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Making Banks Transparent

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I. INTRODUCTION

It was March 2007, and in the Mediterranean resort of Monte Carlo, Matt King was making dire predictions about a collapse of the U.S. subprime housing market—a subject that must have seemed as inconsequential as it was foreign to most of this casino town's well-heeled visitors. But for Mr. King, head of quantitative credit strategy for Citigroup, the ramifications of rising subprime foreclosure rates were anything but inconsequential. Speaking at Citigroup's annual credit conference, King emphasized how subprime credit had been repackaged into securities such as collateralized debt obligations ("CDOs"), which now sat in large quantities on banks' balance sheets.[1] Noting that a "significant proportion of the [asset-backed securities] which has gone into CDOs . . . has been of the subprime variety,"[2] he warned that subprime losses had already forced several large banks to set aside additional funds to cover subprime losses. These losses, in turn, made him "deeply suspicious" of banks "with exposures in that space who have not declared anything like the same degree of provisioning."[3]

As it turned out, it was King's own employer, Citigroup, that ultimately proved especially vulnerable to these concerns. Following weeks of speculation that Citigroup was heavily exposed to subprime credit, the bank finally revealed on November 4, 2007, the size of its subprime-linked CDO portfolio: the third-quarter loss of between $8 billion and $10 billion it announced that day stemmed from a significant write-down in its direct holdings of $43 billion of CDOs.[4] For many, the revelation led to an immediate reassessment of the firm, with all three credit rating agencies downgrading the bank or

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1.   Carrick Mollenkamp, *Subprime Surprise for Europeans*, WALL ST. J. (EUROPE), Mar. 9, 2007, at 17.

2.   *Id.*

3.   *Id.*

4.   *Citi's Sub-Prime Related Exposure in Securities and Banking*, BUS. WIRE, Nov. 4, 2007, http://www.businesswire.com/news/home/20071104005056/en/Citis-Sub-Prime-Related-Exposure-Securities-Banking.

placing it on negative watch.[5] Of potentially greater concern, however, was the considerable uncertainty that remained about the bank's true subprime exposure. Recognizing that Citigroup had only disclosed its direct, unhedged CDO exposure, analysts on the next day's earnings call repeatedly asked for information regarding the amount of additional, undisclosed exposures hedged with monoline insurers.[6] Gary Crittenden, Citigroup's chief financial officer, acknowledged the importance of the issue, but could only provide a simple, "No, we haven't disclosed it."[7]

Not surprisingly, in the aftermath of the financial crisis of 2008 ("Financial Crisis"), making financial institutions more transparent to the marketplace has become a central reform objective for both commentators and regulators alike.[8] Informed largely by the failure of

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5. *Moody's, Fitch Downgrade Citigroup*, ASSOCIATED PRESS, Nov. 5, 2007, http://www.abcmoney.co.uk/news/052007158725.htm; *see also* Yves Smith, *How Messed Up Is Citi*?, NAKED CAPITALISM, Nov. 5, 2007, http://www.nakedcapitalism.com/2007/11/how-messed-up-is-citi.html (expressing surprise upon learning that, compared to Merrill Lynch, "Citi had bigger exposures and yet has done nothing to reduce its positions. This is unforgivable, and it will have consequences.").

6. Guy Moszkowski of Merrill Lynch was especially interested in obtaining additional information regarding its hedged CDO positions. *See Citigroup Inc. to Discuss Recent Announcements—Conference Call*, FD WIRE, Nov. 5, 2007, http://seekingalpha.com/article/53200-citigroup-risk-managers ("Maybe you can comment for us . . . on the dependence in any of the vehicles . . . on guarantees . . . from the monoline insurers like MBIA or Ambac that have obviously had some pretty significant credit spread blowouts? . . . And again, you can't sort of give us a sense for how much that might be?").

7. *Id.*

8. *See, e.g.*, FIN. ACCOUNTING STANDARDS BD., FASB STAFF POSITION NO. 133-1 AND F11445-4, DISCLOSURES ABOUT CREDIT DERIVATIVES AND CERTAIN GUARANTEES: AN AMENDMENT OF FASB STATEMENT NO. 133 AND FASB INTERPRETATION NO. 45; AND CLARIFICATION OF THE EFFECTIVE DATE OF FASB STATEMENT NO. 161 (2008), *available at* http://www.fasb.org/jsp/FASB/Page/ nr091208.shtml (requiring enhanced disclosure requirements for sellers of credit derivatives and financial guarantees); SQUAM LAKE WORKING GRP. ON FIN. REGULATION, A NEW INFORMATION INFRASTRUCTURE FOR FINANCIAL MARKETS 1–5 (2009) (proposing a new information infrastructure to manage systemic risk in which large financial institutions provide government regulators with the identity of individual positions that would then be released to the public), *available at* http://www.cfr.org/publication/ 18568/new_information_infrastructure_for_financial_markets.html; Margaret M. Blair & Erik F. Gerding, *Sometimes Too Great a Notional: Measuring the "Systemic Significance" of OTC Credit Derivatives*, LOMBARD STREET, Aug. 2009, at 10, 11 (proposing that the "Federal Reserve (or other systemic risk regulator) . . . require that financial institutions publicly disclose detailed information on the size, counterparties, and closing dates of credit derivatives in their portfolios on a regular and frequent basis, such as at the close of business each business day"); Michael Simkovic, *Secret Liens and the Financial Crisis of 2008*, 83 AM. BANKR. L.J. 253, 289–95 (2009) (arguing that Congress should enhance the transparency of financial institutions' true leverage by establishing a mandatory, universal recordation system for any instrument that substantively creates a secured liability for an institution, including liabilities arising from derivatives and asset securitizations).

banks' internal risk departments to manage risk, the general intuition is that by reducing the opacity of financial institutions, market participants such as Matt King might more effectively monitor and price the risks embedded in particular institutions. Thus, sections 115(f) and 165(d) of the Dodd-Frank Wall Street Reform and Consumer Protection Act[9] ("Dodd-Frank") grant the newly created Financial Stability Oversight Council ("FSOC") as well as the Federal Reserve Board ("FRB") broad authority to require additional, periodic public disclosures of banks and nonbank financial companies to "support market evaluation of the risk profile, capital adequacy, and risk management capabilities thereof."[10] Internationally, too, a similar proposal[11] to enhance market discipline of international banks has been suggested for the Basel Accords of the Basel Committee on Banking Supervision.[12]

But exactly *how* should one go about making banks more transparent? Both Dodd-Frank and the Basel proposal provide surprisingly little guidance. At the same time, the Citigroup experience above suggests market participants such as Mr. King, left with only his suspicions, may indeed lack the information necessary to engage in effective market discipline, leaving oversight of banks entirely in the hands of their prudential regulators. Yet the now-infamous ineffectiveness of regulators in understanding the risks embedded in financial firms prior to 2008—such as the Office of Thrift Supervision's failed monitoring of AIG Financial Products and

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9.   Dodd-Frank Wall Street Reform and Consumer Protection Act, Pub. L. No. 111-203, §§ 727, 763, 124 Stat. 1376 (2010).

10.   *Id.* §§ 115(f), 165(d) (authorizing FSOC and the FRB). The enhanced disclosures would apply to "large, interconnected bank holding companies" as well as any nonbank financial companies supervised by the FRB. *Id.* § 165(d).

11.   On March 25, 2009, the European Commission published a staff working document on possible amendments to the Basel II Capital Accords to enhance market discipline of banking institutions. EUROPEAN COMM'N, COMMISSION SERVICES STAFF WORKING DOCUMENT: POSSIBLE CHANGES TO THE CRD 1–10 (2010), *available at* http://ec.europa.eu/internal_market/bank/docs/regcapital/consutbesec_en.pdf.

12.   The Basel Committee on Banking Supervision is a committee of bank supervisory authorities that was established in 1974 by the central bank governors of the Group of Ten countries in an effort to promote international harmonization of banking regulations. The committee comprises senior representatives of bank supervisory authorities and central banks from Belgium, Canada, France, Germany, Italy, Japan, Luxembourg, the Netherlands, Sweden, Switzerland, the United Kingdom, and the United States. Press Release, Bank for Int'l Settlements, Consultative Paper on a New Capital Adequacy Framework 16 (June 3, 1999), *available at* http://www.bis.org/press/p990603.htm. Although not binding on any individual nation, the Basel Accords represent the committee's framework for regulating capital adequacy among international banks. *Id.*

Washington Mutual[13]—only underscores the need to move beyond mere talk of greater transparency and to think concretely about a conceptual basis for implementing it. The argument advanced here is that, somewhat surprisingly, the very credit risk modeling techniques that failed so spectacularly during the Financial Crisis may provide part of the answer.

To see why, it is important to emphasize that in advocating for greater market discipline of financial institutions, Dodd-Frank was hardly writing on a blank slate. The idea that market discipline might be used to supplement regulatory oversight of financial institutions has been a long-standing policy both in the United States and abroad.[14] Indeed, from a disclosure perspective, one of the more difficult aspects of the Financial Crisis was that the very institutions whose subprime exposures were so opaque were the same institutions producing enormous quantities of mandatory disclosures. For publicly traded firms such as Citigroup, these disclosures included the periodic reporting obligations imposed by the Securities Exchange Act of 1934,[15] as well as quarterly and annual banking reports required to be filed by all banks and bank-holding companies.[16] Additionally, international banks, subject to the Basel Accord, were required to make quarterly and annual public disclosures pursuant to the Accord's "Pillar 3" Market Discipline provisions.[17] In the case of

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13. *See* Patricia A. McCoy et al., *Systemic Risk Through Securitization: The Result of Deregulation and Regulatory Failure*, 41 CONN. L. REV. 1327, 1357–61 (2009) (summarizing OTS regulatory failures).

14. *See, e.g.*, BASEL COMM. ON BANKING SUPERVISION, ENHANCING BANK TRANSPARENCY: PUBLIC DISCLOSURE AND SUPERVISORY INFORMATION THAT PROMOTE SAFETY AND SOUNDNESS IN BANKING SYSTEMS (1998), *available at* http://www.bis.org/publ/bcbsc141.pdf (arguing that market discipline and public disclosure promote a more stable banking system); *see also* GRP. OF THIRTY, ENHANCING PUBLIC CONFIDENCE IN FINANCIAL REPORTING (2003), *available at* www.enhyper.com/content/G30_2003_EPCFR.pdf (arguing the same).

15. 15 U.S.C. §§ 78m(a), 78n(a), 78n(d) (2006).

16. *See* 12 U.S.C. § 161 (2006) (national banks); 12 U.S.C. § 324 (state member banks); 12 U.S.C. § 1817(a) (state nonmember banks). In particular, banks must publicly file each quarter a Consolidated Report of Condition and Income (or Call Report), while bank holding companies must file each quarter a Form Y-9C. The Form Y-9C requires substantially the same information as a Call Report. *FR Y-9C: Consolidated Financial Statements for Bank Holding Companies*, BD. OF GOVERNORS OF THE FED. RESERVE SYS., Sept. 29, 2011, http://www.federalreserve.gov /reportforms/ReportDetail.cfm?WhichFormId=FR_Y-9C.

17. Following the development of an original set of capital requirements in 1988, the Basel Committee on Banking Supervision developed a more robust system for regulating capital adequacy in the late 1990s, commonly referred to as "Basel 2." Under Basel 2, capital adequacy is assessed using three distinct "pillars": Pillar 1 prescribes the minimum capital requirements for banks, Pillar 2 addresses the associated supervisory review process, and Pillar 3 requires

Citigroup's 2008 financial results, for instance, the end result was an impressive 395 pages of disclosures, excluding exhibits.[18]

The problem with prevailing bank disclosures, however, is that they are generally limited to aggregated metrics that make it difficult to assess a bank's credit concentrations, underwriting standards, or portfolio quality.[19] Two main factors impede the publication of the type of granular, position-level data demanded by Citigroup's analysts above. The first factor is banks' concern with protecting the confidentiality of the bank-customer relationship as well as a bank's proprietary investment strategies.[20] Both could be jeopardized by more

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certain public disclosure to facilitate market discipline. *See* JOHN C. HULL, RISK MANAGEMENT AND FINANCIAL INSTITUTIONS 231–32 (2010).

18. *See, e.g.*, Citigroup, Inc., Annual Report (Form 10-K) (2009), *available at* http://www.citigroup.com/citi/fin/data/ar08c_en.pdf (242 pages); CITIBANK, N.A., CALL REPORT (2008), *available at* http://www.citigroup.com/citi/fin/data/call081231cb.pdf?ieNocache=381 (60 pages); Citigroup, Inc., Form Y-9C (2008), *available at* http://www.citigroup.com/citi/fin/data/y9c081231c.pdf?ieNocache=381 (44 pages); CITIBANK EUROPE PLC, PILLAR 3 DISCLOSURES (2008), *available at* http://www.citigroup.com/citi/fin/data/b2p3d081231b.pdf?ieNocache=176 (26 pages); CITI UK FSA REGULATED LEGAL VEHICLES, PILLAR 3 DISCLOSURES (2008), *available at* http://www.citigroup.com/citi/fin/data/b2p3d081231.pdf?ieNocache=619 (49 pages).

19. For instance, while all SEC-reporting entities must file financial statements as part of their periodic reports, firms' reporting obligations under U.S. Generally Accepted Accounting Principles ("GAAP") typically require only aggregate disclosures of their fixed income investments. *See, e.g.*, ACCOUNTING FOR CERTAIN INVESTMENTS IN DEBT AND EQUITY SECURITIES, Statement of Fin. Accounting Standards No. 115, § 19 (Fin. Accounting Standards Bd. 1993) [hereinafter SFAS], *available at* www.fasb.org/pdf/fas115.pdf (requiring all reporting entities to "disclose the aggregate fair value" for securities classified as available for sale); *see also* ERNST & YOUNG LLP, FINANCIAL REPORTING DEVELOPMENTS: ACCOUNTING FOR CERTAIN INVESTMENTS IN DEBT AND EQUITY SECURITIES (2009) (summarizing disclosure obligations with respect to securities that are available for sale and held to maturity). Moreover, attempts to argue that a firm's financial statements are materially misleading in the absence of more granular portfolio disclosures have generally failed in court. *See*, *e.g.*, *In re* N.Y. Cmty. Bancorp, Inc. Sec. Litig., 448 F. Supp. 2d 466, 479 (E.D.N.Y. 2006) (explaining that additional disclosure is not required where "it is apparent from the quarterly reports disclosed to the public that the company was heavily involved in investing in mortgage-backed securities").

20. *See, e.g.*, GRP. OF THIRTY, *supra* note 14, at 21 (expressing concern that enhanced disclosures could have the "de facto effect of compromising proprietary information of individual firms in ways that undercut the competitive edge of the most innovative and creative institutions"). More generally, Merritt Fox has suggested that a firm might disclose to investors a suboptimal amount of proprietary information concerning its operations on account of the fact that the disclosing firm will be unable to capture the significant value these disclosures provide to competitors. Merritt B. Fox, *Retaining Mandatory Securities Disclosure: Why Issuer Choice Is Not Investor Empowerment*, 85 VA. L. REV. 1335, 1339 (1999). This is especially true where disclosing proprietary information would cause the disclosing firm to suffer a competitive disadvantage. Michael D. Guttentag, *An Argument for Imposing Disclosure Requirements on Public Companies*, 32 FLA. ST. U. L. REV. 123, 147 (2004). Each of these concerns may be particularly acute in the context of financial firms' investment holdings where release of trading strategies could greatly benefit other firms at the same time that they might harm the disclosing

detailed disclosures of a bank's investment positions and loans—a concern that has largely been echoed in a federal banking policy that exempts such position-level data from mandatory public reporting.[21] The second factor relates to the complexity of a bank's investment activities. Of course, ex post, when individual borrowers, market sectors, or entire countries suffer distress—as in the case of Enron's bankruptcy, the subprime market collapse, or Greece's fiscal crisis— market participants might easily identify the type of granular, specific data they require to assess an institution's risk of loss. However, the notion that banks should have ongoing obligations to disclose similarly detailed information for the full multitude of firms, industries, and regions to which they have credit exposure naturally raises the question of whether the sheer costs involved in the enterprise would be justified. This is particularly true for large commercial banks that may have credit exposure not only from their traditional loan portfolios, but also from their dealing and trading in securities and over-the-counter ("OTC") derivatives.[22]

The central claim of this Article is that using the knowledge of credit risk modeling to inform banks' disclosure obligations can significantly enhance bank transparency while largely averting each

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firm (for example, by allowing competitors to take an adverse trading position against the disclosed position).

21. For instance, Title VII of Dodd-Frank, which governs "Wall Street Transparency and Accountability," mandates the central clearing of swaps and imposes on swaps dealers a number of record-keeping and reporting obligations. The statute, however, limits any *public* reporting to "real-time public reporting" of swaps transactions, making clear that all such reports are to be made "in a manner that does not disclose the business transactions and market positions of any person." *See* Dodd-Frank Act § 727. This concern also motivated the initial refusal by the New York Federal Reserve to disclose the names of the CDOs it acquired from AIG in 2008. *See AIG Discloses Details on Toxic Securities*, ASSOCIATED PRESS, Jan. 29, 2010 (detailing the Federal Reserve's fear that disclosure will make the resale of CDOs more difficult); *see also* GRP. OF THIRTY, *supra* note 14, at 21 (expressing regulators' concern with revealing banks' proprietary information). *See generally infra* notes 43–64 and accompanying text (discussing federal bank disclosure policy).

22. Arthur E. Wilmarth, Jr., *The Transformation of the U.S. Financial Services Industry, 1975–2000: Competition, Consolidation, and Increased Risks*, 2002 U. ILL. L. REV. 215, 347 (noting that increased use of derivatives trading by larger banks makes their operations more complicated and opaque for regulators and investors). Evidence indicating that market participants may be particularly slow to react to detailed, position-level data concerning an institution's exposure to these more complex securities further diminishes the rationale for requiring more detailed disclosures to facilitate market discipline. *See generally* Robert P. Bartlett, III, *Inefficiencies in the Information Thicket: A Case Study of Derivatives Disclosures During the Financial Crisis*, 36 J. CORP. L. 1 (2010) (finding no notable market reaction in the stock price of monoline insurers following significant downgrades in their disclosed CDO positions).

of these two issues. Notwithstanding the complex ways a bank can be exposed to credit risk, the practical need for institutions to manage it has nevertheless facilitated a rich literature on credit risk modeling that offers insight into the type of disclosures that can enable more effective market discipline.[23] In particular, by analyzing credit risk in a bank's investment portfolio in terms of a limited, standard set of quantifiable metrics, credit risk models provide an architecture for analyzing a bank's overall exposure to credit risk that is both well understood within the financial sector and parsimonious in the information required to be processed. For the same reasons, disclosure of these standard metrics provides a potentially simple but powerful method for a financial institution to communicate useful information concerning its exposure to credit risk without the need to disclose proprietary position information. Yet to date, standard bank disclosures generally omit mention of these parameter estimates,[24] thus missing an important opportunity to make banks more transparent by using the very analytical tools banks themselves developed to make credit risk less opaque.

To explore the ways in which credit risk models could better inform bank disclosure policy, this Article undertakes a pair of case studies examining two of the most severe banking crises in U.S. history: the collapse of the Continental Illinois National Bank and Trust Company ("CINB") in 1984 and the near collapse of Citigroup in 2008. In each instance, the bank's distress prompted either a subsequent government investigation or private litigation that provided sufficient details concerning the composition of each bank's credit portfolio to estimate the core set of parameters needed for a basic credit risk model of the bank's credit portfolio. As such, each crisis provides a unique opportunity to explore how a "model sensitive" disclosure regime might better enable market participants to detect a bank's insolvency risk and assess its overall capital adequacy.

Although the problems afflicting each bank's credit portfolio differed markedly, the analysis below illustrates how standard approaches to credit portfolio modeling might have used disclosure of these parameter estimates to detect each bank's insolvency risk well in advance of its distress. At the same time, in neither case would the

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23. For accessible introductions to the topic, see JOHN B. CAOUETTE ET AL., MANAGING CREDIT RISK (2d ed. 2008); ARNAUD DE SERVIGNY & OLIVIER RENAULT, MEASURING AND MANAGING CREDIT RISK (2004).

24. *See infra* notes 263–66 and accompanying text (discussing current mandatory disclosure requirements pertaining to a bank's exposure to credit risk).

public disclosures have required the firm to reveal individual position-level data, suggesting the potential for greater market discipline without the need to reveal proprietary trading information. Of course, the fact that such parameter estimates are publicly available for so few failing firms—and not at all available for nonfailing firms—makes it impossible to assess the error rate of such an approach. Nor do we know the precise credit models market participants would use were such disclosures routinely provided. Yet by providing a detailed thought experiment of how market participants might use such disclosures with even basic, textbook credit models, the case studies below provide good reason to believe that the same credit modeling techniques long valued by bank managers to assess their portfolio's credit risk might also be used by capital markets to understand better a bank's overall capital position and insolvency risk. For similar reasons, as bank regulators around the world consider how to revise the disclosure obligations for systemically important financial institutions, designing pilot disclosure programs that facilitate credit modeling among market participants can provide more general data concerning the conditions under which such modeling would be conducted and the error rates associated with it.[25]

To be sure, credit risk modeling is hardly perfect. The simplifying assumptions undergirding even the most sophisticated of models necessarily make them subject to potentially significant error—a risk made all the more acute if market participants seek to utilize them with only limited knowledge of a bank's portfolio.

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25. The use of a temporary pilot program (as opposed to a permanent regulatory rule) may be especially appropriate where an administrative agency lacks the data or information with which to fully evaluate a particular regulatory proposal. *See, e.g.*, Short Sales, 68 Fed. Reg. 62,972 (proposed Nov. 6, 2003) (proposing a year-long mandatory pilot program in which the "uptick" rule would be removed for trading in "specified liquid securities"); Community Bank-Focused Regulation Review: Lending Limits Pilot Program, 65 Fed. Reg. 57,292 (proposed Sept. 22, 2000) (proposing a three-year pilot program providing eligible national banks with the authority to utilize larger lending limits for certain types of borrowers); Electronic Filing, Processing and Information Dissemination System, 49 Fed. Reg. 12,707 (proposed Mar. 30, 1984) (proposing a pilot program in which participating companies would file all periodic reports with the SEC in an electronic format). In general, such pilot programs are entitled to ordinary *Chevron* deference. *See* Tex. Sav. & Cmty. Bankers Ass'n v. Fed. Hous. Fin. Bd., 201 F.3d 551 (5th Cir. 2000) (approving pilot lending program authorized by the Federal Housing Finance Board). As such, Dodd-Frank's broad grant of authority to the FRB to design enhanced public disclosures for systemically important financial institutions would presumably be sufficient to authorize the disclosures proposed in Part V on either a permanent or a pilot basis. *See* Pub. L. No. 111-203, §165(d) (authorizing the FRB to promulgate enhanced disclosures that it "determines are appropriate").

Admonitions to be cautious in the use of models[26] would thus seem to apply with particular force to the type of analysis conducted below. Yet without denying the wisdom of such an admonition, the exploration presented here suggests that even this sound advice might also be taken with a dose of caution. While the models below use only minimal information about a bank's credit exposure, they nevertheless could have predicted the significant insolvency risk for both CINB and Citigroup, providing reason to question whether the recent hostility directed toward credit models[27] may have gone too far. With sufficient caution and a due regard for questioning a model's assumptions, the analysis that follows suggests that even with their faults, credit risk models can help facilitate the long-desired, but persistently evasive, goal of providing a metric with which to probe a bank's portfolio risk.

This Article proceeds as follows. Part II provides a short overview of the role of market discipline in bank regulation and the unique challenges that have plagued both voluntary and mandatory efforts at making banks more transparent to capital markets. Motivated by the need to design a disclosure regime that is more meaningful to market participants, Part III looks to how bank managers themselves assess an institution's risk through the use of credit risk modeling, highlighting both its conceptual simplicity and the core set of parameter estimates used in most models. With this background established, Part IV examines how modest changes to prevailing bank disclosures to facilitate estimation of these parameters, when combined with a standard, simulation-based credit risk model, could have revealed the undercapitalization of both CINB and Citigroup—two radically different banks that each required significant government intervention. Having established the hypothetical benefits of a model-sensitive disclosure regime, Part V examines how such a disclosure regime might be implemented and assesses some of the practical challenges that would nevertheless remain for effective market discipline, concluding that none of the

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26. *See, e.g.*, NASSIM NICHOLAS TALEB, THE BLACK SWAN: THE IMPACT OF THE HIGHLY IMPROBABLE 274–85 (2007) (arguing that financial models make useless predictions because they fail to foretell rare, catastrophic events); Emanuel Derman, *Models*, 65 FIN. ANALYSTS J., Jan./Feb. 2009, at 28 (noting that, unlike models in the "hard" sciences, financial models reveal only guesses at causal relationships between data and future outcomes); Erik Gerding, *Code, Crash, and Open Source: The Outsourcing of Financial Regulation to Risk Models and the Global Financial Crisis*, 84 WASH. U. L. REV. 127, 169 (2009) ("The scope of the current global financial crisis and the necessity of massive government intervention demonstrate the failure of the risk models throughout the web.").

27. *See* sources cited *supra* note 26.

challenges justify withholding from public disclosure the minimal information used to design the models in Part IV. Part VI concludes.

II. MARKET DISCIPLINE AND BANKING

As noted previously, the notion that market discipline might provide a meaningful complement to regulatory oversight of financial institutions has come to play a central role in modern banking regulation.[28] The basic motivation stems from the unique position of banks as being at once central to economic stability while also being vulnerable to systemic crises. By matching the needs of borrowers having long-term funding requirements with lenders demanding short-term deposits, banks represent a central source of liquidity in the economy and provide a core source of financing for investment.[29] At the same time, however, if a bank's liquid reserves and assets are insufficient to meet depositors' demands, a sudden withdrawal of funds by depositors may cause a liquidity crisis for the bank. Moreover, interlinkages among banks (real and imagined) might simultaneously transmit financial distress from one institution to another, potentially causing a self-fulfilling crisis of confidence in the entire banking sector.[30]

Over the years, concern with this basic threat to banks has led to the creation of an extensive array of safety nets aimed at reducing the risk of bank runs and their concomitant economic dislocations. Most notably, federal deposit insurance and the liquidation strategies used by bank regulators have greatly reduced the incentive of depositors and other fixed claimants to engage in a traditional bank run.[31] In so doing, however, such systems have also created the well-known problem of moral hazard in banking that has amplified the need for some form of prudential oversight of bank-lending activities.[32] In particular, by insulating depositors and most creditors from the risk of loss, these regulatory safety nets induce a bank's suppliers of capital to disregard the riskiness of a bank's loans and, in the process,

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28. *See* BASEL COMM. ON BANKING SUPERVISION, *supra* note 14 (arguing that market discipline and public disclosure promote a more stable banking system).

29. *See* Douglas W. Diamond & Philip H. Dybuig, *Bank Runs, Deposit Insurance, and Liquidity*, 91 J. POL. ECON. 401, 403 (1983) (explaining the role of banks in the economy).

30. *See* Craig H. Furfine, *Interbank Exposures: Quantifying the Risk of Contagion*, 35 J. MONEY CREDIT & BANKING 111, 125 (2003) (explaining how this self-fulfilling crisis can occur).

31. Jonathan R. Macey & Elizabeth H. Garrett, *Market Discipline by Depositors: A Summary of the Theoretical and Empirical Arguments*, 5 YALE J. ON REG. 215, 217–19 (1988).

