.2d 1053 (Fed. Cir. 1992), the Federal Circuit found the requisite statutory subject matter with respect to a patent claim that included a mathematical algorithm, based on EKG data, that a heart attack patient would suffer from ventricular tachycardia. Cf. Pamela Samuelson, Benson Revisited: The Case Against Patent Protection for Algorithms and Other Computer Program-Related Inventions, 39 Emory L.J. 1025, 1092-94 (1990).
\item[\textsuperscript{156}] Method and Apparatus for Funding A Future Liability of Uncertain Cost, U.S. Patent No. 4,752,877, issued June 21, 1988.
\end{itemize}
Notwithstanding such competitive and intellectual property law considerations, much of the research appears highly inappropriable—at least under current social norms in the tightly knit community of major money center banks.\(^\text{158}\) In the world of OTC options, "there is very little that is truly proprietary for very long."\(^\text{159}\)

Four characteristics of the institutional context militate against appropriability. First, imitation is an honored tradition in financial innovation. The head of product development at First Boston notes, "[e]veryone’s a knockoff artist."\(^\text{160}\) If Morgan Stanley has "Steps," Goldman Sachs has "Stairs."\(^\text{161}\)

Second, there is a high turnover rate among rocket scientists. Indeed, turnover is so fast and the reliance on individual researchers so extensive that regulators worry that institutions will be unable to handle their financial products after key personnel depart.\(^\text{162}\) Knowledge about derivatives is often "embodied" in these traders, and it is routine for foreign banks to buy this human talent from other banks when they create OTC derivatives operations.\(^\text{163}\) In standard human capital terminology, the research yields "general" rather than "specific" human capital.\(^\text{164}\) In such a situation, subject to intellectual property and other laws and enforceable contractual prohibitions,\(^\text{165}\) investment will benefit a rocket scientist's next employer.

Third, banks may disclose results of their derivative research in order to market their products. For example, some end-users have become concerned about the overpricing of OTC derivatives.\(^\text{166}\) To convince customers that the price is fair, banks may offer to compare the investment to other alternatives, price the component parts of a transaction, or put clients in touch with third-

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\(^{157}\) Renewable option accounting and marketing system, U.S. Patent No. 4,823,265, issued Apr. 18, 1989 to George E. Nelson.


\(^{159}\) Schmerken, *supra* note 101, at 23 (quoting American options strategist).


\(^{163}\) See Schmerken, *supra* note 159, at 23.


party consultants. In each case, proprietary information may be imparted.

Fourth, norms play an important part in governing the relationships within the derivatives industry. For example, in one case market participants apparently pressured a bank not to seek the enforcement of certain termination provisions of a swap agreement. In addition, although the documentation of swaps appears to be lax compared to the documentation of loans, there seem to have been relatively few attempts at repudiation. Professor Robert Ellickson has hypothesized that close-knit groups develop norms that maximize their aggregate wealth. Whether or not the knockoff norm in the OTC derivatives industry furthers collective wealth, pending a major disruption—such as an intellectual property lawsuit resulting in massive damages—it serves to limit appropriability.

3. The Subtle Distortions of Inappropriability

If some of the gains of financial R & D are inappropriable, then the effects will be subtle and widespread. The following crude illustration demonstrates that, under certain circumstances, inappropriability can contribute to aggregate informational failure even if individual banks may, in the aggregate, be spending enormous (and individually rational) amounts on developing bank-specific risk information.

Assume a situation where there is full appropriability: when a bank develops a product, the law prevents imitators. The market for a new product consists of fifty deals, and the innovator bank may expect to do all of them. Under these conditions, assume that the bank would find it optimal to invest $400,000 in understanding the product's risks. Thus, there is a new derivative

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167. See, e.g., Smart People Ask Chase About Index Swaps, Caps, Floors and Other Equity Derivatives (Chase Manhattan advertising brochure, undated, on file with author) (discussing how Chase Manhattan can help clients evaluate fairness of pricing).
171. Norms can change or prove ineffective in extraordinary circumstances. See, e.g., ROBERT C. ELICKSON, ORDER WITHOUT LAW: HOW NEIGHBORS SETTLE DISPUTES 267-68 (1991) (noting that welfare destroying norms among Ik people arose when Ik were starving to death).
172. Cf. Nelson, supra note 142, at 501 (discussing problems with conventional appropriability analysis in the industrial R & D context, with special focus on duplication of research).
and the only market player selling it has $400,000 worth of understanding of the product. 173

In a world characterized by inappropriability, on the other hand, a bank deciding how much to spend on risk research is fully cognizant of the large spillover effects. Since clones will appear, the original bank knows it will do only ten deals and only at a lower price; the other forty 174 will be done by—just suppose—four imitators. The innovator bank will spend less, say $200,000, in understanding the product because the marginal benefits will be lower. The four imitator banks will, at most, also each spend $200,000. (More likely, each will spend some fraction of that, relying heavily on the spillover of technology.) Now there are five banks, each making an individually rational decision to invest $200,000. In this state of the world, the society's total investment in understanding the risks adds up to $1,000,000, compared to $400,000 when one bank had the entire market.

The overall risk posed by the derivative is more or less the same in both scenarios. Though five banks share the risk in the second scenario, the absence of monopoly pricing may reduce profit margins and, hence, increase risk. However, these scenarios do represent a difference in the understanding of risk. In the second scenario, each of the five participants has spent $200,000 in R & D. Each participant's level of understanding would probably be somewhat higher than that figure reflects because they all benefit from the spillover of knowledge. Nevertheless, this effect will not be too great; people tend to think alike and tend to approach problems the same way. 175 Let us assume that taking into account such spillover and duplication effects, each market participant reaches a $200,000 to $300,000 level of understanding. If so, none of the market participants will have as deep an understanding of the instrument's risks as the monopoly bank did in the first scenario. Thus, the bank informational problems have increased even though the banking industry is spending $1,000,000 in R & D, more than double the amount of R & D spent in the first scenario.

173. This $400,000 level of understanding is probably still too low from society's standpoint. See infra note 229.

174. This figure may underestimate the size of the market in this state of the world. With competition, the prices for the derivative would presumably be lower and hence the overall consumption of the derivative might increase.

175. For example, when computer programmers are put to work designing programs for a given task, they tend to "have closely related errors." See David L. Parnas et al., Evaluation of Safety-Critical Software, 33 COMM. OF THE ACM 636, 638 (1990).
C. The Effects of Cognitive Bias

1. Departures from the Rational Actor Model

Swaps, by definition, involve the periodic exchange of cash flows between a bank and its customer. As a relatively new form of derivative, they have posed some unique legal problems for bankers. When swaps first began, many banks simply assumed that, as in the case of loan agreements, in the event its client went bankrupt, the bank could terminate future payments. They had not realized that, in fact, the automatic stay and executory contract provisions of the U.S. bankruptcy laws probably would not have permitted this. Outside of bankruptcy, a more fundamental problem would arise if the bank’s customer could repudiate the swap after the market went the wrong direction: heads I win, tails you lose. This, in effect, has already happened, surprising all concerned. On November 1, 1989, Britain’s High Court ruled that swaps entered into by a local authority in London were ultra vires and unenforceable. In 1991, the House of Lords agreed. This one situation appears to have caused about half of all default losses on swaps from the entire decade ending in 1991.

