Measuring the Impact of Regulation on Market Stability: Evidence from the US Markets

Colin Beardsley
University of Reading

John R. O'Brien
Carnegie Mellon University, jo0x@andrew.cmu.edu

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Colin Beardsley and John R. O'Brien

c.j.beardsley@ismacentre.rdg.ac.uk
jobrien@cmu.edu

University of Reading and Carnegie Mellon University

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Abstract

In this paper, we introduce a new methodology designed to test the effect of new regulatory disclosure requirements on the disclosure threshold as predicted by the extant literature (Verrecchia (1983), Dye (1985)). We apply our methodology to test the consistency between observed effects from major US regulation past and present (1933/1934 Securities Acts, Regulation Fair Disclosure 2000, and the Sarbanes-Oxley Act 2002) with regulatory objectives.

We find unambiguous support for the consistency between theoretical predictions and regulatory objectives in relation to the 1933/1934 Acts. For the current regulation we find mixed support because of observed differences between NYSE and NASDAQ/AMEX. We explore two possible explanations for this result, a small versus large firm effect versus an effect induced from the different observed strength of the three major exchanges/markets in terms of embracing the disclosure aspects of the new regulation. Our evidence provides stronger support for this latter explanation.
Suppose that you are a regulator charged with ultimate responsibility for financial regulation that is designed to increase investor confidence and market stability. How would you predict and measure if the regulation is efficient in meeting such statutory objectives? Recent regulatory trends, faced with this type of objective, have assumed a relationship between greater mandated disclosure and volatility in the market, for example:

“…Information would give investors more confidence about a company, as well as a ‘truer picture’ … which could reduce market volatility.” Alan Beller SEC, Corporate Finance Division Director, Northwestern Law School conference January 2003.

This point is more precisely described in a theoretical paper by Kanodia (1980)

“Information structure, …. determines this true distribution, and the true distribution of asset prices could differ substantially from one information structure to another.”

When statutory objectives are tied to issues of investor confidence and market stability attention must shift toward measuring the impact upon of the information structure upon the higher order moments of the return distribution. In this paper we introduce a new methodology that is designed both to measure and to interpret the impact of the regulation upon the return distribution itself. We do this by drawing upon the analytical insights from the voluntary disclosure literature that provides testable predictions regarding the behavior of the voluntary disclosure threshold (Verrecchia (1983, 1990); Dye (1985, 1986); and Jung and Kwon (1988)). This literature is relevant to the problem of measuring the extent that regulation is meeting statutory objectives because it provides inferable predictions regarding how investor expectations respond to the regulation in markets where prices are arbitrage free and expectations are rational. In addition, when combined with the literature on estimation risk (Clarkson, Guedes, and Thompson
(1996), we can draw conclusions regarding the impact of the regulation upon systematic risk and therefore on the behavior of the cost of equity capital. Viewed from this perspective, promoting market stability is a positive regulatory goal because it is consistent with creating positive incentives for new investment by lowering the cost of equity capital.

Increased disclosure requirements come as an aftermath to market excesses. In this context, the run up of the financial markets in the 1990’s have some interesting parallels with the run up of the financial markets in the 1920’s. In both cases a new economic order was discussed among economists. For example, just prior to the crash of 1929, Irving Fisher asserted the following:

"The nation is marching along a permanently high plateau of prosperity"

as well as the now (in)famous

"Stock prices have reached what looks like a permanent high plateau... I expect to see the stock market a good deal higher than it is today within a few months"

Irving Fisher, October 15, 1929.

Similar observations were made in the latter phase of the 1990’s expansionary cycle, (Zarnowitz (1999)):

“Some have viewed the current business expansion in the US as the onset of the Golden Age in which the long-time evils of inflationary booms followed by recessions with high unemployment will never return….”
In both cases history repeated itself and the boom in stock prices ended with major corporate collapses, conflicts of self interests among market professionals, entrepreneurs and investors; followed by calls for Government action that resulted in significant new regulation. In each case government passed legislation, designed to restore investor confidence in the financial markets that increased obligations for mandated disclosure.

The 1933/34 regulation in the US introduced sweeping new reporting standards. For example, the pro-shareholder focus of the 1934 Securities Act mandated a system of timely reporting consisting of a combination of annual, quarterly and current reporting. Similarly, sweeping regulatory amendments to the 1933/34 acts resulted in Regulation Fair Disclosure (Regulation FD) 2000, and the Sarbanes-Oxley Act 2002. These Acts created stronger enforceable obligations for timely and non selective disclosure obligations that reflect internet and database capabilities available today. Other parts of the Sarbanes-Oxley Act redefined the responsibilities and skill set for corporate governance such that both executives and auditors are responsible for evaluating companies’ internal financial controls. That is, disclosure policy and internal controls have been elevated to become a significant part of a company’s corporate governance practice.

In this paper, we first review and identify important economic linkages between regulatory trends and the impact upon investors’ expectations. We assess economic consequences of the new regulation by identifying the predicted impact upon the voluntary disclosure threshold as identified in the disclosure literature. This requires using a new methodology that can measure shifts in the disclosure threshold in a manner that permits impact upon investor expectations to be interpreted. We contrast two important periods of time, 1933/34 and 2000/2002, that provide a unique opportunity for the independent testing of our predictions approximately 70-years apart. Our results broadly support
conclusions that regulation had an impact upon the voluntary threshold in a manner that is consistent with predictions from the theory. However, the results from recent regulatory trends also identify potentially important interactions that exist between the regulation and different responses to implementing it. That is, history has not precisely repeated itself!

This paper is structured as follows. Section I reviews current international trends in models for regulation; Section II reviews the literature on the impact of mandated disclosure on stock prices; Section III focuses on the theory and predictions that are tested in this current paper; Section IV discusses our methodology and Section V presents our results. Finally, Section VI concludes with further directions for research.

**Section I: Trends in Models of Financial Regulation**

Theories of financial regulation have been extensively reviewed in two sources (Dale and Wolfe (1998), Goodhart, Hartmann, Llewellyn, Rojas-Suárez and Weisbrod (1998)) but no single model has emerged as dominant. In the US a specialist regulator model resulted from the 70 year old legislation from the Securities and Exchange Act, 1934. The Securities and Exchange Commission created by this Act has, over the years, been the subject of periodic criticism on the grounds of ineptitude and ineffectiveness (Stigler (1964)), and defended on both counts (Friend and Herman (1964)). In conjunction with the SEC, state regulators maintain a watchdog role - a practice subject to much controversy today. Critics of this decentralized system maintain that the U.S. securities market should have one “watchdog” - the SEC1. This would result in a similar situation to the UK, where the powers for a single regulatory body, the Financial Services Authority

1 Commentary: Competing Watchdogs Are Good for the Street Business Week September 1, 2003
(FSA), flow from the Financial Services and Markets Act 2000 that received royal assent on June 14, 2000.

Although the sweeping reforms to mandated disclosure in the US took place with the Securities Act 1934 which put into place a system of Annual reports (Form 10-K), Quarterly reports (Form 10-Q), and current reports (Form 8-K), the SEC recently embraced again a stronger pro-shareholder value agenda. Regulation FD that took effect on October 23, 2000 pursues an aggressive equal access approach to voluntary public disclosures. Public disclosure can be via the Form 8-K or by other methods that are reasonably designed to effect non-exclusionary access to the information. Although this Act does not require additional disclosure of events not covered by Form 8-K such disclosure is encouraged.