32. *Id.*

incentivize a bank's stockholders to increase the overall volatility of a bank's business.[33] Since the creation of the Federal Deposit Insurance Corporation ("FDIC") in 1933, U.S. bank policy has therefore developed an extensive regulatory apparatus to manage the risk of moral hazard. Most notably, each U.S. commercial bank is closely supervised by at least two regulatory agencies, each tasked with the power to engage in periodic on-site exams, mandate regulatory filings, establish capital adequacy requirements, and regulate lending practices.[34]

Although the original approach to addressing moral hazard in banking focused on the promise of sound prudential regulation, two events in the 1980s led regulators and commentators alike to call for greater market discipline in policing against excessive risk-taking by banks. First, a rash of banking failures during the early 1980s (in particular, the monumental collapse of CINB discussed below) highlighted the enormity of the challenge faced by banking regulators.[35] Additionally, deregulation within the financial sector simultaneously threatened to enlarge the moral hazard challenge in banking by, among other things, allowing banks to pay higher interest rates on federally insured deposit accounts.[36] In light of these events,

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33. *Id.*

34. In general, the U.S. banking system is a dual banking system, consisting of federally chartered (national) banks and state chartered (state) banks. The Office of Comptroller of the Currency ("OCC") is the primary regulator of all national banks, while state banking regulators are the primary regulators of all state banks. All state banks that are members of the Federal Reserve System are additionally regulated by the Federal Reserve, while all state nonmember banks are additionally regulated by the FDIC. The Federal Reserve also serves as a secondary regulator for all national banks. Because the FDIC administers the federal deposit insurance program, it also has regulatory authority over national banks and state member banks. In addition to commercial banks, a number of other organizations engaged in banking activities (e.g., thrifts, savings associations) are also generally subject to overlapping bank regulators. For an overview, see Luigi De Ghenghi et al., *United States*, *in* THE BANKING REGULATION REVIEW 434, 435–36 (Jan Putnis ed., 2010).

35. *See* Douglass D. Evanoff, *Preferred Sources of Market Discipline*, 10 YALE J. ON REG. 347, 351 (1993) (summarizing how the regulatory problems of the 1980s led Congress to increase the role of the depositor as a source of market discipline to supplement regulatory discipline).

36. As the FDIC stated in a 1984 policy statement:

Deregulation of the financial services industry is removing deposit interest rate controls and other restrictions that previously constrained the actions of many institutions. Because of the greater freedom within which financial institutions can operate, the FDIC believes the supervisory efforts of the regulatory agencies must be supplemented by market discipline to promote sound bank and thrift management.

Proposed Statement of Policy Regarding the Availability and Use of Financial and Other Information by Depositors and Other Creditors of Banks and Thrifts, 49 Fed. Reg. 26,809 (proposed June 29, 1984).

it was generally believed that market participants could potentially provide an important ally in bank oversight.[37] In particular, with their strong incentives to understand financial innovation, properly motivated market participants could help ensure that a bank's funding costs were better calibrated to its overall risk.[38]

Notwithstanding this general enthusiasm for market discipline, however, it was also widely acknowledged that the conditions necessary for market participants to actually exert market discipline might be difficult to attain. A central challenge facing efforts to increase market discipline was that the very deposit insurance that created such strong incentives for risk-taking also diminished the incentive of depositors and creditors to monitor banks.[39] For this reason, most advocates of greater market discipline have generally focused on the potential of uninsured bank creditors (such as subordinated bondholders), while also advocating for the need to avoid implicit debt guarantees.[40] Indeed, a central goal of financial regulation over the past two decades has been to redesign the safety net in a fashion that maximizes the incentive of depositors and creditors to monitor banks without precipitating a return to traditional bank runs. For instance, both the Federal Deposit Insurance Corporation Improvement Act[41] ("FDICIA") in 1991 and Dodd-Frank sought to reduce the implicit guarantee of a financial institution's creditors beyond what was explicitly provided for by federal deposit insurance.[42]

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37. *See, e.g.*, Albert J. Boro, Jr., *Banking Disclosure Regimes for Regulating Speculative Behavior*, 74 CALIF. L. REV. 431 (1986) (advancing the argument); Macey & Garrett, *supra* note 31, at 220–21 (same).

38. *See* Macey & Garrett, *supra* note 31, at 220–21 (explaining how properly motivated participants encourage banks to calibrate funding to overall risk).

39. *Id.* at 220.

40. *See, e.g.*, *id.* at 223–33 (advocating the elimination of bank settlement techniques that effectively guarantee full protection for every depositor, regardless of the size of the deposit); *see also* Mark Van Der Weide & Satish Kini, *Subordinated Debt: A Capital Markets Approach to Bank Regulation*, 41 B.C. L. REV. 195, 255 (2000) ("In order to implement a successful market discipline approach to bank regulation, the federal government must credibly commit not to insure the losses of the relevant market participants.").

41. 12 U.S.C. § 1823(c)(4) (2006).

42. In general, the FDICIA prohibits the FDIC from taking any action "that would have the effect of increasing losses to any insurance fund by protecting . . . depositors for more than the insured portion of deposits [or] creditors other than depositors." 12 U.S.C. § 1823(c)(4)(E)(i). Among other things, Titles I and II of the Dodd-Frank Act created a new supervisory and resolution framework designed to render any financial institution "resolveable" in a fashion that would put at risk the value of shareholder and creditor claims. Whether or not this new framework will function as planned, however, is a subject of considerable debate. *See, e.g.*,

In addition to the need for market participants to have sufficient incentives to monitor banks, a second, equally important condition for effective market discipline is the availability of useful and timely information concerning banks' lending activities.[43] Yet in contrast to the considerable debate concerning ways to curtail implicit government bank guarantees, considerably less academic attention has been paid to this latter issue. Part of this intellectual reticence may simply reflect a belief that with the proper incentives for monitoring, market participants can be trusted to demand the information they need to assess lending risks.[44] In the context of banking, however, a number of factors above and beyond implicit government subsidies may very well interfere with the operation of an entirely voluntary disclosure regime. For one, as noted previously, a bank's proprietary interest in protecting confidential information concerning its lending strategies as well as concerns about protecting the confidentiality of customer information may create strong incentives for banks to resist disclosure concerning their credit portfolios.[45] As discussed in more detail in Part V, even if market participants impose an "opacity discount" on such institutions, high-quality banks may nonetheless conclude that the discount is justified by the benefits of maintaining secrecy in ordinary market conditions.[46]

Equally important, the ability of market participants to contract for appropriate bank disclosures has no doubt also been

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Arthur E. Wilmarth, Jr., *The Dodd-Frank Act: A Flawed and Inadequate Response to the Too-Big-to-Fail Problem*, 89 OR. L. REV. 951, 986–1015 (2011) (arguing that the Dodd-Frank Act continues to permit the FDIC and other federal regulators to provide full protection for certain creditors of large financial institutions).

43.   *See* Krishna G. Mantripragada, *Depositors As a Source of Market Discipline*, 9 YALE J. ON REG. 543, 559 (1992) ("Another important condition for an effective system of depositor-imposed market discipline is the availability of relevant information to depositors on a timely basis.").

44.   *Cf.* Macey & Garrett, *supra* note 31, at 223 ("[I]n a market system unencumbered by guarantees, depositors would demand contractual limitations on bank risks.").

45.   *See* Boro, *supra* note 37, at 476 (advancing the argument that banks may have strong incentives to resist disclosure). A vivid illustration of these concerns occurred in connection with the SEC's 2009 proposal that money market funds make monthly, public disclosures of their securities holdings. *See, e.g.*, Letter from Federated Investors, Inc. to Elizabeth M. Murphy, Sec'y to the U.S. Sec. & Exch. Comm'n, regarding File No. S7-11-09 (Sept. 8, 2009), *available at* http://www.sec.gov/comments/s7-11-09/s71109-104.pdf (objecting to the public disclosure of portfolio holdings on the basis that money market funds "would have a legitimate fear that, if disclosed, certain information could be used to create a competitive disadvantage").

46.   *See infra* notes 285–92 and accompanying text (explaining why investors may value more granular portfolio information but may not receive it until exposures within a bank become distressed).

impeded by federal banking policy itself. Indeed, it is hardly an exaggeration to say that federal banking policy during most of the twentieth century was affirmatively hostile to the notion of bank transparency. Inspired in large part by the banking panics of the past, federal banking policy historically strived to withhold bank information from the marketplace out of concern that any sign of negative information could trigger a bank run.[47] In the words of a former Chief Counsel of the Office of Comptroller of the Currency ("OCC"), the traditional wisdom was that "[a]nything that smacked of controversy was considered bad for the banking 'image.' "[48] Moreover, in addition to the need to prevent the loss of depositor confidence, bank regulators also sought to keep confidential any information concerning bank examinations and oversight to protect customer privacy and to encourage banks to cooperate with their examiners.[49] By 1941, a congressional study thus concluded that "the exercise of supervisory powers over banks has traditionally been attended by a secrecy antithetical to the publicity which marks most regulatory activities."[50] Indeed, the belief during this time that bank regulation and oversight was best relegated to the confidential confine of bank regulators was perhaps most tellingly revealed by the exclusion of banks from the new mandatory disclosure regime implemented by the Securities Act of 1933 ("Securities Act") and the Securities Exchange Act of 1934 ("Exchange Act").[51]

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47. *See* Boro, *supra* note 37, at 437–38 (explaining history of federal policy encouraging the withholding of bank information from the marketplace).

48. Robert Bloom, *Hearing Procedures of the Office of the Comptroller of the Currency*, 31 LAW & CONTEMP. PROBS. 723, 723 (1966).

49.   *See* Roy A. Schotland, *Re-Examining the Freedom of Information Act's Exemption 8: Does It Give An Unduly "Full Service" Exemption for Bank Examination Reports and Related Material?*, 9 ADMIN. L.J. 43, 55 (1995) (quoting former FDIC Chairman Robert Barnett as saying, "If the confidentiality is lost or the process becomes adversarial, there quite possibly would be a deterioration in the quality of examinations.").

50. Boro, *supra* note 37, at 437 n.26.

51. *See* Michael P. Malloy, *The 12(i)'ed Monster: Administration of the Securities Exchange Act of 1934 by the Federal Bank Regulatory Agencies*, 19 HOFSTRA L. REV. 269, 277–81 (1990). The exemption in the Securities Act of "any security issued or guaranteed by . . . any bank" was premised on the fact that Congress was simultaneously reforming banking regulation with the Banking Act of 1933, which more directly expanded federal regulation of commercial banks. *Id.* at 278. The issuance of bank securities, however, remained (and continues to remain) subject to the antifraud provisions of the Securities Act. 15 U.S.C. §77q(a), (c) (2006). With regard to the Exchange Act, the exemption of bank securities was the practical consequence of the fact that the Exchange Act originally required registration only of those securities that were listed on a national securities exchange, and very few commercial banks had listed securities. *See* Malloy, *supra*, at 280 (noting that by 1963, the securities of only five banks were listed on any national

Although federal banking policy increasingly grew to embrace market discipline of banks during the 1980s, remnants of this traditional attitude toward bank transparency have frequently created inconsistencies in the regulation of bank disclosure. With respect to federal securities disclosure, for instance, congressional concern in 1964 with the volume of OTC trading in the shares of banks and other nonlisted companies ultimately prompted Congress to subject any company with greater than 500 shareholders of record and $1 million of assets to the mandatory disclosure requirements of the Exchange Act.[52] Yet while the move ended the three-decade exemption of many banks from federal periodic disclosure obligations, section 12(i) of the Exchange Act provided that the disclosure rules that would apply to banks would nevertheless be the domain of their federal prudential regulator, not the Securities and Exchange Commission ("SEC").[53] Given that the legislation as originally proposed vested enforcement power exclusively in the SEC, this compromise left some doubt as to whether Congress really intended to mandate full disclosure for commercial banks.[54] Even as late as the 1980s, ambiguity regarding whether banks were truly subject to the same level of disclosure as other companies occasionally surfaced when banks accused of failing to disclose adverse bank examinations sought to claim a confidentiality privilege.[55] Writing in 1993, one former thrift regulator went so far as to claim that the "schizophrenic approach to bank

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securities exchange). Additionally, shortly after the Exchange Act was enacted, the SEC promulgated Rule 12a-1 that exempted exchange-listed bank securities from the registration requirement of the Exchange Act pending adoption of an appropriate registration form. In light of the extremely small number of banks with listed securities, however, the form was never adopted. *See id.* at 281 n.62 (explaining why a temporary exemption was never adopted).

52. *See* Securities Acts Amendments of 1964, Pub. L. No. 88-467, § 3(c), 78 Stat. 565, 566–68 (codified as amended at 15 U.S.C. § 78l (2006)) (outlining the disclosure requirements of companies that meet certain criteria).

53. In particular, section 12(i) provides that, with respect to banks, the administration and enforcement of sections 12, 13, 14(a), 14(c), 14(d), 14(f), and 16 of the Exchange Act (as well as certain provisions of the Sarbanes-Oxley Act of 2002) are vested in the bank's primary federal banking regulator. 15 U.S.C. § 78l(i). Notwithstanding this express delegation, all federal banking regulators have simply chosen to incorporate by reference all of the SEC's rules pertaining to these sections. *See* 12 C.F.R. § 33.101 (2011) (OCC); *id.* § 208.36 (Federal Reserve); *id.* § 335.101 (FDIC). *See generally* Malloy, *supra* note 51, at 285–89 (examining the process by which bank regulators incorporated by reference the SEC rules).

54. David G. Oedel, *Civil Liability for the Concealment of Bank Trouble*, 6 ANN. REV. BANKING L. 443, 466 (1987).

55. *See id.* at 468–69 (explaining when banks seek to claim a confidentiality privilege).

regulation and disclosure obligations persists to this day, and indeed, can be said to be worse than at any other time."[56]

Similarly, with respect to regulatory bank disclosures, suspicion toward bank transparency has often resulted in inconsistent disclosure policies, potentially sending mixed signals to the market concerning what can and cannot be disclosed by a bank. For instance, although all federally insured banks are required to submit quarterly Reports of Condition and Reports of Income ("Call Reports") to the FDIC,[57] it was not until 1972 that the FDIC made such reports publicly available "to assist in maintaining public confidence in the Nation's banks."[58] As federal banking policy shifted during the 1980s to increase the role of market discipline, Call Reports were revised to increase the information available about a bank's loan portfolio,[59] but even so, concern with preserving banks' proprietary interests and customer privacy limited such disclosures to aggregate credit metrics.[60] Moreover, voluntary efforts to enhance bank transparency by banks have often been met with formal resistance by bank regulators. Following reform of federal examination procedures in the early 1990s, for instance, federal banking regulators prohibited banks from disclosing to third parties the new capitalization categories in which a bank was placed or the bank's examination rating.[61] And throughout the current system of bank oversight, bank examination reports have been deemed the property of bank regulators, subject to strict prohibitions on their use and disclosure by banks[62] and

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56. Schotland, *supra* note 49, at 97 (quoting C. Thomas Long).

57. 12 U.S.C. § 1817(a); 12 C.F.R. § 304.3.

58. Public Disclosure of Reports of Condition, 37 Fed. Reg. 28,607-02 (Dec. 28, 1972).

59. *See* Notice of Request for Comments on the Proposed Revised Quarterly Report of Condition and Income Required of All Insured Commercial Banks, 47 Fed. Reg. 25,615 (June 14, 1982) (requesting comments on a proposal revising quarterly Call Reports to include, among other things, more information "on past due, renegotiated, and non-accrual loans and leases, and charge-offs to assist in determining credit quality"). The FDIC submitted final forms to the OMB for approval in 47 Fed. Reg. 40,479-02 (Sept. 14, 1982).

60. *See infra* text accompanying notes 265–66 (discussing Call Report data). Some of these additional disclosures would subsequently be removed from the public domain. *See, e.g.*, Notice of Public Disclosure of Reports of Condition, 55 Fed. Reg. 32,168 (Aug. 7, 1990) (notifying savings associations that proprietary information concerning classified assets, specific valuation allowances, and loans thirty to eighty-nine days past due but still accruing will be removed from public disclosure thrift data).

61. *E.g.*, 12 C.F.R. § 325.101(e) (2011) (FDIC prohibition on disclosure of capital categories).

62. *E.g.*, *id.* § 4.36 (2011) ("All non-public OCC information remains the property of the OCC. No supervised entity, government agency, person, or other party to whom the information is made available, or any officer, director, employee, or agent thereof, may disclose non-public OCC information without the prior written permission of the OCC . . . ."); FDIC, Risk

specifically exempted from disclosure under the Freedom of Information Act.[63] This conflicted approach toward bank disclosure has no doubt cast an inhibiting pallor over market-based solutions for making banks transparent to the capital markets.[64]

   In addition to suggesting why an entirely voluntary regime of bank disclosure might result in suboptimal disclosures, the foregoing discussion also highlights the difficult policy considerations at stake when evaluating the options available for addressing this market failure—a task made all the more pressing given the mandate for greater bank transparency following the Financial Crisis. At the extreme, for example, one could in principle simply advocate for a model of full transparency such as that which applies to a number of other financial intermediaries. Both money-market mutual funds and insurers, for instance, are required to periodically disclose a full listing of their investments on a position-by-position basis.[65] Yet given the concerns about protecting customer information shared by both banks and regulators, any such proponents would no doubt bear a heavy burden of demonstrating that the benefits of such a disclosure regime would justify its costs. Indeed, the task may very well be politically insurmountable given that, even within the insurance market, evidence suggests that market participants did not widely use insurers' position-by-position disclosures during the Financial Crisis.[66]

MANAGEMENT MANUAL OF EXAMINATION POLICIES § 1.1 (2005), *available at* http://www.fdic.gov/regulations/safety/manual/section1-1.html ("The Report of Examination is highly confidential. Although a copy is provided to the bank, that copy remains the property of the FDIC. Without the FDIC's prior authorization, directors, officers, employees and agents of a bank are not permitted to disclose the contents of a report.").

   63. 5 U.S.C. § 552(b)(8) (2006). *See generally* Schotland, *supra* note 49, at 99–106 (examining breadth of Exemption 8 to the Freedom of Information Act with regard to bank examinations).

   64. *See, e.g.*, Press Release, FDIC, Interagency Advisory on the Confidentiality of the Supervisory Rating and Other Nonpublic Supervisory Info. (Feb. 28, 2005), *available at* http://www.fdic.gov/news/news/financial/2005/fil1305.html (reminding banking institutions that, while insurers may have begun requesting disclosure of the bank's CAMELS rating when underwriting insurance policies, "they are prohibited by law from disclosing CAMELS rating and other nonpublic supervisory information to insurers as well as other non-related third parties without permission from the appropriate federal banking agency").

   65. *See* 17 C.F.R. § 270.30b1-7 (requiring every money market fund to report publicly each month information concerning each portfolio security held in the fund); Bartlett, *supra* note 22, at 9 (describing disclosure regime applicable to monoline insurance companies, which requires "detailed quarterly and annual disclosures concerning an insurer's holding of debt and equity securities").

   66. *See* Bartlett, *supra* note 22, at 25–42 ("[T]he general absence of any notable market reaction to these significant CDO downgrades would seem to call into question whether [portfolio-level] disclosures mattered at all.").

Even aside from this particular disclosure option, however, the historic opacity of banks would no doubt pose obstacles for even less ambitious proposals. For in the absence of more granular, historical data concerning banks' lending activities, any disclosure proposal will risk revealing incrementally more information concerning a bank's customers and proprietary strategies, yet will be lacking in empirical support for how market participants can be expected to use the information. Examining how best to increase bank transparency thus requires not only sensitivity to the unique resistance to disclosure within banking but also some willingness to experiment with disclosure policy to enable a fuller understanding of how market participants would use disclosed information. This need to design a disclosure regime likely to be of use to market participants motivates the following discussion of how banks themselves use information to manage and understand the risk of their credit portfolios.

III. MODELING CREDIT RISK

A. An Overview of Credit Risk Analysis

Analyzing the credit risk associated with a loan portfolio is one of the most critical challenges facing any financial institution. A cursory review of the basic business model for a bank illustrates why. Figure 1, for instance, presents a hypothetical balance sheet for a simple bank. As the figure indicates, the vast majority of the bank's assets consist of loans that the bank has funded primarily through a combination of customer deposits and subordinated debt. A smaller amount of funds has also been raised through the sale of equity securities. This disproportionate reliance on debt financing (which, for this purpose, includes deposits) is what allows a bank's equity investors to realize potentially significant returns on their investment: to the extent a bank's loans earn returns that exceed its cost of debt financing, the excess returns accrue to the bank's equity investors. But it is also for this same reason that a bank's balance sheet is especially susceptible to the credit risk of its loan portfolio. For our hypothetical bank, a small drop in the value of its loan portfolio would be sufficient to render it insolvent.

FIGURE 1: HYPOTHETICAL BANK BALANCE SHEET

Assets		Liabilities	
Cash	$5	Deposits	$700
Marketable Securities	$40	Subordinated Debt	$200
Trading Book:	$45		
Total Gross Loans:	$1,000		
less loan loss reserve	($50)		
Total (net) loans:	$950		
Other Assets	$5	Equity Capital	$100
Total	$1,000	Liabilities + Equity	$1,000

In light of this risk, financial institutions undertake considerable credit risk analysis due to both externally mandated regulations[67] and internal risk management protocols.[68] It is also for this reason that the past three decades have witnessed a considerable evolution in credit risk modeling, with a single institution often utilizing a number of different models to analyze its portfolio's credit risk.[69] Yet notwithstanding this variation, at the core of virtually every credit risk model is a recognition that credit risk is fundamentally an elaborate form of a Bernoulli trial.[70] That is, the primary risk of holding a loan—a borrower's default—resembles a simple coin flip in that the borrower will either pay or not pay the loan.

From this perspective, understanding the credit risk for a loan therefore hinges on three initial parameters: a loan's *exposure amount*, its *probability of default*, and its *loss given default*.[71] To illustrate,

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67. In particular, bank regulators impose specific capital requirements on banks to help ensure there will be a capital cushion against the risk of loss from a loan portfolio. For a helpful summary of the various regulations imposing capital requirements on financial institutions (including banks), see Charles K. Whitehead, *Reframing Financial Regulation*, 90 B.U. L. REV. 1 app. B at 47 (2010).

68. In addition to having to ensure sufficient regulatory capital, a bank's managers also analyze credit risk to ensure a bank has sufficient economic capital that represents "management's internal assessment of the capital cushion to be provided to the asset or the line of business." CAOUETTE ET AL., *supra* note 23, at 362; *see infra* text accompanying notes 249–52.

69. *See* HULL, *supra* note 17, at 313–29 (providing an overview of credit risk quantification).

70. *See* ANTÚLIO N. BOMFIM, UNDERSTANDING CREDIT DERIVATIVES AND RELATED INSTRUMENTS 316 (2005) (describing loan defaults as a sequence of Bernoulli trials).

71. CAOUETTE ET AL., *supra* note 23, at 277 ("Three main variables affect the credit risk of a financial asset: (1) the *probability of default* (PD); (2) the *loss given default* (LGD), which is equal to PD times one minus the *recovery rate* (RR); and (3) the *exposure at default* (EAD).").

return again to the hypothetical bank discussed previously. If we assume for simplicity that its loan portfolio consists of ten identical loans of $100 each that are uncorrelated in their default risk, analyzing the riskiness of this portfolio would require only two additional pieces of information: an estimate of each loan's default probability and how much the bank expects it could collect in the event of a loan's default. For instance, if the bank believed there was a 5% chance each borrower would default over the next year and that it would recover nothing in such a scenario, the bank would expect to lose $50 (i.e., $100 [loss given default] x (0.05 x 10) [expected defaults]) from its portfolio. Based on this analysis, it would then establish a $50 loan loss reserve (as it has in Figure 1) as a means of protecting against this default probability, otherwise known as *expected loss*.[72]

To the extent credit defaults resemble a Bernoulli trial, however, using these loss reserves as the primary means to manage credit risk will be insufficient due to the potential variance of actual defaults. As in a series of coin flips, simple random variation will cause actual defaults to depart from expected defaults, with the actual results generally falling into the familiar binomial distribution with: (a) a mean number of defaults equal to the product of the number of loans (N) and the default probability (PD), and (b) a standard deviation equal to $[(N)(PD)(1-PD)]^{1/2}$.[73] In the example above, if the bank's loans are drawn from a population of loans having similar default characteristics, the distribution of possible loan defaults (and therefore default losses) will also tend to follow a binomial distribution, albeit one having a mean equal to the expected loss of $50 (i.e., $100 x 0.05 x 10) and a standard deviation equal to $68.92 (i.e., $100 x $[(10)(0.05)(1-0.05)]^{1/2}$).

To account for this potential variance, a bank's internal risk managers as well as its prudential regulator will therefore require an additional reserve of equity capital on top of the loan loss reserve.[74] A common way to estimate this reserve for unexpected losses is to

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72. *See* ANDREA RESTI & ANDREA SIRONI, RISK MANAGEMENT AND SHAREHOLDERS' VALUE IN BANKING 281 (2007) ("[T]he expected loss on a loan portfolio should give rise to . . . a reserve in the bank's balance sheet.").

73. That a series of Bernoulli trials with a constant probability of success yields a binomial distribution is a basic principle of probability theory.

74. *See* RESTI & SIRONI, *supra* note 72, at 281 ("[U]nexpected loss should be covered by the bank's capital because, as the shareholders benefit from any results above expectations . . . they also must cover higher than expected losses with their own funds.").

multiply the standard deviation of expected losses by a constant to ensure that the bank has a sufficient amount of capital to absorb unexpected losses with a given level of confidence. For example, both the Basel Capital Accords and standard approaches to credit risk management require using a constant that would allow a bank to absorb 99.9% of the credit losses that could theoretically arise from its credit portfolio over one year's time.[75] Assuming credit losses are approximately normally distributed,[76] this constant could be calculated by taking the inverse of the standard normal cumulative distribution at 99.9% confidence, yielding a reserve equal to 3.09 standard deviations of the expected loss.[77] The measure, generally referred to as credit value-at-risk (or "credit VaR"), can then be used by banks and banking regulators to determine the appropriate amount of equity capital required to minimize the insolvency risk posed by a bank's leveraged business model. In the case of our hypothetical bank, this would translate into the bank holding equity capital against the loan portfolio of $262.98 (i.e., $50 + 3.09 x $68.92)—far more than the $100 of equity capital it has set aside in Figure 1.

All of this, of course, ignores the beneficial effects of loan diversification on credit risk. Rather than hold just ten loans of $100 each, our hypothetical bank would be well advised to diversify its $1,000 loan book into a larger number of loans having uncorrelated

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75. Federal Reserve Board, Notice of Proposed Rulemaking (NPR) and Supporting Board Documents, 71 Fed. Reg. 55830-01 (2006) (noting that the Basel II framework "for assessing credit risk capital requirements is based on a 99.9% nominal confidence level, a one-year horizon, and a supervisory model of credit losses embodying particular assumptions about the underlying drivers of portfolio credit risk, including loss correlations among different asset types" and further noting that the "framework is broadly similar to the credit VaR approaches used by many banks as the basis for their internal assessment of the economic capital necessary to cover credit risk").

76. This assumption stems from basic probability theory: for a sufficiently large number of Bernoulli trials (e.g., coin flips), a binomial distribution can be approximated with a normal distribution. In the example here, a portfolio of ten loans would be insufficient to justify such an approximation; however, for expositional purposes, the normal approximation is used (as well as in the paragraph that follows) to illustrate the procedure for estimating a reserve for unexpected losses and the beneficial effects that loan diversification has on it.