The apparent initial disregard of legal risks illustrated by these two problems is surprising. After all, swap agreements involve high stakes and are executed by sophisticated specialists. Simple reliance on social norms to ensure adherence to agreements, which is seen in the context of close-knit groups, seems manifestly imprudent. The community involved in swaps is not

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176. See BOOKSTABER, supra note 45.
178. One practitioner noted that many people assumed that the bankruptcy laws would operate the same way on both swaps and loans. Id. This view may have been incorrect, but the International Swap Dealers Association helped spark statutory changes that address this problem. See, e.g., Daniel P. Cunningham et al., Interest Rate and Currency Swaps and Other Related Transactions, in SWAPS AND OTHER DERIVATIVES IN 1992 at 22-28 (William P. Rogers, Jr. chairman, 1992).
179. See Hu, Regulatory Paradigm, supra note 6, at 386-87 n.154; cf. British Local-Authority Swaps; We’re a Special Case, Old Chap, ECONOMIST, May 11, 1991, at 74 (“[T]he Lords’ decision arose because one extremely foolish authority—a London borough, Hammersmith and Fulham—thought (correctly, in the event) that it had found a legal way out of escaping obligations that it had freely entered into, once they became burdensome.”).
181. See INTERNATIONAL SWAP DEALERS ASSOCIATION, INC., ANALYSIS OF THE RESULTS OF THE ISDA DEFAULT SURVEY 3 (undated, released in July 1992) (unpublished manuscript, on file with author); Michael Liebowitz, Will the ISDA Default Study Impress the Regulators?, INVESTMENT DEALERS’ DIG., Aug. 3, 1992, at 10. The problem might even be more serious than once thought: some believe that this ultra vires risk was not sui generis, but could affect swaps entered into with a wide range of institutions, including insurance companies and building societies. Garry Evans, Lawyers Warn on Void Swap Deals, EUROMONEY, Apr. 1992, at 14.
182. See, e.g., ELLICKSON, supra note 171, at 76-79 (in rural Shasta County, “[n]o rancher, and no attorney, could recall a written—much less a recorded—fencing contract between private landowners”).
completely close-knit; issuers deal not only with each other, but also with corporate and governmental clients worldwide.

The answer may lie, to some extent, in the fact that decisionmakers are not always economically rational. Studies have shown that individuals frequently rely on cognitive shortcuts (heuristics and biases) to solve complex problems under conditions of uncertainty or incomplete information. Sometimes these shortcuts are irrational and mistaken.

Corporate/securities law scholars have begun to make use of this scholarship. Without attempting to be comprehensive, I now discuss how several cognitive pathologies may lead bankers to underestimate the privately optimal amount of investment in bank-specific risk information.

2. Specific Biases

a. Threshold Effects

Individuals tend to ignore low probability catastrophic events. This tendency is often termed a "threshold effect." Psychologists theorize that individuals do not worry unless the probability of the event is perceived to be above some critical threshold. The effect may be caused by individuals' inability to comprehend and evaluate extreme probabilities, or by a lack of any direct experience with the underlying risks. This effect manifests itself in attitudes towards tornados, safety belts, and earthquake insurance.

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184. Noll & Krier, supra note 183, at 750.
185. See Langevoort, supra note 58, at 914-915 n.220 (offering examples where such behavioral work has been used by such scholars).
186. One obvious example of a cognitive bias that deserves exploration in the OTC derivatives context is the "herd effect." It has been argued, for instance, that financial players may migrate in herds, as when firms increase their debt-equity ratios, S&Ls invest in junk bonds, and the like. See Jayendu Patel et al., The Rationality Struggle: Illustrations from Financial Markets, 81 Am. Econ. Rev.: Pap. & Proc. 232, 234-35 (1991); cf. supra notes 134-53 and accompanying text (apparent tendency on part of some banks to participate in markets they do not fully understand).
188. See Kunreuther, supra note 187, at 209.
190. Colin F. Camerer & Howard Kunreuther, Decision Processes for Low Probability Events: Policy Implications, 8 J. Pol'y Analysis & Mgmt. 565, 566 (1989). Because of transactions, information processing, and other costs, it may sometimes be rational to ignore such events.
191. See Howard Kunreuther & Louis Miller, Insurance versus Disaster Relief: An Analysis of Interactive Modelling for Disaster Policy Planning, Pub. Admin. Rev. 147 (Special Issue 1985) (considerable empirical evidence supports individuals' failure to mitigate against these events); Cass R.
There is evidence consistent with the presence of such an effect in the financial world. For instance, one investment banker suggested that financial models ignore low probability states of the world:

Financial models assign particular values to securities under different states of the world. Some states of the world are so complex that no model can quantify all their pertinent variables. If an attempt is made to value a security under these conditions, the results will be questionable. A good model is one which, given a set of accounted-for variables and no "surprise" variables, produces relatively realistic valuations. A bad model is one which either attempts to consider too many marginally relevant states of the world or, given a set of accounted-for variables with no "surprises," produces a poor valuation.

Similarly, one mathematician-turned-trader recently noted: "As various possible outcomes become less and more likely, certain neglected ones of small probability pop into view—a threshold phenomenon. The market has to discount these "new" possibilities somewhat discontinuously." Before the fall 1992 European currency crisis, one investment house opined, "[s]ome people have probably paid so much for contingent options that they will end up losing money for anything less than a massive realignment." Yet, the realignment did happen.

The British local authority debacle appears consistent with this threshold effect in the evaluation of legal risks. The Legal Risk Review Committee established by the Bank of England following the Lords' decision noted that sophisticated institutions participating in the financial markets "do not expect to learn that a transaction is set aside on a technicality or formality which

\begin{footnotes}
\footnotetext[192]{Sunstein, Legal Interference with Private Preferences, 53 U. CHI. L. REV. 1129, 1167-68 (1986).}
\footnotetext[193]{Cf. Jack M. Guttentag & Richard J. Herring, Disaster Myopia in International Banking, in ESSAYS IN INTERNATIONAL FINANCE No. 164 1, 2 (Princeton Univ. 1986) (arguing international lenders had "systematic tendency to underestimate shock probabilities (events that occur very infrequently and have large potential effects")].}
\footnotetext[194]{Paul Scra et al., Financial Innovation and New Corporate Securities, in III CORPORATE AND MUNICIPAL SECURITIES 633 (Robert L. Kuhn ed., 1990) (emphasis added).}
\footnotetext[195]{SCHWAGER, supra note 86, at 120 (interview with William Eckhardt).}
\footnotetext[196]{Cookson, supra note 96, at 61.}
\end{footnotes}
would not be evident to a reasonably well-informed [lay] person." As the chairman of one bank expressed it: "To me . . . a contract is a contract, and I was brought up to honour contracts."

b. Availability and Expert Effects

One belief widely shared among psychologists is that there exists an "availability heuristic": people estimate the probability of an event by the ease with which related associations come to mind. For example, extensive publicity about some notable crime greatly enhances lay assessment of the probability of a similar event. Conversely, difficulty in recalling instances may decrease the estimated probability.

The British ultra vires ruling also illustrates the availability effect. Prior to the repudiation, bankers appeared insensitive to the issue of the enforceability of swaps, and pricing models generally did not take legal risks into account. In the wake of the House of Lords' decision, foreign institutions called U.K. participants to ascertain whether it was true that all interest rate swaps were now illegal under English law.


198. See Norbert Schwartz, et al., Ease of Retrieval as Information: Another Look at the Availability Heuristic, 61 J. PERSONALITY & SOC. PSYCH. 195, 195 (1991); Amos Tversky & Daniel Kahneman, Availability: A Heuristic for Judging Frequency and Probability, 5 COGNITIVE PSYCHOLOGY 207 (1973); Adele Gabrielcik & Russell H. Fazio, Priming and Frequency Estimation: A Strict Test of the Availability Heuristic, 10 PERSONALITY & SOC. PSYCH. BULL. 85, 85 (1984) ("If it is very easy to retrieve instances of a class, then the class size must be large.") The frequency of occurrence of an event, an individual preoccupation with a highly desirable outcome, emotional interest, and other factors may affect the likelihood of recall. See, e.g., Tversky & Kahneman, supra at 230; Richard E. Nisbett et al., Popular Induction: Information Is Not Necessarily Informative, in JUDGMENT UNDER UNCERTAINTY: HEURISTICS AND BIASES 101, 112 (Daniel Kahneman et al., eds. 1982), citing BERTRAND RUSSELL, PHILOSOPHY 269 (1927).


202. This kind of misperception would not be surprising to cognitive psychologists. Relying in part on the availability effect, observers have noted that "[a] damaging event, if timed appropriately and if widely publicized, induces people to behave as if the likelihood of such events had increased." Noll & Krier, supra note 183, at 769.

The "competence" or "expert" effect is related to the availability effect. The basic notion is that an individual's willingness to bet on an uncertain event depends on the individual's "general knowledge or understanding of the relevant context." Thus, people tend to overemphasize the importance of the field they understand best.

This expert effect may cause bankers to undervalue the possibility of legal risks. Since their area of expertise is in finance, they focus on financial, numerate issues to the exclusion of legal issues. Also, since lawyers rarely provide quantitative estimates of legal risks, bankers accustomed to quantitative evidence may fail to integrate legal risks into their calculations. As Professor Lawrence Tribe has noted, hard statistical data tends to "dwarf the soft variables" in the minds of decisionmakers.