Following Regulation FD, the Sarbanes-Oxley Act was signed into law on August 1, 2002. This Act has both extended the mandated reporting obligations of the Form 8-K, reduced filing deadlines from the then current 5-days to 2-days after the triggering event as well as embracing the concept of continuous mandated disclosure in its Section 409. This section creates an obligation for companies to deliver timely reports to investors and other stakeholders on any “material events” that can affect the finances and operations of a business. The net effect of the recent events in the US has been to again increase the expected level of mandated reporting in the economy.

**The Regulatory Timeline for US**

Implementing the principle of supervision takes time. The time frames over history provide a unique period of time separated by approximately 70 years, that permits predicted
shifts in the disclosure threshold to be tested for. To summarize, we provide event times in table 1.

**INSERT TABLE 1 HERE**

### Section II: Literature on Impact of Mandated Disclosure on Stock Prices

A number of researchers have focused on the 1933 and 1934 Securities Acts over the years – see for example Benston (1973), Friend and Herman (1964), Jarrell (1981), Simon (1989), Stigler (1964). These studies largely conclude that the disclosure requirements of the Act had little or no impact upon mean returns, although all detected a significant impact upon the dispersion of returns. To our knowledge there has been no satisfactory explanation of the latter finding. For example, Stigler (1964) and Benston (1973) interpret dispersion as the consequence of “other factors” while Friend and Herman (1965) interpret it as the beneficial effect of mandatory disclosure by improving investors’ intrinsic value forecasting accuracy. Jarrell (1981) concluded it was evidence of the Act imposing greater costs upon riskier ventures. Simon (1989) concluded it could either be due to “left out factors” from an asset pricing model or improvements in the quantity and quality of information.

The above conclusions of little to no impact of regulation have received additional support when a wider set of regulatory events have been studied. For example, in a representative paper, Binder examined 20 major changes in regulatory constraints from 1887 to 1985 and from tests of first moments of both monthly and daily data the conclusion was that such tests have “surprisingly little ability to detect the effects of regulation” (Binder (1985)).
Other authors (Horwitz and Kolodny (1977), Simonds and Collins (1978)) have examined the line of business reporting (LIBUR) first required by the Securities and Exchange Commission in 1971 using a capital asset pricing model to assess the effectiveness of this disclosure requirement on the securities market. Horwitz and Kolodny report that LIBUR did not affect investors’ assessments of the riskiness of multi-segment firms. Simonds and Collins disagree citing shortcomings in sample selection and hypothesis testing procedures – their empirical analysis indicated that LIBUR disclosure did convey useful information to investors and that the average effect was a downward shift in their assessment of a multi segment firm’s market risk.

Regulation FD has been the focus of a number of event studies (Heflin, Subramanayam and Zhang (2001)). In their paper they study stock return volatility before and after the event date. They motivate this study in response to alarms raised by the analyst sector that Regulation FD would increase volatility. They conclude that Regulation FD did not increase return volatility on either a daily or per incidence of extreme days’ bases. Bailey, Li, Mao and Zhong (2003) also find that after Regulation FD market behavior around earnings releases displays no significant change in return volatility (after controlling for decimalization of stock trading) but analyst forecast dispersion increases. Consistent with this finding, Irani and Karamanou (2002) document a decrease in analyst following and an increase in forecast dispersion following the passage of Regulation FD. Zitzewitz (2002) reports evidence that Regulation FD had its desired effect of reducing selective disclosure of information about future earnings to individual analysts without reducing the total amount of information disclosed.
Botosan (1997) has examined the question of voluntary disclosure levels and its impact upon cost of capital. Although this paper did not examine the impact of regulation, it did use a disclosure measure that was limited to the information provided in the annual reports. Botosan documented an association with the measure of sensitivity to market risk (beta) where she suggests a relationship between disclosure and systematic risk.

In this paper the approach we adopt is to start from the premise that these major Securities Acts and regulatory initiatives are likely to have a real impact upon investor expectations. Although, we cannot observe expectations directly we can infer shifts in expectations by observing the behavior of the voluntary disclosure threshold. Reasons supporting these predictions come from the analytical disclosure literature which we review and develop in the next section.

**Section III: Theory and Predictions**

In the voluntary disclosure literature if there are no costs associated with the truthful disclosure of information, and investors can form rational expectations; a fully separating equilibrium results (Grossman and Hart (1980), Grossman (December 1981)). Full separation is inconsistent, however, with the fact that in the 1930s, prior to the 1933 Act, some firms disclosed voluntarily and others chose not to. It is also inconsistent with the emphasis placed upon drafting strong disclosure regulation in the 1930’s and again the current extensions of this regulation. As a result, regulatory trends support the premise that there are non trivial explicit and opportunity costs associated with disclosure.

More recently, Regulation FD created an obligation for prompt disclosure of material information to the general public (e.g., 8-K reports). Regulation FD explicitly prohibits selective disclosure to subgroups such as analysts, a requirement that would be unneces-
sary if full separation existed. From a disclosure cost perspective, Regulation FD also creates an obligation for boards to manage disclosure policy on an ongoing basis. This was reinforced by the significant overhaul of Corporate Governance requirements in the Sarbanes-Oxley regulation including Section 409 which pertains to ongoing disclosure.

Regulation FD was predicted to have a significant impact upon the disclosure of information. Most commentators predicted an increase in available information apart from the recipients of selective disclosures who predicted the opposite. However early empirical studies of Regulation FD’s impact failed to detect significant evidence that lent unambiguous in support to either side (Bailey, Li, Mao and Zhong (2003), Zitzewitz (2002)). This leads to questions regarding the lack of enforcement of Regulation FD suggesting that more definitive results may be possible once more data has been accumulated post October 2000.

For example, subsequent to passing Regulation FD the new Republican appointed head of the SEC, Harvey Pitt, was reportedly critical of Regulation FD resulting in questions regarding its intent. Such concerns became a major political issue with the likes of Al Gore, Tom Daschle and John McCain openly calling for Pitt’s resignation. Ultimately a consensus formed between Washington and Wall Street that a more aggressive chairman was needed to head the SEC to enforce regulatory changes. Evidence of how widespread such speculation had become is reflected in the following headline in the popular press (December 10, 2002):

“Bush picks polar opposite of Pitt to head SEC” (USA Today 12/10/2002).

The replacement of Pitt by Donaldson to head the SEC and the enactment of the Sarbanes-Oxley Act signaled that significant regulatory change had become a permanent
part of the new financial environment. In terms of affecting mandated disclosure requirements these events lead to the over-the-counter market, NASDAQ, implementing significant changes to its listing requirements, a significant signal of intent to enforce the disclosure components of the new regulation. Examples, in relation to creating obligations for the ongoing Disclosure of Material Information under NASDAQ listing rules, are SR-NASD-2002-85 filed August 7, 2002 and approved by the SEC December 9, 2002. As summarized by NASDAQ (December 9, 2002):

“NASDAQ is the first major stock market to modernize its disclosure rules, making it easier for NASDAQ-listed companies to comply with both NASDAQ disclosure rules and Regulation FD. Now, in addition to issuing press releases, companies can utilize current technology, including webcasts, conference calls and 8-K filings. The new rules will minimize confusion between Reg FD-compliant and NASDAQ-compliant disclosure mediums and address concerns that self-regulatory organization (SRO) rules have the effect of overriding the disclosure flexibility provided by Reg FD” (NASDAQ Bulletin titled: “SEC Approves New NASDAQ Disclosure Rules” December 9, 2002).