77. In general, a standard normal variable X would have a mean of 0 and a standard deviation of 1, and if each occurrence of the variable were observed and plotted, the distribution of observations from negative infinity to positive infinity would be clustered at 0 with positive and negative values tapering off on either side. In other words, the familiar bell-shaped curve would appear. The inverse of the standard normal cumulative distribution at 99.9% confidence represents the value of X such that one would have a 99.9% probability of observing it or a number less than it.

default risk. Consistent with modern portfolio theory, doing so would significantly reduce the variance of expected losses, thereby allowing the bank to set aside considerably less capital to cover its unexpected losses. For instance, by making 1,000 loans of $1 each (with each loan having the same credit characteristics as in the original example), the bank would continue to have an expected loss of $50 (i.e., a loss given default of $1 x expected defaults of (0.05 x 1,000)), but the standard deviation of expected losses would be reduced from $68.92 to $6.89 (i.e., $1 x $[(1,000)(0.05)(1-0.05)]^{1/2}$). The 99.9% credit VaR would similarly be reduced from $262.98 to $71.30 (i.e., $50 + 3.09 x $6.89). Not surprisingly, a core principle of credit risk management—as well as a core bank regulatory principle—is for financial institutions to minimize the degree to which an institution is exposed to any single borrower, or "name concentration."[78]

Yet, while avoiding name concentration is a primary consideration in bank risk management, a critical challenge for financial institutions is that the default behavior of individual obligors can often reveal strong dependencies with one another. A common example involves two obligors who have substantial business ties—say a vendor and its primary customer. To the extent the customer represents a significant component of the vendor's business, credit deterioration of the customer may result in credit deterioration of the vendor. Risk concentrations may exist, however, even short of these direct dependencies. For instance, obligors may be subject to common risk factors that could cause them to default together, particularly where firms operate within the same business sector. More generally, the financial performance of firms will also depend on broader macroeconomic factors leading to potential default dependencies even among firms in different sectors. For these reasons, in addition to measuring a loan's probability of default and loss given default, effective credit risk management requires the measurement and management of default correlations within a loan portfolio—a topic that, as the following Section reveals, has produced no shortage of measurement challenges.[79]

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78. Klaus Duellmann, *Measuring Concentration Risk in Credit Portfolios*, *in* THE ANALYTICS OF RISK MODEL VALIDATION 59, 59–64 (George Christodoulakis & Stephen Satchell eds., 2008) (illustrating the need to measure and manage name concentration within a credit portfolio).

79. *See id.* at 64–69 (illustrating a methodology for measuring sector concentrations); *see also* GUNTER LÖFFLER & PETER N. POSCH, CREDIT RISK MODELING USING EXCEL AND VBA 103–18 (2007) (summarizing methodologies for measuring default correlation).

B. Measurement Challenges in Credit Risk Analysis

Although the foregoing principles constitute a widely shared foundation for modern credit risk management, any attempt to implement them quickly gives rise to the need to measure the primary parameters of interest. In the simple portfolio of 1,000 loans above, for instance, the conclusion that the bank should hold $71.30 in capital was based on an assumption that each loan had a one-year default probability of 5% and a 100% loss given default. Each loan was also assumed to have a zero default correlation with each other loan in the portfolio—i.e., they were assumed to be independent flips of a coin—thus avoiding the need to measure default dependencies. In the real world, of course, each of these parameters would need to be measured. In this domain, there is considerably less agreement on the proper manner to undertake this process.

In general, the literature on credit risk measurement divides itself into two main schools of thought often referred to as intensity-based (or reduced-form) and structural (or option-theoretic) approaches.[80] A complete description of each approach is beyond the scope of this Article, but for present purposes it is helpful to understand the contours of the latter approach as it currently constitutes the dominant approach used within the industry as well as by banking regulators.[81] As such, it provides a natural starting point for examining how we might leverage existing credit risk technology to construct a more meaningful disclosure regime.[82]

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80. Jorge Sobehart & Sean C. Keenan, *New Challenges in Credit Risk Modeling and Measurement in Risk Management: A Modern Perspective*, *in* RISK MANAGEMENT 203, 225–26 (Michael Ong ed. 2006). A third, nontheoretical approach to measuring credit risk also exists based on the pioneering work of Edward Altman. *Id.* This largely statistical approach seeks to determine the relationship between a firm's default probability and various firm-specific accounting variables as well as more general market data. *Id.*; *see also* Eric Talley & Johan Walden, The Supervisor Capital Assessment Program: An Appraisal (June 2009), *included as an Appendix to* CONGRESSIONAL OVERSIGHT PANEL, JUNE OVERSIGHT REPORT: STRESS TESTING AND SHORING UP CAPITAL 57–62 (June 2009), *available at* http://www.gpo.gov/fdsys/pkg/CPRT-111JPRT50104/pdf/CPRT-111JPRT50104.pdf (summarizing modern credit risk models as representing either structural models or reduced form models).

81. *See* Sobehart & Keenan, *supra* note 80, at 226 ("Reduced form models are the approach most widely used by academics and credit derivative trading desks for pricing debt instruments.").

82. In general, the two approaches differ primarily in how they estimate a borrower's default probability. Intensity-based (or reduced-form) approaches assume that the timing of a borrower's default depends on an exogenous random process that is unrelated to any observable characteristics of a firm (e.g., a firm's leverage or its cash flows). *Id.* Instead, defaults are assumed to occur unexpectedly, with a firm's default probability being modeled as the result of a

According to the structural approach, a firm's default behavior can best be explained by starting with the empirical fact that when a limited liability firm faces a potential default on its debt obligations, its equity owners effectively have an option to pay off the firm's debt to save the firm from bankruptcy.[83] The reason stems from the absolute priority rule, according to which equity holders stand as residual claimants to the firm's assets given that debt holders are paid first in the case of a default. Thus, if equity holders believe the value of the firm's assets is greater than the value of its debt obligations, they can choose to save the firm from insolvency by paying off its debt, effectively "exercising" their right to its assets. Conversely, if the value of the firm's assets falls beneath the value of its debt obligations, the firm's equity holders will simply walk away (thanks to their limited liability), in the same fashion as the holder of an out-of-the-money stock option upon its expiration. In effect, the payoff to a firm's equity holders is the same as the payoff of a European call option: nothing if the firm's assets are worth less than its debt (i.e., the strike price); the excess of the firm's asset value over its liabilities if otherwise.[84]

Significantly, recognizing that a firm's equity owners hold a de facto call option on its assets permits an analysis of a firm's default behavior using standard option pricing theory. To do so simply requires two additional assumptions. The first is to assume that the value of a firm's assets follows geometric Brownian motion, resulting in a log-normal distribution of asset values.[85] Figure 2 provides an illustration. In general, the figure represents the value of a firm's assets over time compared to the value of its liabilities. As the firm proceeds through time over the x-axis, the value of its assets fluctuates until the maturity date *(T)* of the firm's debt. As noted above, if the firm's assets happen to fall below the value of its debt obligations, the firm defaults. Assuming that its asset value follows a

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stochastic process (generally a Poisson process) that can be calibrated from market-based variables (such as bond spreads or CDS prices). *Id.* As such, the approach relies heavily on the availability of market data. *Id.* As discussed in the text, structural models assume default occurs when the value of a borrower's assets falls below the amount of its liabilities. *See infra* text accompanying note 84.

83.   *See* LÖFFLER & POSCH, *supra* note 79, at 27 (stating that equity holders possess a walk-away option as a result of limited liability and can therefore leave a firm that has a negative equity value to the creditors).

84.   *Id.* at 27, 29 (noting that since equity holders receive the residual value of the firm, the value of equity is negative if the asset value is smaller than the value of liabilities, and, thus, the payoff to equity holders can be described with the same mathematical formula as the payoff of a European call option).

85.   *Id.* at 27–28.

log-normal distribution permits the estimation of this probability using basic statistics.[86] This statistical technique, however, requires the current market value of the firm's assets and an estimate of their volatility as inputs. To obtain these figures requires the second additional assumption: for a publicly traded firm, the aggregate market value of its equity securities is assumed to reflect the value of equity holders' call option on the firm's assets.[87] With this assumption, a firm's asset value and its volatility can then be calculated by use of the standard Black-Scholes call-option formula.[88]

FIGURE 2: DEFAULT PROBABILITY IN THE STRUCTURAL MODEL
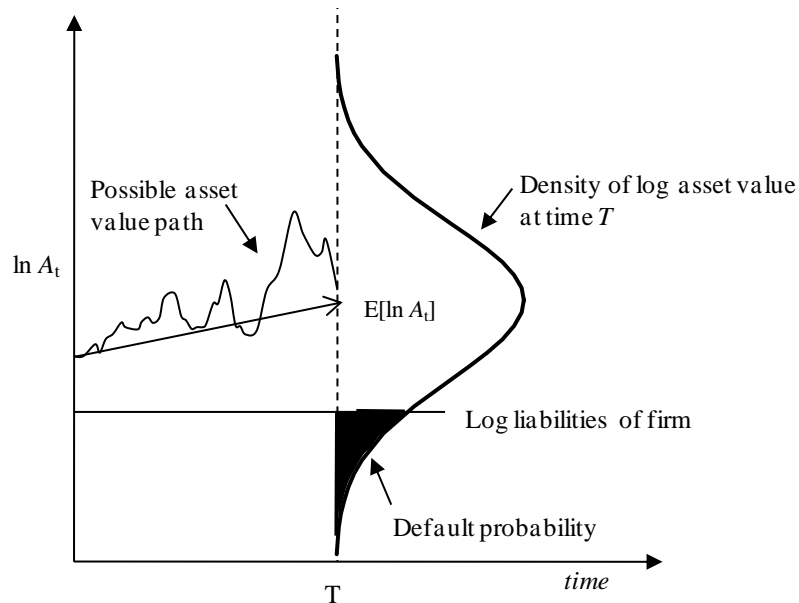
The final result of this series of steps is to produce an estimate of a firm's default probability. Given the assumptions required for the process to work, it should come as no surprise that the resulting estimates can be subject to considerable error. The distribution of a particular firm's assets, for instance, may be more or less likely to

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86.   For a description of this estimation, see *id.* at 28.

87.   *See id.* at 29 (noting that since the market value of assets is unobservable, but the market value of equity is available for publicly traded firms, "option pricing theory can help as it implies a relationship between the unobservable . . . and observable variables").

88.   *Id.* at 29–30.

follow a log-normal distribution. It is also not necessarily the case that a firm only defaults at the maturity of its debt. As a result, other "first passage" models permit default to occur at any time a firm's asset value falls below the value of its liabilities.[89] The fact that many of the assumptions underlying the model may not necessarily hold for particular firms, as well as the fact that so many different structural models exist at all, merely serves to emphasize the considerable uncertainty that surrounds estimation of a firm's probability of default.

Similar challenges plague the other two parameters needed to estimate credit risk: loss given default ("LGD") and default correlation. In the case of LGD, the uncertainty arises largely from our relatively weak empirical understanding of what determines the recovery rate of defaulted obligations. Early credit models generally ignored this issue entirely and assumed a fixed rate.[90] The Basel Committee, for instance, assessed a fixed 45% LGD on loans if they were fully secured by physical, non-real-estate collateral, and 40% if they were secured by receivables.[91] More recently, research has indicated that there appears to be a stochastic component to LGD that may fluctuate with both firm-specific and industry-wide factors.[92] As will be discussed in more detail below, several credit models have therefore resorted to estimating default risk on the assumption of nonstable, random LGDs.

Finally, some of the greatest challenges in credit risk measurement relate to estimating default correlation.[93] In theory, the measurement of default correlation (represented by ρ) should reflect the likelihood that if loan *I* defaults, loan *J* will also default. For instance, if ρ_{IJ} were equal to 1, loans *I* and *J* would always default together, while if it were 0, they would default independently of one another. Unfortunately, measuring such default correlations is made difficult by the low level of defaults among firms in general

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89. *See, e.g.*, TOMASZ R. BIELECKI & MAREK RUTKOWSKI, CREDIT RISK: MODELING, VALUATION AND HEDGING 65–120 (2002) ("The *first-passage-time approach* extends the original Merton model by accounting for the observed feature that the default may occur not only at the debt's maturity, but also prior to this date.").

90. ANTHONY SAUNDERS & LINDA ALLEN, CREDIT RISK MEASUREMENT IN AND OUT OF THE FINANCIAL CRISIS 135 (3d ed. 2010).

91. *Id.* at 135–37.

92. *Id.* at 139.

93. Sobehart & Keenan, *supra* note 80, at 224. For an overview of different approaches to measuring default correlation and related empirical findings, see DE SERVIGNY & RENAULT, *supra* note 23, at 167–212.

(particularly among investment grade firms) as well as the practical challenge of estimating correlation coefficients for even a moderately sized loan portfolio.[94]

Given these challenges, a common approach to modeling default correlations is to rely on the structural approach to default behavior discussed previously.[95] As represented in Figure 2, the structural approach assumes that a firm defaults if its asset value falls below a critical threshold determined by the level of its liabilities. Under this approach, if two firms have a high default correlation, their asset values should accordingly move together through time causing them to both approach their respective default thresholds in a correlated fashion.[96] But what would cause their asset values to move in this correlated fashion? An approach widely used in practice[97] as well as adopted by the Basel Committee's capital adequacy rules[98] is to assume that each firm's asset value is a function of: (a) its relationship to a common, systemic factor Z (e.g., the economy as a whole) and (b) a firm-specific idiosyncratic component ε:[99]

$$A_i = \omega_i Z + \sqrt{1 - \omega_i^2}\, \varepsilon_i \ (1)$$

The extent to which a particular firm's asset value (A_i) is driven by a common, systemic factor versus an idiosyncratic factor is then determined by the parameter ω_i. Thus, much like the familiar Capital Asset Pricing Model, a firm's asset value is assumed to be completely determined by its correlation with a common, system-wide variable (denoted by $Z)$ as well as factors that are unique to the

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94. Even in a simple portfolio with five hundred obligors, for instance, there would be 124, 750 (i.e., 500!/2!(500-2)!) pairs of default correlations.

95. *See* SRICHANDER RAMASWAMY, MANAGING CREDIT RISK IN CORPORATE BOND PORTFOLIOS: A PRACTITIONER'S GUIDE 100–02 (2004) (arguing that the default of an obligor is assumed to occur if the asset returns of the obligor falls below a certain threshold value).

96. *See id.* (stating that since a firm's default is driven by changes in its asset value, the correlation between the asset returns of two obligors can be used to compute the default correlation between them, because "the joint probability of two firms defaulting within a certain time period is simply the likelihood of both firms' asset values falling below their outstanding liabilities").

97. LÖFFLER & POSCH, *supra* note 79, at 104.

98. *See* Paul H. Kupiec, *Financial Stability and Basel II*, 3 ANNALS FIN. 107, 108 (2007) (explaining that the Basel II framework sets minimum regulatory capital requirements using a model which "assumes the default risk is generated by Gaussian uncertainty and includes a single common source of risk and independent risk factors for each credit").

99. For background information regarding the development of this equation, see LÖFFLER & POSCH, *supra* note 79, at 103–05.

individual firm (denoted by ε_i).[100] For these reasons, to the extent the assets of two, three, or more firms are highly correlated, it is assumed to be through their correlation with the common factor *Z*. In short, by estimating ω_i for each firm in a loan portfolio, we can estimate its default correlation with all other firms in the portfolio.

Yet, while such an approach imposes some simplifying structure on the challenge of estimating default correlations among firms, it nonetheless raises the challenge of estimating ω_i for each firm. A standard solution is to estimate a single factor sensitivity for all obligors within a particular class of obligors—for example, all investment grade debtors—for which there is data concerning their historical default patterns. The parameter ω_i can then be estimated on a class-by-class basis for all firms in each class.[101] Given the need for estimating each firm's individual sensitivity to *Z*, the restriction that each firm in a class must share a uniform factor sensitivity is hardly ideal, but empirical research examining the possibility of relaxing this restriction has generally found that imposing it produces substantially more accurate estimates of factor loadings than more flexible approaches.[102]

* * *

In summary, by focusing on four core portfolio parameters— exposure amount, probability of default, loss given default, and default correlation—modern credit risk analysis provides a conceptual foundation for identifying the type of aggregated, nongranular loan information that market participants might use to assess a bank's portfolio risk. At the same time, however, the considerable uncertainty associated with estimating these parameters highlights the analytical challenges any such market-based approach is likely to encounter in assessing individual institutions. Imagining how market participants

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100. As noted previously, a critical assumption of the structural approach is that asset values are log-normally distributed. *See supra* text accompanying note 85. In equation (1), both *Z* (the common factor) and ε (the firm-specific factor) are assumed to be standard normal variables, thereby making A_i a standard normal variable as well. LÖFFLER & POSCH, *supra* note 79, at 104–05.

101. A common technique is to calculate w_i using maximum likelihood estimation. For an illustration, see LÖFFLER & POSCH, *supra* note 79, at 108–14. The method was originally proposed in MICHAEL GORDY & ERIK HEITFIELD, ESTIMATING DEFAULT CORRELATIONS FROM SHORT PANELS OF CREDIT RATING PERFORMANCE DATA 7–9 (2002), *available at* http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.131.8244&rep=rep1&type=pdf.

102. *See* GORDY & HEITFIELD, *supra* note 101, at 9. The primary reason stems from the limited number of years for which there is default data with which to calculate the maximum likelihood estimation. *See id.* at 11.

might nevertheless use information concerning these parameter estimates in light of such challenges is a topic to which we now turn.

IV. CREDIT MODELS, DISCLOSURE, AND THE DETECTION OF RISKY BANKS: TWO CASE STUDIES

Given the foregoing discussion, the considerable opprobrium directed toward those who advocate greater use of credit risk models in banking regulation is hardly surprising.[103] Even before the Financial Crisis, the Basel Committee's decision to allow certain banks to use their internal credit risk models to determine their regulatory capital was met with significant opposition in part because of concerns about uncertainties surrounding quantitative modeling of credit risk.[104] That these same credit risk models were also used for pricing the credit derivatives at the heart of the Financial Crisis only served to accentuate this criticism. Indeed, even within the mainstream media, credit models and their creators have become key culprits in the morality tale that has emerged from the financial collapse.[105]

Notwithstanding the limitations of credit modeling, the fact that virtually all modeling approaches use the same primary parameters makes it an intriguing domain for considering how to facilitate greater market discipline of financial institutions. In particular, by analyzing portfolio credit risk in terms of the four parameters discussed in Part III, credit models provide a common language in the financial industry for analyzing credit risk with only minimal information. For the same reasons, disclosure of these parameter estimates should provide to the marketplace critical new information concerning a bank's investment portfolio (and the risks embedded in it) without the need to disclose proprietary position information. Disclosure of these estimates would also permit market

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103. *See supra* note 26.

104. *See, e.g.*, *New Basil Accord: Hearing Before the Subcomm. on Domestic and Int'l Monetary Policy, Trade, and Tech. of the H. Comm. on Fin. Servs.*, 108th Cong. (2003) (statement of Donald E. Powell, Chairman, FDIC), *available at* http://www.fdic.gov/news/news/speeches /archives/2003/sp27feb03.html ("It is important not to place exclusive reliance on quantitative methods and models. Internal risk estimates are likely to be as robust as the credit culture in which they are produced.").

105. *E.g.*, Editorial, *After the Crash: How Software Models Doomed the Markets*, SCI. AM., Dec. 2008, at 45 ("The causes of this fiasco are multifold . . . but the rocket scientists and geeks also bear their share of the blame."); *see supra* note 26.

participants to examine for themselves the extent to which parameter uncertainty poses a material risk to an institution.

To examine the potential of such a disclosure regime, the following Part analyzes the extent to which basic credit risk modeling was capable of detecting the portfolio risk at the center of two important banking crises in recent history: the collapse of CINB in 1984 and the near collapse of Citigroup in 2008. Although the crises differed significantly, the following Part reveals that the same basic credit risk modeling technique, when combined with modestly improved portfolio disclosures, was capable of revealing each firm's undercapitalization well in advance of its distress. In neither case would the disclosures have required the firms to reveal individual position-level data, suggesting the potential for greater market discipline of financial firms without the need to reveal proprietary trading information.

A. Continental Illinois National Bank and Trust Company

1. Background

Until the failure of Washington Mutual in 2008, the collapse of CINB in 1984 represented the largest bank failure in U.S. history.[106] With over $40 billion in assets at the time of its resolution by the FDIC,[107] CINB stood as the sixth largest bank in the country with a portfolio of loans that was truly national in scope.[108] Moreover, with limited access to retail banking markets and core deposit funding because of state branching restrictions, funding for this portfolio also took on a national flavor as most of its loans were funded through federal funds, negotiable certificates of deposit, and interbank lending.[109] When CINB experienced a significant decline in its loan quality in late 1981, however, its access to these wholesale funding

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106. For a discussion of the CINB rescue, see Itzhak Swary, *Stock Market Reaction to Regulatory Action in the Continental Illinois Crisis*, 59 J. BUS. 451, 454 (1986) ("[T]he $4.5 billion the FDIC provided as part of the Continental rescue represented 26.8% of its funds, a figure larger than the combined total spent on all previous rescues.").

107. *Inquiry into Continental Illinois Corp. and Continental National Bank: Hearings Before the Subcomm. on Fin. Insts. Supervision of the H. Comm. on Banking, Fin. and Urban Affairs*, 98th Cong. 227 (1984) [hereinafter *CINB Hearings*] (app. to statement of C. T. Conover, Comptroller of the Currency), *available at* http://fraser.stlouisfed.org/historicaldocs/678/download /63823/house_cinb1984.pdf.

108. *Id.*

109. *Id.* at 235–36.

sources quickly evaporated, with CINB losing 40% of its domestic funding in 1982.[110] Although it managed to secure additional funding from European wholesale markets, mounting losses in its loan portfolio through 1982 and 1983 eventually caused a crisis of confidence among all of its wholesale lenders.[111] Faced with the prospect of such a significant financial institution failing, the FDIC ultimately arranged a rescue of the bank in May 1984, thus introducing the term "too big to fail" into the modern lexicon.[112]

With the benefit of hindsight, the collapse of CINB is remarkable as much for its speed as for its size. Throughout the late 1970s and early 1980s, bank examiners uniformly provided positive assessments of the bank's loan portfolio and management. In 1980, for instance, the bank's examiners at the OCC conducted a comprehensive review of the bank's loan approval and review process and reported that "the results of these efforts were favorable to the bank and revealed what is considered to be a generally efficient loan process."[113] Moreover, the report emphasized that the bank had continued to decrease the ratio of problem loans to capital from a ratio of 121% in 1976, to 80% in 1979, and finally to 61% in 1980.[114] Although this ratio would increase slightly to 67% the following year,[115] the examiners in 1981 continued to conclude that the overall system of loan origination and management was "functioning well and accurately reporting the more severely rated advances to the Board and senior management."[116]

The overall satisfactory quality of CINB's loan portfolio was also suggested by its financial reports. As shown in Figure 3, from 1976 to 1981, CINB's ratio of annual loan charge-offs to total loans was consistently below that of its peer group, while the bank's loan-

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110. *Id.* at 258–59.

111. *Id.* at 259–60, 273.

112. It was in the 1984 congressional hearings on the FDIC's intervention that the term "too big to fail" was popularized by Congressman Stewart McKinney. *See* WALTER ADAMS & JAMES W. BROCK, THE BIGNESS COMPLEX: INDUSTRY, LABOR, AND GOVERNMENT IN THE AMERICAN ECONOMY 293 (1986) ("We have a new kind of bank. It is called too big to fail, TBTF, and it is a wonderful bank." (quoting Congressman McKinney)).

113. SUBCOMM. ON FIN. INSTS. SUPERVISION, REGULATION AND INS. COMM. ON BANKING, FIN. AND URBAN AFFAIRS, EXAMINATION FINDINGS REGARDING CONTINENTAL ILLINOIS NATIONAL BANK'S LOAN MANAGEMENT AND CAPITAL 8 (1984) [hereinafter CINB LOAN MANAGEMENT REPORT], *available at* http://fraser.stlouisfed.org/historicaldocs/house/download/66197/19840918 _hr_examci.pdf.
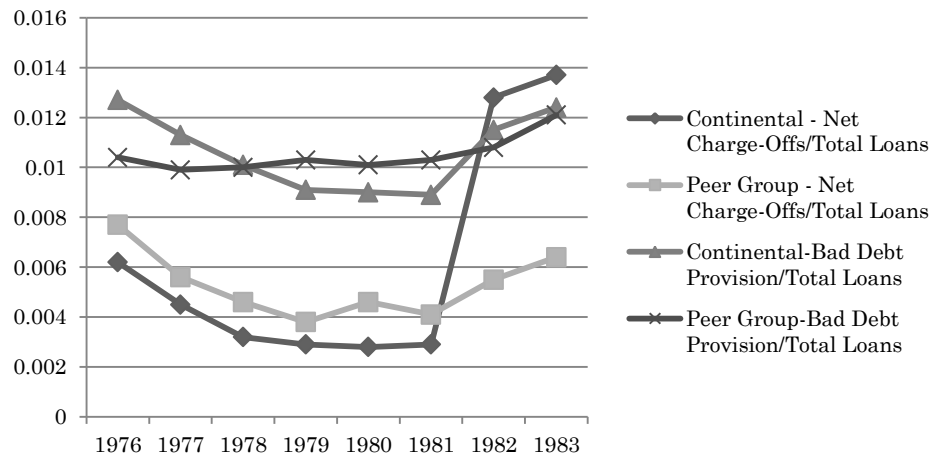
114. *Id.* at 3.

115. *Id.*

116. *Id.* at 9.

loss provisions similarly lagged that of its peers from 1979 to 1981. As Figure 3 indicates, though, the quality of its loans deteriorated dramatically in 1982.

FIGURE 3: CONTINENTAL ILLINOIS LOAN PERFORMANCE AND LOAN-LOSS PROVISIONING VS. PEER GROUP, 1976–1983

Continental - Net Charge-Offs/Total Loans

Peer Group - Net Charge-Offs/Total Loans

Continental-Bad Debt Provision/Total Loans

Peer Group-Bad Debt Provision/Total Loans

What prompted this sudden increase in nonperforming loans? While subsequent investigation of CINB would reveal a fair degree of mismanagement,[117] much of CINB's dramatic change in circumstances stemmed from the bank's rapid expansion in the late 1970s and early 1980s.[118] Beginning in 1976 under the stewardship of its chief executive officer Roger Anderson, CINB embarked on an aggressive expansion of its lending business in an effort to become one of the nation's largest banks.[119] A core component of this growth strategy was expanding the bank's commercial and industrial ("C&I") loan portfolio, which the bank grew from $4.9 billion in 1974 to $14.3 billion in 1981.[120] Within its C&I business, the bank was especially aggressive in extending loans to the energy sector. The 1973 oil embargo produced a significant demand for domestic oil production, and CINB was quick to target oil-producing states such as Texas and

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117. *See id.* at 11–12.

118. *See CINB Hearings*, *supra* note 107, at 231.

119. *See id.* at 230–32.

120. *Id.* at 231.

Oklahoma as key areas for expanding its loan business.[121] Moreover, an informal relationship in Oklahoma with Penn Square National Bank gave it access to a large number of loan syndications that were being sourced through Penn Square's office in Oklahoma City.[122] As a result of these efforts, by 1981, Continental's energy portfolio represented 20% of its total loans and 47% of its total C&I loans.[123]

When an excess worldwide supply of crude oil drove the energy sector into a recession in late 1981, this heavy concentration in energy loans naturally produced a significant stress in CINB's loan portfolio. While CINB experienced losses throughout its portfolio, its concentration of energy loans was at the heart of the bank's misfortunes.[124] From June 1982 through June 1983, energy-related loans would represent 67% of CINB's total loan losses, with 41% of these losses stemming from loans purchased from Penn Square.[125]

2. Modeling CINB's Portfolio Risk

Given the concentrated nature of CINB's credit losses, subsequent analyses of the bank's failure were quick to note the risk inherent in its aggressive expansion plan. For instance, a congressional investigative report noted in 1984 that the "lending and management practices that Continental had to adopt in order to reach its corporate goals . . . made it particularly vulnerable to the effects of the recession."[126] Similar allegations of reckless portfolio management would also be made twenty-five years later when large numbers of commercial banks collapsed under the weight of their concentrated portfolios of real estate loans.[127]

Yet, while such conclusions were undoubtedly accurate ex post, the harder issue raised by the failure of banks with concentrated loan portfolios is understanding how market participants might better

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121. *Id.* at 233.

122. *See id.* at 250. Loan purchases from Penn Square were especially pronounced from 1980 to 1982. *See id.* at 250–51. As of the end of 1980, for instance, CINB had purchased over $167 million of energy loans from Penn Square. *Id.* at 250. By 1981, this amount would increase to $500 million, with another $600 million being purchased by 1982. *Id.* at 250–51. At its peak, CINB would hold $1.1 billion of loans originated through Penn Square, representing 17% of CINB's total oil and gas loan portfolio. *Id.* at 251.

123. *Id.* at 245.

124. *Id.* at 263–64.

125. *Id.* at 264–65.

