

Review Essay

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

Capital Ideas: The Improbable Origins of Modern Wall Street. By Peter L. Bernstein.* *New York: The Free Press, 1992.* Pp. ix, 340. \$24.95.

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INTRODUCTION

New financial products are being introduced throughout the industrialized world at an unprecedented rate.¹ Innovation has been especially striking in the market for over-the-counter (OTC) derivatives,² a type of financial contract

1. Robert C. Merton, *The Financial System and Economic Performance*, 4 J. FIN. SERV. RES. 263, 265 (1990); Merton H. Miller, *Financial Innovation: Achievements and Prospects*, J. APPLIED CORP. FIN., Winter 1992, at 4, 4; James C. Van Horne, *Of Financial Innovations and Excesses*, 40 J. FIN. 621, 621 (1985).

2. The term "derivatives" is more fully defined at *infra* notes 26-28 and accompanying text.

individually negotiated among major financial institutions³ and between such institutions and their sophisticated clients.⁴ 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.⁵ The OTC derivatives market has enjoyed enormous growth. On a crude, "notional amount" basis⁶ the market for selected OTC derivatives reached four trillion dollars by year-end 1991, eight times its level five years before.⁷ The notional amount of outstanding "swaps,"⁸ one important genus of derivatives, now exceeds the combined value of all shares listed on the New York and Tokyo stock exchanges.⁹ Such activities are concentrated in those large, money center financial institutions¹⁰ central to the

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).

5. *See* Wendy Gramm, *Plus ça Change, RISK*, Oct. 1992, at 88, 88 ("The OTC market acts as an important laboratory for new products" for organized exchanges.); Mary L. Schapiro, *The Growth of the Synthetic Derivative Market: Risks and Benefits*, Speech Before the National Option & Future Society 1 (Nov. 13, 1991) (calling OTC derivatives market "breeding ground" for innovative new products).

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).

7. In contrast, there was a six-fold increase in selected exchange-traded derivatives in the same period. Bank for International Settlements: Monetary and Economic Department, *International Banking and Financial Market Developments During the Fourth Quarter of 1991* at 15-16 (May 1992) (unpublished manuscript, on file with author). Similarly, one April 1992 survey found that turnover in the OTC "currency options" market grew from four percent of daily turnover in the foreign exchange market in 1989 to seven percent in 1992, while turnover in exchange-traded currency options market remained unchanged at 2 percent. Federal Reserve Bank of New York, *Summary of Results of the U.S. Foreign Exchange Market Turnover Survey Conducted in April 1992* at 7-8 (1992) (unpublished manuscript, on file with author). At year-end 1991, three New York-based bank holding companies had currency options with a notional amount of \$185 billion on their books. This \$185 billion figure is based on the consolidated figures in annual reports, and these figures do not distinguish between exchange-traded and nonexchange-traded currency options. *See* BANKERS TRUST NEW YORK CORP., 1991 ANNUAL REPORT 53 (1992); CHEMICAL BANKING CORP., FORM 10-K FOR THE FISCAL YEAR ENDED DECEMBER 31, 1991 at 90 (1992); J.P. MORGAN & CO., 1991 ANNUAL REPORT 64 (1992). Standardized, exchange-traded currency options and customized, OTC currency options provided by banks both became available in the early 1980's. JULIAN WALMSLEY, *THE NEW FINANCIAL INSTRUMENTS* 179 (1988).

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.

9. William Glasgall & Bill Javetski, *Swap Fever: Big Money, Big Risks*, BUS. WK., June 1, 1992, at 102.

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.¹¹ A second round of international regulatory action appears possible, if not imminent.¹² 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.

11. These standards were set forth in the "Agreement on International Convergence of Capital Measurement and Capital Standards," as reported by the Basle Committee on Banking Supervision and were implemented by federal regulators through the promulgation of risk-based capital guidelines. See 12 C.F.R. § 3, app. A (1992) (national banks); 12 C.F.R. § 208, app. A (1992) (state member banks); 12 C.F.R. § 225, app. A (1992) (bank holding companies and state nonmember banks). These commercial bank capital adequacy regulatory efforts and their relationship to "credit risk," insofar as they relate to new financial products and the modern process of financial innovation, are the primary focus of Hu, *Regulatory Paradigm*, *supra* note 6; cf. Risk-Based Capital Standards, 57 Fed. Reg. 35,507 (1992) (soliciting comments for revising risk-based capital guidelines to take account of interest rate risk and risks from nontraditional activities) [hereinafter Risk-Based Capital Standards]; Tony Shea, *Implementation in the United Kingdom of the Second Banking Directive*, 7 J. INT'L BANKING L. 506, 507-08 (1992) (describing status of risk-based capital adequacy standards in Europe and international negotiations regarding such standards); *Swap Dealers Find "Debauché" Report Misleading*, AM. BANKER, Sept. 2, 1992, at 5 (letter discussing recent actions taken by bank regulators pertaining to swaps). I do not deal with capital adequacy issues in this Review Essay except in passing.

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).

12. Increased regulation of OTC derivatives could take place on at least three fronts. First, there may be increased regulation of the institutions engaged in derivatives activity. In reviewing the capital adequacy of commercial banks, federal banking regulators already consider the credit risks banks assume on their derivatives. See *supra* note 11. Moreover, § 305 of the Federal Deposit Insurance Corporation Improvements Act of 1991 requires federal banking agencies to revise their risk-based capital guidelines to take adequate account of, among other things, interest rate risk and the "risks of nontraditional activities." See Federal Deposit Insurance Corporation Improvements Act of 1991, Pub. L. No. 102-242, § 305, 105 Stat. 2236 [hereinafter FDIC Improvements Act]; Risk-Based Capital Standards, *supra* note 11. Second, there may be regulation of the products themselves. In the United States, regulation at the product level has been light thus far. Cf. Futures Trading Practices Act of 1992, Pub. L. No. 102-546, § 502, 106 Stat. 3590 (authorizing Commodity Futures Trading Commission to exempt swap agreements, as defined at 11 U.S.C. § 101, from Commodity Exchange Act); 17 C.F.R. §§ 35.1-35.2 (rule adopted January 1993 exempting most swaps from most provisions of Commodity Exchange Act); Sandra Block, *CFTC to Exempt Most Swaps From Its Rules*, WALL ST. J., Jan. 15, 1993, at A5 (same). Third, there may be increased attempts on the part of the tax authorities to deal with financial innovation in a more coherent way. See, e.g., Richard Briffet, *Avoiding New Evils by Applying New Remedies: Taxes and Cross-Border Transactions*, J. APPLIED CORP. FIN., Winter 1992, at 109; Edward D. Kleinbard, *Equity Derivative Products: Financial Innovation's Newest Challenge to the Tax System*, 69 TEX. L. REV. 1319, 1320, 1353-54 (1991); Reed Shuldiner, *A General Approach to the Taxation of Financial Instruments*, 71 TEX. L. REV. 243, 245-46 (1992). While the legal implications of financial innovation for the regulation of banks,

OTC derivatives could cause the next great banking crisis,¹³ and major governmental studies on the risks posed by derivatives are now under way on three continents.¹⁴ 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, 1276-78, 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).

13. See, e.g., Heidi Fiske, *Where Do We Go From Here?*, INSTITUTIONAL INVESTOR, July 1992, at 209, 213 (quoting Felix Rohaytn of Lazard Freres); Glasgall & Javetski, *supra* note 9, at 103 (quoting economist Henry Kaufman); Saul Hansell & Kevin Muehring, *Why Derivatives Rattle the Regulators*, INSTITUTIONAL INVESTOR, Sept. 1992, at 49, 50-51 (quoting chairman of Royal Bank of Canada); Floyd Norris, *Swapping Woes: A Fed Official Sees Problems*, N.Y. TIMES, Feb. 9, 1992, at C1 (quoting Gerald Corrigan, President of Federal Reserve Bank of New York); Lisa Vaughan, *Swaps Boom Worries Regulators*, THE INDEPENDENT, Aug. 25, 1992, at 19 (citing regulators at Bank of England). For more sanguine views, see, e.g., Tanya Azarchs, *Banks Face Manageable Risks in Derivative Businesses*, STANDARD & POOR'S CREDITWEEK, Nov. 1992, at 1; Gramm, *supra* note 5.

The two most important components of the risk created by a derivative transaction or by a bank's portfolio of derivative transactions are "credit risk" and "market risk." See *infra* Section I(A)(2). Tanya Azarchs of Standard & Poor's has recently attempted to estimate the credit risk component of the risks associated with the derivatives portfolios of leading American commercial banks. For instance, she estimated that as of June 30, 1992, the credit risk faced by Citicorp with respect to its derivatives portfolio was \$23.5 billion (as against a notional amount of \$1.4 trillion). She did not try quantifying the market risk associated with these portfolios. Azarchs, *supra*, at 1, 5.

14. See, e.g., Futures Trading Practices Act of 1992, *supra* note 12 (requiring Commodity Futures Trading Commission to conduct study); Beese, *supra* note 11, at 11 (noting study by, among others, Japan's Ministry of Finance); William Falloon, *Capitol Hill Paper Chase*, RISK, July-Aug. 1992, at 11 (describing GAO study and noting that agency official expected preliminary report in about one year); Patrick Harverson, *It's Time to Know What's Going On*, FIN. TIMES, Dec. 8, 1992, § III, at II (mentioning Bank of England study); cf. Tracy Corrigan, *G30 Names Head of Study Group*, FIN. TIMES, Aug. 21, 1992, at 20 (chairman of J.P. Morgan named head of study sponsored by Group of Thirty, an influential private group); WORKING GROUP ESTABLISHED BY THE CENTRAL BANKS OF THE GROUP OF TEN COUNTRIES, RECENT DEVELOPMENTS IN INTERNATIONAL INTERBANK RELATIONS 1992 (on file with author) (study conducted under auspices of governors of central banks of the Group of Ten countries).

the regulation of commercial banks,¹⁵ investment banks,¹⁶ and capital markets¹⁷ 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.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.”¹⁹ This poses the puzzle: how could banks suffer from such

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”). Banks “have been lobbying for a rollback of some of the regulations.” John H. Cushman, Jr., *Keep Strict Bank Rules, Officials Urge*, N.Y. TIMES, Dec. 18, 1992, at C1.