As a result, it is clear that exchange responses to Regulation FD disclosure obligations have taken time. It is questionable, however, what the predicted impact will be for the NYSE. This is because the NYSE has focused upon integrating the Corporate Governance changes introduced by Sarbanes-Oxley into their listing obligations while NASDAQ has focused upon both disclosure and corporate governance implications. This point was emphasized by NASDAQ’s senior vice president in charge of listing (Emen (2003)):

“NASDAQ’s proposals incorporate steps to increase transparency and disclosure…. we propose to require all issuers to adopt codes of conduct conforming to the requirements

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2 NASDAQ was the earliest mover to embrace mandated disclosure changes implied from Regulation FD into its listing requirements. Arguably, it had the greatest incentive because on June 7, 2001 it filed to the SEC for National Securities Exchange status under Section 6 of the Securities Exchange Act 1934.
of SOX for all employees and directors, and to disclose any waivers granted to executive
officers and directors. More generally, NASDAQ is the only U.S. market to have fully en-
dorsed the spirit behind the adoption of SEC Regulation FD by recognizing that any
Regulation FD compliant public disclosure by an issuer will satisfy its NASDAQ disclo-
sure obligations. New rules will only be effective if they are vigorously enforced and the
best deterrent against future misconduct is the realization that non-compliance will come
at a high cost. NASDAQ devotes nearly 60 full-time staff to enforcing its listing standards.
While some have suggested that there should be alternative sanctions to delisting proceed-
ings, NASDAQ believes the threat of delisting is the only tool powerful enough to assure
future compliance.”

For the case of the American Stock Exchange (AMEX), however, we predict that it is
likely to have the same impact upon investor expectations as NASDAQ given the fact
that a merger between NASDAQ and AMEX was implemented on November 2, 1998
(Sapp and Yan (2003)).

We note also that Regulation FD represents a major advancement over the 1933/1934
regulations by exploiting modern technology for modernizing the rules for disclosure.
Technology permits increased levels of ongoing disclosure to be implemented. This is
important for implementing the Sarbanes-Oxley Act which places communication policy
on the center stage of a company’s corporate governance practice by extending the obli-
gations for and increasing the potential costs associated with the disclosure requirements
in Regulation FD. Sarbanes-Oxley also opens the possibility for stronger “continuous”
disclosure obligations in the future, with its Section 409. As a result, the new
NASDAQ-compliant disclosure media for modernizing their rules provide the basis for a
broader implementation of these stronger mandated disclosure requirements by including
required operational details as part of their listing requirements.
The above regulatory trends fit well the assumptions made in analytical literature on voluntary disclosures and especially so for the case of NASDAQ compared to the NYSE given the above discussion. Both impact and/or possible differential impact upon investor expectations thus become an interesting and largely unexplored issue. In this paper, we will draw upon predicted behavior from the voluntary disclosure literature for the disclosure threshold in our attempt to take steps towards filling this void.

In one strand of the literature a unique disclosure threshold results at the point where the marginal benefit from not disclosing equals the marginal exogenous cost from disclosing (Verrecchia (1983), Verrecchia (1990)). A second strand of the literature considers endogenous disclosure costs arising from the conflict of self interests from the decision to disclose versus withhold when investors are not sure whether the manager is in possession of the information. In this strand of the voluntary disclosure literature a unique threshold again results because the unraveling into a separating equilibrium stops when the marginal benefits from mimicking equals the marginal cost to existing shareholders from disclosing the information in a rational expectations equilibrium (Dye (1985), Dye (1986), Jung and Kwon (1988)).

Both of these strands capture essential features of the recent regulatory trends which influence the marginal cost and marginal benefits associated with the decision to disclose versus not to disclose. First, the regulation has created a legal obligation for the truthful and non selective disclosure of information material to prices. This influences directly the marginal cost associated with truthful disclosure. The major cost here is the cost associated with the communication policy that includes the board and has been estimated as
high as $7 billion in year one, because an obligation for timely and non selective disclosure now exists. Second, the general thrust of mandated disclosure regulation has the effect of reducing the probability of insiders being privately informed with price sensitive information as well as increasing the precision of investor priors regarding assessed future value distributions given the finer information that is available.

In this paper we work at the general market level. Although the analytical voluntary disclosure literature focuses upon a single firm, and therefore, arguably diversifiable sources of risk, it provides testable systematic risk implications when combined with the insights from the estimation risk literature. This is because reducing estimation risk, has systematic risk implications when investors assess the distribution of future payoffs from a firm ((for a review of this literature see Clarkson, Guedes and Thompson (1996)). As a result, mandating disclosure has the effect of reducing estimation risk by increasing the precision of investor priors, which in turn has the implied impact upon the voluntary disclosure threshold identified in the literature. In addition, the above literature assumes that the information being disclosed in aggregate has no production implications (and thus no aggregate impact upon the future value distribution in terms of the first moment (see Pae (1999)). For our current purposes this is a useful feature because the statutory objectives for the regulation reviewed do not rest upon production related assumptions. It does, however, rest upon assumptions about restoring investor confidence, market stability, eliminating informational asymmetries and therefore reducing systematic risk.

We now first develop a set of testable hypotheses and then the methodology for testing them which will rest upon the underlying assumption that prices are arbitrage free.

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3 The internal control rules are by far the most contentious and potentially onerous provisions. Industry experts say that as a result of these rules, auditing costs are likely to double, while the total tab for compliance could top $7 billion in the first year.” Business Week “Honesty is a Pricey Policy” October 27, 2003
Testable Hypotheses

First, if the regulation is meeting statutory objectives then the voluntary disclosure threshold should shift to the right. In the presence of stronger obligations for truthful disclosure support for this hypothesis follows because, although investors still form assessments about the manager possessing private information, the overall likelihood of managers being in possession of private information is reduced. As a result, the hypothesis follows from Proposition 2 of Jung and Kwon (1988). Alternatively, with greater amounts of mandated information available to investors then the precision of investor priors about the future value distribution increase which results in a right shift of the disclosure threshold (Verrecchia (1990)).

Second, we predict that Regulation FD has a larger and delayed effect upon stocks traded on NASDAQ and AMEX versus stocks traded on the New York Stock Exchange (NYSE). The major reason is the alignment of both the disclosure and corporate governance requirements with the NASDAQ listing requirements versus only the alignment of the Corporate Governance requirements associated with the listing requirements of the NYSE. For the case of AMEX, given its merged status with NASDAQ the same prediction as for NASDAQ should carry over to the AMEX.

Third, we predict the right shift in the disclosure threshold will be stronger for NASDAQ traded securities versus securities listed on other exchanges.