Further evidence of the expert effect can also be found in the casualness with which some swap transactions have been documented. Some banks have exhibited a persistent tendency to commit verbally to swap transactions and document them later. This is despite the fact that many such agreements may be subject to challenge under state statutes of frauds. One recent informal survey found that half the master agreements were still undocumented one year after the transaction. Intellectual property issues have also been neglected and misunderstood. One industry expert flatly, and incorrectly, stated that "[n]ew financial products are not patented; there is no copyright in the banking business." A failure to understand the importance of intellectual property may not only result in foregone opportunities but in large out-of-pocket losses, since a bank held to be willfully infringing an applicable patent may be liable for treble damages.

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206. Businessmen generally have long expressed a desire that lawyers give their opinions in probabilistic ("odds") terms rather than flatly stating in a legal opinion whether a proposed transaction is lawful. See, e.g., Detlev F. Vagts, Legal Opinions in Quantitative Terms: The Lawyer as Haruspex or Bookie?, 34 BU. LAW. 421, 421 (1979).
208. In one early article, a swap specialist noted that "[a]n interest rate swap is normally executed on the telephone and may begin to accrue immediately. The two parties sign a legal contract that governs the exchange of cash flows at a later date." Tanya S. Arnold, How To Do Interest Rate Swaps, HARV. BUS. REV., Sept.-Oct. 1984, at 96, 96.
209. See Lillian Chew, A Bit of a Jam, RISK, Sept. 1992, at 82, 93 (describing results of First Manhattan’s informal survey).
D. The Effects of Principal-Agency Conflicts

Viewed narrowly, an agency relationship involves one or more persons (the principal) engaging another (the agent) to exercise decisionmaking authority on their behalf. The problem is that agents often have incentives to take actions contrary to their principal’s best interests.\footnote{212} Determining whether principal-agency conflicts contribute to banker informational failures requires us to focus on the agent’s incentives to acquire (and distribute) risk information and on the principal’s ability to observe deviations from optimal behavior.

1. Shareholders-as-Principal and Information

Subject to social norms and the many statutory constraints applicable to corporations, banks, and bank holding companies,\footnote{213} all employees of the bank are supposed to promote the maximization of shareholder wealth. The investment required to produce and distribute bank-specific risk information should be consistent with this goal. Unfortunately, there may be incentives for at least some bank employees to engage in a variety of ploys that would lead to banker information failures. A person engaged in derivatives operations may emphasize rewards and downplay risks. Speaking somewhat loosely, the more an agent can suppress the apparent risk undertaken without arousing the principal’s suspicions, the better the agent will look.\footnote{214} Thus, agents would have incentives to forego investing a shareholder-optimal amount on research on the weaknesses of hedging strategies, pricing models, and the like.

Such incentives could be enormous because success is well rewarded. “Derivative trading is one of the few areas left on Wall [Street] where a smart, creative individual can truly dominate a department and strike it rich—very,
very rich."215 The temptation is further exacerbated by the extraordinary asymmetry in payoffs. In the event a trader is caught, he may, at most, lose his job and suffer reputational losses. On the other hand, a successful gamble could mean lifetime wealth.

Several factors undermine the efficacy of internal monitors such as senior bank managers, and most of them relate to the fact that financial science has only recently come of age. First, although the situation is changing, many senior bank managers do not have a quantitative background. Modern financial science draws heavily on sophisticated quantitative knowledge that emerged subsequent to the ascendancy of many of today's senior bank managers. In recent years, there have been repeated instances of senior bank managers not understanding the true risks their employees were undertaking.216

Second, many of the material risk exposures on certain derivatives occur years after the execution of the transaction. Since employee turnover in the derivatives industry is high,217 the "negatives" may arise long after the rocket scientist is gone.218 Often, the credit exposure for a derivative with a large final payment increases continuously as the expiration date approaches.219 So, an employee's short term focus may have the counter-intuitive result of the entity making too many, rather than too few, long-term investments.

Third, commercial finance lacks many of the traditional controls that check scientific errors. It does not utilize the classic policing mechanisms of peer review, the referee system, and replication.220 The methods that substitute for these controls can be expensive. At some banks, a second set of valuations is done by different employees in order to check the initial valuations.221 In addition, banks may hire outside derivatives experts to do "auditing."222

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215. Jill Dutt, Derivative Trading; High profit—high risk, THE GAZETTE (Montreal), May 12, 1992, at D12; see also supra note 100 and accompanying text. The moral hazard here is similar to that faced by corporations when they are rapidly approaching insolvency; because they have little to lose, they may be tempted to gamble in order to try to save the company. See, e.g., John C. Coffee, Jr., Shareholders versus Managers: The Strain in the Corporate Web, 85 MICH. L. REV. 1, 61-63 (1986); cf. Hu, Fiduciary Principles, supra note 60, at 330 n.145; Jensen & Meckling, supra 63, at 334. Another analogy would be the disincentives created by limited liability for the behavior of corporations. See, e.g., Henry Hansmann & Reinier Kraakman, Toward Unlimited Shareholder Liability for Corporate Torts, 100 YALE L.J. 1879, 1882-83 (1991).

216. See Hu, Regulatory Paradigm, supra note 6, at 369-70; Hu, Fiduciary Principles, supra note 60, at 326.

217. See supra note 162 and accompanying text.

218. Cf. Patricia M. Dechow & Richard G. Sloan, Executive Incentives and the Horizon Problem, 14 J. ACCT. & ECON. 51 (1991) (growth rate of R & D expenditures drops during CEOs' last full fiscal year); Hu, Fiduciary Principles, supra note 60, at 326 n.131 (citing report that most banks pay staff bonuses on specific trades of new financial products long after deals are made); id. at 335 (discussing investment projects which generate large negative cash flows in long term).

219. See Chew, supra note 209, at 82.


221. Cf. infra notes 265-66 and accompanying text (illustrating use of second set of valuations); infra note 285 and accompanying text (discussing "front offices," "middle offices," and "back offices").

222. Cf. infra note 292 and accompanying text (discussing outside "auditing" of derivatives modelling).
External monitors like the capital market may be even less effective than senior managers. The capital market has had problems evaluating the exposures of even the loan asset quality of banks. Evaluating derivatives—or determining the optimality of investment expenditures on gathering information about derivatives—would be even more difficult. While the situation is improving dramatically, relatively little public disclosure on derivatives exposure is required; and it may even be against the interests of the shareholders to volunteer pertinent information. Compiling information can be so difficult that one stock analyst took the unusual step of hiring a squad of bankers, accountants, and foreign-currency analysts to help him analyze the currency activities of Dell Computer.

2. Society-as-Principal and Information

Banks, especially large money center banks, enjoy an explicit or implicit governmental safety net. If they fail, the costs are borne by healthy institutions paying premiums or, if the insurance funds are depleted, by taxpayers. Thus, bank management has a legal obligation to run the bank in a safe and sound manner; even if running the bank in a more aggressive manner would enhance the share price. For both legal and policy reasons then, bank managers are, to some extent, the agents of society.

223. See, e.g., Richard E. Randall, Can the Market Evaluate Asset Quality Exposure in Banks?, NEW ENGLAND ECON. REV., July/Aug. 1989, at 3, 18 (“The evidence of this study is that neither the stock market nor the bond rating agencies identified problems in large [bank holding companies] in the 1980’s until after very substantial damage was done.”); cf. John Kambhu, Concealment of Risk and Regulation of Bank Risk Taking, 2 J. REG. ECON. 397, 398 (1990) (“Banking is one economic activity where incomplete information appears to be intrinsic to the nature of the activity.”).