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).

17. See U.S. Equity Market Structure Study, Exchange Act Release No. 30,920, 57 Fed. Reg. 32,587 (1992) (SEC request for comments in connection with SEC’s Division of Market Regulation’s “Market 2000” study of U.S. equity marketplace); Mahlon M. Frankhauser & Ellen S. Levinson, *Commodity Exchange Act Amendments*, 25 REV. SEC. & COMM. REG. 245, 251 (1992) (noting Congress intends to use derivatives studies to address larger issues of regulatory policy); cf. *Single Securities and Futures Agency Ahead for U.S.*, *CME Chairman Predicts*, 24 Sec. Reg. & L. Rep. (BNA) 1633 (Oct. 23, 1992) (predicting that single “super-agency” will regulate securities, futures, options, and derivative products); Gary Weiss, *Nightmare on Wall Street: A New Rule Book*, BUS. WK., Dec. 21, 1992, at 76, 76 (Wall Streeters “aren’t worried about the outcome [of the SEC’s “Market 2000” study]. They’re petrified.”).

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 C1, 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.”).

19. *Review of 1992 and Outlook for 1993*, SWAPS MONITOR, Dec. 28, 1992, at 1, 1. Corrigan is also chair of the Bank for International Settlements’ Committee on Banking Regulations and Supervisory

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

Practices. This Committee centerposts the international supervision of commercial banks and was responsible for the 1988 international capital adequacy accord. Hu, *Regulatory Paradigm*, *supra* note 6, at 372-76. Mr. Corrigan has announced that he will resign in August, 1993. Saul Hansell, *New York Fed’s President Resigning*, N.Y. TIMES, Jan. 6, 1993, at D1.

20. Concern over informational failures has, on the other hand, tended to focus on those of investors, consumers, and workers. See, e.g., WESLEY A. MAGAT & W. KIP VISCUSI, INFORMATIONAL APPROACHES TO REGULATION (1992); Howard Beales et al., *The Efficient Regulation of Consumer Information*, 24 J.L. & ECON. 491, 492-93 (1981); Jeffrey N. Gordon & Lewis A. Kornhauser, *Efficient Markets, Costly Information, and Securities Regulation*, 60 N.Y.U. L. REV. 761 (1985); Alan Schwartz & Louis L. Wilde, *Intervening in Markets on the Basis of Imperfect Information: A Legal and Economic Analysis*, 127 U. PA. L. REV. 630, 630 (1979).

21. See, e.g., Hu, *Regulatory Paradigm*, *supra* note 6, at 405-12 (discussing causes of regulatory lag in information); *Brady Warns of Risks Posed by Swaps Market, Urges One Regulator*, 24 Sec. Reg. & L. Rep. (BNA) 1888, 1888 (Dec. 25, 1992) (Treasury Secretary Nicholas Brady referring to “wide knowledge gaps between regulators and the regulated”); Craig Torres & Michael Siconolfi, *Leverage: Wall Street’s Two-Edge Sword*, WALL ST. J., Aug. 21, 1992, at C1 (stating that “[t]he private derivative markets, for the most part, are beyond the expertise, surveillance and laws of regulators”).

22. Simon Brady, *The Ref Gets Rough*, EUROMONEY, Apr. 1992, at 25, 25 (quoting Richard Farrant, senior Bank of England official).

23. PETER L. BERNSTEIN, CAPITAL IDEAS: THE IMPROBABLE ORIGINS OF MODERN WALL STREET (1992).

24. For analysis of other “supply” factors and of “demand” factors in the market for financial innovation, see, e.g., STUDY GROUP ESTABLISHED BY THE CENTRAL BANKS OF THE GROUP OF TEN COUNTRIES, RECENT INNOVATIONS IN INTERNATIONAL BANKING 169-187 (1986); John D. Finnerty, *Financial Engineering in Corporate Finance: An Overview*, FIN. MGMT., Winter 1988, at 14; Hu,

To partially explain the puzzle, I analyze banker informational failure from several different perspectives. From an economics standpoint, I apply “inappropriability”²⁵ 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.²⁶ 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

Shareholder Welfare, *supra* note 12, at 1298-99; Hu, *Regulatory Paradigm*, *supra* note 6, at 335-41 & 363-66; Miller, *supra* note 1, at 10; Merton H. Miller, *Financial Innovation: The Last Twenty Years and the Next*, 21 J. FIN. & QUANTITATIVE ANALYSIS 459 (1986); Stephen A. Ross, *Institutional Markets, Financial Marketing, and Financial Innovation*, 44 J. FIN. 541, 541-44 (1989).

25. “Inappropriability” is defined in Section II(B)(1) *infra*.

26. Frank J. Fabozzi & Franco Modigliani, CAPITAL MARKETS: INSTITUTIONS AND INSTRUMENTS 5 (1992); Atsuo Konishi & Ravi E. Dattatreya, *Introduction in THE HANDBOOK OF DERIVATIVE INSTRUMENTS: INVESTMENT RESEARCH, ANALYSIS, AND PORTFOLIO APPLICATIONS 1* (Atsuo Konishi & Ravi E. Dattatreya eds., 1991).

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.²⁷ 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.²⁸

Sophisticated end-users, typically corporations and sovereign entities, can participate in an alternative market.²⁹ 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.³⁰

From a private perspective,³¹ derivatives serve several financial functions.

27. For instance, all futures contracts traded in the United States are cleared through clearinghouses that become the buyer to every seller and the seller to every buyer. See Thomas A. Russo & Marlisa Vinciguerra, *Financial Innovation and Uncertain Regulation: Selected Issues Regarding New Product Development*, 69 TEX. L. REV. 1431, 1433 n.4 (1991). But cf. *infra* note 284 (discussing credit concerns with clearinghouses).

28. Cf. DEBORAH G. BLACK, SUCCESS AND FAILURE OF FUTURES CONTRACTS: THEORY AND EMPIRICAL EVIDENCE 1 (Salomon Brothers Center for the Study of Financial Institutions: Monograph No. 1986-1, 1986) (distinguishing between “success” and “failure” of futures contracts). The Chicago Board Options Exchange is proposing a system that would allow even exchange traded options to be customized. See Jeffrey Taylor, *CBOE Will Let Small Investors Tailor Options*, WALL ST. J., Jan. 29, 1993, at C1.

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.266 (discussing possibility of clearinghouse arrangements for OTC derivatives); Kenneth M. Raisler, *Swaps Clearinghouse: The Next Frontier*, FUTURES INDUSTRY, Nov./Dec. 1992, at 15 (same).

31. It is important to separate the private and social benefits of financial innovation. The analysis in the text focuses on some of the *private* benefits of financial innovation. Discussions of the benefits of financial innovations to society tend to focus on how they “complete markets,” reduce transactions costs, lower liquidity and reduce agency costs. Robert C. Merton, *Financial Innovation and Economic Performance*, J. APPLIED CORP. FIN., Winter 1992, at 12, 17; Merton, *supra* note 1, at 265-72; Stephen A. Ross, *Institutional Markets, Financial Marketing, and Financial Innovation*, 44 J. FIN. 541 (1989); Lawrence H. Summers & Victoria P. Summers, *When Financial Markets Work Too Well: A Cautious Case for a Securities Transactions Tax*, 3 J. FIN. SERV. RES. 261, 261-62, 264-74 (1989).

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.³² Second, end-users may be able to arbitrage differences between the price of the derivative and the price of the underlying asset,³³ or between prices in different capital markets.³⁴ 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.³⁵ For instance, currency exchange rate volatility increased with the breakdown of the Bretton Woods system in 1973 and increased further in the 1980's.³⁶ Similarly, interest rate volatility has reached unprecedented levels, higher than even the period just before 1929.³⁷ Commodity price volatility in the late 1970's and 1980's far exceeded the volatility experienced in the 1950's and 1960's.³⁸

Derivatives can insulate end-users from exogenous risks—a derivative that rises in value if oil prices fall could protect a sheikdom,³⁹ 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.⁴⁰ “Option-based products” provide price insurance by

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).

33. See Ira G. Kawaller et al., *The Relationship Between the S&P 500 Index and S&P 500 Index Futures Prices*, ECON. REV., May/June 1988, at 2 (published by Federal Reserve Bank of Atlanta).

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).

36. Sean Beckett & Gordon H. Sellon, Jr., *Has Financial Market Volatility Increased?*, in RESEARCH DIVISION: FEDERAL RESERVE BANK OF KANSAS CITY, FINANCIAL MARKET VOLATILITY AND THE ECONOMY 14-15 (1990).

37. *Id.* at 9.

38. Robert J. Shiller, *Causes of Changing Financial Market Volatility*, in FEDERAL RESERVE BANK OF KANSAS CITY, FINANCIAL MARKET VOLATILITY 3-4 (1988).

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 DEPARTMENT, INTERNATIONAL BANKING AND FINANCIAL MARKET DEVELOPMENTS DURING THE SECOND QUARTER OF 1992 86-87 (Nov. 1992).

40. Cf. Clifford W. Smith, Jr. & Charles W. Smithson, *Financial Engineering: An Overview*, in THE HANDBOOK OF FINANCIAL ENGINEERING: NEW FINANCIAL PRODUCT INNOVATIONS, APPLICATIONS, AND

giving the owner of the contract the right, but not the obligation, to buy an asset at a specified price.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.⁴²

The type of derivative that has sparked much of the current regulatory concern is a forward-based product called a “swap.”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.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.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.⁴⁶

ANALYSES 4-9 (1990) (characterizing forward contracts as “price fixing building blocks” and options as “price insurance building blocks”).