In the next section, we discuss how the empirical tests of the above testable hypotheses have been constructed.
Section IV: Methodology

Overview

The method we employ is designed to test analytical results that relate shifts in the voluntary disclosure threshold, to definitions of first and second degree stochastic dominance (e.g., Jung and Kwon (1988) Proposition 3 and similarly Verrecchia’s Corollary 2 (1990)). In the Verrecchia economy, the comparative static results have recently been extended to generalized distributional forms by Jorgensen and Orbay (2003). Secondly, it should permit implications to be drawn from shifts in the threshold for systematic risk. To make the linkages precise we first exploit the set of equivalence relationships derived by Rothschild and Stiglitz (1970). In addition, because analytical characterizations are derived in terms of real world probabilities second we provide the link between the testable implications of the theory and risk neutralized probability distribution.

Equivalence Relationships Rothschild and Stiglitz (1970)

First, we observe that distributions with the same first moment can be ranked using the mean preserving increase in spread definition of risk Rothschild and Stiglitz (1970). Formally, if distributions $F$ and $G$ are defined over the interval $[a,b]$ and $y$ is any element within the interval, then $F$ is less risky than distribution $G$ if and only if:

\[ \int_{a}^{b} (G(x) - F(x)) \, dx = 0 \]

\[ \int_{a}^{y} (G(x) - F(x)) \, dx \geq 0 \]
Second, this definition can equivalently be formulated in terms of outcomes. That is, consider a random variable $y$ constructed from another random variable $x$ by adding unbiased noise (i.e., an additional source of volatility to $x$). Under this construction an equivalent relationship to mean preserving spreads can be characterized in terms of mean preserving outcomes. Under this interpretation and when $x$ and $y$ are portfolio realizations pre and post some event, then dominance, defined in the usual Markowitz sense of the term, is captured

Finally, these two definitions are also equivalent to the usual utility based definitions of risk aversion. As a result, operationally we can directly test and interpret the implications from a shift in the disclosure threshold by measuring shifts in mean preserving distributions.

The above equivalence relations are provided relative to real world probability distributions. To complete the derivation of the methodology introduced here, we will demonstrate that the information for inferring a shift in the voluntary disclosure threshold is preserved by measuring shifts in the risk neutral probability distributions. To establish this last fact we observe that the risk neutral distributions permit, without loss of generality, the mean preserving condition to be invoked because first moment information drops out. We then implement a marginal utility approach to constructing the risk neutral probabilities in a manner that retains the information required to exploit the Jung and Kwon linkage between shifts in the voluntary disclosure threshold and stochastic dominance. We develop this approach next.

**Estimating the Risk Neutralized Distribution**

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4 This is the same condition exploited by Jorgensen and Orbay (2003) to characterize a sufficient condition between monotone comparative statics and second order stochastic shifts in the generalized Verrecchia economy.
Luenberger (1997) discusses the theoretical basis for estimating the implied risk neutral return distribution from a single path of realized returns. Winston (1999) has applied this methodology using Monte Carlo simulation. This technique has the advantage of not placing structure upon the assumed distribution but instead places the structure upon preferences. In particular, the preference assumption is logarithmic. There is support in the financial literature for using the logarithmic utility function \( U(w) = \ln(w) \) (Brown (1987), Kelly (1956), Latane (1959), Luenberger (1998)) as a way of capturing some important basic properties of observed investor behavior. The logarithmic utility function is consistent with maximizing expected long-term growth rate of wealth when using a single period optimization strategy and is consistent with the utility function implied from aggregate market behavior (Brown (1987)).

In this paper, we are only concerned with detecting shifts in the voluntary disclosure threshold not interpreting behavior in any absolute manner. So as long as the logarithmic utility function is correlated with the marginal risk preferences of the market it will serve this purpose. The literature reviewed above lend support to the premise that the logarithmic utility function captures important information about the marginal risk preferences of the market. We consider how it may be used to risk neutralize the distribution next.

For the case of the log utility preference \( U(w) \), we may uniquely risk neutralize empirical probabilities by assuming that the set of daily price changes over some period of time is arbitrage free and the frequency distribution represent the empirical probabilities. We then uniquely “risk neutralize” the empirical probabilities by using the logarithmic utility approach. That is, we begin with some initial wealth invested in the stock index and assume that the marginal investor chooses an amount \( \alpha \) to invest in the index and \((1 - \alpha)\)
in the risk-free asset to maximize their expected log utility of ending wealth relative to the empirical probabilities (i.e., along the realized path for the specified period of time). Associated with this optimal choice $\alpha^*$ let $W_k^* = \alpha^*(1 + r_k) + (1- \alpha^*)(1 + r)$ be terminal wealth for outcome $k$ and therefore the marginal utility and empirical probabilities imply the risk neutralized probabilities as follows.

The risk neutral probability $q_k$ for return $r_k$ is given by

$$ q_k = \frac{p_k U(W_k^*)}{\sum_{k=1}^{K_k} p_k U(W_k^*)} $$

where $p_k$ are the real world probabilities associated with the path of price changes.

We analyze the sample of realized returns before and after a major economic event. We then bootstrap the expected risk neutral returns of these indices by assuming that each daily return for one year has the same chance of being the index’s return for any given day along the path (Winston (1999)). Under the assumption that the realized path of price changes is arbitrage free, we ran 100,000 iterations of a Monte Carlo program to generate expected risk neutral distributions of the terminal values pre and post a significant market event over the time periods associated with each legislative event.

To test the assumption of arbitrage free price changes we examine an implication from the weak form of the efficient market’s hypothesis. That is, if price changes follow geometric Brownian motion then the terminal distribution at the end of any period of time is lognormal. As a result, we test the null Hypothesis of a lognormal distribution. This implies that:
\[ E(S_T) = S \exp(\sigma^2 T) \]
\[ \text{Var}(S_T) = [E(S_T)] \exp(\sigma^2 T) - 1 \]

where \( S \) is the spot price at beginning of the year, and \( E(S_t) \) and \( \text{Var}(S_t) \) were estimated from the simulation. Combined, the above demonstrates that the important information is preserved in the higher order moments of the risk neutralized distribution.

In summary, our methodology is designed to detect shifts in the disclosure threshold, induced by revisions in investor expectations, by examining the behavior in terms of stochastic dominance of the risk neutralized terminal distribution of the index value implied from the path of realized price changes before and after some event.

We note, however, that statistically our technique depends upon the realized path of price changes being arbitrage free. This is the condition that implies the existence of the risk neutralized probabilities. After that we are dealing with population estimates and therefore any shift is statistically significant.

**Section V: Results**

As discussed above, our main interest is to infer shifts in the threshold by examining the whether the risk neutral return distribution satisfies the property of second order stochastic dominance when estimated before and after an important economic event. If this condition is satisfied we can draw inferences about the direction of the shift in the disclosure threshold.
In particular, if distribution $F$ stochastically dominates distribution $G$ in the second order then we infer that the disclosure threshold associated with $G$ is to the left of the threshold associated with $F$. We analyze this by observing whether or not the single crossing point property is satisfied and in what the implied direction of the shift is.

**Test of the assumption that prices are arbitrage free**

To be able interpret the results from the stochastic dominance analysis we first test that price changes over the time periods examined are arbitrage free by testing the hypothesis that the implied risk neutral return distribution is lognormal which is consistent with price changes satisfying weak form market efficiency.