225. For one possible example, see Robert Lenzner, The Secrets of Salomon, FORBES, Nov. 23, 1992, at 123.


227. See supra note 213 (concerning requirement of safety and soundness).

Gathering information about the “soft spots” in banks’ derivatives activities would bolster the safety and soundness of the bank. Bank managers who focus entirely on shareholder welfare should value this information. Unfortunately, such managers do not value it as much as society does because the social costs of bank failure are far greater than the private costs.\textsuperscript{229}

III. TOWARD INCREMENTALIST MARKET INTERVENTION

A. Implications of Deviations from Classic Scientific Norms

1. Incrementalism and Information

Solving the problem of banker informational failure is difficult. Regulators readily concede that they know far less than the bankers.\textsuperscript{230} Regulators could, of course, solve the informational problem by banning derivative instruments. After all, corporations and governments have survived without them in the past. This Procrustean solution would be undesirable. Since the relationship between derivative markets and underlying markets is poorly understood, such a ban could be unpredictable and potentially destabilizing.\textsuperscript{231} Furthermore, due to “portfolio effects,” the existence of derivative instruments may well strengthen the overall safety and soundness of many banks.\textsuperscript{232} Also, the private, decentralized, and international characteristics of the market would make it difficult to enforce a ban. Moreover, the very existence of a constantly growing four trillion dollar market suggests that these instruments create substantial private value. In the face of these private benefits, a prohibition

\begin{itemize}
\item \textsuperscript{229} See Robert C. Clark, The Soundness of Financial Intermediaries, 86 YALE L.J. 4, 10-26 (1976).
\item \textsuperscript{230} See infra notes 21-24 and accompanying text.
\item \textsuperscript{231} Notwithstanding the analyses of derivatives-based trading strategies that came in the wake of the stock market crash of 1987, the overall impact on the financial system remains difficult to determine. Empirical studies suggest that some derivatives dampen volatility in the markets for the underlying assets while other derivatives—like stock index futures—exacerbate volatility in the market for the underlying. Damodaran & Subrahmanyam, supra note 31, at 17-18. The theoretical literature on this point is sparse. \textit{Id.} at 1.
\item \textsuperscript{232} Litan, supra note 137, at 10-19 (discussing how financial institutions can reduce risk through diversified portfolios with banking and nonbanking activities).
\end{itemize}
would be justified only by compelling empirical evidence demonstrating that the social costs outweighed the social benefits. No such empirical evidence exists. Given the nascent understanding of the economics of the instruments, this empirical issue will not soon be resolved.

I argue that the proper regulatory approach should be incremental, rather than drastic. Such a process-based regulatory approach has the usual advantages of incrementalist solutions.\textsuperscript{233} Among other things, the consequences of incrementalist solutions are easier to predict, the survival of existing institutions allows for more efficient rules, and such reforms are less costly to reverse if they are misguided. In the case of derivatives, there are particularly strong, information-based reasons for incrementalism. First, regulators have difficulty understanding the risks banks assume through their respective derivative portfolios.\textsuperscript{234} I now argue that financial science's departures from traditional scientific norms of "openness" and "universalism" also undermine regulators' understanding of such "bank-specific" risks. I further show, on the other hand, that regulators have a special responsibility as well as the capacity to deal with the "systemic" risks posed by derivatives, which are the risks to the financial system itself. I thus conclude that, since regulators and bankers have comparative advantages in different forms of information, regulators should concentrate on the production of systemic risk information and rely essentially on the private sector to produce and then provide it with bank-specific risk information.

2. Bank-Specific Risk Information and Violations of the Scientific Norms of "Openness" and "Universalism"

Broadly speaking, there are two ways to value a financial product. Under one view, the security has some sort of true value, based on a theoretical notion of value. For instance, some calculate the theoretical (and true) value of common stock as the discounted stream of dividends. With respect to options, the Black-Scholes option pricing model, or another model, would purport to yield the option's true value given the applicable assumptions.

Under another view, the attractiveness of a security is judged not only by its theoretical value but also by what others think the security is worth. Keynes argued, for instance, that if one wishes to predict the winner of a beauty contest, one should not choose the contestant one deems most worthy but

\textsuperscript{233} The classic exposition of these advantages is set out at ROBERT A. DAHL & CHARLES E. LINDBLOM, POLITICS, ECONOMICS, AND WELFARE 82-85 (1953). It should be emphasized that incrementalism does not inevitably result in less aggregate change. Professor Lindblom has argued that: "Incrementalism in politics is not, in principle, slow moving. It is not necessarily, therefore, a tactic of conservatism. A fast-moving sequence of small changes can more speedily accomplish a drastic alteration of the status quo than can an only infrequent major policy change." Charles E. Lindblom, Still Muddling, Not Yet Through, PUB. ADMIN. REV. 517, 520 (1979).

\textsuperscript{234} See Hu, Regulatory Paradigm, supra note 6, at 405-12.
instead should pick the contestant whom one believes the judges will select.\textsuperscript{235} More recently, Robert Schiller surveyed investor behavior during the stock market crash and found evidence of investors attempting to predict the actions of other investors.\textsuperscript{236}

Many studies have documented discrepancies between observed prices of derivatives and those predicted by theory.\textsuperscript{237} In fact, professionals sometimes trade on the basis of predictable deviations between theoretical and market values.\textsuperscript{238} Such valuation differences are important to dealers and regulators because they relate to pricing, exposure, and proper hedging strategy. Good theoretical prices—presumptively close to true values—could help both get a sense of the “real” bank exposure.\textsuperscript{239} Market prices for derivatives, like market prices for common stock, are often distorted by irrational factors.\textsuperscript{240} But market prices, no matter how “irrational,” are relevant, especially if a bank needs to liquidate positions.

The departure from the scientific norm of “openness” makes it difficult for regulators to obtain information about theoretical valuation methodologies; violations of the norm of “universalism” make it difficult for regulators to gather information about formal and informal market valuation methodologies.

\begin{itemize}
\item \textsuperscript{235} Cf. J.M. Keynes, \textit{General Theory of Employment, Interest and Money} 156 (1936) (discussing the “beauty contest” analogy to professional investing); Bernstein, supra note 23, at 117 (distinguishing among three conceptions of value); id. at 119 (discussing Samuelson’s notion of “shadow prices” to characterize so-called true values).
\item \textsuperscript{238} See, e.g., William Falloon, \textit{Critical Mass}, Risk, June 1992, at 49, 49-50 (discussing one fund’s reliance on predictable discrepancies between market price for municipal bond futures and their theoretical value).
\item \textsuperscript{239} The difference between the market value and true value also poses interesting issues outside of the bank regulatory context. Under certain circumstances, for instance, the actions that a corporate manager would take to maximize the \textit{actual} share price would be somewhat different from the actions he would take if he focused instead on maximizing the \textit{true} value of the shares. Assuming that a corporation is primarily oriented to shareholder wealth maximization in some form rather than some other goal, I believe it is currently an open question as to whether, as a private or social matter, what I have termed "blissful" shareholder wealth maximization is to be preferred to actual shareholder wealth maximization. While there are demonstrable advantages over the actual shareholder wealth maximization approach, the monitoring and other costs are likely to be higher under the blissful approach. For discussions outlining differences between actual and blissful shareholder wealth maximization and how they can arise, see Hu, \textit{Shareholder Welfare}, supra note 12, at 1282-86, 1312-16; Hu, \textit{Fiduciary Principles}, supra note 60, at 355-366; cf. Michael E. Porter, \textit{Capital Choices: Changing the Way America Invests in Industry} 35-36, 43 (1992) (noting possible difference between actual stock price and what Porter refers to as "true economic value" and reasons for difference). More recently, three Cambridge economists have noted this fiduciary conflict. See Kenneth Froot et al., \textit{Shareholder Trading Practices and Corporate Investment Horizons}, J. Applied Corp. Fin., Summer 1992, at 42, 48-50 (illustrating this conflict).
\item \textsuperscript{240} See, e.g., Bookstaber, supra note 45, at 160 (“Rather than being a refutation of the option model, a deviation between the market price and model price may present an investor with an opportunity to make arbitrage profits.”); Chew, supra note 209, at 91 (quoting one banker as saying that "[I]f you include credit risk in your prices and the market does not, it will make you appear uncompetitive at times"); Stein, supra note 111 (discussing overreactions in options market).
\end{itemize}
These add significantly to the usual difficulties regulators have in understanding as much as industry. As traditionally conceived, scientific norms contemplate free access to and wide dissemination of knowledge. Such openness furthers the “extension of certified knowledge,” the institutional goal of science. Despite industrial funding and the increasing emphasis on intellectual property, this norm has a profound influence on most research arrangements. In this vein, at least one prominent Wall Street rocket scientist has commented that the proprietary nature of derivatives research hinders progress.

In finance, as with science generally, truth is ephemeral, and the current overarching theories could be wrong. For example, the “capital asset pricing model” has been taught to a generation of students, has led William F. Sharpe to a Nobel Prize, and has influenced Wall Street practitioners. Notwithstanding some empirical contradictions, its place in theory and practice seemed secure. Yet, in 1992, Eugene Fama and Kenneth French published data that did not support the central prediction of the capital asset pricing model.