126. CINB LOAN MANAGEMENT REPORT, *supra* note 113, at 4.

127. *See infra* note 165 (discussing material loss reviews conducted in 2009 and 2010).

understand ex ante—and therefore price—the risks that a particular portfolio of loans poses to a bank's solvency. Even where a bank discloses that its loan portfolio might have one or more concentrations,[128] not all loan concentrations necessarily lead to banking failures. After all, some banks may simply have expertise in making loans of a particular type or in a particular region and managing their associated risks. How can market participants identify those banks that build concentrated loan portfolios without managing their attendant risks?

The CINB experience suggests that combining basic credit risk modeling techniques with moderately improved portfolio disclosures may very well provide an answer. Like most banks today, CINB's periodic Call Reports provided the total dollar value for the bank's loan portfolio and the aggregate dollar value of all C&I loans, but these public disclosures otherwise provided few details concerning the structure of its loan portfolio.[129] In contrast, by providing a glimpse inside this portfolio, a congressional investigation of the bank's failure in 1984 permits the construction of a hypothetical portfolio model that illustrates the significant risk a portfolio such as CINB's could pose. Notably, the exercise requires surprisingly little proprietary information about CINB's actual loan holdings.

In particular, two simple facts revealed during the congressional investigation—that the average exposure amount for a C&I loan at CINB was approximately $6 million and that its C&I portfolio had a 50% exposure to the energy sector[130]—are all the additional information needed to begin building a hypothetical portfolio model of the bank's C&I loan portfolio at the height of its expansion in 1981. Indeed, because banks are likely to have idiosyncratic differences in their loan sizes and industry

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128. For instance, SFAS-107 requires a financial institution to disclose "significant concentrations of credit risk . . . whether from an individual counterparty or groups of counterparties." *See* DISCLOSURES ABOUT FAIR VALUE OF FINANCIAL INSTRUMENTS, Statement of Fin. Accounting Standards No. 107, ¶ 15A (Fin. Accounting Standards Bd. 1991), *available at* http://www.fasb.org/pdf/aop_FAS107.pdf. Whether or not a significant concentration risk exists is to be determined in the bank's judgment. *See* TERMS OF LOAN PRODUCTS THAT MAY GIVE RISE TO A CONCENTRATION OF CREDIT RISK, Staff Position Statement No. SOP 94-6-1 (Fin. Accounting Standards Bd. 2005), *available at* http://www.fasb.org/pdf/fsp_sop94-6-1.pdf.

129. *See* Boro, *supra* note 37, at 446–48 (describing paucity of disclosures concerning a bank's loan book through the mid-1980s).

130. *See supra* text accompanying note 123 (noting proportion of energy loans in the C&I portfolio). The estimate for the average exposure amount was derived from the Comptroller's statement that 375 loans, totaling $2.4 billion, had not been reviewed by CINB's rating committee within one year. *CINB Hearings*, *supra* note 107, at 248.

concentrations, information concerning these two portfolio characteristics is perhaps the most critical information that is not publicly disclosed by banks but that is necessary to build a credit risk model. As shown below, estimates of the other parameters of interest, in contrast, can often be made using a bank's aggregate portfolio disclosures along with the significant amount of empirical research on credit risk.

Consider, for instance, how an analyst today might evaluate a bank like CINB knowing only that it has a $14.3 billion portfolio of C&I loans having a 50% exposure to the energy sector and an average exposure amount of $6 million. In the absence of the bank's disclosure of the other parameters needed to model the portfolio, analysis of the portfolio might begin by simply estimating each loan's *probability of default* and *loss given default* by using one of several studies examining historical one-year default rates and recovery rates among credits of differing investment grades and industries. For example, research by Astrid Van Landschoot and Norbert Jobst suggests a one-year default rate among energy-related corporate debtors of approximately 1.7%,[131] while data from Standard & Poor's indicates that bank debt has historically shown an average loss given default of 22.5%.[132] Given CINB's relatively low loan-loss rate through 1981,[133] the model below assumes for simplicity a slightly lower annual default rate of 1.0%. Likewise, an estimate of the loans' correlation structure can also be taken from the large literature examining asset correlations.[134] For instance, using corporate loan data, Fitch Ratings estimated an asset correlation for corporate credits of 5.15%, yielding a ω_i for equation (1) of 22.7%.[135] Lastly, given that the C&I portfolio totaled $14.3 billion, an average exposure amount of $6 million would suggest a portfolio of 2,383 loans. Table 1 summarizes these estimates. To be sure, using such basic estimates oversimplifies the

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131. Astrid Van Landschoot & Norbert Jobst, *Rating Migration and Asset Correlation: Structured Versus Corporate Portfolios*, *in* THE HANDBOOK OF STRUCTURED FINANCE 217, 235 (Arnaud de Servigny & Norbert Jobst eds., 2007).

132. *See* STANDARD & POOR'S, ANNUAL 2005 GLOBAL CORPORATE DEFAULT STUDY AND RATING TRANSITIONS 26 tbl.17 (2006) (showing recovery rate of 77.5% for bank debt).

133. *See supra* fig.3.

134. For an overview of this literature, see Peter Grundke, *Regulatory Treatment of the Double Default Effect Under the New Basel Accord: How Conservative Is It?*, 2 REV. MANAGERIAL SCI. 37, 46–50 (2007) (summarizing the findings of twenty studies).

135. FITCH RATINGS, BASEL II CORRELATION VALUES: AN EMPIRICAL ANALYSIS OF EL, UL AND THE IRB MODEL 9 (2008), *available at* http://www.securitization.net/pdf/Fitch/BaselII_19May08.pdf. w_i represents the square root of asset correlation. *See* HULL, *supra* note 17, at 217.

structure of the portfolio (e.g., Table 1 ignores the possible existence of name concentration), but they nevertheless provide a starting point for our analyst's examination of the portfolio's credit risk. Equally important for our purposes, starting with such basic estimates also provides a benchmark for examining how disclosing incrementally more information concerning the portfolio's structure can affect an analyst's portfolio model.

TABLE 1: PARAMETER ESTIMATES FOR A HYPOTHETICAL C&I PORTFOLIO

Parameter	*Estimate*
Average Exposure:	$6 million
Probability of Default:	1.0%
Loss Given Default:	22.5%
Factor Correlation:	22.7%
Total Loans:	2,383

Following the estimation of the loan portfolio, the analysis of its credit risk can then proceed by using a standard Monte Carlo procedure. In general, the fact that each loan in a portfolio is assumed to default based on a combination of its own idiosyncratic risk as well as its correlation with a random, systemic factor Z makes it extremely challenging to evaluate analytically a portfolio's probable performance. A Monte Carlo procedure facilitates this analysis through use of a computational algorithm that relies on repeated sampling of random variables to simulate the performance of a loan portfolio several thousand times. By creating a dataset of thousands of hypothetical one-year portfolio values, the procedure provides information regarding the range of credit losses that can be expected from a particular portfolio as well as the frequency with which these losses occurred in the simulations. As such, it can provide critical insight into the extent to which a bank is adequately capitalized to absorb potential losses.

For purposes of the present study, the Monte Carlo procedure used was based on a Visual Basic algorithm written in Microsoft Excel that simulated the structural model of default discussed previously.[136]

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136. The basic framework for the VBA program was inspired by the simulation code used in LÖFFLER & POSCH, *supra* note 79, at 135–37. The VBA code is available from the author upon request.

In particular, for each simulation, the asset value of each of the 2,383 borrowers as of the end of 1982 was determined based on equation (1) following: (a) a random draw of a standard normal variable for each borrower (the idiosyncratic component, ε_i) and (b) a random draw of a standard normal variable that applied to all borrowers (the systemic component, Z).[137] After applying equation (1), those borrowers whose asset values fell below their default threshold (based on a probability of default of 1.0%) were deemed to have defaulted.[138] From Table 1, defaulted loans were then assumed to suffer an average loss in value of 22.5%. To capture the significant variance in empirical recovery rates, the exact loss for each default was based on a second algorithm in which the recovery rate was randomly drawn from a beta distribution.[139] Finally, each simulation summed these losses across all 2,383 loans to obtain an estimate of the total losses that might be expected over one year in CINB's C&I loan portfolio.

By repeating the simulation 100,000 times, this basic model generated the distribution of portfolio losses summarized in Table 2 (Simulation 1).

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137. Given the assumption that Z and ε_i are standard normal variables, each firm's asset value will also be standard normal by construction. The assumption that both factors represent standard normal variables (and that A_i is therefore standard normal) is consistent with the structural model discussed previously and is widely used in credit risk management. *See id.* at 104–05. In recent years, however, models increasingly use the multivariate Student *t*-distribution, which provides greater tail correlation than a normal distribution. *See id.* at 138; HULL, *supra* note 17, at 214–15. The assumption of normality is relaxed below.

138. Because each firm's asset value is standard normal, its default threshold can be calculated using the inverse of the standard normal cumulative distribution, in this case $\Phi^{-1}(.01)$ or -2.33.

139. Empirical studies of debt recovery rates have revealed significant variation within different asset classes. For instance, while bank loans have a mean 22.5% loss given default ("LGD"), they have a 30.9% standard deviation, suggesting substantial variation. LÖFFLER & POSCH, *supra* note 79, at 140 tbl.6.5. To model this variation, a standard approach is to assume that LGDs follow some parametric distribution, with the parameters calibrated to observed data. *Id.* at 140. For purposes of the Monte Carlo procedure used here, LGD was determined using a random draw from the commonly used beta distribution whose shape parameters were based on a mean and variance of the LGDs for bank loans (i.e., .225 and $.309^2$, respectively). For a discussion of this methodology, see *id.*

TABLE 2: PORTFOLIO LOSS BY DECILE AFTER 100,000 SIMULATIONS

Decile	Portfolio Loss (in millions)	No. of Loan Defaults	Z Realization
10%	$7.67	9	0.97
20%	$12.66	9	1.21
30%	$17.12	16	0.66
40%	$21.62	24	(0.39)
50%	$26.36	22	(0.64)
60%	$31.70	20	(0.27)
70%	$39.21	28	(0.53)
80%	$47.28	41	(1.47)
90%	$62.02	30	(0.30)

As the table indicates, fewer than thirty loans defaulted in the vast majority of the simulations, leading to relatively low portfolio losses. Moreover, even for 90% of the simulations, there were fewer than fifty defaults, producing at most an aggregate portfolio loss of just $62.02 million.

Yet while Table 2 appears to suggest a fairly low level of credit risk for the portfolio, it provides a potentially misleading depiction for several reasons. First, dividing the simulator results into deciles provides little information about the extent to which the modeled portfolio might suffer losses under extreme stress. In the simulation above, for instance, Table 2 indicates that in 90% of the simulations, the portfolio suffered no greater than a $62 million loss, but it says nothing about how much the portfolio lost in the remaining 10% of the simulations. Assessment of such "tail risk" is especially important where a portfolio consists of credits with a low default probability and some degree of default correlation. In such situations, loans will both survive together and default together, raising the possibility that portfolio losses will increase dramatically in the tail of the distribution as multiple loans default at once.

For this reason, a standard approach to analyzing Monte Carlo simulations is to examine portfolio losses through the 99.9th percentile of the loss distribution (or the 99.9% confidence interval).[140] Even here, an alternative risk measure is frequently used to examine tail risk beyond this measure. Generally called "expected shortfall" or "conditional value at risk," this latter risk measure provides a

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140. *See* HULL, *supra* note 17, at 321–22.

summary of the expected loss in a simulated portfolio beyond a particular loss percentile.[141] For instance, expected shortfall at 99.9% confidence would provide the average loss generated by the simulator in the worst 0.1% of the simulations.

Using these alternative risk measures, analysis of Simulation 1 reveals that portfolio losses could in fact be far greater than $62 million. In particular, examination of the 99.0th through 99.9th percentile of the simulated results reveals some evidence of default clustering, summarized in Table 3.

TABLE 3: PORTFOLIO LOSS DISTRIBUTION FROM 99.0% TO 99.9% CONFIDENCE AFTER 100,000 SIMULATIONS

Percentile	Portfolio Loss (in millions)	No. of Loan Defaults	Z Realization
99.0%	$111.37	79	(2.10)
99.1%	$113.01	82	(2.44)
99.2%	$115.91	82	(2.25)
99.3%	$117.74	74	(2.24)
99.4%	$121.66	77	(1.99)
99.5%	$124.44	92	(2.71)
99.6%	$131.41	100	(2.53)
99.7%	$134.86	87	(2.36)
99.8%	$141.93	92	(2.62)
99.9%	$160.76	111	(2.89)

Not surprisingly, losses beyond 99.9% confidence were even more severe, with expected shortfall at 99.9% confidence reaching $181 million.

Yet even with this adjustment, our hypothetical analyst could still improve her analysis of the portfolio's risk in several ways. For one, the foregoing analysis made a common assumption that each borrower's asset values are normally distributed, with default correlations being modeled through a normal or Gaussian copula. As a number of commentators have suggested, this distributional assumption may fail to capture the fact that a firm's asset value might exhibit more extreme movements than suggested in a normal distribution, causing the Gaussian copula to underestimate the degree

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141. *See* DE SERVIGNY & RENAULT, *supra* note 23, at 241–42.

of default dependence between loans in a portfolio.[142] To the extent this is the case, using an alternative distributional assumption having "thicker tails" would provide a more conservative means to assess joint default behavior.[143] A popular candidate in this regard is the Student t-distribution with minimal degrees of freedom.[144]

Additionally, as noted above, relying on existing empirical research to estimate so many portfolio parameters obviously runs the risk of misrepresenting the portfolio's true structure, as does assuming all loans are identical in their four parameter estimates. To the extent one can obtain additional details regarding the loan portfolio, the portfolio analysis should therefore be all the more accurate. In the present case, the congressional investigation into CINB's collapse provided at least two additional facts that illustrate the incremental benefits of receiving additional, general information about a loan portfolio's structure.

First, as noted previously, the CINB investigation indicated that nearly half of its C&I portfolio consisted of loans made to borrowers in the U.S. energy sector. Given that the economic fortunes of these borrowers would likely rise and fall together, this additional fact suggests that the single-factor model used above might ignore an important correlation structure within the portfolio. In light of this additional information, the model would ideally permit the ability to use both the systemic factor Z_1 as well as an additional industry-specific factor Z_2 to account for the portfolio's industry concentration.[145]

Second, testimony provided by the Comptroller of the Currency indicated that the assumption of homogenous exposure amounts was also inappropriate. In particular, the Comptroller discussed two nonperforming oil and gas loans having an aggregate balance of $85 million,[146] suggesting certain C&I loans might well exceed $6 million in exposure amount. Reports concerning CINB's exposure to several prominent bankruptcies during the early 1980s confirm the likelihood of several large exposures. For instance, its loans to bankrupt companies included a $200 million loan to American Harvester, a $200 million loan to Dome Petroleum, a $173 million loan to NuCorp Energy, and a $100 million loan to the Mexican Grupo Industrial

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142. *See supra* note 137.

143. *See* HULL, *supra* note17, at 214–15.

144. *See id.*

145. *See* LÖFFLER & POSCH, *supra* note 79, at 137–38 (discussing multifactor models).

146. *CINB Hearings*, *supra* note 107, at 247.

Alfa.[147] Additional reports of CINB's C&I loans also suggest that several were substantially lower than $6 million.[148] While modeling CINB's portfolio risk need not include such specific loan-level information, the model should at a minimum incorporate the fact that CINB's portfolio included some degree of name concentration.

To accommodate the foregoing concerns, a number of adjustments to the original simulation model were therefore made. First, to accommodate concerns about non-normality of asset returns, the original simulation was rerun with the exception that Z and ε_i were each drawn from a Student t-distribution with three degrees of freedom rather than a standard normal distribution, producing a multivariate Student t-distribution for A_i (Simulation 2).[149] Because a Student t-distribution with minimal degrees of freedom is characterized by so-called "fat tails," using this alternative distribution provides a more conservative estimate of how often a random variable (such as the state of the economy or an individual borrower) experiences a negative event.[150]

Next, to address the significant concentration of loans within the energy sector, Simulation 2 was further modified in Simulation 3 so that the asset value of each obligor was determined using the following two-factor model, rather than the single-factor model set forth in equation (1):[151]

$$A_i = \sum_{k=1}^{2} \omega_{ik} Z_k + \sqrt{1 - \left(\sum_{k=1}^{2} \omega_{ik}^2\right)}\ \varepsilon_i \ (2)$$

In this modified equation, the one-year asset value for each obligor was a function of both its own idiosyncratic factor (ε_i) as well as: (a) its correlation with a single systemic factor affecting all obligors (now denoted Z_1) and (b) an additional industry-specific factor affecting obligors in the energy sector (Z_2). As with Simulation 2, each

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147. *See* 2 INTERNATIONAL DIRECTORY OF COMPANY HISTORIES 262 (Lisa Mirabile ed., 1990).

148. *See, e.g.*, MARK SINGER, FUNNY MONEY 65 (1985) (describing three loan participations purchased by CINB of $1 million and $1.5 million).

149. A Student t-distribution with minimal degrees of freedom is often used in portfolio models to produce greater dependencies among asset values. *See* HULL, *supra* note 17, at 214–15; LÖFFLER & POSCH, *supra* note 79, at 138–39.

150. The means to implement this change to the model is described more fully in LÖFFLER & POSCH, *supra* note 79, at 138–39. In effect, the procedure models the default correlation of loans within a portfolio through a Student t copula function rather than the much-criticized Gaussian copula. *Id.*

151. *See* HULL, *supra* note 17, at 210 (discussing multifactor models); LÖFFLER & POSCH, *supra* note 79, at 137–38 (same).

factor was assumed to represent a random variable that was *t*-distributed with three degrees of freedom. Similarly, empirical research on asset correlations was once again used to estimate the relevant correlation parameters (i.e., ω_{i1} and ω_{i2}) for each factor. For instance, using a similar two-factor model to measure asset correlations among different industries, Van Landschoot and Jobst found energy firms to have a correlation with the general market of 6.3% and an intra-industry correlation of 14.7%.[152] Given that approximately half of CINB's loans were in the energy sector, Simulation 3 therefore assumed that one-half of the loans had a 14.7% correlation with Z_2 and a 6.3% correlation with Z_1. The other half of the loans, in contrast, were assumed to have solely a 6.3% correlation with Z_1. For simplicity, Simulation 3 also assumed that the factors Z_1 and Z_2 were independent from one another.[153]

Finally, to address heterogeneity in loan size, adjustments were then made to Simulation 3 to reflect the existence of both large and small loans in CINB's portfolio. Specifically, in light of the anecdotal evidence discussed previously, this last simulation (Simulation 4) assumed that the portfolio included twenty loans at $200 million, twenty loans at $100 million, and twenty loans at $50 million. To ensure an average loan exposure of $6 million, it also assumed that the remainder of the portfolio consisted of 2,317 loans at $3.15 million. Because of the proportion of energy-related loans in the portfolio, half of the loans in each size category were deemed energy loans. While the absence of more specific data on the distribution of CINB's loan sizes is less than ideal, using these estimates nonetheless provides an opportunity to examine how knowledge about loan size within a portfolio can affect a portfolio model's analysis.

Figure 4 illustrates the consequence of each of these modifications on the tail distribution of the hypothetical C&I loan portfolio.[154] The top, relatively flat line represents the tail distribution of the original credit model in Simulation 1. As set forth in Table 3, estimated portfolio losses in the 99th to 99.9th percentile of Simulation 1 ranged from $111 million to $161 million. Moving from top to bottom in Figure 4, the second line represents the tail distribution of Simulation 2, which assumed that borrowers' asset

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152. *See* Van Landschoot & Jobst, *supra* note 131, at 234.

153. *See id.*

154. As before, each version of the modified model was simulated one hundred thousand times.

values followed a fat-tailed Student *t*-distribution rather than the common practice of assuming normally distributed asset values. As the figure illustrates, modifying this assumption had a dramatic effect on the estimated tail losses for the portfolio: at 99.0% to 99.9% confidence, losses now ranged from approximately $600 million to almost $1.2 billion. As one might have predicted, estimated losses also increased upon accounting for the portfolio's industry- and name-concentration. The third line, for instance, indicates that accounting for the portfolio's energy concentration in Simulation 3 increased estimated losses at 99.9% confidence by an additional $200 million to $1.4 billion, while accounting for name concentration in Simulation 4 increased them further still. In particular, adding an element of name concentration to the portfolio increased expected losses at 99.9% confidence to almost $1.5 billion. Expected shortfall at 99.9% confidence for each modification similarly showed a uniform increase from $160 million in Simulation 1 to $1.3 billion, $1.5 billion, and $1.6 billion in Simulations 2, 3, and 4, respectively.

FIGURE 4: DISTRIBUTION OF PORTFOLIO LOSSES USING FOUR ALTERNATIVE SIMULATIONS
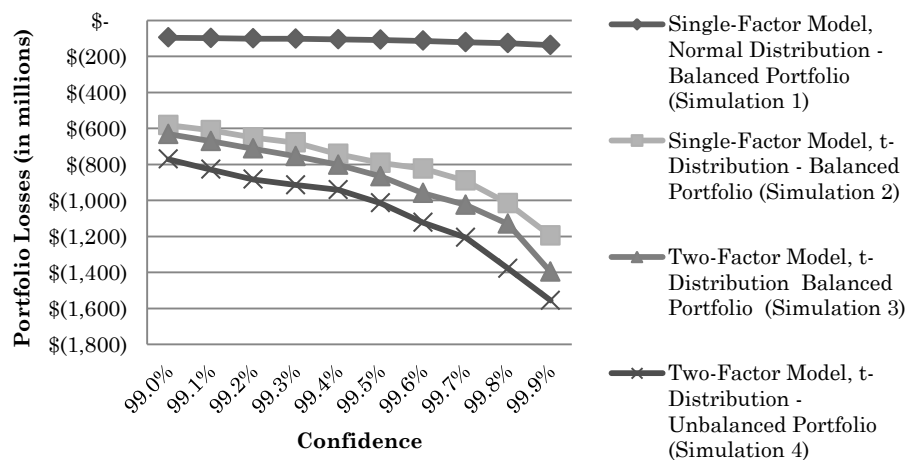
3. Model Assessment

To be sure, given the large number of assumptions used in the foregoing modeling exercise, these loss figures can at best be understood as "back-of-the-envelope" estimates of how a loan portfolio such as CINB's might perform under conditions of stress. At the same

time, they nevertheless reveal a number of important attributes about the risk of the portfolio. For one, the simulations help reveal the consequence of loan concentrations: if and when severe adverse conditions struck CINB's portfolio, losses would not be gradual but shockingly fast.

In addition, these rough estimates might also be useful for market participants to better understand a financial institution's capital adequacy. A central conclusion of the OCC examiner report following the collapse of CINB was that its high loan growth was not supported by adequate loan management or capital levels to account for the possibility of loan defaults.[155] Nor was this inadequacy detected by the OCC in its earlier examinations.[156] While the type of modeling used previously was not typically conducted at the time of CINB's collapse, it is easy to imagine how a similar failure of capital management and regulatory oversight might be more difficult today if market participants had access to the information used to undertake the foregoing simulations. For instance, an analyst performing the exercise undertaken in the prior Section might find it surprising that a bank whose C&I portfolio had a potential 99.9% credit VaR of $1.5 billion held only $1.8 billion of capital for its entire loan portfolio, as was the case with CINB in the spring of 1981.[157] This would be especially true if, as was the case with CINB, its C&I loans represented just 44% of the bank's total loans.[158]

For similar reasons, this type of credit modeling could also help illuminate how the portfolio would perform under severely stressed conditions or if certain risks were otherwise underestimated. Imagine, for instance, that the parameter estimates used previously had actually been disclosed by our hypothetical bank. With this information in hand, the foregoing modeling technique provides a ready means by which market participants can stress test the

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155. CINB LOAN MANAGEMENT REPORT, *supra* note 113, at 6 (noting that CINB's "reduced capital position made it difficult to absorb the losses associated with both greater lending and a deteriorating loan management system").

156. The house subcommittee report on the OCC's examinations of CINB was especially critical of the OCC on this front. *See, e.g.*, *id*. at 15 ("For the examiners to continue to refrain from outright criticism of CINB's capital position for so many years is difficult to understand.").

157. *Id*. at 18.

158. Total loans held by CINB at the end of 1981 stood at approximately $33 billion. *See* SUBCOMM. ON FIN. INSTS. SUPERVISION, REGULATION AND INS., COMM. ON BANKING, FIN., AND URBAN AFFAIRS, THE FINANCIAL PERFORMANCE OF CONTINENTAL ILLINOIS NATIONAL BANK: A CHRONOLOGY AND PEER GROUP COMPARISON 9 (1984), *available at* http://fraser.stlouisfed .org/historicaldocs/678/download/66199/19840917_hr_finperfci.pdf.

portfolio. Indeed, in the case of both default probabilities and LGD, a significant amount of empirical evidence indicates that both tend to increase during economic downturns, suggesting the need to revisit our assumption that we have correctly estimated these parameters using historical data.[159]

Figure 5, for instance, illustrates the consequence on the C&I loan portfolio used previously if we stress both the default probability and LGD. The first, highest line represents the (unstressed) results of Simulation 4 reported previously in Figure 4. The second highest line shows the results of rerunning Simulation 4 but increasing the default probability from 1.0% (approximately the average default rate for BB rated bonds)[160] to 1.9% (approximately a one standard deviation increase in the BB default rate).[161] As Figure 5 reveals, doing so increased 99.9% credit VaR by over $200 million to approximately $1.75 billion. In the case of LGD, the fact that the portfolio had a significant energy concentration would suggest the need for an even greater stress given evidence that recovery rates for energy-related loans decline in adverse market conditions.[162] For purposes of the stress, Simulation 4 was therefore rerun, setting LGD equal to the average LGD and variance for senior unsecured bonds.[163] The third line indicates that modifying Simulation 4 in this manner had an especially dramatic consequence on potential loan losses, increasing the 99.9% VaR estimate to $3.5 billion. And if both modifications were made to Simulation 4, the consequences were even more dire still, with the loss estimate at 99.9% confidence rising to over $4 billion. To the extent the unstressed model above caused our hypothetical analyst concern, these stressed versions would presumably be all the

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159. *See, e.g.*, Fabien Couderc et al., *Business and Financial Indicators: What Are the Determinants of Default Probability Changes?*, *in* CREDIT RISK: MODELS, DERIVATIVES, AND MANAGEMENT 235, 247–54 (Niklas Wagner ed. 2008) (showing that default probability changes are the joint effects of past and subsequent economic trends); Viral Acharya et al., Understanding the Recovery Rates on Defaulted Securities 19–25 (Sept. 2003), *available at* http://finance.wharton.upenn.edu/department/Seminar/2003Fall/Micro/acharya-micro111303.pdf (finding that industry conditions at the time of default are important determinants of recovery rates).

160. *See* STANDARD & POOR'S, *supra* note 132, at 17 tbl.12, 18 tbl.14.

161. *See id.*

162. *See* Acharya et al., *supra* note 159, at 23 (finding that borrowers across a number of industries (including energy) experience a significant drop in their debt recoveries when the borrowers' industry is in distress relative to the industry's nondistress setting).

163. According to S&P, senior unsecured bonds had an average recovery rate of 42.6% and a standard deviation of 34.8%. *See* STANDARD & POOR'S, *supra* note 132, at 26 tbl.17.

more reason for her to question whether $1.8 billion was sufficient capital for the bank to survive a stressed environment.