41. Fabozzi & Modigliani, *supra* note 26.

42. *Id.*; SUSAN ROSS MARKI, DERIVATIVE FINANCIAL PRODUCTS 5, 13-16 (1991).

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).

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.

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”).

46. *But cf.* Saul Hansell, *The Risk Collectors*, INSTITUTIONAL INVESTOR, Sept. 1992, at 57 (noting options can be more difficult to hedge than swaps).

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.

57. For an excellent brief introduction to the emergence of modern finance, see Richard Whitley, *The Transformation of Business Finance Into Financial Economics: The Roles of Academic Expansion and Changes in U.S. Capital Markets*, 11 ACCT. ORGANIZATION AND SOC'Y 171, 172-77 (1986).

58. Donald C. Langevoort, *Theories, Assumptions, and Securities Regulation: Market Efficiency Revisited*, 140 U. PA. L. REV. 851 (1992).

59. John H. Langbein & Richard A. Posner, *The Revolution in Trust Investment Law*, 62 A.B.A.J. 887, 890 (1976).

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

60. See Henry T.C. Hu, *Risk, Time, and Fiduciary Principles in Corporate Investment*, 38 U.C.L.A. L. REV. 277, 295-306 (1990) [hereinafter Hu, *Fiduciary Principles*]; Hu, *Shareholder Welfare*, *supra* note 12, at 1306-1309.

61. See Hu, *Fiduciary Principles*, *supra* note 60, at 387-88; Executive Compensation Disclosure, Securities Act Release No. 33-6962, [1992 Transfer Binder] Fed. Sec. L. Rep. (CCH) ¶ 85,056 (Oct. 16, 1992); FASB *Continues Talks on Projects on Stock Compensation, Asset Impairment*, 24 Sec. Reg. & L. Rep. (BNA) 1759 (Nov. 13, 1992).

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).

64. The book has already been cited by prominent academics. See, e.g., Merton, *supra* note 31, at 13 n.3; J. Bradford De Long & Andrei Shleifer, *Closed-end Fund Discounts*, J. PORTFOLIO MGMT., Winter 1992, at 46.

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.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.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.”⁶⁹ It was considered bizarre to believe that “beating the market” was difficult because stock prices rapidly assimilated all available information.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,⁷¹ and most of the articles published in finance journals were descriptive, relying on ordinary language and reasoning.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.⁷³

67. Articles on economic theory began to meet the standards of rigor common in mathematical periodicals with the publication in 1944 of John Von Neumann's *Theory of Games and Economic Behavior*. Gerard Debreu, *Theoretic Models: Mathematical Form and Economic Content*, 54 *ECONOMETRICA* 1259, 1265-66 (1986). Von Neumann's *Theory of Games* not only sparked new rigor in economic theory but helped lead the way to Harry Markowitz's 1952 *Journal of Finance* article. See Christopher Welles, *The Beta Revolution: Learning to Live With Risk*, INSTITUTIONAL INVESTOR, Sept. 1971, at 21, 25.

68. Lawrence Fisher & James H. Lorie, *Rates of Return on Investments in Common Stocks*, 37 *J. BUS.* 1 (1964). See BERNSTEIN, *supra* note 23, at 129-30; Lawrence Fisher & James H. Lorie, *Rates of Return on Investments in Common Stock: The Year-by-Year Record, 1926-65*, 41 *J. BUS.* 291, 291 (1968) (describing 1964 study as “first comprehensive and refined measurement of the performance of stocks listed on the New York Stock Exchange for a significant number of time periods”).

69. BERNSTEIN, *supra* note 23, at 133.

70. James H. Lorie & Richard A. Brealey, *Introduction: A Startling Idea: Current Prices Reflect What is Knowable*, in *MODERN DEVELOPMENTS IN INVESTMENT MANAGEMENT: A BOOK OF READINGS* 101 (James H. Lorie & Richard A. Brealey eds., 1972).

Bernstein noted that investment professionals used to joke that they were social workers to the rich. Bernstein, *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., *The Structure and Performance of the Money Management Industry*, BROOKINGS PAPERS ON ECON. ACTIVITY: MICROECONOMICS 339, 375 (1992).

71. Whitley, *supra* note 57, at 173.

72. *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 *Journal of Finance* up to 1959. Bernstein, *supra* note 23, at 42; cf. Terry L. Zivney & William J. Bertin, *Publish or Perish: What the Competition is Really Doing*, 47 *J. FIN.* 295, 305 (1992) (referring to *Journal of Finance* as one of the top three finance journals).

73. Whitley, *supra* note 57, at 173.

Today, all directors and officers of the American Finance Association are academics.⁷⁴ The articles in the finance journals are now more abstract and restricted to those with academic training in theory and mathematics.⁷⁵ Finance scholars work on problems that have attracted the best economists,⁷⁶ and they have even received the Nobel prize.⁷⁷ 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.⁷⁸ 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.⁷⁹

Bachelier was a frustrated unknown in his time, teaching not at the Sorbonne but at the provincial university at Besancon,⁸⁰ which was "about as provincial as provincial France can get."⁸¹ Among academics, Bachelier's work was not noticed until it was rediscovered by accident in the 1950's.⁸²

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.⁸³ 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.

76. Nils H. Hakansson, *The Fantastic World of Finance: Progress and the Free Lunch*, 14 J. FIN. & QUANTITATIVE ANALYSIS 717, 718 (1979).

77. Michael J. Mendel, *Hurrah for the Founding Fathers of Modern Finance*, BUS. WK., Oct. 29, 1990, at 33.

78. See BERNSTEIN, *supra* note 23, at 18-19; ROBERT C. MERTON, CONTINUOUS-TIME FINANCE 330 (1990).

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 "[e]ver 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.

85. Eliot Katz, *History of Options*, in *OPTIONS: ESSENTIAL CONCEPTS AND TRADING STRATEGIES* 17 (The Options Institute ed., 1990).

86. *Id.*; JACK D. SCHWAGER, *THE NEW MARKET WIZARDS: CONVERSATIONS WITH AMERICA'S TOP TRADERS* 353 (1992) (interview with Joe Ritchie); cf. Hal Lux, *The Derivatives Lab*, *INVESTMENT DEALERS DIG.*, Mar. 16, 1992, at 20 ("By producing a benchmark pricing formula for all options traders, the Black-Scholes model narrowed bid-ask spreads and added crucial liquidity to the market.").

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.*

88. *Id.*; Fischer Black & Myron Scholes, *The Pricing of Options and Corporate Liabilities*, 81 *J. POL. ECON.* 637, 641 n.3 (1973).

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:

[Y]ou 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,”⁹³ while Stephen Ross of Yale has called it “the most successful theory not only in finance but in all economics.”⁹⁴ It is the central theory underlying modern financial innovation.⁹⁵

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 options⁹⁶ 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.⁹⁷ 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 restricted simply to *purchasing* an option

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).

93. Susan Lee, *What's with the Casino Society?*, FORBES, Sept. 22, 1986, at 150 (quoting Rubinstein).

94. *Of Butterflies and Condors*, ECONOMIST, Feb. 16, 1991, at 58 (quoting Ross).

95. One prominent Wall Street rocket scientist has equated financial innovation with the application of option pricing theory. BOOKSTABER, *supra* note 45, at viii.

96. I refer to the Garman-Kohlhagen model. See Mark B. Garman & Steven W. Kohlhagen, 2 *Foreign Currency Option Values*, 2 J. INT'L MONEY & FIN., 231 (1983); see also HENRY K. CLASING, JR. ET AL., CURRENCY OPTIONS: HEDGING AND TRADING STRATEGIES 39-40 (1992). For other discussions of the pricing of currency options, see James N. Bodurtha, Jr. & Georges R. Courtadon, THE PRICING OF FOREIGN EXCHANGE OPTIONS (Salomon Brothers Center for the Study of Financial Institutions Monograph 1987-4/5); James N. Bodurtha, Jr. & Georges R. Courtadon, *Efficiency Tests of the Foreign Currency Options Market*, 41 J. FIN. 151 (1986); Eric Briys & Michael Crouhy, *Creating and Pricing Hybrid Foreign Currency Options*, FIN. MGMT., Winter 1988, at 59; Richard Cookson, *Models of Imperfection*, RISK, Oct. 1992, at 55, 57-58.

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”⁹⁸ 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.⁹⁹ 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.¹⁰⁰ Foreign financial institutions establishing OTC derivatives operations have hired American traders at seven-figure salaries.¹⁰¹ In fact, world-class academics are particularly useful and well compensated.¹⁰²

Elaborate computer systems are also essential to OTC derivatives dealers. To be competitive, they need real-time data feeds and large databases.¹⁰³ Computer simulations help dealers evaluate the quality of alternative mathematical models.¹⁰⁴ 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.

99. See Jack Hirshleifer, *Investment Decision Criteria*, in THE NEW PALGRAVE: A DICTIONARY OF ECONOMICS 991 (John Eatwell et al. eds., 1987).

100. Hillibrand reportedly developed complex interest rate options and engaged in proprietary trading. This remuneration package attracted the attention of Hillibrand's MIT thesis advisor, Paul Samuelson. See Paul A. Samuelson, *Foreword*, 1 FIN. MARKETS, INSTITUTIONS & INSTRUMENTS 1 (1992); *Turning Eggheads Into Supertraders*, INSTITUTIONAL INVESTOR, July 1992, at 200; Jonathan Fuerbringer, *2 Key Executives Resign From Salomon Brothers*, N.Y. TIMES, Jan. 16, 1992, § 1, at 35.