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241. Much of the technical information may be in the hands of industry. The industry can try to use the information to influence the agency as a bargaining chip. Developing the information in-house may avoid some of these problems but the agency may lack the requisite technical ability. Independent outside consultants or academics may be expensive or may themselves have limited access to information. Consumer groups may, among other things, suffer from an anti-industry bias. See Stephen Breyer, Regulation and Its Reform 109-12 (1982).

242. See, e.g., Robert K. Merton, The Sociology of Science 273-78 (1973) (discussing “communism,” “disinterestedness,” and “organized skepticism”). This norm is particularly strong in the academic context. According to Donald K. Fowler, the general counsel of Caltech:

Freedom to publish... is a deep-seated matter of principle in academe, which has at its base a curious mixture of a need to be able to publish and a sort of academic “machismo” that sometimes defies description or categorization. The need to publish is based both on the concept of the free exchange of ideas and knowledge, which is so essential to scientific inquiry, and on the fact that universities are usually tax exempt institutions which must protect that status in order to exist. In any event, freedom to publish is a—nay, the—governing fact of life at many, if not most, research universities. It cannot, and should not, be bargained away for funding, industrial or otherwise.


243. Merton, supra note 242, at 270.

244. For discussions of the conflict between this norm and the world of commerce, see Fowler, supra note 242, at 523-25; Rebecca S. Eisenberg, Proprietary Rights and the Norms of Science in Biotechnology Research, 97 YALE L.J. 177 (1987).

245. Bookstaber, supra note 45, at 159.

246. Sometimes, the shifts can be dramatic, as in the case of the emergence of new paradigms. Professor Thomas Kuhn has defined “paradigms” as “universally recognized scientific achievements that for a time provide model problems and solutions to a community of practitioners.” Thomas S. Kuhn, The Structure of Scientific Revolutions viii (2d ed. 1970). After a paradigm change has occurred, “the profession will have changed its view of the field, its methods, and its goals.” Id. at 85.

247. The prediction is that average stock returns are positively related to the standard measure of systematic risk. Eugene F. Fama & Kenneth R. French, The Cross-Section of Expected Stock Returns, 47 J. Fin. 427, 449 (1992). Many Wall Street practitioners all but celebrated the news. See, e.g., Mark Hubert, Beta is Dead, FORBES, June 22, 1992, at 239, 239 (“[I]t leaves finance departments... with the unsavory prospect of teaching theories to their students and then having to concede that those theories are wrong.”). Yet, rumor has it that several studies contradicting Fama and French are under way. Beating the Market: Yes, It Can Be Done, ECONOMIST, Dec. 5, 1992, at 21.
On a more mundane level, specific advances in modelling can render old techniques obsolete and unprofitable. With interest rate swaps, an early valuation model (based on the so-called "par yield" method) turned out to be wrong, and the dealers who switched to the newer, "zero coupon" method had an advantage of many basis points.\textsuperscript{248} Similarly, the market for perpetual floating rate notes appeared to have collapsed in 1986, at least in part due to a fundamental investor reappraisal of the characteristics of the instrument.\textsuperscript{249}

The ephemeral nature of financial truths would not be problematic for regulators if, consistent with the openness norm, knowledge of new theoretical developments spread quickly to regulators. Unfortunately, this is unlikely to be the case with much of the relevant financial science. The refereed academic journal, the primary source for the spread of new theoretical knowledge in science, is not a timely regulatory tool. One derivatives expert has noted that "every time he picks up a journal, the article is talking about something that was important three years ago."\textsuperscript{250} More generally, journals publish relatively little good empirical work on derivatives.\textsuperscript{251} Industry "rocket scientists" are naturally reluctant to publish some of their most interesting findings. Although academics can produce revolutionary breakthroughs,\textsuperscript{252} they also may have incentives to refrain from publication if their insights translate into lucrative opportunities. Finally, regulators may have trouble tapping into the informal information networks accessible to bankers. The personnel movement that causes information flow is unlikely to occur between the government and industry because, among other things, the salary differentials are awesome.\textsuperscript{253}

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248. \textit{See supra} note 107 and accompanying text.


250. Lux, \textit{supra} note 86.

251. See, e.g., Stewart D. Hodges et al., \textit{Recent Developments in Derivative Securities: 20 Years on from Black and Scholes}, FIN. MARKETS, INSTITUTIONS & INSTRUMENTS, Dec. 1992, at 41, 54. ("There still seems to be a dearth of good and innovative empirical work in the area [of derivatives]."); cf. Litzenberger, \textit{supra} note 53, at 831-32 (noting "relative lack of academic research" on more complex forms of interest rate swaps).

252. \textit{See, e.g.,} Lux, \textit{supra} note 86.

253. Hu, \textit{Regulatory Paradigm, supra} note 6, at 409-10; Hansell & Muehring, \textit{supra} note 13, at 62 (quoting an SEC official: "[f]or 112,000 a year [the top U.S. federal bureaucrat's salary], we can't hire someone who can check the models of kids making ten times that"); cf. Judith Havemann, \textit{Addressing a "Quiet Crisis" in the Civil Service: Volcker Commission Plans Two-Year Effort to Increase Respect for Public Careers}, WASH. POST, Sept. 11, 1987, at A23 (quoting former Federal Reserve Board chairman Paul Volcker as saying the "the depth of really talented staff" at the Federal Reserve "may be less than it was 20 years ago"). As of November 1991, no employee at the Federal Reserve earned as much as $156,500. Jerry Knight, \textit{The Little Pay Cut That Couldn't: House Banking Committee Ends Up Giving Fed Chairman a Raise}, WASH. POST, Nov. 22, 1991, at A23.
Mertonian "universalism" is another of the major institutional imperatives of science that does not neatly apply to financial science. Its canon is that the truth of claims should be determined through the application of impersonal criteria without regard to the source's personal, social, or other attributes. As an example, Merton states: "The Haber process cannot be invalidated by a Nuremberg decree nor can an Anglophobe repeal the law of gravitation."

If the financial science that drives the OTC derivatives market had a solid grounding in Mertonian universalism, then it would not matter who did the science, be it a rocket scientist or a bank regulator. Unfortunately, the universal imperative does not entirely apply to financial science. The predictive power of each theory depends on who is doing the thinking and on what others actually think of that thinker. In economic terms, there is a problem of "infinite regress in expectations." Beliefs of others about the value of the derivative matter, and so do beliefs about beliefs, and so forth. This poses a fundamental problem for regulators; they, unlike bankers, have an extremely difficult time discovering what bankers actually believe.

Andrew Krieger, reportedly responsible for about $300 million in profits in trading currencies and currency options for Bankers Trust, described a particular price move:

Was there a delayed reaction? If there is now a sudden move, is this a false move based upon rumor? Or a real move—but also based upon the rumor? Perhaps the rumor will become a fact—or is already a fact—and if that's the case, traders are trading on fact instead of rumor. So what should I be doing[?]...

In order to determine which way the currency is most likely to go, the foreign-exchange trader must have a view on other traders' views of the currency.

James Hohorst, while head of foreign-exchange trading in North America for Manufacturers Hanover, reported:

Ninety percent of what we do is based on perception. It doesn't matter that perception is right or wrong or real. . . . I may know it's crazy. I may think it's wrong. But I lose my shirt by ignoring it. . . . I can't afford to be five steps ahead of everybody else in the market. That's suicide.

254. MERTON, supra note 242, at 270.
255. Id.
256. Id.
259. Walter S. Mossberg, Making Book on the Buck, WALL ST. J., Sept. 23, 1988, § 3, at 1, 27R.
If the market, as a systematic matter, uses the “wrong” model to price a derivative, the price generated by that model is at least as important as the theoretically correct price; the “true value” may never win out. Indeed, one of the tests of a model is how well the theoretical price approximates market prices.

Regulators would have more difficulty gathering information about the nature of market valuations than the nature of theoretical valuations. Market beliefs are more elusive because they are shaped by trading practices and the personalities of different traders and their institutions. If a dealer who dominates the market for a given derivative thinks a particular model is suitable for valuing that derivative, then his identity is relevant. Even if the model is seriously flawed as a theoretical matter, his importance alone makes the model at least temporarily relevant. Moreover, should the dealer decide to withdraw from the market for that derivative, liquidity may dry up and the pure “theoretical” value may be particularly irrelevant. There is no Mertonian universalism here. The impact of this is likely to be especially severe as to the more arcane instruments and products dominated by a few dealer and in chaotic market conditions.