**Results from 1933/34: The Securities Act 1933 and the Security Exchange Act**

**1934**

For the DJIA over the time periods in the 1930’s examined, we found that, in all cases, the null hypothesis of consistency with the lognormal distribution could not be rejected. The Tables provided in Appendix A provide the supporting analysis and Appendices C and D provide the supporting analysis for the recent data. By equating the means for the before and after risk neutralized terminal value distribution to the average of the first moments over the combined period, we test for stochastic dominance from the implied single crossing condition.

**A. Graphs of Stochastic Dominance Effects**
In the following results section we provide the dominance relationship below each graph. Because we are dealing with population estimates, any shift is significant. However, interpretation depends largely upon the realized path of price changes being arbitrage free over the time periods examined.

We consider three time periods: one year prior to July 27, 1933; July 27, 1933 to August 31, 1934; and one year after August 31, 1934 corresponding to T-1, T, T+1 as labeled. For comparison purposes each graph is provided with its domain scaled to equal the mean plus/minus two times the average volatility. Volatility of the interim period between July 27, 1933 and August 31, 1934, has been standardized with respect to time by invoking the assumption of linear in the square root of time. As a result, the pre-, in-between and post periods of time are comparable for the stochastic dominance analysis.

The supporting table of numbers is provided in Appendix B. Below the graph we indicate the dominance relationship as > implying the shift is to the right for the threshold (and therefore to the right in the region below the single crossing point and to the left above the single crossing point). The Chi-Square statistic tests the hypothesis of no shift in the distribution from T versus T-1 and then T+1 versus T respectively.

For the case of the 1933 Securities Act, we detect a monotonic shift as we move from pre 1933 through to post 1934 as depicted in Figure 1.

\[\text{INSERT FIGURE 1 HERE}\]

Here post 1934 dominates significantly the interim period which in turn dominates pre 1933. This implies that the shift in the threshold point was to the right over the interval
of time from pre 1933, to the interim to post 1934. This is consistent with the hypothe-
sized effect of mandated disclosure.

Recall that the empirical analyses of the mandated disclosure Act of 1933 have all re-
ported a shift in the dispersion. We demonstrate the relationship between the fitted dis-
tribution and dispersion in Table 1 (Appendix 1). From this table both the fitted distri-
bution and the actual distribution of the dispersion results exhibit the same declining
trend. As result, this table supports the interpretation that this systematic empirical find-
ing is an implication a shift in the voluntary disclosure threshold to the right. That is, the
above evidence is consistent with the prior studies of the SEC 1933/1934 Acts but the
difference is that the dispersion results are now the predicted consequence of the regulation.

The economic interpretation of the 1933/1934 analysis, in conjunction with results from
prior empirical studies reported in the literature, is that mandated disclosure does not en-
hance the informational efficiency of the economy, but rather shifted the economy from
one voluntary disclosure rational expectations equilibrium to another in a manner that is consistent
with regulatory objectives. Furthermore, these results are highly significant. We show in
the chart below the change in risk neutralized volatility flowing from the legislation.

We note that our conclusions are substantially different from the conclusions drawn from
the older empirical studies in this area. Furthermore, the fact that the structure put in
place by the 1933/34 regulation has survived in tact over the last 70 odd years suggests,
contrary to conclusions drawn from earlier empirical studies, that the regulators at that
time achieved significant success relative to their objectives! Our above findings are con-
sistent with this conclusion. Our results are also consistent with reported volatility results in the older empirical literature. The main difference, however, between our current paper and these earlier works is that we exploit theory (not available to the majority of the older empirical papers) to identify refinements of set of hypotheses that can be tested. That is, by testing directly for the impact upon investors’ rational expectations, by measuring for shifts in the disclosure threshold.

**Results from 2000/2002: US Regulation FD and Sarbanes-Oxley**

To examine the impact we break the estimation periods down into approximate one year periods designed to account for various intervening factors. In particular, we control for two major events - decimalization and the September 11 terrorist attack on the World Trade Center. Our event estimation periods are as follows:

i. 1-Year Pre-Regulation FD (October 23, 2000), denoted as T-1.

ii. 221-days after October 23, 2000 denoted as T. This is post Regulation FD but prior to September 11, 2001. It includes the shift to decimalization by the Exchanges and NASDAQ.

iii. 221-days after September 11, 2001 which is pre-Sarbanes-Oxley, denoted as T+1.

iv. 1-year post Sarbanes-Oxley denoted as T+2.

In the above classification, we note that decimalization could affect our hypotheses to the extent that it impacts the higher moments of the risk neutralized distribution. Previous papers have reported a reduction in the variance of returns post decimalization which would work in favor of supporting our major hypotheses. On the other hand,

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5 By breaking up the data in this manner the sample falls cleanly either side of September 11 and the shift to decimal quotations falls within the first 221-day period.
September 11, 2001 is likely to work against the major hypotheses by increasing variance. Further, it is likely that September 11 effects have a much stronger impact than decimalization and therefore overall this is likely to bias our results against detecting any effects. To control for such events we analyze both the pooled period covering ii. and iii. above as well as the separated sub-periods. We report the more detailed analysis because pooling does not alter any of our general conclusions. We provide the supporting table of numbers in Appendix E.

In reporting these results, we provide the stochastic dominance test with the dominance relationship provided below each graph. For comparison purposes each graph has its domain scaled to equal the mean plus/minus two times the average volatility. Volatility has been standardized with respect to time by invoking the assumption of linear in the square root of time as specified in the theory section of this paper. As a result, the pre-, in-between and post periods of time are comparable for the stochastic dominance analysis.

In addition, we show the results of a Chi-Square Statistic which provides a numerical measure of the degree to which the distribution has shifted. Finally, the first moment of the risk neutralized return distribution is normalized to a risk free rate equal to 5% annualized.

Below each graph we indicate the dominance relationship as > implying the direction of the voluntary disclosure shift. In particular, “T-1 < T” implies a shift of the voluntary disclosure threshold to the right after an event occurring at time T.
The relative size of the separation can be gauged by the size of the Chi-Square statistic. The three Chi–Square statistics correspond to 221-days post Regulation FD versus Pre-Regulation FD, Post 9/11 versus Pre 9/11, and Post Sarbanes-Oxley versus Pre Sarbanes-Oxley. We first present our results by major market indexes given the differences predicted between the NASDAQ and the NYSE for hypothesis 2. Thus the results for the NYSE index, two NASDAQ indexes (technology heavy 100 as well as the general NASDAQ index), and finally the AMEX index known as XAX.

The above results provide a striking contrast. The NASDAQ and AMEX results provide strong support for the impact of the recent regulation shifting the voluntary disclosure threshold to the right as predicted. The strongest has been NASDAQ which is consistent with the fact that this market has been the most aggressive in terms of their response to enforcing Regulation FD. The NYSE results support the inference that the disclosure threshold shifted to the left. That is, NYSE results are not consistent with the hypothesis but as noted earlier or is it consistent with NASDAQ/AMEX results. The NYSE has been aggressive on the Corporate Governance front but not on the disclosure aspects in the new regulation. This suggests that an individual market’s responses in

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6 We computed risk neutralized both with and without the actual September 11 day. No real difference was observed and therefore in the following results the day of September 11 has been excluded.
terms of strong statements in support of the regulation combined with changes to listing requirements that are designed to facilitate the implementation of the new regulation has a positive impact upon investor expectations.