101. Ivy Schmerken, *Is the U.S. Losing Its Edge? Foreign Competition in Derivatives Trading*, WALL ST. & TECH., Mar. 1992, at 23.

102. Myron Scholes became co-head of derivatives trading at Salomon. Manjeet Kripalani, *Formula for Success*, FORBES, Oct. 28, 1991, at 202. Fischer Black became a partner involved with quantitative strategies at Goldman Sachs. *Fischer Black Moves to the Trenches*, INSTITUTIONAL INVESTOR, Feb. 1990, at 18.

103. Schmerken, *supra* note 101.

104. Richard M. Bookstaber, *Simulation Methods for the Evaluation of Option Models*, in FIXED INCOME ANALYTICS: STATE-OF-THE-ART DEBT ANALYSIS AND VALUATION MODELING 277 (Ravi E. Dattatreya ed., 1991); Financial Engineering Associates, Inc., *DerivaTool* (1992) (advertising brochure) (noting that “DerivaTool [an integrated environment for Monte Carlo simulation of derivatives] makes it easy to obtain highly accurate determinations of the fair market value and hedging parameters of the most

traders to let them “do in four minutes what it takes competitors four to eight hours [to do].”¹⁰⁵

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.”¹⁰⁶ 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.¹⁰⁷ 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.¹⁰⁸ 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.¹⁰⁹ 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.¹¹⁰ The market can, of course, also be wrong. Indeed, studies have shown that market views on volatility—like market views on the value

complex derivative securities, in minutes instead of weeks.”); cf. Mark Ferron & George Handjinicolaou, *Understanding Swap Credit Risk: The Simulation Approach*, J. INT’L SEC. MARKETS, Winter 1987, at 135 (describing Monte Carlo simulation for evaluating swap credit risk); Krystyna Krzyzak, *Monte Carlo Simulation*, RISK, June 1992, at 10 (developing new derivative involves up to million financial Monte Carlo simulations).

105. Ivy Schmerken, *Japanese Buy Into Derivatives Technology*, WALL ST. COMPUTER REV., June 1991, at 72. One financial institution has reportedly used a supercomputer to deal with derivatives. John R. Wilke, *Parallel Computing Finds Mainstream Uses*, WALL ST. J., Jan. 6, 1992, at B1. This is not to say that a souped-up IBM PC is outmoded. Stephen Davis, *The Durable Popularity of the IBM PC*, INSTITUTIONAL INVESTOR, Nov. 1991, at 65.

106. Lux, *supra* note 86, at 22.

107. See Ronald Cooper, *Swap Houses Switch to New Values*, EUROMONEY, Jan. 1987, at 32; *Swap Unwinds; What Are They Worth?*, CORP. FIN., Jan. 1989, at 15.

108. Cf. Kenneth S. Leong, *Model Choice*, RISK, Dec. 1992, at 60 (specifying features of option pricing models critical for daily bank operations).

109. For an excellent discussion of the estimation of volatility, see Brown, *supra* note 97.

110. *Id.* at 527-35. See, e.g., Frederic Barnaud & Jean Dabouineau, *Past Correction*, RISK, Sept. 1992, at 108, 111 (comparing implied and historical volatilities for oil during Operation Desert Storm).

of stocks—can be irrational.¹¹¹ As an empirical matter, uncertainty in estimating volatility creates “wide margins of error” in pricing and hedging.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.”¹¹³

Second, theoretical models, including Black-Scholes, all depend on unrealistic assumptions.¹¹⁴ Indeed, they are unrealistic enough that Fischer Black recently wrote an article entitled, *How to Use the Holes in Black-Scholes*.¹¹⁵ Newer, fancier models that relax these assumptions are regularly developed.¹¹⁶ Even now, most option models are based on an arbitrage assumption that simply does not hold in the real world.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,¹¹⁸ but studies have shown that the historical distribution is different, especially for minor currencies. They have “fat tails.”¹¹⁹ Also, the models assume constant volatility, even though currency volatility changes over time.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.¹²¹ As a

111. See Jeremy Stein, *Overreactions in the Options Market*, 44 J. FIN. 1011 (1989).

112. See Kenneth S. Leong, *Volatility and Option Pricing*, in THE HANDBOOK OF DERIVATIVE INSTRUMENTS: INVESTMENT RESEARCH, ANALYSIS AND PORTFOLIO APPLICATIONS 113 (Atsuo Konishi & Ravi E. Dattatreya eds., 1991); cf. Barry Schachter, *Breaking Up Is Hard to Do: The Risks in the Financial Engineering of Customized Options*, 1 J. FIN. ENGINEERING 133, 138-41 (1992) (discussing how unanticipated changes in volatility and jumps in price can reduce efficacy of hedging).

113. Kenneth S. Leong, *Estimates, Guesstimates and Rules of Thumb*, in FROM BLACK-SCHOLES TO BLACK HOLES: NEW FRONTIERS IN OPTIONS 67 (1992).

114. Fischer Black and Myron Scholes state that their model for pricing stock options depends on “ideal conditions” in the market for the underlying asset and for the option. Black & Scholes, *supra* note 88, at 640.

115. Fischer Black, *How to Use the Holes in Black-Scholes*, J. APPLIED CORP. FIN., Winter 1989, at 67; cf. Saul Hansell, *Playing for the House*, INSTITUTIONAL INVESTOR, Apr. 1991, at 35 (even slight alteration in assumption that direction of prices is unpredictable “can lead to far different values for options and thus to spread-trading possibilities”).

116. See Charles Smithson, *Wonderful Life*, RISK, Oct. 1991, at 7 (showing how Black-Scholes assumptions have been relaxed by subsequent researchers).

117. Stephen Figlewski, *Options Arbitrage in Imperfect Markets*, 44 J. FIN. 1289, 1310 (1989); Konishi & Dattatreya, *supra* note 26, at 9.

118. That is, the Garman-Kohlhagen model referred to at *supra* note 106, assumes that currency fluctuations are based mainly on percentage changes in price. For the mathematical specification and graphical illustration, see CLASING ET AL., *supra* note 96, at 32-33.

119. See Richard C. Stapleton & Constantine Thanassoulas, *Foreign Exchange Options*, in FINANCIAL OPTIONS: FROM THEORY TO PRACTICE 295 (Stephen Figlewski et al. eds., 1990).

120. See, e.g., Stapleton & Thanassoulas, *supra* note 119, at 295 (regarding time variation of volatility of currency exchange rates); cf. Figlewski, *supra* note 117, at 1290 (discussing time variation of stock prices).

121. Cookson, *supra* note 96, at 55.

consequence, the models were “totally inappropriate” for valuing options on European currencies.¹²²

Third, the sophisticated hedging techniques associated with option pricing models are imperfect, especially in chaotic market conditions.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.”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.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.¹²⁶

Fourth, product complexity further reduces the efficacy of the models. To stay competitive, banks constantly introduce new financial products¹²⁷ because margins on products decline quickly.¹²⁸ This leaves little time to assess the proper pricing and hedging of the product.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

122. *Id.*

123. As before, I am focusing here on options, especially currency options. Dealers also have difficulty perfectly hedging the market risks of swaps. See, e.g., Hu, *Regulatory Paradigm*, *supra* note 6, at 356-58; KENNETH R. KAPNER & JOHN F. MARSHALL, *THE SWAPS HANDBOOK: SWAPS AND RELATED RISK MANAGEMENT INSTRUMENTS* 389-93 (1990); John F. Marshall & Vipul K. Bansal, *Hedging Swaps*, in KENNETH R. KAPNER & JOHN F. MARSHALL, *THE SWAPS HANDBOOK: SWAPS & RELATED RISK MANAGEMENT INSTRUMENTS: 1991-92 SUPPLEMENT* 675-706 (1992); David Shirreff, *Noises From the Hedge*, *RISK*, Nov. 1992, at 21 (describing how dealers cannot perfectly hedge “diff swaps”).

124. Stapleton & Thanassoulas, *supra* note 119, at 312; *supra* note 98 and accompanying text.

125. See, e.g., CLASING ET AL., *supra* note 96, at 41-42; Stapleton & Thanassoulas, *supra* note 119, at 312.

126. See, e.g., Richard Cookson & Lillian Chew, *Things Fall Apart*, *RISK*, Oct. 1992, at 44, 44 (quoting John Hull). These reasons for the reduced effectiveness of delta hedging in chaotic markets are, in some ways, similar to the reasons for the shortcomings of portfolio insurance during the stock market crash of 1987. See Hayne LeLand, *Portfolio Insurance: The Lessons of History*, *RISK*, Dec. 1992, at 15, 16.

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).

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).

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).¹³⁰ The pricing and hedging of such variants can be demanding exercises.¹³¹

The complexity can overwhelm even experts. In one ironic case, a bank mistakenly analyzed a transaction as a complicated swap instead of as an outright loan.¹³² Some early dealers appear to have found exotic currency options more costly to hedge than anticipated.¹³³ 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.¹³⁴ Today, there is concern that some dealers do not understand the full risks associated with "diff swaps" and equity derivatives.¹³⁵

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,¹³⁶ 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.¹³⁷

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.¹³⁸ Yet, if financial R & D has benefits, then why cannot banks be

130. See, e.g., David Aaron, *Forex Options*, in THE 1991 GUIDE TO CURRENCIES 108 (published with the September 1991 issue of EUROMONEY); Stapleton & Thanassoulas, *supra* note 119, at 306; cf. Chase Securities Inc., *Mundane Problems, Exotic Solutions*, EUROMONEY, Aug. 1992, at 42 (discussing exotic currency options).

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

132. WORKING GROUP ESTABLISHED BY THE CENTRAL BANKS OF THE GROUP OF TEN COUNTRIES, *supra* note 14, at 18; cf. Schwager, *supra* note 86, at 37-39 (former Salomon trader discussing mispricing).