The central point is that the theoretical and market pricing of derivatives is still, to an uncomfortable extent, an art rather than a science. The valuation of Bankers Trust’s currency options for the purposes of its 1987 reported income is instructive. In 1988, Bankers Trust issued a press release reporting preliminary unaudited earnings indicating that its foreign exchange trading income for 1987 was $593 million. It turned out that certain currency options had not been correctly valued. The earnings release went out

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261. Leong, supra note 108, at 60-61 (regarding “fitting error”).

262. There is a related problem for regulators. Sometimes understanding how a market truly operates requires intimacy with market practices hard to obtain by outside observers. Nobel laureate Merton Miller recently made the following observations:

Like most economists, I had studied the theory of futures pricing. When I got to the floor the first day, they introduced me to a trader, and I asked, “What do you do here?” He said, “I fill paper in the back options, the red and green months.” It suddenly dawned on me that although I had read much about futures prices and although I knew the meaning of very word he said, I really didn’t know what he was talking about.


263. Cf. Credit Implications of Firms that Use Derivatives, supra note 47, at 8 (stating that “the more arcane, customized and long-term the derivative, the less liquid it is”); Working Group Established by the Central Banks of the Group of Ten Countries, supra note 14, at 17 (noting “sudden erosion of liquidity” would occur as result of unusually sharp volatility shock or withdrawal of key market maker); supra note 126 and accompanying text.

264. Cf. Azarchs, supra note 13, at 5 (stating that “significant discretion is permitted in the area of marking derivatives contracts to market”).

on January 20th before a second set of valuations had been run on the year-end portfolio. When that report came in, it reduced the value of that portfolio by a full $80 million. We see then that violations of the norms of openness and universalism undercut the ability of regulators to compile information on the nature of theoretical and market valuation of derivatives. Therefore, for bank-specific risk information, regulators should rely primarily on the private sector.

3. **Systemic Risk Information**

A derivative transaction may also create risks for the financial system quite apart from its effect on an individual bank. These risks are often referred to as "systemic risks." Understanding systemic risks is difficult. Consider the effects on the financial system of a bank offering a single derivative. In offering the derivative, the bank needs to hedge against market risk. Instead of doing so by simply entering into a directly offsetting derivative transaction of the same type, banks will typically hedge this market risk "synthetically," relying on mathematical strategies and the use of a variety of instruments. For example, banks initially hedged their market risks on interest rate swaps synthetically by relying on the cash market for U.S. Treasury bonds; they later began using the futures markets, first with Treasury-note and Treasury-bond futures and, later, with Eurodollar and swap futures. Since hedging can involve all of these instruments, the swaps market is now directly linked to the Treasury bond market and many futures markets. Thus, all manner of capital markets have been linked in novel ways.

There are other interdependencies as well. Payments received on one derivative transaction may be used by the market participant as payments on another derivative transaction. Fragile networks—often with a leading money center bank at the center—may thus be created. In 1991, the credit problems of even a relatively small swaps participant created ripple effects throughout the market. Moreover, since even industrial corporations can be part of this network, their failures could be matters of international concern.

Government, rather than the private sector, has the incentive and ability to become informed about systemic risks. Research on systemic effects of derivatives is akin to basic research in science: the benefits from such research are significant as a social matter but are extremely difficult to appropriate by a private party. Absent government intervention, too little such research will be done. In addition, regulators may also be able to perform such research more efficiently than private actors. Their broader perspective, their ability to

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compel information from a variety of bank and nonbank participants, and their historical role in analyzing the workings of the international financial system suggest that they are far better suited to analyzing such systemic effects.

The comparative, if not absolute, advantage of private entities lies in the production of bank-specific risk information, while regulators have a comparative advantage in the production of systemic risk information. Comparative advantage dictates that the private sector produce bank-specific risk information and the public sector produce systemic risk information. There should be informational specialization and trade between the two sectors. I now sketch, in very broad outline, one mechanism for this "trade" and some ideas to help bankers and regulators overcome their informational difficulties.

B. Establishment of Institutionalized Risk Assessment Mechanism

The process of financial innovation that emerged in the late 1980's, like other forms of modern technological innovation, has resulted in a constant, rapid flow of sophisticated products. Financial regulators should have an institutionalized system of information gathering to cope with this accelerating change; a one-time effort to obtain information on derivatives will not do. Such a system would have the direct benefit of alleviating regulatory informational gaps, and it might have the indirect benefit of reducing banker informational soft spots.

1. The Need for Institutionalized Risk Management

Financial regulators could look to other technocratic risk management methodologies. Two kinds of tasks are central to technocratic risk management decisions. First, "hazard identification": regulators must determine whether a risk agent can cause harm under plausible circumstances. There is little attempt at quantification. Second, "risk assessment": estimating the severity and likelihood of harm from exposure to a risk agent. Both of these steps could be applied to the regulation of financial derivatives.

Currently, it is difficult for regulators to identify potential hazards. An infinite number of derivative combinations are possible. It is pointless for bank regulators to investigate the risks of each of the possible variations. Bounded

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rationality, scarce regulatory resources, and common sense would dictate otherwise. Instead, regulators should focus on products likely to be introduced to the marketplace. Unfortunately, this is not possible at present for two reasons.

First, there is no reliable, centralized mechanism for identifying new derivatives as they are introduced. Hazard identification is complicated by the fact that, generally speaking, banks may introduce a new OTC derivative without any clearance from banking authorities. There have been many instances of government bureaucrats learning of new derivatives by happenstance, long after the products have been introduced. 271

Second, detailed information as to the volume and sources of derivatives activity is unavailable. As a theoretical matter, regulators should not find it difficult to obtain a fair amount of such information. Federal banking and securities regulators have always had ample powers of moral suasion. Also, especially with the passage of the FDIC Improvements Act of 1991 and the Market Reform Act of 1990, they have obtained ample legal authority to obtain almost all the information they could want. 272 They do not need to rely on the aggregate information made available by financial institutions to their shareholders. 273

However, financial banking regulators currently require very little data from financial institutions. To complete federal banking reports, commercial banks and their holding companies, must provide little more than aggregate information about the notional amounts and maturities of broad categories of derivatives they have outstanding. 274 Proposed banking rules that contemplate linking capital adequacy with interest rate risk 275 would require only somewhat more detailed disclosures on various interest-related derivatives. 276 While disclosures mandated by accounting rules are improving, the degree of

271. Hu, Regulatory Paradigm, supra note 6, at 406.


273. Relatively little data is available to serve as the foundation for regulators to understand bank specific or systemic risks, even though the Statement of Financial Accounting Standards No. 107 will increase public disclosure of the derivatives activities of banks and other entities. See Financial Accounting Standards Board, supra note 224; Ernst & Young Economists Suggest Methods for Implementing New FASB Requirements, supra note 224.


275. See Risk-Based Capital Standards, supra note 11.

detail as to the precise nature and amounts of instruments is still relatively limited.\textsuperscript{277}

As a result, comprehensive information is unavailable even for highly aggregated categories of OTC derivatives, much less for precisely defined categories. The primary source of information on banks' derivatives activities is still data submitted to the International Swap Dealers Association by its members.\textsuperscript{278} However, some banks are not members and compliance with reporting requirements has reportedly proved erratic.\textsuperscript{279}

Also, no institutionalized process exists for risk assessment. Regulators have no steady way to obtain information from the private sector on the bank-specific risks associated with derivatives. Specific regulatory initiatives have comprised the most rigorous mechanisms of information gathering. For example, bank and trade association comments heavily influenced the 1988 international capital adequacy standards. These comments sometimes ran hundreds of pages and included sophisticated mathematical models, disclosing far more information on the credit risks of these instruments than had been previously available.\textsuperscript{280} The information flow, however, is not only spasmodic, but is circumscribed in subject matter; there is little incentive for banks to address bank-specific risk issues unrelated to the regulatory initiative of the moment.

Banks also provide risk assessment information during the course of individual bank examinations. Yet, such highly fragmented data collection is unlikely to facilitate the development of comprehensive data on how derivatives activities impact banks, much less other market participants.