We examine a number of other indexes viz. the DJIA, S&P100, S&P500, Russell 1000, and Russell 2000 indexes. The results for these indexes are shown in Appendix F. There is a monotonic trend when moving from large liquid stocks to smaller less liquid stocks (negative to a relative more positive impact). However, the given that each of these indexes exhibit a systematically lower proportion of non NYSE stocks (moving from DJIA to Russell 2000) we conclude that this is primarily due to the market differences whereas the impact upon small versus large stocks is of second order significance.

**Regulation FD and Sarbanes-Oxley Implications**

The above findings for Regulation FD combined with Sarbanes-Oxley suggest that the broad indexes reflect two opposing trends. The NYSE exchange aggressively embraced the corporate governance requirements but not the disclosure requirements, which coincided with a left shift of the disclosure threshold. For the case of NASDAQ, on the other hand, which aggressively embraced both the corporate governance and the disclosure obligations as part of their listing requirements, coincided with a right shift in the threshold as predicted by the theory.

We now summarize the effect on volatilities for our pooled period in the charts below.

**INSERT FIGURE 7 HERE**
The chart above shows annualized risk neutral volatilities relating to major indices by exchange/market plus for comparison with the previous graph the Dow Jones Industrial Average (which is predominantly NYSE but includes two stocks listed on NASDAQ). Volatilities are split into three time periods (and standardized for the size of the time period differences):

- One year pre Regulation FD (252 working days before October 23, 2000).
- 21 months between Regulation FD and Sarbanes-Oxley (442 working days between October 23, 2000 and August 1, 2002).
- One year post Sarbanes-Oxley (252 working days after August 1, 2002). This period includes the “harmonization” of NASDAQ’s disclosure requirements with the Securities and Exchange Commission’s Regulation FD on November 25, 2002.

The results from 70 years earlier are also strongly consistent with the NASDAQ/AMEX results today. In both cases there were strong new disclosure laws including policies in conjunction with the mode of disclosure. For 1933/34 this was the specific set of SEC reports that are still in place today and for the case of the recent regulation this was an expanded form of acceptable reporting designed with today’s technology in mind. In both cases the estimated impact upon the voluntary disclosure threshold has been consistent with predictions from the voluntary disclosure literature but in a manner that suggests that it is important to address both the nature of the disclosure requirements as well as implementation issues arising from the new regulation’s disclosure requirements. For
example, NASDAQ (which has merged status with AMEX) summarized their new rules that largely coincided with the passing of the Sarbanes-Oxley as follows:

“NASDAQ is the first major stock market to modernize its disclosure rules, making it easier for NASDAQ-listed companies to comply with both NASDAQ disclosure rules and Reg FD. Now, in addition to issuing press releases, companies can utilize current technology, including webcasts, conference calls and 8-K filings. The new rules will minimize confusion between Reg FD-compliant and NASDAQ-compliant disclosure mediums and address concerns that self-regulatory organization (SRO) rules have the effect of overriding the disclosure flexibility provided by Reg FD”.

**Section VI: Conclusions**

In this paper, we tested hypotheses designed to identify the impact of regulation upon investor confidence and market stability under the assumption that financial market prices are arbitrage free. Overall, there is a remarkable degree of consistency in the results from two important periods of time in history. In both periods the impact of the regulation was positive in relation to statutory objectives with the exception of the NYSE stock index. For the case of NYSE, which is in stark contrast to NASDAQ and AMEX, this could imply that the recent legislation has had a positive impact upon smaller stocks but a negative impact upon larger stocks. This is consistent with the analyst industry functioning appropriately for large stocks, but the more far reaching implications of Sarbanes-Oxley inadvertently creating incentives for less overall disclosure for large stocks. That is, by institutionalizing communication policies at the corporate governance level may result in less (but more sterilized) disclosure. For example,

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“Execs are grumbling about the steep costs of complying with new financial controls. Welcome to the brave new world of Section 404 of the 2002 Sarbanes-Oxley Act, which requires executives and auditors to evaluate companies’ internal financial controls. On Oct. 7, the accounting profession's new overseer, the Public Company Accounting Oversight Board (PCAOB), proposed standards to guide auditors and companies in how to do that. The aim is to prevent the kind of financial shenanigans that caused meltdowns at WorldCom, Enron, and a host of other former highfliers.

Although these requirements are not the only ones at issue they are commonly perceived to be the most costly: But the internal control rules are by far the most contentious and potentially onerous provisions. Industry experts say that as a result of these rules, auditing costs are likely to double, while the total tab for compliance could top $7 billion in the first year.”

Our results provide some support for this type of current criticism in relation to large, but not small, stocks. However, the evidence is more consistent with the observed effects of regulation being driven by differences among the exchanges/market response to the regulation as opposed to firm size per se. This was because the favorable impact of the regulation upon smaller firms was much less pronounced than the observed impact when cutting the data by exchange/market response. This position is further reinforced by the documented different subsequent behavior observed from NASDAQ versus the NYSE with respect to embracing issues related to disclosure, as opposed to corporate governance, relative to the new regulation. NASDAQ’s strong actions in support of the disclosure intentions of Regulation FD had a significant favorable impact upon investors’ expectations.

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8 Business Week “Honesty is a Pricey Policy October 27, 2003
Finally, the evidence also supports the conclusion that the behavior of investors’ expectations today is *consistent* with the behavior of investors’ expectations in the 1930’s. Our strong positive findings from the 1933/34 Acts are not consistent with conclusions drawn from earlier studies in the literature even though they are consistent with volatility evidence reported from these earlier studies. Two reasons for these differences discussed in this current paper are that we measure for the effects of *predicted shifts* in rational expectations equilibrium as opposed to asking the question whether the market became in some sense more efficient. Secondly, we are testing hypotheses that have become possible in the light of later developments in the analytical voluntary disclosure literature. This permits the volatility related evidence to be reassessed in a different manner and supports our conclusion that the original regulators produced a very acceptable set of laws that stood the test of time for some 70 years.
References


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<td>August 31, 1934</td>
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<td>Regulation Fair Disclosure (Regulation FD)</td>
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<td>Sarbanes-Oxley Act</td>
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Figure 1: Cumulative Risk Neutralized Return Distribution for the Dow Jones Industrial Index one year pre The Securities Act 1933; Interim between 1933/1934 Acts; and one year post the Securities Exchange Act 1934. This graph depicts the estimated shifts in the disclosure threshold by examining the stochastic dominance behavior of the cumulative risk neutralized terminal distributions estimated 1-year prior to the passing of the 1933 Securities Act (T-1), the interim time between the 1933 and 1934 Acts (T), and 1-year after the 1934 Act (T+1). The observed dominance relationships are: T-1 < T < T+1 where “<” denotes stochastic dominance of the second degree. That is, below the single crossing point the graphs from left to right are T-1, T, and T+1. The Chi-Square statistics, testing the null hypothesis for no shift in the distribution (from T-1 to T; and T to T+1) are 49780.91 (T to T-1), and 20270.91 (T+1 to T).
Figure 2: From the estimated risk neutralized terminal payoff distribution, we show the volatility of returns by the critical 1930's event dates for the Dow Jones Industrial Index. Volatility is estimated from: 