133. Ken Ferris, *Exotic Options Struggle to Establish a Pedigree*, REUTERS, Jan. 30, 1991.

134. See Lisabeth Weiner, '89 Will Bring Closer Scrutiny of Swap Product, AM. BANKER, Jan. 3, 1989, at 3.

135. Caren Chelser-Marsh, *Nightmare on Wall Street*, EUROMONEY, Feb. 1992, at 23, 26; Peter Lee, *How to Exorcise Your Derivatives Demons*, EUROMONEY, Sept. 1992, at 36, 37.

136. See, e.g., Daniel P. 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).

137. See, e.g., Alan Greenspan, International Financial Integration, Remarks by Alan Greenspan, Chairman, Board of Governors of the Federal Reserve System, before the Federation of Bankers Associations of Japan (Oct. 14, 1992) (unpublished manuscript, on file with author). For a discussion of analyzing risks on a portfolio basis, see, for example, Hu, *Shareholder Welfare*, *supra* note 12, at 1306-09; Robert E. Litan, *Evaluating and Controlling the Risks of Financial Product Deregulation*, 3 YALE J. ON REG. 1, 10-12 (1985).

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?¹³⁹ 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.¹⁴⁰ 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.¹⁴¹ At least theoretically, large spillover effects will result in less R & D investment than would be socially optimal.¹⁴²

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 applications¹⁴³—as opposed to applied research.¹⁴⁴ Consistent with this

other costs, such as waiting costs. Cf. Richard C. Levin, et al. *Appropriating the Returns from Industrial Research and Development*, 3 BROOKINGS PAPERS ON ECON. ACTIVITY 783, 805-12 (1987) (discussing cost and time required for imitation in scientific R & D context).

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.

140. See Jeffrey I. Bernstein & M. Ishaq Nadiri, *Research and Development and Intra-industry Spillovers: An Empirical Application of Dynamic Duality*, 56 REV. ECON. STUD. 249, 249 (1989).

141. See, e.g., *id.* at 263; 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.¹⁴⁵ Relying on this fact¹⁴⁶ and other rationales,¹⁴⁷ government support of R & D is relatively higher with respect to basic research.¹⁴⁸

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,¹⁴⁹ 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

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.

NATIONAL SCIENCE BOARD, *SCIENCE & ENGINEERING INDICATORS 1991 91* (10th ed. 1991).

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.

146. Cf. *Policy Options for Promoting Economic Growth: Hearings Before the Committee on Science, Space, and Technology*, 102d Cong., 2d Sess. 29-31 (1992) (statement of Charles L. Schultze, Senior Fellow, Brookings Institution).

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. I (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.

149. Schmerken, *supra* note 105; Michael Schrage, *Nomura: Acquiring, Studying, Learning American Financial Technology*, WASH. POST, Feb. 8, 1991, at F3.

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.¹⁵⁰ Merrill Lynch, for example, initiated a patent infringement suit against Paine Webber for infringement of its "Cash Management Account" system.¹⁵¹

The Supreme Court has held that scientific truths and abstract intellectual concepts like $E=mc^2$ are not patentable.¹⁵² Thus, an improved option pricing model or a new strategy for hedging market risks might not be patentable subject matter.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.¹⁵⁴ This means of avoiding the unpatentability 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.¹⁵⁵ Patents already have been granted for a computer system that involves hedging against a future liability of uncertain value¹⁵⁶ and an option accounting and marketing system.¹⁵⁷

150. Additionally, copyright, misappropriation, trade secret, and trademark law have all proven helpful in promoting financial innovation. See, e.g., Bruce W. Foudree & Peter K. Trzyna, *Toward the Exclusive Right to Market Innovative Insurance Products: The Use of Intellectual Property Law in the Business of Insurance*, 1 J. FIN. ENGINEERING 264, 264-68 (1992); Christopher Petruzzi et al., *Patent and Copyright Protection for Innovations in Finance*, FIN. MGMT., Winter 1988, at 66. Morgan Stanley sued successfully on grounds of common law misappropriation to require a former swaps specialist to return documents that described how Morgan Stanley orchestrated complicated transactions. *Mayer v. Morgan Stanley & Co.*, 703 F. Supp. 249 (S.D.N.Y. 1988). Historically, financial institutions have tended to rely primarily on trade secret law. Petruzzi et al., *supra* at 67. For discussions of the relative advantages and disadvantages of patent and trade secret protection, see Foudree & Trzyna, *supra* at 279, 285; David D. Friedman et al., *Some Economics of Trade Secret Laws*, 5 J. ECON. PERSP., Winter 1991, at 61, 63-64.

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.

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.

153. Even if the subject matter hurdle is surmounted, the utility, novelty, and nonobviousness requirements would still have to be met.

154. Foudree & Trzyna, *supra* note 150, at 274-75.

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).

156. *Method and Apparatus for Funding A Future Liability of Uncertain Cost*, U.S. Patent No. 4,752,877, issued June 21, 1988.

Notwithstanding such competitive and intellectual property law considerations, much of the research appears highly inappropriate—at least under current social norms in the tightly knit community of major money center banks.¹⁵⁸ In the world of OTC options, “there is very little that is truly proprietary for very long.”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.”¹⁶⁰ If Morgan Stanley has “Steps,” Goldman Sachs has “Stairs.”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.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.¹⁶³ In standard human capital terminology, the research yields “general” rather than “specific” human capital.¹⁶⁴ In such a situation, subject to intellectual property and other laws and enforceable contractual prohibitions,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.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-

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

158. For evidence on the relevance of social norms, see Jonathan Bendor & Dilip Mookherjee, *Norms, Third-Party Sanctions, and Cooperation*, 6 J.L. ECON. & ORGANIZATION 33, 33 (1990).

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

160. Gregory Miller, *The Knockoff Artists*, INSTITUTIONAL INVESTOR, May 1986, at 81.

161. See Tom Pratt, *Goldman on Bandwagon with Another Steps Clone*, INVESTMENT DEALERS’ DIG., Mar. 23, 1992, at 21.

162. Brady, *supra* note 22, at 25. After one swaps specialist returned to his old investment firm, a reporter asked him whether he would ever leave again. He replied, “[n]ever is not in the swap man’s dictionary.” Joe Kolman, *Sultans of Swap*, INSTITUTIONAL INVESTOR, Oct. 1985, at 258; cf. MICHAEL LEWIS, *LIAR’S POKER: RISING THROUGH THE WRECKAGE ON WALL STREET 205* (1989) (quoting trader responding to entreaties to stay at Salomon: “You want loyalty, hire a cocker spaniel.”).

163. See Schmerken, *supra* note 159, at 23.

164. See, e.g., Edmund Kitch, *The Law and Economics of Rights in Valuable Information*, 9 J. LEGAL STUD. 683, 684 (1980).

165. See generally, Michael A. Epstein & Stuart D. Levi, *Protecting Trade Secret Information: A Plan for Proactive Strategy*, 43 BUS. LAW. 887 (1988); Laura Wheeler, Note, *Trade Secrets and the Skilled Employee in the Computer Industry*, 61 WASH. U. L.Q. 823 (1983).

166. See, e.g., Jonathan Fuerbringer, *In Options Trading, Volatility Is a Virtue*, N.Y. TIMES, Jan. 26, 1992, § 3, at 5; Erik Ipsen, *The Biggest Pool in Town*, INSTITUTIONAL INVESTOR, June 1990, at 100. One dealer reportedly “sold OTC options for 45% above their theoretical value.” Schachter, *supra* note 112, at 134.

party consultants.¹⁶⁷ In each case, proprietary information may be imparted.¹⁶⁸

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.¹⁶⁹ 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.¹⁷⁰ 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.¹⁷¹

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.¹⁷²

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

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).

168. In fact, Wall Street firms have circulated the results of research on exchange-traded derivatives to generate business. See Joe Kolman, *The Growth of Derivatives Research*, INSTITUTIONAL INVESTOR, Nov. 1991, at 143, 143-44.

169. For a discussion of "Limited Two-Way Payments" provisions, related litigation, and the market pressure described in the text, see *Walk-away Clauses in Swaps Upheld in Court, But Appeal is Likely*, DERIVATIVES WEEK, Oct. 26, 1992, at 1; David Shirreff, *Swappers Win in DC and NZ*, RISK, Oct. 1992, at 5, 6. The economic significance of these provisions is discussed in Litzenberger, *supra* note 53, at 837. Bank regulators have objected to the utilization of such provisions. See, e.g., Ernest T. Patrikis, *Bank Regulatory Issues Relating to Swaps*, in SWAPS AND OTHER DERIVATIVES 295, 312-15 (PLI Corp. L. and Practice Course Handbook Series No. 778, 1992).

170. Robert C. Ellickson, *A Hypothesis of Wealth-Maximizing Norms: Evidence from the Whaling Industry*, 5 J.L. ECON. & ORGANIZATION 83, 83-84 (1989).

171. Norms can change or prove ineffective in extraordinary circumstances. See, e.g., ROBERT C. ELLICKSON, *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 forty¹⁷⁴ 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.¹⁷⁶ 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.¹⁷⁷ 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.¹⁷⁸ 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.¹⁷⁹ In 1991, the House of Lords agreed.¹⁸⁰ This one situation appears to have caused about half of all default losses on swaps from the entire decade ending in 1991.¹⁸¹

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,¹⁸² seems manifestly imprudent. The community involved in swaps is not

176. See BOOKSTABER, *supra* note 45.

177. See, e.g., Schuyler K. Henderson, *Termination of Swaps Under U.S. Insolvency Laws*, INT'L FIN. L. REV., Dec. 1984, at 17, 21.

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.").

180. *Hazell v. Hammersmith and Fulham L.B.C.* 2 W.L.R. 372 (1991).