2. \textit{A Possible Institutional Mechanism}

Financial regulators need to obtain hazard identification and risk assessment information from market participants in a more systematic and comprehensive fashion. One initial—though perhaps excessively burdensome—approach would involve regulators and specified market participants\textsuperscript{281} establishing an initial catalogue of known OTC derivatives,
broken down by genus, family, and species. The catalogue would need to be updated regularly, again with the cooperation of industry and, perhaps, Wall Street ratings agencies. These market participants would be required to make confidential, after-the-fact filings, in computerized form, as follows:

(1) Included participants must collect and report information on transactions in a "contract specific" manner and enter the information pertinent to each transaction (such as the notional amount, exercise price, expiration date and its extendibility) in the classification. If the participant has entered into a transaction that does not fall squarely within a existing classification, it must report separately on that transaction. If the participant has entered into a directly offsetting transaction in order to reduce or eliminate the participant's market risk, the participant must provide corresponding information for this mirror transaction.

(2) Most of the classifications would have theoretical pricing and volatility estimation methods listed in the catalog. In placing a transaction in such a classification, a participant would note any objections to the applicability of such models; to the extent it does so, it must note the assumptions associated with the participant's own model. With respect to other classifications, the participant would list the models used and the assumptions underlying those models.

(3) The participant must report the theoretical and market values of each contract. It must also provide evidence as to extent of the contract's liquidity.

(4) The participant must specify in detail how it hedged the market risks of its overall portfolio of derivatives. The assumptions underlying the hedging techniques used and the sensitivity of the techniques to those assumptions must be estimated in a quantitative way.

(5) The participant should have the right to attempt to quantify how "portfolio effects" arising from diversification as to, inter alia, interest and exchange rates, types of derivative products, and actual derivative transactions may reduce the overall risk associated with the participant's derivatives activity.

This mechanism could contribute to solving both regulator and banker information failures. The benefits to regulators are most obvious. First, hazard identification could be facilitated by this kind of approach. Regulators would

282. The experience of ratings agencies should prove helpful in the detailed structuring of this mechanism. Such ratings agencies have, among other things, rated the separately capitalized derivatives subsidiaries of investment houses. See, e.g., Merrill Lynch Derivative Products Inc., supra note 30.

283. Cf. FINANCIAL ACCOUNTING STANDARDS BOARD, supra note 224, at FAS 107.24-107.25 (discussing how fair value of certain derivatives could be ascertained for accounting disclosure purposes).
be informed on a timely basis of both new financial products and which financial institutions are engaging in these transactions.

Second, this mechanism may help overcome the subversive effects of departures from classic scientific norms in the derivatives area. Notwithstanding the lack of openness, regulators would be made aware of "breakthrough" valuation or hedging models that are unpublished or otherwise inaccessible. As for the lack of Mertonian universalism, regulators would understand how market participants actually value derivatives and their liquidity and market structures.

Third, this mechanism would help regulators understand the systemic risks generated by derivatives activity. They would better understand the steps banks take to hedge against their market risks, one of the primary sources for such risk. In the case of hedging through offsetting transactions, at least partial "schematics" of linkages could be generated through appropriate computer-coding of the offsetting parties. Moreover, these partial schematics of networks would be useful in the event of a crisis similar to the failure of the Bank of New England. In the case of synthetic hedging, the bank regulators would understand better which other markets may be involved and how they are related. If there are particular exchange-traded instruments that appear heavily used, special focus could be put on the applicable exchange's clearinghouse arrangements.284

Banker informational failure would also be reduced. This would occur in two basic ways. First, the mandating of such information would force banks to confront the weaknesses in their pricing, risk assessment, and hedging systems. To the extent that existing computer systems of the "front offices," "middle offices," and "back offices" of derivatives houses cannot easily generate such information,285 suitable software and hardware systems would have to be developed.

Second, banks would be subject to a form of market discipline in their pricing and hedging techniques. More importantly, regulators would have a better sense of the relative ability of individual banks to deal with derivative risks. The "triangulation" of outlier banks or products would be possible; if only one bank uses a particular hedging strategy, then this anomaly could be investigated. Banks may be deterred from ill-understood actions if they know that their ignorance would be fully exposed to regulators.

Depending on the quality of existing computer systems used by market participants, the burdens of so comprehensive and detailed a reporting system

284. There is a remote possibility that a clearinghouse can itself default. See, e.g., Financial Systems and Financial Regulation in Dynamic Asian Economies, FINANCIAL MARKET TRENDS, Oct. 1990, at 17, 39-40 (describing problems of Hong Kong Futures Guarantee Corporation).

might be quite heavy, even though some of the tasks could be delegated by individual participants to some central representative (such as a trade association). Government and industry must work together to determine whether the direct and indirect burdens of such a scheme—or an abbreviated version—would be justified.\footnote{286}

The indirect costs would likely loom larger than the direct costs. A classification system could lead to the micromanagement\footnote{287} of banks as banks are tempted to follow regulator-approved models on pain of increased regulatory scrutiny. Perhaps even more important, banks might suffer the loss of valuable proprietary information. It is essential that confidential information be adequately protected, both from disclosure under the Freedom of Information Act and similar laws and from losses of intellectual property.\footnote{288}

C. Enhancement of the Role of Existing Market Institutions

1. User Fee Funding for Regulator Utilization of Private Expertise

Bank regulators may be unable to interpret the information collected by the foregoing system. As studies of high technology have shown, absorbing new technology requires a fair degree of sophistication.\footnote{289} One possible solution would be to allow regulators to go to the private sector for interpretive expertise. In the private sector, independent third parties offer software that can value OTC derivatives; precisely because their software is used in many institutions, its vendors are aware of—and, to an extent, define—how market participants assign prices to products.\footnote{290} The absence of openness and universalism should hinder such vendors less than they do regulators. One vendor asserts that it "provides in-depth coverage of virtually all financial instruments, with products for trading, risk-management, back office and

\footnote{286. The American Bankers Association has argued that compliance during 1991 with government regulatory policies cost industry $10.7 billion—59% of industry profits. Burden of Regulation, Banking Pol’y Rep. (P-H) 13 (July 20, 1992).}

\footnote{287. The FDIC Improvements Act, supra note 12, has come in for harsh criticism on precisely this ground. \textit{Cf.} Kenneth H. Bacon, \textit{Bankers Aim to Slash Red Tape Imposed By FDIC’s 1991 Law on Supervision}, Feb. 1, 1993, at A5 (quoting banker as saying that law may cause intelligent bankers to “get out of the business and let the twenty-two year old regulators start running banks”).}


\footnote{289. \textit{Cf.} Levin et al., \textit{supra} note 138.}

accounting and with quality support throughout a global organization." The firm that pioneered portfolio insurance has begun selling software to audit the complex mathematics associated with a wide range of derivatives. Such vendors help senior managers at financial institutions measure the true performance of their rocket scientists.

Regulators are in a position similar to that of senior managers. If appropriate steps can be taken to ensure confidentiality and sufficiently reduce conflicts of interest, regulators could use such auditing services or, possibly, analogs of investment banker "fairness opinions." Since the expertise will be expensive, it may be politically impossible for regulators to use taxpayer dollars to pay for third party evaluations. Yet, given the derivatives houses' interest in ensuring timely and intelligent regulation, they might be willing to contribute to a mechanism that would procure the expertise. The history of the Prescription Drug User Fee Act of 1992 suggests that, at least in some circumstances, industry will fund improved regulation. Pharmaceutical manufacturers have long complained about the length of time it took to bring a new drug to market. To speed this process, trade associations lobbied for legislation imposing heavy fees on drug companies devoted entirely to expediting the process. This law is expected to provide the Food and Drug Administration with $327 million over five years.

2. Legal Risks and Collective Action

We have seen that inappropriability of research and cognitive biases can contribute to banker informational failure relating to the legal risks of derivatives. Here, I suggest that both trade associations and major Wall Street law firms serve as vehicles for collective action to overcome these problems. Encouraging these creatures of the market may thus provide some social benefits.

291. SUNGARD DATA SYSTEMS INC., 1991 ANNUAL REPORT 8 (1992). Another vendor offers not only analytics associated with a "full spectrum of derivative products" but also those associated with entire portfolios of derivatives. CATS SOFTWARE INC., CATS: THE LEADER IN TECHNOLOGY FOR DERIVATIVES PRODUCTS 2, 6 (undated) (on file with author).