FIGURE 5: DISTRIBUTION OF PORTFOLIO LOSSES UNDER STRESSED CONDITIONS
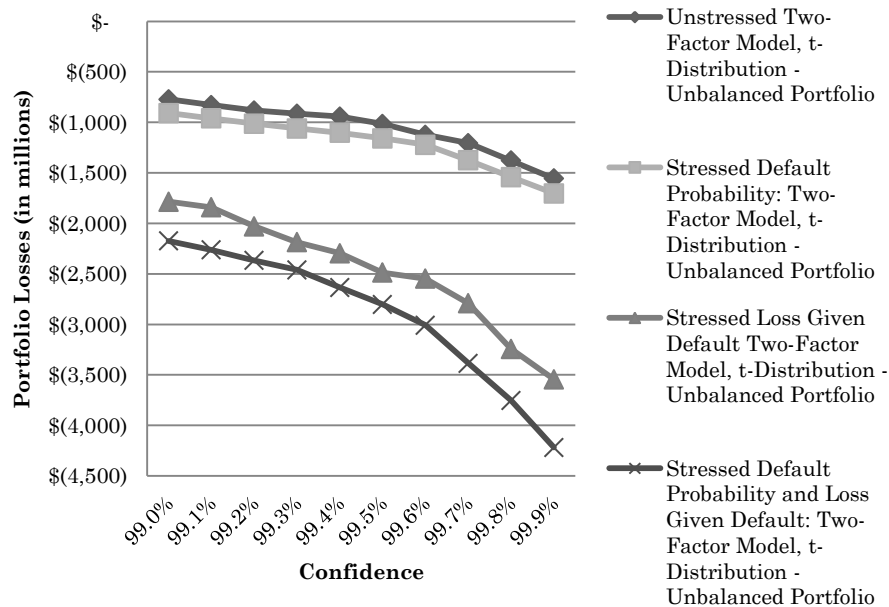
Thus, while estimating the credit risk of a loan portfolio can be done with considerably more accuracy, even the basic modeling technique used here can provide a starting point for assessing a loan portfolio's overall risk. Moreover, the fact that it was done with such a limited amount of information confirms the possibility that leveraging credit modeling technology may indeed be a means to facilitate portfolio analysis while averting the disclosure of proprietary position data. Yet, while this conclusion appears appropriate for analyzing a traditional loan portfolio like CINB's, it remains to be seen whether such a disclosure regime can be effective in the more complex world of finance revealed by the Financial Crisis. It is to that more challenging issue that we now turn.

B. Citigroup

1. Background

As is well known, the Financial Crisis of 2008 represents one of the most significant economic crises since the Great Depression. It also represents one of the most complex given that so many different types of institutions were ensnared by the panic that spread throughout the financial system for most of 2008 and 2009. In many ways, the situation resembled a straightforward banking crisis having a number of similarities with the failure of CINB. From January 2008 through December 2009, data from the FDIC reveal that 165 U.S. banks failed,[164] representing one of the most significant periods of bank closures in U.S. history. Moreover, the story that routinely emerges from the postmortem reports of these institutions is remarkably familiar in light of CINB's experience: significant losses produced by concentrated real estate portfolios induced wholesale lenders to flee for better capitalized institutions.[165] These similarities with CINB's collapse underscore the continuing importance of the basic credit portfolio analysis illustrated previously.

Yet, while commercial bank failures no doubt contributed to market instability, they were in many ways a sideshow to the main attraction of the financial turmoil of 2008: the teetering of some of the world's largest financial institutions. Like the banking failures, the source of these institutions' instability also arose from the credit risk embedded in their real estate investments, but the manifestation of these losses proved considerably more complex—and ultimately, more significant—than the simple default risk that has traditionally bedeviled banks' loan portfolios. In particular, the credit risk that

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164. *See Failed Bank List*, FDIC, http://www.fdic.gov/bank/individual/failed/banklist.html (last visited Jan. 27, 2012).

165. From January 2009 through September 2010, the FDIC Office of the Inspector General published seventy-one Material Loss Reviews ("MLRs") analyzing instances where the FDIC incurred a material loss (defined as a loss greater than $25 million) due to a bank closure. *Material Loss and In-Depth Reviews*, OFFICE OF INSPECTOR GEN., FED. DEPOSIT INS. CORP., http://www.fdicoig.gov/mlr.shtml. In sixty-six of the MLRs (93%), the Inspector General attributed a bank's failure to its heavy concentration of either commercial real estate ("CRE") or residential acquisition, development, and construction ("ADC") lending. Fifty-one of the MLRs additionally faulted a bank for relying on "volatile," noncore funding sources such as brokered deposits. *See also* Sarah Woo, *Micro-Prudence, Macro-Risk: Where Financial Regulation Meets Bankruptcy* 9 (Oct. 22, 2010) (unpublished manuscript), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1639606 ("[C]onstruction and development loans constitute by far one of the most significant drivers of commercial bank failures.").

proved toxic to firms ranging from Bear Stearns to AIG to Citigroup came in the form of structured credit exposures that were perceived to be considerably less risky than the real estate loans that were defaulting in large numbers in the portfolios of commercial banks.[166]

Exposure to bonds issued by CDOs backed by residential mortgages proved especially problematic for these firms.[167] Through securitization, an investment bank could form a CDO to acquire a portfolio of loans from one or more loan originators, the funds for which would be raised through the CDO's issuance of multiple tranches of notes to institutional investors. Moreover, because the basic building blocks of a CDO consisted of contractually allocating interest and principal payments to the various tranches, any type of credit instrument could be acquired. This led to the development of CDOs built with not only commercial and residential mortgages, but even other CDOs and synthetic credit instruments using credit default swaps. Between 2003 and 2007, nearly $700 billion of CDOs were created, most holding some percentage of mortgage-backed securities as collateral.[168]

For banks underwriting the issuance of a CDO, the method by which its notes were structured often resulted in the underwriting bank retaining a significant portion of the CDO's most senior notes. In general, the basic structure of a CDO was to allocate expected credit losses from the underlying portfolio to the more junior CDO notes (for which their holders would be paid a correspondingly higher rate of return).[169] Moreover, as the foregoing discussion of credit risk might suggest, expected losses for a standard portfolio of loans in a CDO would generally represent just a fraction of the total portfolio's value. The consequence was that for the most senior tranche of CDO notes, the attachment point in the CDO structure—or the percentage of the portfolio that had to be wiped out before the senior notes suffered any loss—could be quite low. Indeed, anywhere from 70% to 90% of a CDO's capital structure was often deemed by credit rating agencies to be safer than even AAA-rated corporate debt,[170] causing the most

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166. *See infra* text accompanying note 241.

167. *See* FIN. CRISIS INQUIRY COMM'N, THE FINANCIAL CRISIS INQUIRY REPORT 129 (2011) [hereinafter FCIC REPORT], *available at* http://www.gpo.gov/fdsys/pkg/GPO-FCIC/pdf/GPO-FCIC.pdf ("In the end, CDOs turned out to be some of the most ill-fated assets in the financial crisis.").

168. *Id.*

169. *See* HULL, *supra* note 17, at 337–38.

170. *See id.* at 339.

senior CDO notes to generally be dubbed the "super senior" tranche. At the same time, the fact that a CDO could have more than a billion dollars of underlying loans left the underwriting bank with the challenge of finding a market for these large, low-yielding notes.

In the end, many banks simply retained the super senior tranches on their balance sheets,[171] occasionally obtaining insurance on any potential losses from insurers such as AIG or monoline insurance companies.[172] While the notional amounts of these positions were large, it was an article of faith among firms exposed to super senior notes that they posed extremely low default risk. For instance, as late as December 2007, Martin Sullivan, AIG's chief executive officer, confirmed the firm's large exposure to super senior CDO tranches but stressed the low credit risk they posed: "Because this business is carefully underwritten and structured with very high attachment points to the multiples of expected losses, we believe the probability that it will sustain an economic loss is close to zero."[173]

The problem with this perspective, however, was that it ignored the different ways in which credit risk can affect a financial institution. So far, the discussion of credit risk has largely proceeded on the assumption that the principal risk of loss arises from an actual default—an assumption that is entirely appropriate for examining a bank's held-to-maturity loan portfolio. The reason is that for most commercial banks, accounting standards and bank regulatory authorities generally require institutions to report held-to-maturity loans at historical cost until default or repayment, less any deduction for probable losses.[174] In a world where credit is held to maturity, Sullivan's statement would thus have considerable support: so long as the institution reasonably believes a super senior note has a low probability of actual default, it would pose very little risk on a company's balance sheet.

In contrast, this conclusion changes when credit instruments are held for trading purposes rather than held to maturity. Like any financial asset, credit instruments can be traded to capture price

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171. *See* FCIC REPORT, *supra* note 167, at 129.

172. *See id.* at 139–42 (describing AIG swaps); *id.* at 276–78 (describing monoline swaps).

173. *American International Group Investor Meeting—Final*, FD (FAIR DISCLOSURE) WIRE, Dec. 5, 2007, at 4 [hereinafter *AIG Investor Meeting*] (statement of Martin Sullivan); *see also* FCIC REPORT, *supra* note 167, at 266 ("The mantra at [AIG Financial Products] had always been . . . that there could never be losses.") (quoting Joseph St. Denis).

174. *See* Christian Laux & Christian Leuz, *Did Fair-Value Accounting Contribute to the Financial Crisis?*, 24 J. ECON. PERSP. 93, 98–99 (2010).

movements in the relevant trading market with the firm holding the asset recording a profit or loss in its income statement based on the asset's current change in value.[175] And in the case of most financial institutions, a considerable portion of their exposure to super senior CDOs was held in trading positions subject to mark-to-market accounting.[176] In the case of insurers such as AIG and financial guarantee companies, for instance, their most critical exposures to subprime debt were in the form of credit default swaps ("CDS") the firms had written to cover any loss of principal on the senior-most tranche of securities issued by multisector CDOs. Even though the CDS contracts would only be triggered on a default of the underlying CDO, the contracts constituted derivatives under Statement of Financial Accounting Standards ("SFAS") No. 133.[177] As such, changes in their fair value were required to be recorded on the insurers' income statements as unrecognized gain or loss in each accounting period, while their aggregate fair value was to be recorded on the balance sheet as a derivative liability.[178]

Likewise in the case of financial institutions such as Citigroup and Merrill Lynch, exposures to CDOs backed by subprime mortgages were often held in the firms' trading accounts where they were subject to mark-to-market accounting.[179] Although the market for these securities was extremely thin, the regulatory capital requirements that applied to financial institutions through 2008 created significant incentives for firms to maintain that these securities were being held

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175. *Id.* at 99. A bank's "trading assets" represent a distinct category of financial assets under GAAP. Under SFAS 115, a bank's trading assets comprise instruments that are bought and held principally for the purpose of selling them in the near term. *Id.*

176. *See* FIN. STABILITY FORUM, REPORT OF THE FINANCIAL STABILITY FORUM ON ENHANCING MARKET AND INSTITUTIONAL RESILIENCE 14 (2008), *available at* www.financialstabilityboard .org/publications/r_0804.pdf ("A large proportion of structured credit products are held in banks' and securities firms' trading books . . . .").

177. *See* ACCOUNTING FOR DERIVATIVE INSTRUMENTS AND HEDGING ACTIVITIES, Statement of Financial Accounting Standards No. 133 (Fin. Accounting Standards Bd. 1998) (outlining accounting and reporting standards for derivative instruments).

178. *Id.*; *see also* WALLACE ENMAN, MOODY'S INVESTORS SERV., INC., REP. NO. 105498, SPECIAL COMMENT: INTERPRETING FINANCIAL GUARANTORS' MARK-TO-MARKET LOSSES (2008), *available at* http://www.ambac.com/pdfs/RA/Moodys/07-2008.pdf (analyzing insurers' mark-to-market losses arising from CDS written on multisector CDOs).

179. *See, e.g.*, FCIC REPORT, *supra* note 167, at 382–83 (noting Merrill Lynch's treatment of CDOs). Citigroup's treatment of its CDOs is discussed *infra* text accompanying note 239; UBS AG, SHAREHOLDER REPORT ON UBS'S WRITE-DOWNS 40 (2008), *available at* www.ubs.com/1/ShowMedia/.../agm?...080418ShareholderReport.pdf ("The Super Senior notes were always treated as trading book . . . .").

with trading intent and thus eligible for trading book treatment.[180] In particular, the capital requirements that applied to most financial institutions drew a sharp distinction between capital that must be held against an institution's "trading book" and capital held against its "banking book."[181] Most notably, under both U.S. banking regulations and the Basel Accords, larger banks that had well-established risk management protocols were permitted to determine the amount of regulatory capital for trading book assets using an "internal model-based approach."[182] Under this approach, a bank would set regulatory capital for its trading book based on an estimate of the worst trading (or "market") loss that could be expected from its trading assets over a ten-day period with 99% confidence.[183] In contrast, the regulatory capital requirements that applied to the same firm's "banking book" required it to set aside capital to cover banking book assets based on an estimate of the worst portfolio credit losses that could be expected over a one-year period with 99.9% confidence.[184] Since this latter calculation commonly exceeded the capital required for a CDO's market-based risk,[185] assigning CDO securities to the trading book could lead to a significant reduction in regulatory capital—a point repeatedly emphasized by financial firms in their own advisory work with other banks.[186] The end result was the significant growth of many firms' trading books during the mid-2000s, fueled in part by the retention of the senior notes of CDOs. Figure 6, for instance, reflects the rapid growth of trading assets at Citigroup where they rose from $120 billion at the end of 1998 to $580 billion by

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180. *See* FIN. STABILITY FORUM, *supra* note 176, at 14 ("Where market risk capital measures do not fully capture the credit risk of these products, there is a regulatory arbitrage incentive to reduce capital requirements by holding such exposures in the trading book.").

181. *See* HULL, *supra* note 17, at 229 (describing trading book and banking book capital requirements).

182. *Id.* Basel's market risk approach was implemented for U.S. banking institutions in 1996. *See* Risk-Based Capital Standards: Market Risk, 61 Fed. Reg. 47,358 (Sept. 6, 1996).

183. *See* HULL, *supra* note 17, at 229.

184. *See id.* at 234. Through the Financial Crisis, banks that did not qualify to use the internal model-based approach were required to hold capital to cover both their trading books and their banking books using a standardized approach that assigned capital charges to specific categories of assets (e.g., equity securities vs. investment-grade debt securities vs. unrated debt securities). *See id.* at 229, 232–33.

185. *See* FIN. STABILITY FORUM, *supra* note 176, at 14.

186. *See, e.g.*, CITIGROUP, INC., CREDIT DERIVATIVES 2001—ISSUES AND OPPORTUNITIES 7 (2001) (emphasizing that if collateralized notes are held in the trading book rather than the banking book the "originating bank obtains [regulatory capital] relief under the market risk rule."); JOHN HUNT ET AL., LEHMAN BROS., BANK STRATEGIES: COLLATERALIZED LOAN OBLIGATIONS AND CREDIT DERIVATIVES 27 (1999) (same).

the third quarter of 2007.[187] In contrast, the amount of regulatory capital Citigroup was required to hold against these assets was but a small fraction of their notional amount.[188]

FIGURE 6: GROWTH OF CITIGROUP'S TRADING BOOK VS. REGULATORY CAPITAL FOR MARKET RISK, 1999–2007
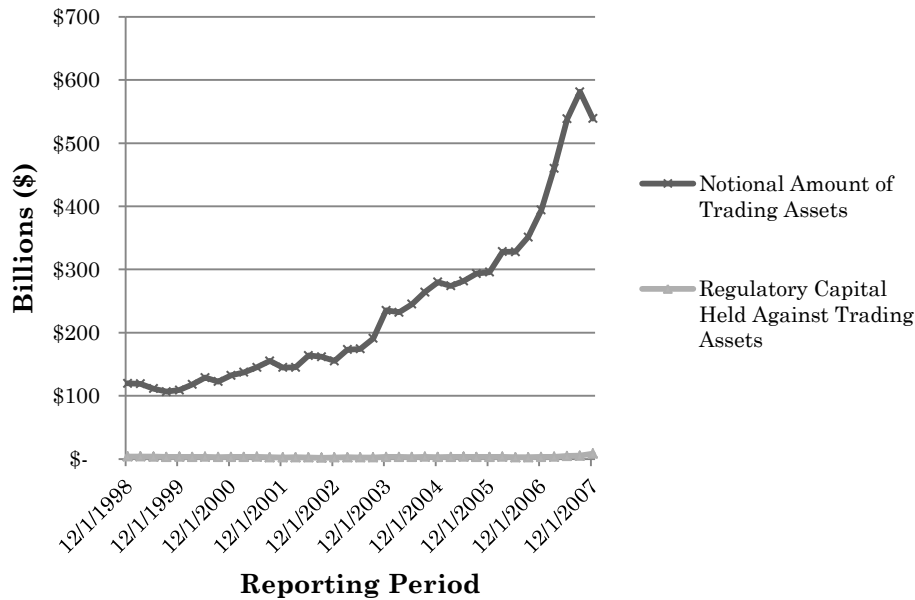
Having built such large CDO positions in their trading books, financial firms were required to take extraordinarily large mark-to-market losses on them once the housing market began to deteriorate in 2007.[189] In particular, rising delinquency and default rates among subprime borrowers during the summer of 2007 prompted a general

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187. Data for Figure 6 was taken from the Bank Regulatory Database provided through Wharton Research Data Services. Data for the database was obtained from Citigroup's Form Y-9C reports. *See* Citigroup, Inc., Form Y-9C, *supra* note 18.

188. Regulatory capital was based on Citigroup's reported "market risk equivalent assets" set forth in its Form Y-9C. A bank's risk-weighted assets ("RWA") for market risk are defined as 12.5 times the market risk capital determined from its internal-based model. *See* HULL, *supra* note 17, at 230. Therefore, Citigroup's market risk capital was calculated by dividing Citigroup's market risk equivalent assets by 12.5.

189. FCIC REPORT, *supra* note 167, at 256 (discussing significant losses in 2007 among U.S. financial institutions due to their CDO holdings).

reassessment of any securities backed by subprime mortgages.[190] At the same time, CDOs issued in 2005 through 2007 had increasingly been structured to purchase mortgage-backed securities. By 2007, more than half of all outstanding CDOs were believed to be "structured finance CDOs" composed of residential mortgage-backed securities ("RMBS") and other asset-backed securities (often including tranches of other CDOs).[191] Of course, the structural protections of a CDO were designed to minimize the risk that losses experienced in the underlying RMBS would flow through to the senior tranches of a CDO held by most financial institutions. However, for a senior CDO tranche subject to mark-to-market accounting, the rising expectation of losses within a CDO's portfolio (even if localized in the CDO's junior tranches) would seem to demand *some* valuation adjustment given the tranche's diminished subordination protection.

Because CDO tranches rarely traded,[192] quantifying this valuation adjustment hinged on modeling the expected cash flows and default probabilities of the underlying securities.[193] Moreover, in the case of a CDO backed by subprime RMBS, the underlying collateral also rarely traded, thus complicating further the estimation of the securities' default probabilities.[194] Such challenges were, in part, a key reason for the development of the ABX.HE indices in 2006.[195] In general, the indices tracked the value of CDS written on a designated list of twenty subprime RMBS transactions, with each index limited to the CDS written on one of their five investment grade tranches

190. *See generally id.* at 214–29 (detailing collapse in the markets for subprime-linked securities).

191. *See, e.g.*, ELAINE BUCKBERG ET AL., SUBPRIME AND SYNTHETIC CDOS: STRUCTURE, RISK, AND VALUATION 4 (2010), *available at* http://www.nera.com/nera-files/PUB_CDOs_Structure_Risk_Valuation_0610.pdf.

192. *See, e.g.*, Citigroup, Inc., Annual Report (Form 10-K) 169 (Feb. 22, 2008) [hereinafter Citigroup 2007 10-K Report], *available at* http://www.sec.gov/Archives/edgar/data/831001/000119312508036445/d10k.htm#fin69414_69 (noting that prior to the third quarter of 2007, "the secondary market for CDO super senior subprime tranches was extremely limited").

193. *See* BUCKBERG ET AL., *supra* note 191, at 24–25 (describing procedure for valuing CDOs).

194. *Id.* As discussed previously, reduced form models can be used to derive a default probability from the market price of a credit instrument. *See supra* text accompanying note 82. In the absence of market prices for subprime RMBS, default probabilities would have to be estimated using historical data such as past loan performance data, which may be slow to capture changes in the economy. *See* BUCKBERG ET AL., *supra* note 191, at 24–25.

195. The ABX.HE index was among a larger family of credit and structured finance indices that are administered by Markit Group Limited. *See Indices Overview*, MARKIT, http://www.markit.com/en/products/data/indices/indices.page? (last visited Oct. 17, 2011).

ranging from AAA to BBB-.[196] Once the indices began trading, the price of each index could therefore be used to calculate credit spreads for each of the five tranches, which in turn, could be used to infer default probabilities for the RMBS tranche underlying the index.[197] To the extent these RMBS tranches resembled the securities in a particular CDO, these default estimates could then be used to value the securities of a CDO, an outcome that was encouraged by fair value accounting rules.[198] As a result of these developments, by early 2007, both investors and financial institutions were regularly using the ABX.HE indices to value subprime-linked CDOs.[199]

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196. The same twenty RMBS transactions serve as the reference entities for the CDS that make up the indices for a single vintage and do not change over the life of the index. BUCKBERG ET AL., *supra* note 191, at 18. Thus, the first index—the 2006-1 vintage released in January 2006—had five indices that were all based on five different tranches of the same twenty RMBS deals. To accommodate the fact that RMBS transactions change over time, a new index was therefore constructed semi-annually comprised of a new sample of twenty transactions issued within the prior six months of the release date. In all, four vintages of indices were introduced, each covering twenty RMBS transactions issued in the last half of 2005 through the first half of 2007. No new indices were introduced following the decline in the value of the indices after the first half of 2007. *Id.*

197. *See id.* at 25; *see also* John C. Hull & Alan White, *Valuing Credit Default Swaps I: No Counterparty Default Risk*, 8 J. DERIVATIVES 29, 29–40 (2000) (describing the method for converting spreads into default probabilities).

198. Assets subject to fair value accounting—such as trading book assets—must be valued in accordance with SFAS 157, which sets forth the procedure for determining an asset's fair value. *See* Laux & Leuz, *supra* note 174, at 96–97. In general, SFAS 157 expresses a strong preference for fair value to be based on quoted prices from transactions or dealers in active markets ("Level 1" inputs) where they are available. *Id.* at 97. In the absence of market prices, fair value must be determined using models that are required to use observable inputs ("Level 2"), which include quoted prices for similar assets and other relevant market data such as market prices of an appropriate index. *Id.* Unobservable inputs, typically model assumptions, can be used if observable inputs are unavailable ("Level 3"). *Id.*

199. *See, e.g.*, KEVIN MCGOVERN & BRIAN SCIACCA, CDO PRICE VERIFICATION POLICY & PROCEDURE (Lehman Brothers Internal Document) 4 (2008), *available at* http://www.jenner .com/lehman/docs/debtors/LBHI_SEC07940_4228806-4228809.pdf ("ABS CDO's can be priced off ABX Tranches by implying that residential mortgage collateral are valued at the ABX tranche with the same credit rating."); *October Year to Date Trading Performance at Barclays Capital Ahead of Record Prior Year Period*, BARCLAYS PLC, (Nov. 15, 2007), http://www.newsroom .barclays.co.uk/imagelibrary/downloadMedia.ashx?MediaDetailsID=
5424 (same); *see also* Gary B. Gorton, *The Panic of 2007*, at 131, 212 (Fed. Reserve Bank of Kan. City Symposium, Maintaining Stability in a Changing Financial System, 2008), *available at* http://www.kansascityfed.org/publicat/sympos/2008/Gorton.03.12.09.pdf ("Once the ABX indices started to drift downwards, accountants required market participants to use these indices for mark-to-market purposes . . . ."); Richard Stanton & Nancy Wallace, *The Bear's Lair: Indexed Credit Default Swaps and the Subprime Mortgage Crisis* 2 (Fisher Ctr. for Real Estate & Urban Econ., Working Paper, 2009), *available at* http://ssrn.com/abstract=1434686 ("[M]any portfolio investors in subprime mortgage securities are using the more liquid ABX.HE prices as a benchmark for marking-to-market their portfolios of subprime securities.").

The challenge for financial institutions holding CDOs, however, was that the very liquidity that made the ABX.HE appropriate for pricing subprime credit risk also made it attractive for purposes of hedging and trading it.[200] With the increase in subprime delinquency and default rates in 2007, the index became a primary means for market participants to express a negative view of subprime credit risk as well as for financial institutions to hedge their subprime exposures.[201] As shown in Figure 7, by the autumn of 2007, demand for subprime protection had resulted in a precipitous drop in the price of the ABX.HE among all investment grade tranches. While subsequent research would strongly suggest that much of this drop was the product of liquidity-driven hedging and trading,[202] the significant drop nevertheless indicated a substantial fall in the value of the CDO positions residing in the trading books of financial institutions.[203] By the end of 2007, financial firms who had only a year earlier been reporting record net profits found themselves reporting extraordinary losses from CDO write-downs. At Citigroup, for instance, deterioration in the value of its CDO portfolio led the firm to make its November 4, 2007 announcement of between $8 billion and $10 billion of CDO-related losses,[204] or 10% of its 2007 revenue.[205] Likewise, at AIG, declining values of the CDOs it had insured led to both its announcement of a net loss of $8.4 billion for the fourth quarter of 2007 as well as the initial collateral calls that would

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200. *See* BUCKBERG ET AL., *supra* note 191, at 18 ("These Markit indices are not merely data series that track constituents over time—they also underlie tradable OTC contracts used by broker-dealers and other market participants to hedge, speculate, and trade.").

201. *See* Gorton, *supra* note 199, at 207–08.

202. *See* Stanton & Wallace, *supra* note 199, at 3–4 (finding that under modest assumptions, the ABX.HE prices in 2009 implied default rates of 100% of the underlying RMBS).

203. Not surprisingly, the collapse of ABX prices naturally led institutions to argue against using the index as a benchmark for pricing their subprime exposure. *See, e.g.*, *AIG Investor Meeting*, *supra* note 173 (statement of Joe Cassano) ("Why don't we use the ABX? I think the short answer is the ABX is not at all in any way representative of our portfolio."). Indeed, as the Financial Crisis worsened, financial institutions attempted to utilize the limited flexibility under SFAS 157 to price mortgage-related securities using Level 3 rather than Level 2 inputs. *See* Laux & Leuz, *supra* note 174, at 107–09 (finding that "net transfers into the Level 3 category were substantial" with many institutions making substantial transfers in the fourth quarter of 2007).

204. Citigroup, Inc., Current Report (Form 8-K) (Nov. 5, 2007), *available at* http://www.sec.gov/Archives/edgar/data/831001/000110465907079495/0001104659-07-079495-index.htm.

205. *See* Citigroup 2007 10-K Report, *supra* note 192, at 4 (noting 2007 revenue of $81.7 billion).

ultimately lead to the insurer's demise.[206] In the process, the firms illustrated how debt securities that pose only minimal credit risk to a diversified balance sheet can produce market risks capable of destroying the firms.

FIGURE 7: PRICING OF ABX.HE 2006–07
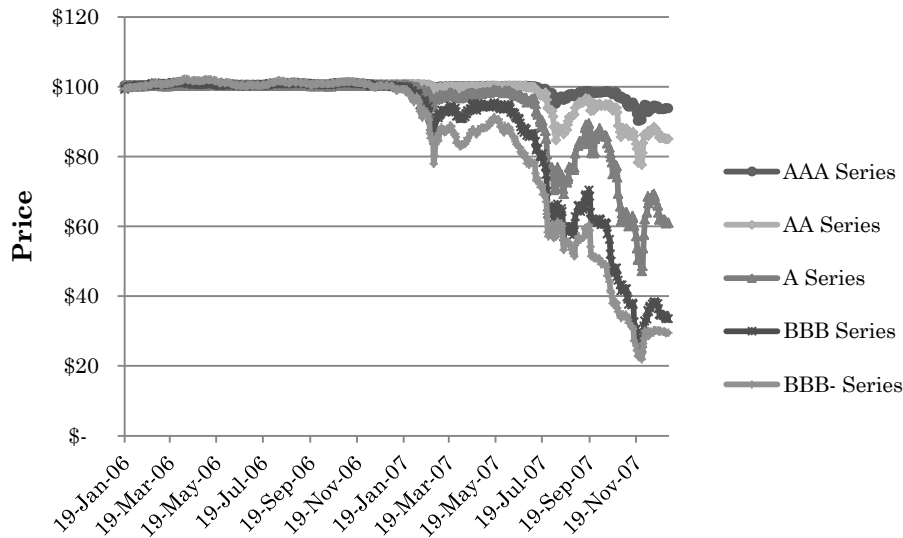
2. Modeling Citigroup's Portfolio Risk

As the foregoing discussion of the Financial Crisis might suggest, the complex interaction of events in 2007 and 2008 complicated attempts to anticipate the losses that would ultimately result from a portfolio of subprime-linked CDOs. After all, realized losses from CDOs were a product of both their underlying credit risk as well as dynamics within the financial markets (such as liquidity-driven pricing of the ABX.HE) that were unlikely to have been anticipated. As with CINB, however, even with their limitations, many of the same credit modeling techniques discussed previously could have nevertheless highlighted financial firms' significant exposure to credit risk as they built large, unhedged trading portfolios of CDO notes. Indeed, similar to the experience of CINB, the primary

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206. Am. Int'l Grp., Inc., Annual Report (Form 10-K) 34 (Feb. 28, 2008), *available at* http://www.sec.gov/Archives/edgar/data/5272/000095012308002280/y44393e10vk.htm.

challenge to analyzing a firm's exposure to credit risk was not developing a sufficiently sophisticated model but rather having access to the same basic parameter estimates used to analyze CINB's hypothetical C&I portfolio. The following analysis of Citigroup's CDO portfolio provides an illustration.