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.¹⁸³ Studies have shown that individuals frequently rely on cognitive shortcuts (heuristics and biases) to solve complex problems under conditions of uncertainty or incomplete information.¹⁸⁴ Sometimes these shortcuts are irrational and mistaken.

Corporate/securities law scholars have begun to make use of this scholarship.¹⁸⁵ Without attempting to be comprehensive,¹⁸⁶ 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.¹⁸⁷ 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.¹⁸⁸ The effect may be caused by individuals' inability to comprehend and evaluate extreme probabilities,¹⁸⁹ or by a lack of any direct experience with the underlying risks.¹⁹⁰ This effect manifests itself in attitudes towards tornados, safety belts, and earthquake insurance.¹⁹¹

183. See, e.g., RICHARD H. THALER, *QUASI RATIONAL ECONOMICS* xxi (1991); Kenneth Arrow, *Risk Perception in Psychology and Economics*, 20 *ECON. INQUIRY* 1, 6 (1982); Roger G. Noll & James E. Krier, *Some Implications of Cognitive Psychology for Risk Regulation*, 19 *J. LEGAL STUD.* 747 (1990).

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).

187. John C. Hershey, et al., *Sources of Bias in Assessment Procedures for Utility Functions*, in *DECISION MAKING: DESCRIPTIVE, NORMATIVE, AND PRESCRIPTIVE INTERACTIONS* 422, 428 (David E. Bell et al. eds., 1988); Howard Kunreuther, *The Economics of Protection Against Low Probability Events*, in *DECISION MAKING: AN INTERDISCIPLINARY INQUIRY* 195, 195 (Gerardo R. Ungson & Daniel N. Braunstein eds., 1982); Paul Slovic et al., *Facts Versus Fears: Understanding Perceived Risk*, in *JUDGMENT UNDER UNCERTAINTY: HEURISTICS AND BIASES* 468-70 (Daniel Kahneman et al. eds., 1982).

188. See Kunreuther, *supra* note 187, at 209.

189. Daniel Kahneman & Amos Tversky, *Prospect Theory: An Analysis of Decision Under Risk*, 47 *ECONOMETRICA* 263, 282-83 (1979).

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.¹⁹² 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.¹⁹³

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."¹⁹⁴ 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."¹⁹⁵ Yet, the realignment did happen.

The British local authority debacle appears consistent with this threshold effect in the evaluation of legal risks.¹⁹⁶ 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

Sunstein, *Legal Interference with Private Preferences*, 53 U. CHI. L. REV. 1129, 1167-68 (1986).

192. 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)").

193. Paul Scura et al., *Financial Innovation and New Corporate Securities*, in III CORPORATE AND MUNICIPAL SECURITIES 633 (Robert L. Kuhn ed., 1990) (emphasis added).

194. SCHWAGER, *supra* note 86, at 120 (interview with William Eckhardt).

195. Cookson, *supra* note 96, at 61.

196. This is not to suggest that all legal risks are necessarily low in probability and hence subject to this threshold phenomenon. For instance, as nothing is as certain as death and taxes, there seems to be widespread utilization of tax advice in the derivatives area. See, e.g., Robert Willens, *Innovative Financial Products: Tax Aspects*, J. OF ACCT., Nov. 1990, at 71 ("[A] high degree of certainty about tax consequences often is a prerequisite to launching a new product."); Edward Kleinbard, *Tax Strategies for Corporate Financings and Refinancings: The New Financial Products*, in INTERNATIONAL FINANCIAL TRANSACTIONS (PLI Law and Estate Planning Series, 1987) ("I think it fair to suggest that it is far more common than generally realized for economically viable new international financial products to be shelved because of U.S. tax uncertainties."). This is especially the case because some new financial products are tax-driven. See, e.g., Simon Brady, *The Banks' New Money Machine*, EUROMONEY, Dec. 1991, at 27.

would not be evident to a reasonably well-informed [lay] person.”¹⁹⁷ As the chairman of one bank expressed it: “To me . . . a contract is a contract, and I was brought up to honour contracts.”¹⁹⁸

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.¹⁹⁹ For example, extensive publicity about some notable crime greatly enhances lay assessment of the probability of a similar event.²⁰⁰ Conversely, difficulty in recalling instances may decrease the estimated probability.²⁰¹

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.²⁰² 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.²⁰³

197. LEGAL RISK REVIEW COMMITTEE, CONSULTATION PAPER: REDUCING UNCERTAINTY—THE WAY FORWARD 4 (Feb. 18, 1992) [hereinafter, LEGAL RISK REVIEW COMMITTEE, CONSULTATION PAPER]; *London's legal liabilities*, ECONOMIST, Feb. 22, 1992, at 77.

198. Philip Moore, *Cleaning Up the Town Hall Mess*, EUROMONEY, Apr. 1991, at 31. This is not to say that bankers did not check with the lawyers about the enforceability of the swaps with the local councils. See *id.* (banks had “engaged in comprehensive cross-checks with lawyers and other responsible authorities to confirm that the swap dealings were lawful”).

199. 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).

200. Ward Edwards & Detlof von Winterfeldt, *Cognitive Illusions and their Implications for the Law*, 59 S. CAL. L. REV. 225, 248 (1986).

201. Schwartz et al., *supra* note 199, at 201.

202. See Raj Aggarwal, *True Cost of Default*, CORP. FIN., Feb. 1991, at 12.

203. LEGAL RISK REVIEW COMMITTEE, CONSULTATION PAPER, *supra* note 197, at 5. 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.

This cognitive bias is one of the conventional explanations of why securities investors appear to “overreact” to recent information. See, e.g., Allen B. Atkins & Edward A. Dyl, *Price Reversals, Bid-Ask Spreads, and Market Efficiency*, 25 J. FIN. & QUANTITATIVE ANALYSIS 535 (1990); Werner F. M. De Bondt & Richard Thaler, *Does the Stock Market Overreact?*, 40 J. FIN. 793 (1985). But see Kevin C. Brown et al., *Risk Aversion, Uncertain Information, and Market Efficiency*, 22 J. FIN. ECON. 355, 383 (1988) (evidence against overreaction hypothesis).

The reaction is somewhat surprising in light of a widely publicized ultra vires case involving 10,000 bondholders—involving the authority of public utilities to enter into certain financing arrangements to

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.”²⁰⁴ Thus, people tend to overemphasize the importance of the field they understand best.²⁰⁵

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,²⁰⁶ 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.²⁰⁷

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.²⁰⁸ 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.²⁰⁹ 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.”²¹⁰ 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.²¹¹

guarantee bond payments—decided in the United States prior to *Hammersmith*. See, e.g., *Chemical Bank v. WPPSS*, 666 P.2d 329 (1983), *aff’d on reh’g* 691 P.2d 524 (1984), *cert denied*, 471 U.S. 1075 (1985).

204. Chip Heath & Amos Tversky, *Preference and Belief: Ambiguity and Competence in Choice under Uncertainty*, 4 J. RISK & UNCERTAINTY 5, 7 (1991).

205. See *id.*; Richard Zeckhauser et al., *Nonrational Actors and Financial Market Behavior*, 31 THEORY & DECISION 257, 266 (1991) (suggesting expert effect explains failure of money managers to diversify internationally).

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 BUS. LAW. 421, 421 (1979).

207. Lawrence H. Tribe, *Trial by Mathematics: Precision and Ritual in the Legal Process*, 84 HARV. L. REV. 1329, 1361 (1971).

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).

210. DIMITRIS N. CHORAFAS, *THE NEW TECHNOLOGY OF FINANCIAL MANAGEMENT* 25-26 (1992). *But see supra* notes 150-157.

211. 35 U.S.C. §§ 284-85 (1992).

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.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,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.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,

212. See, e.g., Joseph E. Stiglitz, *Principal and Agent*, in *THE NEW PALGRAVE: A DICTIONARY OF MONEY AND FINANCE* 185 (1992).

213. Such constraints include "other constituency" statutes, the Community Reinvestment Act, and safety and soundness requirements. See Committee on Corporate Laws of the Business Section of the ABA, *Other Constituencies Statutes: Potential for Confusion*, 45 *BUS. LAW.* 2253 (1990); see also Community Reinvestment Act, 12 U.S.C. § 2901, *et seq.* (1988). For instance, federal banking agencies can terminate any bank activity it deems an "unsafe or unsound" practice. 12 U.S.C. § 1818(a)-1818(b) (1988). Section 39(a) of the FDIC Improvements Act, *supra* note 12, requires federal banking agencies to prescribe rules for operational and managerial standards that promote safety and soundness. *Cf. infra* note 228 (discussing conflict between interests of society and those of diversified shareholders).

214. One director of swaps trading noted that "[s]ometimes people are too scared to ask the rocket scientist whether the product he has devised actually generates any real profit; you get blinded by the science and so you simply cannot prove them wrong." Louise Ireland, *The Worm in the Derivatives Apple*, *CORP. FIN. DEC.* 1989, at 13; *cf.* WORKING GROUP ESTABLISHED BY THE CENTRAL BANKS OF THE GROUP OF TEN COUNTRIES, *supra* note 14, at 18 ("Management ignorance could be exploited by traders wishing to hide latent losses in positions they carried."). On the other hand, a trader may want to invest adequately in risk information to demonstrate the superiority of his risk-adjusted performance relative to other traders. However, this incentive would be lessened if this behavior was impolitic or heightened senior management's sensitivity to risk issues.

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

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.

220. WILLIAM BROAD & NICHOLAS WADE, *BETRAYERS OF THE TRUTH* 61 (1982).

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.²²³ 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,²²⁴ and it may even be against the interests of the shareholders to volunteer pertinent information.²²⁵ 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.²²⁶

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,²²⁷ even if running the bank in a more aggressive manner would enhance the share price.²²⁸ 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.”).