$$Var(S_T) = [E(S_T)]^2 \exp(\sigma^2 T) - 1$$
Figure 3: Cumulative Risk Neutralized Return Distribution for the New York Stock Exchange Index (NYA) One year pre Regulation FD; Two 221-day Interim periods between Regulation FD and Sarbanes-Oxley; and one year post the Sarbanes-Oxley Act. This graph depicts the estimated shifts in the disclosure threshold by examining the stochastic dominance behavior of the cumulative risk neutralized terminal distributions estimated 1-year prior to Regulation FD (T-1), 221 days after Regulation FD (which includes the shift to decimalization but is just prior to September 11), (T), 221 days immediately after September 11 up to Sarbanes-Oxley (T+1), and 1-year after the Sarbanes-Oxley Act (T+2). The observed dominance relationships are: $T-1 > T > T+1 = T+2$ where “<” denotes stochastic dominance of the second degree. That is, below the single crossing point the graphs from left to right are $T+2$, $T-1$, $T$, $T-1$. The Chi-Square statistics, testing the null hypothesis for no shift in the distribution (from $T-1$ to $T$; $T$ to $T+1$, $T+1$ to $T+2$) are 5795.434 ($T$ vrs $T-1$), 10982.44 ($T+1$ vrs $T$), 97.69161 ($T+2$ vrs $T+1$).
Figure 4: Cumulative Risk Neutralized Return Distribution for the NASDAQ Stock Market Index One year pre Regulation FD; Two 221-day Interim periods between Regulation FD and Sarbanes-Oxley; and one year post the Sarbanes-Oxley Act. This graph depicts the estimated shifts in the disclosure threshold by examining the stochastic dominance behavior of the cumulative risk neutralized terminal distributions estimated 1-year prior to Regulation FD (T-1), 221 days after Regulation FD (which includes the shift to decimalization but is just prior to September 11), (T), 221 days immediately after September 11 up to Sarbanes-Oxley (T+1), and 1-year after the Sarbanes-Oxley Act (T+2). The observed dominance relationships are: T-1 > T < T+1 < T+2 where “<” denotes stochastic dominance of the second degree. That is, below the single crossing point the graphs from left to right are T, T-1, T+1, T+2. The Chi-Square statistics, testing the null hypothesis for no shift in the distribution (from T-1 to T; T to T+1, T+1 to T+2) are 17208.13855 (T vrs T-1), 20720.17384 (T+1 vrs T), 5199.126 (T+2 vrs T+1).
Figure 5: Cumulative Risk Neutralized Return Distribution for the NASDAQ 100 Stock Market Index One year pre Regulation FD; Two 221-day Interim periods between Regulation FD and Sarbanes-Oxley; and one year post the Sarbanes-Oxley Act. This graph depicts the estimated shifts in the disclosure threshold by examining the stochastic dominance behavior of the cumulative risk neutralized terminal distributions estimated 1-year prior to Regulation FD (T-1), 221 days after Regulation FD (which includes the shift to decimalization but is just prior to September 11), (T), 221 days immediately after September 11 up to Sarbanes-Oxley (T+1), and 1-year after the Sarbanes-Oxley Act (T+2). The observed dominance relationships are: T-1 > T < T+1 < T+2 where “<” denotes stochastic dominance of the second degree. That is, below the single crossing point the graphs from left to right are T, T-1, T+1, T+2. The Chi-Square statistics, testing the null hypothesis for no shift in the distribution (from T-1 to T; T to T+1, T+1 to T+2) are 26275.6247 (T vrs T-1), 18268.19 (T+1 vrs T), 8781.248 (T+2 vrs T+1).
Figure 6: Cumulative Risk Neutralized Return Distribution for the American Stock Exchange Index (XAX) One year pre Regulation FD; Two 221-day Interim periods between Regulation FD and Sarbanes-Oxley; and one year post the Sarbanes-Oxley. This graph depicts the estimated shifts in the disclosure threshold by examining the stochastic dominance behavior of the cumulative risk neutralized terminal distributions estimated 1-year prior to Regulation FD (T-1), 221 days after Regulation FD (which includes the shift to decimalization but is just prior to September 11), (T), 221 days immediately after September 11 up to Sarbanes-Oxley (T+1), and 1-year after the Sarbanes-Oxley Act (T+2). The observed dominance relationships are: T-1 < T < T+1 < T+2 where “<” denotes stochastic dominance of the second degree. That is, below the single crossing point the graphs from left to right are T-1, T, T+1, T+2. The Chi-Square statistics, testing the null hypothesis for no shift in the distribution (from T-1 to T; T to T+1, T+1 to T+2) are 1568.097 (T vrs T-1), 8032.79 (T+1 vrs T), 180.1181 (T+2 vrs T+1).
Figure 7: From the estimated risk neutralized terminal payoff distribution the volatility of returns is plotted by the critical event dates surrounding Regulation FD and Sarbanes-Oxley each of the major Exchanges/Markets. For comparison purposes with Figure 2 the Dow Jones Industrial Index is added even though this largely consists of NYSE stocks but also includes two NASDAQ listed stocks.

Return volatility is estimated from: $\text{Var}(S_T) = [E(S_T)]^2 [\exp(\sigma^2 T) - 1]$
Appendix A: Estimated Risk Neutralized Terminal Value Distribution for the
Dow Jones Industrial Index One year pre The Securities Act 1933 (T-1); Interim
between 1933/1934 Acts (T); and one year post the Securities Exchange Act 1934
(T+1). The end of period risk neutralized distribution in levels, estimated from
the observed path of daily price changes under the assumption they are arbitrage
free. The null hypothesis tested using the Chi-Square statistic is that this distri-
bution is lognormal.

<table>
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<th>Lognormal Estimate</th>
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<th>Mean</th>
<th>Std Dev</th>
<th>Chi Square</th>
<th>Probability</th>
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Appendix B: Return Distribution Estimates and Tests of the Shift in the Risk Neutralized Return Distributions From 1-Year Prior to Federal Securities Act, 1933 to the Interim Period between the 1933 and 1934 Acts (T-1 to T), and Interim Period to 1-Year After the Securities Exchange Act, 1934 (T to T+1). From the estimated risk neutralized terminal payoff distribution the volatility of returns is estimated for the Dow Jones Industrial Index by critical 1930's event dates (T-1 = 1-year prior to the passing of the 1933 Securities Act, T = the interim time between the 1933 and 1934 Acts and T+1 = 1-year after the 1934 Act). It is estimated from: $Var(S_T)=[E(S_T)]^2[exp(\sigma^2 T)-1]$. The Chi-Square statistics are constructed from the test of the null hypothesis for no shift in the distribution either side of a critical event date.

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<td>T+1</td>
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Appendix C: Estimated Risk Neutralized Terminal Value Distribution for the
Major Exchange/Market Indexes One year pre Regulation FD (T-1); Two 221-day
Interim periods between Regulation FD and Sarbanes-Oxley (T, T+1); and
one year post the Sarbanes-Oxley Act (T+2). The end of period risk neutralized
distribution in levels, estimated from the observed path of daily price changes
under the assumption they are arbitrage free. The null hypothesis tested using
the Chi-Square statistic is that this distribution is lognormal.