As in the case of CINB, the near failure of Citigroup in 2008 ultimately produced a considerable amount of information concerning the investments at the heart of the institution's turmoil. In contrast to the congressional investigation of CINB, details concerning Citigroup's CDO portfolio arose primarily as a result of private securities litigation initiated against Citigroup in 2008.[207] The litigation, which alleged that Citigroup failed to disclose its exposure to subprime-backed securities prior to its press release on November 4, 2007, revealed a number of details concerning the firm's CDO portfolio. Among other things, the litigation provided an itemized list of the fifty positions that comprised Citigroup's $43.9 billion portfolio of CDOs along with their date of issuance.[208] It also confirmed (as did Citigroup's 2007 Form 10-K) that each of these positions represented the senior-most debt securities of the CDOs and were originally rated AAA upon issuance.[209]

With this basic information in hand, assessing the risk of Citigroup's CDO portfolio prior to the Financial Crisis proceeded by means of constructing a hypothetical portfolio risk model in much the same manner that was done in the previous analysis of CINB. As with the prior analysis, the overall objective of the model was to provide a forecast of the potential losses Citigroup might suffer over a specified time horizon on account of the credit risk embedded in its CDO portfolio. In keeping with both industry practice[210] and Citigroup's

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207. *See* Amended Consolidated Class Action Complaint, *In re* Citigroup Inc. Sec. Litig., 753 F. Supp. 2d 206 (S.D.N.Y. 2010) (Nos. 09 MD 2070 (SHS), 07 Civ. 9901 (SHS), 07 Civ. 10258 (SHS), 08 Civ. 135 (SHS), 08 Civ. 136 (SHS)) [hereinafter Citigroup Complaint].

208. *See id.* at 56–77.

209. *Id.*; Citigroup 2007 10-K Report, *supra* note 192, at 91. Citigroup appears to have treated these positions as AAA-rated assets until sometime during the third quarter of 2008. *Id.* at 169. The $43.9 billion excludes an additional $9.5 billion Citigroup held but had hedged with monoline insurers. Citigroup Complaint, *supra* note 207, at 76–77.

210. *See, e.g.*, J.P. MORGAN & CO. INC., CREDITMETRICS—TECHNICAL DOCUMENT 32 (1997) [hereinafter CREDITMETRICS TECHNICAL DOCUMENT] (noting that "using as a convention a one year risk horizon [for market risk] . . . is common"); THE JOINT FORUM, BASEL COMM. ON BANKING SUPERVISION, TRENDS IN RISK INTEGRATION AND AGGREGATION 32 (2003), *available at* http://www.bis.org/publ/joint07.pdf (noting that banks typically calculate market VaR over a few trading days but then convert this measure to a one-year measure for VaR to calculate their economic capital). In theory, a portfolio model designed to examine the risk of trading assets

own disclosed risk management policy,[211] a one-year time horizon was once again utilized. July 1, 2007, was selected as the measurement date to enable analysis of Citigroup's portfolio after it had already accumulated most of its CDO positions but prior to its cessation of CDO structuring. Indeed, in early July 2007, Citigroup was either in the process of marketing or of preparing to market an additional $5.5 billion of CDOs, of which $4.2 billion would end up in its trading book.[212]

In contrast to the model used for CINB (which focused on the credit risk within CINB's banking book), the fact that Citigroup held its CDO positions as part of its trading book required a slightly different analysis than used previously. In particular, whereas the primary concern with CINB's loan portfolio was how loan defaults might affect the bank's balance sheet, holding debt securities as part of a trading portfolio raises the additional risk that the securities might decline in value even in the absence of outright defaults. For instance, even if a borrower does not actually default on its debt obligations, a deterioration of the borrower's credit quality nevertheless makes the cash flows on its debt obligations more risky and, as a consequence, subject to a greater pricing discount. Accounting for this market risk thus called for several modifications to the modeling approach used previously, which, in keeping with traditional risk analysis of banking books, examined only whether a loan was in default as of the end of the forecast period.

For purposes of conducting this additional market analysis, I turned to a common modeling technique originally pioneered by JPMorgan in its widely used *CreditMetrics* portfolio model.[213] In general, *CreditMetrics* accounts for potential changes in the value of debt securities by relying on the well-established relationship between

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might be designed to examine losses over a period less than a year where the trading assets represent highly liquid securities. *See, e.g.*, MICHEL CROUHY ET AL., THE ESSENTIALS OF RISK MANAGEMENT 374 (2006) (noting that "[i]n the case of a proprietary trading desk, with highly liquid positions and no clients to service . . . risk reduction can take place very quickly indeed"). For purposes of the model, the liquidity of super senior CDO securities—which was limited even before 2007, *see supra* text accompanying note 192—was assumed to have largely evaporated by July 2007.

211. *See infra* text accompanying note 251 (describing Citigroup's economic capital calculation).

212. The CDOs consisted of Pinnacle Peak CDO I (closed on July 3, 2007), Bonifacius (closed on July 27, 2007) and Jupiter High Grade CDO VII (closed on August 2, 2007). *See* Citigroup Complaint, *supra* note 207, at 73.

213. *See generally* CREDITMETRICS TECHNICAL DOCUMENT, *supra* note 210, at 5–21 (providing overview of CreditMetrics methodology).

credit ratings and credit spreads.[214] As initially outlined by JPMorgan, the fact that debt markets systematically demand higher yields on lower-rated bonds provides a straightforward means to estimate the value of nondefaulted debt obligations. In particular, to the extent a debt obligation is upgraded or downgraded, its value should reflect the present value of its anticipated cash flows (e.g., interest and principal payments) discounted at the yields for similarly rated debt instruments. For any bond that has not defaulted, estimating its market value for a future period thus becomes an exercise of estimating its credit rating and the discount rate that should be associated with it.[215]

Following this logic, an important step in designing Citigroup's CDO portfolio model was estimating the one-year credit rating for each position. As in *CreditMetrics,* the model accomplished this estimation using two procedures. The first was to rely on historical migration rates of rated debt to estimate the probability that debt with a given rating will migrate to another rating category within one year.[216] Table 4, for instance, provides the historical one-year transition rates for rated debt between 1981 and 2005.[217] As the table indicates, rated debt tends to retain the same rating after one year's time, although significant migrations can occur in all rating categories including a migration to default ("D"). Of course, future transition rates might differ significantly from these historic averages, but the *CreditMetrics* approach makes the simplifying assumption that migration rates over the next year will largely conform to these historic patterns.[218] In the Citigroup model, each position in its portfolio was therefore assumed to have a twelve-month migration probability equivalent to the rates set forth in Table 4. For debt initially rated AAA, for example, using this assumption suggested that after one year there would be a 91.39% probability the debt would remain AAA, a 7.95% probability it would migrate to AA, and a 0.001% probability it would default.

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214. *Id.* at 10.

215. *Id.* at 9–10.

216. *Id.* at 24–25.

217. STANDARD & POOR'S, *supra* note 132, at 14. Standard & Poor's also tracks issuers who transition from a rating to "not rated." The procedure for adjusting the transition matrix to isolate only those transitions from one rating to another rating is described in LÖFFLER & POSCH, *supra* note 79, at 88–89.

218. CREDITMETRICS TECHNICAL DOCUMENT, *supra* note 210, at 49 ("[W]e assume that the transition process is stationary in that the same transition matrix is valid from one year to another.").

TABLE 4: ONE-YEAR TRANSITION RATES FOR RATED DEBT

From: \ To:	AAA	AA	A	BBB	BB	B	CCC	D
AAA	91.39%	7.95%	0.51%	0.09%	0.06%	0.00%	0.00%	0.001%
AA	0.60%	90.65	7.94%	0.60%	0.06%	0.11%	0.02%	0.01%
A	0.05%	1.99%	90.43	6.86%	0.44%	0.16%	0.03%	0.04%
BBB	0.02%	0.17%	4.11%	89.85	4.56%	0.81%	0.18%	0.29%
BB	0.03%	0.04%	0.28%	5.80%	83.51%	8.11%	0.99%	1.23%
B	0.00%	0.00%	0.22%	0.35%	6.25%	82.33%	4.77%	6.09%
CCC	0.00%	0.00%	0.32%	0.47%	1.43%	13.56%	54.14%	30.08%

Having determined the migration probabilities for each debt position, the second step of the model was a Monte Carlo procedure that simulated the one-year credit migration for all positions in the portfolio several thousand times.[219] As with simulating defaults in the CINB loan portfolio, a key challenge for the model was addressing the possibility of correlated behavior—in this case, correlated migrations as well as defaults. To account for this issue, the same structural approach to default used for the CINB model was used to simulate correlated asset values for each position based on equation (1) or, as discussed below, equation (2). The primary difference in the Citigroup model was that the model now had to evaluate a borrower's future asset value against the full range of rating possibilities, as opposed to simply a single default state. In keeping with the *CreditMetrics* approach, this latter task was accomplished by mapping each simulated asset value to a particular rating category (including default) using the probability estimates obtained from the transition matrix.[220]

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219. *Id.* at 113 (describing the Monte Carlo procedure used in CreditMetrics).

220. *Id.* at 113–116. More specifically, each predicted asset value was mapped to a particular rating category by means of converting each rating probability in the transition matrix to a value within the cumulative distribution function for either a standard normal or a *t*-distributed random variable, as applicable. *See* LÖFFLER & POSCH, *supra* note 79, at 144–45 (describing methodology). For instance, if asset values were generated using a standard normal distribution, a default was deemed to occur if the asset value fell below a default threshold (D) defined as the inverse of the standard normal cumulative distribution of the default probability set forth in the transaction matrix for the borrower's initial rating. For asset values greater than the applicable default threshold, the issuer was assigned a nondefault rating grade k by applying the inverse of

The final step in designing Citigroup's portfolio model was estimating in each simulation the debt security's present value in one year's time in order to calculate the portfolio's value.[221] For simplicity, each CDO position was assumed to pay interest at a fixed rate of 5.50% per year (approximately the average yield on AAA-rated debt on June 30, 2007) and to have a maturity of five years. For each position, these five years of cash flows were then discounted using estimates of the term structure of interest rates for the future rating category the simulator predicted for the position. Following *CreditMetrics*, all estimated term structures were based on the one-year forward rates that existed on June 30, 2007, using data obtained from Bloomberg and Bondsonline.[222] In cases where a debt position was predicted to default in a simulation, Citigroup was assumed to recover 50% of the principal balance on June 30, 2008.[223]

The end result of this process was a market-sensitive portfolio model that was used to assess the credit risk in Citigroup's portfolio of CDOs. As with the model used for CINB, the model was run four separate times (100,000 simulations each) to examine the effect of using different assumptions concerning the portfolio's structure. The first, most basic set of simulations (Simulation 1) assumed the $43.9 billion of CDO securities was evenly distributed among 439 AAA-rated positions of $100 million each. Asset values for each position were

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the standard normal cumulative distribution to the cumulative probability of moving into grade *k* or a lower grade (including default). For instance, for a bond with an initial rating of "A," applying this procedure would yield the following rating thresholds after one year assuming asset values were normally distributed:

To:

AAA	AA	A	BBB	BB	B	CCC	D
∞	3.28	2.04	-1.44	-2.47	-2.83	-3.18	-3.35

Assuming the simulation drew an asset value of -2.5, the debt would then be assigned a rating of "BB" after one year. In contrast, if the simulation drew an asset value of -3.00, the debt would be assigned to a rating of "B."

221. CREDITMETRICS TECHNICAL DOCUMENT, *supra* note 210, at 27–28.

222. *Id.* at 28. More precisely, estimations of one-year forward curves were first obtained by calculating the one-year forward risk-free curve using the credit curve for U.S. Treasury STRIPS obtained from Bloomberg. Estimations of forward curves for each rating category were then obtained by adding to these figures the appropriate spread for the rating category as of June 30, 2007, using the bond spreads provided by Bondsonline. The methodology is discussed in more detail in SAUNDERS & ALLEN, *supra* note 90, at 195–200.

223. *See* JAN KREGEL, LEVY ECON. INST. OF BARD COLL., MINSKY'S CUSHIONS OF SAFETY: SYSTEMIC RISK AND THE CRISIS IN THE U.S. SUBPRIME MORTGAGE MARKET 13 (2008). Because the results below were driven primarily from rating migrations rather than defaults, simulated trading losses did not change materially upon using different recovery rates.

then modeled using the one-factor structural model discussed previously, assuming normally distributed asset values. For purposes of assessing the effect of correlated migrations within the portfolio, all positions were assumed to have a factor correlation of 22.7%—the same figure used in the first simulation of CINB's portfolio.[224] Although the average exposure amount and correlation assumptions misrepresent the true CDO portfolio, they might represent reasonable assumptions to make had Citigroup disclosed simply the fact that it had a $43.9 billion portfolio of AAA-rated bonds.

As with the second set of simulations for CINB, the next set of simulations (Simulation 2) focused on changing the distributional assumption for A_i. In particular, rather than assume the systematic factor Z and each issuer's idiosyncratic factor ε_i were normally distributed, the model was modified so that each factor came from a Student t-distribution with three degrees of freedom. Using this assumption produced a multivariate Student t-distribution for A_i,[225] which was intended to produce greater migration and default dependencies among obligors.

The final two simulations focused on the effect of obtaining two additional pieces of information concerning Citigroup's CDO portfolio. In contrast to the first two simulations, the third set (Simulation 3) was run with knowledge that the $43.9 billion of AAA-rated securities actually represented a portfolio of notes issued by CDOs. In reality, the additional complexity of modeling structured-finance notes would most likely merit a substantially more complicated credit model,[226] but for present purposes, I assumed an analyst would adopt the practice (not uncommon in 2007)[227] of analyzing them using the structural model of default.[228] As with CINB, this additional knowledge could

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224. *See supra* tbl.1.

225. *See supra* text accompanying note 149.

226. *See* LÖFFLER & POSCH, *supra* note 79, at 197–210 (overview of modeling CDOs).

227. *See, e.g.*, Tomer Yahalom et al., Moody's KMV Co., *Modeling Correlation of Structured Instruments in a Portfolio Setting* (2008), *in* ENCYCLOPEDIA OF QUANTITATIVE FINANCE, *available at* http://www.moodysanalytics.com/Insight/Quantitative-Research/Portfolio-Modeling.aspx (noting that "traditional approaches to modeling economic capital, credit-VaR, for structured instruments whose underlying collateral is comprised of structured instruments treat structured instruments as a single-name credit instrument (i.e., a loan-equivalent)").

228. This approach is not entirely without support within the credit risk literature. *See id.* (providing methodology for calibrating loan-equivalent correlation parameters to permit the use of a single-factor structural approach to modeling portfolios of structured finance credits). Once again, however, the point here is not to endorse this approach, but rather to imagine what a conventional risk model in June 2007—even one that might be flawed—could have predicted had Citigroup disclosed additional information concerning its CDO portfolio.

then be used to calibrate the model to reflect the performance behavior of similar credits. With respect to asset correlation, for instance, the Van Landschoot and Jobst study cited previously also estimated asset correlations for CDO notes using the same two-factor model set forth in equation (2).[229] Their study suggested that CDOs had an overall asset correlation with the market (Z_1) of just 1.8% but had an intra-CDO correlation (Z_2) of 17.6%. The third set of simulations therefore adopted the two-factor structural model of equation (2) using these two correlation estimates to calculate ω_{ik}. It otherwise adopted the same assumptions as Simulation 2.

The fourth set of simulations (Simulation 4) replicated Simulation 3 but modified the composition of the CDO portfolio to reflect the actual notional amounts of Citigroup's positions. In particular, the portfolio was modified so that Citigroup's AAA positions consisted of fifty positions ranging in value from $170 million to $4.4 billion.

Figure 8 illustrates the results of all four simulations. As with the CINB analysis, different assumptions concerning the structure of the CDO portfolio produced notably different estimates for the tail distribution of Citigroup's modeled trading losses. Once again, the results highlight the critical importance of the distributional assumption of asset values underlying a given factor model. In Simulation 1, the model produced tail losses at 99.9% confidence of less than $150 million, or about 0.5% of the portfolio's value. In contrast, simply switching to an assumption in Simulation 2 that asset values followed a *t*-distribution resulted in trading losses at 99.9% confidence of approximately $700 million, 1.5% of the portfolio's initial value. Likewise, the simulations also confirm the importance of accounting for position concentration. In Simulation 4, moving from the assumption of a balanced, evenly distributed portfolio of CDOs to Citigroup's actual, more concentrated portfolio increased estimated trading losses even further. This last set of simulations yielded estimated trading losses at 99.9% confidence of almost $900 million, or 2% of the portfolio's initial value.

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229. Van Landschoot & Jobst, *supra* note 131, at 232.

**FIGURE 8: DISTRIBUTION OF ESTIMATED TRADING LOSSES FOR
CITIGROUP'S CDO PORTFOLIO USING FOUR SETS OF SIMULATIONS**
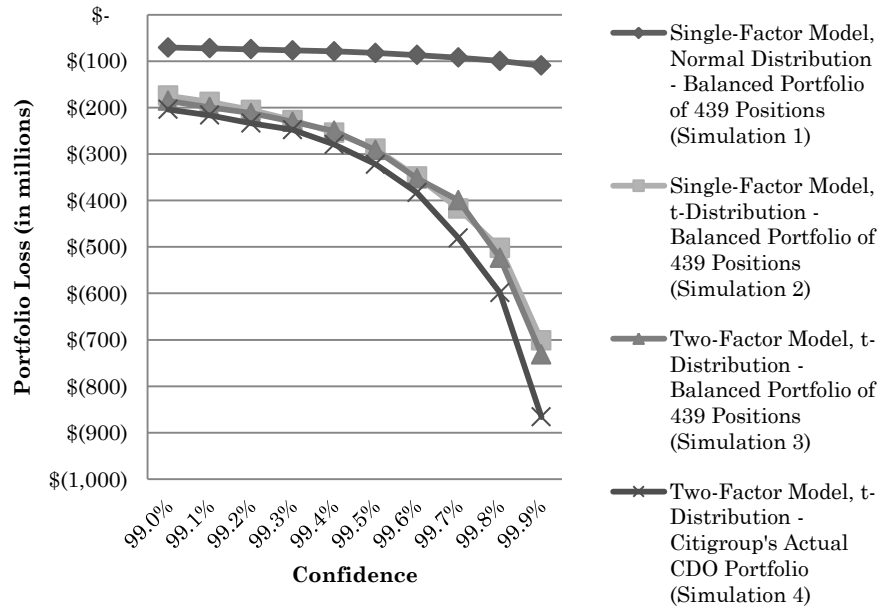
Similar results persisted with regard to each simulation's expected shortfall. Using 99.9% confidence, Table 5 presents the expected shortfall for the four sets of simulations. In all four, the expected shortfall figure was virtually double what was estimated to be the portfolio's trading loss at 99.9% confidence.

TABLE 5: EXPECTED SHORTFALL MEASURES

Simulation	Expected Shortfall at 99.9% Confidence (millions)
Single-Factor Model, Normal Distribution – Balanced Portfolio of 439 Positions (Simulation 1)	$124
Single-Factor Model, *t*-Distribution – Balanced Portfolio of 439 Positions (Simulation 2)	$1,353
Two-Factor Model, *t*-Distribution – Balanced Portfolio of 439 positions (Simulation 3)	$1,204
Two-Factor Model, *t*-Distribution – Citigroup's Actual Portfolio (Simulation 4)	$1,702

While none of these loss estimates reach the $8 billion to $10 billion of CDO-related losses Citigroup announced on November 4, 2007, they nevertheless reveal the considerable tail risk Citigroup created by holding an unhedged portfolio of even AAA-rated trading securities. They also highlight the danger of emphasizing the low default risk of a portfolio of AAA-rated CDOs while ignoring their market risk—a practice that, as noted above, was frequently employed by firms in hopes of addressing investor concerns about their CDO exposures. Simulation 4, for instance, produced actual defaults in less than 0.01% of the simulations, but trading losses in excess of $200 million appeared in over 1% of the simulations.

More importantly, the foregoing summary of the Citigroup portfolio model suggests the appropriateness of stress testing the model's simplifying assumptions in the same fashion that was done with CINB previously. In particular, a more accurate assessment of how the portfolio would perform in times of economic stress would seemingly require a more nuanced approach to the relation between the general economy and other parameters used in the model. For instance, credit spreads generally widen during times of economic stress, suggesting that one-year forward rates as of June 30, 2007, would underestimate credit spreads in a recession. Likewise, using historic migration rates to predict migrations suffers from the fact that the business cycle has historically experienced longer periods of economic expansion than contraction.[230] Average historic migration rates thus represent a biased, overly optimistic depiction of the "true" migration rates to be expected in a period of economic contraction, leading several commentators to recommend adjusting them according to some model for macroeconomic variables or empirical evidence when using them in credit models such as *CreditMetrics*.[231]

For these reasons, Simulation 4 was rerun with several modifications to reflect credit spreads and migration rates under "stressed" conditions. With regard to credit spreads, in Simulation 4A,

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230. *See* Anil Bangia et al., *Ratings Migration and the Business Cycle, with Application to Credit Portfolio Stress Testing*, 26 J. BANKING & FIN. 445, 467 (2002) (noting that because of the existence after 1981 of longer periods of economic expansion than contraction, by using "unconditional transition matrices . . . one implicitly assumes the favorable business cycle pattern to be persistent going forward").

231. *See, e.g.*, STEFAN TRUECK & SVETLOZAR T. RACHEV, RATING BASED MODELING OF CREDIT RISK: THEORY AND APPLICATION OF MIGRATION MATRICES 5–6 (2009) (surveying literature and concluding that "it seems necessary to extend transition matrix application to a conditional perspective using additional information on the economy or even forecast transition matrices using revealed dependencies on macroeconomic indices and interest rates").

the credit curves used to value each CDO position were modified to reflect the credit curves in existence in October 2002, a time in which credit spreads widened dramatically following the bankruptcy of Enron and WorldCom.[232] Similarly with regard to migration rates, in Simulation 4B, the migration rates set forth in Table 4 were replaced with the one-year migration rates for 2002.[233] In contrast to Table 4, the 2002 transition matrix reflected a greater number of rating downgrades on account of the 2002 U.S. recession. Lastly, in Simulation 4C, the original credit curves and the transition matrix were both replaced with their stressed 2002 versions. In each of these three stressed simulations, Citigroup's actual portfolio was again simulated 100,000 times using the same portfolio assumptions as in the original Simulation 4.

As Figure 9 reveals, each of these stressed simulations produced considerably greater estimates of the tail risk embedded in Citigroup's CDO portfolio. At 99.9% confidence, expected trading losses increased from approximately $900 million in Simulation 4 to almost $3.5 billion (or 8% of the portfolio's value) in Simulation 4C. Estimates of expected shortfall revealed a similarly stark increase. Whereas expected shortfall in Simulation 4 was $1.7 billion, Simulation 4C produced an estimate for expected shortfall of nearly $7.4 billion. As these stressed estimates indicate, Citigroup's November 2007 announcement of CDO losses of $8 billion to $10 billion might have been improbable, but it was hardly unforeseeable— at least from the perspective of credit risk modeling technology in existence in June 2007.

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232. *See* Scott Grannis, *Credit Spread Update: Market Still Priced to Fearful Expectations*, SEEKING ALPHA (Sept. 16, 2009), http://seekingalpha.com/article/161709-credit-spread-update-market-still-priced-to-fearful-expectations (noting that before the Financial Crisis, corporate spreads had most recently peaked in October 2002 following the bankruptcies of Enron and Worldcom). As before, spread data was obtained from Bloomberg and Bondsonline. *See supra* note 222.

233. STANDARD & POOR'S, *supra* note 132, at 44 (providing 2002 transition matrix).

FIGURE 9: DISTRIBUTION OF ESTIMATED TRADING LOSSES FOR
CITIGROUP'S CDO PORTFOLIO UNDER STRESSED CONDITIONS
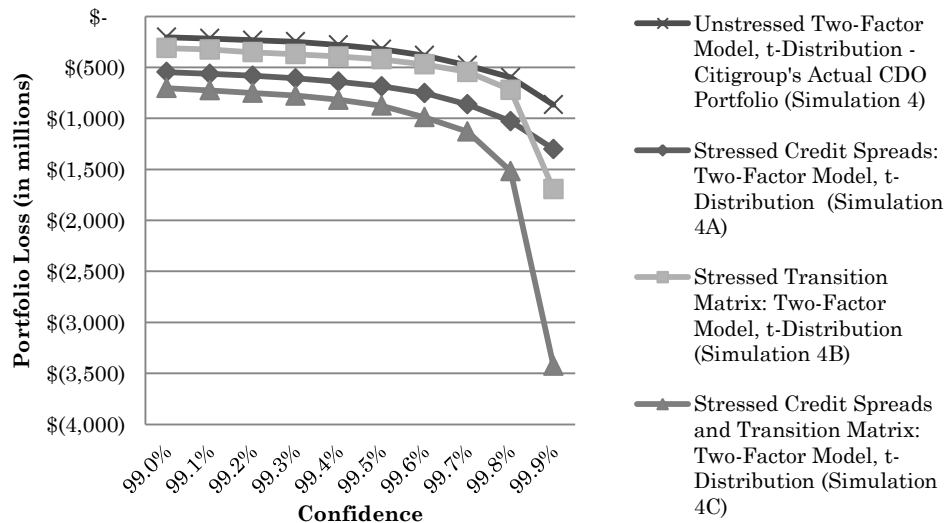
3. Model Assessment

As with the CINB illustration, the portfolio model used in the prior Section has a number of limitations that potentially undermine the reliability of its loss estimates. Most notably, the model treated the CDO notes held by Citigroup as largely the same as corporate bonds—an approach that, while not uncommon, has been criticized in the credit risk literature.[234] Specifically, because senior CDO tranches have been shown to be especially sensitive to systematic risk,[235] treating CDO notes as corporate bonds may have underestimated the portfolio's actual risk. Moreover, by limiting the analysis to Citigroup's CDO positions, the model also ignored how its CDOs (even if they did behave like corporate bonds) might also be correlated with other credit instruments in Citigroup's trading book. For instance, of its $538 billion of trading assets as of June 30, 2007, Citigroup's bank regulatory filings indicated it had approximately $21 billion of debt

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234. *See, e.g.*, LÖFFLER & POSCH, *supra* note 79, at 204 ("In credit portfolio modeling, one shouldn't treat CDO tranches as bonds with a standard factor sensitivity. This could lead to severe underestimation of portfolio risk.").

235. *Id.* (illustrating how a mezzanine tranche of a CDO with the same default probability of a corporate bond under normal market conditions can, under adverse market conditions, have a higher default probability).

securities issued by U.S. states and political subdivisions, $66 billion of mortgage-backed securities, and $71 billion of "other debt securities in domestic offices."[236] Each of these most likely had some positive correlation with the value of its CDO securities. A similar criticism could be made of the fact that the model did not incorporate the risk associated with Citibank's off-balance liabilities, such as its considerable indirect exposure to subprime mortgages held by several structured investment vehicles ("SIVs").[237] A more accurate analysis of Citigroup's trading risk might therefore have incorporated these other positions and their associated correlations with the CDO notes—a process that would undoubtedly have increased Citigroup's estimated losses.