224. Cf. Hu, *Fiduciary Principles*, *supra* note 60, at 326 (discussing possible effect of “off-balance-sheet” nature of many new financial products). The Financial Accounting Standards Board has adopted new rules enhancing disclosures relating to derivatives. See e.g., FINANCIAL ACCOUNTING STANDARDS BOARD, DISCLOSURES ABOUT FAIR VALUE OF FINANCIAL INSTRUMENTS (STATEMENT OF FINANCIAL ACCOUNTING STANDARDS NO. 107, DEC. 1991); FINANCIAL ACCOUNTING STANDARDS BOARD, DISCLOSURES OF INFORMATION ABOUT FINANCIAL INSTRUMENTS WITH OFF-BALANCE-SHEET RISK AND FINANCIAL INSTRUMENTS WITH CONCENTRATIONS OF CREDIT RISK (STATEMENT OF FINANCIAL ACCOUNTING STANDARDS NO. 105, MAR. 1990); *Ernst & Young Economists Suggest Methods for Implementing New FASB Requirements*, THRIFT ACCOUNTANT, Oct. 26, 1992, at 5.

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

226. Kyle Pope & Anita Raghavan, *Battle Stations: Dell Computer at War With Analyst Critical Of Its Currency Trades*, WALL ST. J., Nov. 30, 1992, at A1; cf. Gregory J. Millman, *Trade Secrets: Analyzing Corporate Currency Dealings Isn’t Easy*, BARRON’S, Dec. 28, 1992, at 16 (noting securities analysts usually know little about company hedging strategies).

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

228. In certain circumstances then, there is a conflict between the interests of diversified shareholders and the public interest. Hu, *Regulatory Paradigm*, *supra* note 7, at 366-69; Hu, *Fiduciary Principles*, *supra* note 60, at 352-54; cf. Loretta J. Mester, *Owners Versus Managers: Who Controls the Bank?*, BUS. REV.: FED. RES. BANK PHILADELPHIA, May-June 1989, at 13, 14-16. Undiversified shareholders are less likely to be concerned about this conflict. See Hu, *Fiduciary Principles*, *supra* note 60, at 292-93; Hu, *Shareholder Welfare*, *supra* note 12, at 1309.

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.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.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.²³¹ Furthermore, due to “portfolio effects,” the existence of derivative instruments may well *strengthen* the overall safety and soundness of many banks.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

229. See Robert C. Clark, *The Soundness of Financial Intermediaries*, 86 YALE L.J. 4, 10-26 (1976). Banks even have affirmative incentives to avoid investing in the development of such information. More complete information on the “soft spots” may trigger stricter regulation. Professor Mary Lyndon has made an analogous argument that sellers of chemicals will not produce much data on the toxicity of their chemicals, because they have no commercial incentive to do so. See Mary L. Lyndon, *Information Economics and Chemical Toxicity: Designing Laws to Produce and Use Data*, 87 MICH. L. REV. 1795, 1813-14 (1989). This feedback effect has been recognized in other contexts. For instance, one reason for attorney-client privilege is the fear that parties may be reluctant to obtain legal advice if it is not privileged. Stephen Shavell, *Legal Advice About Contemplated Acts: The Decision to Obtain Advice, Its Social Desirability, and Protection of Confidentiality*, 17 J. LEGAL STUD. 123 (1988).

This banker informational failure arises from a differential valuation in the safety and soundness of individual banks. In contrast to the analysis in Section II(B)(3), the failure does not arise from the inability of a bank to “appropriate” all of the benefits of its research or the socially wasteful effects of duplicative research. One could have one monopolist doing all 50 deals—and thus achieve the \$400,000 level of understanding—and still not be at a socially optimal level of understanding. See *supra* Section II(B)(3).

230. See *infra* notes 21-24 and accompanying text.

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. *Id.* at 1.

232. Litan, *supra* note 137, at 10-19 (discussing how financial institutions can reduce risk through diversified portfolios with banking and nonbanking activities).

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.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.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

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).

234. See Hu, *Regulatory Paradigm*, *supra* note 6, at 405-12.

instead should pick the contestant whom one believes the judges will select.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.²³⁶

Many studies have documented discrepancies between observed prices of derivatives and those predicted by theory.²³⁷ In fact, professionals sometimes trade on the basis of predictable deviations between theoretical and market values.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.²³⁹ Market prices for derivatives, like market prices for common stock, are often distorted by irrational factors.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.

235. Cf. J.M. KEYNES, *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).

236. See, e.g., Robert J. Shiller, *Speculative Prices and Popular Models*, J. ECON. PERSP., Spring 1990, at 55, 58.

237. See, e.g., Stephen Figlewski, *Options Arbitrage in Imperfect Markets*, 44 J. FIN. 1289 (1989); Robert E. Whaley, *Valuation of American Futures Options: Theory and Empirical Tests*, 41 J. FIN. 127 (1986).

238. See, e.g., William Falloon, *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).

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 *actual* share price would be somewhat different from the actions he would take if he focused instead on maximizing the *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, *Shareholder Welfare*, *supra* note 12, at 1282-86, 1312-16; Hu, *Fiduciary Principles*, *supra* note 60, at 355-366; cf. MICHAEL E. PORTER, *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., *Shareholder Trading Practices and Corporate Investment Horizons*, J. APPLIED CORP. FIN., Summer 1992, at 42, 48-50 (illustrating this conflict).

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).

These add significantly to the usual difficulties regulators have in understanding as much as industry.²⁴¹ As traditionally conceived, scientific norms contemplate free access to and wide dissemination of knowledge.²⁴² Such openness furthers the "extension of certified knowledge," the institutional goal of science.²⁴³ Despite industrial funding and the increasing emphasis on intellectual property, this norm has a profound influence on most research arrangements.²⁴⁴ In this vein, at least one prominent Wall Street rocket scientist has commented that the proprietary nature of derivatives research hinders progress.²⁴⁵

In finance, as with science generally, truth is ephemeral, and the current overarching theories could be wrong.²⁴⁶ 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.²⁴⁷

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.

Donald K. Fowler, *University-Industry Research Relationships: The Research Agreement*, 9 J.C. & U.L. 515, 523 (1982-83).

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 Hulbert, *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.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.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."²⁵⁰ More generally, journals publish relatively little good empirical work on derivatives.²⁵¹ Industry "rocket scientists" are naturally reluctant to publish some of their most interesting findings. Although academics can produce revolutionary breakthroughs,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.²⁵³

Chaos theorists firmly reject the capital asset pricing model and believe that they can predict certain patterns of market behavior. See, e.g., EDGAR E. PETERS, *CHAOS AND ORDER IN THE CAPITAL MARKETS: A NEW VIEW OF CYCLES, PRICES, AND MARKET VOLATILITY* vii-viii (1991) (arguing that fractals and chaos theory leads to new paradigm); cf. David A. Hsieh, *Chaos and Nonlinear Dynamics: Application to Financial Markets*, 46 J. FIN. 1839, 1839-40 (1991) (noting "explosion of papers searching for chaotic behavior in macroeconomic and financial time series"); Gary Weiss, *Chaos Hits Wall Street—The Theory, That Is*, BUS. WK., Nov. 2, 1992, at 138 (noting Wall Street is examining chaos theory).

248. See *supra* note 107 and accompanying text.

249. John J. Duffy, *Death and Rebirth of Perpetual Floating Rate Notes*, AM. BANKER, Apr. 3, 1987, at 2.

250. Lux, *supra* note 86.

251. See, e.g., Stewart D. Hodges et al., *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, *supra* note 53, at 831-32 (noting "relative lack of academic research" on more complex forms of interest rate swaps).

252. See, e.g., Lux, *supra* note 86.

253. Hu, *Regulatory Paradigm*, *supra* note 6, at 409-10; Hansell & Muehring, *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, *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, *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.²⁵⁴ 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.²⁵⁵ As an example, Merton states: “The Haber process cannot be invalidated by a Nuremberg decree nor can an Anglophobe repeal the law of gravitation.”²⁵⁶

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.²⁵⁷ 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.²⁵⁸

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.²⁵⁹

254. MERTON, *supra* note 242, at 270.

255. *Id.*

256. *Id.*

257. See Spyros Vassilakis, *Infinite Regress in Expectations*, in *THE NEW PALGRAVE: A DICTIONARY OF MONEY AND FINANCE* 392 (John Eatwell et al. eds., 1992).

258. ANDREW J. KRIEGER, *THE MONEY BAZAAR: INSIDE THE TRILLION-DOLLAR WORLD OF CURRENCY TRADING* 87-88 (1992).

259. Walter S. Mossberg, *Making Book on the Buck*, *WALL ST. J.*, Sept. 23, 1988, § 3, at 1, 27R. Kenneth A. Froot et al. developed a formal model based on such notions and quoted Hohorst in *Herd on*

If the market, as a systematic matter, uses the “wrong” model to price a derivative,²⁶⁰ 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.²⁶¹

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.²⁶² 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.²⁶³

The central point is that the theoretical and market pricing of derivatives is still, to an uncomfortable extent, an art rather than a science.²⁶⁴ 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.²⁶⁵ It turned out that certain currency options had not been correctly valued. The earnings release went out

the Street: Informational Inefficiencies in a Market with Short-Term Speculation, 47 J. FIN. 1461 (1992); cf. *supra* note 239 (distinguishing between actual and blissful price).

260. Cf. Eric Briys et al., *The Pricing of Default-Free Interest Rate Cap, Floor, and Collar Agreements*, 46 J. FIN. 1879, 1880 (1991) (suggesting that application of widely used option pricing model to interest rate-dependent instruments is “flawed since bond prices obviously do not follow a geometric Brownian motion”).

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.

Paula Tosini, *Interview: Merton H. Miller*, FIA REV., Nov.-Dec. 1990, at 16, 18.