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Appendix D: Estimated Risk Neutralized Terminal Value Distribution for the Major Stock Market Indexes Ordered by Firm Size One year pre Regulation FD (T-1); Two 221-day Interim periods between Regulation FD and Sarbanes-Oxley (T, T+1); and one year post the Sarbanes-Oxley Act (T+2). The end of period risk neutralized distribution in levels, estimated from the observed path of daily price changes under the assumption they are arbitrage free. The null hypothesis tested using the Chi-Square statistic is that this distribution is lognormal.

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<td>0.8542</td>
</tr>
<tr>
<td>T</td>
<td>449.559</td>
<td>111.286</td>
<td>141.188</td>
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</tr>
<tr>
<td>T+1</td>
<td>400.938</td>
<td>87.78208</td>
<td>152.5426</td>
<td>0.2392</td>
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<tr>
<td>T+2</td>
<td>496.702</td>
<td>117.307</td>
<td>132.8898</td>
<td>0.6746</td>
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Appendix E: Return Distribution Estimates for Exchanges/Markets and Tests of the Shift in the Risk Neutralized Return Distributions From 1-Year Prior to Regulation FD, 221-Trading Days Post Regulation FD (T-1 to T), 221-Trading Days Post Regulation FD to 221-Days Prior to Sarbanes-Oxley (T to T+1), 221-Days Prior to Sarbanes-Oxley to 1-Year Post Sarbanes-Oxley (T+1 to T+2). From the estimated risk neutralized terminal payoff distribution the volatility of returns is estimated for the Exchanges/Markets by critical event dates. Volatility is estimated from: \( \text{Var}(S_T) = [E(S_T)]^2 \cdot \exp(\sigma^2 T) - 1 \). The Chi-Square statistics are constructed from the test of the null hypothesis for no shift in the distribution either side of a critical event date.

<table>
<thead>
<tr>
<th>Annualized Volatility of Returns</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NYSE/ NYA</strong></td>
<td></td>
</tr>
<tr>
<td>T-1</td>
<td>0.1651</td>
</tr>
<tr>
<td>T</td>
<td>0.1745</td>
</tr>
<tr>
<td>T+1</td>
<td>0.2133</td>
</tr>
<tr>
<td>T+2</td>
<td>0.2181</td>
</tr>
<tr>
<td><strong>NASDAQ Index</strong></td>
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</tr>
<tr>
<td>T-1</td>
<td>0.4244</td>
</tr>
<tr>
<td>T</td>
<td>0.5406</td>
</tr>
<tr>
<td>T+1</td>
<td>0.3585</td>
</tr>
<tr>
<td>T+2</td>
<td>0.2976</td>
</tr>
<tr>
<td><strong>NASDAQ 100</strong></td>
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</tr>
<tr>
<td>T-1</td>
<td>0.5008</td>
</tr>
<tr>
<td>T</td>
<td>0.6674</td>
</tr>
<tr>
<td>T+1</td>
<td>0.4555</td>
</tr>
<tr>
<td>T+2</td>
<td>0.3547</td>
</tr>
<tr>
<td><strong>AMEX XAX</strong></td>
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</tr>
<tr>
<td>T-1</td>
<td>0.1652</td>
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<tr>
<td></td>
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<tr>
<td>-----</td>
<td>-------</td>
</tr>
<tr>
<td>T</td>
<td>0.150</td>
</tr>
<tr>
<td>T+1</td>
<td>0.1182</td>
</tr>
<tr>
<td>T+2</td>
<td>0.1146</td>
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Appendix F: Return Distribution Estimates Ordered by Firm Size and Tests of the Shift in the Risk Neutralized Return Distributions From 1-Year Prior to Regulation FD, 221-Trading Days Post Regulation FD (T-1 to T), 221-Trading Days Post Regulation FD to 221-Days Prior to Sarbanes-Oxley (T to T+1), 221-Days Prior to Sarbanes-Oxley to 1-Year Post Sarbanes-Oxley (T+1 to T+2). From the estimated risk neutralized terminal payoff distribution the volatility of returns is estimated for the Exchanges/Markets by critical event dates. Volatility is estimated from: 

\[ \text{Var}(S_T) = \left[ E(S_T) \right]^2 \text{exp}\left( \sigma^2 T \right) - 1 \]

The Chi-Square statistics are constructed from the test of the null hypothesis for no shift in the distribution either side of a critical event date.

<table>
<thead>
<tr>
<th>Exchanges/Markets</th>
<th>Annualized Volatility of Returns</th>
<th>Chi Square</th>
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</thead>
<tbody>
<tr>
<td><strong>DJIA</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T-1</td>
<td>0.1961</td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>0.2064</td>
<td>T versus T-1: 547.6090</td>
</tr>
<tr>
<td>T+1</td>
<td>0.2377</td>
<td>T+1 versus T: 4888.9333</td>
</tr>
<tr>
<td>T+2</td>
<td>0.2467</td>
<td>T+2 versus T+1: 286.2901</td>
</tr>
<tr>
<td><strong>S&amp;P100</strong></td>
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</tr>
<tr>
<td>T-1</td>
<td>0.2190</td>
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</tr>
<tr>
<td>T</td>
<td>0.2636</td>
<td>T versus T-1: 9125.1145</td>
</tr>
<tr>
<td>T+1</td>
<td>0.2496</td>
<td>T+1 versus T: 528.0506</td>
</tr>
<tr>
<td>T+2</td>
<td>0.2551</td>
<td>T+2 versus T+1: 294.8863</td>
</tr>
<tr>
<td><strong>S&amp;P500</strong></td>
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<tr>
<td>T-1</td>
<td>0.2065</td>
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<tr>
<td>T</td>
<td>0.2329</td>
<td>T versus T-1: 3404.0537</td>
</tr>
<tr>
<td>T+1</td>
<td>0.2342</td>
<td>T+1 versus T: 6.3094</td>
</tr>
<tr>
<td>T+2</td>
<td>0.2484</td>
<td>T+2 versus T+1: 732.4843</td>
</tr>
<tr>
<td><strong>Russell 1000</strong></td>
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<tr>
<td>T-1</td>
<td>0.2132</td>
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<tr>
<td></td>
<td>Value</td>
<td>Comparison</td>
</tr>
<tr>
<td>-------</td>
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</tr>
<tr>
<td>T</td>
<td>0.2396</td>
<td>T versus T-1: 3204.9781</td>
</tr>
<tr>
<td>T+1</td>
<td>0.2399</td>
<td>T+1 versus T: 0.3072</td>
</tr>
<tr>
<td>T+2</td>
<td>0.2501</td>
<td>T+2 versus T+1: 357.1576</td>
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<tr>
<td>Russell 2000</td>
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<td></td>
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<tr>
<td>T-1</td>
<td>0.2614</td>
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</tr>
<tr>
<td>T</td>
<td>0.2599</td>
<td>T versus T-1: 6.4734</td>
</tr>
<tr>
<td>T+1</td>
<td>0.2306</td>
<td>T+1 versus T: 2866.8383</td>
</tr>
<tr>
<td>T+2</td>
<td>0.2349</td>
<td>T+2 versus T+1: 66.2324</td>
</tr>
</tbody>
</table>