Yet, while each of these issues limits the accuracy of the model used above, neither necessarily undermines the utility of using credit modeling technology to impose greater market discipline on financial institutions or of encouraging better disclosure of the relevant parameter estimates to facilitate it. For one, the fact that the model ignored correlations between the CDOs and other trading assets was a product of the limited public information regarding the composition of Citigroup's trading portfolio rather than a limitation of credit modeling per se. As a bank holding company, Citigroup has long been required to make quarterly filings on Form Y-9C with the Federal Reserve, which, among other things, provide an overview of the firm's assets and liabilities. With regard to trading assets, Schedule HC-D of the form requires bank holding companies to describe all trading positions, but the schedule has historically provided only aggregate notional amounts for select exposures.[238] Table 6, for instance,

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236. *See infra* text accompanying notes 238–40.

237. Citigroup had historically used SIVs to formally purchase AAA-rated securities from it, but it nevertheless remained exposed to their credit risk due to explicit and implicit guarantees to provide liquidity support to the SIVs were they unable to obtain financing in the short-term, asset-backed commercial paper market. When this market collapsed in winter of 2007, Citigroup was forced to rescue its SIVs, bringing $49 billion of assets onto Citigroup's balance sheet. *See* Arthur E. Wilmarth, Jr., *The Dark Side of Universal Banking: Financial Conglomerates and the Origins of the Subprime Financial Crisis*, 41 CONN. L. REV. 963, 1032–34 (2009) (describing SIVs); Shannon D. Harrington & Elizabeth Hester, *Citigroup to Consolidate Seven SIVs on Balance Sheet*, BLOOMBERG, Dec. 13, 2007, http://www.bloomberg.com/apps/news?pid=20601087&sid=amwIRXuKwRR8&refer=home (describing Citigroup rescue of its SIVs).

238. In addition, Citigroup provided a similar breakdown of its trading assets in its footnotes to its financial statements filed with the SEC. As with the Form Y-9C report, the breakdown was limited to approximately eight categories of security types. *See, e.g.*, Citigroup 2007 10-K Report, *supra* note 192, at 142 (describing its $538 billion of trading assets).

reproduces the trading assets listed on Citigroup's Schedule HC-D for June 30, 2007:[239]

TABLE 6: TRADING ASSETS OF CITIGROUP, INC. AS OF JUNE 30, 2007

U.S. Treasury securities in domestic offices	$10,119,000
U.S. Government agency obligations in domestic offices (excluding mortgage-backed securities)	$10,548,000
Securities issued by states and political subdivisions in the U.S. in domestic offices	$21,186,000
Mortgage-backed securities in domestic offices:	
a. Pass-through securities issued or guaranteed by FNMA, FHLMC, or GNMA	$19,936,000
b. Other MBS issued or guaranteed by FNMA, FHLMC, or GNMA	$8,076,000
c. All other mortgage-backed securities	$38,076,000
Other debt securities in domestic offices	$71,321,000
Other trading assets in domestic offices	$107,041,000
Other trading assets in foreign offices	$191,300,000
Derivatives with a positive fair value:	
a. In domestic offices	$26,969,000
b. In foreign offices	$33,744,000
Total trading assets	$538,316,000

Despite these disclosures, the vagueness of these categories makes it extraordinarily difficult to gauge even the scope of Citigroup's exposure to credit risk in its trading book, let alone the parameter estimates for its credit positions. At a minimum, the $38 billion of "all other mortgage-backed securities" most likely included private-label RMBS and CMBS not subject to any form of government guarantee, while the $71.3 billion of "other debt securities" presumably included credit instruments such as corporate bonds, loans, and (as the future would reveal) most of its CDO securities.[240]

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239. Citigroup, Inc., Consolidated Financial Statements for Bank Holding Companies (Form FR Y-9C) 16 (June 30, 2007) [hereinafter Citigroup 2007 Second Quarter Y-9C], *available at* http://www.citigroup.com/citi/fin/data/y9c070630c.pdf.

240. Comparison of Citigroup's Y-9C for June 30, 2007 with that for September 30, 2007 indicates that Citigroup classified its CDO positions as "other debt securities in domestic offices." Beginning in July 2007, Citigroup commenced the purchased of approximately $22 billion of the senior-most notes of CDOs which had previously been funded through the commercial paper markets. *See* Citigroup 2007 10-K Report, *supra* note 192, at 91. Despite these purchases, Citigroup's Form Y-9C for September 30, 2007, indicated a decrease from June 30, 2007, in the notional amount of almost all categories of trading assets except for "other debt securities,"

Yet credit risk may have also existed within the $298 billion of "other trading assets" in domestic and foreign offices and within the "derivatives" category. Had more detail concerning these credit positions been available—such as information on exposure amount by security type, each type's average parameter estimates, and a breakdown of security type by industry and country to estimate asset correlations—the model used previously could have produced a more comprehensive portfolio assessment.

Similarly, with respect to the model's failure to account for CDOs' greater exposure to systemic risk, this shortcoming does little to undermine the model's ability to provide market participants greater insight into the riskiness of a firm's trading portfolio. On the contrary, the fact that even the model used here was capable of producing significant loss estimates for Citigroup's CDO portfolio suggests the potential for even simple credit models to provide insight into firms' trading portfolios on both a relative and absolute basis. For instance, comparing the loss distribution for Citigroup's actual CDO portfolio of fifty positions against a hypothetical balanced portfolio of 439 positions illustrates how risk models might facilitate risk comparisons across firms. Were the hypothetical balanced portfolio to represent the trading portfolio of another bank, utilizing this type of analysis might highlight how name concentration within Citigroup's portfolio represented a significantly more risky strategy than was being pursued by other firms. For the same reasons, it might also facilitate better pricing of financial institutions within the capital markets while creating a powerful incentive to avoid name concentration in the first place. Moreover, even on an absolute basis, the fact that the model showed the potential for CDO-related losses of between $3 billion and $7.4 billion could be used to challenge the belief maintained by Citigroup through the fall of 2007 that "any downside risk in the CDO business was minuscule."[241]

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which increased from approximately $71 billion to $107 billion. *See* Citigroup 2007 Second Quarter Y-9C, *supra* note 239, at 16.

241. FCIC REPORT, *supra* note 167, at 262 ("[Charles] Prince and [Robert] Rubin [of Citigroup] appeared to believe up until the fall of 2007 that any downside risk in the CDO business was minuscule."); *see also* Bradley Keoun, *Citigroup, Ex-Chief Prince, Rubin Face Grilling on Loan Losses*, BUSINESSWEEK, Apr. 7, 2010, http://news.businessweek.com/article .asp?documentkey=1377-akilajq_ugua-4ablg0d9rk2rfakf5cff21uiin (statement of Thomas Maheras, former head of Citigroup trading) ("Even in the summer and fall of 2007, I continued to believe, based upon what I understood from the experts in the business, that the bank's super-senior CDO holdings were safe.").

In this regard, perhaps the greatest benefit of facilitating enhanced portfolio analysis by market participants is the extent to which it could provide a concrete means to probe a firm's risk-management practices. Consider, for instance, the ability of market participants to assess the consequence of Citigroup's efforts to engage in regulatory arbitrage in 2007. As noted previously, the distinct regulatory capital charges that applied to banking positions compared to trading positions created significant incentives for institutions to hold CDO securities in their trading books prior to the Financial Crisis.[242] Understanding whether this incentive actually led firms to hold insufficient capital against these positions, however, was made difficult by the absence of detail regarding firms' trading portfolios.

Again, Citigroup's trading position as of June 30, 2007, provides a vivid illustration. According to its quarterly report filed with the SEC on Form 10-Q for the quarter ended June 30, 2007, Citigroup appeared to be in full compliance with federal capital reserve requirements.[243] With risk-adjusted assets of $1.2 trillion, Citigroup's total regulatory capital of $131.25 billion—of which $92.4 billion was Tier 1 capital—indicated that it had a total capital ratio of 11.23% and a Tier 1 capital ratio of 7.91%.[244] This made Citigroup "well capitalized" for purposes of federal banking regulations.[245] Moreover, Citigroup's Form Y-9C filed with the Federal Reserve for the same quarter further indicated that its regulatory capital included $4.8 billion that Citigroup had specifically set aside to cover potential losses in its trading book,[246] $3.7 billion of which was attributable to

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242. *See supra* text accompanying notes 180–88.

243. As a U.S. bank holding company, Citigroup was subject to risk-based capital ratio guidelines issued by the FRB. Citigroup, Inc., Quarterly Report (Form 10-Q) 38 (Aug. 3, 2007) [hereinafter Citigroup Second Quarter 10-Q]. Under these guidelines as then in effect, a bank's capital adequacy was measured via two risk-based ratios, Tier 1 and Total Capital (Tier 1 + Tier 2 Capital). Tier 1 Capital was considered core capital and consisted of items such as equity and noncumulative perpetual preferred stock, while Total Capital also included other items such as subordinated debt and loan loss reserves. To be "well capitalized" under federal bank regulations in 2007, a bank holding company must have had, among other things, a Tier 1 Capital Ratio of at least 6% and a Total Capital Ratio of at least 10%. In computing these ratios, a bank's capital was measured as a percentage of the bank's risk-adjusted assets (which represented a type of weighted-average tally of a bank's assets intended to measure their credit and market risk). *See* 12 C.F.R. § 225.2(r)(1) (2009) (defining "well-capitalized").

244. Citigroup Second Quarter 10-Q, *supra* note 243, at 38.

245. *Id.*

246. *See* Citigroup 2007 Second Quarter Y-9C, *supra* note 239, at 32. Specifically, Citigroup's regulatory capital disclosures indicated that it had approximately $60 billion of "market risk equivalent assets." *Id.* Because regulatory capital was 8% of risk-weighted assets, this figure

"specific risk" or the pricing risk arising from idiosyncratic changes in a security's value including, most importantly, changes related to its default risk.[247]

Yet, whether these sums were sufficient to cover Citigroup's trading positions was unclear given the lack of detail concerning the composition of its trading portfolio. As Table 6 indicates, Citigroup had approximately $538 billion of trading assets, for which little information was provided with which to assess their riskiness and, consequently, the adequacy of Citigroup's $4.8 billion of regulatory capital established for its trading book. Moreover, because Citigroup qualified to use its own internal model to establish its market risk capital,[248] there was very little information available to the marketplace concerning the methodology it used to determine this amount. In contrast, the model used above might have provided the type of concrete analysis market participants could have used to press Citigroup on its capital assessment. Specifically, while the model analyzed just $43 billion of its trading portfolio (approximately 8% of its trading assets), the model indicated trading losses under 2002 stressed conditions of up to $3.5 billion at 99.9% confidence. Expected shortfall at 99.9% confidence was nearly twice this figure, at $7.4 billion—well in excess of both the $3.7 billion of regulatory capital Citigroup had set aside for specific risk and the $4.8 billion of regulatory capital it set aside for the *entire* trading book.

A similar analysis might have also provided insight into the reliability of Citigroup's assessment of its nonregulatory, "economic capital" in June 2007. Because regulatory capital represents the mandatory capital regulators require to be maintained by a financial institution, it may not necessarily reflect the capital that a firm's internal managers feel is necessary to maintain a firm's solvency under adverse market conditions.[249] For this reason, a firm's risk

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indicated that it had set aside capital to cover 8% of this amount. *See* HULL, *supra* note 17, at 230.

247. Citigroup 2007 Second Quarter Y-9, *supra* note 239, at 33 (recording $46 billion of market risk equivalent assets attributable to specific risk); *see* Federal Reserve System, Agency Information Collection Activities: Proposed Collection; Comment Request, 70 Fed. Reg. 66,426 (Nov. 2, 2005) (proposing specific risk disclosure requirement and noting that "[s]pecific risk means changes in the market value of specific positions due to factors other than broad market movements and includes event and default risk").

248. *See* Citigroup 2007 10-K Report, *supra* note 192, at 64 (describing internal model's compliance with FRB requirements).

249. *See* HULL, *supra* note 17, at 425 (distinguishing between regulatory capital which is mandated by bank regulators and economic capital which is "a bank's own internal estimate of the capital it needs for the risks it is taking").

managers routinely calculate their own estimate of economic capital based on an internal assessment of the firm's risk exposures and the confidence level they feel is appropriate to ensure that the firm will remain a going concern under adverse market conditions.[250] In the case of Citigroup, its 2007 annual report stated that it calculated its economic capital based on the amount of capital that would be required to absorb potential unexpected losses resulting from "extremely severe events over a one-year time period," which it defined as a "potential loss at a 99.97% confidence level."[251] The high confidence level reflected the fact that Citigroup's senior debt currently carried a debt rating of AA, and credit rating agencies used a 99.97% or 99.98% standard as a criterion for maintaining an AA rating.[252]

As of June 30, 2007, the result of Citigroup's economic capital analysis was to establish total risk capital of $74.2 billion.[253] Of this amount, Citigroup's 2007 second-quarter 10-Q indicated that $27.6 billion was allocated to its "Markets & Banking" segment which generally housed the firm's trading and investment banking operations as well as its commercial lending business.[254] As such, it represented the division that held Citigroup's $191 billion portfolio of held-to-maturity corporate loans,[255] its CDO exposures, and most of its other trading assets.[256] Like the assessment of regulatory capital, however, the means by which Citigroup determined that $27.6 billion was adequate to cover losses in the segment at 99.97% confidence was nowhere described in any of Citigroup's public filings. Indeed, even though the Markets & Banking segment engaged in a considerable amount of bank lending, the disclosure of the $27.6 billion of "risk

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250. *See* JAMES LAM, ENTERPRISE RISK MANAGEMENT 111 (2003) ("Economic capital is . . . a function of two quantities: the organization's so-called solvency standard and its risk.").

251. Citigroup 2007 10-K Report, *supra* note 192, at 39. For purposes of this calculation, drivers of "economic losses" were "risks, which can be broadly categorized as credit risk (including cross-border risk), market risk and operational risk." *Id.*

252. *See* PHILIPPE JORIAN, VALUE AT RISK 407 (3d ed. 2007) ("Banks routinely provide their economic capital measure using a 99.98% confidence level, which . . . corresponds to a target credit rating of Aa.").

253. Citigroup Second Quarter 10-Q, *supra* note 244, at 24.

254. *Id.* at 18.

255. *Id.* at 47.

256. Of Citigroup's other five divisions, only Alternative Investments (which managed investments primarily in private equity and hedge funds) was likely to hold a significant amount of Citigroup's trading assets. Citigroup's annual report for 2006, for instance, indicated that the division managed $38.5 billion of client capital and $10.7 billion of Citigroup's capital. Citigroup, Inc. Annual Report (Form 10-K) 54 (Feb. 23, 2007).

capital" made no distinction between the portion that represented risk arising from its banking book compared to its trading book.

As with the analysis of Citigroup's regulatory capital, the simple model used above might have provided useful information with which to examine how well the segment was protected against stressed losses at 99.97% confidence. For instance, rerunning Simulation 4C 1,000,000 times, a loss distribution was generated to estimate the portfolio's loss at this higher degree of confidence. Doing so revealed a loss estimate at 99.97% confidence of approximately $8 billion, approximately one-third of the $27.6 billion of capital allocated to the entire segment. With this figure alone, one might naturally wonder how securities comprising just 7% of the firm's trading portfolio could absorb one-third of the capital allocated for the division holding this portfolio as well as $191 billion in corporate bank loans. Indeed, the question becomes all the more puzzling given that most of the corporate bank loans were likely to have a lower credit rating than the CDOs, thus potentially requiring a significant portion of this $27 billion to cover their unexpected losses.[257]

Of course, whether or not investors would actually engage in this type of analysis must remain speculative. As the next Part examines, there may indeed be a number of factors that impair the incentives of investors to probe the risk management practices of financial institutions prior to the onset of distress. Yet while the aforementioned benefits may be speculative, it bears emphasizing how little they would require in terms of additional disclosure obligations from the perspective of individual financial institutions. As with the prior analysis of traditional banking risk, modeling credit risk within a trading portfolio requires just a handful of parameter estimates, none of which would seem to implicate the disclosure of either proprietary trading positions or customer information.

Indeed, in the case of Citigroup, constructing its CDO portfolio was based primarily on the simple disclosure of position sizes and

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257. To be sure, an analyst performing this hypothetical exercise would have to consider the possibility that Citigroup had offset a portion of this credit risk through hedging transactions. Such a possibility, however, does little to undermine the utility of the foregoing analysis. Rather, by providing market participants with a metric to examine the risk associated with Citigroup's gross credit exposures, the analysis could be used to press Citigroup management (e.g., during analyst calls) as to why these loss estimates might overstate Citigroup's actual position (whether due to hedging or other risk mitigation strategies). Additionally, the possibility of hedging might also be addressed through requiring credit exposures to be disclosed on both a hedged and un-hedged basis. *See infra* Appendix. In the case of Citigroup's actual CDO positions, no hedges were used for the $43 billion of CDOs analyzed here. *See supra* note 209.

credit ratings, with the remainder of the parameter estimates coming from publicly available sources. Yet even the individual position sizes need not be disclosed to the extent such disclosure might compromise a firm's proprietary trading strategy. For instance, the same simulated results obtained from analyzing Citigroup's actual position data could have been roughly approximated if Citigroup had simply disclosed that its $44 billion CDO portfolio was spread over fifty positions. As Figure 10 reveals, rerunning Simulation 4 and Simulation 4C using a hypothetical portfolio of fifty CDO positions with each having an exposure amount of $880 million produced risk measures that were remarkably similar to the measures obtained using Citigroup's actual exposure amounts. Ultimately, the fact that enabling the type of market discipline discussed above would require simply a breakdown of the trading assets already disclosed in Schedule HC-D by asset type, average rating, and average exposure amount is perhaps the most notable insight from the Citigroup modeling exercise.

FIGURE 10: ESTIMATED TRADING LOSSES FOR CITIGROUP'S CDO PORTFOLIO UNDER DIFFERENT ASSUMPTIONS OF NAME CONCENTRATION
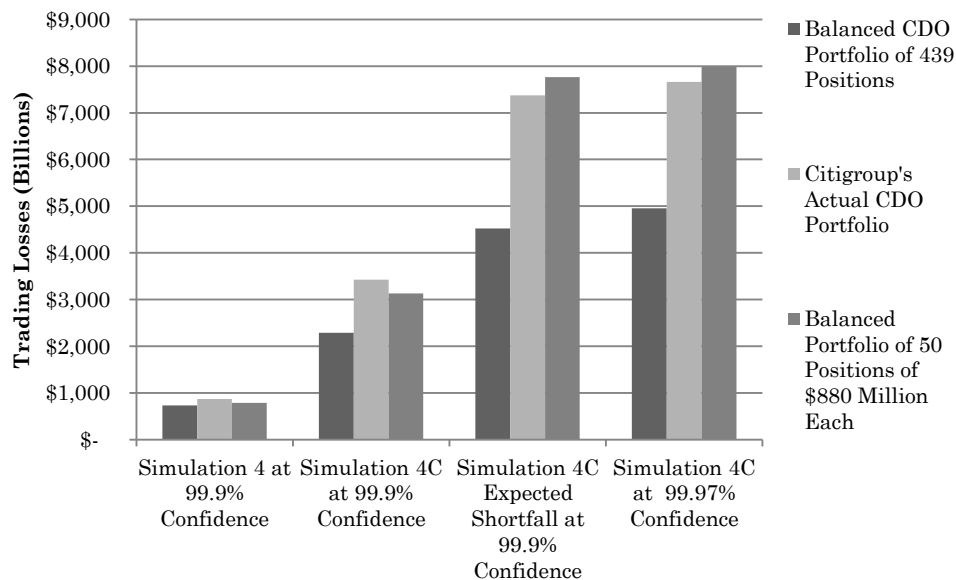
V. TOWARD A MODEL-SENSITIVE DISCLOSURE REGIME

As the foregoing discussion illustrates, providing market participants with greater information about a financial institution's solvency risk need not require the disclosure of a firm's proprietary position information. Nor would it necessarily require a significant overhaul of existing disclosure regulations or require market participants to sift through a maze of different disclosures to stitch together an understanding of a firm's credit portfolio. Despite the significantly different problems that afflicted CINB and Citigroup, the analysis of each firm in Part IV required only incrementally more information regarding each institution's banking book and trading book than current disclosure obligations require. In particular, greater disclosure within each bank's federal banking reports concerning its segmentation of credit risk across industries (including segmentation by structured finance vehicle), combined with estimates within these segments of the distribution of exposure amounts and average default probabilities and recovery rates, were all that our hypothetical analyst needed to build a model that highlighted each firm's undercapitalization.

To be clear, the claim made here is not that market participants would have used the particular credit models designed for this study. As was noted at the outset, the models utilized in Part IV represent merely basic, textbook credit portfolio models as of the time shortly before the Financial Crisis. As such, were the core set of parameter estimates explored in Part III disclosed by banks, real-life credit analysts would no doubt use more modern, sophisticated approaches to analyze banks' credit portfolios.[258] In the absence of such disclosures, however, one can only speculate as to the types of models that would be used and their overall effectiveness, thus motivating the use of the thought experiment in Part IV. That it relied on such basic credit models was simply meant to illustrate how even a simple model prior to the Financial Crisis (and one that in hindsight

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258. Presumably, these would include updated, off-the-rack approaches such as JP Morgan's CreditMetrics, McKinsey's CreditPortfolioView, or KMV's Portfolio Manager, as well as proprietary models designed by particular analysts. *See* CAOUETTE ET AL., *supra* note 23, at 231–51 (describing different portfolio approaches); Bartlett, *supra* note 22, at 42–48 (describing Pershing Square's model used for analyzing monoline insurance companies).

made unduly optimistic assumptions[259]) could have still been used to highlight some of the risks CINB and Citigroup were taking— provided the banks had disclosed even some of the core set of parameter estimates at the heart of credit analysis.

Nor does this Article intend to suggest that a model-sensitive disclosure regime would necessarily be restricted to the core set of risk parameters used in Part IV. Portfolio analysis has evolved significantly over recent years and will no doubt continue to do so, making the analysis provided above simply a snapshot of the basic structure of credit risk analysis as it stands today. The foregoing analysis was also limited to each bank's on-balance-sheet, unhedged, gross exposures.[260] While these exposures played a critical role in the turmoil at CINB and Citigroup, real-life credit models would naturally reflect a more sophisticated account of the full scope of a firm's credit exposure, including the extent to which hedges affect the risk of these gross exposures along with the hedges' basis risk.[261] A disclosure regime that was truly responsive to credit modeling technology might thus entail disclosures concerning a more expansive, evolving set of parameters than the four estimates that are currently at the heart of credit risk analysis.

Rather, the general argument advanced here is that the same sensitivity to state-of-the-art credit analysis that informs banks' own risk management processes should also inform the structure of mandatory bank disclosures. Indeed, sensitivity to developments in credit risk analysis is already a well-established practice when it comes to setting capital requirements both in the United States and abroad. It was, after all, an appreciation of the evolution of credit risk analysis that initially prompted regulators to permit banks to set their regulatory capital using their own internal models in Pillar I of the

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259. *See supra* text accompanying notes 234–35. Additionally, the model used to analyze Citigroup's CDO portfolio relied on a transition matrix for bonds that significantly underestimated the true, downward migration rate of the highly rated bonds issued by CDOs in 2008. *See* Saunders & Allen, *supra* note 90, at 29–31 (discussing failure of rating agencies to account for the poor quality of collateral underlying subprime mortgage pools prior to the Financial Crisis).

260. For instance, as noted previously, the model used for Citigroup did not account for the bank's indirect exposure to subprime-backed CDOs held in June 2007 in one of several off-balance-sheet SIVs. *See supra* text accompanying note 237.

261. *See* HULL, *supra* note 17, at 313–19 (describing methodology for accounting for credit hedging).

Basel II Capital Accords.[262] As this Article has demonstrated, however, there is no reason why the lessons of credit risk management should be so limited. Notwithstanding the simplicity of the CINB and Citigroup models, each provides an intriguing illustration of how integrating bank disclosure policy with even basic credit risk modeling might provide significant new information to the marketplace while avoiding the constraints that have traditionally hamstrung bank disclosures. As such, credit risk modeling would seem especially pertinent to designing not only banks' Pillar I capital requirements but also their Pillar III disclosure obligations.

What exactly would a model-sensitive disclosure regime require? Because of the evolving nature of credit risk analysis, the exact form of such a regime will necessarily involve some degree of fluidity. As credit models change, the informational architecture for assessing portfolio risk should also be expected to change, and with it, the assessment of what disclosures would be most useful for assessing the credit risk within a financial institution. But at a minimum, it is clear any such disclosures would depart notably from the current U.S. reporting system which, in many ways, has historically functioned as if the considerable world of credit risk analysis is limited to banks' internal risk management. Despite the central role of correlation and concentration risk in credit analysis, for instance, existing disclosures mandated by federal banking regulations make it extraordinarily difficult to discern how even these two critical issues might affect a banking institution's risk profile. As noted in Part IV, the disclosures regarding a bank's trading assets set forth in Schedule HC-D of Form Y-9C provide virtually no information concerning the extent to which the trading book is even exposed to credit risk, let alone how it might be affected by name or sector concentration. With respect to a bank's traditional loan portfolio, the disclosures mandated in areas such as Schedule HC-C of Form Y-9C are slightly more useful insofar that they provide a partial breakdown of a bank's loan book by loan type,[263]

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262. *See supra* text accompanying note 182 (describing market risk capital); *see also* MICHAEL K. ONG, INTERNAL CREDIT RISK MODELS: CAPITAL ALLOCATION AND PERFORMANCE MEASUREMENT 20 (1999) (quoting Alan Greenspan: "These internal capital allocation models have much to teach the supervisor, and are critical to understanding the possible misallocative effects of [an] inappropriate capital rule.").

263. *See* BD. OF GOVERNORS OF THE FED. RESERVE SYS., INSTRUCTIONS FOR PREPARATION OF CONSOLIDATED FINANCIAL STATEMENTS FOR BANK HOLDING COMPANIES: REPORTING FORM FR Y-9C, at HC-C-2 to -23 (Mar. 2007), *available at* http://www.federalreserve.gov/reportforms/forms /FR_Y-9C20101231_i.pdf (describing loan categories to which loans held for investment must be assigned).

but similarly lack useful details concerning whether these loan types are exposed to sector, name, or regional concentrations.[264] For example, disclosures concerning a bank's commercial and industrial loans are limited to the aggregate dollar-value of loans made "[t]o U.S. addressees" and those made "to non-U.S. addressees."[265] Most other itemized loan categories provide even less information, listing simply the dollar-value of loans "secured by 1-4 family residential properties" or "credit card loans."[266]

In contrast, a disclosure regime that was more sensitive to credit risk analysis would presumably begin by acknowledging the central role of concentration and correlation in understanding the portfolio risks posed in an institution's banking and trading books. Again, the precise format would ideally involve an ongoing consideration of the technology banks and analysts use to measure and monitor credit risk, but the basic principles of credit analysis outlined previously suggest a number of ways in which current disclosure policy could be enhanced. Outlined in the Appendix, for instance, is but one way in which existing quarterly bank reports could be modified to enhance the disclosure of credit exposures in an institution's banking and trading books. By breaking down net and gross exposures by both region and industry as well as by providing information on name concentration, the disclosures described in the Appendix would provide a starting point for the analysis of a portfolio's correlation structure and concentration risk in much the same fashion that was done for CINB and Citigroup in Part IV. Using this approach would also maximize the ability of market participants to use the considerable third-party research on credit risk that commonly analyzes credit risk using the same categories set forth in the Appendix (e.g., by industry and structured finance classification).[267] Standardizing the classification of credit risk by itself may also facilitate the production of additional third-party research on how the primary parameters of credit risk operate within these categories. By using additional arrays within this structure, banks could further provide their own internal estimates of credit

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264. *Id.*

265. *Id.* at HC-C-10.