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”).

265. Carol Loomis, *How Bankers Trust Lied About \$80 Million*, FORTUNE, Sept. 7, 1992, at 78, 79.

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.²⁶⁶ 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.²⁶⁷ 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.²⁶⁸ 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

266. *Id.*; Martin Mayer, *The Currency Options Snafu*, AM. BANKER, Aug. 4, 1988, at 1.

267. See Marshall & Bansal, *supra* note 123, at 675-77.

268. Craig Torres, *Dangers Deals—How Financial Squeeze Was Narrowly Avoided in "Derivatives" Trade*, WALL ST. J., June 18, 1991, at A1.

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.²⁶⁹ Two kinds of tasks are central to technocratic risk management decisions.²⁷⁰ 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

269. The methodology associated with the Environmental Protection Agency's regulation of toxic substances could provide an especially useful start. See 15 U.S.C. §§ 2601-29 (1976).

270. Here, I draw on John J. Cohnsen & Vincent T. Covello, *RISK ANALYSIS: A GUIDE TO PRINCIPLES AND METHODS FOR ANALYZING HEALTH AND ENVIRONMENTAL RISKS* 5-9 (1989); John S. Applegate, *The Perils of Unreasonable Risk: Information, Regulatory Policy, and Toxic Substances Control*, 91 COLUM. L. REV. 261, 278-79 (1991); Dennis J. Paustenbach, *Health Risk Assessments: Opportunities and Pitfalls*, 14 COLUM. J. ENVTL. L. 379, 385-409 (1989). "Risk management" is a process in which the regulator integrates technical information about a risk with economic, political, and social values in order to determine how to reduce it.

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 risk²⁷⁵ 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.

272. Insurance companies can sometimes fall outside the net. Cf. GENERAL ACCOUNTING OFFICE, *supra* note 16, at 48-49 (chart showing how scope of U.S. securities laws limits regulation of securities firms).

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.

274. See, e.g., Board of Governors of the Federal Reserve System, Consolidated Financial Statements for Bank Holding Companies With Total Consolidated Assets of \$150 Million or More, or With More Than One Subsidiary Bank: FR Y-9C: Schedules HC-I and HC-J (Dec. 31, 1992) (bank holding companies); Federal Financial Institutions Examination Council, Call Number 181: Schedule RC-L (Sample Call Report) (FIL-65-62) (Sept. 30, 1992); Final Temporary Risk Assessment Rules, 57 Fed. Reg. 32,159 (1992) (to be codified at 17 C.F.R. § 240.17h1T-17h2T).

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

276. *Id.* The Office of Thrift Supervision has made similar proposals for savings and loan associations. Regulatory Capital: Interest Rate Risk Component, 57 Fed. Reg. 40,524 (1992).

detail as to the precise nature and amounts of instruments is still relatively limited.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.²⁷⁸ However, some banks are not members and compliance with reporting requirements has reportedly proved erratic.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.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. *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 participants²⁸¹ establishing an initial catalogue of known OTC derivatives,

277. Public disclosure of the derivatives activities of banks and other entities will improve significantly with the effectiveness of Statement of Financial Accounting Standards No. 107. See Financial Accounting Standards Board, *supra* note 224; *Ernst & Young Economists Suggest Methods for Implementing New FASB Requirements*, *supra* note 224.

278. WORKING GROUP ESTABLISHED BY THE CENTRAL BANKS OF THE GROUP OF TEN COUNTRIES, *supra* note 14, at 50.

279. *Id.*

280. See Hu, *Regulatory Paradigm*, *supra* note 6, at 346 n.36, 378.

281. Whether market participants other than commercial banks should be required to file is a difficult issue. Detailed joint market participant-regulator review is essential to ensure that regulation is effective and, to the extent sensible, consistent across countries and types of market participants; as a general matter, a level playing field make sense. For a discussion of the level playing field issue, see Hu, *Regulatory Paradigm*, *supra* note 6, at 374-76.

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.²⁸² 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.²⁸³ 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).

285. For discussions of front offices, back offices, and middle offices, see *Derivatives Trading: Missing Middle*, ECONOMIST, Sept. 5, 1992, at 82; Ivy Schmerken, *Middle Office Closes Trading Gap*, WALL ST. & TECH., Aug. 1992, at 18.

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.²⁸⁶

The indirect costs would likely loom larger than the direct costs. A classification system could lead to the micromanagement²⁸⁷ 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.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.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.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

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).

287. The FDIC Improvements Act, *supra* note 12, has come in for harsh criticism on precisely this ground. Cf. Kenneth H. Bacon, *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”).

288. For instance, the trade secret status of the information must be protected. Governmental indemnity from the inadvertent loss of proprietary information may need to be part of such a filing system. Congress has not hesitated to exempt from the Freedom of Information Act data involving extensive government-industry cooperation. See, e.g., National Defense Authorization Act for Fiscal Years 1988 and 1989, Pub. L. No. 100-180, § 276, 101 Stat. 1019; 15 U.S.C. § 3710a (c)(7) (technology transfers between federal laboratories and private sector). The decision in *Critical Mass Energy Project v. Nuclear Regulatory Commission*, 975 F.2d 871 (D.C. Cir. 1992) (holding FOIA exemption applies to certain commercial information voluntarily submitted to government) has enhanced the ability of businesses to prevent public disclosure.

289. Cf. Levin et al., *supra* note 138.

290. Patrick Harverson, *Regulators Want Answers*, FIN. TIMES, Dec. 8, 1992, § III, at VI.

accounting and with quality support throughout a global organization.”²⁹¹ The firm that pioneered portfolio insurance has begun selling software to audit the complex mathematics associated with a wide range of derivatives.²⁹² 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.”²⁹³

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 1992²⁹⁴ 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.²⁹⁵ This law is expected to provide the Food and Drug Administration with \$327 million over five years.²⁹⁶

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. C.ATS SOFTWARE INC., C.ATS: THE LEADER IN TECHNOLOGY FOR DERIVATIVES PRODUCTS 2, 6 (undated) (on file with author).

292. Laura Jereski, *Deconstructing Black Boxes*, FORBES, Feb. 15, 1993, at 224.

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).

294. Prescription Drug User Fee Act of 1992, Pub. L. No. 102-571, 106 Stat. 4491 (1992).

295. M. David, *Drug Companies See Benefit in the User Fees They Will Pay*, PHILADELPHIA BUS. J., Nov. 30, 1992, § 1, at 1.

296. *User Fee Program to be Top Priority for FDA Over Next Five Years, Kessler Says*, Daily Rep. for Execs. (BNA), Feb. 3, 1993, at 21.

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 research²⁹⁷ and insurance companies can fund informational clearinghouses to evaluate applicants for insurance.²⁹⁸ 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.²⁹⁹ With the exception of tax-related R & D,³⁰⁰ 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,³⁰¹ 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.³⁰² 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.³⁰³ ISDA obtained legal opinions on the netting issue from lawyers in most industrialized nations, drafted contractual provisions applying netting, and facilitated consistent statutory changes.³⁰⁴

297. See, e.g., P. S. JOHNSON, CO-OPERATIVE RESEARCH IN INDUSTRY: AN ECONOMIC STUDY (1973); Morton I. Kamien et al., *Research Joint Ventures and R & D Cartels*, 82 AM. ECON. REV. 1293, 1293 (1992).

298. See, e.g., Carolyn T. Geer, *High Risk Life*, FORBES, June 22, 1992.

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.

301. For an early example of this, see Letter from Patrick de Saint-Aignan, Chairman, International Swap Dealers Association, Inc., to Brian Quinn, Head of Banking Supervision, Bank of England and William W. Wiles, Secretary, Board of Governors of the Federal Reserve System (May 28, 1987), reprinted in THE 1987 LONDON SWAPS SEMINAR 10 (1987) (transcript of address). See, e.g., Cunningham & Rogers, *supra* note 136 (noting ISDA's efforts to amend U.S. Bankruptcy Code and to enact new legislation).

302. See, e.g., Daniel P. Cunningham et al., *Interest Rate and Currency Swaps and Related Transactions*, in SWAPS AND OTHER DERIVATIVES IN 1992 (PLI Corp. L. & Practice Course Handbook Series No. 778, 1992).

303. See, e.g., Cunningham & Rogers, *supra* note 136.

304. See, e.g., Daniel P. Cunningham & Paul Michalski, *Enforcability Under Various Bankruptcy Laws of the Advanced Termination and Netting Provisions of the ISDA Standard Form Agreements*, in ADVANCED SWAPS AND DERIVATIVE FINANCIAL PRODUCTS (PLI Corp. L. & Practice Course Handbook

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,³⁰⁵ the redundancy costs of research on legal risks would be reduced. The *n*th 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.³⁰⁶

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.³⁰⁷

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).

307. Cf. Louis Kaplow & Stephen Shavell, *Legal Advice About Information to Present in Litigation: Its Effects and Social Desirability*, 102 *HARV. L. REV.* 565, 586-93 (1989) (on social desirability of legal

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.³⁰⁸ There is increasing recognition of this issue on Wall Street.³⁰⁹ 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.³¹⁰ Now, Myron Scholes (of Black-Scholes fame) advises Salomon on how to structure appropriate incentives.³¹¹

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.³¹² 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.³¹³ 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.

311. *Stern Stewart Roundtable on Management Incentive Compensation and Shareholder Value*, J. APPLIED CORP. FIN., Spring 1992, at 110, 111; Cf. Louise Ireland, *The Worm in the Derivatives Apple*, CORP. FIN., Dec. 1989, at 13, 13.

312. See Executive Compensation Disclosure, *supra* note 61; 17 C.F.R. 228.402.; Hu, *Fiduciary Principles*, *supra* note 60, at 378-88 (calling for and describing system of enhanced compensation disclosure).

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.