293. For an excellent discussion of some of the problems associated with investment banker fairness opinions, see Lucian Arye Bebchuk & Marcel Kahan, Fairness Opinions: How Fair Are They and What Can Be Done About It?, 1989 DUKE L.J. 27 (1989). Advisory committees staffed by experts acting on a volunteer basis are unlikely to provide as effective expertise as paid experts. For a discussion of the problems associated with scientific advisory committees, see Thomas O. McGarity, Some Thoughts on "Deossifying" the Rulemaking Process, 41 DUKE L.J. 1385, 1407-10 (1992).


In theory, direct collective action can overcome some of the disadvantages associated with the inappropriability of R & D. Groups of high technology corporations can form consortia to conduct scientific research and insurance companies can fund informational clearinghouses to evaluate applicants for insurance. Yet, financial R & D may be too sensitive for such cooperation. Certain risk information would be of immediate value. Thus, it would be unrealistic to expect the cooperative research to focus on superior option pricing models or hedging techniques. With the exception of tax-related R & D, legal R & D is less sensitive and, hence, cooperation easier.

In fact, direct collective action has already occurred, most notably through the efforts of the International Swap Dealers Association (ISDA). In part as a byproduct of its lobbying activities, ISDA has served, in effect, as a privately-funded consortium for legal R & D. Among other things, ISDA has produced several generations of standardized language and master forms used by most market participants. Since commencing work in 1984, ISDA has continually revised its forms to reflect changing products, market practices, and laws. Although ISDA is a trade association, not an independent research institution, it has performed a valuable social function by increasing each market participant’s understanding of legal risks.

Indeed, ISDA has gone further by actually reducing risks. Most notably, it was the major force behind explicit international acceptance of “netting.” “Netting” occurs when two parties who have entered into multiple derivative transactions with each other aggregate all such transactions in the event of bankruptcy, thereby reducing credit risk. ISDA obtained legal opinions on the netting issue from lawyers in most industrialized nations, drafted contractual provisions applying netting, and facilitated consistent statutory changes.

299. P. S. Johnson has argued on similar grounds that applied research and development is unsuited to industrial research and development consortia. Johnson, supra note 297, at 82-83.
300. Many new financial products are driven by tax considerations. Such research could be highly proprietary. See, e.g., Brady, supra note 22.
303. See, e.g., Cunningham & Rogers, supra note 136.
The derivative expertise of major money center law firms also facilitates collective action, albeit indirectly. If each of five banks, for instance, used the same Wall Street law firm, the redundancy costs of research on legal risks would be reduced. The nth bank approaching the legal specialist would benefit from the knowledge that specialist had gained from working on similar legal questions for other banks. Over time, the identity of the first mover will alternate; when a particular bank is the first to approach the law firm, the hourly fees will seem outrageous while when the same bank, on another matter, is the fifth such bank, the hourly fees may actually seem fair. The five banks using the same Wall Street law firm will have achieved some of the advantages of collective action without any direct collective action. This "serial collective action" may help explain how Wall Street law firms provide real value and charge accordingly.

Trade associations and expert law firms also help moderate the effect of the cognitive biases that might prevent bankers from integrating legal risks into their decisionmaking. By their very existence, ISDA and law firms testify to the importance of legal risks.

Regulators may be able to encourage such market mechanisms. They may wish to ensure that banks use state-of-the-art legal analysis, and they may want to be satisfied that the law firms upon which banks rely have enough reputational capital to be deterred from "opinion selling." Finally, regulators could look askance at derivatives houses that "shirk" their ISDA responsibilities.

Before such a plan could be adopted, however, more empirical work would be needed to determine the costs of such a system. Ensuring that the members are aware of legal risks may further the social interest. However, trade associations, by their nature, would want to further the interests of their members; what is good for the derivatives industry is not necessarily good for society. Also, although there is a theoretical basis for believing that centralizing legal research in Wall Street law firms may reduce overall costs, this is not necessarily the case. Finally, some increased legal activity is of questionable social utility. Society may not be better off if legal risks are reduced through clever circumvention of the clear intent of laws and regulations.

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Series No. 746, 1991).

305. Sophisticated legal work relating to financial innovation appears to be highly concentrated among the great money center law firms, facilitating this kind of collective action. For example, Cravath, Swaine & Moore is the primary outside counsel for ISDA. The private practitioners who had written articles for the May 1991 Texas Law Review symposium issue on financial innovation came from Cadwalader, Wickersham & Taft, Sullivan & Cromwell, and the New York and London offices of Cleary, Gottlieb, Steen & Hamilton.

306. There has been relatively little analysis of the value provided by business lawyers. For the seminal analysis, see Ronald G. Gilson, Value Creation by Business Lawyers: Legal Skills and Asset Pricing, 94 YALE L.J. 239 (1984).

3. Confidential Disclosure of Incentive Structures

As we have seen, a trader involved with derivatives has various incentives to exaggerate the extent of his risk-adjusted contribution to the firm; under certain circumstances, it may also be in his interest to take risks that informed shareholders would regard as excessive. These, in turn, contribute to banker information failures. As an empirical matter, extensive studies have shown how incentive structures affect employee behavior and managerial decisions. There is increasing recognition of this issue on Wall Street. In the early 1980's, Salomon did not even allocate costs; traders were rewarded on the basis of the total revenues on their books regardless of their costs. Now, Myron Scholes (of Black-Scholes fame) advises Salomon on how to structure appropriate incentives.

Through the recent adoption of rules that enhance mandatory disclosure to shareholders of the incentive compatibility of executives, the Securities and Exchange Commission could improve corporate performance by forcing corporations to reexamine their compensation policy. More detailed confidential disclosure to bank regulators of the incentive structures of individual bankers would be helpful as well. In particular, such schemes would involve detailed disclosure of how individuals are evaluated for purposes of compensation and advancement. Such details should include how and when "profits" on trades are calculated, the valuation models used to calculate profits, how derivative risk is measured, and how a bank determines the proper risk-adjusted reward for its traders.

This disclosure may increase regulators' ability to monitor inappropriate behavior. Familiarity with such compensation details could enable outsiders to determine when close scrutiny of banker decisions is warranted and when it is not. It would also enable regulators to decipher opaque managerial decisions, for much the same reasons that the common law requires fiduciaries to disclose, at a minimum, their interest in self-dealing transactions. Such disclosure would enable regulators to judge how much banks worry about safety. Disclosure would also be useful for comparative purposes. If a bank has

advice).

308. See, e.g., Hu, Fiduciary Principles, supra note 60, at 319-26, 333-36.
309. See, e.g., Tom Wilson, RAROC Remodelled, RISK, Sept. 1992, at 112.
310. LEWIS, supra 162, at 109.
313. This Review Essay's call for consideration of enhanced disclosure of the compensation arrangements of certain bankers is far less intrusive than the substantive standards for employee compensation that federal banking regulators are statutorily mandated to develop by August 1, 1993. See 18 U.S.C. §§ 1813 & 1813(c) (1992).
a compensation structure that treats risk differently than do other banks' structures, then closer attention may be warranted. Finally, this disclosure might spur boards of directors to craft appropriate incentive structures ex ante.

Detailed disclosure of the incentive compatibility of relevant personnel is an extremely complicated issue. Questions about who should be covered, what should be disclosed, and to whom disclosure should be made are difficult. Luckily, this regulation need not begin with a blank slate. Commentary and rules concerning disclosure of executive compensation in proxy statements would be good starting points for analysis.

CONCLUSION

Everyone stands in the shadow of OTC derivatives activities. Large, growing, and complex, they appear menacing in the dark. Some observers who fear that neither bankers nor regulators understand the risks are tempted to halt these activities altogether. To do so would be Procrustean, unnecessary, and destructive of social wealth.

The possible regulator and banker informational failures may stem in part from the youth and the peculiarities of the financial science that now underlies the process of financial innovation. An examination of possible cognitive biases, which are only beginning to be explored in financial contexts, as well as theories pertaining to inappropriability and principal-agency relationships, further contributes to our understanding.

This understanding should discourage regulatory adventurism. I hope that the pathways for dealing with banker and regulator informational failures outlined here can provide a starting point for objective discussion. We should take comfort that the informational failures are explicable, and we should lay plans to slowly—incrementally—begin turning on the lights.