266. *Id.* at HC-C-4, HC-C-12.

267. *See*, *e.g.*, Van Landschoot & Jobst, *supra* note 131, at 235 (analyzing asset correlation using the same industry classifications as used in the Appendix).

parameters such as average default probability, loss given default, and asset correlation.[268]

Focusing on regional, industrial, and name concentrations might also address one other limitation of prevailing disclosures: the issue of complexity. As noted previously, one of the primary challenges facing bank disclosure policy has been the fact that requiring a disaggregated presentation of a bank's assets could entail an extraordinarily complex and costly procedure for both banks and investors. As Citigroup argued in its defense to the allegation that it had failed to disclose its CDO exposures prior to November 2007, "the type of line item disclosure suggested by plaintiffs would be overly burdensome and time consuming to prepare, and the resulting disclosure would be too granular to be meaningful."[269] Scholars and investors, too, have frequently articulated the concern that the amount of information required to assess a bank's risk profile may be too complicated for investors to process quickly in a meaningful way, particularly with respect to a bank's exposure to complex credit derivatives.[270]

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268. To facilitate voluntary disclosure of these additional estimates, the regime could also make clear that disclosures concerning a portfolio's parameter estimates constitute forward-looking statements under section 21E of the Exchange Act. Such an approach would insulate potentially inaccurate estimates from private civil liability under federal securities laws yet still render them subject to public antifraud enforcement. *See* 15 U.S.C. §§ 77z-2(c)(1)(A)(i), 78u-5(c)(1)(A)(i) (providing a safe harbor from private civil 10b-5 liability for forward-looking statements "accompanied by meaningful cautionary statements"). As Amanda Rose has noted, private civil antifraud liability under U.S. securities laws may have considerable chilling effects on firms' disclosure of forward-looking information (such as a prediction relating to default probabilities) given the inability to ensure its accuracy and the considerable liability that will attach if a tribunal, after the fact, views a mistaken prediction as having been made with fraudulent intent. *See* Amanda M. Rose, *The Multienforcer Approach to Securities Fraud Deterrence: A Critical Analysis*, 158 U. PA. L. REV. 2173, 2184 (2010). Limiting the authority to police deceitful disclosure of a portfolio's parameter estimates to a financial institution's primary regulator under section 12(i) of the Exchange Act would diminish the incentive of firms to make inaccurate estimates while avoiding the chilling effect of full civil liability. Ideally, such an approach would also be coupled with incentivizing regulators to balance both the social costs of permitting fraudulent parameter estimates and the chilling effects of mistakenly finding fraud where none exists. *See id.* at 2192–98 (articulating theory of the "well-incentivized" antifraud enforcer).

269. *See* Defendants' Memorandum of Law in Support of Their Motion to Dismiss the Amended Consolidated Class Action Complaint at 26 n.21, *In re* Citigroup Inc. Sec. Litig., 753 F. Supp. 2d 206 (S.D.N.Y. 2010) (No. 07 Civ. 9901), 2009 WL 773441.

270. *See, e.g.*, Steven L. Schwarcz, *Rethinking the Disclosure Paradigm in a World of Complexity*, 2004 U. ILL. L. REV. 1, 19 (arguing that many legitimate transactions in which securities are issued are "so complex that less than a critical mass of investors can understand them in a reasonable time period [and to that extent] the market will not reach a fully informed price equilibrium, and hence will not be efficient"); *see also* Letter from Warren Buffett,

Without diminishing the significance of this challenge, one of the more notable features of both the CINB and Citigroup analyses in Part IV was the remarkably straightforward way in which each institution's credit woes were manifested. Despite the vast difference between the two institutions, each ultimately suffered from poorly managed, unhedged credit concentrations that could have been highlighted with a disclosure regime outlined in the Appendix. To be sure, even such disclosures would understate the actual extent to which each firm was exposed to credit risk. For instance, simply disclosing the aggregate amount of Citigroup's holdings of CDOs, RMBS, and other asset-backed securities would have concealed the extent to which Citigroup was exposed to the subprime housing market.[271] Yet doing so would have nevertheless highlighted the fact that Citigroup held close to $50 billion of unhedged CDOs across just fifty positions. Moreover, by standardizing this disclosure across institutions, such information might have also helped make more salient the significant, largely illiquid CDO concentrations that many banks began building in their trading books throughout 2006 and 2007.[272] In the process, it may have even provided a deterrent for doing so in the first place.

Having chosen to focus on two historical banking crises, this Article nevertheless raises two potential objections worth addressing in closing. The first relates to the oft-mentioned concern that any regulatory proposal aimed at addressing past crises potentially risks "fighting the last war" rather than anticipating the new and different crises of the future.[273] The second, somewhat conflicting one relates to the traditional concern that if market participants failed to detect these significant banking crises in the past, what confidence can we

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Chairman of the Bd., Berkshire Hathaway Inc., to the Shareholders of Berkshire Hathaway 17 (Feb. 27, 2009), *available at* http://www.berkshirehathaway.com/letters/2008ltr.pdf ("Improved 'transparency'—a favorite remedy of politicians, commentators and financial regulators for averting future train wrecks—won't cure the problems that derivatives pose. I know of no reporting mechanism that would come close to describing and measuring the risks in a huge and complex portfolio of derivatives . . . . When I read the pages of 'disclosure' in 10-Ks of companies that are entangled with these instruments, all I end up knowing is that I *don't* know what is going on in their portfolios (and then I reach for some aspirin).").

271. *See supra* text accompanying note 237 (describing Citigroup SIVs).

272. *See supra* text accompanying notes 179–88 (describing buildup of CDOs within financial institutions' trading books).

273. *See, e.g.*, Adam J. Levitin, *In Defense of Bailouts*, 99 GEO. L.J. 435, 462 (2011) ("As a general matter, regulators tend to regulate to prevent the last crisis, much as generals often train to fight the last war. Unfortunately, financial crises tend to be perennial but always appear in a new guise.").

have that they will use incrementally improved disclosures to behave differently in the future?

　　With respect to the first consideration, the history of banking crises has unfortunately demonstrated the very real problems that can arise when bank regulations focus on "fighting the last war." Indeed, bank regulations implemented after the collapse of CINB provide a telling illustration. Recognizing the risk that loan concentrations can pose for a bank, both U.S. and international banking regulators imposed regulations during the late 1980s designed to limit credit concentrations within a loan portfolio.[274] It was also during this time period that bank regulators significantly revised capital requirements for credit risk, as reflected in the original 1988 Basel Accords.[275] Neither set of reforms, however, anticipated the extent to which concentrations of credit risk could migrate from the banking book to the trading book where, as noted previously, the market risk capital requirements permitted banks to reduce the capital they were required to hold for what was simply a new manifestation of credit risk. More recently, reforms such as the Basel Committee's "incremental risk charge"[276] as well as Dodd-Frank's Volcker Rule[277] aim to prevent a repeat of such regulatory arbitrage between banking and trading books, but for many, these attempts to prevent a

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274. *See, e.g.*, Ellen W. Smith, *New Controls on Global Debt: The International Lending Supervision Act of 1983*, 17 CORNELL INT'L L.J. 425, 433–46 (1984) (describing concentration limits imposed on banking lending in the wake of CINB's collapse).

275. *Cf.* Patricia A. McCoy, *Musings on the Seeming Inevitability of Global Convergence in Banking Law*, 7 CONN. INS. L.J. 433, 444 (2001) (noting how the original Basel capital accords were developed in response to international banking scandals, including among them, the failure of CINB).

276. The incremental risk charge (or IRC) for the trading book was originally proposed by the Basel Committee in 2005 due to concerns that banks were reducing their capital requirements by shifting their exposures from the banking book to the trading book in the manner described at text accompanying notes 179–88. *See* HULL, *supra* note 17, at 242. In general the IRC will require banks to hold additional capital against their trading book assets to capture both default and migration risk for debt securities within it. For an overview of the IRC calculation, see STANDARD & POOR'S, PROPOSED BASEL II RULES WOULD REQUIRE BANKS TO HOLD MORE CAPITAL AGAINST TRADING RISK 2–3 (Feb. 24, 2009), *available at* http://www2.standardandpoors.com/spf/pdf/media/Basel_II_Banks_Capital_03_30_09.pdf.

277. The so-called "Volcker Rule," implemented in section 619 of the Dodd-Frank Act, prohibits banking entities from engaging in certain forms of proprietary trading, which might significantly reduce the size of banking institutions' trading books. Dodd-Frank Wall Street Reform and Consumer Protection Act, Pub. L. No. 111-203, 124 Stat. 1376-2223 (2010).

recurrence of the Financial Crisis simply provide an incentive for banks to find new means to hold and trade credit risk.[278]

In contrast, one of the benefits of making bank disclosures sensitive to credit risk modeling is that it should help reduce the ability of banks to reinvent credit risk in new and opaque ways. As noted above, despite the significant differences between the CINB and Citigroup crises, the fundamental challenge was remarkably similar in that both institutions failed to manage credit risk concentrations. What distinguished the two experiences from a risk management perspective was that the locus of these credit concentrations had migrated from the banking book to the trading book—a migration that was actually induced by regulatory attempts to capture credit risk.[279] Yet, while an institution's exposure to credit risk might not be fully reflected in its banking book, bank risk managers knew it still existed in the trading book. Indeed, models such as *CreditMetrics* were designed so that banks could measure and manage that risk. As capital markets continue to develop new forms of credit risk instruments, there is no reason to expect the market for credit risk models to behave any differently. Focusing on how the banking industry itself continues to measure and manage credit risk can thus help ensure that market participants are also capable of tracking credit risk presence through other yet-to-be-determined domains of a bank's operations.

The more difficult question to answer is gauging the extent to which market participants will actually undertake the type of analysis illustrated in Part IV. As has frequently been noted, both federal deposit insurance as well as the implicit (and, as demonstrated in 2008, explicit) government guarantees afforded large banking institutions may very well diminish the incentives of a bank's

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278. *See, e.g.*, Simone Varotto, *Stress Testing Credit Risk: The Great Depression Scenario*, (ICMA Centre Discussion Papers in Finance DP2010-03, 2010), *available at* http://www.icmacentre.ac.uk/files/dp201003.pdf (finding that although the IRC may be considerable, the capital needed to absorb market risk related to trading losses in stressed scenarios can be more than twenty times larger than the IRC requires); Raj Date, Through the Looking Glass (Steagall): Banks, Broker Dealers, and the Volcker Rule (Jan. 27, 2010), *available at* http://www.cambridgewinter.org/Cambridge_Winter/Archives/Entries/
2010/1/27_THROUGH_THE_LOOKING_GLASS_(STEAGALL)_files/looking%20glass%20steagall%20012710_1.pdf (criticizing limits to the Volcker Rule as implemented in the Dodd-Frank Act); *The Volcker Rule, Merkley-Levin, and Loopholes (Gory Details Edition)*, ECONOMICS OF CONTEMPT, Nov. 6, 2010, http://economicsofcontempt.blogspot.com/2010/11/volcker-rule-merkley-levin-and.html (same).

279. *See supra* text accompanying note 274.

depositors and investors to monitor its risk profile.[280] Moreover, for reasons discussed previously, a bank's equity investors may also have strong incentives for a banking institution to hold inadequate capital to support its risk-taking activities.[281] The potential for such incentives among a firm's investors naturally poses a challenge for any attempt to facilitate enhanced market discipline of financial institutions.

Yet, despite this possibility, banking institutions are hardly immune from market discipline. A significant body of empirical research, for instance, has documented that market participants do in fact exact an institution-specific risk premium from banking organizations.[282] Perhaps because they are less likely to benefit from the government's implicit guarantee, a bank's junior creditors appear to be especially active in monitoring banks.[283] And of course, when particular industries or regions experience a significant downturn, there is no shortage of analysts, such as Matt King or hedge funds, who exert downward pricing pressure on institutions believed to be exposed to distressed credits.[284] With regard to understanding the incentives of a bank's investors, the more accurate question is thus not whether markets can discipline banks at all, but why they do not seem to obtain more granular banking disclosures in nondistress settings. Stated somewhat differently, if investors truly valued additional bank disclosures in nondistress settings, why wouldn't banks already be providing them voluntarily?

While it is difficult to know for sure, there are good reasons to believe that the lack of more granular information in nondistress settings may stem from a basic principal-agent challenge within

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280. *See, e.g.*, Levitin, *supra* note 273, at 490 ("[I]f either or both creditors and shareholders of such a [Too-Big-To-Fail] institution believe they will be made whole in a bailout—or not bear all the losses—they will have a reduced incentive to monitor the . . . institution's risk-taking.").

281. *See supra* Part II.

282. *See generally* Mark J. Flannery & Stanislava Nikolova, *Market Discipline of U.S. Financial Firms: Recent Evidence and Research Issues*, *in* MARKET DISCIPLINE ACROSS COUNTRIES AND INDUSTRIES 87 (Claudio Borio et al. eds., 2004) (summarizing literature).

283. *See*, *e.g.*, *id.* (summarizing research on market discipline by subordinated debt holders); Isabelle Distinguin & Clovis Rugemintwari, The Role of Market Discipline on Bank Capital Buffer: Evidence from a Sample of European Banks (Jan. 2011) (unpublished manuscript), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1739690 (finding that junior and senior debt holders exert pressure on commercial banks to hold additional capital, with junior creditors requiring additional capital for banks that pursue non-traditional lending activities).

284. *See supra* text accompanying notes 1–6 (discussing Citigroup's analysts in 2007); *see also* Bartlett, *supra* note 22, at 42–48 (discussing use by Pershing Square Capital of disclosures made by monoline insurers in early 2008).

financial institutions that is particularly acute given the history of federal banking policy discussed in Part II. As is well known, in a world where contracts are incompletely specified, any principal-agent relationship will necessarily entail some risk that an agent will use her discretion in a fashion that may adversely affect the welfare of the principal.[285] For this reason, in well-functioning markets, investors (acting as principals) should ordinarily be expected to demand contract covenants from managers (acting as their agents) to protect against this risk, of which enhanced disclosure is but one type of protective mechanism.[286] Alternative methods of policing agency risks include securing some form of a performance bond from the agent or simply discounting the price at which the principal is willing to enter into the relationship.[287]

As applied to a bank's managers and its investors, this basic framework admits a straightforward explanation as for why investors may value more granular portfolio information but may not receive it until exposures within a bank become distressed. While the type of disclosures suggested in the Appendix does not require revelation of a bank's proprietary position information, the disclosures nevertheless impose some degree of costs on bank managers. These costs might include, for instance, the cost to the banking institution of revealing incrementally more information concerning its investment strategies as well as costs to bank managers of highlighting potential

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285. *See* Michael C. Jensen & William H. Meckling, *Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure*, 3 J. FIN. ECON. 305, 309 (1976) (noting that "agency costs arise in any situation involving cooperative effort . . . by two or more people even though there is no clear-cut principal-agent relationship"). To be clear, the principal-agent relationship at issue here is derived from principal-agent economics, rather than from the law of principal-agent. *See* Kenneth Arrow, *The Economics of Agency*, *in* PRINCIPALS AND AGENTS: THE STRUCTURE OF BUSINESS 37, 44 (1985) (describing an agency relationship as one in which "[t]he action [of the agent] affects the economic welfare of both the agent and another person, the principal").

286. *See generally* Robert P. Bartlett, III, *Venture Capital, Agency Costs, and the False Dichotomy of the Corporation*, 54 UCLA L. REV. 37, 48–51 (2006) (summarizing literature applying agency theory to explain the capital structure of business organizations).

287. *See id.* at 50; Jensen & Meckling, *supra* note 285, at 309 (describing the solution to agency problems as consisting of monitoring, bonding, or pricing the agency costs). A similar dynamic is at work in George Akerlof's classic model of a market-for-lemons: if buyers cannot adequately observe the quality of products, they will demand a discount to bear the risk of quality uncertainty, driving good quality products from the marketplace until a market can no longer function. *See generally* George A. Akerlof, *The Market for "Lemons": Quality Uncertainty and the Market Mechanism*, 84 Q. J. ECON. 488 (1970) (developing the "market for lemons" theory). For an explanation for why discounting is unlikely to create a market for lemons in the context of bank investors, see *infra* note 288.

mismanagement of credit risk. For this reason, a bank's managers may very well choose to suffer a pricing discount within the capital markets rather than disclose additional portfolio information that investors could use to more precisely calibrate the risk of its credit portfolio. This might be especially true in light of federal banking policy that has historically privileged prudential regulation and oversight of banks at the expense of bank transparency.[288] In contrast, if the bank's loan portfolio later becomes distressed, bank managers may then have strong incentives to avoid this pricing discount by providing more information concerning the distressed sectors. The reason stems from the fact that the pricing discount imposed by capital markets will often demonstrate nonlinearity upon credit deterioration within a loan portfolio.[289]

To see how this could occur, consider a bank holding a simple two-loan portfolio as illustrated in Figure 11a. The bank, of course, knows that the true composition of its $1,000 loan portfolio is evenly split between two companies that are exposed to Sector A and Sector B, respectively. The bank's managers, however, may be reluctant to disclose this information to the public so long as the pricing discount imposed by the capital markets is less than the value the managers place on confidentiality. In particular, assuming the bank discloses only its general exposure to Sector A and Sector B, rational investors might penalize the bank for not disclosing more granular information

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288. More specifically, federal banking policy might incentivize bank managers to opt for a pricing discount over more granular disclosures for two reasons. First, as discussed previously, the historically inconsistent approach to bank disclosure policy might make banks and investors uncertain of what may and may not be voluntarily disclosed by banks, thus adding regulatory compliance risk to the cost of disclosure from the perspective of bank managers. Second, bank regulators represent the type of "counteracting institution" in Akerlof's model for a market for lemons that allows a market to function notwithstanding the inability of investors to distinguish high quality banks from low quality banks. *Cf.* Marc T. Law, *The Origins of State Pure Food Regulation*, 63 J. ECON. HIST. 1103, 1119–28 (2003) (arguing that state regulation of food quality permitted food markets to function in the late 1880s notwithstanding the inability of consumers to distinguish between producers who engaged in food adulteration from those who did not). For similar reasons, the fact that bank regulators monitor the safety and soundness of financial institutions may be perceived to diminish the risks posed by bank opacity and, as a result, the pricing discount markets place on banks that fail to disclose more granular information.

289. Additionally, federal banking disclosure policy has generally encouraged banks to disclose problems within their credit portfolios to the extent they have increased loan loss reserves or are likely to do so. *See, e.g.*, Securities and Exchange Commission, Revision of Industry Guide Disclosures for Bank Holding Companies, 48 Fed. Reg. 37,609 (1983) (requiring bank holding companies to provide in their quarterly SEC filings a description of "nonaccrual, past due and restructured loans" as well as "potential problem loans"). Such policies likely diminish a bank's concern about whether disclosure of its exposure to problematic loans or sectors is consistent with federal banking regulations.

by assuming the bank was concentrated in one of the two sectors. The second half of Figure 11a, for instance, indicates what would happen if investors assumed the bank was exposed 75% to one of the sectors but otherwise shared the bank's estimate of each sector's risk parameters. Based on the assumptions set forth in Figure 11a, this would result in an identical calculation of expected loss, but it would produce a 99.9% credit VaR that was approximately 11% higher than the bank's calculation. Assuming the market expects the bank to withstand losses at 99.9% confidence, the bank might therefore choose to hold slightly more capital than its internal models suggest is necessary rather than disclose more information concerning the composition of its loan portfolio.

FIGURE 11A: ACTUAL PORTFOLIO VS. MARKET ASSUMPTIONS UNDER NORMAL MARKET CONDITIONS

	Actual Loan Portfolio Known by Bank		Bank's Loan Portfolio Assumed by the Market		
	Exposure to Sector		Exposure to Sector		
	A	B	A	B	*Difference Between Actual Loan Portfolio and Market Assumption*
Adjusted Exposure	$500	$500	$750	$250	
Default Probability	5.0%	5.0%	5.0%	5.0%	
Loss Given Default	50%	50%	50%	50%	
Expected Loss	$12.50	$12.50	$18.75	$6.25	
Factor Correlation	0%	0%	0%	0%	
Portfolio Expected Loss	$25		$25		0%
99.9% Credit VaR	$263		$291		11%

Yet this solution might suddenly appear suboptimal for the bank's managers to the extent Sector A experiences a sudden deterioration in credit quality. If, for instance, the default probability for Sector A jumped from 5% to 10% as reflected in Figure 11b, the bank's internal estimate of expected loss would increase to $50 (an increase of 100%), while its 99.9% credit VaR would increase 66% to $436. At the same time, market participants—still lacking information concerning the bank's actual exposure to Sector A—might

now "assume the worse"[290] and conclude that the bank's portfolio is concentrated in Sector A rather than Sector B. Under the same assumption that its portfolio has a 75% exposure to this sector, the market's estimate for expected loss would now increase to $62.50 (25% greater than the bank's) while 99.9% credit VaR would increase to $591 (35% greater than the bank's).[291] Faced with a widening gulf between the market's estimate of the bank's risk and the bank's internal estimate, the bank's managers might now choose to provide more granular details concerning its exposure to Sector A in hopes of diminishing the gulf.

FIGURE 11B: ACTUAL PORTFOLIO VS. MARKET ASSUMPTIONS UNDER STRESSED MARKET CONDITIONS

	Actual Loan Portfolio Known by Bank		Bank's Loan Portfolio Assumed by the Market		
	Exposure to Sector		Exposure to Sector		*Difference Between Actual Loan Portfolio and Market Assumption*
	A	B	A	B	
Adjusted Exposure	$500	$500	$750	$250	
Default Probability	10.0%	5.0%	10.0%	5.0%	
Loss Given Default	75%	50%	75%	50%	
Expected Loss	$37.50	$12.50	$56.25	$6.25	
Factor Correlation	0%	0%	0%	0%	
Portfolio Expected Loss	$50		$63		25%
99.9% Credit VaR	$436		$591		35%

To be sure, real-life markets rarely permit such a precise estimate of the pricing discount markets demand for bank opacity. Nonetheless, the example provides a simple illustration of how investors might value more granular portfolio information under general market conditions but still be unable to obtain it from a bank. It also explains why banks generally become so much more willing to make these disclosures once adverse market conditions cause

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290. The quotation refers to the oft-noted tendency of participants in the capital markets to make adverse assumptions about banks' exposure to suddenly distressed sectors (or countries) in the absence of additional information. *See infra* text accompanying note 292.

291. More pessimistic assumptions concerning the bank's concentration to Sector A would simply widen this wedge: an assumption of 100% concentration to Sector A, for instance, would yield an expected loss of $75 and a 99.9% credit VaR of $770.

investors to make assumptions that can dramatically increase the cost of opacity. As one analyst remarked after the Financial Crisis, "You had no basis on which to make an assumption, so you made the worst assumption possible."[292] To the extent market participants behave in this fashion, using credit models to inform bank disclosures might therefore provide a means to convey valuable portfolio information to the market in advance of adverse market conditions while permitting banks to preserve much of the value that they place on protecting proprietary investment information.

In the end, of course, determining the value market participants might place on the additional disclosures proposed in this Article is rife with uncertainty. Yet so long as bank regulatory policy remains committed to enhancing market discipline, such uncertainty can hardly be a justification for the current gulf that exists between the information required for modern credit risk analysis and the information currently required to be disclosed by banking institutions. Valued by banks themselves for purposes of managing their credit risk exposure—a value reflected in both the large literature on credit risk analysis as well as a robust market for credit risk modeling technology—modern credit risk analysis currently provides a key analytical framework for understanding a banking institution's risk profile. For any regime dedicated to enhancing market oversight of financial institutions, this fact alone would seem reason enough to consider how bank disclosure policy might better enable market participants to similarly leverage the framework's analytical power. Moreover, doing so in a manner that embraces the need for some degree of experimentalism in bank disclosure policy would also permit a more precise understanding of how market participants would actually utilize it.[293]

VI. CONCLUSION

Notwithstanding their considerable disclosure obligations, banking institutions represent an especially opaque form of business organization. Motivated by the conflicting objectives of making banks more transparent while protecting their proprietary investment strategies, disclosure policies in both the United States and abroad

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292. Bradley Keoun, *Trading Eludes Dodd-Frank as Investors See Black Box*, BLOOMBERG, Sept. 12, 2010, *available at* http://www.bloomberg.com/news/2010-09-12/trading-eludes-dodd-frank-as-no-investors-see-inside-black-box.html (statement of analyst Richard Bove).

293. *See supra* text accompanying note 25.

have generally resulted in costly and ineffective disclosure regimes that compromise the ability of market participants to engage in effective market discipline while potentially aggravating systemic risk.

By turning to credit risk modeling technology, this Article has argued that using credit models to inform bank disclosure policy provides a promising means by which to significantly enhance bank transparency while avoiding the need for banks to disclose sensitive position-level information. Moreover, as it would require only incremental changes to existing disclosure obligations, reforming disclosure policies in this fashion also represents a relatively simple and prompt way with which bank regulators could reduce the type of uncertainty concerning a bank's exposure to credit risk that has all too frequently destabilized the financial sector. In the process, by enabling market participants to probe an institution's risk management with their own credit models, the disclosures advocated here may also discourage in the first instance the common credit risk management errors that have been at the heart of some of this country's most significant banking crises.

VII. Appendix

        The following table illustrates a potential disclosure format banks might use to provide additional information concerning the parameter estimates needed to model the credit risk of their banking and trading books. The table shows, for instance, how a bank could disclose its corporate-loan and structured-finance positions for each book. For corporate loans, industry sectors were obtained by using the same industry sectors Standard & Poor's uses in its annual reports on corporate default and migration rates, although alternative sector divisions could be adopted (e.g., by two-letter SIC code). Structured finance positions were divided by asset type and further divided by current rating to provide information regarding tranche seniority. The format for structured finance positions was based largely on the format used by the Federal Reserve to disclose its holdings of the structured finance positions acquired from AIG.[294]

        The table would also require disclosure by geographic region, which could represent either nations, regions, or states. For reasons discussed in the text, the table below focuses on disclosing only a bank's name and sector concentrations, in which case additional parameter estimates could be estimated from third-party sources that use a similar sector-by-sector framework to analyze parameters such as default probability, loss given default, and asset correlation. By using additional columns, banks could also be required to disclose their internal estimates for these other parameters by adding two-dimensional arrays. For instance, columns 1* and 2* could provide the bank's estimate of the mean and standard deviation for the default probability for each sector within Region/Country A. To account for hedges, the table could be presented on both a gross and net-of-hedges basis.

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        294. See Maiden Lane III, Quarterly Report (June 30, 2010), *available   at* http://www.ny.frb.org/markets/maidenlane/pdf/MLIIIQ2_2010.pdf.

	Region/Country A					
	Total Notional Exposure:	Number of Positions	Exposure Amount Per Position		*1**	*2**
			Average	Standard Deviation		
Corporate						
Aerospace / automotive / capital goods / metal						
Consumer / Service Sector						
Energy and Natural Resources						
Financial Institutions						
Forest and building products / homebuilders						
Health Care / Chemicals						
High Technology / Computers / Office Equipment						
Insurance						
Leisure time / media						
Real Estate						
Telecommunications						
Transportation						
Utility						
Structured Finance						
RMBS						
AAA						
AA+ to AA-						
A+ to A-						
BBB+ to BBB						
BB+ and lower						
Total:						
CMBS						
AAA						
AA+ to AA-						
A+ to A-						
BBB+ to BBB						
BB+ and lower						
Total:						

	Region/Country A					
	Total Notional Exposure:	Number of Positions	Exposure Amount Per Position		*1**	*2**
			Average	Standard Deviation		
ABS CDO						
AAA						
AA+ to AA-						
A+ to A-						
BBB+ to BBB						
BB+ and lower						
Total:						
Other CDO						
AAA						
AA+ to AA-						
A+ to A-						
BBB+ to BBB						
BB+ and lower						
Total:						
Other ABS						
AAA						
AA+ to AA-						
A+ to A-						
BBB+ to BBB						
BB+ and lower						
Total:						